

**VELLORE INSTITUTE OF TECHNOLOGY**

**VELLORE, TAMIL NADU**

**DEPARTMENT OF ELECTRONICS & COMMUNICATION**



**VIT<sup>®</sup>**

**Vellore Institute of Technology**

(Deemed to be University under section 3 of UGC Act, 1956)

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**HARMAN INTERNATIONAL,PUNE**



**DURATION OF INTERNSHIP:-**

**SUBMITTED TO**

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**SUBMITTED BY**

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18BEC2014**

## **PREFACE**

The objective of an industrial internship is to learn something about industries and to be familiar with a working style of a technical worker to adjust simply according to industrial environment. As a part of academic syllabus of four year degree course in ECE, every student is required to undergo an industrial training for a duration of 30 days or 120 hours. I am a IIIrd year ECE student and this report is written on the basis of knowledge gained by me during the period of Industrial Internship taken at Harman International Pune Plant.

This report deals with my observations within the industry, my learning outcome and the process involved in making of car audio systems. This report also includes a mini-project which I worked on during internship.

## **ACKNOWLEDGEMENT**

I am grateful to **Mr. Sanjeev Kulkarni Senior Director , Ms. Kshitija More Human Resource Manager** at **Harman International** for providing me an opportunity to work as a intern in Harman International Plant,Pune. I am thankful to my mentor **Mr. Chandradhar Shukla** and all other technical staff of manufacturing department for giving me valuable practical guidance and their keen interest in my training on manufacturing processes.

I am very grateful to **Dr. Prakasam P.** (HOD of ECE Department) at VIT, Vellore for giving me an opportunity to undergo internship at Harman International Pune. I would like to thank all the faculty members of VIT for giving me knowledge in the field of electronics which has helped me indefinitely during the course of this internship.

**RAHUL AWARI**

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## **ABOUT HARMAN**



HARMAN designs and engineers connected products and solutions for automakers, consumers, and enterprises worldwide, including connected car systems, audio and visual products, enterprise automation solutions; and services supporting the Internet of Things.

More than 50 million automobiles on the road today are equipped with HARMAN audio and connected car systems. With leading brands including AKG, Harman Kardon, Infinity, JBL, Lexicon, Mark Levinson and Revel, HARMAN is admired by audiophiles, musicians and the entertainment venues where they perform around the world.

Harman software services power billions of mobile devices and systems that are connected, integrated and secure across all platforms, from work and home to car and mobile. HARMAN has a workforce of approximately 30,000 people across the Americas, Europe, and Asia.

In March 2017, HARMAN became a wholly-owned subsidiary of Samsung Electronics

## **BUSINESS UNITS**

Harman specializes in connected cars,Lifestyle audio,Professional solutions and connected services.

### **CONNECTED CARS**

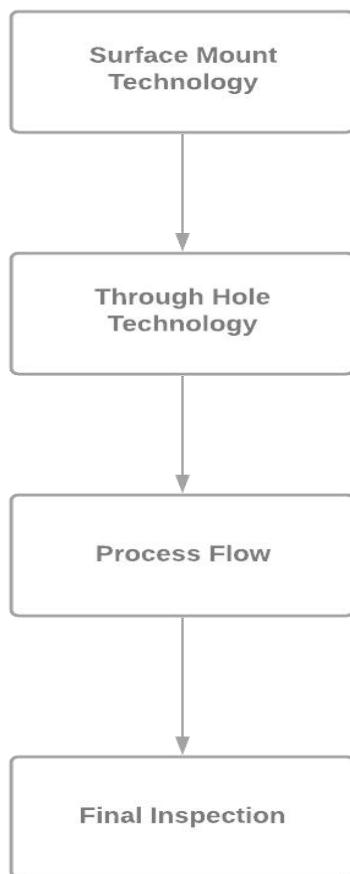
- Harman has a dynamic portfolio of innovative connected car solutions for automakers.
- Harman manufacturing involves both the hardware component production and highly-integrated digital cockpits,ADAS,cybersecurity and telematics control unit.
- Harman International plant in Pune specializes in production of car audio systems and telematics control units.During the course of my internship I gained knowledge on how car audio systems are produced from scratch, right from Printed Circuit Board to fully functional audio system with features such as GPS navigation,Bluetooth etc.
- Harman International main supplies most of its car audio systems to TATA Motors, Maruti Suzuki,Fiat and Volkswagen.It also manufactures audio systems for mercedes Benz unit which is part of telematics unit discuss later.
- Most of the audio systems used in India are manufactured by harman and harman also exports car audio systems outside India.
- The Pune harman manufacturing plant comprises of 5 assembly lines equipped with machinery and skilled operators.
- My learning during this internship was mostly on assembly,programming and manufacturing of car audio systems.
- The manufacturing plant also manufactures microphones used in cars and a single unit is present where manufacturing and testing takes place.

### **OTHER UNITS**

- Harman also manufactures Bluetooth speakers,voice activated speakers,Headphones, Loudspeakers,Soundbars.
- Some of the companies owned by are AKG,JBL,Martin,Lexicon,Infinity etc.

## PRODUCTION

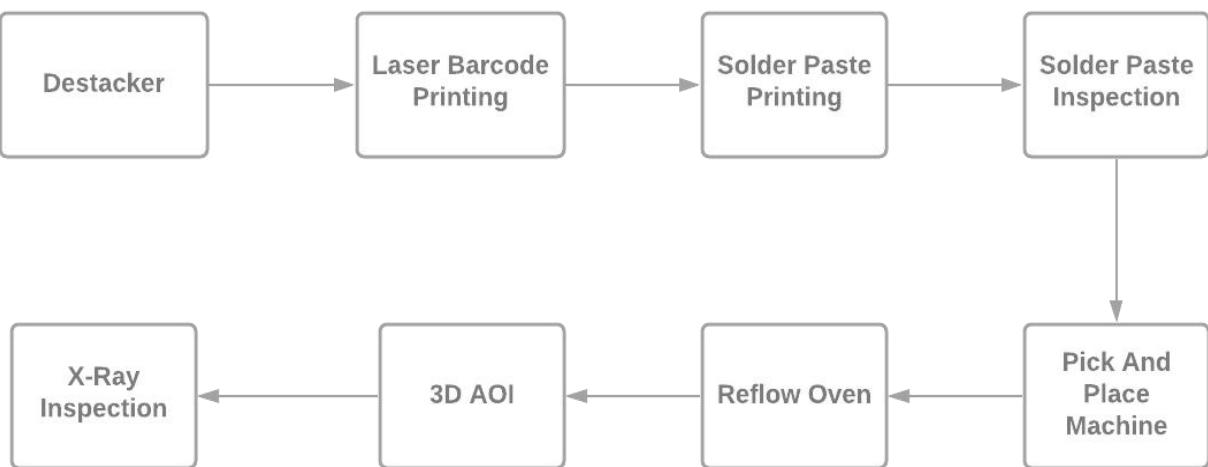
**Production of car audio system In factory can be categorized into four parts**



### **SURFACE MOUNT TECHNOLOGY**

- Surface mount technology is the first step involved in the process. Surface Mount Technology is mainly used for insertion and soldering of smaller components onto the PCB boards. The Industry has 5 SMT lines for TATA, Maruti Suzuki and Mercedes.
- The major steps of SMT include tin paste printing, components mounting and reflow soldering.
- It is suitable for the soldering of all types of SMDs.

## Major Process Involved in Surface Mount Technology



## DESTACKER

- This Process Involves automated feeding of the Printed circuits boards to the conveyor belt and is the first step of this process.
- Loading of PCB,Inspection of PCB's and preparation of process is done here.Inspection of PCB includes testing for scratch ,green mask and other defects on PCB surface.



Destacker

## LASER BARCODE PRINTING

- 2D barcode is etched onto the printed circuits boards after they are passed from destacker to laser etching machine.
- This process is automated and fully controlled by machine ,there is no human intervention

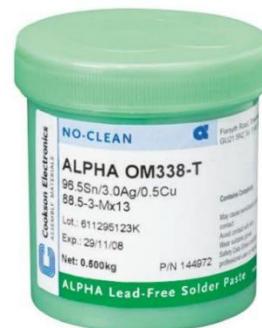
- The main purpose of this machine is to keep track of the PCB. As each car audio systems have different feature this barcode guides the machines further in the process to design and product as per the requirement of the car brand.



MPM Momentum

## SOLDER PASTE PRINTING

- This process involves a automatic paste dispensing machine. It consists of auto stencil where a brush wipes the stencils at regular frequency.
- Wiper rolls over the stencils resulting in deposition of the solder paste.
- With the implementation of RoHS (Restriction of Hazardous Substances) in the Electronics Industry by the European Union and Many other countries, most electronic companies are shifting to Lead Free. Lead Free Solder Wire and Solder Paste are manufactured using different composition and ratio. But the most popular and widely used composition and ratio is SAC (*Tin Silver Copper*) in the Ratio 96.5% Tin + 3.0% Silver and 0.5% Copper.



Solder paste

## **SOLDER PASTE INSPECTION**

- This process is followed soon after solder paste printing. This process involves 3D inspection of the board for paste deposition.
- This process makes use of 3D camera's which produce clear 3D images. Unlike the traditional cameras, 3D cameras are capable of capturing the height of the solder paste printed. The camera captures and checks for proper deposition on parameters such as height and volume. The monitor shows real time happening of this process.
- It is observed that most of the solder joint defects in a PCB assembly are because of improper solder paste printing. With the help of solder paste inspection (SPI) can reduce the defects related to soldering by a considerable amount.
- The monitor check for defects parameters such as position, bridging, Co-polarity, shape excessive, insufficient etc. The machine counts the occurrence of these defects during scanning and brought to the notice of operator who later rejects the board.



Solder paste inspection machine

## **PICK AND PLACE**

- This is the process in which components are placed over the board just before entering the soldering process. Only smaller components such as small IC, resistor are placed on the solder pasted board. The industry has 8 pick and place component lines.
- Before placing of the components component feeder is calibrated and checked for accuracy.
- The components that arrive are in the form of reel and are feed into the machine one by one

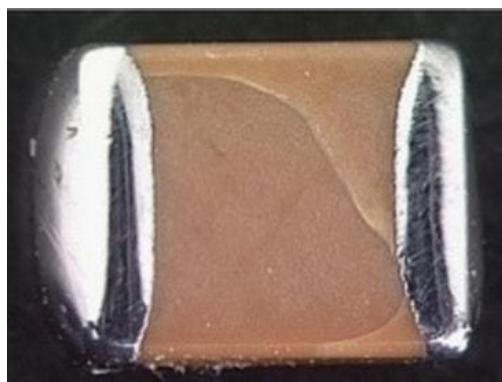
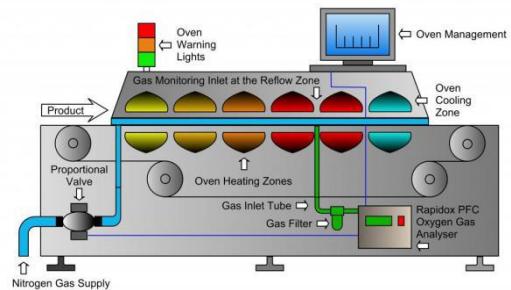
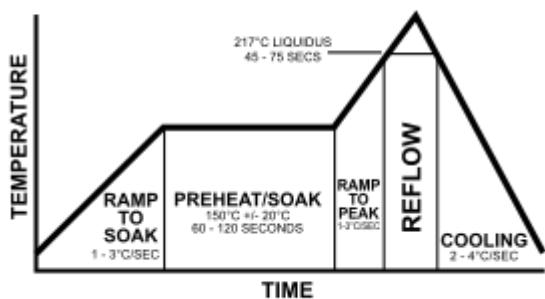
- In this process accurate positioning is of great importance because some components are very small, and also track widths are very narrow.
- The pick and place machines are pre-programmed with the information about component positions so that they know where to place the components. This programme is normally developed directly from the printed circuit board design information.



Pick and Place machine

## REFLOW OVEN

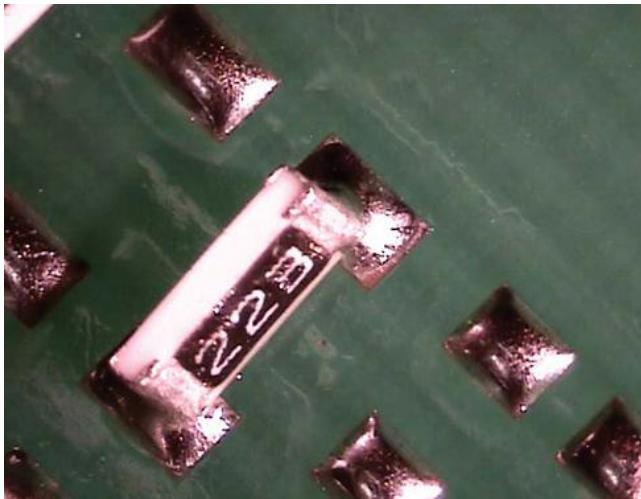
- This Is the process where components are soldered onto the board. This station comprises of 13 heating zones and 1 cooling zone. The temperature in the oven increases gradually from low to high . The maximum temperature was 290 and minimum was approximately 103.
- This process can be further categorized into 3 process Preheat,soak and reflow.
- During Preheat process the components, PCB and solder are all heated to a specified soak or dwell temperature being careful not to heat too quickly. Heating quickly can result in defects such as splashing of solder paste or cracking of components.
- The purpose of soak phase is to ensure all components are up to the required temperature before entering the reflow stage.
- Reflow is the main process.In this stage the temperature within the reflow oven is increased above the melting point of the solder paste causing it to form a liquid. This is followed for 30 to 60 seconds and the time shouldn't be exceeded to avoid formation of brittles.Nitrogen has it's continuous flow within the reflow oven for limited oxidation.
- Later the solder is cooled and inspection is done for defects.



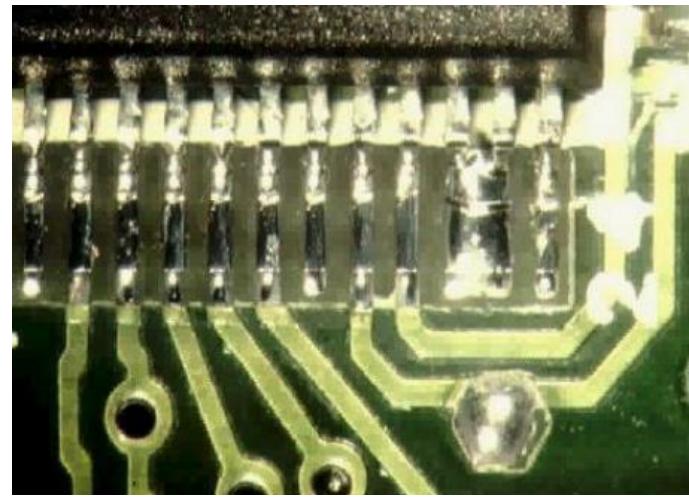
### Defects due to overheating in reflow oven

## 3D AOI INSPECTION

- This method is used for detecting soldering defects. This machine is equipped with 3D camera which is used by the operator for inspection of the soldered components. Prior to this process a machine similarly checks for defects and notifies the operator if any. The camera is capable of moving in all the three direction.
- The defects which can be detected in this inspection are insufficient soldering, component missing, component bill board, soldering component shift, component bridging etc.
- The PCB with defects are further discarded from further process.



Component billboard defect component stand on the side



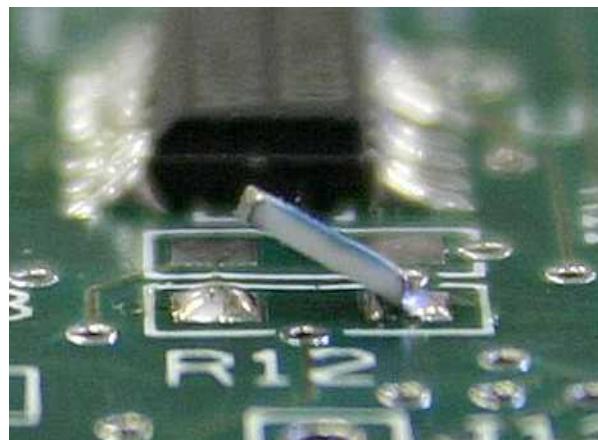
Component bridging

## X-Ray Inspection

- The board further goes through X-ray inspection where the defects that were missed out During 3D AOI process are detected.
- The defects that are detected by machine are tomb-stoned defect, internal soldering defect etc. In tombstone defect the component is lifted up from the board due to insufficient solder.
- The machine is equipped with 40x magnification camera.

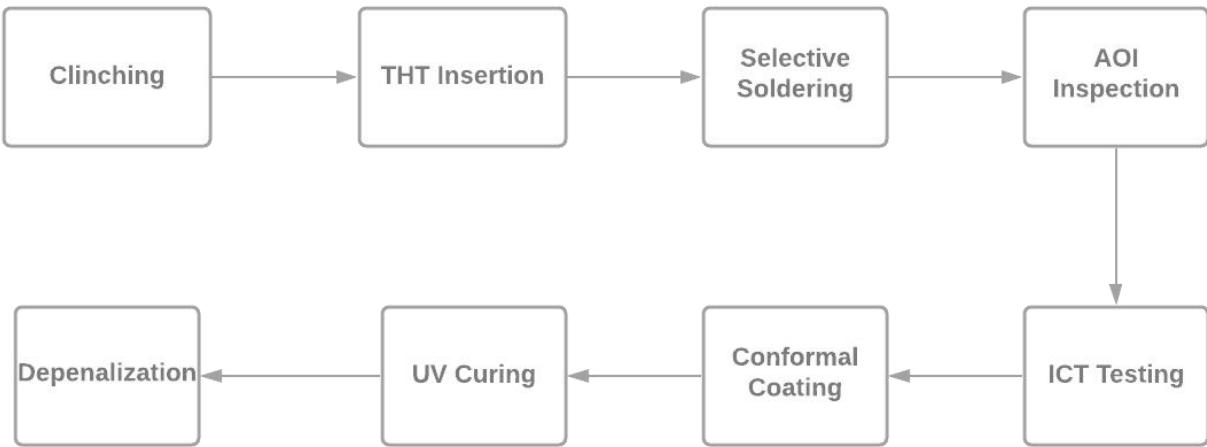


X-Ray Inspection



Tombstone defect

## THROUGH HOLE TECHNOLOGY



### CLINCHING

- Clinching is the process in which the components are placed into the fixture these components include capacitors etc. This process is done manually by the operator. The operator places the component onto the board superficial which further undergoes selective soldering.

### THT INSERTION

- This is another such process which is operated manually. This process involves manual insertion of larger components such as amplifier, Mic, AUX, Larger Capacitor etc. The operator is guided of placement of components onto the board by computer.

### SELECTIVE SOLDERING

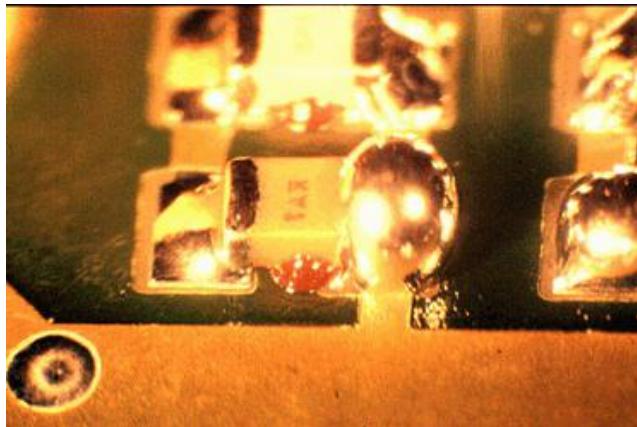
- Selective soldering is a variant of reflow soldering used mainly for soldering printed circuit boards that are assembled partly or even entirely with through-hole components. With Nordson SELECT selective soldering machines, nitrogen inerting is standard and the solder pot is designed with titanium material to resist the corrosive effects of aggressive lead-free solder alloys. The temperature is about 296 celsius
- Selective soldering can be further classified into three stages:
  - 1) Application of liquid flux to soldering area.
  - 2) Preheating of printed circuit board.
  - 3) Soldering with site specific solder nozzle.



Selective Soldering

### **3D AOI INSPECTION**

- Though most defects are identified after wave soldering some defects can also occur during selective soldering such as crack joints, bulbous joint etc. These defects are identified here.



Bulbous Joint



Crack Joint

### **IN-CIRCUIT TESTING**

- This is an important process in THT process. The ICT testing is responsible for checking the correct placement and value of the components soldered onto the board. The machine checks for the values of the components on board and matches it with the schematic as required by the vehicle.
- Another important function that happens here is flashing of program to micro-controllers and microprocessors. Basic programming is only carried out in this station.

- Some of the parameters that are checked here which I have observed are:-
  - 1)Discharging out capacitor values.
  - 2)Checking contact between UUT & Resistor
  - 3)Diodes ,Low value capacitors.
  - 4)JFET drain-source resistance

## **CONFORMAL COATING**

- This station has three sub parts.The larger amplifier and capacitor which are soldered at selective soldering station are further coated with liquid at this station to avoid damages such as rusting.
- It involves automated Coating through robotic nozzle on PCBA at amplifier IC Pins.



Conformal Coating

## **DE PENALIZATION**

- As PCB are to be passed through conveyor belt from the starting of the process they are always kept in square form but when they are to be fixed to silver box the shape changes as per requirement.At this process the PCB is routed and cut into desired shapes.
- Removal of ribs from PCBA through router ribs,routing process.

## **MAIN BOARD PROGRAMMING**

- The initial flashing of program into the microcontroller happens at ICT Testing process but if the circuit is complex and has to be made multi-functional then the board undergoes additional programming at main board programming station.

- The station makes use of alfamation test execution equipment for flashing of program onto the board. Along with flashing of program onto the board testing of other feature also happens such as serial communication protocol test etc.



Main Board Programming

## **ADVANTAGES OF SMT PROCESS**

Surface-mount technology (SMT) permits the creation of smaller PCB designs by allowing components to be placed closer together on the board. This means devices can be designed to be more lightweight and compact.

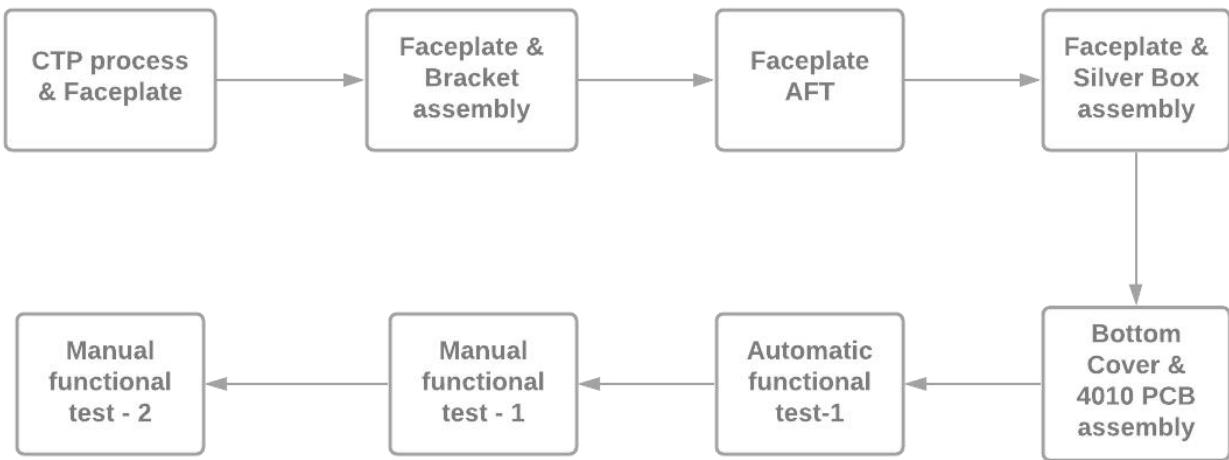
The SMT process is faster to set up for production than its counterpart, through-hole technology, because it does not require the circuit board to be drilled for assembly.

It assures lower resistance and induction at the connection, reducing the unwanted effects of RF signals and providing better and more predictable high-frequency performance.

## **ADVANTAGES OF THT PROCESS**

Efficient in adding larger components onto the PCB board. Through-hole soldering creates a stronger bond between components and the board, making it perfect for larger components that will undergo high power, high voltage, and mechanical stress, including transformers, connectors, semi-conductors etc.

## PROCESS FLOW



### CTP PRESS & FACE PLATE PCBA ASSEMBLY

- Vacuum based holding of parts to avoid offsets.
- Vision based inspection for presence of parts.

### FACEPLATE & BRACKET ASSEMBLY

- The faceplate of the cars audio systems are assembled and test in this station. This station is responsible for assembly and screwing of the chassis and the silver box which holds the pcb and is further connected to the faceplate. This station has position controlled Screw driver with interlock which is guided to the operator.

### FACEPLATE FUNCTIONALITY TEST

- Faceplate is later fitted to the machine and the operator test the faceplate for touch response.
- The operator taps on the screen as instructed by the machine and on finding if the plate is not responsive to his operation then it is rejected.

### FACEPLATE & SILVER BOX ASSEMBLY

- At this station the pcb is attached parallel to the Faceplate and horizontal to the silver box. Later Both these components are screwed and assembled.



Product after assembly

## **AUTOMATIC FUNCTIONAL TEST**

- At this station the assembled product undergoes certain performance test. At this station the assembled product is fitted to machine through sockets and various parameters are tested.

MODULE TESTED	TEST REQUIREMENT
Analog radio (AM/FM)	Multi carrier Signal Generation with different standard formats
Digital Audio Broadcasting(DRM)	Multi carrier Signal Generation with different standard formats
Digital Video Broadcasting	Multi carrier Signal Generation with different standard formats
Bluetooth/WLAN	RF Signal Test
Navigation Systems (GPS)	RF Signal Test with single and different satellite
Touch Screen	HMI Test
Mobile Radio Communication Test(GSM)	RF Signal Test
Audio	Quality test
Video	Quality test
Automotive Protocol	Interfacing

## **MANUAL FUNCTIONALITY TEST**

This station is further divided into 2 parts where in each part the operator manual test the audio system features such as bluetooth connection to smart phones, GPS navigation, Video and Sound quality etc.

## **FINAL INSPECTION**

Before Packaging the infotainment product undergoes final inspection. The functionality which were tested at manual functionality test are again tested here. But at this station the infotainment product is placed to machine which has it's functionality similar to the car. along with Gps,bluetooth, audio and video test the product also undergoes additional test such as PDC test where the reverse parking camera like features are tested.



## **TELEMATICS CONTROL UNIT**

A telematic control unit (TCU) in the automobile industry refers to the embedded system on board of a vehicle that controls tracking of the vehicle. Harman also contributes to this unit as it manufactures the same for Mercedes cars and is exported world wide.

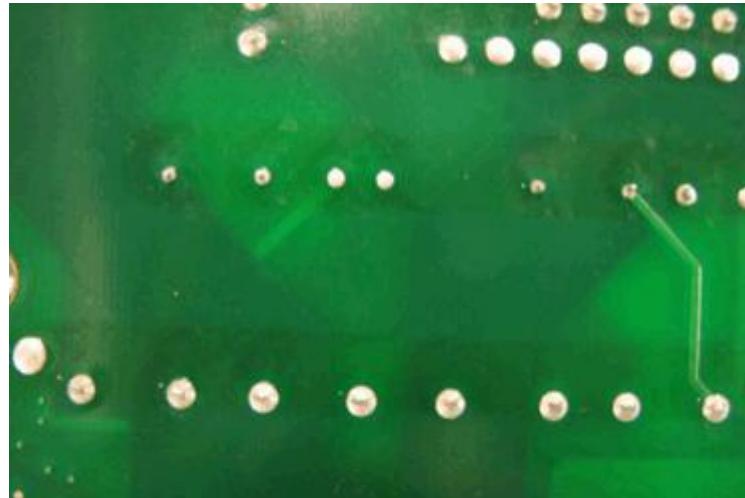
The TCU unit is more often related to security of the vehicle by use of embedded systems. The TCU unit mainly comprises of GPS unit for tracking of the vehicle, GSM unit for controlling functions within the car, microprocessors and microcontroller unit which act as interface between GPS and car. Mobile communication unit and electronic processing unit.

Later in this report I have research and designed PCB catering these functionalities,

## **MANUFACTURING**

The manufacturing process for Telematics control unit is similar to SMT process with additional steps.

- The first step in this process involves inspection of PCB boards where the boards are checked for defects such as green mask on boards, cuts, scratches etc.



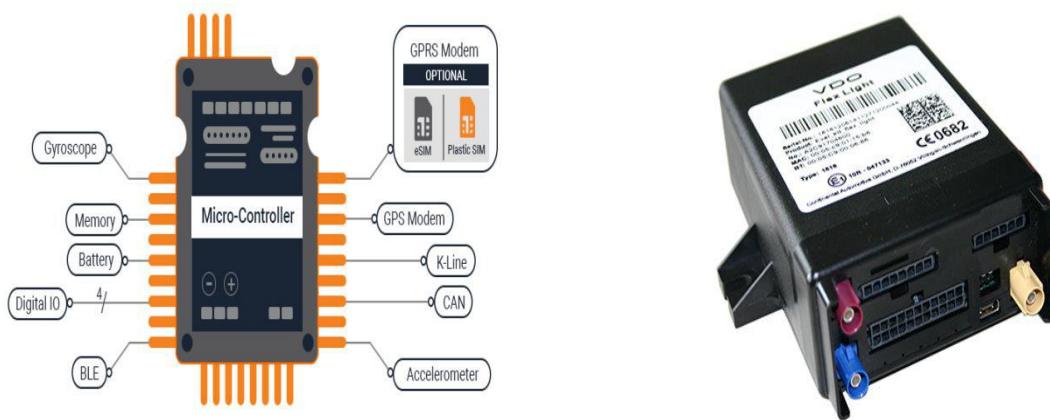
Green Mask on PCB

- After Inspection the PCB are placed into the De-stacker from where the process begins. The PCB are laser barcoded and later sent to solder paste printing machine.
- The machine wipes solder paste onto the surface of PCB boards. The solder pasted PCB boards are further sent to Pick and place machine where the components such as capacitors, microcontrollers, resistors, inductors, BGA etc are placed onto the PCB boards.

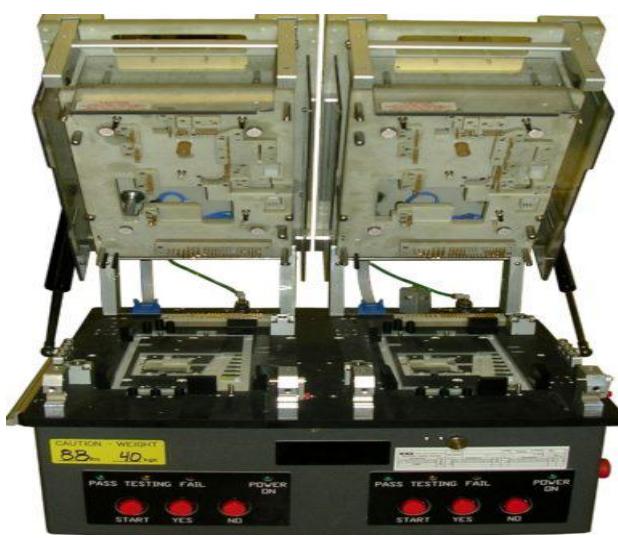
- The board with placed components are passed through reflow oven where the soldering happens. At the pre-heat and soak region the board is heated and the soldering is done at temperature higher than solder paste at which it is melted and later cooled.
- The solder board is then sent through AOI and X-Ray inspection where defects such as tomb-stoned ,Component shift ,Component bridging and other are detected.
- Unlike In-Circuit testing in SMT process this process does not involves ICT testing. Before testing the board undergoes Depenalization where the routing of the board happens.
- After Depenalization the PCB is sent to alfamation test execution machine for parameter and functionality test. The board undergoes following test:-
  - 1) RF test
  - 2) Antenna Tests
  - 3) ICCID,IMEI
  - 4) AT commuincation
  - 5) GPS Test
  - 6) Voltage test
  - 7) Mic test
  - 8) Flashing bios

The machine has four sockets for testing.

- THT process is not included in TCU manufacturing as PCB does not require larger amplifier and IC to be soldered onto the board.
- The board is then programmed after having cleared for all the previous tests.



Telematics control unit



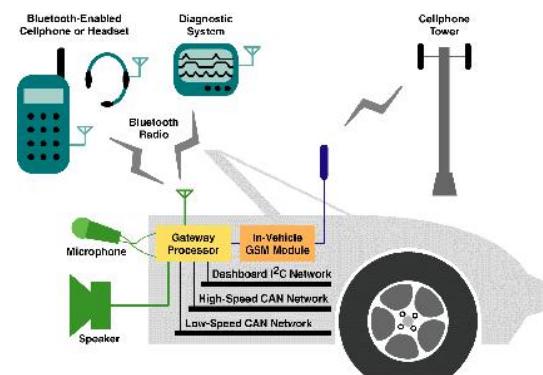
PCB Functionality test



Depenalization



Alfamation machine for programming of TCU



Telematics Component with Car

## **INTERNSHIP RESEARCH ON TELEMATICS CONTROL UNIT**

After having gained knowledge on manufacturing process and design and fabrication of PCB boards I have designed few working PCB prototypes which can be subdivision to Hermes line.

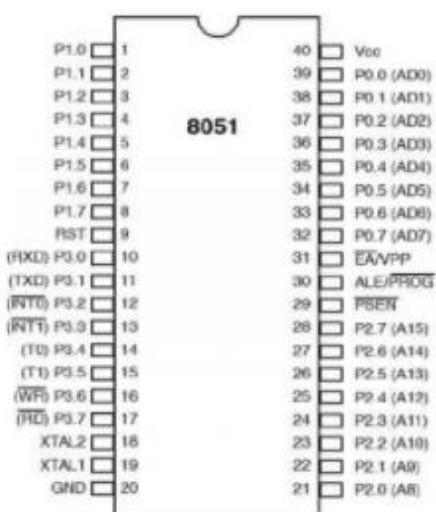
The Telematics control unit manufacturing HERMES line is the production unit for vehicle such as Mercedes with advance feature like GPS navigation,Anti-theft security system etc. They have advance features such as in case of vehicle break down mercedes service center are immediately alerted and provided help.

### **1) PCB interfacing with GPS module**

#### **Components Used:-**

#### **8051 Microcontroller**

8051 microcontrollers are designed by Intel in 1981. It is an 8-bit microcontroller. It is built with 40 pins DIP (dual inline package), 4kb of ROM storage and 128 bytes of RAM storage, 2 16-bit timers. It consists of four parallel 8-bit ports, which are programmable as well as addressable as per the requirement. An on-chip crystal oscillator is integrated in the microcontroller having crystal frequency of 12 MHz.



#### **LCD DISPLAY**

16×2 LCD module is a very common type of LCD module that is used in 8051 based embedded projects. It consists of 16 rows and 2 columns of 5×7 or 5×8 LCD dot matrices. It is available in a 16 pin package with back light, contrast adjustment function and each dot matrix has 5×8 dot resolution.

## GPS Module

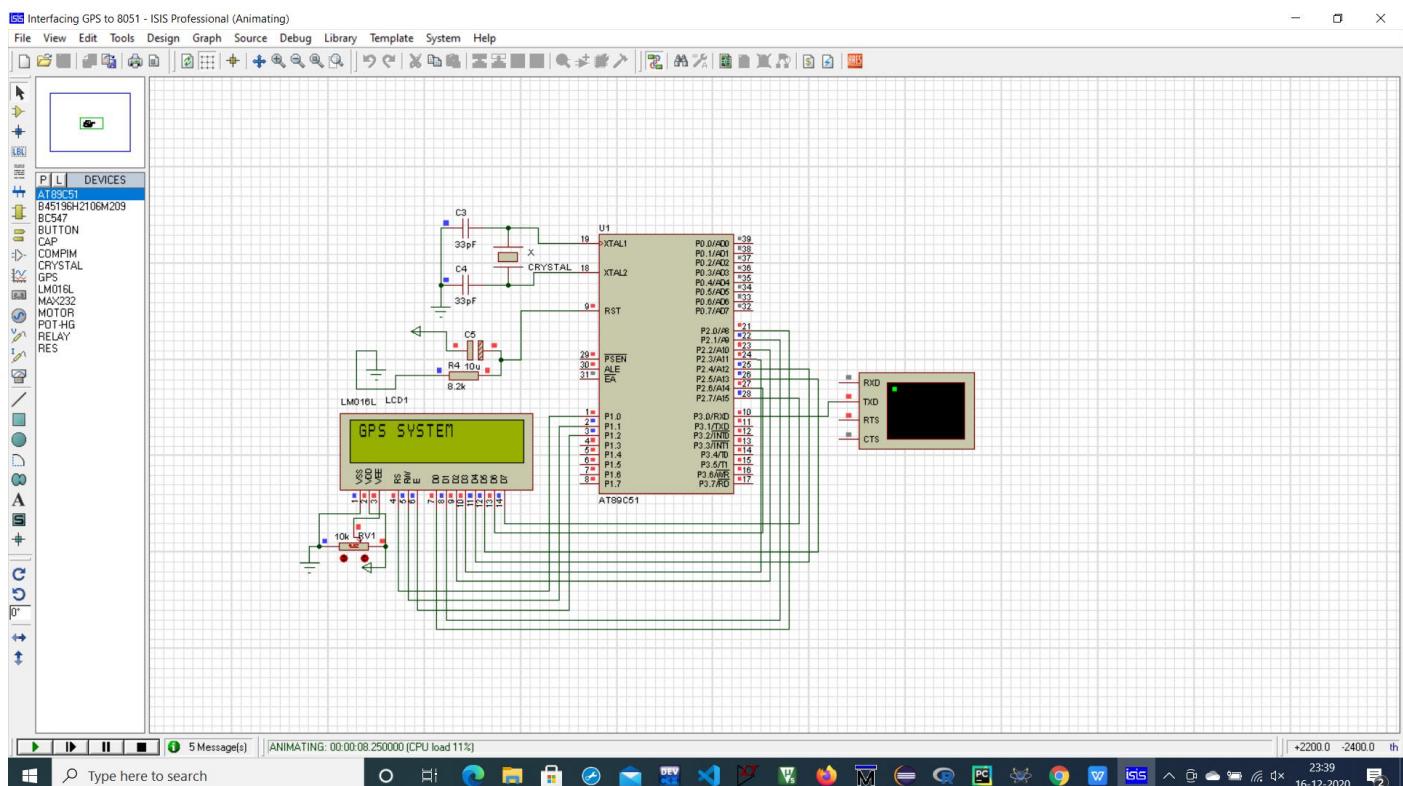
There are different communication protocol such as UART,I2C,SPI etc. The GPS module is configured for UART communication protocol.The GPS module undergoes UART serial communication with the microprocessor or microcontroller after receiving the location.The GPS receiver is already configured for UART communications and requires no external programming or set up to enable.

UART or Universal Asynchronous Receiver Transmitter is a serial communication device that performs parallel – to – serial data conversion at the transmitter side and serial – to – parallel data conversion at the receiver side. It is universal because the parameters like transfer speed, data speed, etc. are configurable.

UART is not configured with clock instead it has two special bits ,start bit and stop bit.Start bit is a synchronisation bit that is added before the actual data. Start bit marks the beginning of the data packet.The Stop Bit, as the name suggests, marks the end of the data packet. It is usually two bits long but often only one bit is used.

Ideal Baud rate for UART communication is 9600.

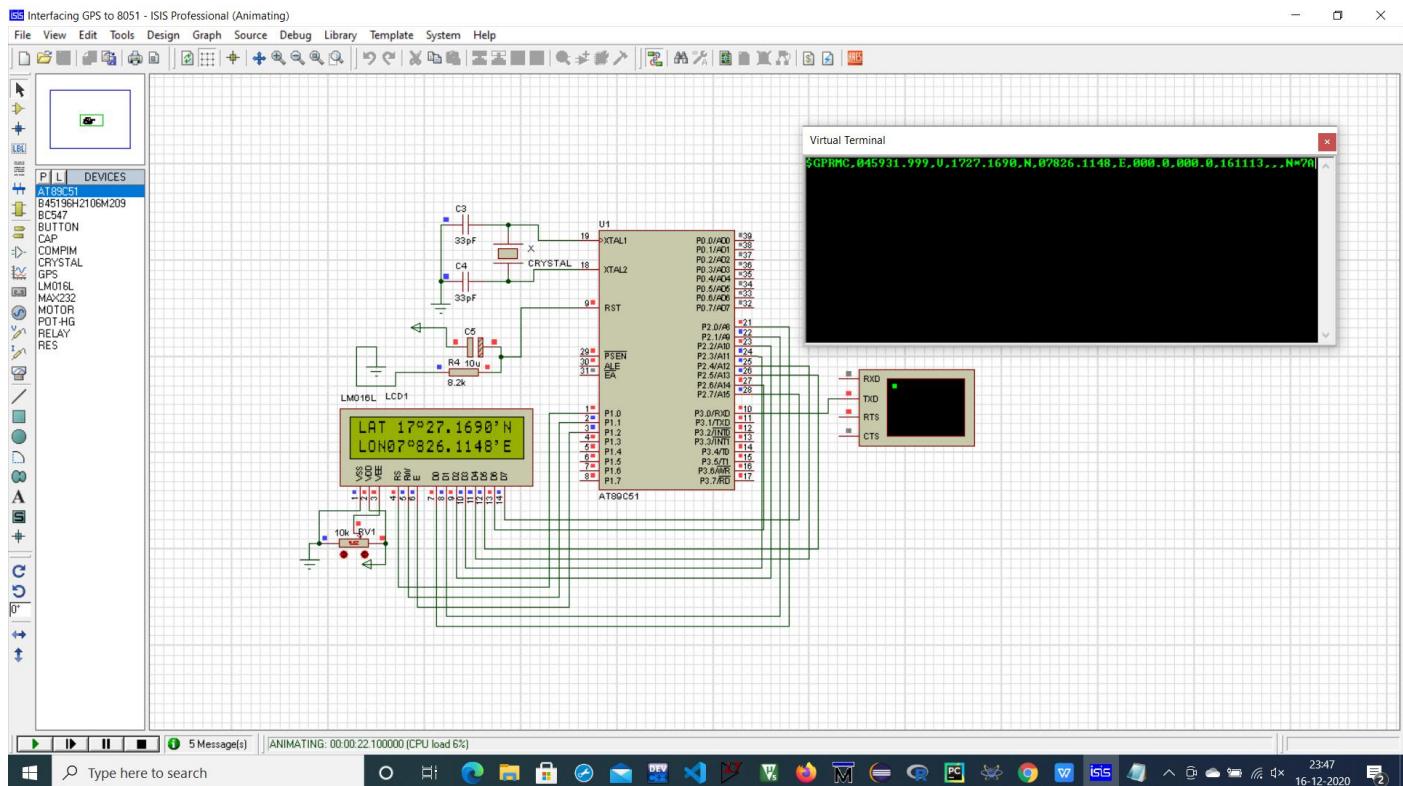
## Circuit Schematic:-



Crystal oscillator frequency is 12MHZ.

Follow AT Communication

## DECODED MESSAGE DISPLAYED ON LCD:-

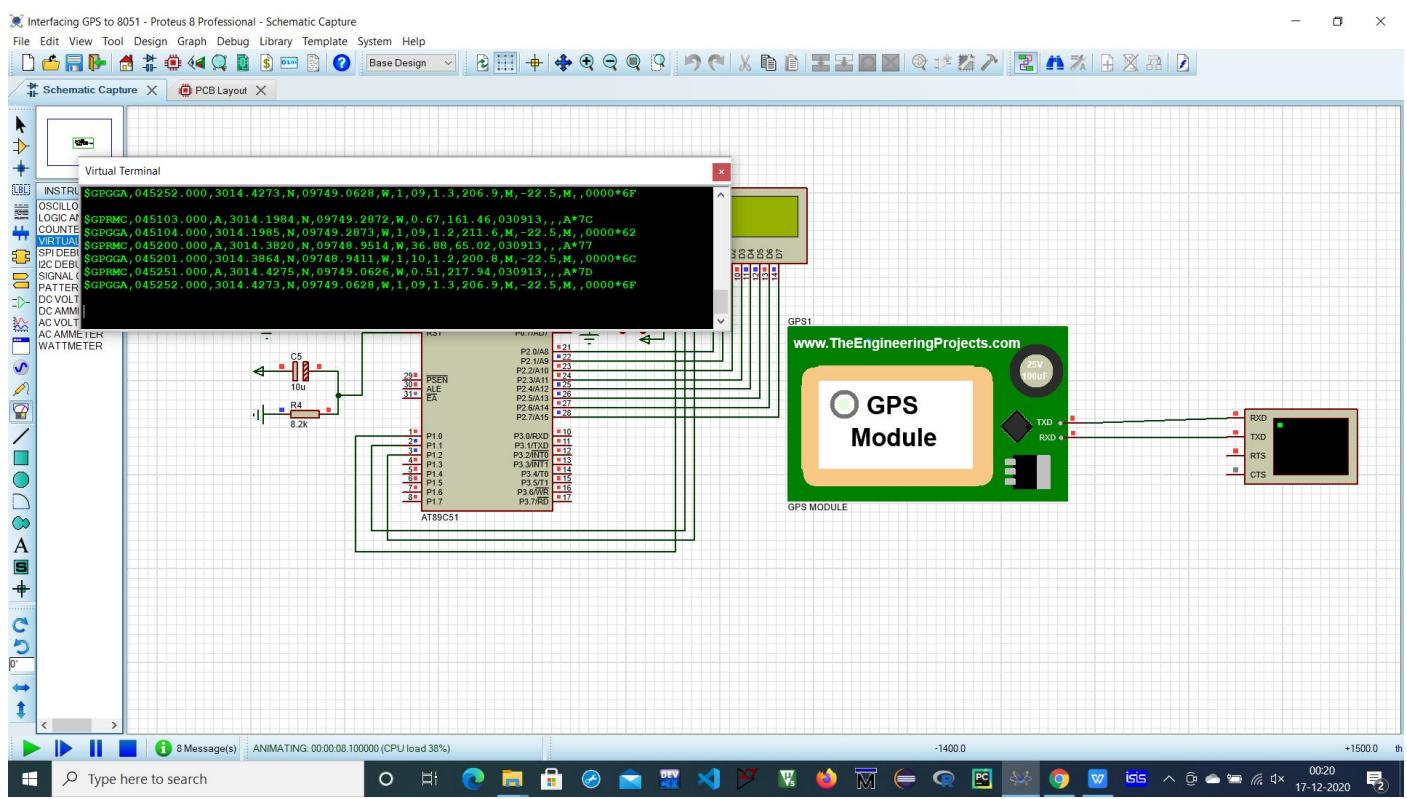
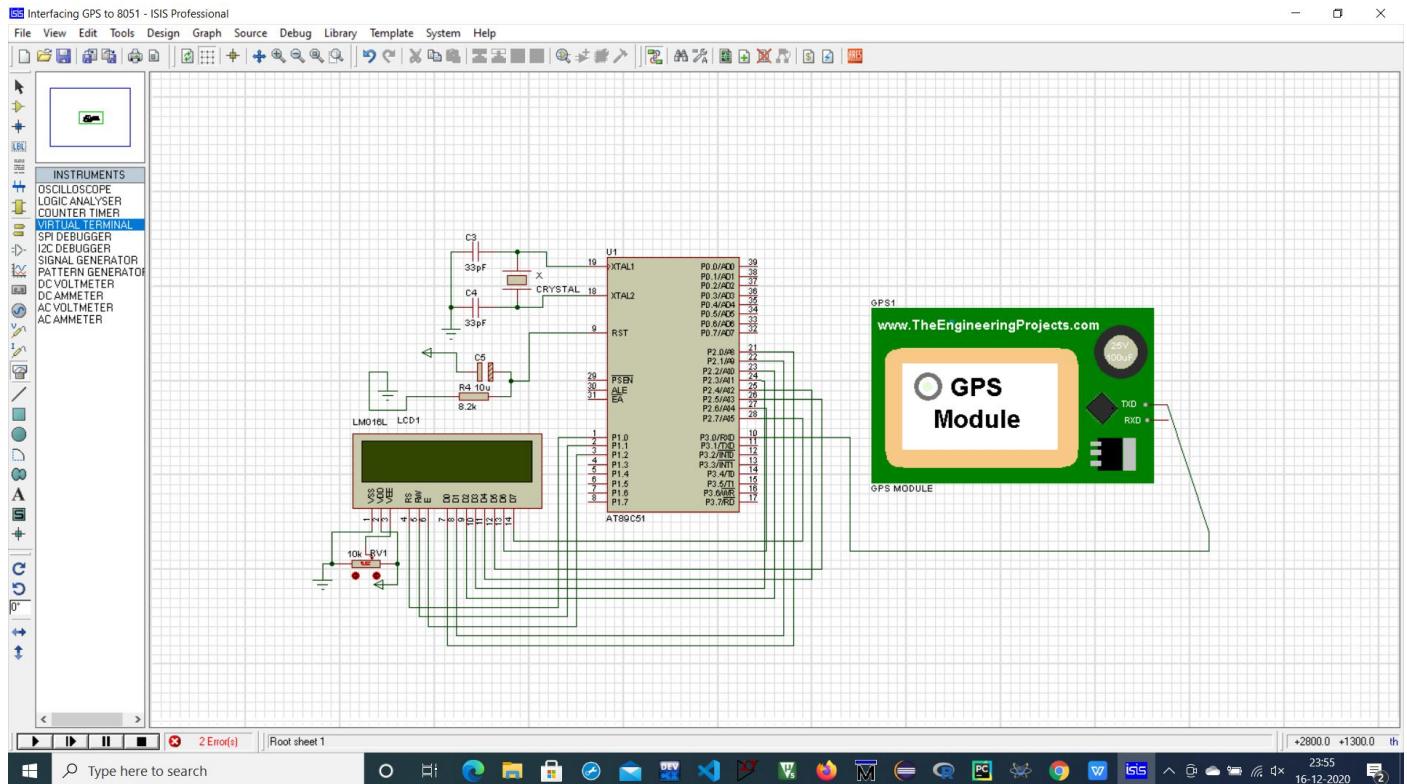


## DECODED MESSAGE AS PER ONLINE TOOL:-

The screenshot shows the GPRMC & GPGGA decoder tool interface. It displays the decoded message: \$GPRMC,045931.999,V,1727.1690,N,07826.1148,E,000.0,000.0,161113,,N\*7A. To the right, a map of southern India and Sri Lanka shows the location of the decoded coordinates. A sidebar titled "Decoding results" provides detailed information: Warning (No satellite fix!), Position (17.452817°N, 78.435247°E), Timestamp (Sat, 16 Nov 2013 04:59:31 UTC), Close to (Kakinada, India), Local time (Sat, 16 Nov 2013 10:29:31 IST), and Timezone (Asia/Kolkata (UTC +0530)). Below the map, there is an illustration of a satellite in orbit.

Here GPS module is replaced with Virtual terminal where the message received by GPS module is decoded and longitude and latitudinal location are displayed which can be used further. The received data is in NMEA format.

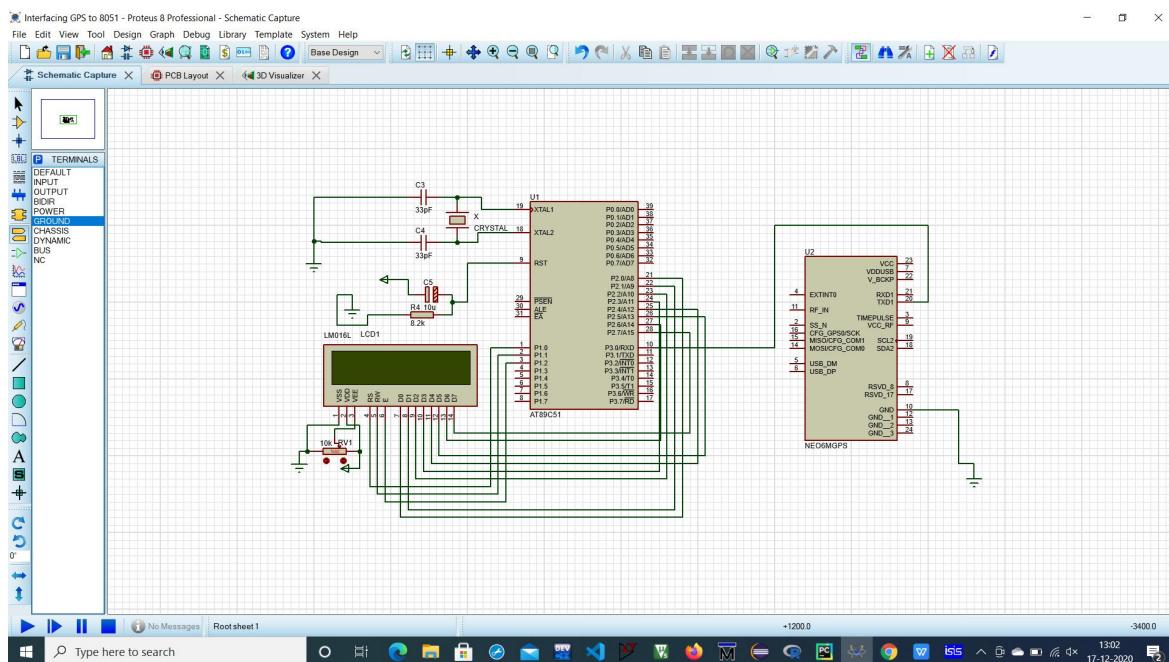
## Circuit Schematic with GPS module Before PCB:-



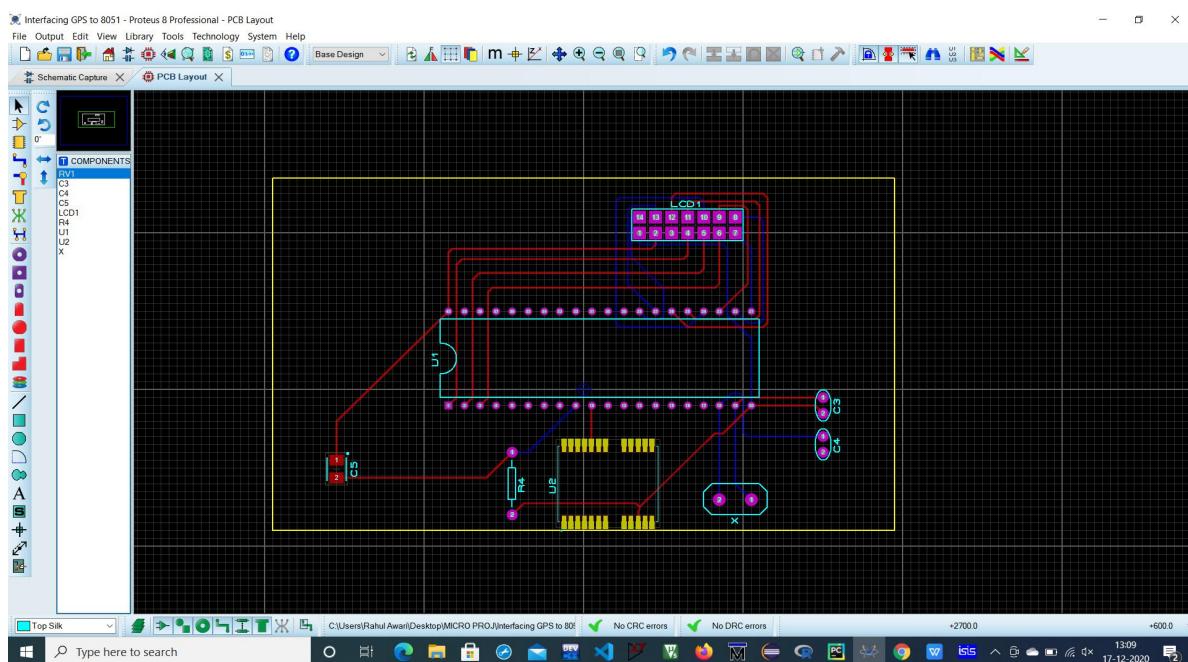
The NMEA format can be represented by following:-

- GPRMC (Recommended Minimum data) // (at the moment this is implemented.)
- GPGGA (Global positioning system fix data)
- GPGSA (GNSS DOP and Active Satellites)
- GPGLL (Latitude and longitude, with time of position fix and status)

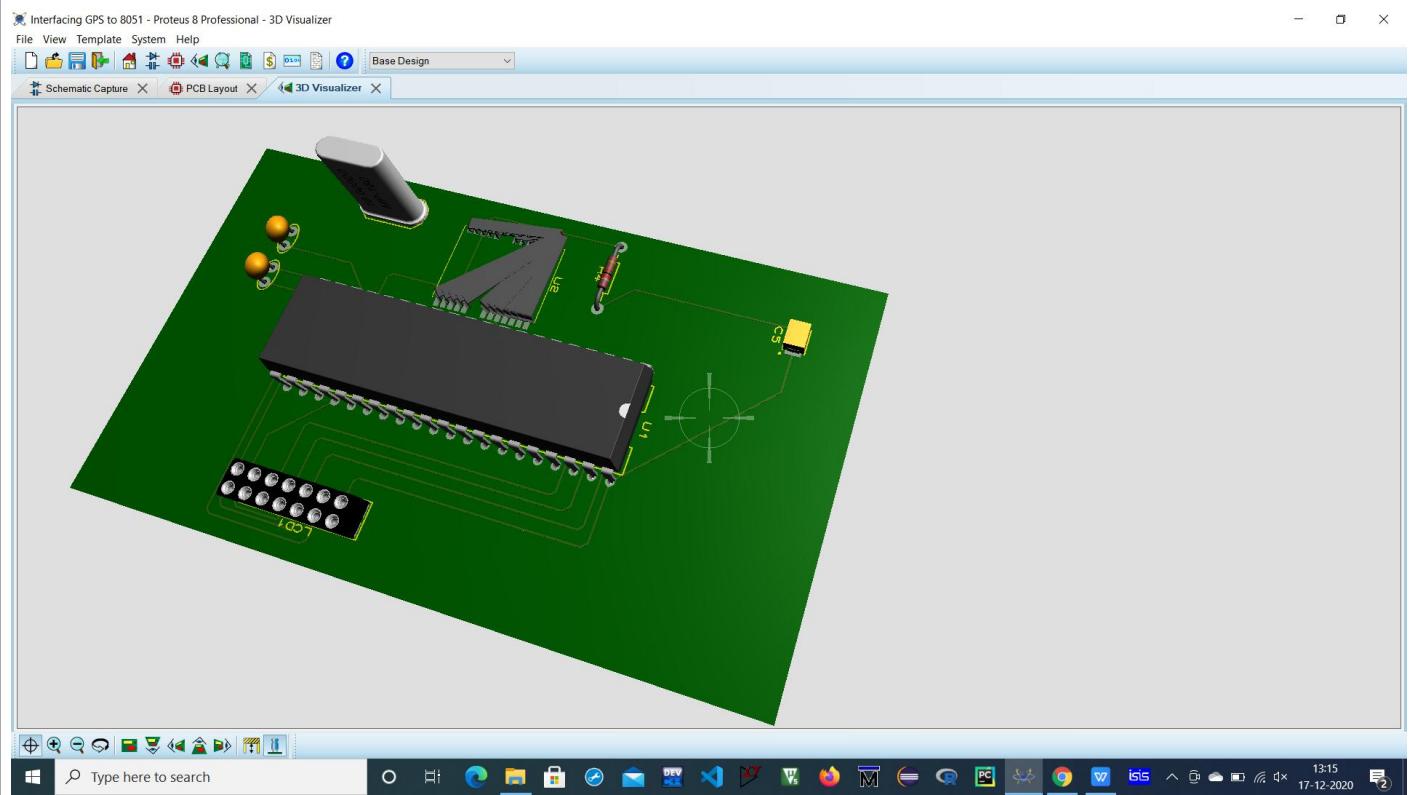
For Computer aided design of PCB I have made use of NEO6MGPS but for stimulation of schematic I have used GPS module by TEP as PCB footprint was not available for the same.



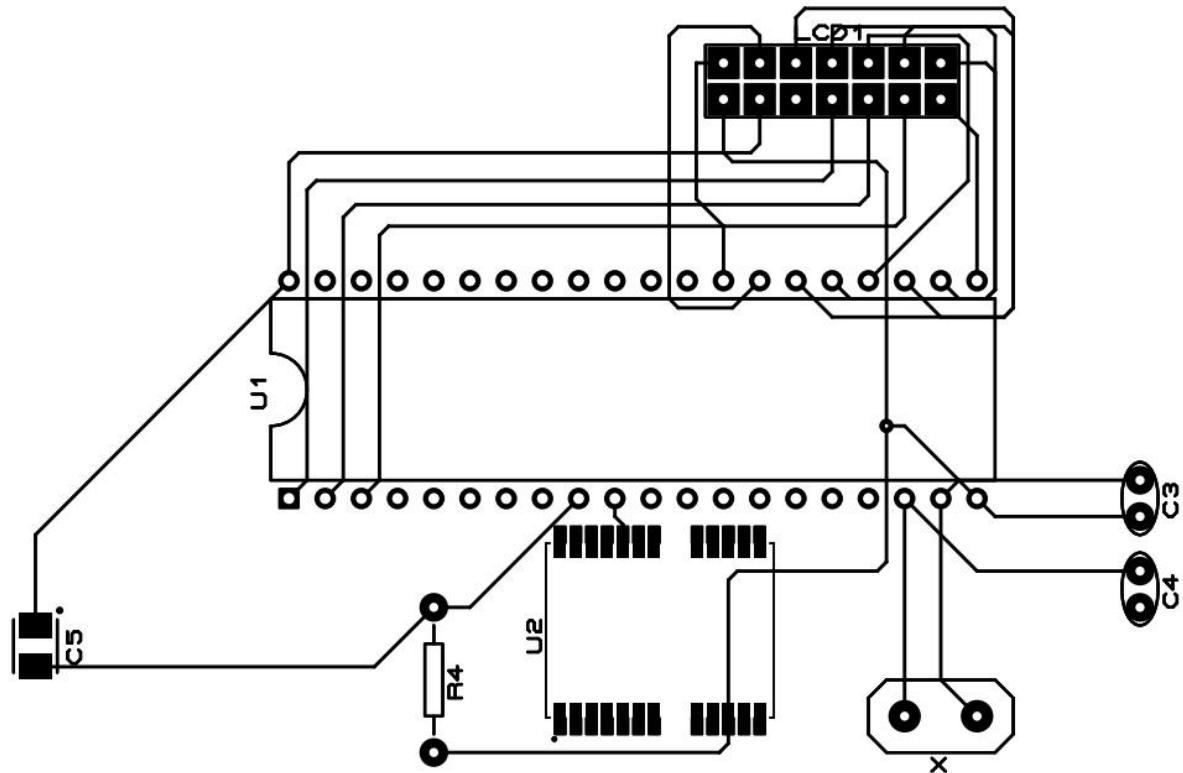
## PCB Layout:-



## 3D-Visualizer



## EXPORT OF PCB



## Code

<https://github.com/awarirahul365/Electronics-Project/blob/main/gps.c>

## Code Explanation

P1.0,P1.1,P1.2 are set as rs,re,e for LCD display, The value for rs,re decide whether the LCD will read command or display command assigned.

For NMEA format GPRMC is assigned and an array is assigned of 15 characters for displaying NMEA based co-ordinates of location.

Functions are defined for receiving data,lcd\_latitude and lcd\_longitude and delay.

LCD function are written which guide the LCD to perform function to read,write or display as per command.

Serial communication function is defined which is used to set baud rate,mode and to start timer flag.

Function for comma checks the ‘,’ in NMEA format of GPS GPRMC

SBUF register is used for receiving data and as when the data is received RI flag returns to 1.

Main function is defined and checked for latitude and longitude and it is converted to following string.

## Applications

Harman Pune plant has hermes manufacturing which has advance feature such as vehicle tracking system,anti-theft system manufactured for mercedes vehicle.

The GPS module from the above PCB design with microcontroller can have its usage in vehicle tracking and navigation for cars.In case of car theft or vehicle break down gps co-ordinates can be useful for necessary help or tracking.

## Software Used

Proteus 8.9 & Proteus ISIS

## 2) Accident detection using VGPS and GPS module

### Arduino Uno R3

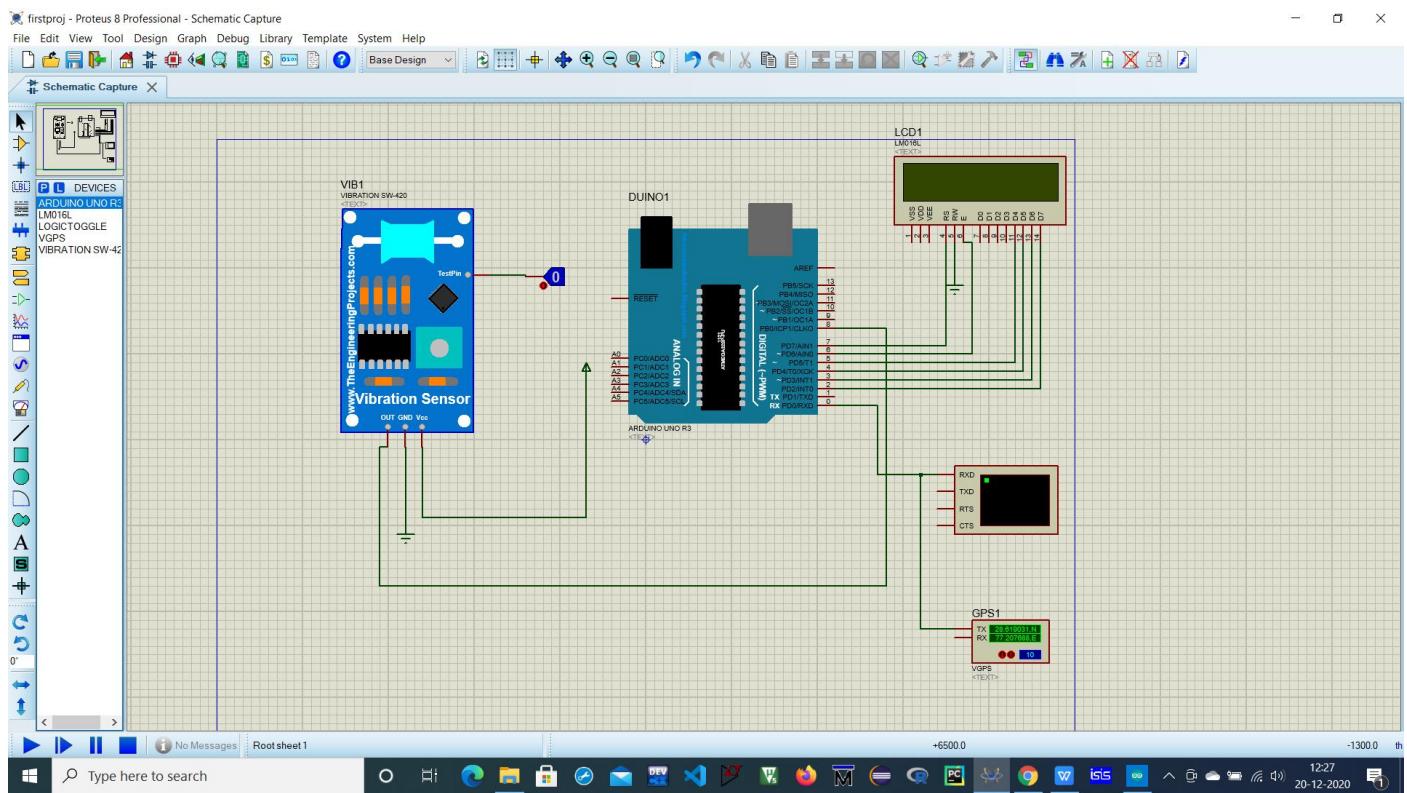
Arduino Uno R3 consists of 5 analog pins from A0-A5 and 13 digital pins from 0-13. It also has reset pin and VCC and GND pins. Arduino can be considered to be an Analog to Digital converter where analog components such as potentiometer, vibrational sensor etc which read analog data is converted to digital data and displayed in LCD.

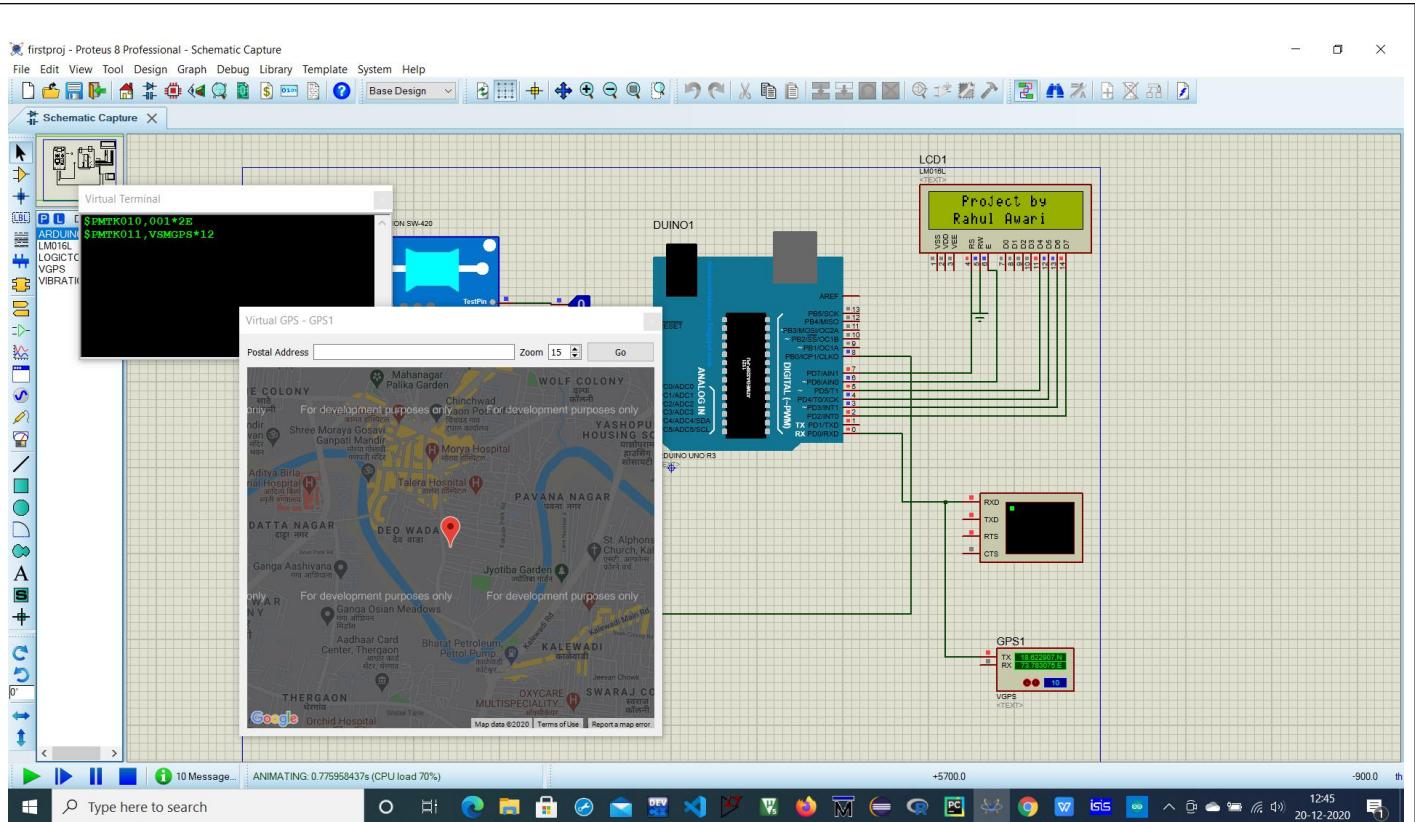
It has a clock frequency of 16MHz. Vibrational Sensor is used in proteus for accident detection ,even a button could be used.

### Vibrational Sensor

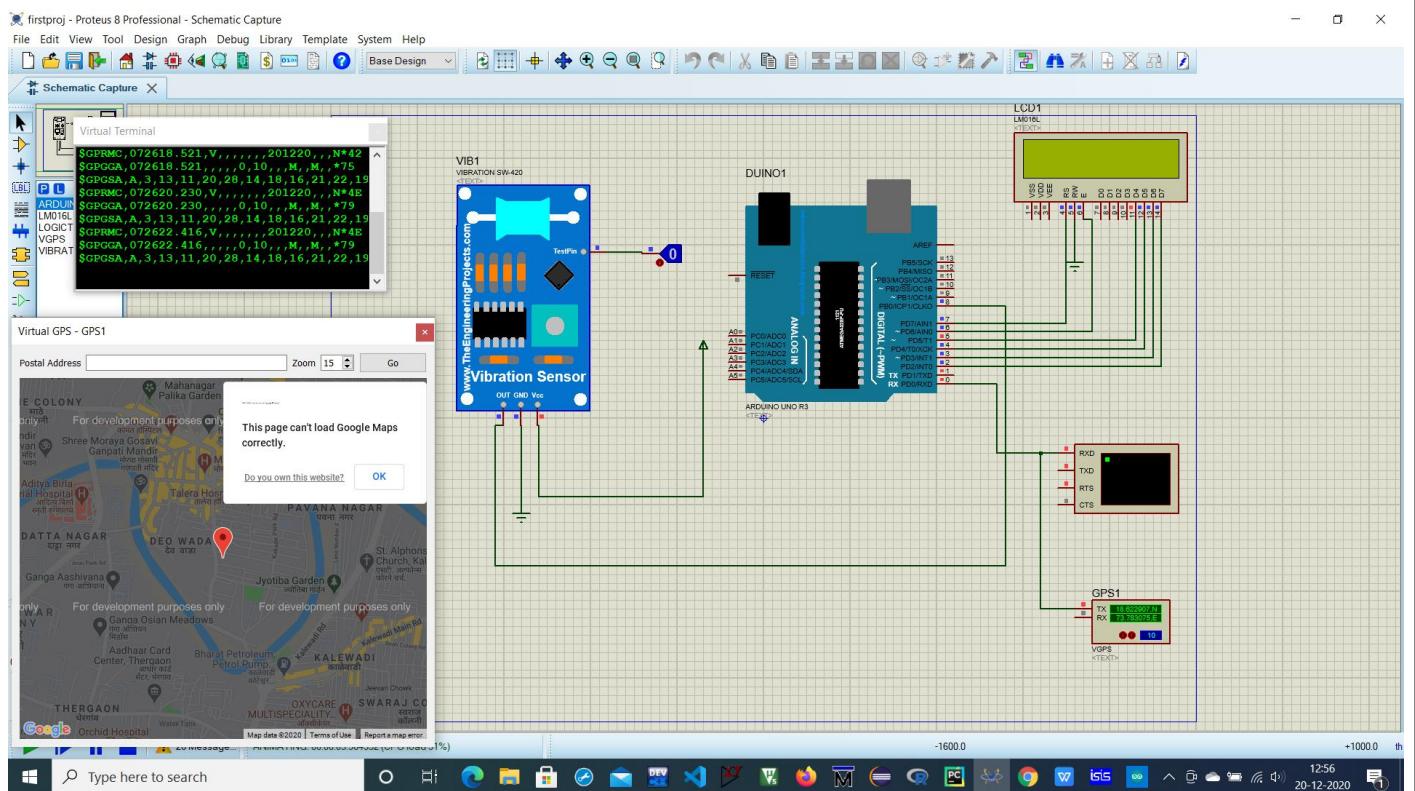
The vibration sensor is also called a piezoelectric sensor. These sensors are flexible devices which are used for measuring various processes. This sensor uses the piezoelectric effects while measuring the changes within acceleration, pressure, temperature, force otherwise strain by changing to an electrical charge. This sensor is also used for deciding fragrances within the air by immediately measuring capacitance as well as quality. Gyroscope vibrational sensor can be used for accident detection.

### Circuit Schematic



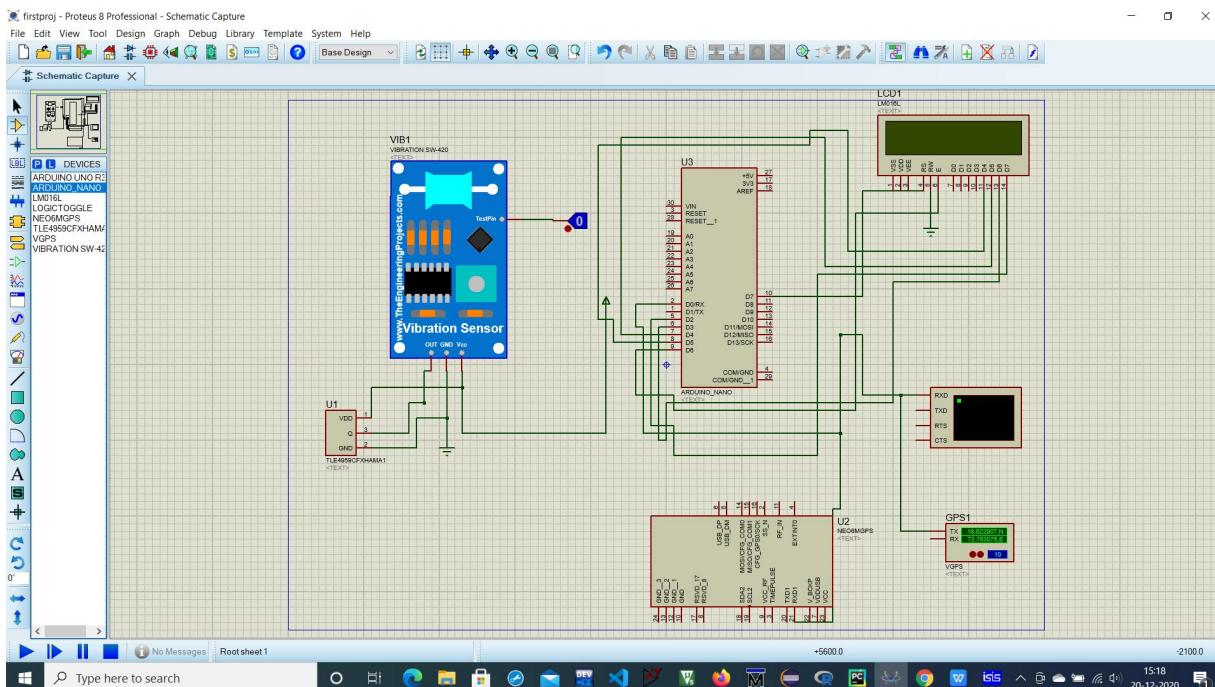
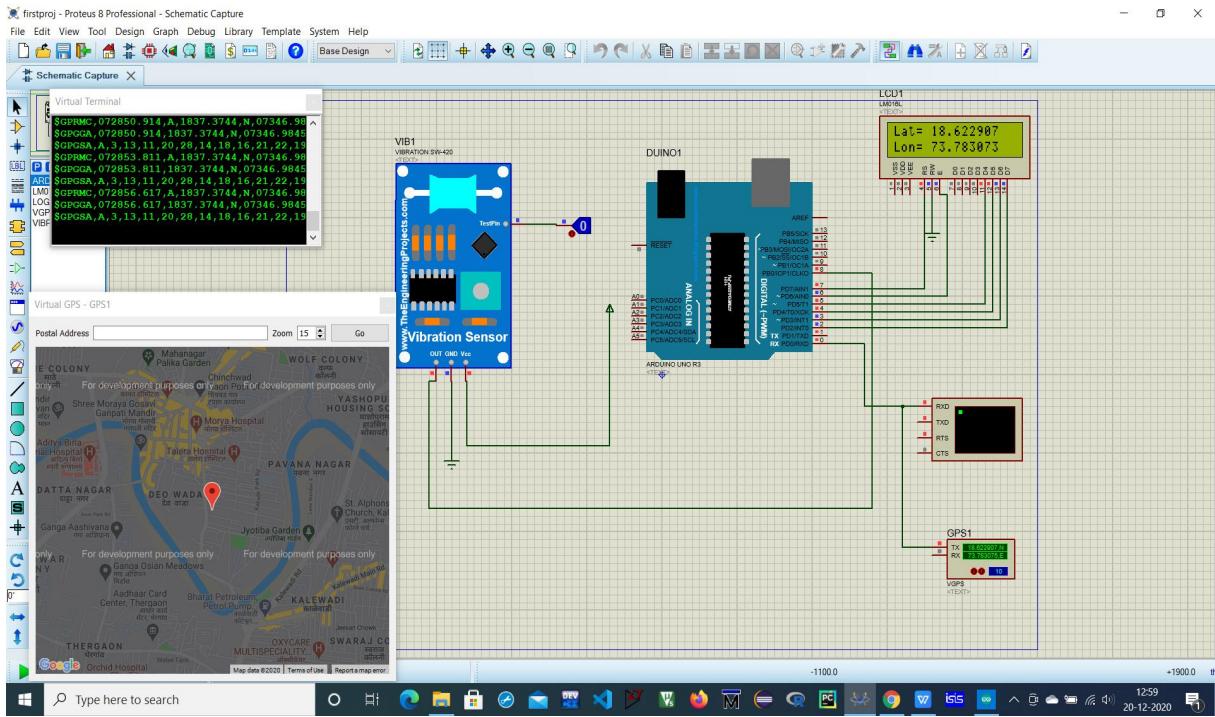


## Before Accident



It can be observed that vibrational sensor has a value of 0 hence no accident scenario.

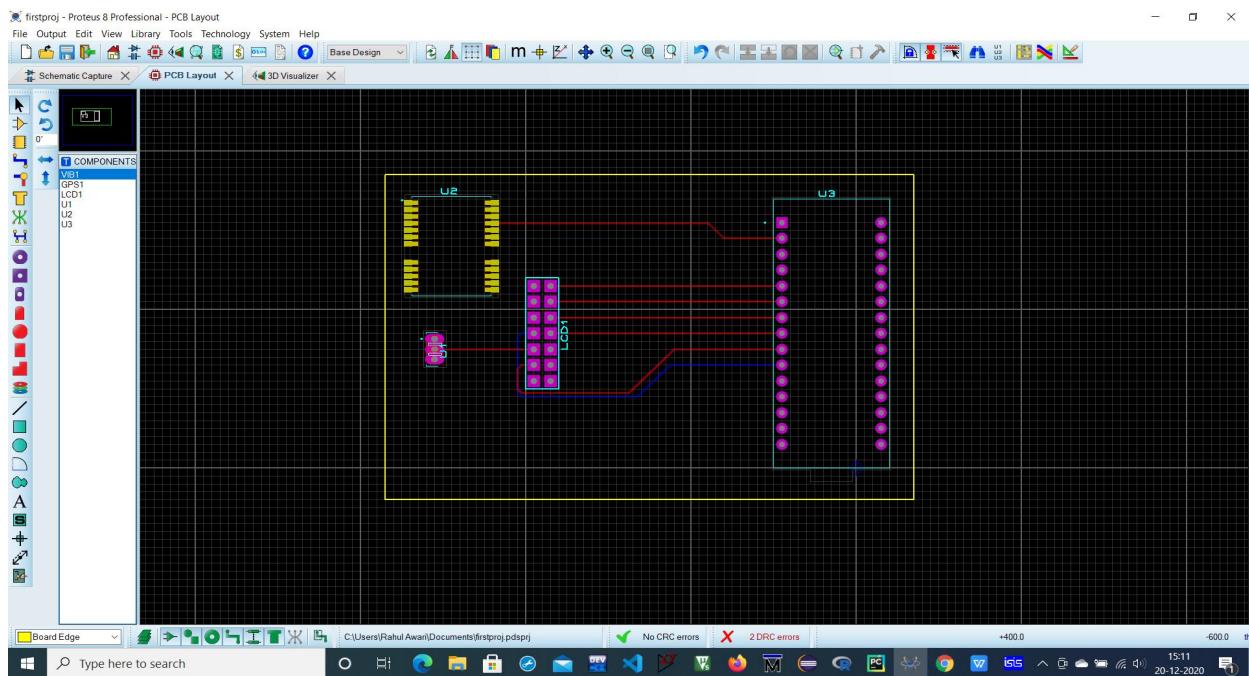
# After Accident



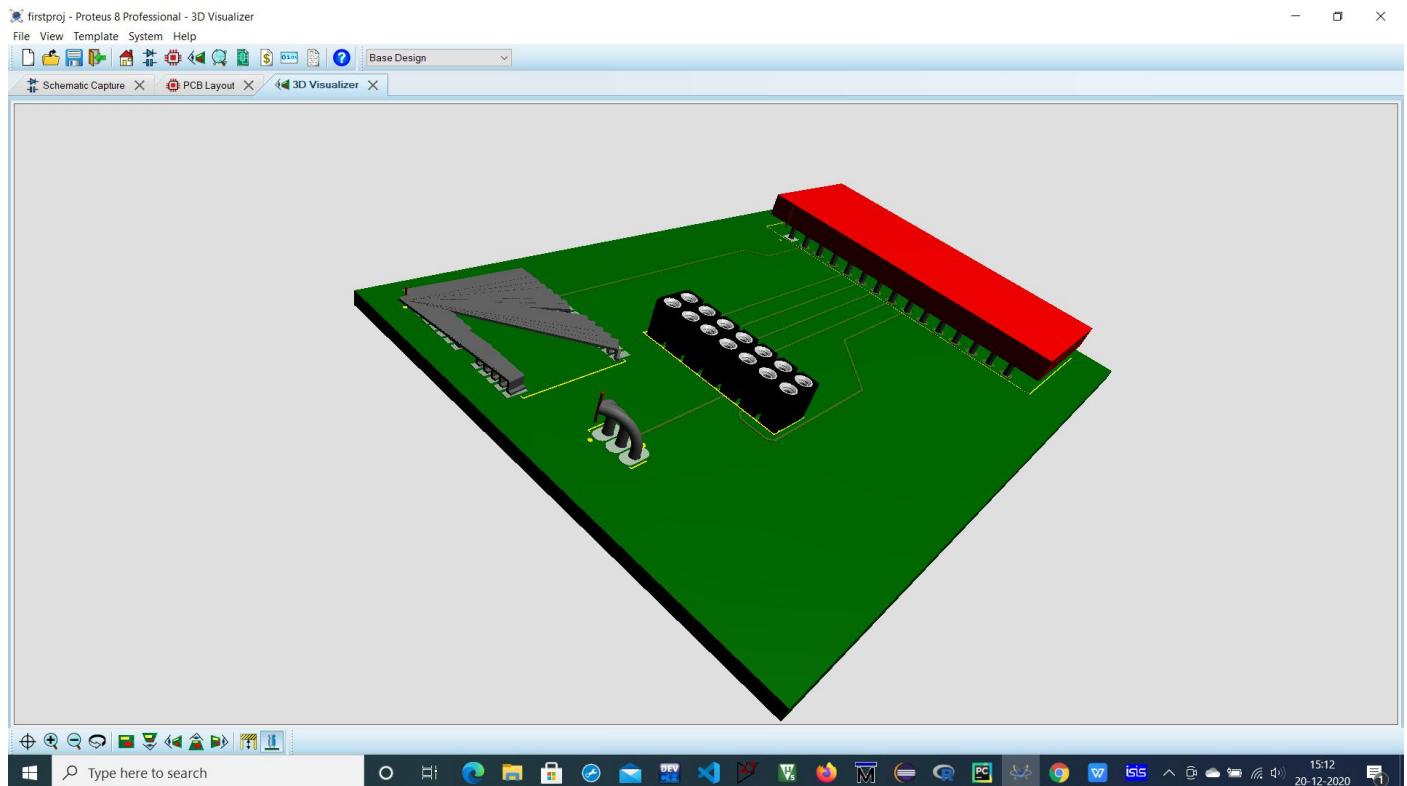
When the vibrational sensor is triggered for 1 then it Is an accident scenario and the co-ordinates are sent and are displayed in LCD. With the use of GSM module the co-ordinates can be sent to service centers for help.

The Virtual terminal displays GPS co-ordinates in NMEA format.

## PCB Layout



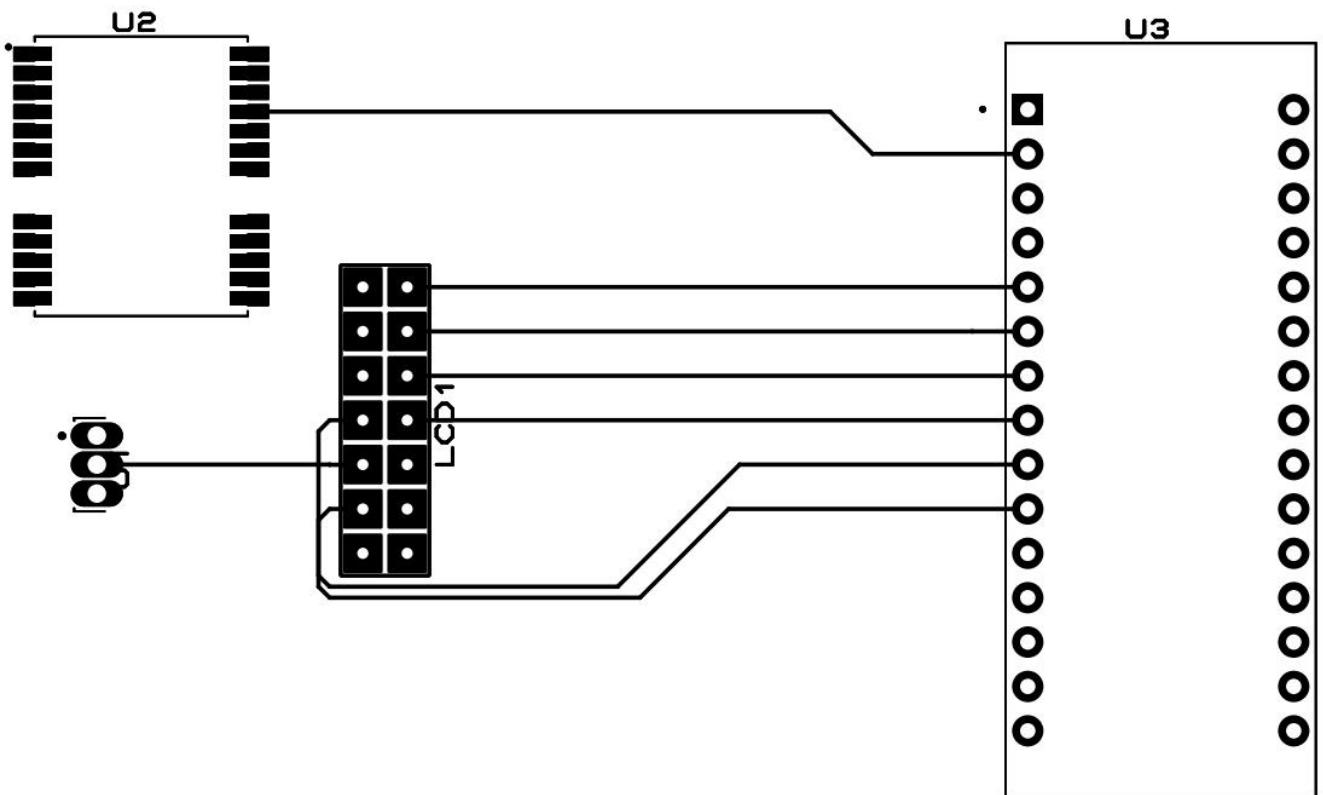
## **3-D Visualiser**



## Code

<https://github.com/awarirahul365/Electronics-Project/blob/main/gps.ino>

## EXPORT FOR PCB



## COMPONENTS (PCB Design)

- Arduino Nano
- GPS module (neo-6m)
- LCD
- Vibrational sensor (piezoelectric sensor)

## APPLICATIONS

In Case of any accident or vehicle breakdown the emergency service can be informed about the location and necessary help could be provided. This feature is already been implemented In many vehicles.

## **LEARNING OUTCOMES**

- Got to know more about printed circuit board of how schematic are designed as per requirement.
- Was introduced to various industrial process such as SMT(surface mount technology),THT(Through hole technology),Assembly lines etc.
- Observed each car audio manufacturing process carefully and researched on various topics on the machines.
- Was able to co-relate the theoretical knowledge which I had gained in college with the practical approach like I had observed the pre-programmed machines testing amplitude ,frequency modulation,signal to noise ratio verification,RF test,antenna test which form part of my curriculum.
- Research on topics such as GSM,GPS module and tried to implement and explore these with PCB design tools such as Proteus and snapEDA
- Got to know about the advance features being implemented in hermes line ADAS,advance emergency services ,anti-Theft systems etc.
- Got exposure to Industrial working culture.

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