Gas Pressure Measurement On Rocket Chamber Based On Strain Gauge Sensor

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ABSTRACT (10PT)

Keywords
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The use of rocket technology is currently also widely used for research. The rocket itself is a flying vehicle that moves by getting a boost through the combustion reaction that occurs in the rocket. The rocket itself can launch the load to the desired destination. In the field of science and technology, continuous efforts are required to realize the development of this rocket in order to achieve independence and prosperity. In the field of science and technology, continuous efforts are required to realize the development of this rocket in order to achieve independence and prosperity. The implementation of the strain gauge sensor through the MPXV7002DP gas pressure sensor obtained the amount of gas pressure during the combustion of the propellant in the rocket chamber, where the gas pressure can be measured, processed through the Arduino Uno microcontroller. The system can measure the maximum pressure up to 380 kPa and then the system can check any changes in voltage level to prove if there is a leak in the rocket.

1. Introduction

Rocket is an aerospace vehicle that has strategic meaning. This vehicle can be used as a satellite launcher (RPS), weather research rockets, guided rockets, ground-to-ground, ground-to-air and air-to-air ballistic rockets[1]. In other words, rockets can also function as equipment to maintain sovereignty. The design of rocketry technology, both in terms of the rocket and its payload, starts from the design stage, manufacturing, testing to flight testing [2].

Basically, a rocket is an air vehicle that works based on the conversion of heat energy into kinetic energy in the form of a gas. The greater the pressure of the gas emitting out of the nozzle, the greater the pressure generated. Gas pressure is a form of energy that is widely used by humans. To determine the gas pressure, measurements were taken. Combustion pressure of rocket thrust can not be measured manually, so we need a tool that can measure the pressure of the gas, in this case the author will apply the MPXV7002DP sensor to convert the pressure into an electric voltage[3][4][5].

Rocket technology is currently developing, has many problems in developing its technology, especially for measuring gas pressure because it is impossible to do it manually[6]. But technological developments are now possible by using the MPXV7002DP gas pressure sensor in combination with the Arduino Uno. With the above problems, the author tries to find a solution by making "MEASUREMENT OF GAS PRESSURE ON ROCKET CHAMBER BASED ON STRAIN GAUGE SENSOR". With this implementation, it can measure the specific impulse of a rocket based on the combustion pressure of the chamber.

2. Method

Measurement of the contents of the wind pressure from the chamber uses a pressure sensor, where this pressure sensor will convert the amount of pressure into voltage and this voltage will be converted into a digital number so that Arduino can process it so that it can control the filling and exhaust gas valve in the chamber. This Arduino will also display the contents of the wind pressure in the chamber being measured.

1 MPXV7002DP Autotonics Pressure Sensor

The pressure control system in the chamber automatically requires a pressure sensor that can convert the amount of wind pressure on the rocket into DC voltage[7]. For this reason, in selecting the component type for the pressure sensor, the PSA-1 type Autonic pressure sensor is used. This series of pressure sensors functions to detect the air pressure in the tires of $\pm\,0$ PSI to $\pm\,50$ PSI, where 1 PSI (Pound Square Inch) ≈ 0.07030696 kg / cm2.
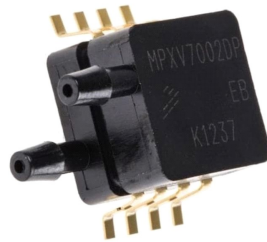

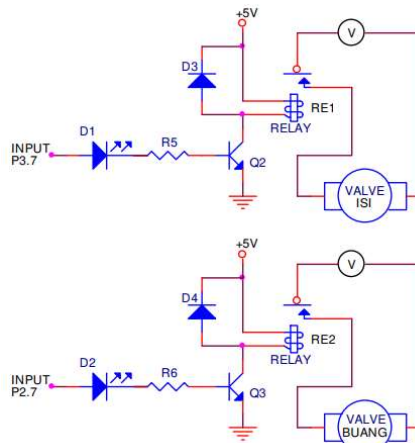**Fig 1**. MPXV7002DP Sensor

2 Valve Control

Fig 2. Valve Control Circuit

This series of fill / exhaust valve controllers is used to fill or exhaust air using a valve that is controlled by voltage. The valve used is driven by a relay that is activated by a transistor. The relay switch connects the power source and the valve. In normal conditions, the relay switch is open so that the valve is off or closed.

3. Results and Discussion

Chamber wind pressure is detected by a pressure sensor. The pressure sensor will change the amount of tire pressure. The measured wind pressure data processed by Arduino will be displayed on an LCD display system. The program starts by initializing the memory, where in this process the program in memory is read to run. The next step carried out by the software on the microcontroller is the data collection process. This process is done by reading wind pressure data which is then

converted to kPa units. Then Arduino will display the results of the wind pressure calculation on the LCD screen. If the wind pressure is still not enough, the valve will open and fill in the wind pressure. From the results of the work process, the measured wind pressure on the rocket is equal to the value of pressure to launch the rocket.

Table 1. Test Results of the Analog to Digital Converter Circuit

Input Voltage (v)	Binary Output				
	Db1	Db2	Db3	Db4	Db5
0	L	L	L	L	L
1	L	L	L	L	L
2	L	H	H	L	L
3	L	H	L	H	H
4	H	L	H	L	H
5	H	H	H	H	H

Table 2. Test Results of Pressure Sensor Circuits

Input Pressure (kPa)	Measured Output Voltage (Volt)
0	0.89
10	1.89
20	2.85
30	3.45
40	4.23
50	5.46

Table 3. Overall System Test Results

Rocket	LCD Display	Desired pressure (kPa)	Valve state (On / Off)	
			Fill	Discard
Rocket 1	17	25	On	Off
Rocket 2	25	25	On	Off
Rocket 3	36	25	Off	On

Testing the MPXV7002DP sensor aims to determine the output voltage of the MPXV7002DP used. Because each pressure applied to the MPXV7002DP has a different output voltage. This voltage output can also be seen on the MPXV7002DP sensor datasheet, so that this test can compare between the actual test results and the data on the MPXV7002DP sensor datasheet. Testing the MPXV7002DP gas pressure sensor is based on the test object, namely rocket propellant. MPXV7002DP sensor gas pressure sensor readings.

Table 4. Test Results For Rocket Propellant Gas Pressure

No	Propellant Composition	Distance	Pressure (kPa)	Time (ms)
1			0	10.208
2			1	10.356
3	Sucrose and KNO3	150 m	5	10.473
4			42	10.776
5			48	11.47

Table 5. Combustion Pressure at 100 Meters Distance

No	Propellant Composition (gr)	Distance (m)	Pressure (kPa)	Time (ms)
1			1	9,386
2			15	35,369
3	Sucrose, KNO3 and 100 Gram Activated Carbon	150 m	28	36,507
4			48	37,771
5			61	39,287
6			43	8,975
7			44	9,101
8	Sucrose, KNO3 and 150 Gram Activated Carbon	250 m	47	9,227
9			52	9,479
10			56	9,985
11			82	11,493
12			85	11,747
13	Sucrose, KNO3 and 200 Gram Activated Carbon	350 m	86	11,999
14			90	12,125
15			94	12,884

From Table 5, it is obtained that the measurement results with the weight of propellant 100g, 150g, and 200g, the data can be sent with a length of time of 163.925 ms. From the data that has been generated the maximum pressure with an average of 154 kPa at an average span of 57.316 ms and the minimum pressure obtained is 1 at 178.825 ms. When the measurement reaches the average maximum pressure is 165 kPa.

4. Conclusion

Based on the results of tests carried out on the gas pressure control system of the automatic rocket chamber, it was found that the whole system could function properly. This system can measure wind pressure from 0 kPa to 50 kPa. This system can also detect small / fine leaks in the rocket. The increase in pressure is always followed by a large increase in voltage as well

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