

SMART HELMET

Enrol. No - 19102162, 19102164, 19102133

Name of Student - Aditi Deb, Priyanjali Chaudhary, Mugdha
Khandelwal

Name of supervisor - Dr. Amit Kumar Goyal



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Bachelor of Technology

DEPARTMENT OF ELECTRONICS AND COMMUNICATION
ENGINEERING JAYPEE INSTITUTE OF INFORMATION
TECHNOLOGY, NOIDA

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CERTIFICATE

This is to certify that the work titled “**SMART HELMET**” submitted by Mugdha Khandelwal, Aditi Deb, Priyanjali Chaudhary in partial fulfilment for the award of degree of B.Tech, of Jaypee Institute of Information Technology, Noida has been carried out under my supervision. This work has not been submitted partially or wholly to any other University or Institute for the award of this or any other degree or diploma.

Signature of Supervisor

Name of Supervisor Dr. Amit Kumar Goyal

Designation Assistant Professor

Date 5th December 2021

ACKNOWLEDGEMENT

It gives me a great sense of pleasure to present the report of the Project Work undertaken during B. Tech. Pre Final Year. I owe special debt of gratitude to my Project Coordinator Dr. Amit Kumar Goyal, , Department of Electronics and Communication Engineering Jaypee Institute of Information Technology, Noida for his constant support and guidance throughout the course of my work. It is only his cognizant efforts that my endeavours have seen light of the day.



Signature of the student

Name of Student Aditi Deb, Priyanjali Chaudhary, Mugdha Khandelwal

Date 5th December 2021

SUMMARY

In this Project we are making a Smart Helmet which will communicate between devices and for this we needed two Bluetooth modules to connect with each other. For the PCB design we are using the Easyeda software tool because of the availability of all the parts in the library. To code the circuit, here we are using Arduino 1.8.13. We started with the 5V lithium battery and a lithium charger. A condenser mic has been used to catch the voice which will give electric pulse signal to LM358 IC pre amplifier. LM358 IC will provide a good amplitude microcontroller acceptable electric pulse. After this we are using ATMEGA 8 for processor processing. This has 8K bytes in system Programmable flash memory and this is a 8 bit IC. To transmit audio signal, we are using the NRF24 Wi-Fi module. Its range is 1.5km and it will require 3.3V voltage supply and for this we have AMS1117 as a volt regulator IC. PAM8403DR IC is being used to produce Loud speakers because ATMEL 8 does not produce loud speakers. Also, this IC is consuming low current. Here we are ready with our Smart helmet and can communicate with our distant friends and workers,



Signature of the student

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Date 5th December 2021

Signature of Supervisor

Name of Supervisor Dr. Amit Kumar Goyal

Date 5th December 2021

INTRODUCTION



Figure 1 – A Pictorial representation of Smart Helmet

“Smart helmet” is a device to make communication easier for travellers than before. This is based on Radio technology. Through this, the communication between multiple groups within a range of distance would be easier. It would help in locating the current location of the people through connections established with the help of smart helmets.

Problem Statement - A group of six people has planned a road trip to Leh and Ladakh. They are excited about the trip but also nervous about the difficulties and problems during the road trip. They are going on this trip for the first time, but Rohan, one of their friends, had done this road trip before. He explained the road map to all of them before the trip but he too had this in his mind, if the connection got lost, how would he guide his friends? The device is useful for communication between the fellow travellers but to also run voice commands for directions and weather updates.

Alternative use – We know how hazardous working at a construction site is, to reduce this we suggest the use of a smart helmet that not just ensures security but also ensures proper communication between all co-workers.

FLOWCHART AND WORKING

Working of the helmet can be divided into 5 major parts as specified below.

SMART HELMET

```
graph TD; A[SMART HELMET] --> B[Power Input - we have used 3.7 V lithium battery with a boost converter of 5 V and a lithium charger to recharge the device]; B --> C[Voice input - Microphone - mic will give a weak signal that is then sent to pre-amplifier LM358]; C --> D[Processing of signal - microprocessor ATMEGA8 ( 8 bit IC with 8 Kb flash memory)]; D --> E[Transmission of audio signal - NRF24 WiFi module ( It has range of 1.5 km and works on 3.3 Volt supply thus AMC1117 regulator IC is used)]; E --> F[Voice output - PAM8403 Audio IC ( 2 watt class D IC )];
```

Power Input - we have used 3.7 V lithium battery with a boost converter of 5 V and a lithium charger to recharge the device

Voice input -

Microphone - mic will give a weak signal that is then sent to pre-amplifier LM358

Processing of signal - microprocessor ATMEGA8
(8 bit IC with 8 Kb flash memory)

Transmission of audio signal -

NRF24 WiFi module (It has range of 1.5 km and works on 3.3 Volt supply thus AMC1117 regulator IC is used

Voice output -

PAM8403 Audio IC (2 watt class D IC)

SOFTWARE USED

- Easy EDA for schematic and PCB Design
- Arduino IDE 1.8.16 for coding of ATMEGA328P-PU

PARTS USED WITH DETAILED DESCRIPTION

Export Schematic BOM								
ID	Name	Designator	Footprint	Qu...	Manufacturer Part	Manufactu...	Supplier	Supplier Part
1	1k	1K,100K,3...	R0603	10				Assign LCSC Part#
2	22pF	1NF,2NF	CASE-A_3216	2				Assign LCSC Part#
3	100uF	,2UF	CAP-TH_BD7...	1	B43456K5568M000	✓ TDK	LCSC	C165786 Assign LCSC Part#
4	22pF	,,,100NF,1...	C0603	6				Assign LCSC Part#
5	4.7uF	C1	CAP-TH_BD7...	1	B43456K5568M000	✓ TDK	LCSC	C165786 Assign LCSC Part#
6	100UF	C6	CASE-A_3216	1				Assign LCSC Part#
7	1u	C8	CASE-A_3216	1				Assign LCSC Part#
8	1N4007W	D1	SOD-123_L2...	1	1N4007W	BLUE RO...	LCSC	C328592 Assign LCSC Part#
9	D-G06030...	LED1	LED0603-RD	1	D-G060306G1-KS2	✓ Wuxi ARK ...	LCSC	C118334 Assign LCSC Part#
10	WIRELES...	M1	WIRELESS-N...	1				Assign LCSC Part#
11	Header-Fe...	P1,P3,SP	HDR-TH_2P-P...	3	2.54-1*2PFemale	✓ BOOMELE	LCSC	C49661 Assign LCSC Part#
12	T_BUTTO...	S2	12X12 4PIN P...	1				Assign LCSC Part#
13	LM358NG...	U2	DIP-8_L10.1-...	1	LM358NG	✓ ON	LCSC	C7552 Assign LCSC Part#
14	ATMEGA3...	U3	DIP-28_L34.6-...	1	ATMEGA328P-PU	✓ MICROCHIP	LCSC	C33901 Assign LCSC Part#
15	AMS1117...	U5	SOT-223-4_L6...	1	AMS1117-2.5	✓ AMS	LCSC	C12087 Assign LCSC Part#
Export BOM Order Parts/Check Stock Cancel								
14	ATMEGA3...	U3	DIP-28_L34.6-...	1	ATMEGA328P-PU	✓ MICROCHIP	LCSC	C33901 Assign LCSC Part#
15	AMS1117...	U5	SOT-223-4_L6...	1	AMS1117-2.5	✓ AMS	LCSC	C12087 Assign LCSC Part#
16	PAM8403DR	U6	SOIC-16_L9.9...	1	PAM8403DR	✓ DIODES	LCSC	C17337 Assign LCSC Part#
17	16MHZ	X1	OSC-49S-1	1	X49SD16MSD2SC	YXC	LCSC	C16212 Assign LCSC Part#
Export BOM Order Parts/Check Stock Cancel								

Figure 2 – Different parts and their description

1. WIRELESS-NRF24L01

NRF24L01 is basically a wireless transceiver, which is used to send and receive data by using radio waves. It is a single chip transceiver module. It uses SPI protocol for transmitting data. Its data transmission speed is up to 2Mbps.

With this modified RF24 module someone could go through four walls with a distance of about 100 feet. This module should also nearly double the distance over a standard nRF24 module when used with line of sight applications; like RF planes, quad-coppers, cars and boats (100s of meters).

nRF24L01 is a single chip radio transceiver for the world wide 2.4 - 2.5 GHz ISM band. The transceiver consists of a fully integrated frequency synthesizer, a power amplifier, a crystal oscillator, a demodulator, modulator and Enhanced ShockBurst™ protocol engine.

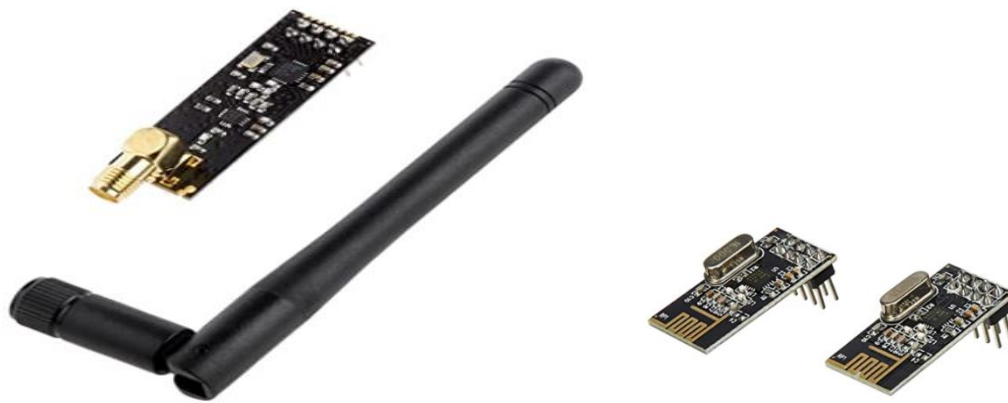


Figure 3 - WIRELESS-NRF24L01

Description: this wireless transceiver module is an easy and suitable module if you want to setup your wireless communication system it can achieve a good balance between wireless transition performance you can easily add it with your own mcu/arm/pic/avr/stm32 system. This nrf24l01+ module is designed with power amplifier and sma antenna this allowed you to use the wireless communication up to 1000 meters! (no barrier).

Specification: frequency: 2.4ghz~2.5ghz.

Operating voltage: 3 ~ 3.6v max. Current: 115ma.

Multi-frequency: 125 frequency. Support up to six channels of data reception.

Package includes: 1 x nrf24l01+pa+lna wireless transceiver module & 1 x sma antenna

2 pieces NRF24L01 modules 2.4ghz RF wireless transceiver module. The NRF24L01 is a highly integrated, ultra-low power (ULP) 2mbps RF transceiver IC for the **2.4Ghz ISM (industrial, scientific, and medical) band**. With peak RX/TX currents lower than 14mA, a sub μ A power-down mode, advanced power management, and a 1.9 to 3.6V supply range, the nrf24l01 provides a true ULP solution enabling months to years of battery life when running on coin cells or AA/AAA batteries. These RF modules are very popular among the Arduino tinkerers. The nrf24l01 is used on a wide variety of applications that require wireless control. They are transceivers which means that each module can transmit and receive data. Nrf24l01 2.4ghz rf wireless transceiver module can be used with arduino, mbed, arm or any other mcu.

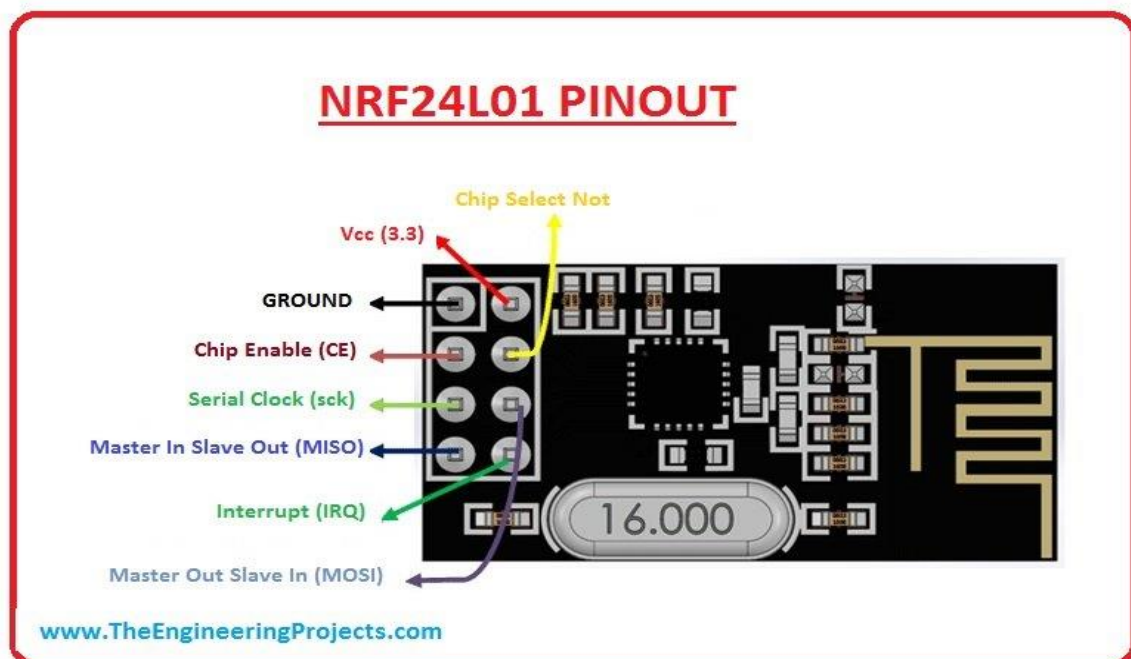


Figure 4 - NRF24L01 PINOUT

2. ATmega8

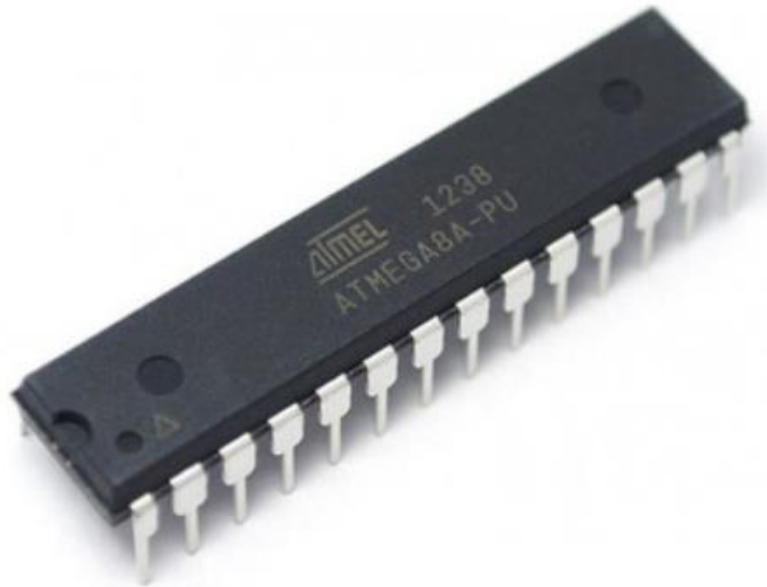


Figure 5 – ATMEGA 8

Features

- High-performance, Low-power Atmel® AVR® 8-bit Microcontroller
- Advanced RISC Architecture
 - 130 Powerful Instructions – Most Single-clock Cycle Execution
 - 32×8 General Purpose Working Registers
 - Fully Static Operation
 - Up to 16MIPS Throughput at 16MHz
 - On-chip 2-cycle Multiplier
- High Endurance Non-volatile Memory segments
 - 8Kbytes of In-System Self-programmable Flash program memory
 - 512Bytes EEPROM
 - 1Kbyte Internal SRAM
 - Write/Erase Cycles: 10,000 Flash/100,000 EEPROM
 - Data retention: 20 years at 85°C/100 years at 25°C
 - Optional Boot Code Section with Independent Lock Bits In-System Programming by On-chip Boot

Program

True Read-While-Write Operation

- Programming Lock for Software Security

- **Peripheral Features**

- Two 8-bit Timer/Counters with Separate Prescaler, one Compare Mode

- One 16-bit Timer/Counter with Separate Prescaler, Compare Mode, and Capture Mode

- Real Time Counter with Separate Oscillator

- Three PWM Channels

- 8-channel ADC in TQFP and QFN/MLF package
Eight Channels 10-bit Accuracy

- 6-channel ADC in PDIP package
Six Channels 10-bit Accuracy

- Byte-oriented Two-wire Serial Interface

- Programmable Serial USART

- Master/Slave SPI Serial Interface

- Programmable Watchdog Timer with Separate On-chip Oscillator

- On-chip Analog Comparator

- **Special Microcontroller Features**

- Power-on Reset and Programmable Brown-out Detection

- Internal Calibrated RC Oscillator

- External and Internal Interrupt Sources

- Five Sleep Modes: Idle, ADC Noise Reduction, Power-save, Power-down, and Standby

- **I/O and Packages**

- 23 Programmable I/O Lines

- 28-lead PDIP, 32-lead TQFP, and 32-pad QFN/MLF

- **Operating Voltages**

- 2.7V - 5.5V (ATmega8L)

- 4.5V - 5.5V (ATmega8)

- **Speed Grades**

- 0 - 8MHz (ATmega8L)

- 0 - 16MHz (ATmega8)

- **Power Consumption at 4Mhz, 3V, 25°C**

- Active: 3.6mA
- Idle Mode: 1.0mA
- Power-down Mode: 0.5 μ A

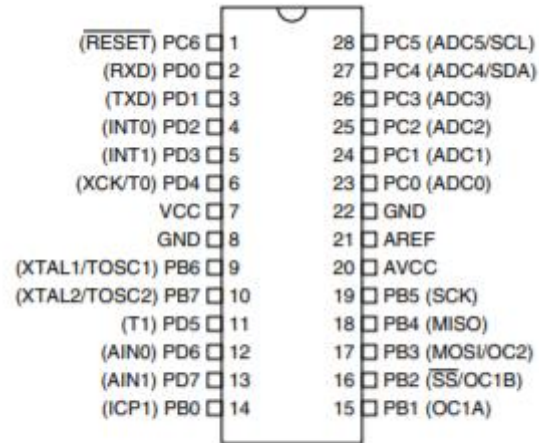


Figure 6- ATMEGA8 -PU Description

3. LM358 OP-Amp (Dual Operational Amplifier)

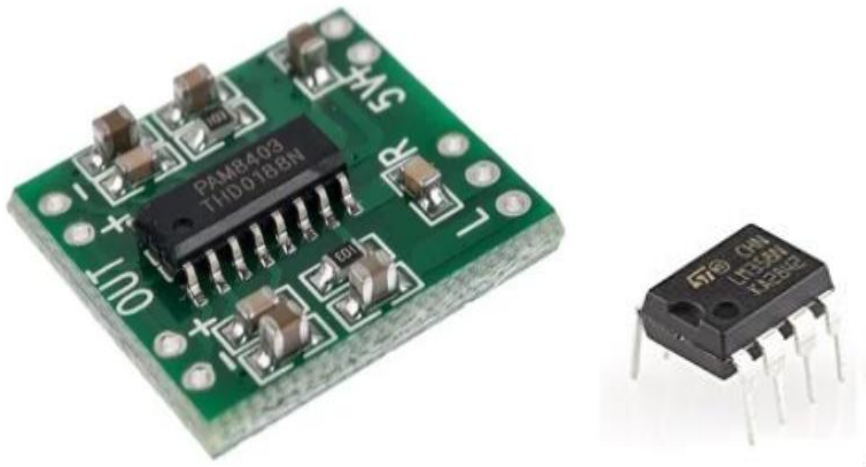


Figure 7 - LM358 OP-Amp

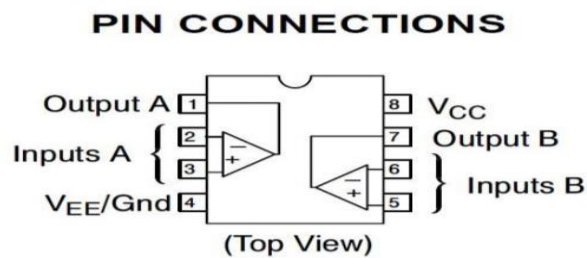


Figure 8 – Pin connections

What does a LM358 op-amp do?

The LM358 is a great, easy-to-use dual-channel opamp. LM358 applications include **transducer amplifiers, DC gain blocks and all the conventional opamp circuits**. If you're looking for a good, standard opamp the LM358 should fill most of your needs. It can handle a supply of 3-32VDC and source up to 20mA per channel.

- Large DC voltage gain: 100 dB
- Wide bandwidth (unity gain): 1.1 MHz (temperature compensated)

- Very low supply current per channel essentially independent of supply voltage
- Low input bias current: 20 nA (temperature compensated)

PAM8403 Super Mini Digital Amplifier Board Digital, 2.5v to 5v,

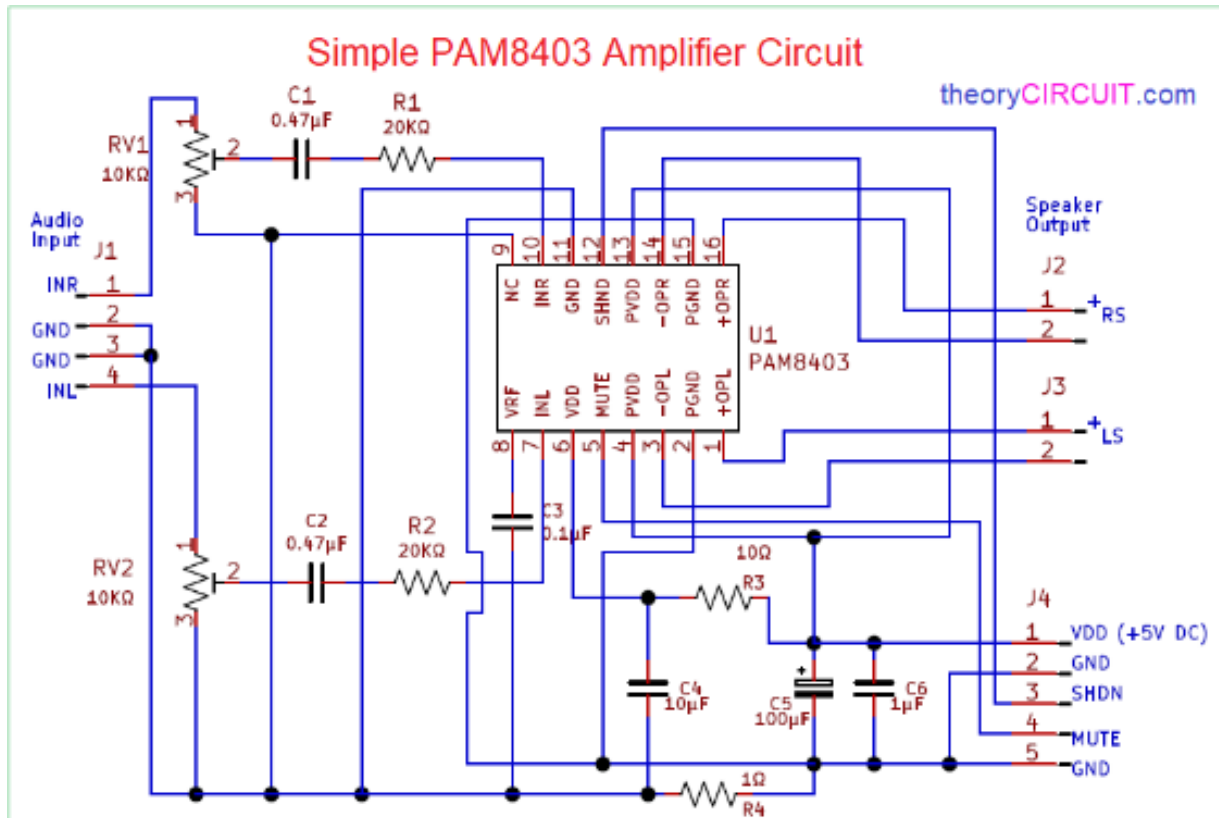


Figure 9 - PAM8403 Super Mini Digital Amplifier Board Digital

- 2 x 3w d class
- Efficient 2.5 - 5v
- Ultrafine size: 1.85 x 2.11 cm
- Rated working voltage 2.5 - 5v, limit operating voltage 5.5v

4. 1N4007

1N4007 is a rectifier diode, designed specifically for **circuits that need to convert alternating current to direct current**. It can pass currents of up to 1 A, and have peak inverse voltage (PIV) rating of 1,000 V. **0.6V** is a forward drop voltage of 1N4007.

Like all diodes, 1N4007 also requires a reverse recovery time to recover during switching from forward to reverse biased mode. During reverse recovery, diode produces a high reverse current which produces heat. The higher is a frequency of input signal, the higher time diode takes to recover its state. 1N4007 is a low-frequency diode due to high recovery time. Therefore, you should use it for low frequency applications only.

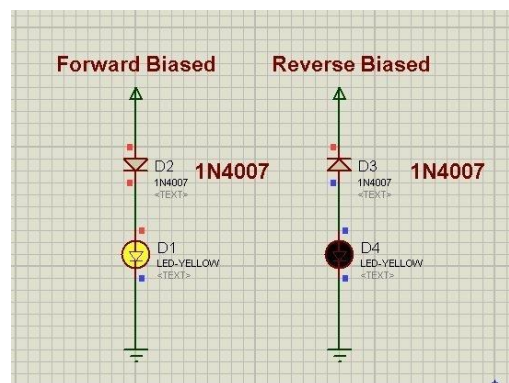


Figure 10 - 1N4007

1N4007 Features and Specifications

- Peak Reverse Voltage: 1000 Volts
- Average Forward Current: 1A
- Non-Repetitive Peak Forward Current: 30A
- Operating Junction Temperature : -55°C – 175°C
- Power Dissipation : 3 Watts
- Forward Voltage: 1.1 Volts
- Reverse Current: 5 μ A
- Package Type: DO-41

Some of the other features are mentioned below:

1. Low forward voltage drop
2. High current carrying capability
3. Almost negligible reverse current

4. Very high reverse peak voltage

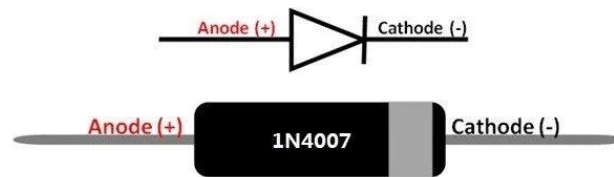


Figure 11 – 1N4007 (Anode and Cathode)

Applications

- Rectifiers
- Freewheeling diode applications
- Embedded systems for switching
- Power supplies
- Protection Circuits

5. AMS1117-2.5

The AMS1117 is a **popular SMD package 3-pin voltage regulator**. The AMS1117 series of adjustable and fixed voltage regulators are designed to provide up to 1A output current and to operate down to 1V input-to-output differential. The dropout voltage of the device is guaranteed maximum 1.3V, decreasing at lower load currents. On-chip trimming adjusts the reference voltage to 1.5%. AMS1117-2.5 is a cost effective, low dropout (LDO) Voltage Regulator designed to provide current up to 1 amp. The maximum input voltage it can support is 15V.

It offers thermal shut down function, to assure the stability of chip and power system. And it uses trimming technique to guarantee output voltage accuracy within 2%. Other output voltage accuracy can be customized on demand, such as 1%.

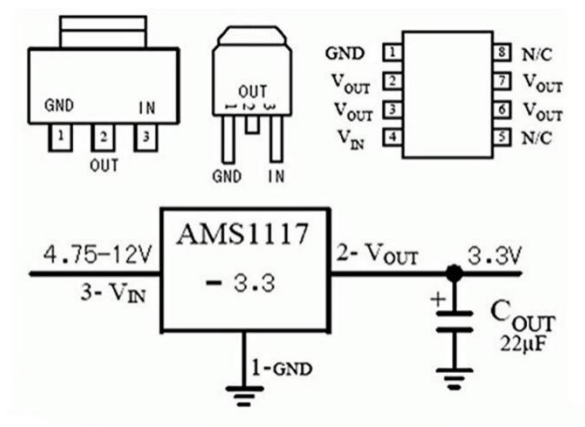


Figure 12- AMS1117-2.5

6. 16Mhz Crystal Oscillator



Figure 13- Crystal Oscillator

The 16MHz crystal oscillator is specially designed to use with single chip microcomputer. The crystal oscillator measures approx. 0.6 inch long, 0.1 inch wide and 0.4 inch high. Specification: Model No.: HC-49S Frequency: 16MHz Load Capacitance: 20pF Frequency Tolerance: $\pm 20\%$ Total Size: Approx. 0.6 x 0.1 x 0.4 inch Pin Length: Approx. 0.5 inch Pitch of Pins: 0.2 inch Package: DIP Package Includes: 10 x Crystal Oscillator

6. 16.00 MHz Crystal Oscillator with 22pf Capacitor

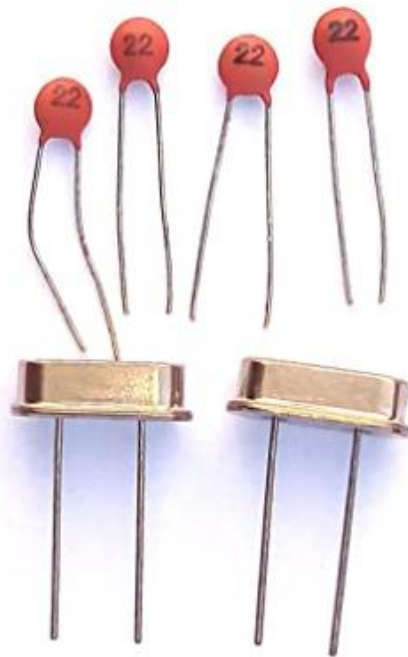


Figure 14 - Crystal Oscillator with 22pf Capacitor

7. Capacitor 100uf 50v Aluminium Electrolytic

Aluminum Electrolytic Capacitors Radial Standard. FEATURES Polarized aluminum electrolytic capacitors, non-solid electrolyte Radial leads, cylindrical aluminum case, insulated with a Green sleeve Charge and discharge proof HC Series for user Electronics Market.



Figure 15 - Capacitor 100uf 50v Aluminium Electrolytic

8. 10k Ohm Carbon Film Resistors, 0.25-Watt, Tolerance 5%, 100 Piece

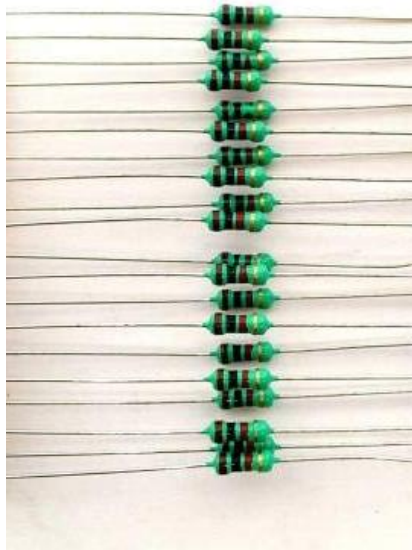


Figure 16 - 10k Ohm Carbon Film Resistors

Electrobot 10k ohm carbon film resistors, 0.25 watt, tolerance 5%, 100 piece - brand name: electrobot
item type: 100 pcs 10k ohm carbon film resistors .25 watt tolerance 5% package content: 1 electrobot
100 pcs 10k ohm carbon film resistors .25 watt tolerance 5%

9. 104 PF Ceramic Capacitor Disc

A ceramic capacitor is a fixed value capacitor in which ceramic material acts as the dielectric. It is constructed of two or more alternating layers of ceramic and a metal layer acting as the electrodes. Features of 100000 pf ceramic capacitor: Multilayer- monolithic ceramic capacitor. Capacitance 100000pf. Voltage-rated 50v. Tolerance 10 percent. T.C z5u. Body diameter 4mm. Lead spacing 5.08mm. Applications of 100000 pf ceramic capacitor: Diy projects. Electrical/electronic projects. Crystal oscillator capacitors. General electronic circuits. Note : Images shown is only for representation. The actual product may vary with the picture shown. Item package quantity: 100.



Figure 17- 104 pf ceramic capacitor disc

10. CIRCUIT SYSTEMS M613 Mini 2 Pin 53-54 DB 6mm*5mm

Electret Microphone Spy Pickup Condenser

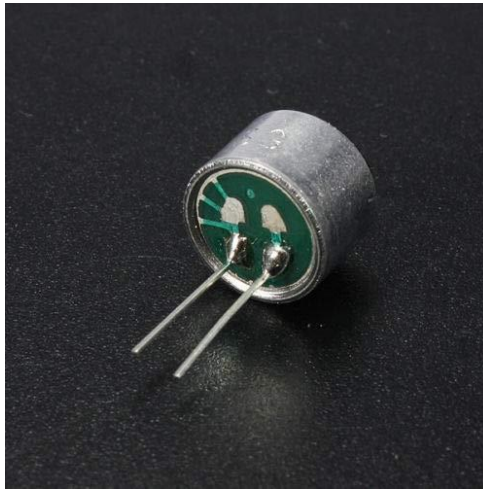


Figure 18 - Electret Microphone Spy Pickup Condenser

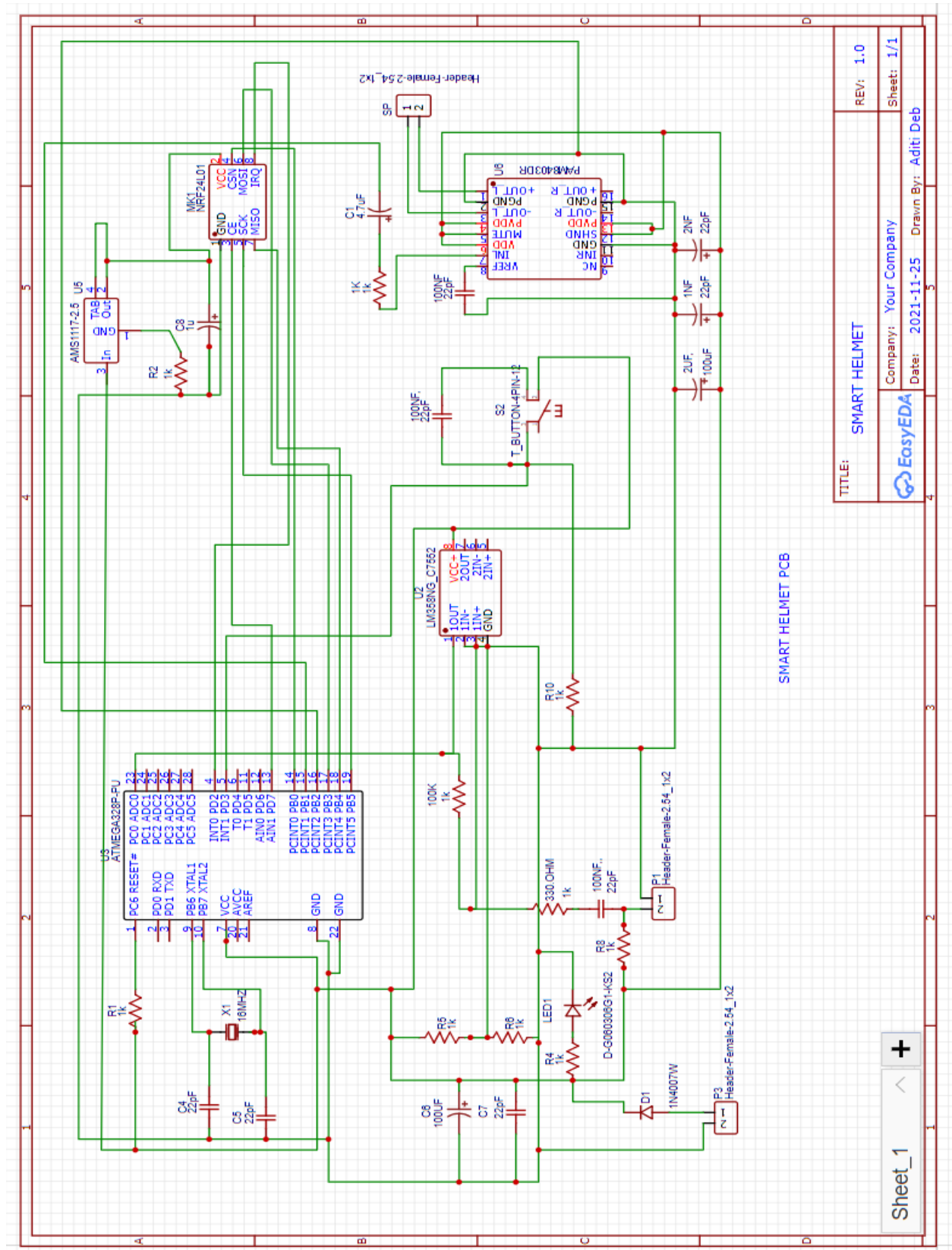
- Mini electret microphone
- Size: 9.7*6.7mm
- Weight: About 10g
- 3.7 V Lithium battery

11. Wire



Figure 19 - PLA Filament 1 kg 1.75 MM 3D Printer Roll

SCHEMATIC



SMART HELMET PCB

TITLE: SMART HELMET	REV: 1.0
Company: Your Company	Sheet: 1/1
Date: 2021-11-25	Drawn By: Aditi Deb

Sheet_1

Figure 20 - Schematic

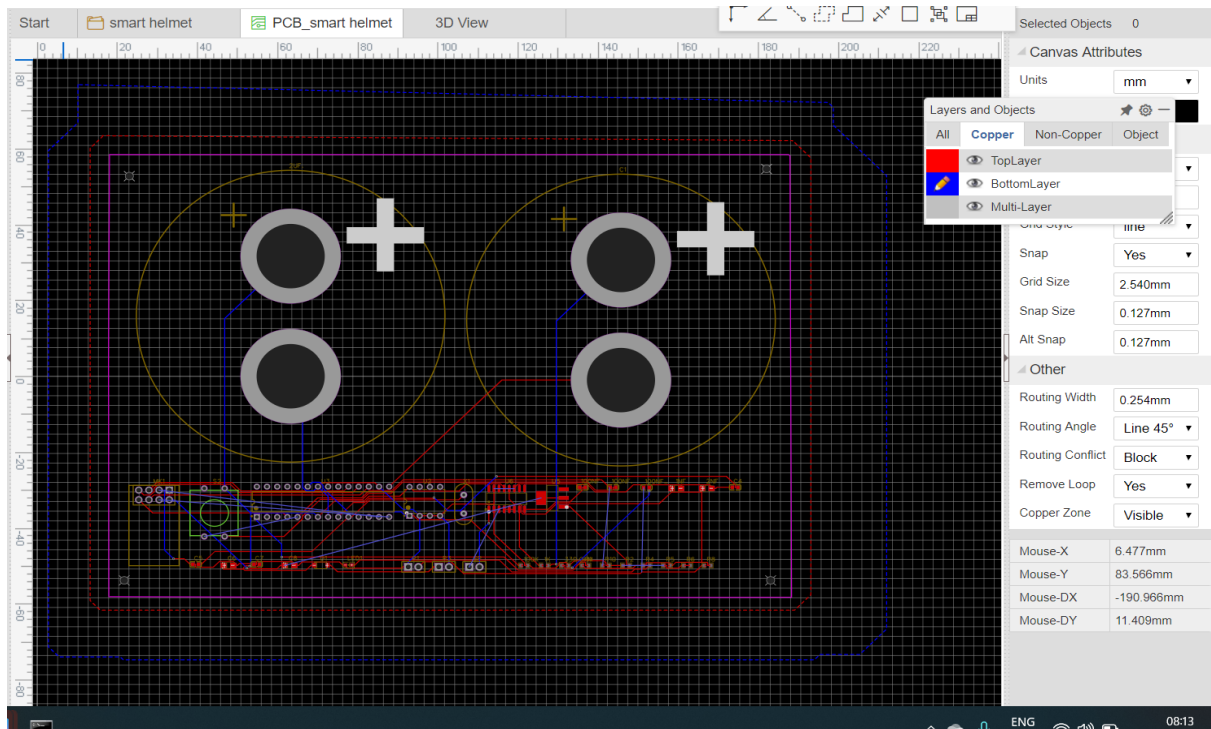


Figure 21 – PCB

3D MODEL

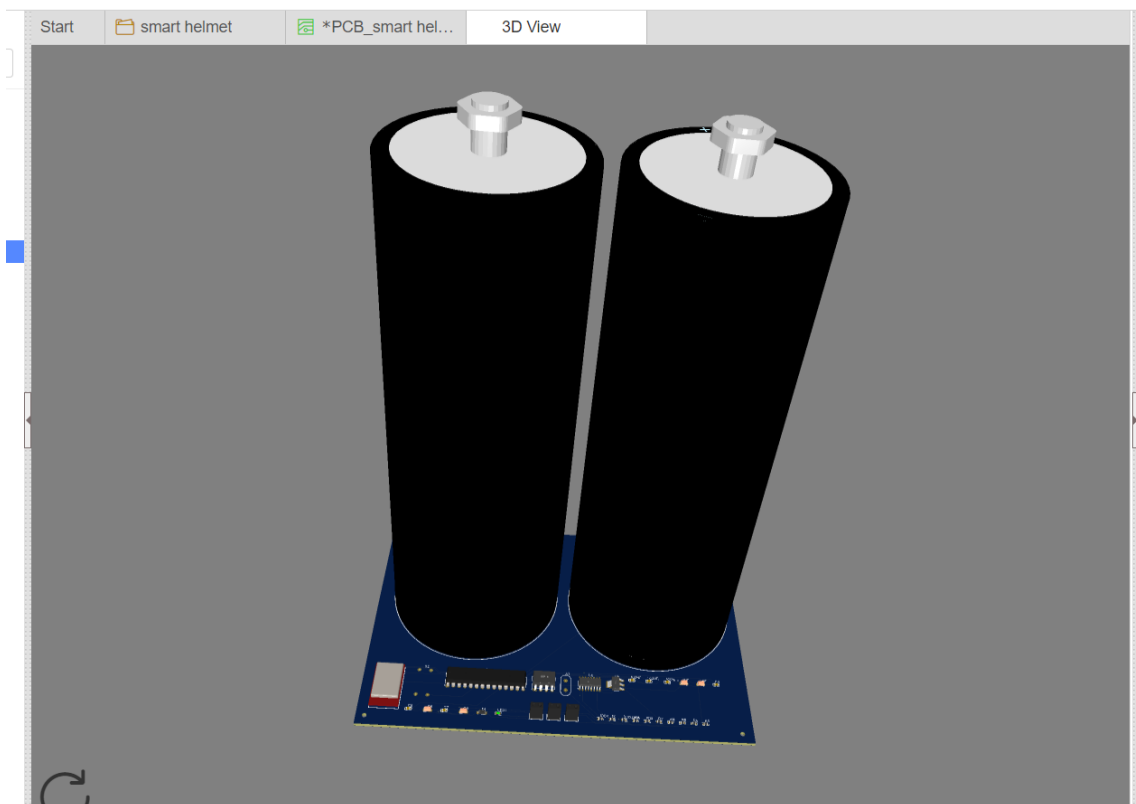


Figure 22 - 3D MODEL (1)

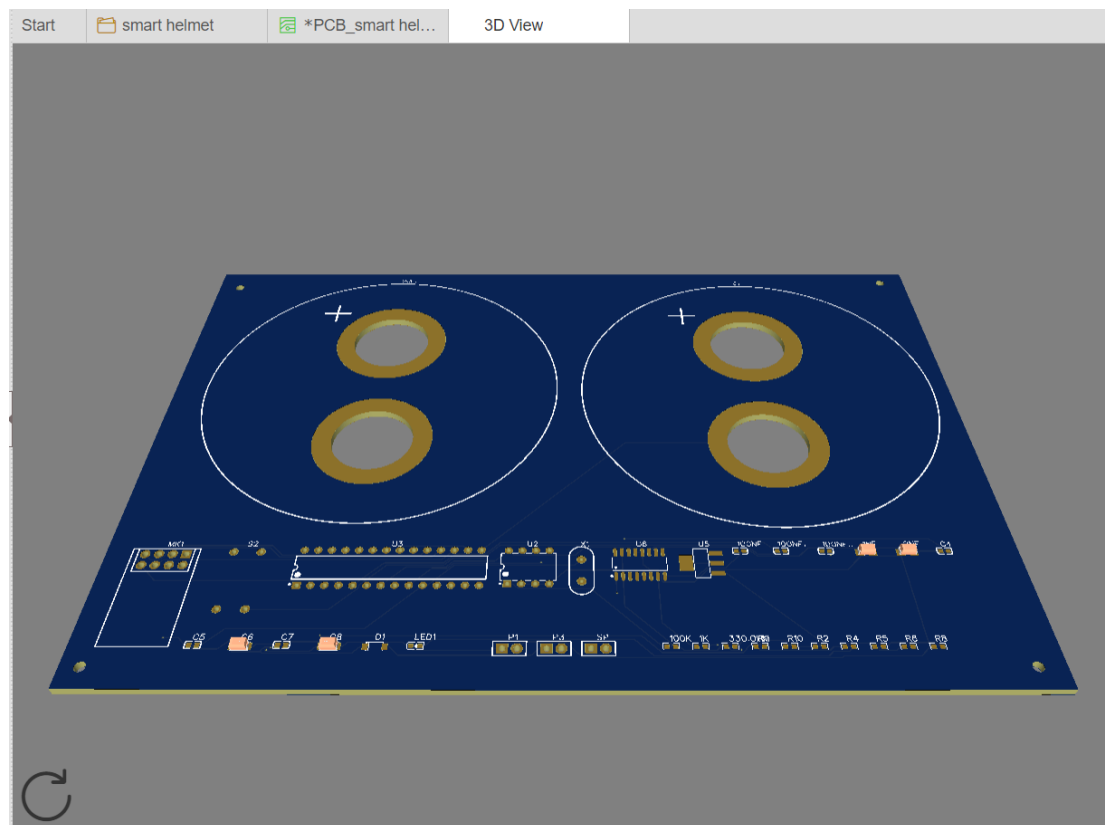


Figure 23 - 3D MODEL (2)

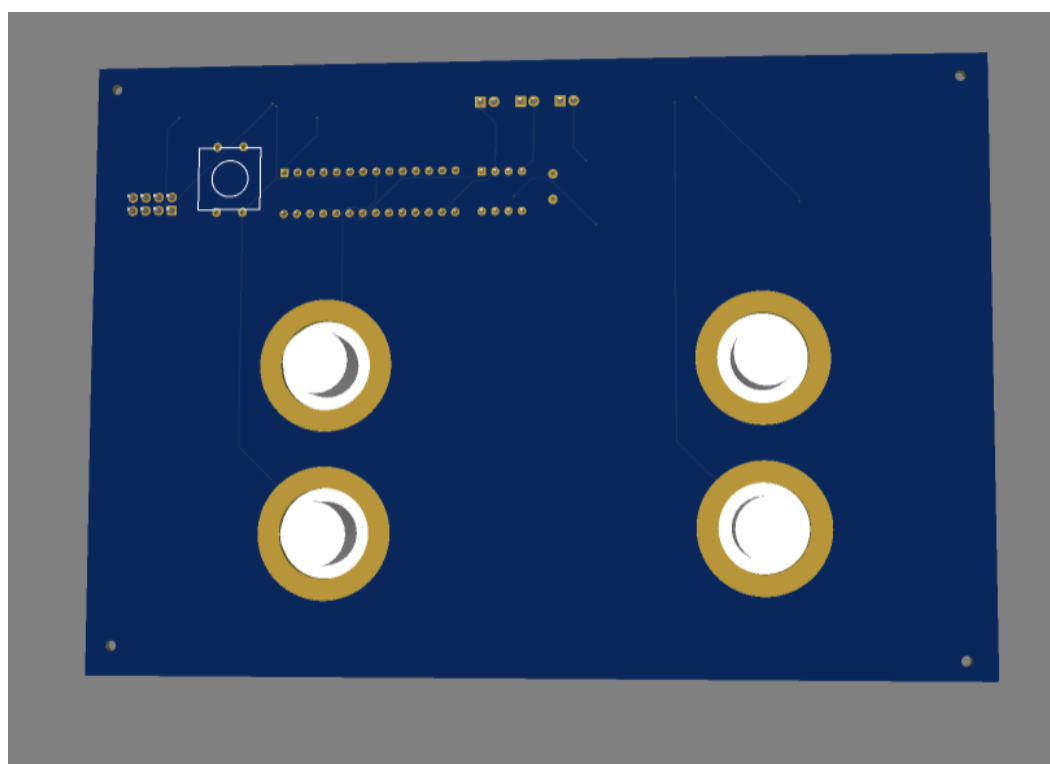
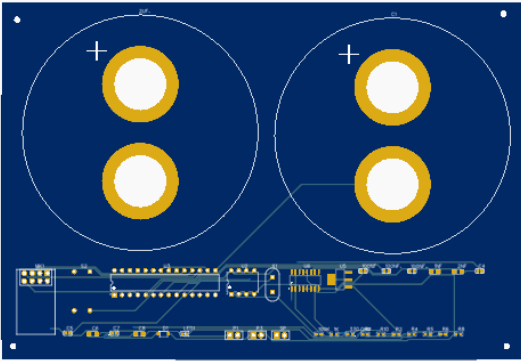


Figure 24 - 3D MODEL (2)

Generate PCB Fabrication File(Gerber)



Layers: 2

Dimensions(Estimated): 170.43mm x 116.97mm

PCB Qty: 5

PCB Thickness: 1.6

PCB Color: White

Surface Finish: HASL(with lead)

Copper Weight: 1oz

Manufacturer: JLCPCB

PCB Price: **\$12.3**

Estimated Delivery Time: 3-7 days

PCB+SMT \$10 Off

Get Coupon >>

Gerber View

Generate Gerber

Order PCB/SMT at JLCPCB

Figure 25 – PCB Fabrication

CODE :

```
#include<RF24.h>

#include<SPI.h>

#include<RF24Audio.h>

#include "printf.h"

RF24 radio(7,8);

RF24Audio rfAudio(radio, 0);

int talkButton = 3;

void setup(){

Serial.begin(115200);

printf_begin();

radio.begin();

radio.printDetails();

rfAudio.begin();

pinMode(talkButton, INPUT);

attachInterrupt(digitalPinToInterrupt(talkButton), talk, CHANGE);

rfAudio.receive();

}

void talk()

{

if(digitalRead(talkButton)) rfAudio.transmit();
```

```

else rfAudio.receive();

}

void loop()

{
}

```

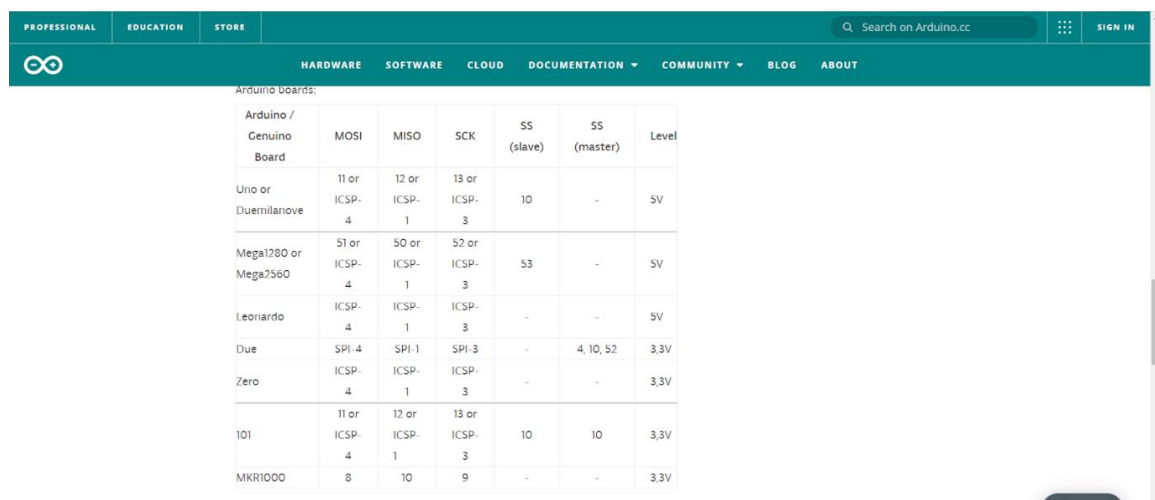
LIBRARIES:

RF24.h → It is the library for communication. Radio driver, OSI layer 2 library for nrf24L01(+) modules. It is the core library for nRF24L01(+) communication.

1. nRF24L01(+) → It is a 2.4GHz RF wireless Transceiver Module. It's cost to performance ratio is pocket friendly. It consists of a fully integrated frequency synthesizer, a power amplifier, a crystal oscillator, a demodulator and a modulator.

It is use to send and receive data by using radio waves and the transmission speed is 2Mbps.

SPI.h → Serial Peripheral Interface (SPI) is a synchronous serial data protocol used by microcontrollers for communicating with one or more peripheral devices quickly over short distances.



The screenshot shows the Arduino.cc website with a table titled "Arduino Boards:" listing various boards and their SPI pin configurations. The table has columns for the board name, MOSI, MISO, SCK, SS (slave), SS (master), and Level.

Arduino / Genuino Board	MOSI	MISO	SCK	SS (slave)	SS (master)	Level
Uno or Duemilanove	11 or ICSP- 4	12 or ICSP- 1	13 or ICSP- 3	10	-	5V
Mega1280 or Mega2560	51 or ICSP- 4	50 or ICSP- 1	52 or ICSP- 3	53	-	5V
Leonardo	ICSP- 4	ICSP- 1	ICSP- 3	-	-	5V
Due	SPI-4	SPI-1	SPI-3	-	4, 10, 52	3.3V
Zero	ICSP- 4	ICSP- 1	ICSP- 3	-	-	3.3V
101	11 or ICSP- 4	12 or ICSP- 1	13 or ICSP- 3	10	10	3.3V
MKR1000	8	10	9	-	-	3.3V

Figure 26 – SPI Library Description

RF24Audio.h → It is a Real Time audio streaming library. It has the following features:

1. Recording and broadcasting of audio to multiple devices using Arduino, RF24 modules and input/output (speaker/microphone) devices.
2. Volume and Remote control
3. Create additional node groups.



```
sketch_dec04a | Arduino 1.8.13
File Edit Sketch Tools Help

sketch_dec04a

#include<RF24.h>
#include<SPI.h>
#include<RF24Audio.h>
#include "printf.h"

RF24 radio(7,8);
RF24Audio rfAudio(radio, 0);

int talkButton = 3;

void setup(){
  Serial.begin(115200);

  printf_begin();
  radio.begin();
  radio.printDetails();
  rfAudio.begin();

  pinMode(talkButton, INPUT);

  attachInterrupt(digitalPinToInterrupt(talkButton), talk, CHANGE);

  rfAudio.receive();
}

void talk()
{
  if(digitalRead(talkButton)) rfAudio.transmit();
  else rfAudio.receive();
}

void loop()
{
}
```

Figure 27 - Code

FEATURES of SMART HELMET Developed

1. Power Supply - 5 V Lithium battery and Lithium Charger.
2. How to catch voice? A condenser mic will give electric pulse signal and this goes to LM358 IC pre amplifier. LM358 IC will provide a good amplitude microcontroller acceptable electric pulse.
3. Processor Processing - Here we using Atmel 8. This has 8K bytes in system Programmable flash memory and a 8 bit IC.
4. RF Audio master library.
5. Transmit audio signal - To transmit audio signal we using nrf24 WiFi module. Range is 1.5km and it will require 3.3V and for this voltage we have AMS1117 as a volt regulator IC.
6. Produce Loud speaker - PAM8403DR IC because ATMEGA 8 does not produce loud speaker. This IC also consuming low current.

FUTURE DIRECTION

Once a communication is developed we can now add features to helmet like :-

- We can add maps, weather and voice commands
- We can add EECT sensors to capture brain waves of the rider and tell him exactly when they are losing focus on the road
- We can even play white noise in his ears to make sure he is in flow state.

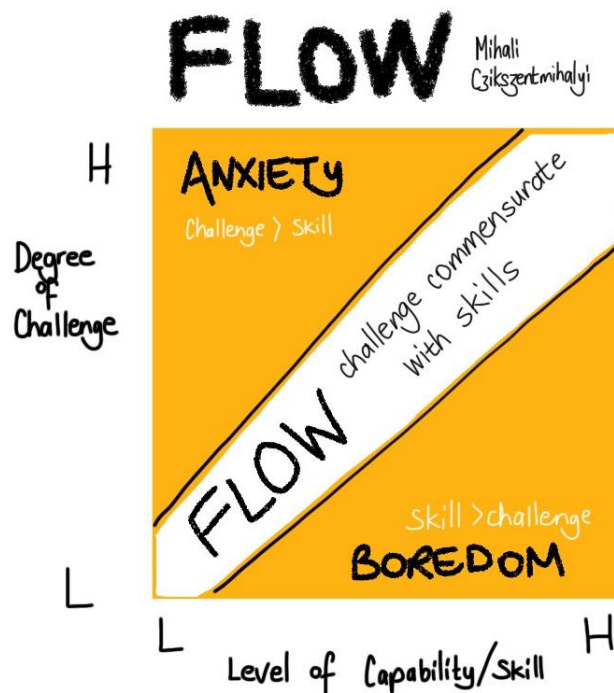


Figure 30 – Future direction

- Safety helmet
 - In case of accident the sensors in the helmet use the mobile to send emergency contacts.
 - The placement of sensors are such that there is maximum probability of it getting damaged on case of head injury.
 - This will ensure that the rider's family is informed in case of any issue.

CONCLUSION

On conclusion of this project of Smart Helmet where the communication between two people via a Helmet is possible. We have used several components in making the PCB design for the Smart Helmet such as AMS1117-2.5 , NRF24LO1 ADAPTER SOCKET , ATMEGA328P-PU , Header-Female-2.54_1x2 , LM358NG_C7552 , 1N4007W diode etc which will take the audio speech and then will convert into electric pulse signal to our respective pre amplifier. Then, the processor would process the signal and transmit this signal using Wi-Fi Module. The final range we have achieved is 1.5km till which communication is possible.

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