# CHAPTER 1

# INTRODUCTION

In the past decades there have been tremendous advancements in the field of automobile industry. Usage of vehicle has been increasing rapidly. Impact on the other side is increasing pollution level. According to European Pollution Agency (EPA), India is generating pollution from automobiles equal to burning of 200 million tonnes of coal every year.

This project is focussed on monitoring this pollution level to provide awareness among people through public displays and open community maps. System is broadly categorised into three parts: data acquisition unit, data posting and finally data retrieving and visualizing. Data acquisition part is sub divided into sensing unit and processing unit. In sensing unit there are two different sensing elements which produce output levels based on gas concentrations and suspended particles concentration (PM2.5 and PM10). As a rule of thumb, sensors produce output in analogue form. This signal is given to microcontroller to convert it in to digitized form using A/D converter. An algorithm applied on these digitized data's to get the gas concentrations in terms of Parts Per Million (PPM) and Micro gram per cubic meter (ug/m3). This sensing and converting process is carried out for some sampling period (say 10 seconds) and average of this is taken as result.

SIM 808 is used to post this data to cloud. It satisfies complete need of a cellular modem because it contains on chip GPS for accessing location information, GPRS to connect to the internet and GSM to make and receives calls and SMS. This modem has software layer for several internet based applications like FTP, HTTP, and TCP. So that it can access these layers by passing AT commands. HTTP protocol is used for sending data to cloud. After processing, the data are sent to cloud using Hyper Text Transfer Protocol. All

data are sent with respect to their location where they monitored. A PHP handler is written on the server side to handle requests that are made during data posting. PHP handler retrieves data from HTTP requests and stores it in a database for future analysis. An open community map with the help of Google maps API was designed which shows the pollution level in the form of coloured circles based on the location. Each colour defines pollution level as good, acceptable, moderate, worst, unhealthy, and dangerous. The data are stored in a database and it can generate periodic reports and perform some data analytics for future prediction of pollution levels and compares it with present. In future developments awareness can be made by public displays placed in remote places.

# CHAPTER 2

# POLLUTANT VISUALIZER

## 2.1 INTRODUCTION

Air pollution level has been increasing rapidly, so there should be some remedies made to avoid and overcome that. Fuel efficient vehicles proved in reduction of pollution emission. One way to overcome this is to protect ourselves. For that, people must be aware of their environment. One such platform is bringing awareness among people. Description of this system is as follows.

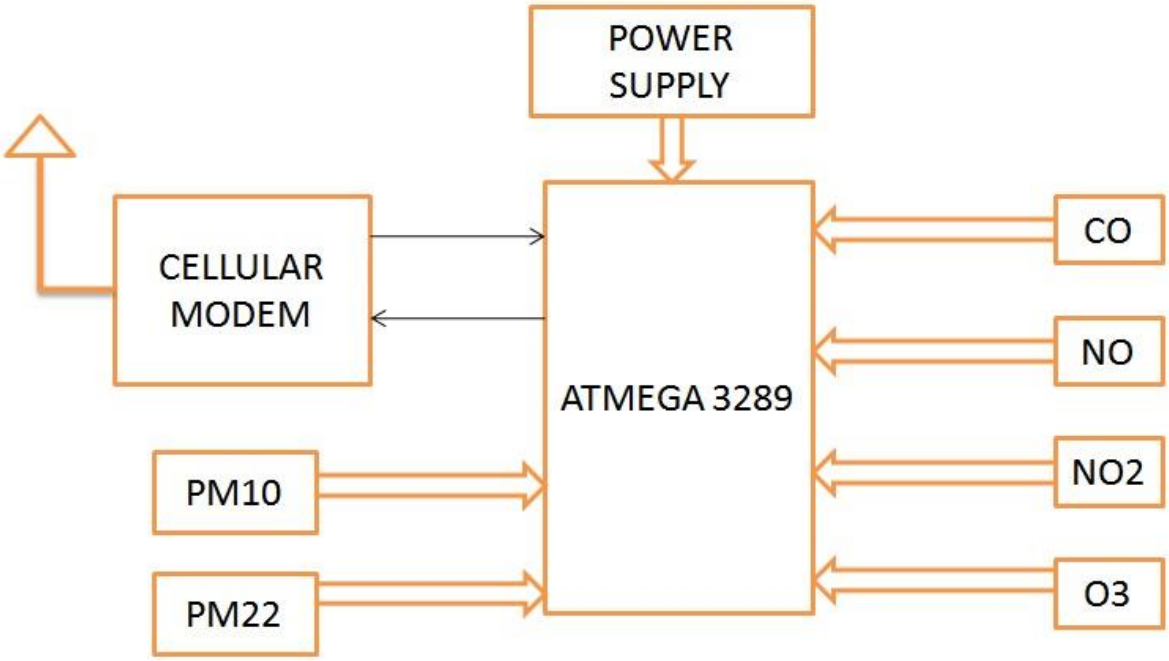


**FIGURE 2.1 BLOCK DIAGRAM OF THE PROPOSED METHOD**

### 2.1.1 DESCRIPTION

The block diagram shows ATMEGA 328 is used as a processing unit which receives data from different sensors which produce outputs based on concentration of gases such as Carbon Monoxide(CO), Nitrous Dioxide(NO2),

Ammonia(NH3) ,Ground ozone(O3) and suspended particles (PM2.5 and PM10). A cellular modem SIM808 is connected to processing unit through serial protocol (UART) and communicate with the server via this cellular modem. A power supply unit which receives input from a battery of(6V-24V) and uses two separate Low Drop Out (LDO) regulators for constant regulation. One is for the cellular modem which dynamically varies the current consumption when connected to internet and the other is for sensing and control unit.

In hardware part, it has sensing elements which gives information about environment (gas) in electrical form and microcontroller which does all manipulations on acquired data. Starting with hardware part. Hardware part is broadly categorized into five parts.

- Data Acquisition (Sensors)
- Processing unit
- Posting Unit

## 2.2 DATA ACQUISITION

The word 'electronic nose' is derived from the behaviour of today's sensors. Humans can sense everything in physical environment. Humans have nose which smell odours and can detect what it is. It works with the help of olfactory glands which sense the smell and sends signal to brain through Olfactory nerves. Brain tells you what type of smell it is by analysing that signal. Same principle applies here. It has sensing elements which produce signals based on gas presents in environment. Processing unit accepts these signals, do manipulations and tells us the concentration of those gases.

## 2.3 PROCESSING UNIT

After passing signals through conditioning unit, the signal gets digitized and processed in on-board microcontroller. ATMEGA 328 from atmel is used as signal processing unit. It has its on-chip analog to digital converter unit with 10 bit resolution. So (0 – 5)V is scaled to (0-1024) in digital form. An algorithm is applied on this digitized data to convert it into informative one. Several sensors are connected to microcontroller as it is having multiple analog input channels.

## 2.4 POSTING UNIT

Processing unit convert data into informative one like colour values based on Air Quality index (AQI). These information will be send to our server through a cellular modem SIM808. It is a single chip cellular modem supports GPS, GSM and GPRS.

There is several gas sensing technologies in market. Each suits for different applications and environments. Few of them are given below.

## 2.5 TYPES OF GAS SENSORS

Gas detectors are sensors that measure the concentration of a particular gas in a particular area. Gas detectors are employed in many places like gas leakage detection, indoor air quality monitoring, fire alarms etc. There are different types of gas detectors which can measure and monitor combustible gases, toxic and flammable gases. Carbon dioxide, carbon monoxide, Sulphur dioxide, methane, ammonia are some common gases measured in industrial applications.

Gas detectors:

- Electrochemical
- Metal oxide
- Infrared
- Pallister
- Semiconductor

### 2.5.1 ELECTROCHEMICAL

This method uses a chemical reaction for detecting the concentration of gases. Its structure consist of Ion conductor sandwiched between two electrodes (working electrode and counter electrode). When gases like carbon dioxide (CO2) some kind of chemical reaction takes place in the working electrode. If short occurs between working and counter electrode together then there will be some flow of electrons between them. If connection is made through an external wire there will also be electron flows through that. By placing an ammeter current level which tells us the concentration of gas level is measured.

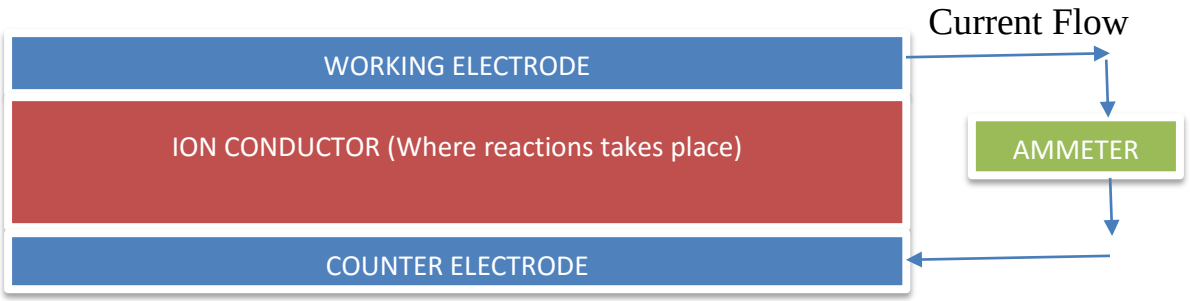


**FIGURE 2.2 ELECTROCHEMICAL SENSOR**

### 2.5.2 METAL OXIDE

Tin oxide is used as a reactant and its surface is filled with absorbed oxygen. The complete arrangement is placed above an alumina. In clean air oxygen prevents the electron flow through this tin layer as it absorbs it. When

any gas falls, reaction takes place and this absorb oxygen gets reduced. So electrons starts to flow and it can be measured by placing an ammeter or load.

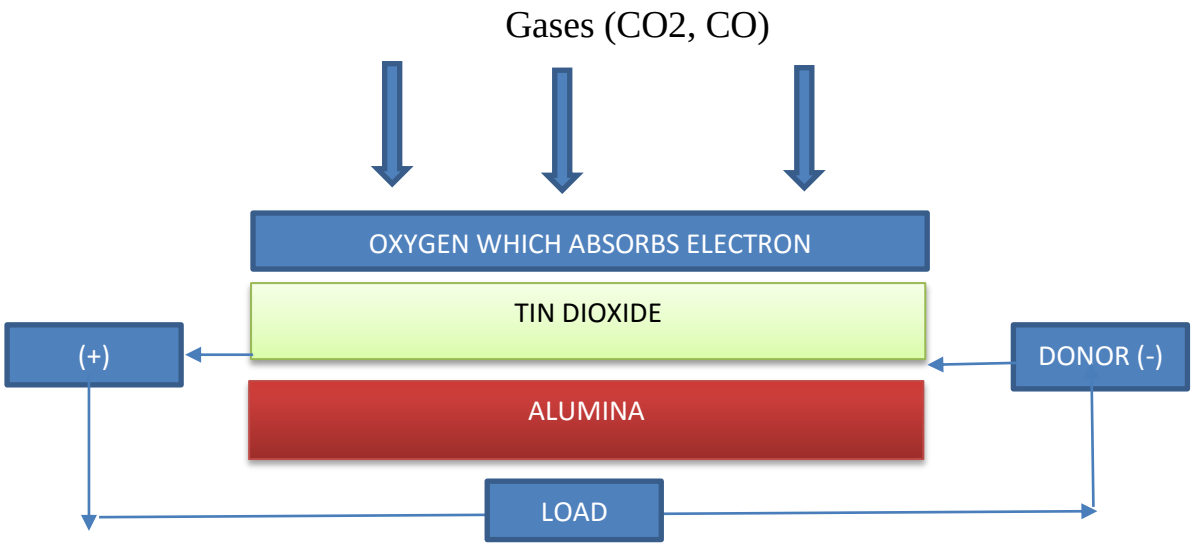


**FIGURE 2.3 METAL OXIDE SENSOR**

### 2.5.3 INFRARED (IR)

This method uses optical reflection technique to measure the gas concentration level. Each gas absorb light of some wavelength. It depends on type of gas that are going to measure. It consists of an infrared led and photodiode arrangement. In clean air all the light get reflected back to photodiode. When some gas falls on it then there will be some change in received light and this difference in signal tells us the concentration of gases.

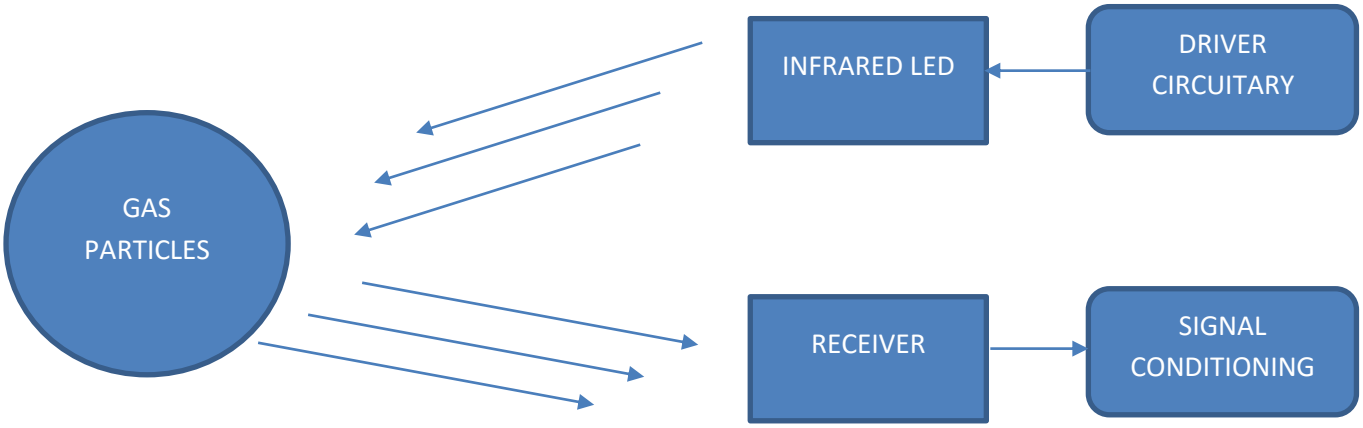


**FIGURE 2.4 INFRARED SENSOR**

### 2.5.4 PALLISTER AND SEMICONDUCTOR

In this the detecting element consists of a pellet and a resistor. Selection of a pellet depends on the gas that is going to be measured. Two beads called active bead and reference bead. When gas comes in contact with these beads active bead burns the gas and produces some heat which changes resistance. Then it is compared with reference bead to determine the concentration of gas applied.

Semiconductor method works on the same principle as pallister. Some resistance change represent the concentration of applied gas. Tin dioxide is the most common reactive material used in semiconductors. Common resistance used with this type of sensor is 50 kilo ohm.

Among these types of sensors in the market Metal Oxide type is chosen because it's settling time is very fast and consumes very less power compared to other types of sensors. Its reaction time is also too fast.

### 2.6 MICS 6814

Recent sensing technology utilize the power of metal oxides with the help of semiconductor technology. Metal Oxides are Nano particles which today takes place in most of Integrated Circuit fabrication technology. Micro Electric Mechanical Systems (MEMS) mostly uses metal oxide in its fabrication in order to decrease size and power consumption. MICS 6814 from SGX sensor tech is a type of Metal Oxide type sensor which uses Zinc Oxide as a sensing element. Working of metal oxide type gas sensing is show in picture below.

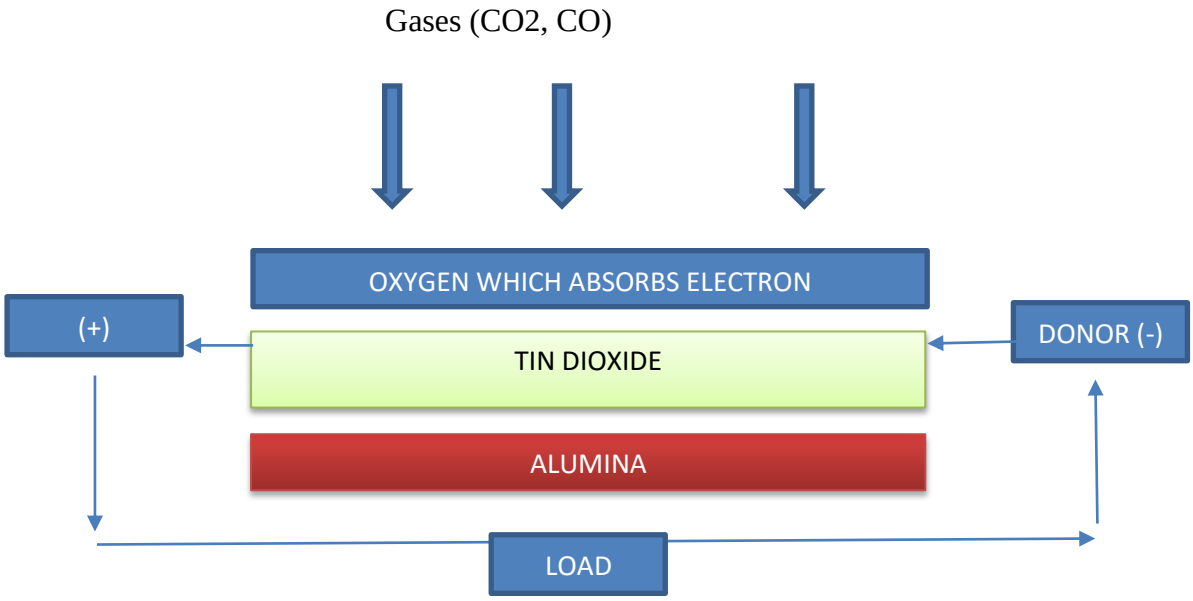


**FIGURE 2.5 MICS 6814**

It consist of Zinc oxide which does not allow any current to pass through it when pure oxygen falls on that. That is the resistance is infinity. When any contaminated gas falls on that, amount of current which starts flow through that and is directly proportional to concentration of fallen gas. By having different sensing elements (heating elements) different type of gas concentration is measured. MICS 6814 uses three different sensing elements in a single package which can measure gases like carbon monoxide, nitrous dioxide, ammonia. Heating element or substrate (RS) which combines with load resistor (RL) forms a voltage divider. Heating element acts as a variable resistor based on concentration of gases fallen. Output voltage swing varies depends on variable resistor. Data manipulation section will provides enough information about how these values are converted into microgram per cubic meter. Sensing element RS which is a variable resistance and RO which is the resistance value measure during calibration. Ratio of variable resistance (RS) to Initial resistance (RO) tells us concentration of gas levels. Each sensing element has its own variable resistance and calibration resistance which produces different ratio levels.

The figure below you the working principle of MICS6814, it contains three different sensing elements (heating elements) for sensing the levels of Carbon Monoxide, Nitrous Dioxide and ammonia. Each sensing element acts as a variable resistor. It needs a load resistor to act as an active voltage divider network. Thus output voltage varies proportional to the resistance of sensing element.

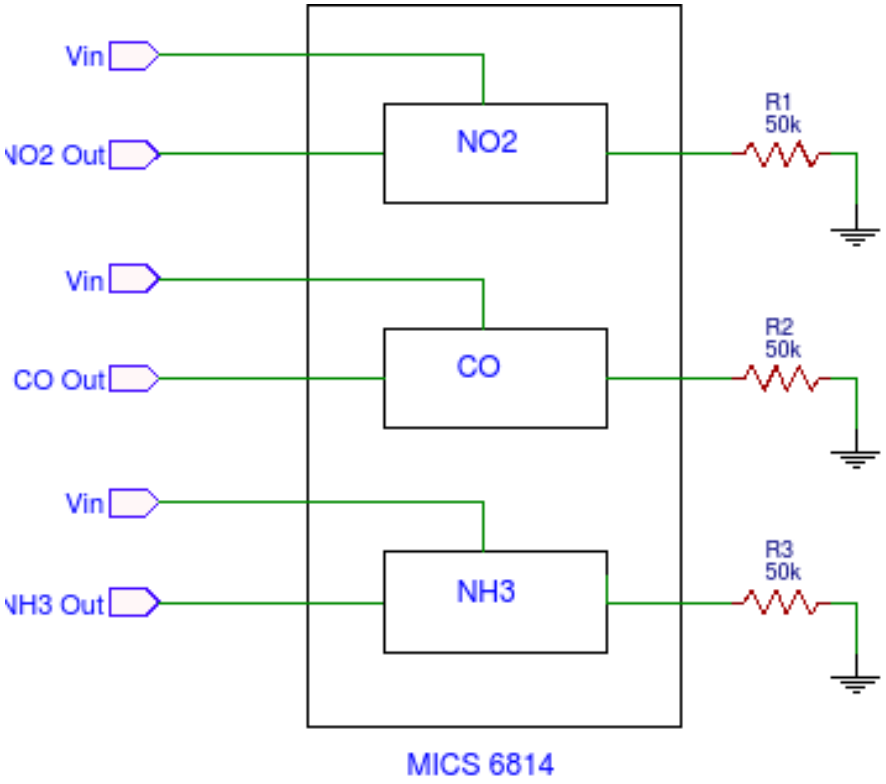


**FIGURE 2.6 MICS WORKING**

### 2.6.1 PERFORMANCE CHARACTERISTICS OF MICS 6814

Parameters which define sensitivity are RO (sensing resistance in air) and RS (Sensing element). Sensitivity factor of variable resistance is given as SR. Following table shows the specification of CO sensing element.

**Sensing characteristics of CO sensor**

**Table 2.1 CO CHARACTERESTICS**

| Characteristic of CO sensor | Symbol | Typical | Minimum | Maximum | Unit |
|---|---|---|---|---|---|
| Sensing resistance in air | RO | - | 100 | 1500 | K ohm |
| Typical CO detection range | FS | - | 1 | 1000 | PPM |
| Sensitivity factor | SR | - | 1.2 | 50 | - |

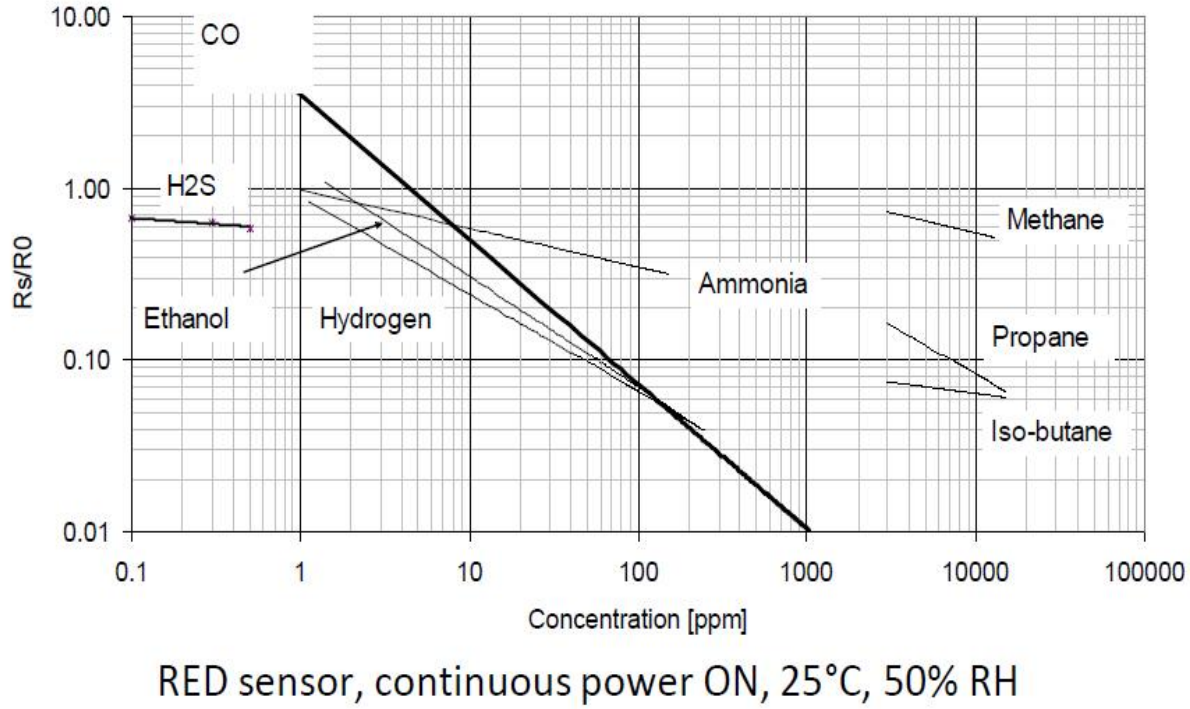


**FIGURE 2.7 CO CHARACTERESTICS**

**Sensing characteristics of NO2 sensor**

Parameters which define sensitivity are RO (sensing resistance in air) and RS (Sensing element). Sensitivity factor of variable resistance is given as SR. Following table shows the specification of NO2 sensing element.

**Table 2.2 NO2 CHARACTERESTICS**

| Characteristic of CO sensor | Symbol | Typical | Minimum | Maximum | Unit |
|---|---|---|---|---|---|
| Sensing resistance in air | RO | - | 0.8 | 20 | K ohm |
| Typical CO detection range | FS | - | 0.05 | 10 | PPM |
| Sensitivity factor | SR | - | 2 | - | - |

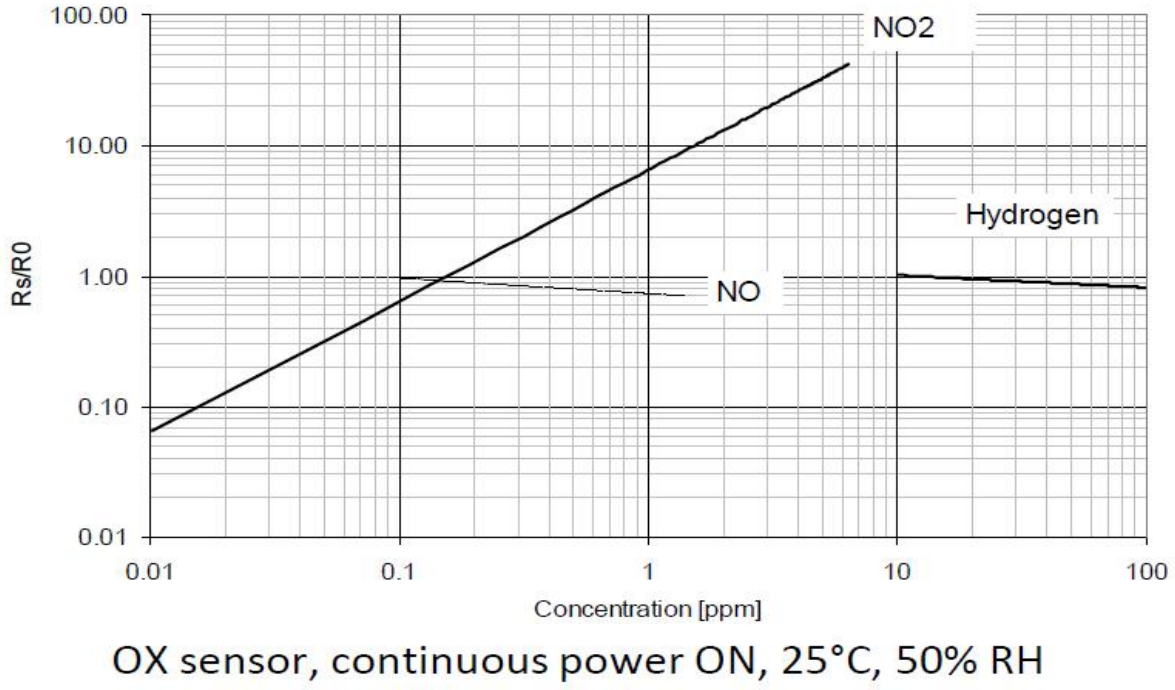


**FIGURE 2.8 NO2 CHARACTERESTICS**

**Sensing characteristics of NH3 sensor**

Parameters which define sensitivity are RO (sensing resistance in air) and RS (Sensing element). Sensitivity factor of variable resistance is given as SR. Following table shows the specification of NH3 sensing element.

**Table 2.3 NH3 CHARACTERESTICS**

| Characteristic of CO sensor | Symbol | Typical | Minimum | Maximum | Unit |
|---|---|---|---|---|---|
| Sensing resistance in air | RO | - | 10 | 1500 | K ohm |
| Typical CO detection range | FS | - | 1 | 300 | PPM |
| Sensitivity factor | SR | - | 1.5 | 15 | - |

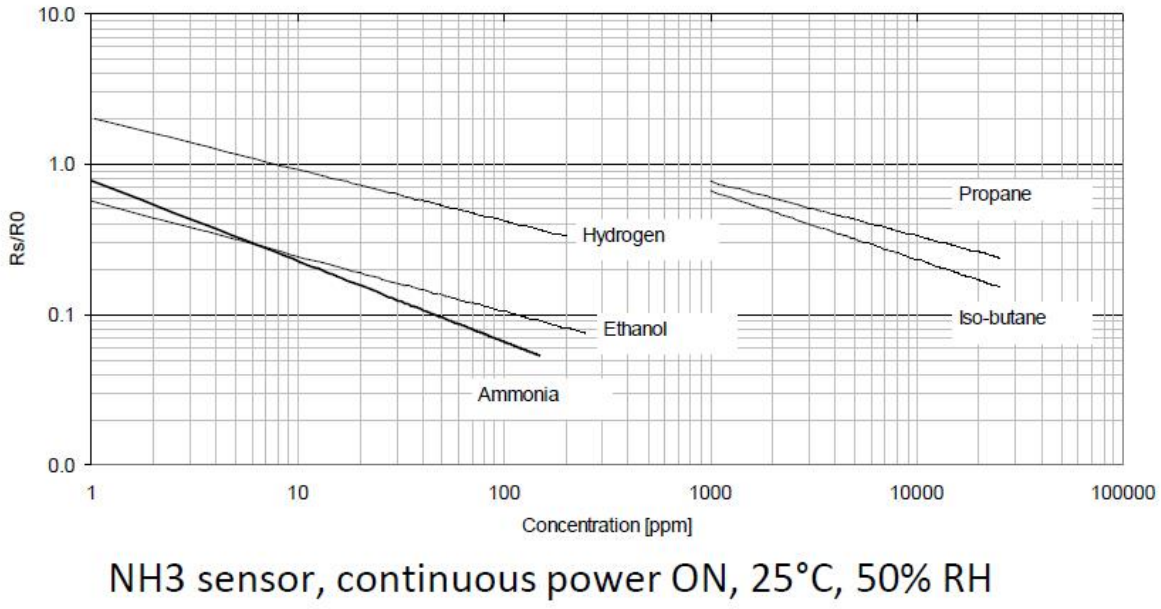


**FIGURE 2.9 NH3 CHARACTERESTICS**

Tables shows the detection range and sensitivity of each sensing elements. Ro value can be taken from calibrating the sensor and Rs values is a run time variable resistance value. Ratio of this will tells us the concentration. Graphs shows how resistance ratio is related to gas concentrations in PPM.Line equation for these graphs to find the relationship between ratio and PPM values is found. By passing RS/RO into that line equation, concentration level in PPM will be obtained.

### 2.6.2 ESTIMATION OF SENSITIVITY

First take two known points from the line to form an equation. Pass X and Y values into line equation Y=Mx+C. Then by solving two known equations, unknown value M that is slope can be found. Then by re arranging equation X is found which is PPM in above graph by passing Y as Rs/Ro above.

Above process is carried for every sampling window and averaged value is passed to following equation which results pollution level in microgram per cubic meter.

**PPB = PPM * 1000** → **Eq 2.1**

**Microgram per cubic meter = (PPM * 12.187 * M) / (273.15 + C) → Eq 2.2**

Where,

M - Single molecule weight of gas.

C – Temperature in Degree Celsius.

### 2.6.3 MICS 6814 MODULE

A module from MGsuper labs is used which has it's on board controller to receive analogue output from sensor. An algorithm which converts this raw data into Parts per Million levels by having pre analysed data's provided by sensor manufacturer. PPM values are taken from that module via Inter Integrated Circuit as a communication interface. Complete block diagram of our module is shown below.

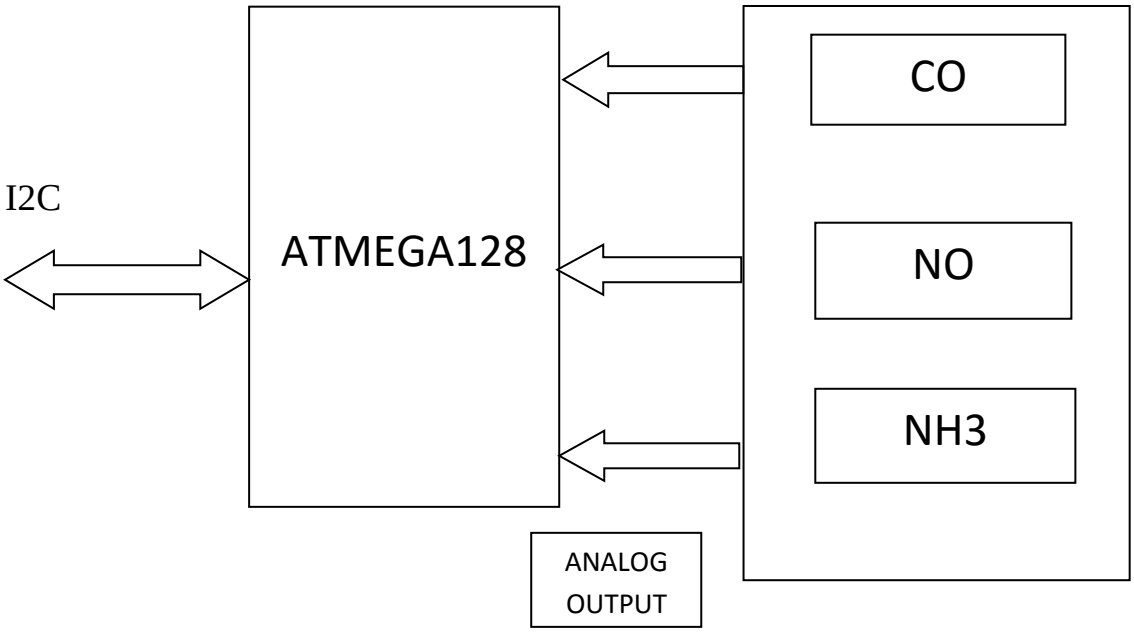


**FIGURE 2.10 MICS 6814 MODULE DIAGRAM**

ATMEGA 128 is an on board controller which continuously tells us the concentration of sensed gases from device start up. It applies an algorithm that will be discussed in software section to result the required values for further manipulations. Data output is taken through I2C protocol for further processing.

## 2.7 MQ131

MQ131, a semiconductor type sensor capable of sensing ground ozone level. Ozone present in ground will get react with hydrocarbons which causes lung and asthma problems. It consist of a heating element which gets react with ozone and changes its resistance proportional to ozone level present. The working principle is as follows.

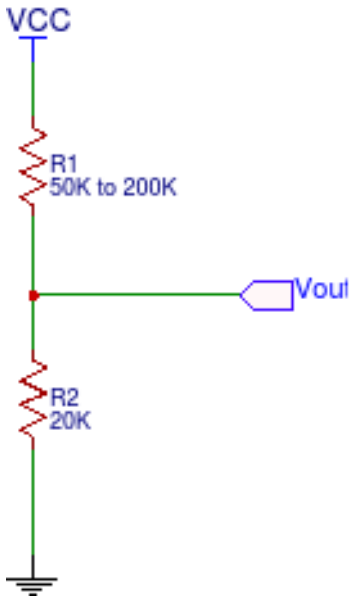


**FIGURE 2.11 MQ131 WORKING PRICIPLE**

Sensing element R1 varies between 50K - 200K. By connecting a load resistor of 20K, the network acts as a voltage divider. So output voltage varies depends on the resistance variation of this resistor R1. Specifications are given below.

### 2.7.1 ELECTRICAL CHARACTERISTICS OF MQ131

**TABLE 2.4 ELECTRICAL CHARACTERISTICS OF MQ131**

| Symbol | Parameter name | Level | Remarks |
|---|---|---|---|
| VH | Heating Voltage | 6V | DC |
| RL | Load Resistance | Variable | - |

## 2.8 PARTICULATE MATTER MEASURING PRINCIPLE

Particulate matter otherwise called as suspended particles can be found in air. They are in the form of dust, soot, smoke which cannot be seen by naked eye. It contains two types of matters. One of them are ‘inhalable matters’ which are less than 10 micro meter in size. Particles less than 2.5 micro meter comes under ‘fine particle’ which can easily pass through deep lungs and cause health problems. There are various techniques available in market for this particulate matter measurement. Optical measurement is one of its type. It is very simple to implement with high accuracy. It can be built with an Infrared transmitter, a photodiode and its signal conditioning circuit.

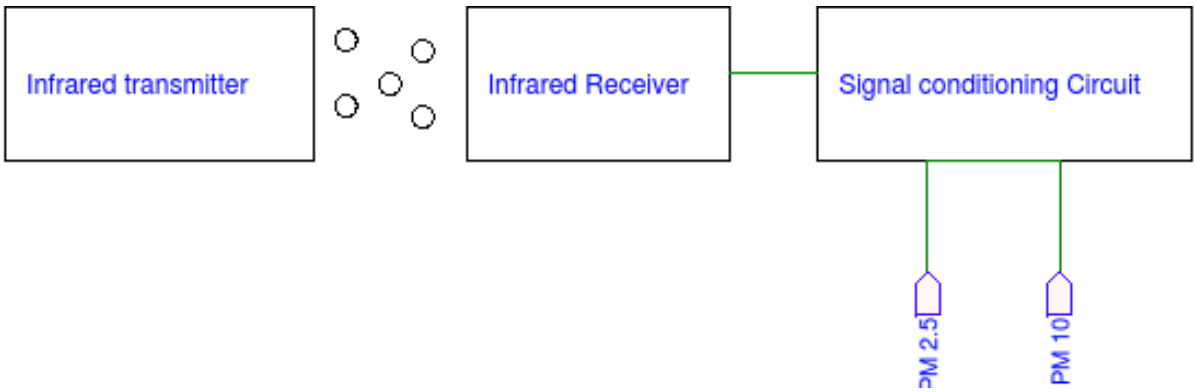


**FIGURE 2.12 DUST SENSOR WORKING PRINCIPLE**

Above block diagram simply explain working principle of optical type particulate measurement technique. It consist of an Infrared transmitter which is driven by constant current. Whenever dust particles comes in line of transmission, then lights gets blocked. Photodiode receives this refracted light and convert it into corresponding voltage by Transimpedance amplifier. Converted voltage is compared with pre calibrated threshold voltage levels to produce Pulse width Modulation (PWM) for both 2.5 and 10 micro meter dust particles. Because light blocked by 2.5 micro meter particle is less than 10 micro meter particle. So two different threshold levels are used to differentiate these two dust particles.

### 2.8.1 DUST SENSOR SM-PWM

Sm_PWM is a dust sensor that detects the dust particle concentration in air by using optical sensing method. An infrared light emitting diode and a photo sensor are optically arranged in the device. The photo sensor detects the reflected light by dust particle in air. It can detect the small particles like cigarette smoke and it can distinguish particles like smoke from large dust particle by use of pulse pattern. Picture below show the working principle.

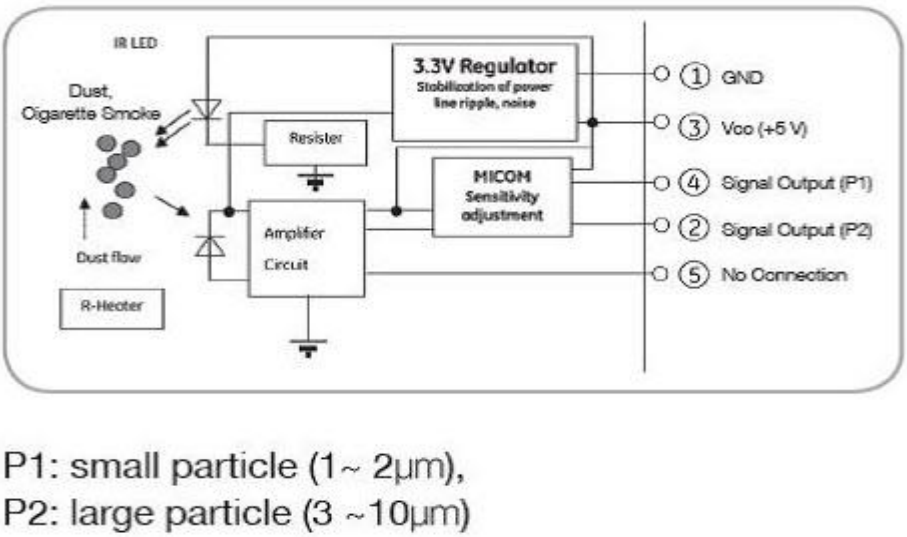


**FIGURE 2.13 SM-PWM WORKING PRINCIPLE**

The devices outputs two dust levels as a pulse modulated signal. Low pulse period indicates the presence of dust particle. So for a sampling window of 10 seconds time occupied by low pulse will tell you the percentage of dust level present. Algorithm is discussed in software section later.

### 2.8.2 FEATURES

- Compact size, Light weight
- PWM output (Active low)
- Distinguishes small particles of cigarette smoke from large particles
- Low pulse is proportional to particle size
- Le.8.2 ad free and ROHS directive compliant

### 2.8.3 APPLICATIONS

- Detection of dust in air for indoor and outdoor air quality monitoring
- Air cleaners, Air purifiers, Air conditioners.
- Smoke type fire alarm.

### 2.8.4 ELECTRICAL CHARACTERISTICS

**TABLE 2.5 ELECTRICAL CHARACTERISTICS OF DUST SENSOR**

| Parameter | Symbol | Rating |
|---|---|---|
| Supply Voltage | VCC | 0 – 7V |
| Operating Temperature | Toper | -10 – 70 |

## 2.9 MICROCONTROLLER ATMEGA 328

The ATmega48A/PA/88A/PA/168A/PA/328/P is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega48A/PA/88A/PA/168A/PA/328/P achieves throughputs approaching 1 MIPS per MHz allowing the system designer to optimize power consumption versus processing speed.

The AVR core combines a rich instruction set with 32 general purpose working registers. All the 32 registers are directly connected to the Arithmetic Logic Unit (ALU), allowing two independent registers to be accessed in one single instruction executed in one clock cycle. The resulting architecture is more code efficient while achieving throughputs up to ten times faster than conventional CISC microcontrollers.

The ATmega48A/PA/88A/PA/168A/PA/328/P provides the following features: 4K/8Kbytes of In-System Programmable Flash with Read-While-Write capabilities, 256/512/512/1Kbytes EEPROM, 512/1K/1K/2Kbytes SRAM, 23 general purpose I/O lines, 32 general purpose working registers, three flexible Timer/Counters with compare modes, internal and external interrupts, a serial programmable USART, a byte-oriented 2-wire Serial Interface, an SPI serial port, a 6-channel 10-bit ADC (8 channels in TQFP and QFN/MLF packages), a programmable Watchdog Timer with internal Oscillator, and five software selectable power saving modes. The Idle mode stops the CPU while allowing the SRAM, Timer/Counters, USART, 2-wire Serial Interface, SPI port, and interrupt system to continue functioning. The Power-down mode saves the register contents but freezes the Oscillator, disabling all other chip functions until the next interrupt or hardware reset. In Power-save mode, the asynchronous timer continues to run, allowing the user to

maintain a timer base while the rest of the device is sleeping. The ADC Noise Reduction mode stops the CPU and all I/O modules except asynchronous timer and ADC, to minimize switching noise during ADC conversions. In Standby mode, the crystal/resonator Oscillator is running while the rest of the device is sleeping. This allows very fast start-up combined with low power consumption. Atmel® offers the QTouch® library for embedding capacitive touch buttons, sliders and wheels functionality into AVR® microcontrollers.

The patented charge-transfer signal acquisition offers robust sensing and includes fully debounced reporting of touch keys and includes Adjacent Key Suppression® (AKS™) technology for unambiguous detection of key events. The easy-to-use QTouch Suite tool chain allows you to explore, develop and debug your own touch applications. The device is manufactured using Atmel's high density non-volatile memory technology. The On-chip ISP Flash allows the program memory to be reprogrammed In-System through an SPI serial interface, by a conventional non-volatile memory programmer, or by an On-chip Boot program running on the AV\R core. The Boot program can use any interface to download the application program in the Application Flash memory. Software in the Boot Flash section will continue to run while the Application Flash section is updated, providing true Read While-Write operation. By combining an 8-bit RISC CPU with In-System Self-Programmable Flash on a monolithic chip, the Atmel ATmega48A/PA/88A/PA/168A/PA/328/P is a powerful microcontroller that provides a highly flexible and cost effective solution to many embedded control applications. The ATmega48A/PA/88A/PA/168A/PA/328/P AVR is supported with a full suite of program and system development tools including: C Compilers, Macro Assemblers, Program Debugger/Simulators, In-Circuit Emulators, and Evaluation kits.

## 2.9.1 ARCHITECTURE

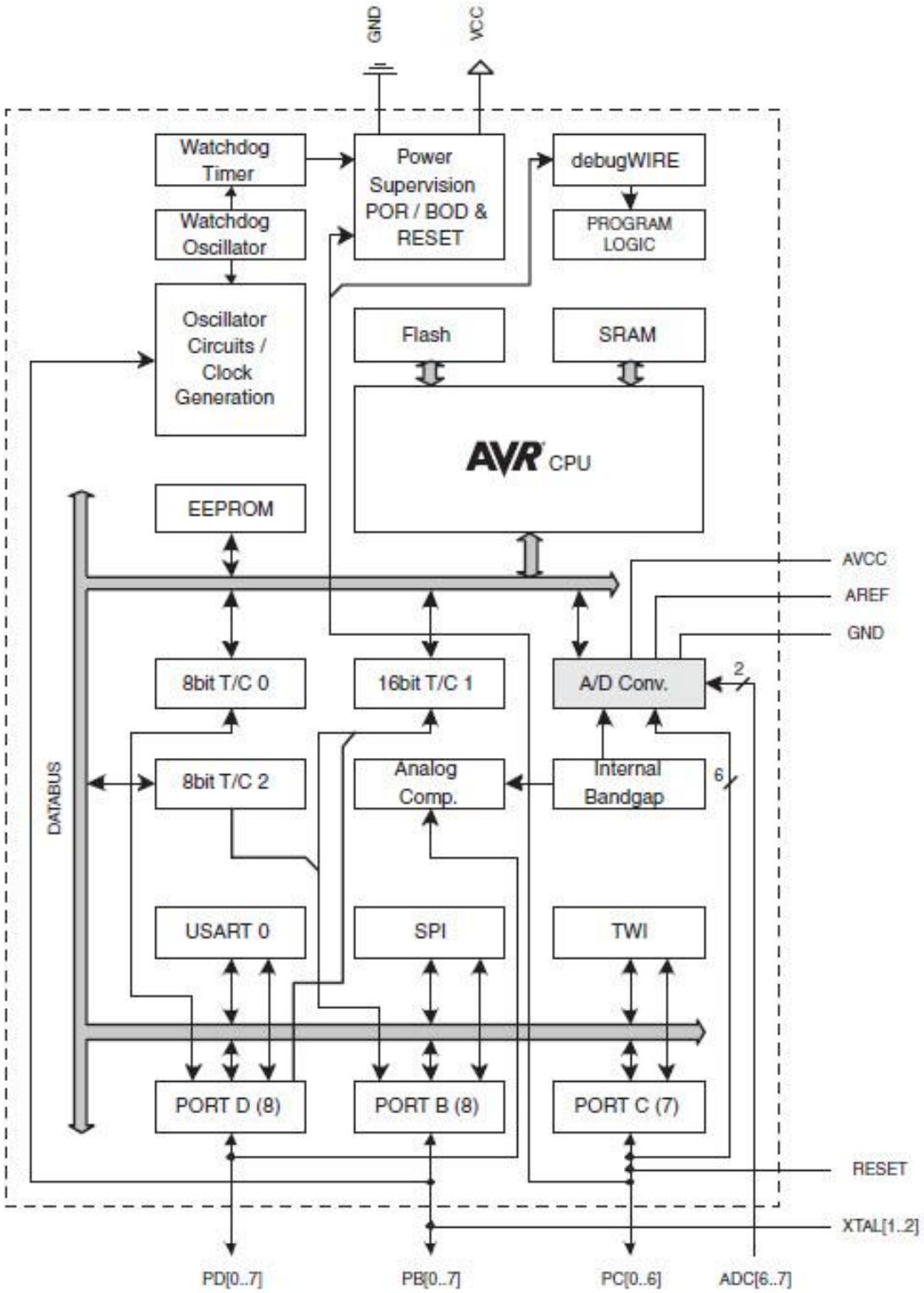


**FIGURE 2.14 ATMEGA 328P ARCHITECTURE**

### 2.9.2 ANALOG TO DIGITAL CONVERTER

To convert analog quantities into digital domain, A/D converters play a major role. ATMEGA328 has a 10 bit, programmable sampling rate analog to digital converter. It has eight analog input channels to interface as many sensors. It has a full scale input of 5V and optional voltage reference pin to vary the full scale input. Its output scale is from 0 to 1024. Four different channels have been used to interface four different gas sensors. Each channel is converted sequentially.

### 2.9.3 FEATURES

- High performance, Low power 8 bit microcontroller family
- Advanced RISC architecture
- 131 powerful instructions
- 32x8 general purpose working registers
- Fully static operation
- Up to 20 MIPS
- 32 Kilo bytes of flash memory
- 256 bytes of EEPROM
- 512 bytes of SRAM
- Programmable serial USART
- Master Slave SPI interface
- Six PWM channels
- Six channel 10 bit Analog to Digital converters
- On chip Analog converter
- Interrupt and wake up
- Power on reset
- Brown out reset
- Operating range – 1.8V to 5.5 V

- Operating frequency - 4 to 20 MHz

## 2.10 SIM808

SIM808 module is a complete Quad band GSM/GPRS module which combines GPS technology for satellite navigation. The compact design which integrated GPRS and GPS in a SMT package will significantly save both time and costs for customers to develop GPS enabled applications. Featuring an industry standard interface and GPS function, it allows variable assets to be tracked seamlessly at any location and anytime with signal coverage.

Here SIM808 is used as a gateway to connect to our server. Free hosting service from hostinger is used. After collecting and processing data that have to be posted it into database for further processing. Here SIM808, a GPS, GPRS and GSM chipset connects to internet through which data is posted to cloud.

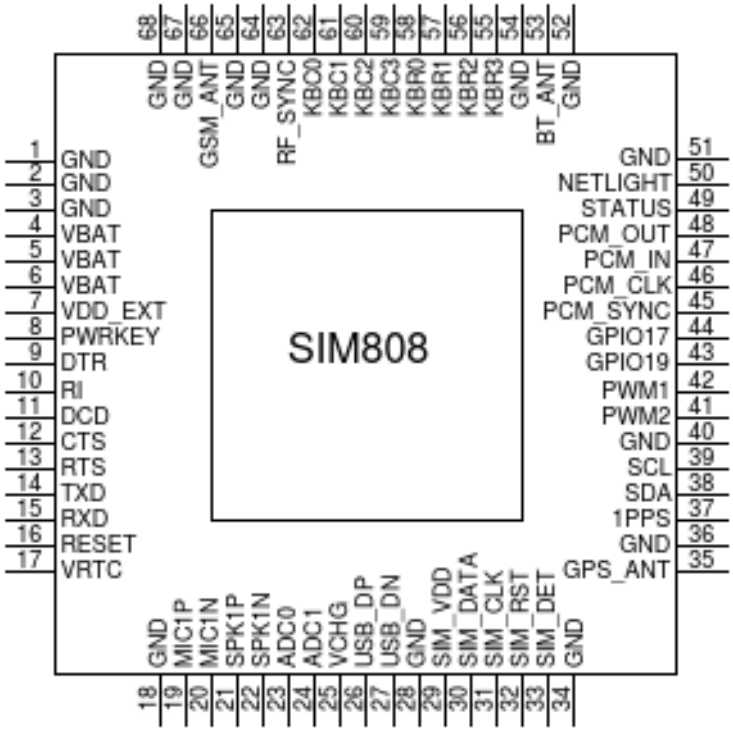


**FIGURE 2.15 SIM808 PINOUT**

Communication between SIM808 and microcontroller via Universal Asynchronous Receiver Transmitter (UART). With the help of AT commands features of this chipset is accessed and controlled.

SIM808 has following functional parts:

- The GSM baseband engine
- The GPS engine
- Flash memory
- The GSM radio frequency part
- The antenna interface
- The other interfaces

### 2.10.1 AT COMMANDS USED

| **COMMAND** | **DESCRIPTION** |
|---|---|
| AT+CGPSPWR | GPS POWER CONTROL |
| AT+CGPSRST | GPS RESET MODE (COLD/HOT/WARM) |
| AT+CGPSINF | GET CURRENT GPS LOCATION INFO |
| AT+CGPSOUT | GET NMEA DATA OUTPUT CONTROL |
| AT+CGPSSTATUS | GPS FIX STATUS |
| AT+SAPBR=3,1”Contype”,”GPRS” AT+SAPBR=3,1”APN”,”CMNET” | CONFIGURE BEARER PROFILE 1 |
| AT+SAPBR=1,1 | TO OPEN A GPS CONTEXT |
| AT+SAPBR=2,1 | TO QUERY THE GPS CONTEXT |
| AT+SAPBR=0,1 | TO CLOSE THE GPS CONTEXT |
| AT+HTTPINIT | INIT HTTP SERVICE |
| AT+HTTPPARA=”CID”,1 AT+HTTPPARA=”URL”,”WWW.XYZ.COM | SET PARAMETERS FOR HTTP SESSIONS |

| | |
|---|---|
| AT+HTTPACTION=0 | GET SESSION START |
| AT+HTTPREAD | READ THE DATA OF HTTP SERVER |
| AT+HTTPTERM | TERMINATE HTTP SERVICE |

SIM808 module supports transfer protocols like FTP, HTTP for transferring of files in machine to machine communication. Data is sent via Hyper Text Transfer Protocol. Problem faced is when using this protocol is that the sent data will be reflected at server side for a fraction of second. So instant data is taken and store it in any other file. A database is used to store our data's. A PHP handler reads the data from HTTP and store it in local variables. Then connect to our database and store these values. Extracting data from Url is as follows.

**$_Variable_1 = $_GET[“variable_1];**

**$_Variable_2 = $_GET[“variable_2];**

Left hand side variable are PH variables which temporarily stores the extracted values. GET is a keyword to indicate that data was sent using which method. Variables inside square braces must be the same name as that are sent while it is sent. PHP variables now holds the values of that key names. Finally posting data to database.

## 2.11 POWER SUPPLY

In order to operate the circuit properly good regulated power supply is provided. There are varieties of voltage regulators in market. They are linear regulators, low drop out regulators and switched regulators. Linear regulators often packaged as a fixed voltage regulator which means it has a constant voltage drop of 1.25V to 1.75V. This provides the perfect regulation because of laser tuned components presents in Integrated circuit. But it is not suitable when input voltage approaches near the output voltage. For example 6V battery is needed to generate 5V for our circuit to operate properly. It cannot be possible by using fixed voltage regulators because, the drop 1.25 is fixed. So it can only generate a maximum of 4.5 to 4.75 at the output. It also produces more heat due to power dissipation. Low drop out regulators comes as variable regulators and it can produce required output voltage when input voltage appears near. Any required voltage can be regulated by just having two external resistors and two filter capacitors. Both linear and low drop out regulators are not efficient in battery operated applications because of high power dissipation. Switched regulators are otherwise called as buck converters does DC to DC conversion by switching operation provides very high efficiency. Cost of buck converters are high when compared two linear and low drop out regulators.

Here two low drop out regulators are to provide separate supply for microcontroller and sensors. The output voltage can be programmed simply using the external resistors. Formula for calculating the resistor values.

$$V_{out} = (1 + R2/R1) * 1.25 \qquad \rightarrow \text{Eq 2.3}$$

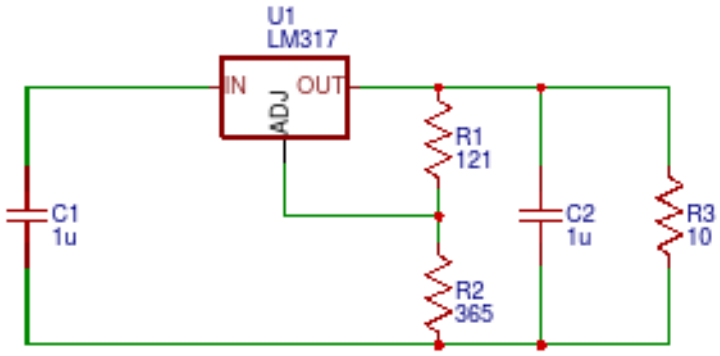


**FIGURE 2.16 LDO CIRCUIT**

For 5V output:

R1 = 121 ohm

R2 = 365 ohm

Vout = (1 + 365/121) * 1.25

## 2.12 TOOLS USED

Development phases include hardware simulation, schematic and layout design, power supply design. Following are the tools used for simulation and designing.

### 2.12.1 ALTIUM DESIGNER

Altium Designer is an electronic design automation software package for printed circuit board, FPGA and software design, and associated library and release management automation. It is developed and marketed by Altium Limited of Australia.

Schematic capture module provides electronic circuit editing functionality, including:

- Component library management
- Schematic document editing (component placement, connectivity editing and design rules definition)
- Integration with several component distributors allows search for components and access to manufacturer's data[3]
- SPICE mixed-signal circuit simulation
- Pre-layout signal integrity analysis
- Netlist export
- Reporting and BoM facilities
- Multi-channel, hierarchical schematics and design re-use

**SCHEMATIC**

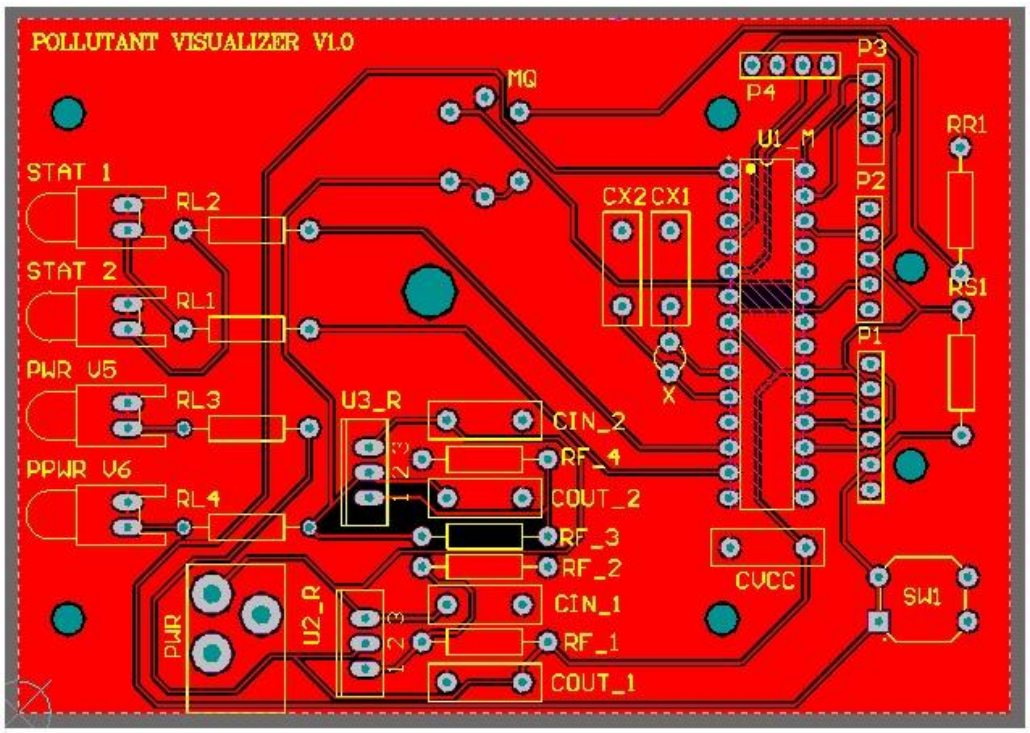


**FIGURE 2.17 PCB LAYOUT**

### 2.12.2 LTSPICE

LTspice IV is a high performance SPICE simulator, schematic capture and waveform viewer with enhancements and models for easing the simulation of switching regulators. Our enhancements to SPICE have made simulating switching regulators extremely fast compared to normal SPICE simulators, allowing the user to view waveforms for most switching regulators in just a few minutes. Included in this download are LTspice IV, Macro Models for 80% of Linear Technology's switching regulators, over 200 op amp models, as well as resistors, transistors and MOSFET models.

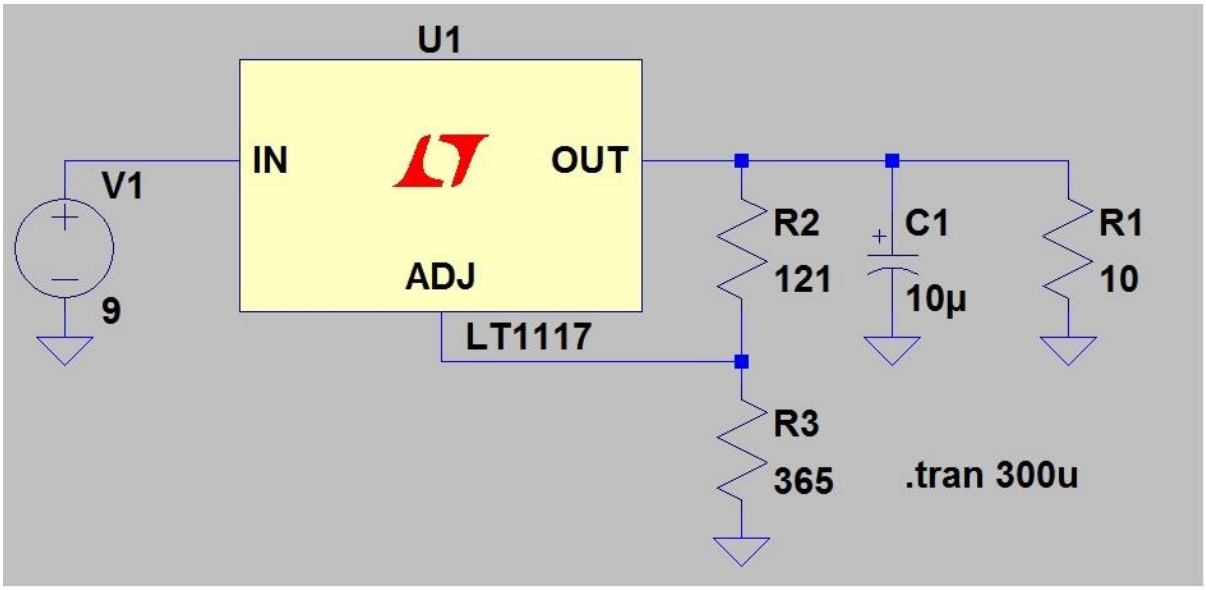


**FIGURE 2.18 LTSPICE SCHEMATIC**

### 2.12.3 PROTEUS

The Proteus Design Suite is an Electronic Design Automation (EDA) tool including schematic capture, simulation and PCB Layout modules. It is developed in Yorkshire, England by Labcenter Electronics Ltd with offices in North America and several overseas sales channels. The software runs on

the Windows operating system and is available in English, French, Spanish and Chinese languages. The Proteus Design Suite is a Windows application for schematic capture, simulation, and PCB layout design. It can be purchased in many configurations, depending on the size of designs being produced and the requirements for microcontroller simulation. All PCB Design products include an auto router and basic mixed mode SPICE simulation capabilities. Schematic capture in the Proteus Design Suite is used for both the simulation of designs and as the design phase of a PCB layout project. It is therefore a core component and is included with all product configurations

The micro-controller simulation in Proteus works by applying either a hex file or a debug file to the microcontroller part on the schematic. It is then co-simulated along with any analog and digital electronics connected to it. This enables it's used in a broad spectrum of project prototyping in areas such as motor control, temperature control and user interface design. It also finds use in the general hobbyist community and, since no hardware is required, is convenient to use as a training or teaching tool. Support is available for co-simulation of:

- Microchip Technologies PIC10, PIC12, PIC16, PIC18, PIC24, dsPIC33 Microcontrollers.
- Atmel AVR (and Arduino), 8051 and ARM Cortex-M3 Microcontrollers
- NXP 8051, ARM7, ARM Cortex-M0 and ARM Cortex-M3 Microcontrollers.
- Texas Instruments MSP430, PICCOLO DSP and ARM Cortex-M3 Microcontrollers.
- Parallax Basic Stamp, Freescale HC11, 8086 Microcontrollers

The PCB Layout module is automatically given connectivity information in the form of a net list from the schematic capture module. It applies this information, together with the user specified design rules and various design automation tools, to assist with error free board design. Design Rule Checking does not include high speed design constraints. PCB's of up to 16 copper layers can be produced with design size limited by product configuration

# CHAPTER 3

# SOFTWARE IMPLEMENTATION

This section will discuss deep into the software development in this section. This section comprised of algorithm development for data posting, database management, data retrieval and Google maps API.

## 3.1 ALGORITHM

The flow chart of our algorithm is shown in figure. As the process involves network connectivity it needs some important thing that has to be done at device start up. The start-up process includes connecting the device to the network. To do that necessary AT commands are to be passed to the cellular modem. For each command modem replies about the success or failure of that command. For example, AT is a command used to verify whether the device is alive or not. Modem replies "OK" if it's working else its reply will be "ERROR". Different responses from the modem for various commands will come. These replies indicate that whether the modem is connected to network or not. Hence, all other process will be in a queue until the modem gets connected to network.

Second process is starting data service to communicate with server. It involves similar process like network connectivity but it needs some network settings like APN, username and password. All these settings are done by AT commands. As the process involves of grabbing location co-ordinates the device has to get lock with GPS satellites which comes third in a queue. Different status led's shows the status of network connectivity, data services, and GPS.

The above mentioned three processes are mandatory for proper operation. All other manipulations will be kept in a queue. After successful start up the key process begins and it is nothing but data acquisition and manipulating. The first sampling window is for the calibration of sensors. Here the main acquisition

begins. The result of this process will be gas concentrations in PPM and Microgram per cubic meter. This process continuous for every 10 seconds and average those data's. The next part plays an important role in cloud connectivity. The accumulated or averaged values are sent to our server with the help of Hyper Text Transfer Protocol. As mentioned earlier our modem has software layer for HTTP, FTP, and TCP etc. HTTP can transmit or receive simple text data's. More about data posting will be discussed in a separate section. The start-up process can stop the main process at any time via interrupts if there is any disconnectivity problems occurred in data or network connectivity. The loop from data acquisition to data posting continuous forever.

HTTP supports two methods in data posting. GET and POST method. Here GET method is used to pot data’s to server. The syntax of posting data via HTTP is below.

**http://www.xyz.com/?variable_1=value1&variable_2=value2**

HTTP denotes the type of transfer protocol . Our domain name comes after that. A question mark symbol (?) denotes the start of data’s. Key and data is the format used. Key is used while retrieving data in server side and values is run time value.

### 3.1.1 FLOW CHART

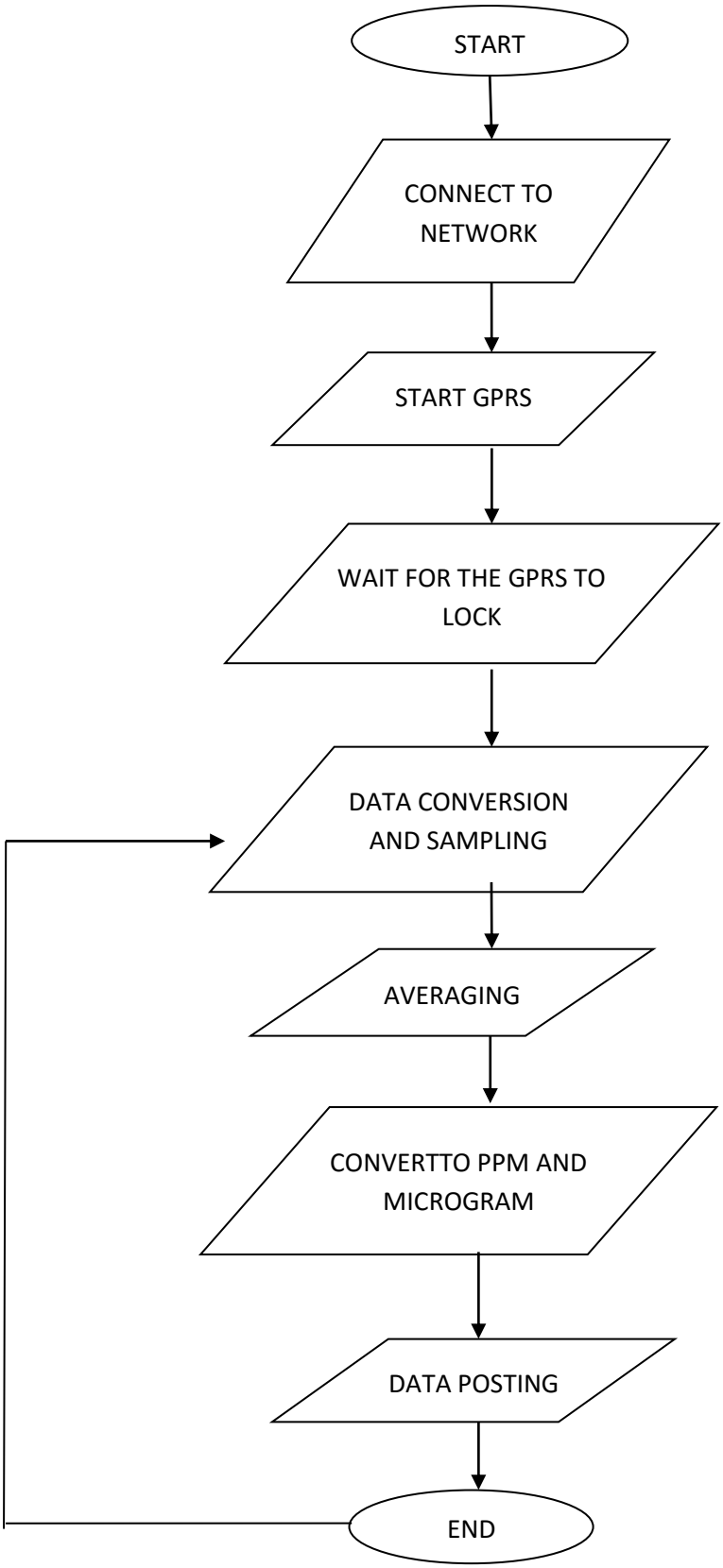


**FIGURE 3.1 DATA ACQUISITION FLOW CHART**

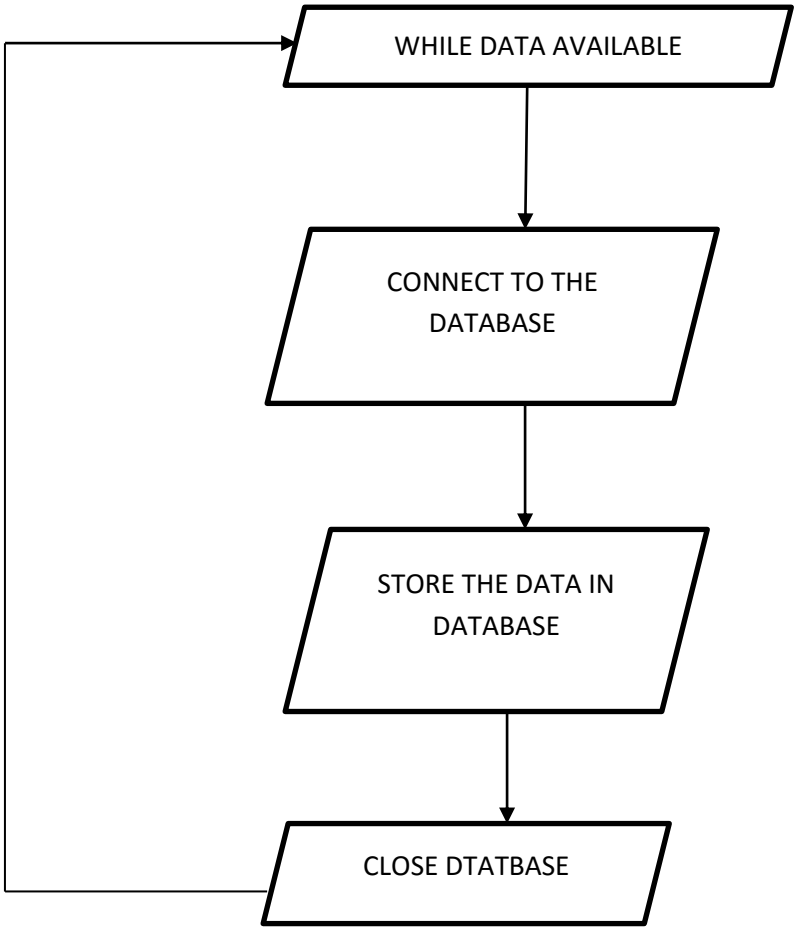


**FIGURE 3.2 FLOW CHART FOR PHP HANDLING**

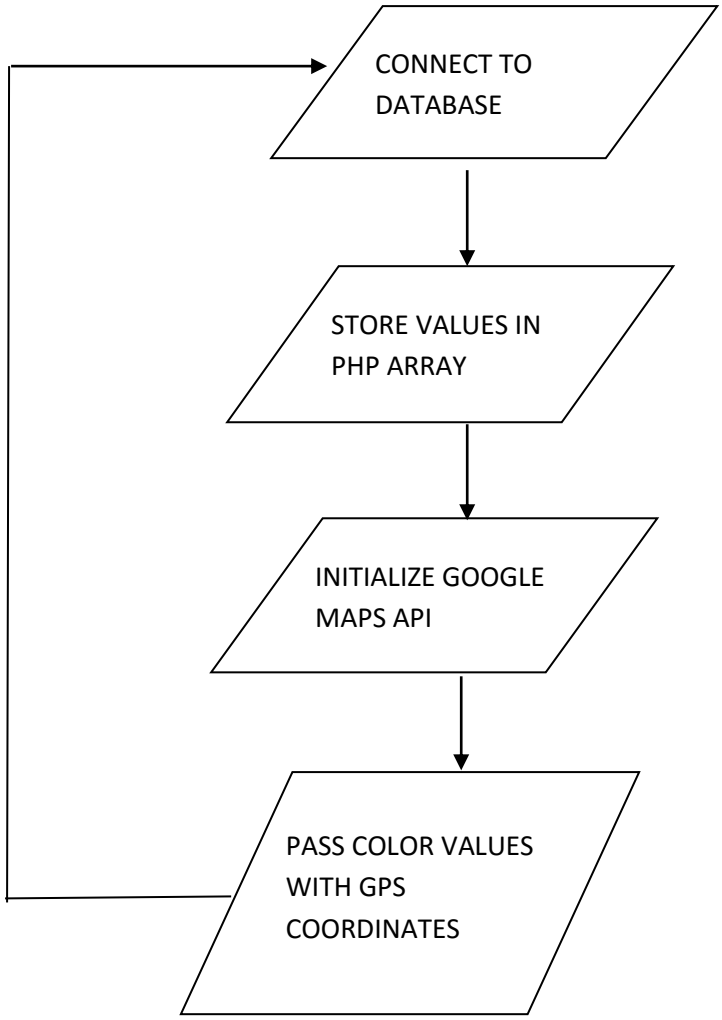


**FIGURE 3.3 FLOW CHART FOR DATA RETRIEVAL**

## 3.2 DATABASE MANAGEMENT

Code below shows how data is extracted and stored in data base. First username, password and database name are stores in separate variables. Those variables are then passed to MySQL query to get access to that database. After successful authentication any number of queries to insert and delete data's into database.

**Syntax for inserting database**

- **INSERT INTO mytable(latitude,longitude,color,size)VALUES ('$a','$b','$c','$d')**

**Syntax for selecting database:**

- **SELECT * FROM mytable**

Where,

Mytable – table name

(*) – select everything

### 3.3 DATA RETRIEVAL

The processed the data and have sent the data to the server. And the server contains a PHP handler which retrieves the data and stores it in a database. Beside the data stored it also contains the location co-ordinates and the colour values. The colour values are based on Indian air quality index.

| **AIR QUALITY INDEX** | **COLOUR** |
|---|---|
| (0-50) GOOD | GREEN |
| (51-100) MODERATE | YELLOW |
| (101-150) UNHEALTHY FOR SENSITIVE GROUPS | BROWN |
| (151-200) UNHEALTHY | RED |
| (201-230) VERY UNHEALTHY | PURPLE |
| (301-500) HAZARDOUS | DARK PURPLE |

Now, these data's should be passed to google maps API, those read data's should be stored in a PHP array. The google API is written in JavaScript. The PHP array should be passed to the array of JavaScript. Now, according to the GPS location the colour values will be shown in the map. The codes for it is shown below

## 3.4 GOOGE MAPS API

Google Maps is a desktop web mapping service developed by Google. It offers satellite imagery, street maps, 360° panoramic views of streets (Street View), real-time traffic conditions (Google Traffic), and route planning for traveling by foot, car, bicycle (inbeta), or public transportation.

After the success of reverse-engineered mashups such as chicagocrime.org and housingmaps.com, Google launched the Google Maps API in June 2005 to allow developers to integrate Google Maps into their websites. It is a free service, and currently does not contain ads, but Google states in their terms of use that they reserve the right to display ads in the future.

By using the Google Maps API, it is possible to embed Google Maps site into an external website, on to which site specific data can be overlaid. Although initially only a JavaScript API, the Maps API was expanded to include an API for Adobe Flash applications (but this has been deprecated), a service for retrieving static map images, and web services for performing geocoding, generating driving directions, and obtaining elevation profiles. Over 1,000,000 web sites use the Google Maps API, making it the most heavily used web application development API.

The Google Maps API is free for commercial use, provided that the site on which it is being used is publicly accessible and does not charge for access, and is not generating more than 25 000 map accesses a day. Sites that do not meet these requirements can purchase the Google Maps API for Business.

The success of the Google Maps API has spawned a number of competing alternatives, including the HERE Maps API, Bing Maps Platform, Leaflet and Open Layers via self-hosting. The Yahoo! Maps API is in the process of being shut down.

In September 2011, Google announced it would discontinue a number of its products, including Google Maps API for Flash.

## 3.5 SOFTWARE TOOLS USED

A number of design tools and development environments helped us for web development. List of tools are as follows.

- WAMP server
- PHP designer
- Hostinger

### 3.5.1 WAMP SERVER

Wamp Server refers to a software stack for the Microsoft Windows operating system, created by Romain Bourdon and consisting of the Apache web server, Open SSL for SSL support, MySQL database and PHP programming language. It is used for testing our program by simply using our PC as a server (i.e local hosting). Similar to LAMP in Linux operating system.

### 3.5.2 PHP DESIGNER

PHP designer is a development tool which provides a complete development environment for web development. It provides facilities to edit, run and debug the code under a single window. It has an intelligent editor with autocomplete feature which reduces our development time.

### 3.5.3 HOSTINGER

Hostinger provides free domains for students and professionals. They provided a user friendly control panel which supports file transfer protocol, database management and many. Two gigabytes of data for hosting our data's for free and two free database.

### 3.5.4 WORKING MODEL

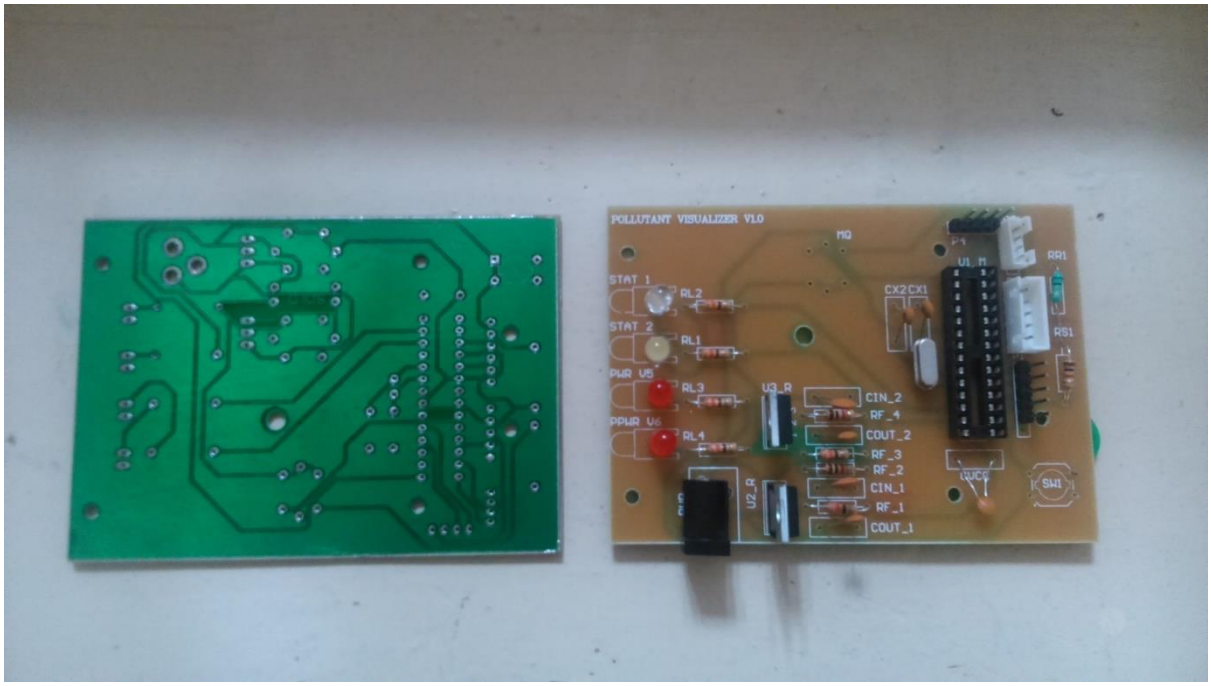


**FIGURE 3.4 PCB AND PCB ASSEMBLY**

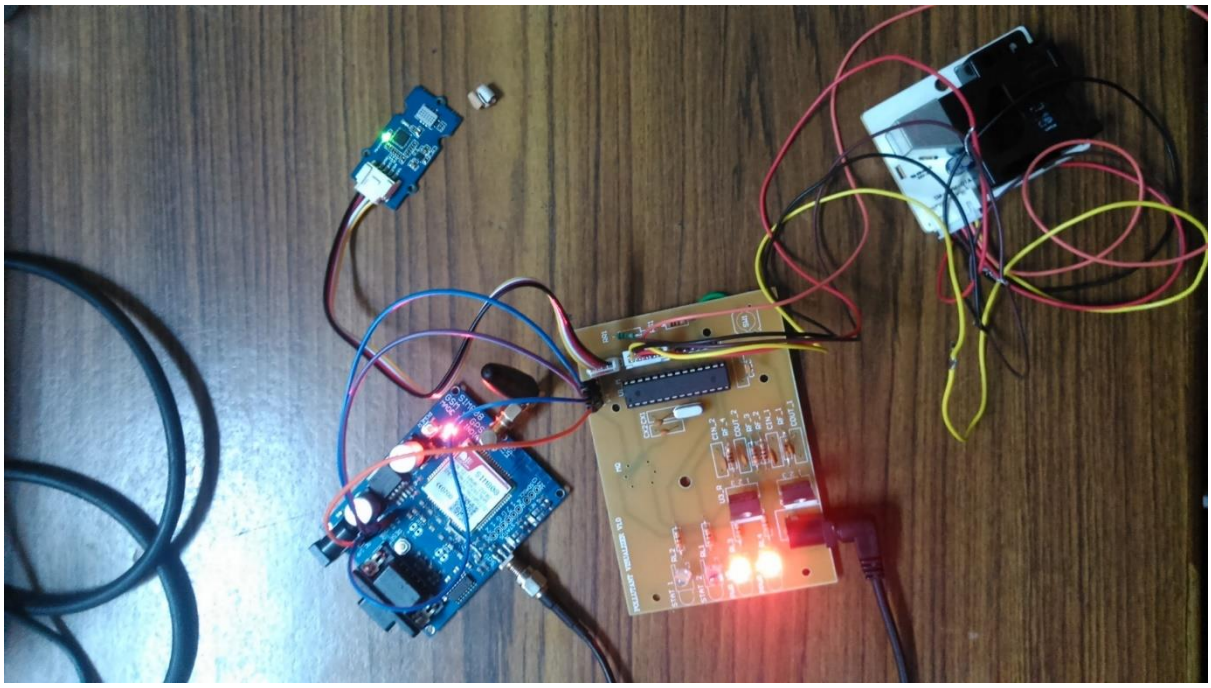

**FIGURE 3.5 COMPLETE PROTOTYPE**

## RESULT

Test map of our final prototype is shown below. We have tested our device inside our campus to get real time reading. As it is a green campus we have very less pollution level. Colour dot is in green which is called as good according to Air Quality Index, India. Each value on map is based on the pollutant that are measured. In future some information's about colour and check boxes will be added to sort out what we are looking for.

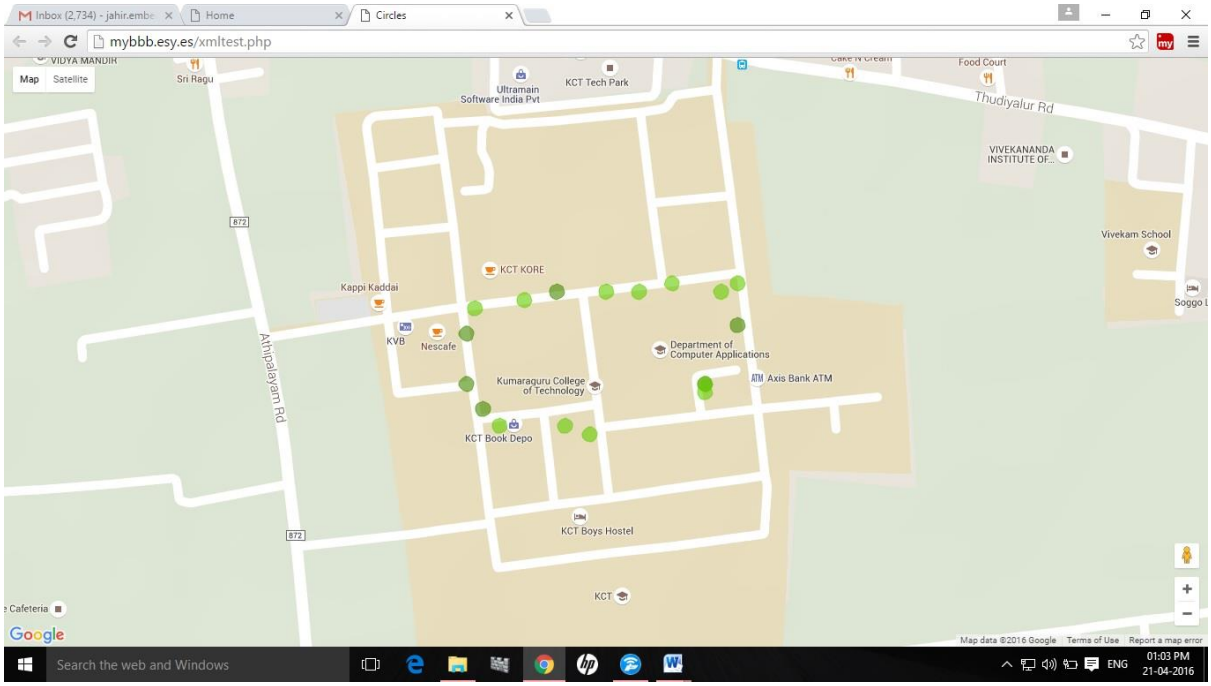


**FIGURE 3.6 ENVIRONMENT TEST**

# CHAPTER 4

# CONCLUSION

This system creates an open community for people to get self-awareness about their surrounding environment. To increase affordability to reach everyone and reduced size to be fit inside a pocket for portability the design has been optimized many times. We have taken a step to create a clean and eco-friendly environment for our future generation. By implementing this in real time we can have personalized health awareness for an individual and they can take part into our open community map so that everyone gets benefited.

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