LPG Gas Detector using a GSM Module

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Abstract

A major problem faced by industries and households alike is Gas Leakage. The accidents caused by the same could potentially be disastrous in nature and a way to keep this in check is the installation of a gas detection system or unit at the leakage prone places. This project caters to such a necessity wherein, along with the detection of leakage, a user is alerted about the same.

Keywords: GSM (Global System for Mobile Communications); LPG (Liquefied Petroleum Gas); Gas Sensor MQ-5; LCD (Liquid Crystal Display); LED (Light Emitting Diode).

I. INTRODUCTION

LPG due to its constituent gases, propane and butane is a highly flammable gas, which upon its leakage puts the lives of many at risk due to the possibility of an explosion. This makes it imperative to curb its leakage along with its timely detection. In this project, after a sensor detects the gas leakage, a buzzer goes off and an exhaust fan turns on in order to drive the gas out. Also, it uses a GSM module, alerting the specified user about the leak by sending a SMS. Thus in a nutshell, the basic and central objective of this effort is the designing of a microcontroller based detecting and alerting unit. The advantage being that due to it being an automated system, it offers a quick response time and in turn facilitates in the diffusion of a potential catastrophe.

II. COMPONENTS DESCRIPTION

A. Microcontroller-AT89S52

The 8952 microcontroller is upgraded version of 8051 family of microcontrollers. The 8051 microcontroller was introduced by Intel Corporation in the year 1981. It is an 8-bit microcontroller with Harvard Architecture manufactured by advanced CMOS processes. It has 128 bytes of on chip RAM, 4k bytes of on chip ROM, two 16-bit timers/counters, four 8-bit ports of which one is a serial port, etc. There are 6 interrupt sources also.

Since this is an 8-bit micro controller, the CPU can work on only 8 bits of data at a time. Data larger than 8 bits has to be broken down to 8 bit pieces. Though it has an addressing capability of 64 Kbytes, only 4k bytes have been provided on chip.

8051 is available in different memory types, such as UV-EPROM, FLASH, and NV-RAM. The UV-EPROM version of 8051 is the 8751. This chip has only 4K bytes of on chip UV-EPROM. To use this chip for development requires access to a PROM burner, as well as a UV-EPROM eraser to erase all the contents of UV-EPROM inside the 8751 chip before you can program it again. It takes about 20 minutes to erase the 8751 before it can be programmed again. This led to introduce FLASH and NV-RAM versions of 8051.

Another popular version of 8051 is DS5000 chip from Dallas Semiconductor. The on chip ROM is in the form of NV-RAM. The read/write capability of NV-RAM allows the program to be loaded into the on chip ROM while in the system. This can be done via a serial port of a PC.

Another advantage of NV-RAM is the ability to change the ROM contents one byte at a time. The entire ROM must be erased before programmed again in the case of UV-EPROM and flash memory. There are also OTP (One Time Programmable) versions of the 8051 available from different sources. Flash and NV-RAM versions are typically used for product development. When a product is designed and finalized, the OTP version of the 8051 is used for mass production since it is much cheaper in terms of price per unit.

There are two other members in the 8051 family of microcontrollers. They are the 8052 and the 8031. The 8052 has all the standard features of the 8051 in addition to an extra 128 bytes of RAM, an extra timer, extra 4K bytes of on chip ROM, and two more interrupt sources. Therefore all programs written for 8051 will run on 8052, but the reverse is not true.

8031 is often referred to as ROM-less 8051 since it has 0K bytes of on chip ROM. To use this chip we must add external ROM to it. The ROM containing the program attached to the 8031 can be as large as 64K bytes. For adding external ROM two ports are needed out of 4 ports, leaving only 2 ports for I/O operations. To solve this, external I/O ports like 8255 can be added to 8031. Atmel Corporation’s AT89C52is a low-power, high-performance CMOS 8-bit microcomputer with 8K bytes of Flash programmable and erasable read only memory (PEROM). The device is manufactured using Atmel’s high-density nonvolatile memory technology and is compatible with the industry-standard MCS-51 instruction set and pin out. The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional on volatile memory programmer. By combining a versatile 8-bit CPU...
with Flash on a monolithic chip, the Atmel AT89C52 is a powerful microcomputer that provides a highly flexible and cost-effective solution to many embedded control applications.

Flash memory can be erased in seconds compared to 20 minutes needed for 8751. For this reason 89C52 is used in place of 8751 to eliminate the waiting time needed to erase the chip and thereby speed up the development time. The development system requires a ROM burner that supports flash memory. The entire contents of ROM should be erased in order to program it again; the PROM burner itself does this. The 89C52 Flash reliably stores memory contents even after 10,000 erase and program cycles. AT89C52 is a popular chip of this category from Atmel Corporation.

The micro-controller generic part number actually includes a whole family of microcontrollers that have numbers ranging from 8031 to 8751 and are available in N-channel Metal Oxide Silicon (NMOS) and CMOS construction. 89c52 is an 8-bit micro-controller having 40 pins arranged as DIP packages. The features unique to micro-controllers include:

- INTERNAL RAM AND ROM
- I/O PORTS WITH PROGRAMMABLE PINS
- TIMERS AND COUNTERS
- SERIAL DATA COMMUNICATION

The 89S52 architecture consists of these specific features:

- Eight-bit CPU with registers A and B
- 16-bit program counter and data pointer
- 8-bit stack pointer
- Internal ROM of 8k
- Internal RAM of 128 bytes
- Four register banks each containing eight registers
- 16 bytes addressable at the bit level
- 80 bytes of general purpose data memory
- 32 input/output pins arranged as four 8-bit ports
- Three 16-bit timer/counter
- Full duplex serial data receiver/transmitter
- Control registers: TCON, TMOD, SCON, PCON, IP and IE
- Two external and three internal interrupt sources
- Oscillator and clock circuits

The internal layout of an 89S52:

### B. Gsm Module SIM300

For sending message a GSM Module named SIMCOM_300 is used. GSM Module SIM300 with sim-card holder, RS232 interface, power supply, buzzer and audio interface. We can connect this to PC using a USB to Serial Adapter and use terminal programs such as Real term to send & receive data. We can also interface GSM Module with microcontroller directly through wires.

GSM Module works with AT COMMANDS. AT commands are used to control MODEMs. AT is the abbreviation for Attention.

AT commands with a GSM/GPRS MODEM or mobile phone can be used to access following information and services:

1. Information and configuration pertaining to mobile device or MODEM and SIM card.
2. SMS services.
3. MMS services.
4. Call services.
5. Data and Voice link over mobile network.
EXPLANATION OF COMMONLY USED AT COMMANDS

1) AT - This command is used to check communication between the module and the computer.
   For example,
   AT
   OK
   The command returns a result code OK if the computer (serial port) and module are connected properly. If any of module or SIM is not working, it would return a result code ERROR.

2) +CMGF - This command is used to set the SMS mode. Either text or PDU mode can be selected by assigning 1 or 0 in the command.
   SYNTAX: AT+CMGF=<mode>
   0: for PDU mode
   1: for text mode
   The text mode of SMS is easier to operate but it allows limited features of SMS. The PDU (protocol data unit) allows more access to SMS services but the operator requires bit level knowledge of TPDUs. The headers and body of SMS are accessed in hex format in PDU mode so it allows availing more features.
   For example,
   AT+CMGF=1 10

3) +CMGW - This command is used to store the message in the SIM.

4) +CMGS - This command is used to send a SMS message to a phone number.
   SYNTAX: AT+CMGS= serial number of message to be send.
   As the command AT+CMGS and serial number of message are entered, SMS is sent to the particular SIM.
   For example,
   AT+CMGS=1

5) ATD - This command is used to dial or call a number.
   SYNTAX: ATD<Phone number>(Enter)
   For example,
   ATD123456789

6) ATA - This command is used to answer a call. An incoming call is indicated by a message „RING” which is repeated for every ring of the call. When the call ends “NO CARRIER” is displayed on the screen.
   SYNTAX: ATA (Enter)
   As ATA followed by enter key is pressed, incoming call is answered.
   For example,
   RING
   RING

7) ATH - This command is used to disconnect remote user link with the GSM module.
   SYNTAX: ATH (Enter).

MQ-6 Gas sensor

FEATURES
* High sensitivity to LPG, iso-butane, propane
* Small sensitivity to alcohol, smoke.
* Fast response. * Stable and long life * Simple drive circuit

APPLICATION
They are used in gas leakage detecting equipment’s in Households and industry, are suitable for detecting of LPG, iso-butane, propane, LNG, avoid, alcohol and cigarette smoke.

SPECIFICATIONS

<table>
<thead>
<tr>
<th>Specification (A)</th>
<th>Standard work condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Symbol</td>
<td>Parameter name</td>
</tr>
<tr>
<td>Tc</td>
<td>Bursting voltage</td>
</tr>
<tr>
<td>Rf</td>
<td>Heating voltage</td>
</tr>
<tr>
<td>Rb</td>
<td>Load resistance</td>
</tr>
<tr>
<td>Rg</td>
<td>Heating resistance</td>
</tr>
</tbody>
</table>

B. Communication condition

<table>
<thead>
<tr>
<th>Specification (B)</th>
<th>Parameter name</th>
<th>Technical condition</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tc</td>
<td>Timing Tmax</td>
<td>-10°C to 30°C</td>
<td></td>
</tr>
<tr>
<td>Tc</td>
<td>Timing Tmin</td>
<td>20°C to 70°C</td>
<td></td>
</tr>
<tr>
<td>Rg</td>
<td>Related humidity</td>
<td>less than 0.05%</td>
<td></td>
</tr>
<tr>
<td>C&lt;sub&gt;3&lt;/sub&gt;</td>
<td>Oxygen concentration</td>
<td>21% (standard condition) O₂ concentration is effective 80% and minimum value is over 2%</td>
<td></td>
</tr>
</tbody>
</table>

C. Sensitivity characteristic

<table>
<thead>
<tr>
<th>Specification (C)</th>
<th>Parameter name</th>
<th>Technical parameter</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>r</td>
<td>Sensing resistance</td>
<td>100Ω ~ 600Ω (1000ppm LPG)</td>
<td>Detecting concentration scope: 200-10000 ppm, LPG, iso-butane, propane, LNG</td>
</tr>
<tr>
<td>k</td>
<td>Concentration slope rate</td>
<td>400V/100ppm</td>
<td></td>
</tr>
<tr>
<td>T&lt;sub&gt;0&lt;/sub&gt;</td>
<td>Standard detecting condition</td>
<td>30°C ± 2°C, Humidity: 60% ± 4%</td>
<td>Rs: 57±6 Ohm, Rs: 57±6 Ohm</td>
</tr>
</tbody>
</table>

D. Structure and configuration, basic measuring circuit

Structure and configuration of MQ-6 gas sensor is shown as Fig. 1 (Configuration A or B), sensor composed by micro AL2O3 ceramic tube, Tin Dioxide (SnO2) sensitive layer, measuring electrode and heater are fixed into a crust made by plastic and stainless steel net. The heater provides necessary work conditions for work of sensitive components. The enveloped MQ-6 has 6 pins, 4 of them are used to fetch signals, and other 2 are used for providing heating current. Electric parameter measurement circuit is shown as Fig.2

E. Sensitivity characteristic curve
SENSITIVITY ADJUSTMENT
Resistance value of MQ-6 is different to various kinds and various concentration gases. So, when using this component, sensitivity adjustment is very necessary. It is recommended that the detector be calibrated for 1000ppm of LPG concentration in air and use value of Load resistance (RL) about 20KΩ (10KΩ to 47KΩ). When accurately measuring, the proper alarm point for the gas detector should be determined after considering the temperature and humidity influence.

C. Power Supply
Power supply for the complete unit can be derived from the mains using a step-down transformer of 230V AC primary to 0-12V, 500mA secondary. A full-wave rectifier followed by a capacitor filter is the output voltage and feeds it to the 5-volt regulator (LM7805) whose output is used to the power supply requirements of microcontroller circuit, other IC’s.

Buzzer
A 12V buzzer is connected to port P1.5 (pin 6) of the microcontroller through a driver transistor (Q2). The buzzer requires 12 volts at a current of around 100 MA, which cannot be provided by the microcontroller. So the driver transistor is added. The buzzer is used to add audible alarm indication. Normally the buzzer remains off. As soon as pin of the microcontroller goes high, the buzzer operates.

A crystal oscillator is an electronic circuit that uses the mechanical resonance of a vibrating crystal of piezoelectric material to create an electrical signal with a very precise frequency. This frequency is commonly used to keep track of time (as in quartz wristwatches), to provide a stable clock signal for digital integrated circuits, and to stabilize frequencies for radio transmitters/receivers.

Piezo buzzer
Piezo buzzer is an electronic device commonly used to produce sound. Light weight, simple construction and low price make it usable in various applications like car/truck reversing indicator, computers, call bells etc. Piezo buzzer is based on the inverse principle of piezo electricity discovered in 1880 by Jacques and Pierre Curie. It is the phenomena of generating electricity when mechanical pressure is applied to certain materials and the vice versa is also true. Such materials are called piezo electric materials. Piezo electric materials are either naturally available or manmade. Piezoceramic is class of manmade material, which poses as piezo electric effect and is widely used to make disc, the heart of piezo buzzer. When subjected to an alternating electric field they stretch or compress, in accordance with the frequency of the signal thereby producing sound.

D. Terminal 1A positive voltage regulator
Features
• Output Current up to 1A
• Output Voltages of 5, 6, 8, 9, 10, 12, 15, 18, 24V
• Thermal Overload Protection
• Short Circuit Protection
• Output Transistor Safe Operating Area Protection

Description
The MC78XX/LM78XX/MC78XXA series of three terminal positive regulators are available in the TO-220/D-PAK package and with several fixed output voltages, making them useful in a wide range of applications. Each type employs internal current limiting, thermal shut down and safe operating area protection, making it essentially indestructible. If adequate heat sinking is provided, they can deliver over 1A output current. Although designed primarily as fixed voltage regulators, these devices can be used with external components for obtaining adjustable voltages and currents.

E. Relays

The relay takes advantage of the fact that when electricity flows through a coil, it becomes an electromagnet. The electromagnetic coil attracts a steel plate, which is attached to a switch. So the switch’s motion (ON and OFF) is controlled by the current flowing to the coil, or not, respectively. A very useful feature of a relay is that it can be used to electrically isolate different parts of a circuit. It will allow a low voltage circuit (e.g. 5VDC) to switch the power in a high voltage circuit (e.g. 100 VAC or more).
The relay operates mechanically, so it cannot operate at high speed.

There are many kinds of relays. You can select one according to your needs. The various things to consider when selecting a relay are its size, voltage and current capacity of the contact points, drive voltage, impedance, number of contacts, resistance of the contacts, etc. The resistance voltage of the contacts is the maximum voltage that can be conducted at the point of contact in the switch. When the maximum is exceeded, the contacts will spark and melt, sometimes fusing together. The relay will fail. The value is printed on the relay.

**WORKING**

The Complete Connection Diagram consists of the Microcontroller Circuit, GSM Module, Power Supply, GAS Sensor Module and Exhaust Fan. The Power Supply is fed to the GSM Module. The output of the sensor goes low as soon as the MQ-6 Gas Sensor senses any gas leakage from the storage. This is detected by the microcontroller and the LED & buzzer are turned ON. After the delay of a few milliseconds, the exhaust fan is also turned ON for throwing the gas out and the microcontroller continues sending message as “GAS LEAKAGE” to a pre-defined mobile number using GSM Module.

**III. FUTURE SCOPE**

Though the main objective of this work is LPG gas detection, as an added functionality, we have made provisions for metal and fire detection and have done the programming accordingly. Using the respective fire and metal detectors we can then implement the same, if needed. The reason for making such a provision is that it could be beneficial in different industry applications.

**IV. SUMMARY AND CONCLUSION**

The advantages of using LPG gas detector far outweigh the disadvantages; it does helps to know the LPG gas detector disadvantages so that the required changes and advancements can be made in future.

Advantages:-

1) Remote indication: With the use of GSM technology owner of the house or industry get remote indication through SMS. So even if the user is away from home or industry, he/she will be intimated about the hazardous or undesirable conditions / situations inside the house.

2) This system is fully automated. So once this system is installed inside home or industry, then it does not require any human interaction to operate. With the use of this system we can save the life of person inside home / industry. Since the accidents caused due to fire and LPG gas leakage can cause life threat.

3) Also the property inside house and various materials inside the house and industry are secured from theft and from fire.

4) It also detects alcohol so it is used as liquor tester which gives a provision for detection of alcohol content in the material.

5) The sensor has excellent sensitivity combined with a fast response time. The sensitivity can be easily analyzed through the sensitivity curve and is observed that it provides satisfactory results owing to reliable detection of gases. The response time of this sensor has a range from msec to sec resulting in fast recognition of a gas leak and supporting the system to provide immediate remedy to the situation.

6) This lpg Gas detectors can be used for detection of gas in vehicles. When it comes to using LPG in vehicles, it is known to shorten the life of an engine.

7) In the long run the maintenance cost is very less when Compared to the present systems. The life span of the sensor is long and the probability of the circuit being damaged often is very less. Thus, the maintenance cost reduces substantially.

8) The system is highly reliable, tamper-proof and secure. The system being small in size it is possible to mount it inside a secure shield which makes it durable and secure.

9) This system has applications in industries and residential LPG gas cylinders but it can also be used for safety from gas leakage in heating gas fired appliances like boilers, domestic water heaters.

Problems Faced:-

Its sensitivity of this module depends on Humidity and temperature. This factor leads to variable sensitivity and reduces the reliability of the system.

This system is little sensitive to smoke so it does not provide a perfect response in premises where smoke is present. These factors make it unsuitable for use in kitchen.

The system response time may vary depending on some factors. In such situation the system may be unable to
provide remedy measure in time and may lead to a disaster. This LPG gas detector module can only work on a 12 ac volt power supply. It may be difficult to provide such power supply provision in some cases. The circuit is solely dependent on the microcontroller. If the microcontroller fails there are no backup measures to provide the detection and enabling the other components in the system.

V. CONCLUSION

The “MICROCONTROLLER BASED LPG GAS DETECTOR USING GSM MODULE” was implemented satisfactorily. More knowledge and more experiences were gained and ultimately, it can be concluded with a great pleasure that the primary aim was achieved.

REFERENCES