



A Design Of Automatic Safety Equipment For Lpg Gas Stoves Based On Atmega 8 Microcontroller

Hermansyah Alam

Universitas Islam Sumatera Utara Medan, North Sumatra Indonesia

Email: hermansyah1@gmail.com

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Abstract. The LPG gas stove explosion was the result of an LPG gas leak and an increase in the temperature of the gas stove frame. In this research, an early warning system is needed regarding the dangers of using LPG gas stoves. This paper discussed about a gas stove safety device designed based on the Atmega 8 microcontroller through gas flow. The use of several sensors such as a gas sensor to detect LPG gas content with a concentration range of 200 – 10,000 mg/L, and a Solenoid Valve which functions as a gas flow breaker to the stove. Also a buzzer as a warning tool when a leak occurs. Apart from that, a timer with a maximum working process of 15 minutes will automatically turn off the stove when the desired time is reached. The entire system can work automatically or manually depending on your needs. After testing it turned out to be true when a gas leak occurred, the system can turn off the stove automatically. Likewise, it shows that if the gas leak detection distance is farther, the system response time will slow down.

1. INTRODUCTION

LPG gas is a clean and easy to use energy source. LPG gas is being promoted by the government as a substitute for kerosene which is increasingly rare and expensive. The conversion from kerosene to LPG gas required several adjustments, for example having to replace the kerosene stove with a gas stove, having to provide gas cylinders and channels and so on. All conversion processes can be carried out well, but there is one factor that is quite difficult to overcome, namely gas leaks due to old use or components. This factor is quite fatal and can result in loss of property and human life. If LPG gas leaks in a closed room and a fire is triggered, there will be a terrible explosion and a fire cannot be avoided (MB Trisnanda, 2014). The solution to avoid this problem is not to place the gas cylinder or stove in a room that is tightly closed and has sufficient ventilation to remove it if a leak occurs. Another solution that the author will offer as research is carried out for the final project is to create a safety device. A gas cylinder safety device consists of a gas sensor, a buzzer, an Atmega 8 microcontroller and a channel lock valve. The gas cylinder safety device works by detecting gas. If LPG gas is detected on a large enough scale, the controller will immediately lock the outflow of gas so that the leak stops immediately. The system can be reactivated by the user if it has been checked and reset. Gas sensors such as the MQ5 have the ability to detect indoor gas and convert it into voltage. The higher the gas detected, the higher the voltage released. The controller will read the sensor values and calibrate them.

Literature Review

Liquefied Petroleum Gas (LPG)

LPG is a hydrocarbon gas that is liquefied under pressure to facilitate storage, transportation and handling which basically consists of propane (C₃H₈), butane (C₄H₁₀), or a mixture of both. LPG is usually used as a substitute for freon, aerosols, refrigerants (cooling agents), cosmetics and fuel. (Bony M. Farid, 2007) Liquefied Petroleum Gas (LPG) or liquefied petroleum gas is gas produced from oil refineries and gas refineries as a result of refining crude oil, in the form of gas. It is a gas under normal conditions, but can be compressed into a liquid by adding pressure or lowering the temperature. This is what we know as liquefied gas fuel. The main components as mentioned above are approximately 99% propane and butane gas and the rest are odorants. LPG is heavier than air. Composition comparison, Methane (C₃H₈): Ethane (C₄H₁₀) = 30:70. Compared to other fuels, using LPG is more profitable, here are the advantages of using LPG:

- a. Clean, clean LPG combustion results with low emissions.
- b. Stable, burning LPG produces a high and stable calorific value.

- c. Flexible, LPG can be distributed to any area using skid tanks or barges, to areas far from supply points.
- d. Suitable for products that are sensitive to odors, the results of burning LPG do not leave an odor, making it suitable for use as fuel or raw material for industries whose products are sensitive to odors.
- e. Environmentally friendly, because the results of burning LPG are clean, the use of LPG will help support world demands for the use of environmentally friendly fuel.
- f. *Cost reduction*, the economical use of LPG and low equipment maintenance costs can reduce the costs that must be spent on fuel and equipment maintenance.

ATmega 8 Microcontroller AVR

is a type of microcontroller which has various functions. The difference with micros that are generally used, such as the MCS51, is that the AVR does not need to use an external oscillator because it already has an internal oscillator. Apart from that, the advantage of the AVR is that it has a Power-On Reset, that is, there is no need for an external reset button because just by turning off the supply, the AVR will automatically reset. For several types of AVR there are several special functions such as ADC, EEPROM around 128 bytes to 512 bytes.

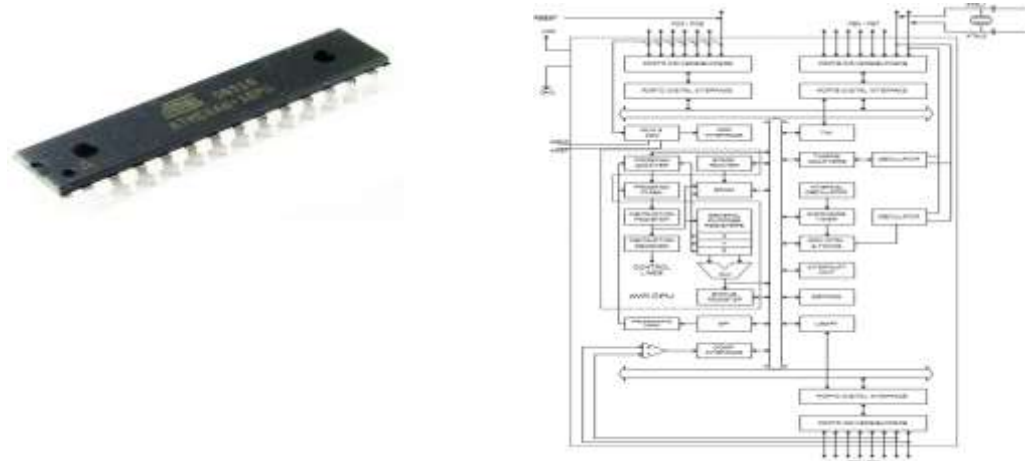


Figure 1. ATMEGA 8 microcontroller

The AVR ATmega8 is an 8-bit CMOS microcontroller with AVR RISC architecture that has 8K bytes of in-System Programmable Flash. This low power consumption microcontroller is capable of executing instructions with a maximum speed of 16MIPS at a frequency of 16MHz. When compared with the ATmega8L, the difference only lies in the amount of voltage required to work. For the ATmega8 type L, this microcontroller can work with a voltage between 2.7 - 5.5V, while the ATmega8 can only work with a voltage between 4.5–5.5 V.

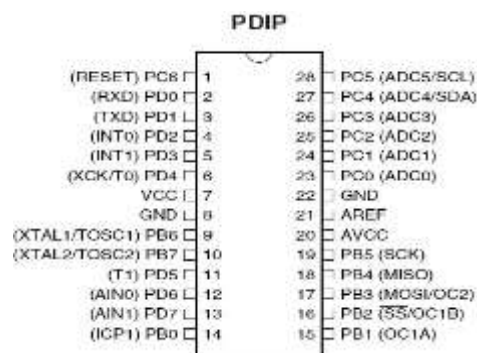


Figure 2. Atmega8 Pin Configuration

Serial Communication on Atmega

The AVR Atmega 8 microcontroller has a USART port on Pin 2 and Pin 3 to carry out data communication between the microcontroller and the microcontroller or the microcontroller and the computer. USART can be used for synchronous and asynchronous data transmission.

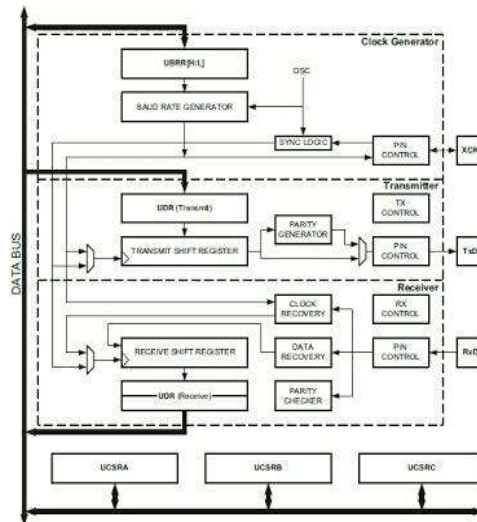


Figure 3. ATmega8 Block Diagram

Synchronous means the clock used between the transmitter and receiver is one clock source. Meanwhile, asynchronous means that the transmitter and receiver have their own clock sources. USART consists of three blocks, namely clock generator, transmitter, and receiver.

a. USART transmitter

Usart transmitter connects to data on Pin TX. Devices that are often used include the UDR register as a place to store data to be transmitted. The TXC flag is a result of the data being transmitted being successful (complete), and the UDRE flag is an indicator if the UDR is empty and ready to be filled with data to be transmitted again.

b. USART receiver

Usart receiver is related to receiving data from the RX Pin. Devices that are often used include the UDR register as a place to store data that has been received, and the RXC flag as an indicator that the data has been successfully (completely) received.

MQ-5 sensors

MQ-5 sensor is a sensor module that is quite easy to use. This sensor is very suitable for detecting LPG, isobutane, propane and LNG gas levels in the air and is suitable for applications in detecting and controlling gas leaks in household and industrial environments with a detection range ranging from 10 to 10,000 ppm (parts per million).

This sensor has high sensitivity and fast response time. The sensor output is an analog resistance. The driver circuit is very simple, all that is needed is a 5V power supply for the heater coil, and connecting the output to the ADC. The MQ-5 gas sensor material is tin dioxide (SnO₂). MQ-5 has 6 pins, 4 pins are used to take signals, and 2 pins are used to provide heating of the sensor material. In table 2.1 the components of the MQ-5 gas sensor are explained and in figure 2.1 the structure and shape of the MQ-5 sensor are shown.

Table 1. MQ-5 Gas Sensor Components

No	Parts	Materials
1	Gas Sensing Layer	SnO ₂
2	Electrodes	Au
3	Electrode line	Pt
4	Heater coils	Ni-cralloy
5	Tubular ceramics	Al ₂ O ₃

6	Anti-Explosion Network	Stainless steel gauze (sus316 100-mesh)
7	Clamp ring	Copper plating Ni
8	Resin base	Bakelite
9	Tube pins	Copper plating Ni

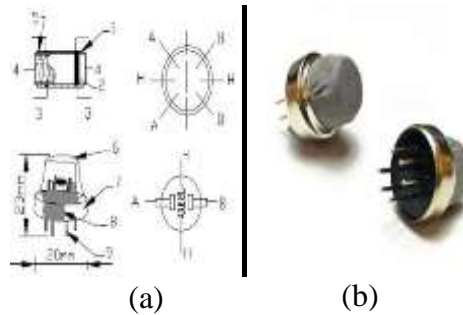


Figure 4. (a) Structure of the MQ-5 gas sensor, (b) Shape of the MQ-5 sensor

Indicator LED

In the gas sensor module there are 2 indicator LEDs, namely a red indicator LED and a green indicator LED. At power-up, the green LED will flash rapidly until the sensor warms up and the sensor reading results are stable. The time required to reach a stable condition varies for each sensor used depending on the speed of the sensor response and the condition of the heater on the sensor. If a stable condition has been reached, the green LED will light up without blinking. Under normal operating conditions (after power-up conditions), the red LED will light up or go out according to the sensor readings and the selected operating mode. Meanwhile, as long as the sensor reading results are stable, the green LED will remain on and only flash slowly (every 1 second) if there is a change in gas concentration. (Hanwei, 2012).

2. METHOD

The materials used in this research are reference books from journals regarding automatic safety devices for LPG gas stoves using microcontrollers.

a. Tool

The tools used in this research are:

- Computer/Laptop equipment
- Oscilloscope
- Measuring instrument
- Digital voltmeter and ohm meter
- Tools /toolset

b. Ingredients

The materials used in this research are:

- MQ5 sensors
- BD139 NPN transistor
- IRF Z44 mosfet
- IC AN7805
- LPG Gas Cylinder
- Gas stove
- The gas hose
- Hose clamp
- 12V mini buzzer
- Atmega 8 microcontroller
- Capacitor 220uF/50V, 10uF/50V
- LED diode

- Resistors
- Diode 1N4002
- Solenoid Valves
- 24V power supply, stepdown
- PCB circuit and box
- Cables and terminals
- Bolts etc.

The block diagram for designing an automatic safety device for an LPG gas stove using a microcontroller and gas sensor is as follows:

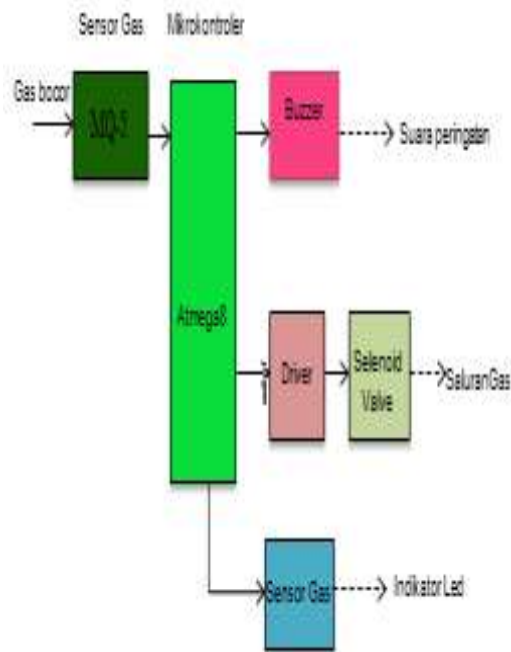


Figure 5. Block diagram of LPG leak safety device.

In Figure 5, the block diagram of the work process for designing an automatic LPG gas stove safety device using an Atmega8 microcontroller and a gas sensor can be explained, where the designed protector circuit has several parts, namely the sensor as an input which provides input from outside, the microcontroller as a controller which processes the input into output, the amplifier section functions as a signal amplifier, namely current and voltage. The buzzer is a component that provides a sound warning while the LED functions to provide a light indicator. The main output is a solenoid valve or valve which works as a lock on the gas channel when a leak occurs in the stove. In general, the circuit works to detect gas leaks in the room. In this way the device is placed in the kitchen where the gas source is located.

In designing this system, Atmega8, MQ5 Smoke Sensor, Solenoid Valve are used as the main system to close the flow of LPg gas from the stove regulator hose. The schematic design for "Automatic safety device for a single-burner LPG gas compass" can be seen below:

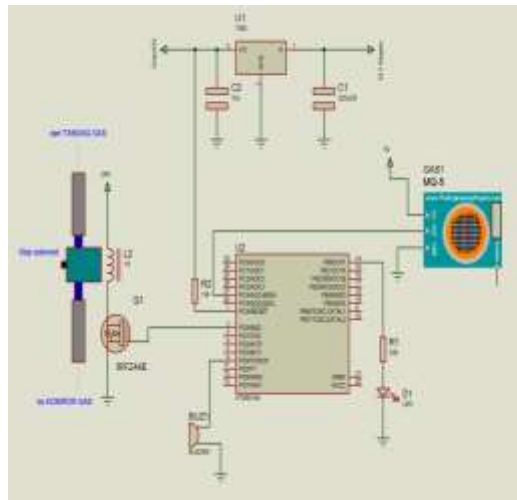


Figure 6. Schematic diagram of LPG leak safety device

3. RESULTS AND DISCUSSION

Analysis And Testing Of Equipment Test

Testing is carried out on components to determine whether the performance of each component is in accordance with the desired and intended objectives of this design. Testing of this tool was carried out by observing the performance of using the Atmega8 Microcontroller, MQ5 Sensor, Buzzer, Solenoid Valve and the entire circuit when running. The results of the overall system design can be seen in the image below.



Figure 7. Photo of the finished tool assembled.

Implementation of Tools

The application of the system discusses the results of applying the theory that the author has successfully developed so that it becomes a fairly stable LPG gas stove safety device. To find out whether the objectives of this tool have been carried out well or not, it is necessary to test and analyze the tool created. You can see in Figure 4.2 the photo of the front and back views of the results of assembling a safety device for a single-burner LPG gas stove based on a microcontroller.

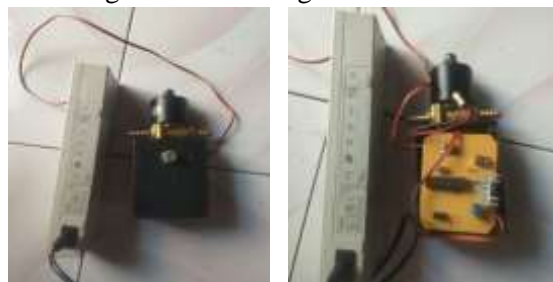


Figure 8. Front and back view of the device

4Tool Testing

Tests carried out at each stage include:

- MQ5 gas sensor testing
- Power Supply Testing
- Solenoid Valve Testing

Overall system testing equipment used for measurement and testing:

- Code Vision AVR
- Digital voltmeter and ohm meter
- Gas lighter/lighter

MQ5 Sensor Testing

Testing on the MQ5 sensor is carried out to find out whether the sensor is functioning properly or not. To find out whether this sensor is working properly or not, it can be seen easily, namely You can see the red line inside the sensor and test it with gas from the tank, which looks like figure 4.3.



Figure 9. MQ5 sensor testing

From the image above it can be concluded that the MQ5 sensor is functioning well. The MQ5 sensor values are as shown in table 2.

Table 2. MQ5 Sensor Testing

MQ5 output voltage	Input conditions
0.1V	No gas
0.31V	Lighter gas
0.69V	Alcohol gas
0.99V	LPG distance 5m
2.23V	LPG distance 2m
2.56V	LPG distance 1m

Testing the MQ5 sensor in location or place conditions

This test was carried out in several places with certain room conditions with estimated neutralization times at certain temperatures, such as air-conditioned rooms and non-AC rooms as shown in the following table.

Table 3. Testing the MQ-5 Sensor in an Air-Conditioned Room

Testing in AC Rooms				
time	Response	LEDs	Solenoid Valve	Buzzers
1 minute	No	On	Off	Off
2 minutes	No	On	Off	Off
3 minutes	No	On	Off	Off
4 Minutes	No	On	Off	Off
5 minutes	Yes	Off	On	On
6 Minutes	Yes	Off	On	On
7 Minutes	Yes	Off	On	On



Table 4. Testing the MQ-5 Sensor in a Non-AC Room

Testing in a Non-AC Room				
time	Response	LEDs	Solenoid Valve	Buzzers
1 minute	Yes	Off	On	On
2 minutes	Yes	Off	On	On
3 minutes	Yes	Off	On	On
4 Minutes	Yes	Off	On	On
5 minutes	Yes	Off	On	On
6 Minutes	Yes	Off	On	On
7 Minutes	Yes	Off	On	On

From the test table above, it can be concluded that the response time for the MQ-5 gas sensor in an air-conditioned room has an estimated time of 5 minutes, while in a non-AC room it has an estimated time of only 1 minute so that the MQ5 gas sensor can work well.

4. CONCLUSION

Conclusion of this paper are: Gas leak detection and gas cylinder safety devices can be made with electronic circuits based on gas controllers and sensors. Gas leak detection can be done with the help of a gas sensor, namely MQ5, while to lock the gas channel, you can use a solenoid valve, namely a valve that is activated by a solenoid coil. All components can be assembled on a PCB and put in a box or casing so that it is safe. The sensor and buzzer are connected by cable to the atmega 8 microcontroller. The test results show that the designed tool works as desired, although there are still weaknesses, for example in large rooms it is less effective.

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