Design & Implementation of Microcontroller based Automated Smart Gas Protection System



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Declaration

It is declared hereby that this thesis paper or any part of it has not been submitted to anywhere else for the award of any degree.

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Certification

This is to certify that this project entitled “Design & Implementation of Microcontroller based Automated Smart Gas Protection System” is done by the following students under my direct supervision. This project work has been carried out by them in the laboratories of the Department of Electrical and Electronic Engineering under the Faculty of Engineering, Sonargaon University (SU) in partial fulfillment of the requirements for the degree of Bachelor of Science in Electrical and Electronic Engineering.

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ABSTRACT

In this communication, an efficient method of detecting the leakage of cooking gas and alerting people about its occurrence via the use of existing Global System for Mobile Communication (GSM) infrastructure was developed. The GSM-based gas leakage alert system utilizes a gas sensor to detect leakages in the event that it occurs and then send short message to a predefined telephone number. MQ4 gas sensor, PIC ATmega328 microcontroller, GSM modem and a DC servo motor are the main hardware components employed in the development the gas leakage detection and alert system. The proposed system plays two roles in the event of gas leakage: alerting people about the leakage of gas by sending short message to the predefined mobile number and by closing of the main gas line to prevent further leakage by using the servo motor. The developed GSM-based gas leakage detection and alert systems is suitable for deployment in homes, laboratories and restaurants to check undesirable event of gas leakages and attendant risks.

Keywords: GSM modem, Detection, Cooking Gas, DC Stepper Motor, PIC Microcontroller

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CHAPTER-1

INTRODUCTION

1.1 INTRODUCTION

In recently gas explosion is rising day by day. According to the survey of Titas Gas Transmission and Distribution Company around 3819 accident occurred in 2013-2014.

The accident is rising day by day about 5123 accident occurred in 2014-2015. In 2015 about 3366 explosion occurred by house stove. There was loss of life as well as loss of property around 38 core 76 lucks Tk. There are disasters that are heard of and looking back at them, we realize they are actually avoidable especially domestic fire incidents. One frequent cause of domestic fire incident, which can be prevented, is the gas leakage. In modern homes, gas cookers are fast replacing electric cookers and kerosene stoves for domestic cooking. In offices and laboratories, cooking gas is employed for diverse applications. The cooking gas, otherwise known as the Liquefied Petroleum Gas (LPG), is first produced in 1910 by Walter Snelling as a mixture of commercial Propane and commercial Butane. It comprises of both saturated and unsaturated hydrocarbons. Going by increasing level of patronage of LPG for cooking and heating applications, coming up with safety measure and method of checkmating the impact of fire outbreak that may result from its leakage has attracted attentions of many researchers.

Prior to the development of household electronic gas detectors in the early 90s, chemically infused paper, that changes its color in response to exposure of the gas, is used to detect presence of cooking gas. Since the introduction of electronic gas detectors, a number of devices have been developed to monitor and alert the people in the event of wide array of gases leakage.



Figure No 1.1 Gas Explosion and Accident

Gas Explosion Report

The tragic death of seven people and injury to a dozen more in an explosion of the gas line of a house on Brick Field Road at Patharghata, Chattogram are a grim reminder of an outsize hidden danger from this utility service. In another such incident at an apartment in the capital's Uttara five of a family perished in February this year. There were gas leak explosions in Dhaka's Mohammadpur and Narayangaj's Demra in November, 2018 and October, 2017 respectively. In those two incidents eight and six people sustained burn injuries. In the case of Patharghata blast, primary reports point an accusing finger at the gas connection to a ground-floor kitchen without windows. Since the door of the kitchen was closed overnight, gas leak might have accumulated there. On lighting fire to the oven, the gas exploded like a time bomb ripping not only through the kitchen's wall but also the boundary wall. Even passers-by on foot or on rickshaws were either killed or injured. The tragic incident follows a number of explosions of gas cylinders used for inflating balloons - the most tragic of which involves death of six children and injury to 20 others at Rupnagar, Dhaka. Quite a few liquefied petroleum gas (LPG) gas cylinders also leaked or gave in to cause a few fatal accidents. These accidents have something common but reasons behind are not unlikely to be the same. Leak at the connection point of oven is often responsible for blasts if the kitchen has inadequate ventilation. Careless or unmindful use of the oven without opening windows can invite disproportionate danger. Excess pressure of gas can as well lead to tragedies but this rarely happens in the mega cities like Dhaka and Chattogram where gas pressure is low. What, however, needs to be ensured is that gas connections as old as four decades were checked thoroughly in order to know if those required repair or replacement?

Why Explosion:

Now that the gas supply to residential homes has passed decades, such accidents cannot be ruled out. Gas pipes and connection points at the cooker are sure to develop wear and tears over such a long period. Much depends on maintenance of such a potential hazardous utility service. It is a fact that mechanics, who fix gas cookers, are not highly trained people. At times they are lax in setting things with the care such devices demand. Regrettably, there is no recommended standard practice here. All they do is out of common sense. So, lapses are not unexpected in the tasks they perform at the time of new connection or during refixing gas cookers. Ageing supply lines together with such inept handling exposes residents of Dhaka and other cities to the danger of gas explosion and consequent fires.

The utility service provider also seems to have washed its hands off after giving gas connection. It only announces its presence in rare cases of default in gas bill payment. There is no provision for regular check-up of gas connections. When involved here is as combustible a substance as natural gas supplied through pipe, such official check-ups should be a standard practice. How come it that there is no such check-up in decades? Gas connections may become loose when buildings are renovated or otherwise reshaped. In such cases, in particular, expert engineering skill is in demand.

Gas pressure also has something to do with the safety of gas stoves. If the pressure builds up in particular areas leaving other areas deprived of gas, there can be accidents on account of high pressure. There is seasonal variation of gas pressure too. Thank to low pressure in the winter, gas does not usually get leaked then. It is time when windows are kept closed at night and not everyone is mindful of opening the windows before lighting the gas burner.

Definition of accidents

(1) LPG accidents

[1] Leakage A case in which liquefied petroleum gas (hereinafter, "LPG") leaked, but it did not catch fire and cause human damages such as poisoning and asphyxiation. However, in this report, leakage of a very little amount of LPG from joints as little as soap bubbles formed when those of threaded parts or rubber tubes are soaked by soap water is excluded.

[2] Leakage and explosion

Cases in which LPG leaked, and it resulted in an explosion or a fire caused by the explosion, as follows.

A. Leakage and explosion, when the explosion resulted from leaked gas only.

B. Leakage, explosion and fire, when a fire broke out following explosion caused by leaked gas.

[3] Leakage and fire

A case in which a fire that is not limited to that recognized as a fire by the fire department resulted from leakage of LPG excluding those covered by [2] above. Here, a fire without leakage, which is caused by the overheating or the failure of LPG appliances including their accessories or by spreading of flames from a cooking oven, grill, etc., is not classified as a LPG accident.

[4] Poisoning and asphyxiation

A case in which human damages of CO poisoning and asphyxiation are caused due to incomplete combustion, leakage of LPG, or leakage of exhaust gas from exhaust pipes, etc., at LPG consumption facilities.

(2) Other accidents (not classified)

[1] Accidents caused by suicide, damage by intention, mischief, theft, or other similar causes

[2] Accidents resulting from a natural disaster

Example) Accidents caused by facilities' damages resulting from collapse of houses due to earthquake ,

Example: Accidents caused by facilities' damages resulting from flood and landslide Even if accidents are resulted from natural disasters, however, those caused by defects in toppling prevention measures, fallen snow prevention measures (snow shelters, protective boards), or other insufficiencies in safety measures, are classified as LPG accidents.

[3] Accidents involving portable cooking stoves and gas cartridges

[4] Other accidents not categorized in the LPG accidents of (1) above

Classification of human damages

Classified as follows according to the level of damage.

Death: when a person was confirmed to have died within about five days from the time of accident

Seriously injured: when a person suffered an injury at the time of accident that took 30 days or more for full recovery

Slightly injured: when a person suffered an injury at the time of accident that took less than 30 days for full recovery.

Occurrences of accidents in the past:

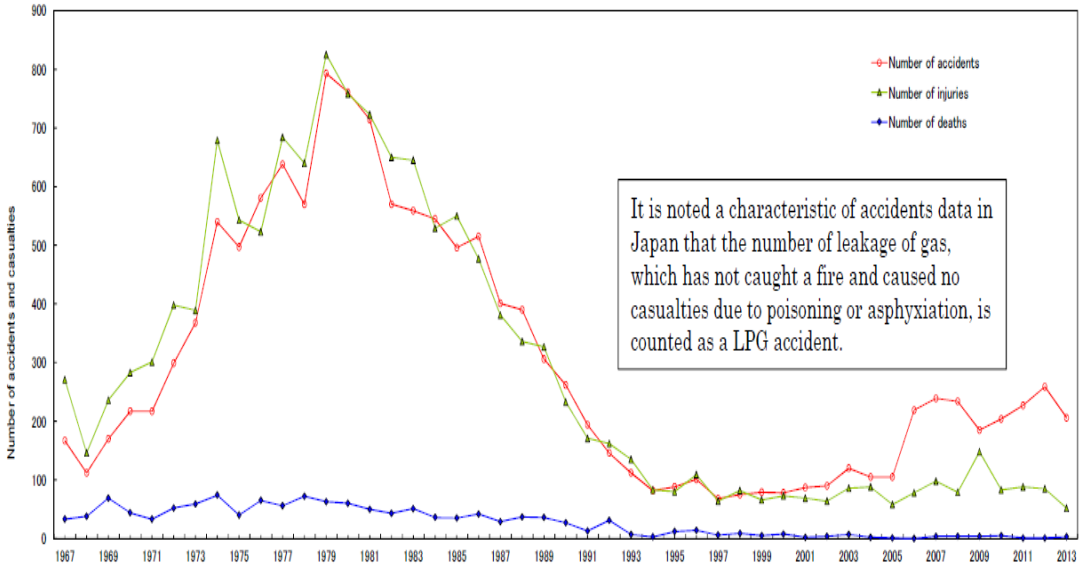


Fig:1.2 Accident report

1.6 Accident situations by phenomenon

Looking at the accident situations by phenomenon that occurred in 2013, the number of leakage-only accidents that did not start fire or explosion were more than half of total accidents. The number of leakage-only accidents was 109, showing a decrease of 50 from the previous year. The number of leakage and explosion (fire) accidents was 48, showing the same number as the previous year. The numbers of accidents by phenomenon in the past decade are shown below.

Table2: Number of accidents by phenomenon

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Leakage	41	46	137	113	115	84	76	116	159	109
Leakage and explosion (Fire)	56	46	70	64	53	45	60	55	48	48
Leakage and fire (Excluding explosion)	1	2	6	51	60	42	60	45	44	43
CO poisoning and asphyxiation	7	11	6	11	6	14	8	11	8	6
Total	105	105	219	239	234	185	204	227	259	206

Analysis of accident situations

The following kinds of LPG accidents that have occurred frequently were analyzed.

(1) CO poisoning accidents as shown in Table 3 and Figure 2, four CO poisoning accidents occurred in 2013, showing a decrease of four from the previous year. Two of four were Class B accidents, resulting the same number as the previous year. The breakdown of four accidents is shown below.

[1] Accident caused by use of commercial oven in an unventilated kitchen (two accidents)

[2] Accident caused by inadequate ventilation of a convection flue (CF) bath heater CF refers to ventilation system that takes in the air inside a room and discharge exhaust outdoor through vent by natural ventilation force.

[3] Accident caused by use of commercial dish washing machine in an unventilated dish washing room incidentally, the reason why the number of casualties increased to 88 in 2009 was attributed to the large number of casualties per accident in 2013.

1.2 Related Works

Various research groups are working all over the world for the development of LPG leakage detectors and response systems. Before the development of electronic household gas detectors in the 1980s and 90s, gas presence was detected with a chemically infused paper that changed its

colour when exposed to the gas. Since then, many technologies and devices have been developed to detect, monitor, and alert the leakage of a wide array of gases.

Ashish *et al*., 2013, designed a GSM based LPG detection system which consisted of a Philip microcontroller, MQ-6 sensor and a GSM module. The MQ-6 sensor is very sensitive to LPG and Propane and hence is capable of detecting the smallest leakage of the gas. The microcontroller response to the leakage detected by the sensor by sending an SMS through the GSM module to the authority for appropriate response.

A similar project by Sunithaa and Sushmitha, 2012, has a system that detects the leakage of the LPG and alerts the consumer about the leak and as an emergency measure, the system switches on an exhaust fan to circulate the gas. An added feature of the system is that the approximate consumption is indicated in terms of the total weight. The proposed system makes use of GSM module in order to alert user about the gas leakage via an SMS. Whenever the system detects the increase in the concentration of the LPG it immediately alerts by activating an alarm and simultaneously sending message to the specified mobile phones. The exhaust fan is switched on. The device ensures safety and prevents suffocation and explosion due to gas leakage .

The former systems mentioned above cannot react in time. This project design however gives an accurate response to the detection of leakage in potential risk area. The system has protection circuitry consisting of Gas Safety Valve. In this system MQ-4 gas sensor is used to detect poisonous gas and has high sensitivity to LPG and also responds to natural gas. Hazardous gasses like Liquefied Petroleum Gas and Propane when detected to exceed a certain threshold or level, an alarm and red signal is generated immediately and the exhaust fan becomes start. The display unit represents the gas condition in the room. The safety valve shuts down the supply of the LPG and then an emergency SMS is sent through the GSM module to the consumer. This work modifies the existing safety model installed in industries for domestic purpose. It offers quick response time and accurate detection.

This project has many advantages which are as follows:

- The Project is easy to use and it gives remote indication to the user;
- The Sensor used in this Project has excellent sensitivity combined with a fast response time;
- The system is highly reliable
- It is possible to get instantaneous results and with high accuracy.

1.3 OBJECTIVE

• To detect the leakage of LPG gas in a closed environment, if any.

• To inform the user about the leakage of gas via SMS.

• To activate the alarm unit to inform neighbors about the gas leakage.

• To switch on the exhaust fan as a primary preventive measure against gas leakage.

• To turn off main power supply after gas leakage.

CHAPTER-2
THEORY OF THE PROJECT

2.1 Name of Components:

S.NO	Component	Quantity
1	9V Power Supply	1
2	MQ4 Gas Sensor	1
5	Atmega328	1
6	Buck Regulator	1
7	Vero board	1
8	Green connector	1
9	Buzzer	1
10	LED	3
11	GSM	1
12	Exhaust Fan	1
13	LCD Display	1
14	Variable Resistor 10K	1
16	Male Connector	2
17	Wire	20’
18	Glue Strike	1
19	PVC Sheet	6 Sqft
20	Super Glue	1

2.2 Gas Sensor

Introduction

A Typical human nose has 400 types of scent receptors enabling us to smell about 1 trillion different odours. But still many of us do not have the capacity to identify the type or concentration of gas present in our atmosphere. This is where Sensors comes in, there are many types of sensors to measure different parameters and a **Gas sensor** is one which comes handy in applications where we have to detect the variation in the concentration of toxic gases in order to maintain the system safe and avoid/caution any unexpected threats. There are various gas sensors to detect gases like oxygen, Carbon Dioxide, Nitrogen, methane etc. They can also be commonly found in devices that are used to detect the leakage of the harmful gases, monitor the air quality in industries and offices etc.

In this article, we will learn more about **gas sensors**, their construction, types, and working and how they can be used to measure the required type and concentration of Gas in our atmosphere. There are many types of Gas sensors but the **MQ type gas sensors** are commonly used and widely popular so will focus more on these types of sensors for this article.

A **gas sensor** is a device which detects the presence or concentration of gases in the atmosphere. Based on the concentration of the gas the sensor produces a corresponding potential difference by changing the resistance of the material inside the sensor, which can be measured as output voltage. Based on this voltage value the type and concentration of the gas can be estimated.

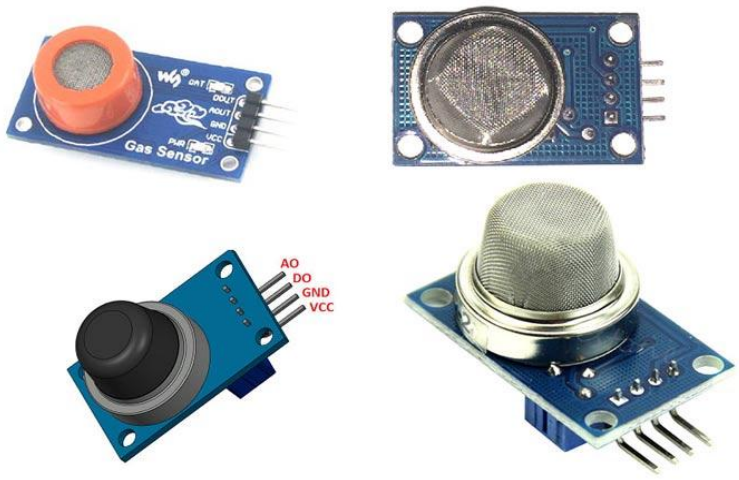


Fig: 2.2.1 Different Types of Gas sensor

The type of gas the sensor could detect depends on the **sensing material** present inside the sensor. Normally these sensors are available as modules with comparators as shown above. These comparators can be set for a particular threshold value of gas concentration. When the concentration of the gas exceeds this threshold the digital pin goes high. The analog pin can be used to measure the concentration of the gas.

Different Types of Gas Sensor:

Gas sensors are typically classified into various types based on the type of the sensing element it is built with. Below is the classification of the various types of gas sensors based on the sensing element that are generally used in various applications:

- Metal Oxide based gas Sensor.
- Optical gas Sensor.
- Electrochemical gas Sensor.
- Capacitance-based gas Sensor.
- Calorimetric gas Sensor.
- Acoustic based gas Sensor.

Gas Sensor Construction

Of all the above-listed types, the most commonly used gas sensor is the Metal oxide semiconductor based gas sensor. All Gas sensors will consist of a sensing element which comprises of the following parts.

1. Gas sensing layer
2. Heater Coil
3. Electrode line
4. Tubular ceramic
5. Electrode

The below image illustrates the parts present in a metal oxide gas sensor

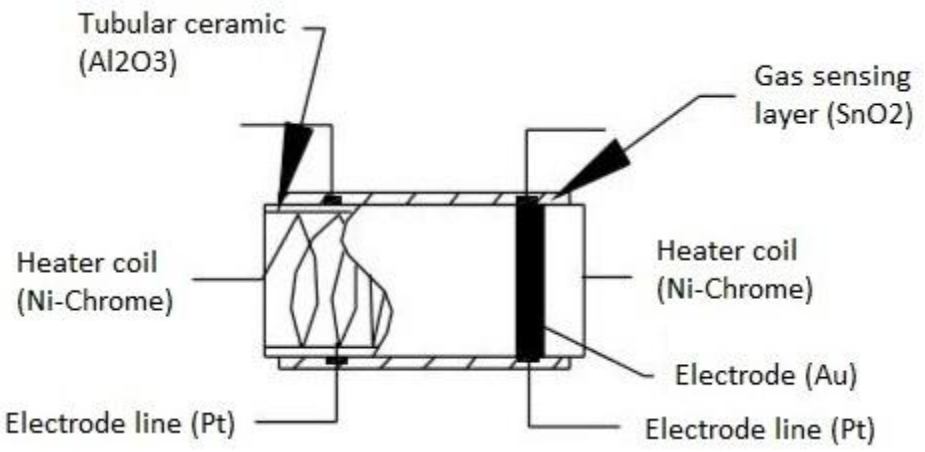


Fig:2.2.2 Internal Construction of Gas Sensor

The purpose of each of these elements is as below:

Gas sensing layer: It is the main component in the sensor which can be used to sense the variation in the concentration of the gases and generate the change in electrical resistance. The gas sensing layer is basically a chemiresistor which changes its resistance value based on The concentration of particular gas in the environment. Here the sensing element is made up of a Tin Dioxide (SnO2) which is, in general, has excess electrons (donor element). So whenever toxic gases are being detected the resistance of the element changes and the current flown through it varies which represents the change in concentration of the gases.

Heater coil: The purpose of the heater coil is to burn-in the sensing element so that the sensitivity and efficiency of the sensing element increases. It is made of Nickel-Chromium which has a high melting point so that it can stay heated up without getting melted.

Electrode line: As the sensing element produces a very small current when the gas is detected it is more important to maintain the efficiency of carrying those small currents. So Platinum wires come into play where it helps in moving the electrons efficiently.

Electrode: It is a junction where the output of the sensing layer is connected to the Electrode line. So, that the output current can flow to the required terminal. An electrode here is made of Gold (Au –Aurum) which is a very good conductor.

Tubular ceramic: In between the Heater coil and Gas sensing layer, the tubular ceramic exists which is made of Aluminum oxide (Al2O3). As it has high melting point, it helps in maintaining

the burn-in (preheating) of the sensing layer which gives the high sensitivity for the sensing layer to get efficient output current.

Mesh over the sensing element: In order to protect the sensing elements and the setup, a metal mesh is used over it, which is also used to avoid/hold the dust particles entering into the mesh and prevent damaging the gas sensing layer from corrosive particles.

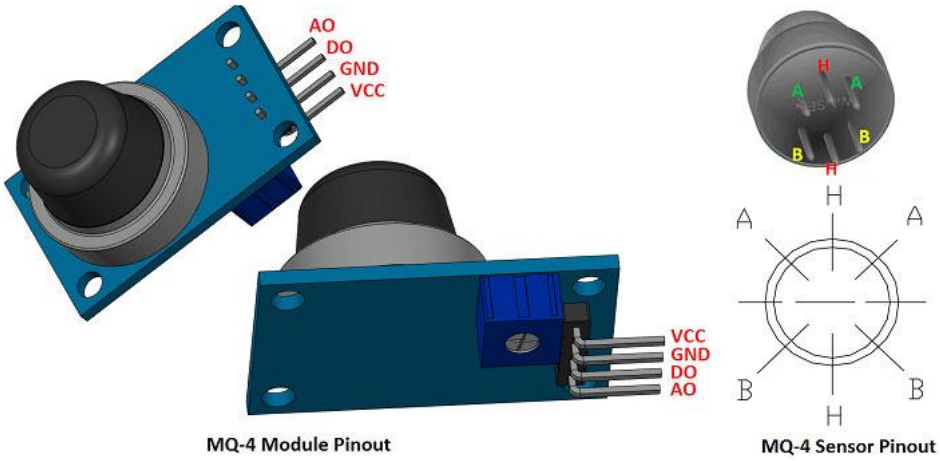
Gas Sensor Working

The ability of a Gas sensor to detect gases depends on the **chemiresister** to conduct current. The most commonly used chemiresistor is Tin Dioxide (SnO2) which is an n-type semiconductor that has free electrons (also called as donor). Normally the atmosphere will contain more oxygen than combustible gases. The oxygen particles attract the free electrons present in SnO2 which pushes them to the surface of the SnO2. As there are **no free electrons** available output current will be zero. The below gif shown the oxygen molecules (blue color) attracting the free electrons (black color) inside the SnO2 and preventing it from having free electrons to conduct current.

When the sensor is placed in the toxic or combustible gases environment, this reducing gas (orange color) reacts with the adsorbed oxygen particles and breaks the chemical bond between oxygen and free electrons thus **releasing the free electrons**. As the free electrons are back to its initial position they can now conduct current, this conduction will be proportional the amount of free electrons available in SnO2, if the gas is highly toxic more free electrons will be available.

How to use a Gas sensor?

A basic gas sensor has 6 terminals in which 4 terminals (A, A, B, B) acts input or output and the remaining 2 terminals (H, H) are for heating the coil. Of these 4 terminals, 2 terminals from each side can be used as either input or output (these terminals are reversible as shown in the circuit diagram) and vice versa.



MQ-4 Module Pinout

MQ-4 Sensor Pinout

These sensors are normally available as modules (shown right), these modules consist of the gas sensor and a comparator IC. Now let's see the pin description of the gas sensor module which we will generally use with an Arduino. The gas sensor module basically consists of 4 terminals

- **Vcc** – Power supply
- **GND** – Power supply
- **Digital output** – This pin gives an output either in logical high or logical low (0 or 1) that means it displays the presence of any toxic or combustible gases near the sensor.
- **Analog output** – This pin gives an output continuous in voltage which varies based on the concentration of gas that is applied to the gas sensor.

As discussed earlier the output of a gas sensor alone will be very small (in mV) so an external circuit has to be used in order to get a digital high low output from the sensor. For this purpose, a comparator (LM393), adjustable potentiometer, some resistors and capacitors are used. The purpose of LM393 is to get the output from the sensor, compare it with a reference voltage and display whether the output is logically high or not. Whereas the purpose of the potentiometer is to set the required threshold value of the gas above which the digital output pin should go high.

Below diagram shows the basic **circuit diagram of a gas sensor in a gas sensor module**

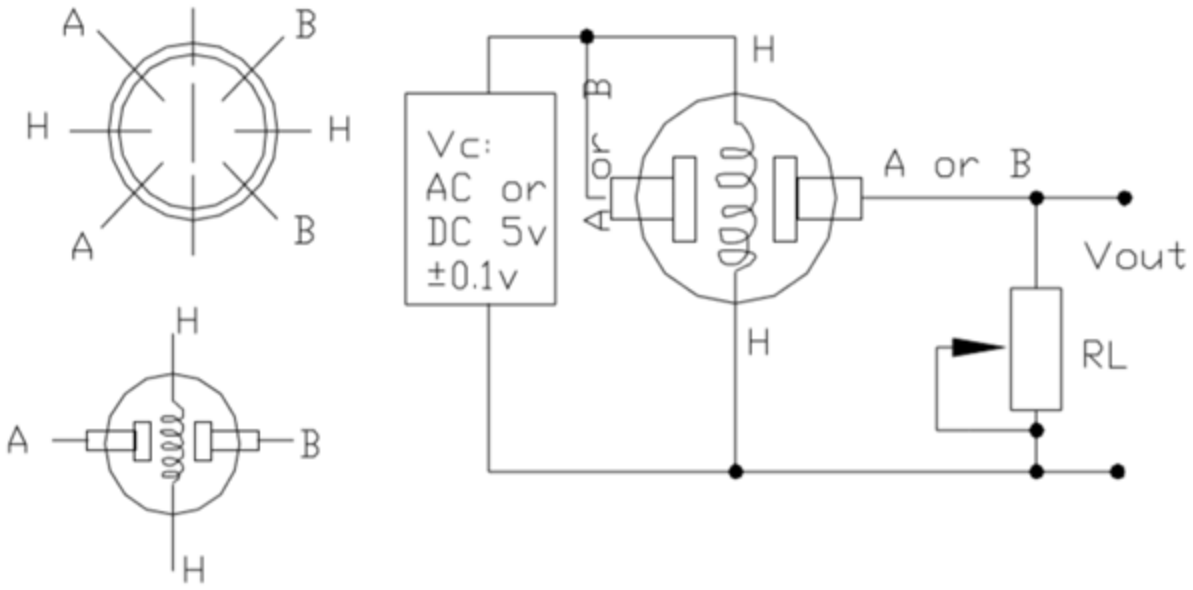


Fig: 2.2.3 Circuit Diagram of Gas Sensor

Here A and B are the input and output terminals (these are reversible - means any of the paired terminals can be used as input or output) and H is the Heater coil terminal. The purpose of the variable resistor is to adjust the output voltage and to maintain high sensitivity.

If no input voltage is applied to the heater coil, then the output current will be very less (which is negligible or approximately 0). When sufficient voltage is applied to the input terminal and heater coil, the sensing layer wakes up and is ready to sense any combustible gases nearby it. Initially let's assume that there is no toxic gas near the sensor, so the resistance of the layer doesn't change and the output current and voltage are also unchanged and are negligible (approximately 0). Now let's assume that there is some toxic gas nearby. As the heater coil is pre-heated it is now easy to detect any combustible gases. When the sensing layer interacts with the gases, the resistance of the material varies and the current flowing through the circuit also varies. This change in variation can be then observed at the load resistance (RL). The value of load resistance (RL) can be anywhere from 10KΩ to 47KΩ. The exact value of the load resistance can be selected by calibrating with the known concentration of the gas. If low load resistance is selected then the circuit has less sensitivity and if high load resistance is selected then the circuit has high sensitivity.

List of Gas Sensors and What Gases They Sense

Sensor Name	Gas to measure
MQ-2	Methane, Butane, LPG, Smoke
MQ-3	Alcohol, Ethanol, Smoke
MQ-4	Methane, CNG Gas
MQ-5	Natural gas, LPG
MQ-6	LPG, butane
MQ-7	Carbon Monoxide
MQ-8	Hydrogen Gas
MQ-9	Carbon Monoxide, flammable gasses
MQ131	Ozone
MQ135	Air Quality
MQ136	Hydrogen Sulphide gas
MQ137	Ammonia
MQ138	Benzene, Toluene, Alcohol, Propane, Formaldehyde gas, Hydrogen
MQ214	Methane, Natural Gas
MQ216	Natural gas, Coal Gas
MQ303A	Alcohol, Ethanol, smoke
MQ306A	LPG, butane
MQ307A	Carbon Monoxide

MQ309A	Carbon Monoxide, flammable gas

Applications of Gas Sensors

- Used in industries to monitor the concentration of the toxic gases.
- Used in households to detect an emergency incidents.
- Used at oil rig locations to monitor the concentration of the gases those are released.
- Used at hotels to avoid customers from smoking.
- Used in air quality check at offices.
- Used in air conditioners to monitor the CO2 levels.
- Used in detecting fire.
- Used to check concentration of gases in mines.
- Breathe analyzer.

2.3 Microcontroller

Introduction

A microcontroller is a compact integrated circuit designed to govern a specific operation in an embedded system. A typical microcontroller includes a processor, memory and input/output (I/O) peripherals on a single chip. Sometimes referred to as an embedded controller or microcontroller unit (MCU), microcontrollers are found in vehicles, robots, office machines, medical devices, mobile radio transceivers, vending machines and home appliances, among other devices. They are essentially simple miniature personal computers (PCs) designed to control small features of a larger component, without a complex front-end operating system (OS).

A microcontroller is embedded inside of a system to control a singular function in a device. It does this by interpreting data it receives from its I/O peripherals using its central processor. The temporary information that the microcontroller receives is stored in its data memory, where the processor accesses it and uses instructions stored in its program memory to decipher and apply the incoming data. It then uses its I/O peripherals to communicate and enact the appropriate action.

Microcontrollers are used in a wide array of systems and devices. Devices often utilize multiple microcontrollers that work together within the device to handle their respective tasks. For example, a car might have many microcontrollers that control various individual systems within, such as the anti-lock braking system, traction control, fuel injection or suspension control. All the microcontrollers communicate with each other to inform the correct actions. Some might communicate with a more complex central computer within the car, and others might only communicate with other microcontrollers. They send and receive data using their I/O peripherals and process that data to perform their designated tasks.

What are the elements of a microcontroller?

The core elements of a microcontroller are:

- The processor (CPU) -- A processor can be thought of as the brain of the device. It processes and responds to various instructions that direct the microcontroller's function. This involves performing basic arithmetic, logic and I/O operations. It also performs data transfer operations, which communicate commands to other components in the larger embedded system.
- Memory -- A microcontroller's memory is used to store the data that the processor receives and uses to respond to instructions that it's been programmed to carry out. A microcontroller has two main memory types:
    1. Program memory, which stores long-term information about the instructions that the CPU carries out. Program memory is non-volatile memory, meaning it holds information over time without needing a power source.
    2. Data memory, which is required for temporary data storage while the instructions are being executed. Data memory is volatile, meaning the data it holds is temporary and is only maintained if the device is connected to a power source.
- I/O peripherals -- The input and output devices are the interface for the processor to the outside world. The input ports receive information and send it to the processor in the form of

binary data. The processor receives that data and sends the necessary instructions to output devices that execute tasks external to the microcontroller.

While the processor, memory and I/O peripherals are the defining elements of the microprocessor, there are other elements that are frequently included. The term *I/O peripherals* itself simply refers to supporting components that interface with the memory and processor. There are many supporting components that can be classified as peripherals. Having some manifestation of an I/O peripheral is elemental to a microprocessor, because they are the mechanism through which the processor is applied.

Table no 2.3Technical specifications

Microcontroller	ATMEL Series
Operating Voltage	5V
Digital I/O Pins	14 (of which 6 provide PWM output)
PWM Digital I/O Pins	6
Analog Input Pins	6
DC Current per I/O Pin	20 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (ATmega328P) of which 0.5 KB used by boot loader
SRAM	2 KB (ATmega328P)
EEPROM	1 KB (ATmega328P)
Clock Speed	16 MHz
Length	68.6 mm

- Analog to Digital Converter (ADC) -- An ADC is a circuit that converts analog signals to digital signals. It allows the processor at the center of the microcontroller to interface with external analog devices, such as sensors.
- Digital to Analog Converter (DAC) -- A DAC performs the inverse function of an ADC and allows the processor at the center of the microcontroller to communicate its outgoing signals to external analog components.
- System bus -- The system bus is the connective wire that links all components of the microcontroller together.
- Serial port -- The serial port is one example of an I/O port that allows the microcontroller to connect to external components. It has a similar function to a USB or a parallel port but differs in the way it exchanges bits.

Feature

High Performance, Low Power Atmel®AVR® 8-Bit Microcontroller Family
• Advanced RISC Architecture
– 131 Powerful Instructions
– Most Single Clock Cycle Execution
– 32 x 8 General Purpose Working Registers
– Fully Static Operation
– Up to 20 MIPS Throughput at 20MHz
– On-chip 2-cycle Multiplier
• High Endurance Non-volatile Memory Segments
– 32KBytes of In-System Self-Programmable Flash program
Memory
– 1KBytes EEPROM
– 2KBytes Internal SRAM
– Write/Erase Cycles: 10,000 Flash/100,000 EEPROM
– Data Retention: 20 years at 85°C/100 years at 25°C(1)
– Optional Boot Code Section with Independent Lock Bits
• In-System Programming by On-chip Boot Program
• True Read-While-Write Operation

– Programming Lock for Software Security

• Atmel® QTouch® Library Support

– Capacitive Touch Buttons, Sliders and Wheels

– QTouch and QMatrix® Acquisition

Peripheral Features

– Two 8-bit Timer/Counters with Separate Prescaler and Compare Mode

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

– Real Time Counter with Separate Oscillator

– Six PWM Channels

– 8-channel 10-bit ADC in TQFP and QFN/MLF package

• Temperature Measurement

– 6-channel 10-bit ADC in PDIP Package

• Temperature Measurement

– Two Master/Slave SPI Serial Interface

– One Programmable Serial USART

– One Byte-oriented 2-wire Serial Interface (Philips I2C compatible)

– Programmable Watchdog Timer with Separate On-chip Oscillator

– One On-chip Analog Comparator

– Interrupt and Wake-up on Pin Change

• Special Microcontroller Features

– Power-on Reset and Programmable Brown-out Detection

– Internal Calibrated Oscillator

– External and Internal Interrupt Sources

– Six Sleep Modes: Idle, ADC Noise Reduction, Power-save, Power-down, Standby, and Extended Standby

• I/O and Packages

– 23 Programmable I/O Lines

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

• Operating Voltage:

– 1.8 - 5.5V

• Temperature Range:

– -40°C to 105°C

• Speed Grade:

– 0 - 4MHz @ 1.8 - 5.5V

– 0 - 10MHz @ 2.7 - 5.5V

– 0 - 20MHz @ 4.5 - 5.5V

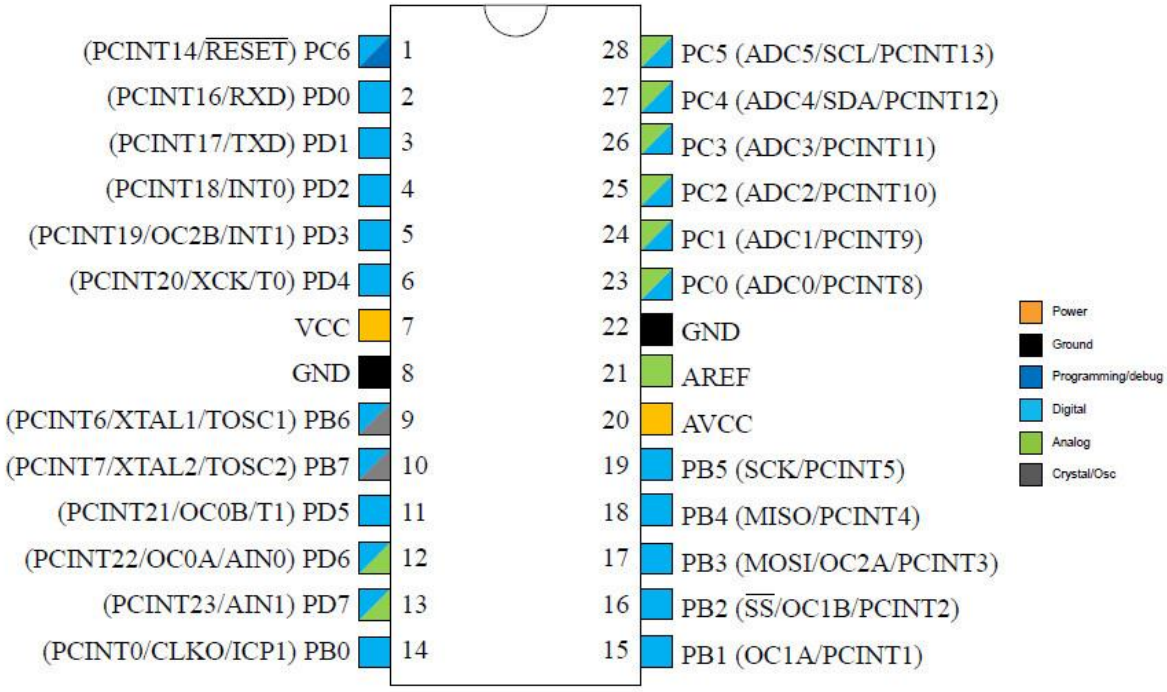
• Power Consumption at 1MHz, 1.8V, 25°C

– Active Mode: 0.2mA

– Power-down Mode: 0.1µA

– Power-save Mode: 0.75µA (Including 32kHz RTC)

Pinout (Atmega328)



Status Register

When addressing I/O Registers as data space using LD and ST instructions, the provided offset must be used. When using the I/O specific commands IN and OUT, the offset is reduced by 0x20, resulting in an I/O address offset within 0x00 - 0x3F.

Name: SREG

Offset: 0x5F

Reset: 0x00

Property:

When addressing as I/O Register: address offset is 0x3F

Bit 6 – T: Copy Storage

The Bit Copy instructions BLD (Bit LoaD) and BST (Bit STore) use the T-bit as source or destination for the operated bit. A bit from a register in the Register File can be copied into T by the BST instruction, and a bit in T can be copied into a bit in a register in the Register File by the BLD instruction.

Bit 5 – H: Half Carry Flag

The Half Carry Flag H indicates a Half Carry in some arithmetic operations. Half Carry Flag is useful in BCD arithmetic. See the Instruction Set Description for detailed information.

Bit 4 – S: Sign Flag, S = N ⊕ V

The S-bit is always an exclusive or between the Negative Flag N and the Two's Complement Overflow Flag V. See the Instruction Set Description for detailed information.

Bit 3 – V: Two's Complement Overflow Flag

The Two's Complement Overflow Flag V supports two's complement arithmetic. See the Instruction Set Description for detailed information.

Bit 2 – N: Negative Flag

The Negative Flag N indicates a negative result in an arithmetic or logic operation. See the Instruction Set Description for detailed information.

Bit 1 – Z: Zero Flag

The Zero Flag Z indicates a zero result in an arithmetic or logic operation.

2.4 POWER SUPPLY UNIT

Introduction

A power supply is an electronic device that supplies electric energy to an electrical load. The primary function of a power supply is to convert one form of electrical energy to another and, as a result, power supplies are sometimes referred to as electric power converters. Some power supplies are discrete, stand-alone devices, whereas others are built into larger devices along with their loads. Examples of the latter include power supplies found in desktop computers and consumer electronics devices.

Operation

The electrical power is almost exclusively generated, transmitted and distributed in the form of ac because of economical consideration but for operation of most of the electronic devices and circuits, dc supply is required. Dry cells and batteries can be used for this purpose. No doubt, they have the advantages of being portable and ripple free but their voltages are low, they need frequent replacement and are expensive in comparison to conventional dc power supplies. Now day, almost all electronic equipment include a circuit that converts ac supply into dc supply. The part of equipment that converts ac into dc is called DC power supply. In general at the input of the power supply there is a power transformer. It is followed by a rectifier (a diode circuit)a smoothing filter and then by a voltage regulator circuit.

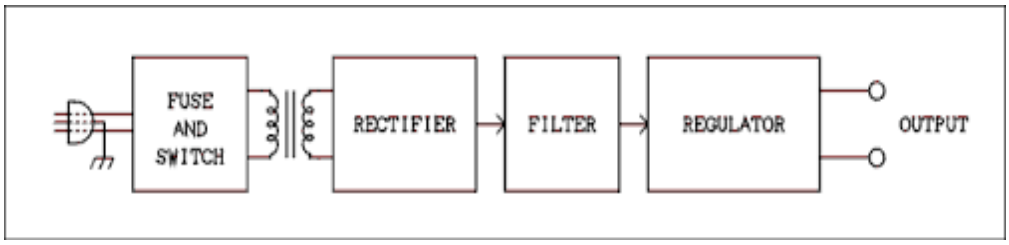


Figure 2.4.1 Block diagram of power supply unit

From the block diagram, four elements of basic power supply such as a transformer, correction, a filter and a controller are combined. The output of the dc power supply is used to provide a constant dc voltage across the load. Let us briefly outline the function of each of the elements of the dc power supply.

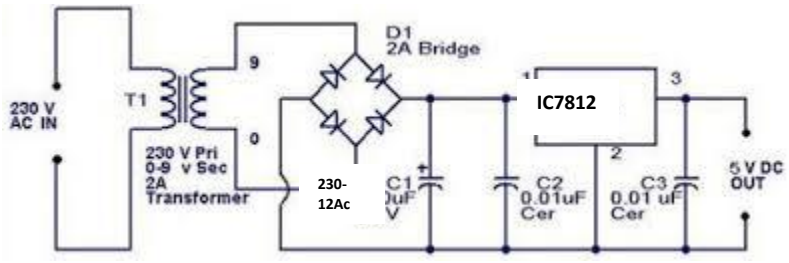


Figure:2.4.2 Circuit diagram of power supply unit

Transformer is used to step-up or step-down (usually to step-down) the-supply voltage as per need of the solid-state electronic devices and circuits to be supplied by the dc power supply. It can provide isolation from the supply line-an important safety consideration. It may also include internal shielding to prevent unwanted electrical noise signal on the power line from getting into the power supply and possibly disturbing the load. Rectifier is a device which converts the sinusoidal ac voltage into either positive or negative pulsating dc. P-N junction diode, which conducts when forward biased and practically does not conduct when reverse biased, can be used for rectification *i.e.* for conversion of ac into dc. The rectifier typically needs one, two or four diodes. Rectifiers may be either half-wave rectifiers or full-wave rectifiers (center-tap or bridge) type. The output voltage from a rectifier circuit has a pulsating character i.e., it contains unwanted ac components (components of supply frequency f and its harmonics) along with dc component. For most supply purposes, constant direct voltage is required than that furnished by a rectifier. To reduce ac components from the rectifier output voltage a filter circuit is required. Thus filter is a device which passes dc component to the load and blocks I ac components of the rectifier output. Filter is typically constructed from reactive circuit I elements such as capacitors and/or inductors and resistors. The magnitude of output dc voltage may vary with the variation of either the input ac voltage or the magnitude of load current. So at the output of a rectifier filter combination a voltage regulator is required, to provide an almost constant dc voltage at the output of the regulator. The voltage regulator may be constructed from a Zener diode, and or discrete transistors, and/or integrated circuits (ICs). Its main function is to maintain a constant dc output voltage. However, it also rejects any ac ripple voltage that is not removed by the filter. The regulator may also include protective devices such as short-circuit protection, current limiting, thermal shutdown, or over-voltage protection.

2.5 LCD DISPLAY

Introduction:

16×2 LCD is named so because; it has 16 Columns and 2 Rows. There are a lot of combinations available like, 8×1, 8×2, 10×2, 16×1, etc. But the most used one is the 16*2 LCD; hence we are using it here.



Figure: 2.5.1liquid Crystal Display

All the above mentioned LCD display will have 16 Pins and the programming approach is also the same and hence the choice is left to you. Below is the **Pinout and Pin Description of 16x2 LCD Module**:

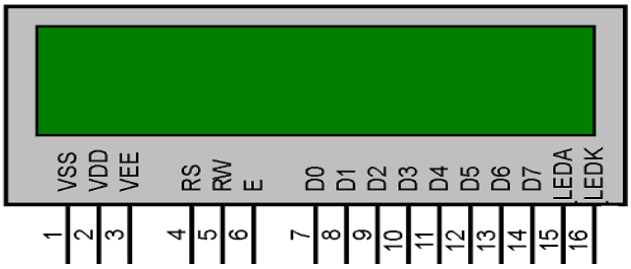


Figure: 2.5.2pin Diagram

Description of pin diagram:

Sr. No	Pin No.	Pin Name	Pin Type	Pin Description	Pin Connection
1	Pin 1	Ground	Source Pin	This is a ground pin of LCD	Connected to the ground of the MCU/ Power source
2	Pin 2	VCC	Source Pin	This is the supply voltage pin of LCD	Connected to the supply pin of Power source
3	Pin 3	V0/VEE	Control Pin	Adjusts the contrast of the LCD.	Connected to a variable POT that can source 0-5V
4	Pin 4	Register Select	Control Pin	Toggles between Command/Data Register	Connected to a MCU pin and gets either 0 or 1. 0 -> Command Mode 1-> Data Mode
5	Pin 5	Read/Write	Control Pin	Toggles the LCD between Read/Write Operation	Connected to a MCU pin and gets either 0 or 1. 0 -> Write Operation 1-> Read Operation
6	Pin 6	Enable	Control Pin	Must be held high to perform Read/Write Operation	Connected to MCU and always held high.
7	Pin 7-14	Data Bits (0-7)	Data/Command Pin	Pins used to send Command or data to the LCD.	In 4-Wire Mode Only 4 pins (0-3) is connected to MCU In 8-Wire Mode All 8 pins(0-7) are connected to MCU
8	Pin 15	LED Positive	LED Pin	Normal LED like operation to illuminate the LCD	Connected to +5V
9	Pin 16	LED Negative	LED Pin	Normal LED like operation to illuminate the LCD connected with GND.	Connected to ground

It is okay if you do not understand the function of all the pins, I will be explaining in detail below. Now, let us turn back our LCD:

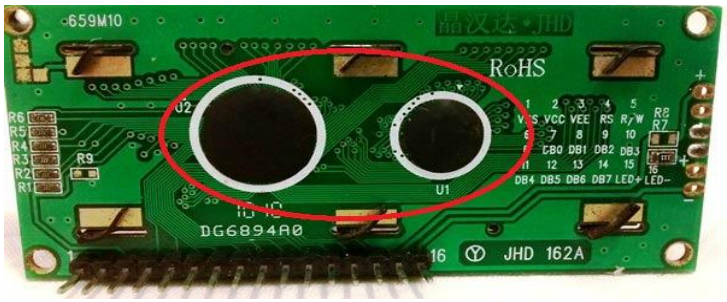


Figure: 2.5.3 black LCD

Okay, what is this two black circle like things on the back of our LCD?

These black circles consist of an interface IC and its associated components to help us use this LCD with the MCU. Because our LCD is a 16*2 Dot matrix LCD and so it will have (16*2=32) 32 characters in total and each character will be made of 5*8 Pixel Dots. A Single character with all its Pixels enabled is shown in the below picture.

So Now, we know that each character has (5*8=40) 40 Pixels and for 32 Characters we will have (32*40) 1280 Pixels. Further, the LCD should also be instructed about the Position of the Pixels.

It will be a hectic task to handle everything with the help of MCU, hence an Interface IC like HD44780is used, which is mounted on LCD Module itself. The function of this IC is to get the Commands and Data from the MCU and process them to display meaningful information onto our LCD Screen. Let's discuss the different type of mode and options available in our LCD that has to be controlled by our Control Pins.

4-bit and 8-bit Mode of LCD:

The LCD can work in two different modes, namely the 4-bit mode and the 8-bit mode. In 4 bit mode we send the data nibble by nibble, first upper nibble and then lower nibble. For those of you who don't know what a nibble is: a nibble is a group of four bits, so the lower four bits (D0-D3) of a byte form the lower nibble while the upper four bits (D4-D7) of a byte form the higher nibble. This enables us to send 8 bit data.

Whereas in 8 bit mode we can send the 8-bit data directly in one stroke since we use all the 8 data lines. Now you must have guessed it, Yes 8-bit mode is faster and flawless than 4-bit mode. But the major drawback is that it needs 8 data lines connected to the microcontroller. This will make us run out of I/O pins on our MCU, so 4-bit mode is widely used. No control pins are used to set these modes. It's just the way of programming that change.

Read and Write Mode of LCD:

As said, the LCD itself consists of an Interface IC. The MCU can either read or write to this interface IC. Most of the times we will be just writing to the IC, since reading will make it more complex and such scenarios are very rare. Information like position of cursor, status completion interrupts etc. can be read if required, but it is out of the scope of this tutorial.

The Interface IC present in most of the LCD is HD44780U**;** in order to program our LCD we should learn the complete datasheet of the IC.

6.4 LCD Commands:

There are some preset commands instructions in LCD, which we need to send to LCD through some microcontroller. Some important command instructions are given below:

Hex Code	**Command to LCD Instruction Register**
0F	LCD ON, cursor ON
01	Clear display screen
02	Return home
04	Decrement cursor (shift cursor to left)
06	Increment cursor (shift cursor to right)
05	Shift display right
07	Shift display left

0E	Display ON, cursor blinking
80	Force cursor to beginning of first line
C0	Force cursor to beginning of second line
38	2 lines and 5×7 matrix
83	Cursor line 1 position 3
3C	Activate second line
08	Display OFF, cursor OFF
C1	Jump to second line, position 1
OC	Display ON, cursor OFF
C1	Jump to second line, position 1
C2	Jump to second line, position 2

Connection diagram of LCD

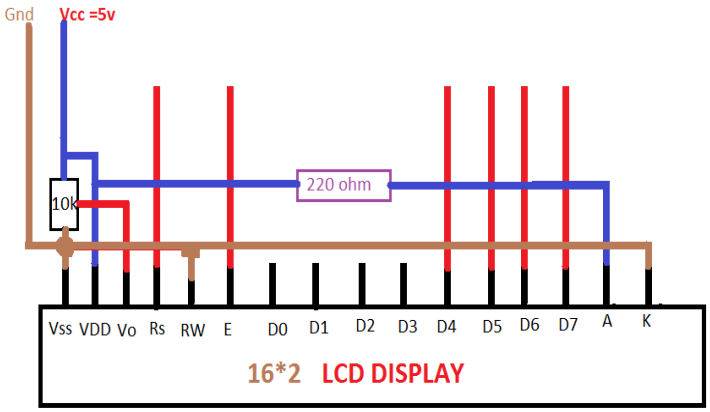


Fig: 2.5.4 Connection diagram of LCD

2.6 Buzzer

A buzzer is a mechanical, electromechanical, magnetic, electromagnetic, electro-acoustic or piezoelectric audio signalling device. A piezo electric buzzer can be driven by an oscillating electronic circuit or other audio signal source. A click, beep or ring can indicate that a button has been pressed.

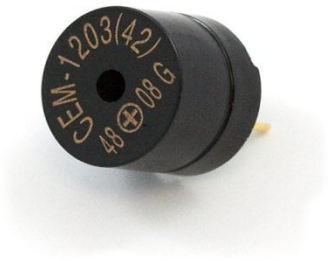


Fig: 2.6 Physical View of Buzzer

Types of Buzzers

There are several different kinds of buzzers. At Future Electronics we stock many of the most common types categorized by Type, Sound Level, Frequency, Rated Voltage, Dimension and Packaging Type. The parametric filters on our website can help refine your search results depending on the required specifications.

The most common sizes for Sound Level are 80 dB, 85 dB, 90 dB and 95 dB. We also carry buzzers with Sound Level up to 105 dB. There are several types available including Electro-Acoustic, Electromagnetic, Electromechanic, Magnetic and Piezo, among others.

Buzzers from Future Electronics

Future Electronics has a complete selection of buzzers from several manufacturers that can be used as an electromagnetic buzzer, piezo buzzer, electro-acoustic transducer, piezo electric transducers or magnetic buzzer for any electric circuit applications. Simply choose from the buzzer technical attributes below and your search results will quickly be narrowed in order to match your specific buzzer application needs.

If you have a preferred brand, we deal with CUI Inc, Intervox/ICC, Mallory and Murata, among others. You can easily refine your buzzer product search results by clicking your preferred buzzer brand below from our list of manufacturers.

Applications for Buzzers:

- Alarm devices
- Timers
- Confirmation of user input (ex: mouse click or keystroke)
- Electronic metronomes
- Annunciator panels
- Game shows
- Sporting events
- Household appliances

When you are looking for the right buzzers, you can filter the results by various attributes with the FutureElectronics.com parametric search: by Sound Level (57 dB, 80 dB, 85 dB, 90 dB, 95 dB,…), Type (Electro-Acoustic, Electromagnetic, Electromechanic, Magnetic or Piezo) and Frequency (from 400 Hz to 20 kHz), to name a few. You will be able to find the right electromagnetic buzzer, electro-acoustic transducer, piezo electric transducers, magnetic buzzer, acoustic transducer or piezo buzzer for an electric circuit.

If the quantity of buzzers required is less than a full reel, we offer to customers many of our products in tray or box quantities that will help you avoid unneeded surplus.

In addition, Future Electronics offers its clients a unique bonded inventory program designed to eliminate potential problems that could arise from an unpredictable supply of products containing raw metals and products with long or erratic lead times. Talk with your nearest Future Electronics branch so you can find out more on how you can avoid possible shortages.

2.7f GSM modem

A **GSM modem** is a specialized type of modem which accepts a SIM card, and operates over a subscription to a mobile operator, just like a mobile phone. From the mobile operator perspective, a GSM modem looks just like a mobile phone. When a GSM modem is connected to a computer, this allows the computer to use the GSM modem to communicate over the mobile network. While

these GSM modems are most frequently used to provide mobile internet connectivity, many of them can also be used for sending and receiving SMS and MMS messages.



Fig2.7: Physical View of GSM A6

GSM modem can be a dedicated modem device with a serial, USB or Bluetooth connection, or it can be a mobile phone that provides GSM modem capabilities. For the purpose of this document, the term GSM modem is used as a generic term to refer to any modem that supports one or more of the protocols in the GSM evolutionary family, including the 2.5G technologies GPRS and EDGE, as well as the 3G technologies WCDMA, UMTS, HSDPA and HSUPA Wide area coverage: GPRS in 34 provinces have good coverage, it is the prevailing 2Gcommunication standard. Basically you can place phone call are available through the GPRS wireless network; Always-on: GPRS is activated as long as the application, will remain online, similar to the wireless private line network services. By the amount of charge: GPRS services, though to be online, but you do not have to worry about the cost issue; due to traffic generated only when charging. High-speed transmission: GPRS currently supports peak data rate of 85.6Kbps, the theoretical peak transfer transport up to more than 100 Kbps. Cheap: Relative to the SIM series module price is only half of it. Greatly reduced Internet of Things entry threshold; With smaller size, lower power consumption and wide operating temperature range, GA6 M2M application is the rationale want solutions for automotive, industrial and PDA, personal tracking, power environmental monitoring, wireless POS, smart metering as well as of other M2M Application, provided for it GSM / GPRS SMS, data transmission and voice services.

GSM Architecture

A GSM network consists of the following components:

- **A Mobile Station:** It is the mobile phone which consists of the transceiver, the display and the processor and is controlled by a SIM card operating over the network.
- **Base Station Subsystem:** It acts as an interface between the mobile station and the network subsystem. It consists of the Base Transceiver Station which contains the radio transceivers and handles the protocols for communication with mobiles. It also consists of the Base Station Controller which controls the Base Transceiver station and acts as a interface between the mobile station and mobile switching centre.
- **Network Subsystem:** It provides the basic network connection to the mobile stations. The basic part of the Network Subsystem is the Mobile Service Switching Centre which provides access to different networks like ISDN, PSTN etc. It also consists of the Home Location Register and the Visitor Location Register which provides the call routing and roaming capabilities of GSM. It also contains the Equipment Identity Register which maintains an account of all the mobile equipment's wherein each mobile is identified by its own IMEI number. IMEI stands for International Mobile Equipment Identity.

Specification

* GA6 size 22.8mm x 16.8mm x 2.2mm ;

* Normal working temperature: -30 ° C ~ +80 ° C ,

* Limited Operating Temperature: -40 ° C ~ -30 ° C and +80 ° C ~ + 85 ° C *

* working voltage 3. 5 V-4.2V;

* Starting voltage > 3.5 V ;

* SLEEP mode current consumption of 0.9mA ;

* Quad band : GSM850, EGSM 900 and DCS 1800 , the PCS1900 can automatically search for four bands. l Meet GSM Phase 2 / 2+ l GPRS Class 10;

* Sensitivity <-10 7 ;

* support voice calls;

* support SMS sms

* Support mobile and China Unicom 2G , and GSM network worldwide

* GPRS data characteristics, the maximum data rate, download 85.6Kbps, upload 42.8Kbps ;

* Supports serial port multiplexing function according to GSM 07.10 protocol

* support two serial ports, one to download the serial port, an AT command port;

* AT command supports standard AT and TCP / IP command interface;

* Support digital audio and analog audio, support HR , FR , EFR , AMR voice coding;

2.8 Buck Converter

Introduction:



Fig2.8.1: Physical View of Buck Converter

This is an LM2596 DC-DC buck converter step-down power module with high-precision potentiometer, capable of driving a load up to 3A with high efficiency, which can work with Freeduino UNO, other mainboards and basic modules. When the output current keeps greater than 2.5A (or output power greater than 10W), please add a heat sink on it.

Specifications:

- Module properties: non-isolated step-down module
- Mode of rectification: non-synchronous rectification
- Input voltage: 4V-35V
- Output voltage: 1.25-30V
- Output current: 3A (MAX)
- Size: 53mm * 26mm approx (just for rough idea, vary depending on the manufacturer)
- Input mode: IN+ input positive IN- input negative
- Output mode: OUT+ output positive OUT- output negative

PCB Layout Guidelines

As in any switching regulator, the layout of the printed circuit board is very important. Rapidly switching currents associated with wiring inductance, stray capacitance and parasitic inductance of the printed circuit board traces can generate voltage transients which can generate electromagnetic interferences (EMI) and affect the desired operation. As indicated in the Figure 15, to minimize inductance and ground loops, the length of the leads indicated by heavy lines should be kept as short as possible. For best results, single−point grounding (as indicated) or ground plane construction should be used. On the other hand, the PCB area connected to the Pin 2 (emitter of the internal switch) of the LM2596 should be kept to a minimum in order to minimize coupling to sensitive circuitry. Another sensitive part of the circuit is the feedback. It is important to keep the sensitive feedback wiring short. To assure this, physically locate the programming resistors near to the regulator, when using the adjustable version of the LM2596 regulator.

Buck Converter Basic Working Principles:

The LM2596 is a "Buck" or Step−Down Converter which is the most elementary forward−mode converter. Its basic schematic can be seen in Figure 16. The operation of this regulator topology has two distinct time periods. The first one occurs when the series switch is on, the input voltage is connected to the input of the inductor. The output of the inductor is the output voltage, and the rectifier (or catch diode) is reverse biased. During this period, since there is a constant voltage source connected across the inductor, the inductor current begins to linearly ramp upwards, as described by the following equation:

$$I_{L(on)} = \frac{(V_{IN} - V_{OUT})t_{on}}{L}$$

During this “on” period, energy is stored within the core material in the form of magnetic flux. If the inductor is properly designed, there is sufficient energy stored to carry the requirements of the load during the “off” period.

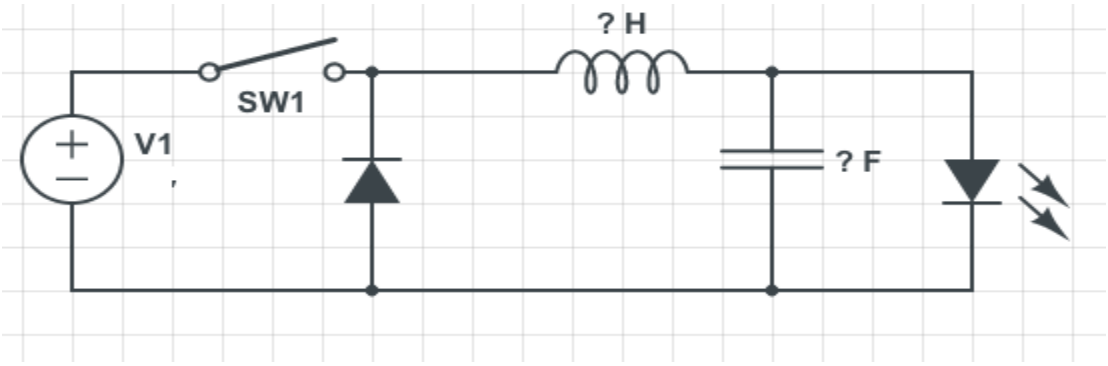


Figure2.8.2. Basic Buck Converter

The next period is the “off” period of the power switch. When the power switch turns off, the voltage across the inductor reverses its polarity and is clamped at one diode voltage drop below ground by the catch diode. The current now flows through the catch diode thus maintaining the load current loop. This removes the stored energy from the inductor. The inductor current during this time is:

$$I_{L(off)} = \frac{(V_{OUT} - V_D)t_{off}}{L}$$

This period ends when the power switch is once again turned on. Regulation of the converter is accomplished by varying the duty cycle of the power switch. It is possible to describe the duty cycle as follows: , $d = \frac{t_{on}}{T}$, where T is the period of switching.

For the buck converter with ideal components, the duty cycle can also be described as:

$$d = \frac{V_{out}}{V_{in}}$$

shows the buck converter, idealized waveforms of the catch diode voltage and the inductor current.

2.9 Servo Motor:

Tiny and lightweight with high output power. Servo can rotate approximately 180 degrees (90 in each direction), and works just like the standard kinds but smaller. You can use any servo code, hardware or library to control these servos. Good for beginners who want to make stuff move without building a motor controller with feedback & gear box, especially since it will fit in small places. It comes with a 3 horns (arms) and hardware.



Fig2.9.1: Micro Servo Motor

Specifications

- Weight: 9 g
- Dimension: 22.2 x 11.8 x 31 mm approx.
- Stall torque: 2.5 kgf·cm
- Operating speed: 0.1 s/60 degree
- Operating voltage: 4.8 V (~5V)
- Dead band width: 10 µs
- Temperature range: 0 ºC – 55 ºC

Wire Configuration

Wire Number	Wire Colour	Description
1	Brown	Ground wire connected to the ground of system
2	Red	Powers the motor typically +5V is used
3	Orange	PWM signal is given in through this wire to drive the motor

Working Process of Servo Motor:

There are lots of servo motors available in the market and each one has its own specialty and applications. The following two paragraphs will help you identify the right type of servo motor for your project/system. Most of the hobby Servo motors operates from 4.8V to 6.5V, the higher the voltage higher the torque we can achieve, but most commonly they are operated at +5V. Almost all hobby servo motors can rotate only from 0° to 180° due to their gear arrangement so make sure you project can live with the half circle if no, you can prefer for a 0° to 360° motor or modify the motor to make a full circle. The gears in the motors are easily subjected to wear and tear, so if your application requires stronger and long running motors you can go with metal gears or just stick with normal plastic gear.

Next comes the most important parameter, which is the **torque** at which the motor operates. Again there are many choices here but the commonly available one is the 2.5kg/cm torque which comes with the Towerpro SG90 Motor. This 2.5kg/cm torque means that the motor can pull a weight of 2.5kg when it is suspended at a distance of 1cm. So if you suspend the load at 0.5cm then the motor can pull a load of 5kg similarly if you suspend the load at 2cm then can pull only 1.25. Based on the load which you use in the project you can select the motor with proper torque. The below picture will illustrate the same.

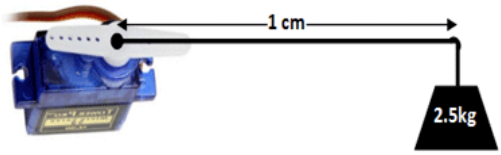


fig2.9.3 Torque in a Servo Motor

Working Process of Servo Motor

After selecting the right Servo motor for the project, comes the question how to use it. As we know there are three wires coming out of this motor. The description of the same is given on top of this page. To make this motor rotate, we have to power the motor with +5V using the Red and Brown wire and send PWM signals to the Orange colour wire. Hence we need something that could generate PWM signals to make this motor work, this something could be anything like a 555 Timer or other Microcontroller platforms like Arduino, PIC, ARM or even a microprocessor like Raspberry Pie. Now, how to control the direction of the motor? To understand that let us a look at the picture given in the datasheet.

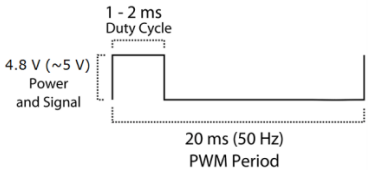


fig2.9.4 Input Signal for Operation

From the picture we can understand that the PWM signal produced should have a frequency of 50Hz that is the PWM period should be 20ms. Out of which the On-Time can vary from 1ms to 2ms. So when the on-time is 1ms the motor will be in 0° and when 1.5ms the motor will be 90°, similarly when it is 2ms it will be 180°. So, by varying the on-time from 1ms to 2ms the motor can be controlled from 0° to 180°.

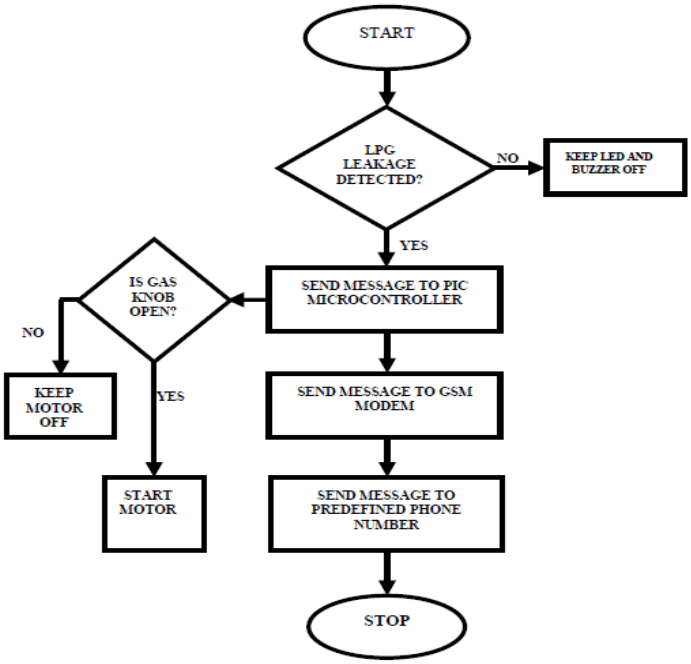
CHAPTER-3

DESIGN AND FABRICATION

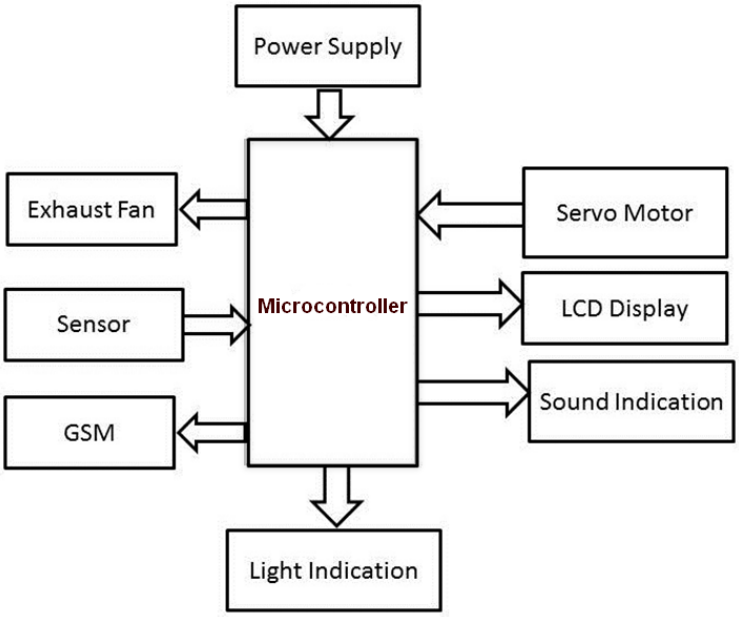
3.1 Proposed System

We purpose a system to come across LPG fuel leakage situations and offer a security alert to supposed customers. We right here endorse to build the gadget the use of a MQ5 gas detection sensor. If the LPG sensor senses any gas leakage from storage, gas sensor is going stumble on it this sign is monitored by using the microcontroller and it'll perceive the gasoline leakage. Now the microcontroller is turn on LED and buzzer. After few milliseconds put off, microcontroller instructions driving force circuitry for exhaust fan to turn the fan on to release the gasoline outdoor from the room and concurrently microcontroller commands every other circuitry a relay circuitry to shut the fuel knob. In our proposed machine we designed two motive force circuitry one to power motor to close knob. And any other is relay circuitry in which is used to switched on and rancid for exhaust fan and a text message send to the user by the GSM module. Microcontroller is programmed by using embedded c language. It's far the complete control of the task. It controls the Exhaust fan, LED, Buzzer and when LPG leak takes place.

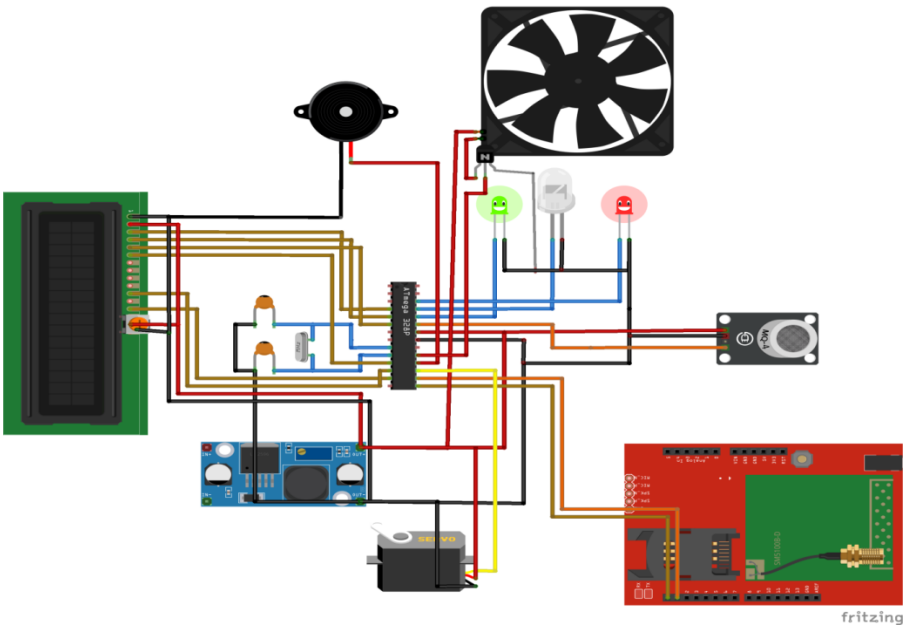
3.2 Flow Chart



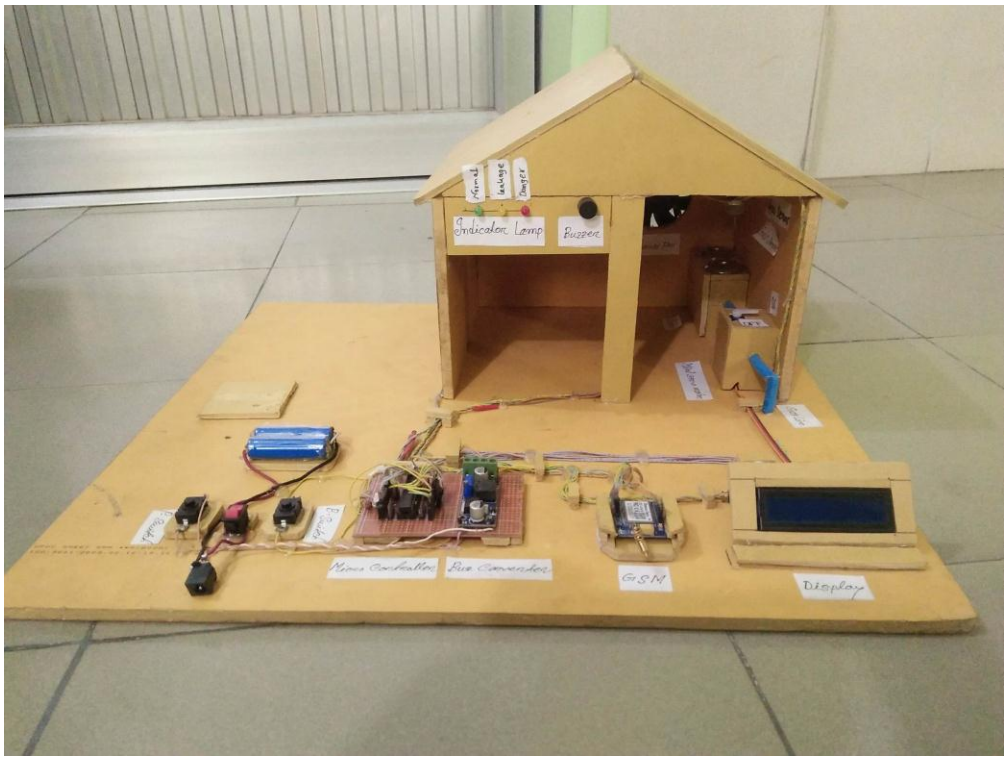
3.3 Block Diagram



3.4 Circuit Diagram



3.5 Hardware Project View:



3.6 Cost Analysis

In the Table shows the cost analysis of the proposed Microcontroller Based LPG leakage detection and response System. The analysis is based on the lowest individual cost of each component used in the simulation while taking into consideration quality, in order to minimise the cost of building the system. This in turn makes the system economical and affordable for domestic use. This analysis is an estimate of the prices of components used in the simulation based on review of online prices.

S.NO	Component	Quantity	Price/Unit	Total Price
1	9V Power Supply	1	200	200
2	MQ4 Gas Sensor	1	300	300
5	Atmega328	1	200	200
6	Buck Regulator	1	200	200
7	Vero board	1	30	30
8	Green connector	3	10	30
9	Buzzer	1	15	15
10	LED	3	1	3
11	GSM	1	650	650
12	Exhaust Fan	1	100	100
13	LCD Display	1	250	250
14	Variable Resistor 10K	1	10	10
16	Male Connector	2	15	15
17	Wire	20’	50	50
18	Glue Strike	1	30	30
19	PVC Sheet	6 Sqft	150	150
20	Super Glue	1	20	20
Total				2403

3.7 Feature of the Project:

- This device is very safe and suitable for your family to use
- It can work with your natural gas line or calendar LPG gas line
- Kitchen-safe device is beautifully designed, compact in size, durable and built with high quality plastic
- It uses very high-quality sensor which can detect gas level precisely
- The device is pre-calibrated and does not produce a false-alarm

- When it detects a problem, it will notify by sounding a high volume alarm and also by bright LED lights
- As soon as it detects the gas, it will automatically turn on the exhaust fan so that the gas can be sucked out of the room quickly thus
- As soon as it detects the gas, it will also automatically turn of the gas line with the help of the gas safety valve.
- It will continue sounding the alarm until all the gas is removed from the room
- It can detect both natural and LPG gas
- This is a micro-controller based design
- Automated main valve control system.

3.8 Advantages

1. Low cost
2. Low power consumption
3. High accuracy
4. It also detects alcohol so it is used as liquor tester.
5. The sensor has excellent sensitivity combined with a quick response time.

3.9 Limitation

The device has become a bit costly then its low valued counterparts as emphasis were given on providing safety by detecting as many gases as possible. As a result the device has become bigger in size. On the other hand, for different industries, some other kinds of gases may be leaked which will require additional gas sensors to detect leakages. However, the design can act as a backbone for all these optimizations which are application specific.

CHAPTER-4

RESULT & DISCUSSION

4.1 Working Procedure:

1. To build this project we have used some of the components such as Microcontroller, GSM, Servo motor, Buzzer, LED, Blower fan, Gas sensor and DC source. In this project we represented in the room because most of the gas explosion occurred in the kitchen room.

2. At first we provide the power supply to activate the system. Normally the display shows natural condition and the green indicator is indicated.

3. To perform the operation we used gas light and we provide the gas manually. When gas is increased the display unit show leakage problem and the yellow LED is lighting and the exhaust fan become turn on, the buzzer make sound also the GSM module send the message to the user mobile phone. When then problem solved the system become normal condition.

4. When the user forget to turn off the gas stove or leakage in the gas line and the gas density form too high then the system perform some action-

i. Display shows danger condition
ii. Buzzer makes sound continuously
iii. Red LED set turn ON
iv. Exhaust fan comes turn on
v. The GSM module send "Danger Condition" to the user
vi. The Servo motor turn off the gas line. If comes natural condition after turn off the gas line again the GSM send "Problem Solved" message to the user others the GSM send "out of control" message to the user mobile phone.

5. When the system comes in danger condition we have solve the problem and reset the system otherwise never comes to normal operation.

4.2 CONCLUSION:

A gas leakage detection and alert system has been developed in this work. The developed system will not only detect LPG leakage but go further to prevent further leakage if the cause of the leakage is due to accidental or deliberate opening of the head. Simultaneously, a short SMS is sent to a pre-defined phone number using GSM infrastructures to alert the concern people of the incident of gas leakage. Going by the results of the tests carried out after implementation of the design of this work, it is concluded that the developed system is suitable for use in homes and restaurants to forestall and check incidence of LPG leakage and disaster that may follow such leakage. All that is required is to place the developed device on or beside the LPG cylinder head.

4.3 Future Enhancement

The solution provided can be further enhanced by displaying in the LCD unit how much amount of gas is leaked. We can also incorporate the location detection feature for the gas leakage area for which SIM900 is purposely used as it comes with added feature of web interfacing by using some extra codes in the microcontroller programming.

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