The International Journal of Engineering and Science (IJES)
|| Volume || 8 || Issue || 3 Series I|| Pages || PP 35-45 || 2019 ||
ISSN (e): 2319 – 1813 ISSN (p): 23-19 – 1805

Development of an Improved Intelligent Gas Leak Monitor Incoporating an Automatic Leak Notification System

Okereke Eze Aru
Department of Computer Engineering Michael Okpara University of Agriculture, Umudike, Umuahia, Abia State, Nigeria

ABSTRACT
Liquefied Petroleum Gas (LPG) is a major source of cooking energy in Nigeria today, especially in the city areas because of its clean energy compare to firewood and charcoals used in the rural areas. There is always a danger of gas leakage as a result of negligence or failure from the regulating valve of the gas cylinder which poses great danger to the inhabitants of those houses, due to highly flammable nature of cooking gas. Cases of gas related fire has been on the rise and this can be avoided by employing a technology. In this work, a gas leakage detector system is proposed. The system is designed using microcontroller 8051, MQ-6 sensor, resistors, transistors, transformer, buzzer etc. The use of microcontroller 8051 is to enable the design and construction of a high accurate and fast response detection system. The detection system uses MQ-6 module, which has a gas detection range of 300-10000ppm as the LPG sensor, 89S52 microcontroller as the control unit, a buzzer as an alarm and a number of LEDs to indicate the gas leakage status. The microcontroller senses the presence of a gas when the voltages signal from the MQ-6 sensor goes beyond a certain level and gives an audio alarm. The microcontroller is programmed using assembly language and all the peripherals connected to it through it pins. When the system is powered ON, the microcontroller light a green LED to show the absence of a gas leakage. LPG is released and the sensor voltage signal monitored through the microcontroller. If the sensor output voltage level is below 2.0V, the green LED is kept ON and when the voltage is more or equal to 2.0V, the microcontroller blinks a red LED and set off an alarm to show the presence of a gas. The sensor has a high resistance in a clean air. In the presence of LPG gas, the sensor conductivity increases and the characteristic of the sensor is at 2.0V output from the sensor, the gas concentration is 300ppm, thus the trigger level is 2.0V.
Keywords: Gas Leak, Microcontroller, Liquefied Petroleum Gas (LPG), Sensors, Alarms, etc

Date of Submission: 20-02-2019 Date of acceptance: 08-03-2019

I. INTRODUCTION

Liquefied Gas is a leading source of energy used for cooking and heating in our homes. It provides an economic and affordable clean source of energy compared to other source of energy like firewood, cool or Electricity. It is also used as a source of energy in industry and fueling our cars. The two major type of gas used are Natural Gas and Liquefied Petroleum Gas (LPG), both of which are hydrocarbons gases. Natural Gas is basically methane gas while LPG is a mixture of butane and propane gas or purely butane or propane gas. Natural gas is extracted from underground while LPG gas is a by-product of Natural Gas and crude oil processing. These gases have a characteristic of being highly flammable and can cause suffocation in high concentration. It is because of these, the usage of gases should be done with great care and safety standards are to put in place to ensure everyone using the gas is safe. Gas used for cooking is supplied in gas cylinders which have a regulating valve. After using the gas you are supposed to turn off the gas. The supplier of the gas should make sure the valve are working well and not leaking the gas.

Observation of the safety standards would avoid the dangers posed by the gas. However, systems made by human being are bound to fail at one point due to wearing out, accident or by intention. Also by accident, we might forget to turn off the gas. This poses an immediate danger to life and property due to the flammable and intoxicating nature of this gas. As an engineer, it is a lifesaving task to design a LPG detector capable of raising an alarm and showing the concentration of the gas leakage. Thus we are going to design a microcontroller based cooking gas leakage detector.

II. MOTIVATION

There will always be a risk of gas leakage while we are using the cooking gas. If the leakage of the gas goes undetected it leads to undesirable consequences. Fire related to gas leakage has not only destroyed millions worth of properties but also have cost lives. Gas leakage also pollutes the environment by adding to the greenhouse effect. In the light of this, a LPG leakage detector can help so much in alleviating this problem. LPG is colorless and odorless but ethane is added to it to help people smell a gas leakage. However, this is not reliable as you may not smell the gas hence the need for a gas leakage detector. A microcontroller based gas leakage detector system is designed under this research. The detector is capable of raising an alarm, showing the concentration of the gas leakage and has gas leakage status LEDs. A red LED when there is a gas leakage and a green LED when there is no gas leakage. The success of the design of the LPG leakage detector will help to efficiently detect the leakage of LPG and avoid risk of fire and pollution, saving life and property.

III. REVIEW OF LPG DETECTOR SYSTEMS.

LPG is the main gas used for cooking and other heating appliances,[E. T. Goerge, 2003]. This is because it is a stable, high energy content, relatively low Sulphur with clean burning fuel which can be transported economically as a liquid. LPG is a by-product of crude oil and Natural Gas processing. It is primarily composed of propane, butane, isobutane or a mixture of these gases. Cooking gas is normally stored in gas cylinders as liquid under relatively low pressure. It has low boiling point and vaporized immediately if it is released into the air. When it leaks, it will tend to flow close to the ground and settle in low lying places in the premises if there is no adequate air ventilation. LPG gas is highly flammable gas with Lower Explosive Limits of about 1.4% that is about 14,000 PPM [E. Hahn, 2016]. No matter the safety standards that are put in place in usage of the gas to ensure there is no gas leakage, there is always the danger of a gas leakage. Human being is prone to error. LPG is odorless and colorless and it would be impossible to detect the presence of a gas leakage. An odorant is normally added to the gas to help detect the gas in case of a leakage but this is not enough as it would require person to be physically present to detect the gas leakage and by the time the gas has built up enough to be detected by smell it will have reached dangerous concentration level. Therefore, it is a great risk to relay on our sense of smell to determine whether there is a gas leakage or not. This has been a great concern for people over time and people have come up with gas leakage detector to solve this problem. According to X. Liu, S 2012, different gas leakage detector systems has been developed using different sensors such as, Electrochemical sensors-mostly used for toxic gases such carbon monoxide.
Metal Oxide Semiconductor sensors- used for both toxic and combustible Catalytic sensor-used for combustible gases such hydrocarbon gases Infrared Sensors- used for combustible gases

The choice of the sensors depends on the type of gas that is to be detected among other factors such as the stability, sensitivity, selectivity, price and durability of the sensor. For hydrocarbon gases such as LPG gas, metal oxide semiconductor sensors are preferred over the rest of sensor because they are relatively cheap and last for a long time being stable, sensitive to low gas concentrations (300PPM) and detect a wide range of gas concentration (300-10000) PPM and resistant to poisoning [Microchip Inc., 2006]. However, its performance is affected by exposure to high corrosive gases (such as hydrogen chloride), organic silicon steam, halogen pollution and water [C. Sansone et al, 2013].

3.1 LPG sensor

It is an ideal sensor to detect the presence of a dangerous LPG leak in our home or in a service Station, storage tank environment and even in vehicle which uses LPG gas as its fuel. This unit can be easily incorporated into an alarm circuit/unit, to sound an alarm or provide a visual Indication of the LPG concentration. The sensor has excellent sensitivity combined with a Quick response time. When the target combustible gas exist, the sensor's conductivity is higher along with the rising of gas concentration [L, Fraiwan et al 2011]

Metal oxide semiconductor detects gases by means of their surface interaction with the target gas which alters the conductivity of the semiconductor. The output voltage signal is converted into gas concentration. Tin oxide and Tungsten Oxide are kind of metal oxide used as the sensing material in metal oxide semiconductor sensor. TGS sensor by Figaro[C. Sansone, 2013] and MQ-6 sensor[Zhengzhou Winsen, 2013] are metal oxide semiconductor based sensors that can be used for detecting LPG gas. The MQ-6 sensor offers the following:

· High Sensitivity to LPG gas
· A Detection Range: 300 - 10,000 PPM
· Fast Response Time: <10s
· Simple drive circuit
· Heater Voltage: 5.0V
· Long lifespan
· Low cost

The specific sensor to be used for this detector is MQ-6 sensor which uses Tin Oxide as the sensing material.

3.2 Operating Principle of MQ-6 Sensor

The Figure 1 shows a photo of MQ-6 sensor. In clean air, the sensor has a high resistance and in presence of a gas the sensor conductivity increases. The sensor has a simple drive circuit shown in Figure 1. The sensor is driven from a 5V supply. A voltage (heating voltage) is applied between Pin 2 and 5 with a resistance of 26 ± 3Ω to heat the sensor to the working temperature[Zhengzhou W., 2013].When Tin Oxide is pre-heat in presence of oxygen, oxygen is adsorbed on the crystal surface with negative charges. The donor electrons on the crystal are transferred to the adsorbed oxygen thus leaving positive charges in a space charge layer. This create a surface potential which acts as potential barrier against electrons flow hence the high resistance of the sensor in clean air [C. Sansone, et al, 2013], [Theraja B.L. and Theraja A.K., 2002]. In presence of reducing gas such as LPG, the gas molecules are adsorbed on the material surface reducing the surface density of the negatively charged Oxygen ions thus increasing concentrations of electrons and the conductivity of the sensor [C. Sansone, et al, 2013], [X. Liu, S, et al 2012].VCC pin

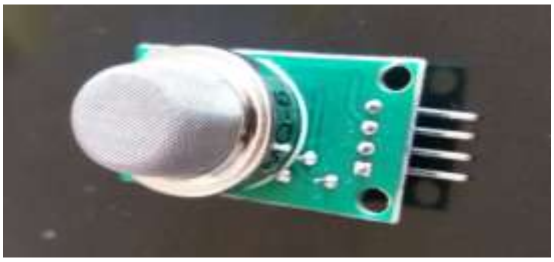

Fig.1: A typical MQ-6 Gas Sensors

Therefore, as the gas concentration increase the conductivity of the sensor will increase and so does the sensor output voltage. This sensor resistance is between pins 6&4 and 1&3 and a loop voltage is applied between the series of the sensor resistance and the load resistance. The sensor output voltage is the voltage across the load resistance. The load resistance is used to change the sensitivity of the sensor. A very high resistance, reduce the sensor sensitivity and small changes in the concentration of the gas would not be noticed. MQ-6 sensor has a load resistance of 4.7K [Zhengzhou, 2014].

The sensor detects the gas concentration from a range of 300-10,000PPM. These sensitivity curves of the sensor form the basis for setting the alarm trigger level and the amount of gas concentration for a given voltage. From the curve, the sensor has an output voltage of 2.0V at 300 PPM and thus the trigger level is 2.0V. When the input voltage to the MCU is equal to or more than 2.0V, the MCU starts the audiovisual alarm. Although the relation between gas concentration and sensor voltage is not linear, there are ranges of sensor output voltage with constant gradient i.e. between 2.0V and 2.5V, for every increase of 20 PPM in gas concentration there is an increase of 0.1V. Thus gas concentration for any other voltage is through extrapolation from the known values of sensor voltage and gas concentration.

3.3 System Design And Analysis

The proposed system is used to take an automatic control action after the detection of 0.001% LPG leakage by MQ6 sensor. The block diagram of this design is shown in Fig.2 below. It is an outline description of the project implementation and the various steps involved in the design. From the block diagram the MQ-6 sensor uses Tin Dioxide as the sensing material and is highly sensitive to Propane and Butane gas and less sensitive to other gases like carbon Monoxide and smoke. The MQ-6 is used as the LPG sensor which detects presence of Propane and Butane gases on the air. The MQ-6 is highly sensitive that it can detect 0.001% of LPG, which is sent to the microcontroller. The microcontroller activates the alarm system by sending a 5volts logic to the base of BC548 NPN transistor which energizes the buzzer.

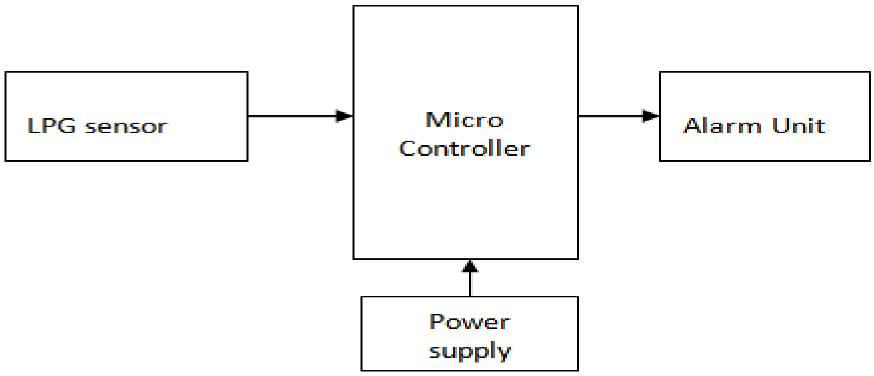

Fig.2, System block Diagram

3.3.1 Power Supply Unit

The sensor, Buzzer and the MCU requires a 5V D.C voltage for powering up. Such a power supply is design using a 5V voltage regulator. The 5V power supply can be achieved using the circuit shown in Figure 3.

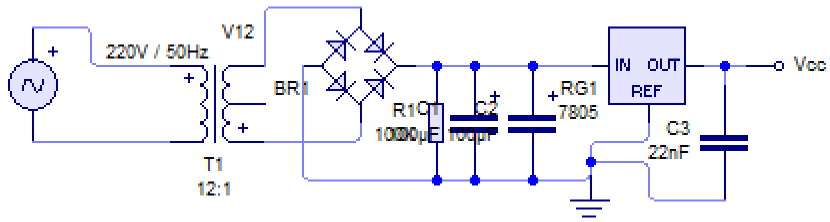

Fig .3, Power supply design with 5Volt output

The circuit uses a 7805 voltage regulator which output 5V. Capacitor C1 filters out the noise from source voltage which is 12V transformer by shorting the AC signal in the source voltage into the ground and allowing the DC signal only to pass. Capacitor C2 is used to filters out any AC signal in the output DC voltage.

- **Transformer**

A transformer is a device consisting of closely coupled coils called (primary and secondary coil). An AC voltage applied to the primary appears across the secondary with a voltage multiplication proportional to the turn ratio of transformer and a current multiplication inversely proportional to the turn's ratio, the power is conversed i.e. Turn ratio = VP/ns and Power out = Power in or VS*IS-VP*IP.

Where:

VP = Primary Voltage
NP = Number of turns in primary coil
IP = Primary (Input) Current
VS = Secondary (Output) Current
NS = Number of turns on Secondary Coil.

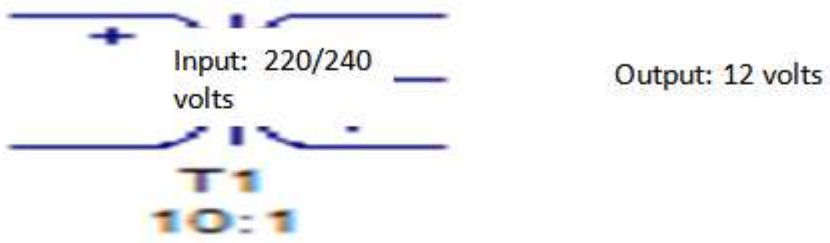

Fig. 4 Transformer Representation

Therefore, a transformer as shown in Figure 4 is a device used to step up or down of electric current. In this design a transformer is used to step-down the electric current from the main supply (220V) to approximately 18V to 12V before being converted to direct current (DC).

- **Rectifier**

These are Diodes connected in a bridge type that allow voltage to flow only in one direction, as shown in Figure 5. Diode is a two-terminal electronic component that conducts electric current in only one direction. The term usually refers to a semiconductor diode, the most common type today. This is a crystalline piece of semiconductor material connected to two electrical terminals. A vacuum tube diode (now little used in some high-power technologies) is a vacuum tube with two electrodes: a plate and a cathode.

The most common function of this diode is to allow an electric current to pass in one direction (called the diodes forward bias direction). Thus, the diode can be thought of as an electronic version of a check valve. This unidirectional behavior is called rectification and is used to convert alternating current to direct current, and to extract modulation from radio signals radio receivers.

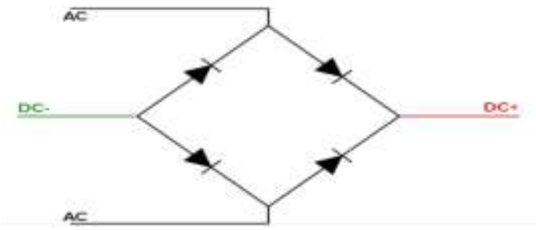

Fig. 5: bridge rectifier Symbols

- **Capacitors**

A Capacitor (condenser) is a passive electronic component consisting of a pair of conductors separated by a dielectric (insulator) when there is a potential difference (voltage) across the conductors; a static electric field develops in the dielectric that stores energy and produces a mechanical force between the conductors. An ideal capacitor is characterized by a single constant value, capacitance, measured in Farads. This is the ratio of the electric charge on each conductor to the potential difference between them.

- **Power Regulators**

A typical power regulator used in this design is LM7805 regulator which is shown in Figure 6. It is a linear voltage regulator integrated circuits, the 78xx family is a very popular choice for many electronic circuits which require a regulated power supply, due to their ease of use and relatively cheap.

This device typically support an input voltage which can be anywhere from a couple of volts over the intended output voltage up to a maximum of 35 or 40 volts, and can typically provide around 1 to 1.5Amps of current, though smaller or larger packages may have a lower or higher current rating.

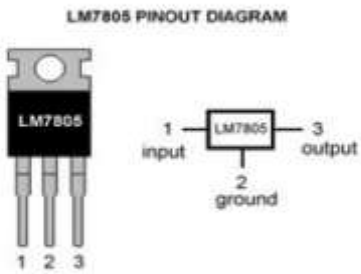

Fig.6: Power regulators

3.3.2 Resistors

Resistors are elements of electrical networks and electronic circuits that are ubiquitous in most electronic equipment. Practical resistor can be made of various compounds and films as well as resistance wire (wire made of a high-resistivity alloy, such as nickel chrome). The primary characteristics of a resistor are the resistance, the tolerance, the maximum working voltage and the power rating. Other characteristics include temperature coefficient, noise, and inductance. The Ohm (Ω) is the SI Unit of electrical resistance named after George Simon Ohm commonly used multiples and sub-multiplies in electronic usage are the milliohm (9×10^{-3}), Kilo-Ohm (1×10^{3}) and Mega ohm (1×10^{6}).

3.3.3 MICROCONTROLLER (89S52)

The 89S52 is an 8-bit microcontroller originally developed by Intel in the late 1970‘s. It included an instruction set of 255 operation codes (opcodes), 32 input output line (i.e. port 1, port 2, port 3, and port 4), three user-controllable timers, an integrated and automatic serial port, and 256 bytes of chip RAM. The 89S52 was designed such that control of the microcontroller and all input/output between the microcontroller and external device is accomplished via special function Registers (SFR). The 89S52 microcontroller structure is shown in Figure 7 below.

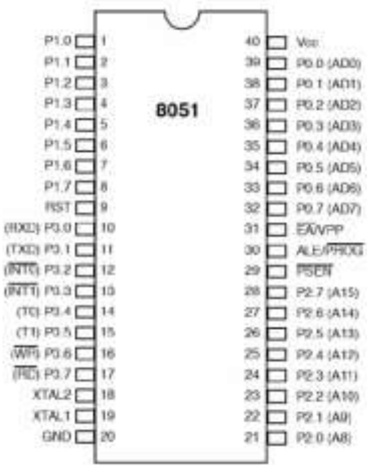

Fig. 7: 8051 family of microcontroller

PORT 1: This is an input/output port. Each bit of this SFR corresponds to one of the pins on the microcontroller. For example, bit 0 of port 1 is P1.0, bit 7 is pin P1.7. Writing a value of 1 to a bit of this SFR will send a high level on the corresponding 1/0 pin whereas a value of 0 will bring it to a low level.
PORT 2: This is an input/output port. Each bit of this SFR responds to one of the pins on the microcontroller. For example bit 0 of port 2 is P2.0 bit 7 of port 1 is also P1.7. Writing a value of 1 to a bit of this SFR will send a high level on the corresponding 1/0 pin whereas a value of 0 will bring it to a low level.
PORT 3: This is an input/output port. Each bit of this SFR corresponds to one of the pins on the microcontroller. For example bit 0 of port 3 is P3.0, bit 7 is pin P3.7. Writing a value of 1 to a bit of this SFR will send a high level on the corresponding 1/0 pin whereas a value of 0 will bring it to a low level.
PORT 0: This is an input/output port. Each bit of this SFR corresponds to one of the pins on the microcontroller. For example bit 0 of port 0 is P0.0, bit 7 is pin P0.7. Writing a value of 1 to a bit of this SFR will send a high level on the corresponding 1/0 pin whereas a value of 0 will bring it to low level.

3.4 Buzzer

The buzzer used is Piezoelectric Active Buzzer. It uses the inverse relationship of piezoelectricity. When an alternating current is applied to piezoelectric material such as Piezo ceramic, they stretch and compress depending on the frequency of the signal producing a sound. The active Buzzer has a built in oscillator circuit and when applied with DC voltage will produce a consistent sound.

IV. SYSTEM DESIGN IMPLEMENTATION

After careful identification, selection, gathering and examination of all the necessary components and modules needed to accomplish this project; the system was designed and simulated using proteus.

Proteus is hardware simulation software used to design electronic circuit and perform a simulation (test) of the design or circuit and observe how it behaves before implementation. It shows the real life behavior of the system being tested, it equally detects error, where wrong values of components are used or wrong wiring is made. This software have the capability of allowing then designer to program a chip being used in the simulation if it is a programmable chip and view the real operation of the system when programmed. During the simulation several adjustments were made to suite the design goal of the project at last the full implementation of the system was carried out stage by stage. These include the power pack design, the sensor microcontroller system.

4.1 Power Supply Design

Here this circuit diagram is for **+5V regulated (fixed voltage) DC power supply**. This **power supply circuit diagram** is ideal for an average current requirement of 500mAp. This circuit is based on IC **LM7805**. It is a 3-terminal (+ve) voltage regulator IC. It has short circuit protection, thermal overload protection.

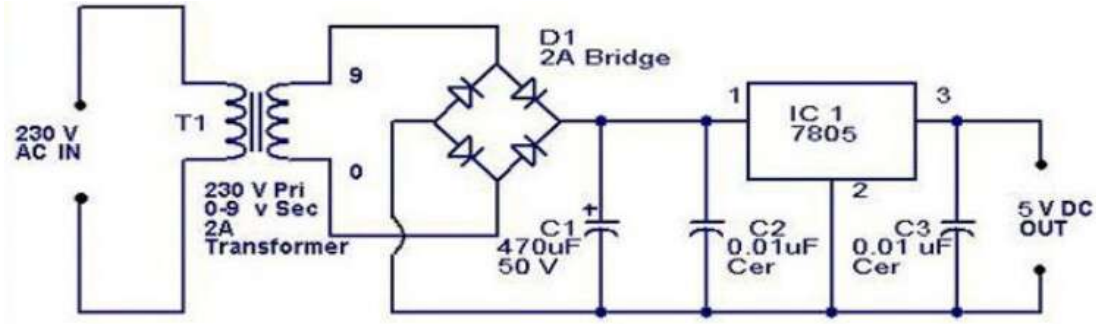

Fig. 8: 5volt Power Supply

A transformer (Tx=Primary 230 Volt, Secondary 12 Volt, 1Amp step down transformer) is used to covert 230V to 12V from mains. Here used a bridge rectifier made by four 1N4007 diode to convert AC to DC. The filtering capacitor 1000uF/25V is used to remove the ripple and get a smooth DC voltage. This circuit is very easy to build. For good performance input voltage should be greater than 5Volt in pin-1 of IC LM7805. Use a heat sink to IC LM7805 for safeguarding it from overheating.

Since this system needs a regulated output of +5volts, a step down transformer of 220, 9 volts used, due to tolerance level of 1 volts, it implies here that we have 9v+1v = 10volts. However, the maximum current rating for the entire system design i.e. 0.5A=500MA, therefore, a transformer of 220/12volts, 500MA where chosen. Also a capacitive fitter was employed with the aid of electrolytic capacitor usually calculated as:

C1 = CF $= \frac{1}{\left(\sqrt[2]{2} \times Fr \times Kr \times R1\right)}$ …………………………………..… (1)

Where Fr = Ripple Frequency

RL = Minimum Load Resistance

Fr = 100Hz (50 +50) Hz

Also, Kr = R.M.S ripple voltage

DC Output voltage

RMS Ripple voltage - RMS Ripple Current

500mV - 300mA

Therefore, Kr $= \frac{500 \times 10^{-3}}{10}$

Kr = 50 x 10^{-3}

RL = 20 Ohms (minimum) to 100ohms from equation (1) above

CF $= \frac{1}{\left(\sqrt[2]{2} \times Fr \times Kr \times RL\right)}$

N/B: $2\sqrt{2} = 2.8$

CF $= \frac{1}{\left(\sqrt[2]{2} \times 100 \times 50 \times 10^{-3} \times 20\right)}$

= 3,533µf

However, a capacitor of the rating 3533µf does not exist in the market so we chose the one closest to the determined value that is available in the market, which is 3300µf.

Also, to determine the voltage rating of a capacitor, we have 2 x DC output voltage. Therefore, 2 x 12volts = 24 volts.

A gas leakage detection system capable of raising an alarm has been developed using the sensor and a comparator. The sensor output voltage is compared with a reference voltage from a potentiometer and if the voltage signal is higher than the reference voltage the comparator output a signal which can be used to drive a circuit setting off an alarm. The potentiometer is used to set the trigger level for the alarm.

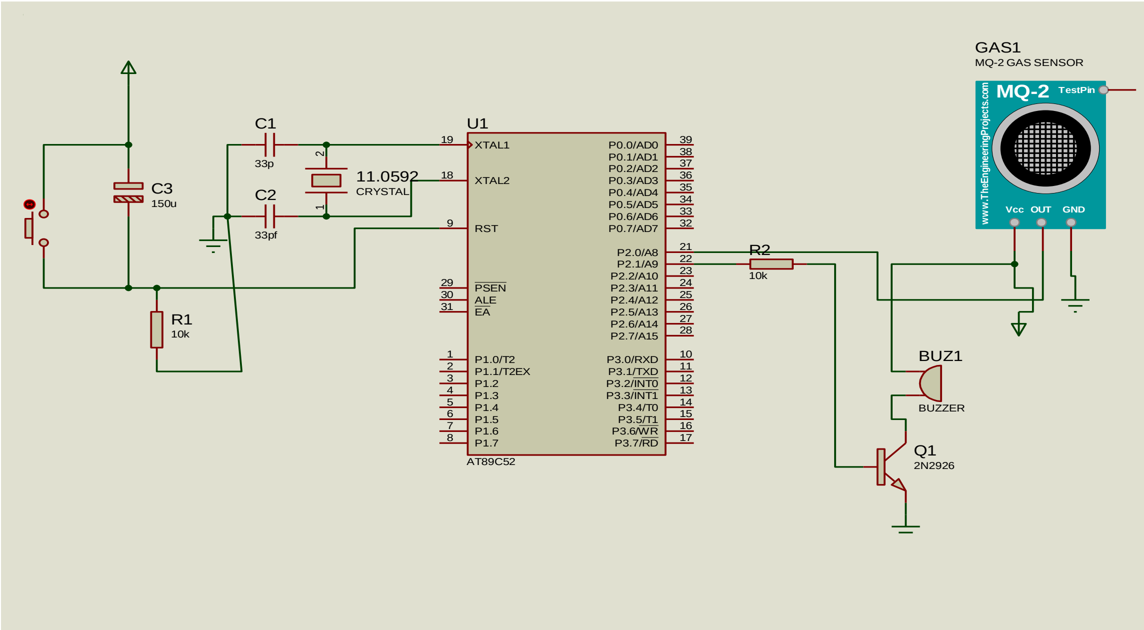

Fig. 9: Gas Leakage Detector Circuit Diagram

Figure 9 above shows a complete circuit diagram of a Gas Leakage Detector. The circuit uses 89s52 microcontroller with MQ-6 gas sensor interfaced to it port2 bit 0. The gas sensor has a simple driver circuit as shown in Figure 4.5. Open detection of gas, the presence of gas such as LPG molecules are adsorbed on the material surface reducing the surface density of the negatively charged Oxygen ions thus increasing concentrations of electrons and the conductivity of the sensor which in return is amplified by lm324 and the output interfaced to the microcontroller. In an open air, the Tin Oxide is pre-heat in presence of oxygen is adsorbed on the crystal surface with negative charges. The donor electrons on the crystal are transferred to the adsorbed oxygen thus leaving positive charges in a space charge layer. This create a surface potential which acts as potential barrier against electrons flow hence the high resistance of the sensor in clean air is detected. And the output pin goes low.

The detector system in addition raises an alarm also with LED indicators for status of the gas leakage. It also incorporates a button that can be used for resetting the alarm. The microcontroller is programmed with an algorithm for converting the voltage signal from the sensor to the respective gas concentration according to the sensor datasheet. The datasheet outline the relationship between the sensor voltage and the gas concentration. Thus, gas concentration can be indicated with high accuracy. The microcontroller runs at a frequency of 11.0592 MHz, thus the detector has a faster response time to changes in concentration of the gas. The specific sensor to be used for this detector is MQ-6 sensor which uses Tin Oxide as the sensing material. The microcontroller being used is Atmel89s52 microcontroller.

4.2 Operating Principle of MQ-6 Sensor

The Figure 10 shows a picture of MQ-6 sensor. In clean air, the sensor has a high resistance and in presence of a gas the sensor conductivity decreases. The sensor has a simple drive circuit shown in Figure 11. The sensor is driven from a 5V supply. A voltage (heating voltage) is applied between Pin 2 and 5 with a resistance of $26 \pm 3\Omega$ to heat the sensor to the working temperature. When Tin Oxide is pre-heat in presence of oxygen, oxygen is adsorbed on the crystal surface with negative charges. The donor electrons on the crystal are transferred to the adsorbed oxygen thus leaving positive charges in a space charge layer. This creates a surface potential which acts as potential barrier against electrons flow hence the high resistance of the sensor in clean air. In presence of reducing gas such as LPG, the gas molecules are adsorbed on the material surface reducing the surface density of the negatively charged Oxygen ions thus increasing concentrations of electrons and the conductivity of the sensor.

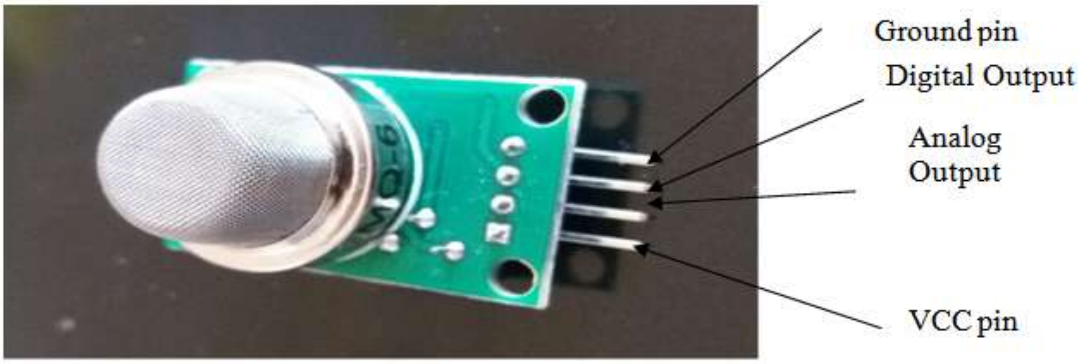

Fig. 10: MQ-6 Gas Sensor

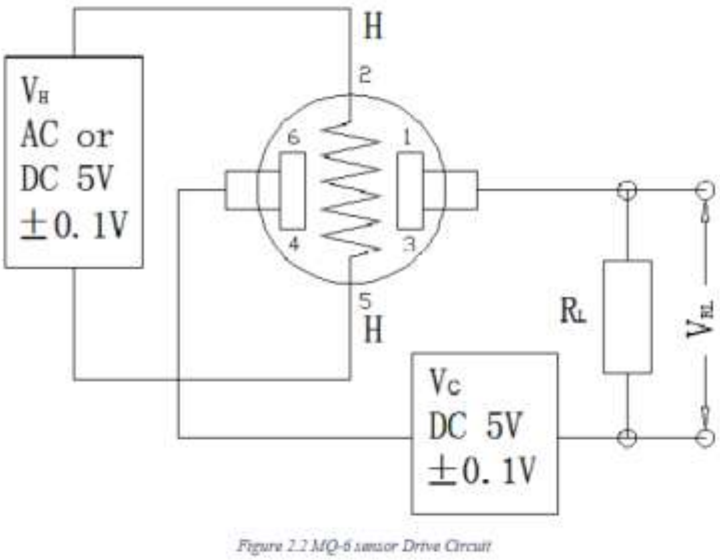

Fig. 11: MQ-6 sensor Drive

Therefore, as the gas concentration increase the conductivity of the sensor will increase and so does the sensor output voltage. This sensor resistance is between pins 6&4 and 1&3 and a loop voltage is applied between the series of the sensor resistance and the load resistance as shown in figure 11 above. The sensor output voltage is the voltage across the load resistance. The load resistance is used to change the sensitivity of the sensor. A very high resistance, reduce the sensor sensitivity and small changes 8 in the concentration of the gas would not be noticed. The MQ-6 sensor has a load resistance of 4.7k.

V. SYSTEM IMPLEMENTATION

After the system design, program development, and simulation, the implementation of the system started. These began by soldering of the different parts of the components and modules used in the circuit design. This include, the Microcontroller, the MQ-6, the power unit, and the Microcontroller etc. as shown in Figure 12.

A Printed Circuit Board (PCB) was design using PCB design suit software, and printed on the board after that it was etched using chemicals. The PCB is where the components were placed and soldered, after all the soldering, then the system is powered module by module to ascertain its workability and later put together and powered.

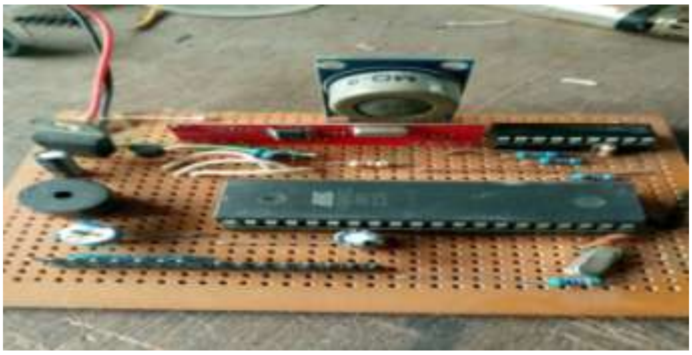

Fig 12: Completed soldered circuits in PCB

5.1 Software Implementation

Assembly language was used in this design, this is because of its reliability, fastness, and memory saving. After developing the software, it was assembled using MIDE – ASMS1 and errors found corrected before the final hex code was produced. After that, an EPROM programmer was used to transfer the hex code to the microcontroller and then powered.

```
;*******************************************************************
ORG     000H

       CALL    INIT_Sensor

again:
       CALL    GET_SENSOR_DATA
              MOV              A,#81H
            ;  CALL        WR_LCD_COMMAND
              CALL DELAY

      CALL       WR_LCD_CHR
       SETB    P2.4

       JMP AGAIN
;**********************************************************************
INIT_LCD:
       MOV      A,#38H              ;2 line 5x7
       CALL    WR_LCD_COMMAND
       MOV      A,#0CH               ;LCD on cursor on
       CALL    WR_LCD_COMMAND
       MOV      A,#01H               ;clear LCD
       CALL    WR_LCD_COMMAND
       MOV      A,#06H               ;shift cursor right
       CALL    WR_LCD_COMMAND
DISP:       MOV       A, #81H  ; Curser at LINE # 1, Position # 3
              CALL        WR_LCD_COMMAND
RET
end
```

VI. SYSTEM TESTING

To verity the functionality of various sub-systems, a test plan was adopted. Here, module by module testing plan is adopted, this is necessary to ensure that all the different sub-systems are working smoothly before assembling. The power supply was tested to ensure that it is producing maximum power of 5 volts before connecting it to the system. The MQ-6 Sub-module was also tested to be sure that it detects LPG gas accurately. The control unit (microcontroller unit) was equally tested to make sure that it is compatible with the program and to know if it is giving the right output. The reason for all this is to be able to trace any error or malfunction that might result while modeling them together or during general testing.

VII. CONCLUSION

A design and construction of a gas detection system has been achieved using Microcontroller 89s52, together with MQ-6 sensor, buzzer, resistors, transistors, capacitors, etc.
The system has been tested and the aim achieved. The system detects liquefied gas (cooking gas) upon detection and an alarm triggered. This will solve the problem of loss of life and property due to this unexpected home and industrial incidents.

REFERENCES

[1]. C. Sansone, S. Manfredi, E. Di Tucci, S. De Vito, G. Fattoruso, and F. Tortorella, "A novel approach for detecting alerts in urban pollution monitoring with low cost sensors," in Measurements and Networking Proceedings (M&N), 2013 IEEE International Workshop, 2013, pp. 89–93.
[2]. E. Hahn, "LPG Gas Blog," LPG Gas Blog, 2016. . "Lower-(LEL)-&-Upper-(UEL)-Explosive-Limits-.pdf." .
[3]. E. T. Goerge, Fuels and Lubricants handbook: technology, properties, performance and testing, 2nd Edition. West Conshohocken, Pa : ASTM International, 2003.
[4]. Fraiwan L, Lweesy K, Bani-Salma, A Mani N (2011), "A Wireless Home Safety Gas Leakage Detection System",
[5]. Proc. of 1st Middle East,Conference on Biomedical Engineering, pp.11-14.
[6]. Microchip Inc., "PIC16F631/677/685/687/689/690 Data Sheet," no. DS41262C, p. 294,2006.
[7]. Theraja B.L. and Theraja A.K.. "A textbook of Electrical Technology". S.Chand & Co. ltd, 23rd Edition, pp 1029-
[8]. 1118(2002).
[9]. Vipin J. V., Paul A., Nisha S. & Kevin J. "Experimental Investigation To Control Alcoholic Driving". International Journal of Research in Engineering & Technology. Impact Journals. ISSN(E): 2321-8843; ISSN(P): 2347-4599. Vol. 2, Issue 4, Pp. 123-128 (2014)
[10]. X. Liu, S. Cheng, H. Liu, S. Hu, D. Zhang, and H. Ning, "A Survey on Gas Sensing Technology," Sensors, vol. 12, no. 12, pp. 9635–9665, Jul. 2012.
[11]. Zhengzhou Winsen Electronics Technology Co., Ltd "Flammable Gas Sensor (MQ-6 MODEL) MANUAL," no. VERSION 1.3, p. 7, May 2014

Okereke Eze Aru" Development of an Improved Intelligent Gas Leak Monitor Incoporating an Automatic Leak Notification System" The International Journal of Engineering and Science (IJES), 8.3 (2019): 35-45