Fuel Injector and Ignition Coil Tester (FIIT)

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Certificate

We accept the work contained in this report as a confirmation to the required standard for the partial fulfillment of the degree of BS(EE).

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Internal Examiner	External Examiner

Dedication

We dedicate this project to our parents who have been a great source of inspiration and never-ending support to us. We also dedicate our work to our Supervisor Sir Umaid Ali and Co-supervisor Sir Abdul Hadi from National Institute of Electronics (NIE) who encouraged us to build our motivations and for their comprehensive advice and efforts for this project. And at last but importantly to our friends, who helped us and supported us throughout the journey of learning.

Acknowledgements

We would like to thank Sir Syed Umaid Ali for the guidance and the mentorship that he has given us during this whole Final Year Project and the National Institute of Electronics, especially Sir Abdul Hadi for giving us the required technical knowledge in the required field and for allowing us the access to their automotive lab tools. We would like to thanks Ma'am Madiha Zoheb for providing us guidance and mentorship.

Abstract

This Project is for testing the Fuel injectors, Ignition Coils and the spark plugs which are the most common reasons of the knocking of the cars. The fuel injectors will test the fuel levels emitted by each injector in the chamber. The ignition coil tester will test the resistance and current of the ignition coil. Spark plug tester will test the resistance of the spark plug. This project is aimed to develop a device that will address the needs of testing coil on plug (ignition coils), spark plugs and fuel injectors. The literacy rate of local mechanics of Pakistan is very low. They are unable to use the diagnostic tools like automotive scope, WYZE and Paddle probes, Pico scope, SNAPON etc. because no one can operate these tools without proper training. So this device will meet the needs of local mechanics and also create mass know how about automotive technology at national level. The project is implemented using PIC16F877, 555 timer IC along with N type Mosfet for driving the fuel injectors and the resistance divider method for measuring resistance and the current on primary side of the ignition coil on pins enabled with ADC. It will observe the loaded and unloaded conditions for the ignition coil on the basis of which it will decide the working of ignition coil is functional or faulty.

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Chapter # 1

Introduction

1.1 OVERVIEW

This Project is for testing the Fuel injectors, Ignition Coils and the spark plugs which are the most common reasons of the knocking of the cars. The fuel injectors will test the fuel levels emitted by each injector in the chamber. The ignition coil tester will test the resistance and current of the ignition coil. Spark plug tester will test the resistance of the spark plug.

1.2 BACKGROUND

We are working in the area of automobiles. Previously in cars distributors and distributor less systems were used for coil ignition. Also for electronic fuel injectors mechanical systems were used. With the evolution of time it became difficult for mechanical systems to be controlled. With the advancements of electronic systems the ignition coils and fuel injector has been replaced with electronic system controlled by ECU. Previously the cars have distributor and distributorless ignition system but now most of the vehicles have Coil on Plugs which consists of individual Coils on each Plug. Ignition coil converts the low voltage high current battery source to a high voltage low current. A faulty ignition coil may lead to the miss fire and inefficient car performance. Fuel Injector is responsible for the mist of fuel and air in the combustion chamber. A faulty fuel injector may lead to poor fuel economy.

1.3 IGNITION SYSTEM

In the ignition system of cars the internal combustion of engine produces spark to ignite the air fuel mixture.

1.3.1 IGNITION COILS

The ignition coils act like a transformer. They consist of two windings primary and secondary.

1.3.1.1 Distributor less systems

In the distributor less systems is replaced with the induction coils and for each cylinder there is a separate coil. ECU (electronic control unit) controls the timings of sparks. They have multiple ignition coils. For some it has one coil for every two sparks or one coil per spark. So with the help of engine sensors it synchronize with ECU and sets the ignition coil to fire the spark plugs.

1.3.1.2 Coil On Plugs

In coils on plugs ignition system each spark plug is ignited by separate coil. Spark and its timings are controlled by (PCM) or (ECM) signal. It helps to provide control over spark plug timings and helps to produce fewer emissions.

1.4 FUEL INJECTORS

Previously in cars carburetor systems were used. Carburetor was used to control the mixture of air and fuel. The disadvantage of that a single cylinder could not efficiently provide equal amount of air fuel mixture to the four cylinders.

The fuel injector is an electronically valve. The fuel pump emits pressurized fuel. It is opens and close valve plenty of times. The pressurized fuel is exerted through the nozzle when the injector valve is opened. The amount of fuel injected through the fuel injector depends on the time for which its valve remains opens.

1.5 WORKING OVERVIEW

For the ignition coil tester we made the circuit for the tester. The ignition coil tester will check the resistance of injectors to determine the working and faulty ignition coils. We used 555 timer IC that worked in Astable and Monostable mode in pair. That made a duty cycle pulse of 8 milliseconds to drive the injector for 5 seconds and 1 second. We simulated the circuit on Proteus. Afterwards the circuit was sent to the PCB (printing circuit board) lab in Nation Institute of Electronics for PCB layout. Once the PCB layout was completed then we completed the hardware. A 12 volts battery was required for the testing. Once the hardware was completed then we moved to the initial testing process. For the initial testing we tested both working ignition coil and faulty one. For the faulty ignition coil a red LED blinked on the tester to indicate its status. No sparks were observed for the faulty one. For the working ignition coil it showed a blinking blue LED in status and sparks produced by the ignition coil were seen. For the fuel injector we used four test tubes that were highly précised and a test tube holder. The fuel pump sends pressurized fuel to the test tubes. The test tubes collect the emissions. We physically observed the level of fuel in all four test tubes. If the fuel in one of the test tube is more or less than others it means that it is faulty. If all have same level than all four injectors are working properly. So basically we will test the fuel injectors on the basis of observing the level of fuel collected in test tubes.

1.6 OBJECTIVES

This project is aimed to develop a device that will address the needs of testing coil on plug (ignition coils), spark plugs and fuel injectors. The literacy rate of local mechanics of Pakistan is very low. They are unable to use the diagnostic tools like automotive scope, WYZE and Paddle probes, Picoscope and SNAPON etc. because no one can operate these tools without proper training. So this device will meet the needs of local mechanics and also create mass know how about automotive technology at national level.

1.7 PROBLEM STATEMENT

Ignition coils are very robust and reliable but can fail for a variety of reasons. It can be due to overheating, vibrations, wear and tear etc. The issue of identification of faults in ignition coils is very difficult. The fuel injectors of a car can get dirty, clogged or completely fail because of different reasons.

If the engine doesn't get enough fuel sprayed into due to clogged injector. The engine will misfire and there will be a pause after you step on the gas pedal. A faulty fuel injector will cause the corresponding cylinder to not be able to fire. This means that the engine will withdraw more fuel from the working injectors causing poor fuel efficiency. We intend to develop a device that can identify the faulty fuel injectors and faulty ignition coils.

1.8 PROJECT SCOPE

The scope of this project is to address the common needs of local mechanics. As their literacy level is very low so we are making a device that will be cheaper and easily used by them. We are making a device which will tackle the three problems in just one device.

Chapter # 2

Literature Review

Ignition coils, fuel injectors and Spark Plugs are very robust and reliable but can fail for a variety of reasons. It can be due to overheating, vibrations, wear and tear etc. Fuel injectors of a car can get dirty, clogged or completely fail because of different reasons. The issue of faulty fuel injectors can be identified by OBD2 on a major scale but the particular error in a part cannot be identified. OBD2 device generates a code but is unable to determine the reason behind it. Another device that Pico-Scope is also being used to test the ignition coils. Basically Pico scope works with a paddle probe and a laptop is always required for it. As the literacy rate is very low so a local mechanic is unable to use these kinds of tools. There isn't any proper diagnostic tool available for faulty spark plugs. Local mechanics measure the gap produced by consecutive sparks or check their resistance. Generally a local mechanic uses hit and trial based method to check for the faulty ignition coils and spark plugs. He checks for used ignition coils and fuel injectors to fix the issue. Hit and trial based method is never reliable so one cannot guarantee for how long the used ignition coil or fuel injector is going to function.

The devices that can check for fuel injectors are SNAP-ON MODIS-Ultra and OTC 3398 fuel injector pulse tester. But SNAP-ON MODIS-Ultra is an expensive diagnostic tool that a common mechanic cannot afford. To check faulty ignition coils PICO Scope that is interfaced with paddle probe is used. A laptop is always needed for channel initialization and special training is required to operate it. So it cannot be used by everyone. In market no such diagnostic tool is available to check for spark plug. They check it manually by measuring the gap between the sparks produced and ignore the leakage current. The ignorance of leakage current compromises the spark of spark plug and a healthy spark is not produced.

We are going to develop a device that will address the need of common mechanics of testing the ignition coils, fuel injectors and spark plugs by keeping in view of their literacy level. Our device will fulfill the needs of local mechanics.it will be a portable device. It will be feasible for them to use and will be a cost effective device as compared to other diagnostic tools used. Our device will focus on three manufacturers of fuel injectors that is of Honda, Toyota and Suzuki. For the ignition coils it will focus on three manufacturers that are Denso, Hitachi and Tech. For the ignition coil tester we will predefine the range of resistance in the microcontroller. If the testing ignition coil's resistance is out of range then tester will show faulty status otherwise it will show pass status.

For example when we need to go in emergency and the fuel injector or car's ignition system is not working properly you go to a mechanic. The mechanic tells you that the car has faulty ignition coil or faulty fuel injector. He does hit and trial method and finds an alternative used one from stock. Although you are more educated than the mechanic but still you cannot challenge the mechanic. Rather than using logics the mechanic uses hit and trial method for testing them. He will not only charge you more but also the re-used ignition coil or fuel injectors will cause damage to the car. With the help of our testing device anyone can check the status of his car's ignition coil or spark plug's working status within five minutes.

The advantage of our device is that it caters all three features in a single device. Instead of three different diagnostics tools we can use a single device.

Chapter # 3

Requirement Specifications

3.1 EXISTING SOLUTIONS

The existing system to check the faulty ignition coil is to test it with Snap-On Modis Ultra or by using the Pico Scope and Paddle probe.

3.1.1 SNAPON MODIS ULTRA

Snap-On Modis Ultra tool read and clear the codes for all available modules in the automobile. That includes systems like transmission, engine, steering, body, airbag, suspension. We can use this device to check the faulty ignition coil. But it shows the waveforms of the firing order of the cylinders.

In this we connect the Snap-On with the car by using the Bluetooth connector.

- All cylinders can be viewed on the scope.
- The primary and secondary side of the ignition coil's waveform appears on the

scope. By these waveform the faulty and good ignition coil can be diagnosed.

Fig 3.1 MODIS Ultra

3.1.2 PICO SCOPE

It is the scope which is used to find the vehicles faults. The Paddle probe is used along with it.

Fig 3.2 Pico scope

Fig 3.3 Paddle Probe

In this we connect the paddle probe with the ignition coil. Then use the Pico scope. For this we require a laptop to check all the waveforms.

But in order to operate such Automotive tools like Snap-On Modis Ultra or Paddle probe and Pico scope. A lot of training is required. Also these tools are very costly. Such tools are not available in Pakistan. We have to import from other countries. An unexperienced person or an uneducated person cannot operate such tools. Because the Local Mechanics of Pakistan are not that much educated. The literacy rate of Pakistan is very low so there is a need for a device that is user friendly and cost efficient.

3.1.3 OBD2

The OBD2 just generates an error code if the ignition coil is faulty. But we cannot identify which particular ignition is faulty and also it generates an error code when the ignition coil is in its worst condition. It does not generates an error code initially when the ignition coil is just a bit faulty.

Figure 3.4 OBD2 device

3.2 PROPOSED SOLUTION

In order to meet the needs of local mechanics of Pakistan we intend to make a device that will help the local mechanics of Pakistan to diagnose the faulty ignition coils. There is not any tool to diagnose the faulty ignition coil except Snap-On Modis Ultra or Pico scope. The local mechanics of Pakistan just check it by hit and trial basis and we have to change all the ignition coils. So this method is not efficient. For this cost become very high. There is not proper device to check the particular faulty coil. So we intend to make a low cost user friendly device that will diagnose the faulty ignition coils.

Our system will specifically tell about the faulty ignition coil by checking certain parameters i.e.

- Primary resistance of ignition coil
- Primary current of ignition coil
- Primary voltage of ignition coil

The local mechanics will just insert the ignition coil in tester and it will indicate whether the coil is faulty or not.

For fuel injector testing we are going to make a hardware that will test the faulty fuel injectors. Basically the symptoms of faulty fuel injectors include starting issues, poor idle, failed emissions, poor performance, engine does not reach full RPM, increased fuel consumption etc. So if any person is experiencing such issues in his or her car then there might be reason of faulty fuel injectors behind it.

In Pakistan the local Mechanics diagnose the faulty injectors by hit and trial method or they use the multi-meter to check the resistance but this method is not reliable.

Our proposed solution will test the faulty injector by certain parameters. And we have made a proper setup like fuel rail, fuel, pump, test tubes which ae used to check whether the fuel level is equal or not in all 4 test tubes.

i.e.

- We will check the fuel pressure in fuel rail
- We will give a pulse to the fuel injector and then the fuel goes into the test tubes.
- If the level of all test tubes are equal then it means that all fuel injectors are good.
- But if any of the fuel level in test tubes is not equal to that of others then it means that particular fuel injector is faulty and it is not squirting out the pressurized fuel and is not giving proper fuel to the engine.

3.3 REQUIREMENT SPECIFICATION

This device is specially made to address the needs of locals and the layman as mentioned in the previously. The design of the device kept simple so that anyone use this diagnostic tools. The main purpose of the device is to identify the issues in the ignition system which can be identified by OBD2 under error code number P0350 but the code generated by OBD2 is only identify the issues on the larger scale which is not sufficient for the identification of the error in ignition system. The main three components for the ignition system are the Coil on Plugs (COPs), Fuel Injectors and the control signals from the Engine Control Unit. The conventional device do not cover all the possible cases for testing all the issues in ignition systems. Some vehicle in the Pakistan still has the Ignition Coil feedback (IGF) in them but the issue still persists in the identification of the issues like fuel injector and the signals generated by ECU. The below given block diagram explain the overview of that how that device is identifying the above said issues.

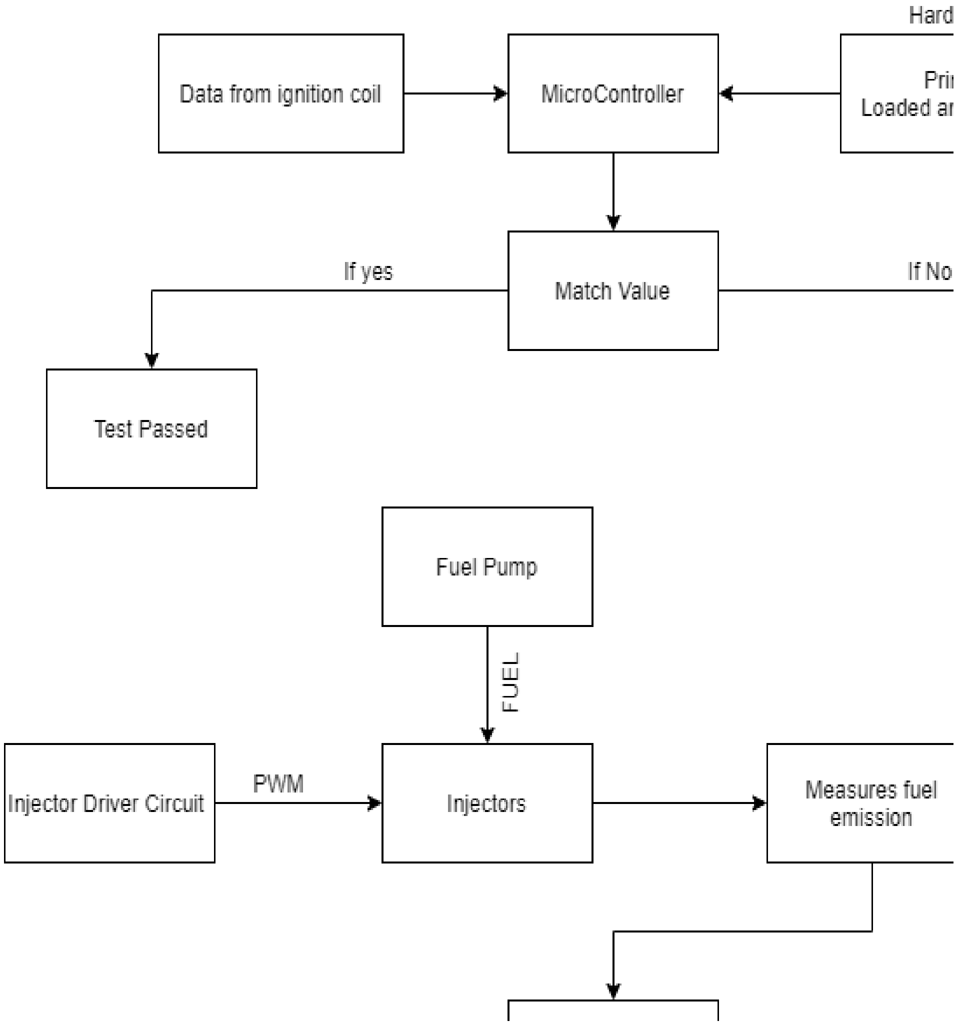


Fig 3.5 Specification Overview

The above diagram gives the brief intro about that how the device will identify the issues those cannot be identified using OBD2 or the conventional methods.

We can consider a classic example for the addressed issue which goes like you went to a mechanic when you see that car is missing, knocking or have some bad ignition problem that mechanic will start tracing the problem at hit and trail basis by replacing the parts which were working just fine and those unnecessary replacements some time cost a lot more than the actual issue was. These kinds of issues will be identified by the device with the more efficient way. This will benefit both the car user and the local mechanic as the car owner do not have to waste excessive money in replacing the ignition system parts that works fine and the mechanic as well in term of diagnosing the actual issue with the effective manner. The device is meant to made portable so that it is easy to carry with for some emergency cases for example if the mechanic have to check some vehicle that have some issues in the vehicle that have suffered an ignition problem far from the garage of the mechanic then the mechanic can carry this device with great ease and comfort. Unlike the conventional devices the proposed device made simpler to coupe up the literacy rate of mechanics and even layman will be able to diagnose the issue using the device for its own and there will be no proper training will be required for using this device. This device is powered by Microchip PIC16F877A, 555 timer circuits for PWM, and many other basic components. The PIC16877A will be the brain of the system which will monitors all the obtained data such as like load current, load resistance, idle resistance and startup current for the ignition coil and the fuel emission will be monitored by the gauges at the medical grade test tubes scale so that emission of all the fuel injector will remain smooth and the fuel emitted by all the injectors are the same in each cylinder.

Chapter # 4

System Design

4.1 SYSTEM ARCHTITECTURE

The main architecture comprises of two subsystems which comprises of the Ignition Coil Tester and the Fuel Injector Tester. The ignition coil is capable of testing the coil on plugs for almost every vehicle. The main objective while designing the ignition coil was to drive the circuit and to design the circuit which could able to handle the high load voltage of almost near 40,000 Volts. The main information was obtained from the Coils was the behavior of the resistance of the primary coil which is responsible for producing coil output voltage.

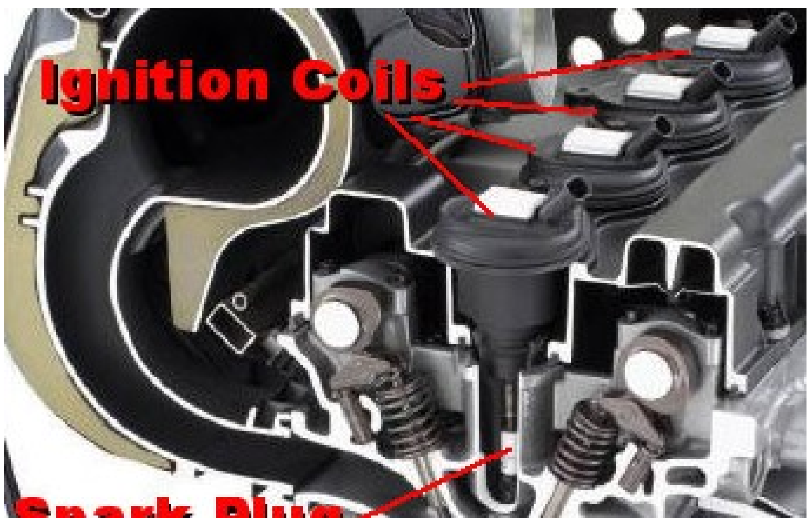


Fig 4.1 Coil on Plugs

As the resistance of the primary coil of the ignition coil was continously monitored by using the voltage divider formula on the ADC pin of the PIC16F877. The voltage divider formula is given below :

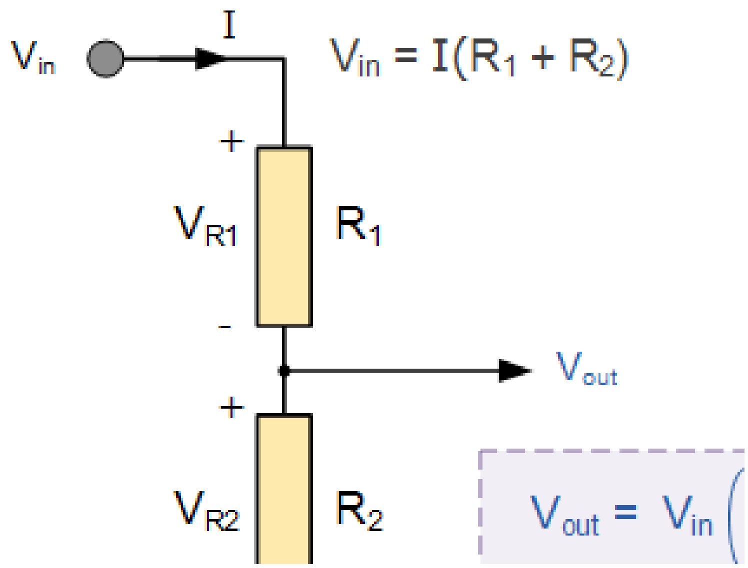


Fig 4.2 Voltage Divider

In the Figure 4.2 the resistance R2 is the resistance of the primary side of the coil and the Vout is connected to the ADC pins of the microcontroller so the voltage Vout is obtained at the ADC pin of the microcontroller. The figure for the configuration is shown below:

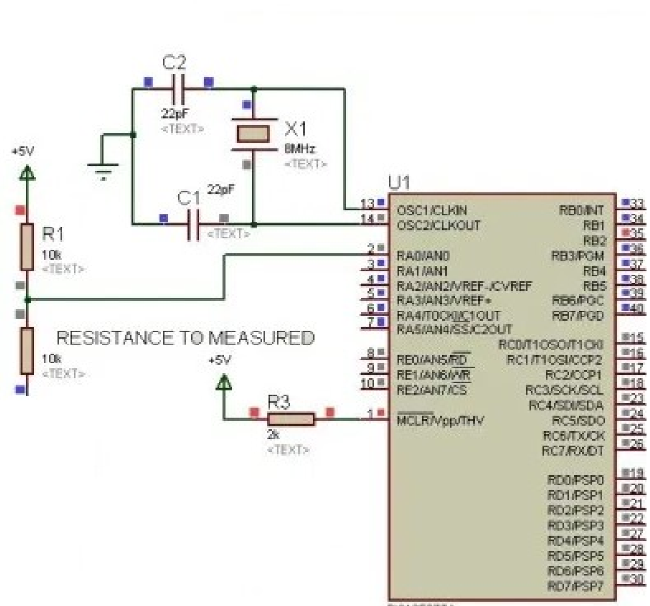


Fig 4.3 System pins Configuration

Using the voltage divider at the pin RA0 at the microcontroller the Vo is obtained at the RA2 and Vin is the 12 Volts from the car supply to the V+ of the ignition coil terminals and the ground as well. The resistance of the primary side is measured using the following formula which is the manipulation of the voltage divider.

$$Vo = (R2 / (R1+R2))*Vin$$

$$Vo / Vin = R2 / (R1+R2)$$

$$(Vo (R1 + R2)) / Vin = R2 \quad \text{------Eq (1)}$$

By implying the equation 1 on the microcontroller we can continuously measure the resistance and the current of the ignition coil is calculated by using ohm's law as follows

$$V=IR$$

$$I=V/R \quad \text{------ Eq (2)}$$

The voltage is as supplied from car's battery and that is equal to 12 volts and the resistance is monitored from the above equation 1 at the pin RA0 of the microcontroller. So by using the primary loaded and unloaded conditions, we can predict the condition of the ignition coil.

The various form of connector are used world wise according to the different manufacture of the ignition coils. The following of them are shown below according to the connection type.

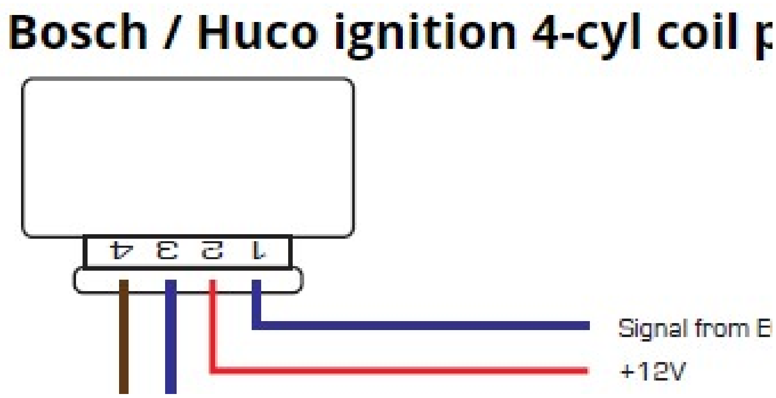


Fig 4.4 Bosch Ignition Coil Pack

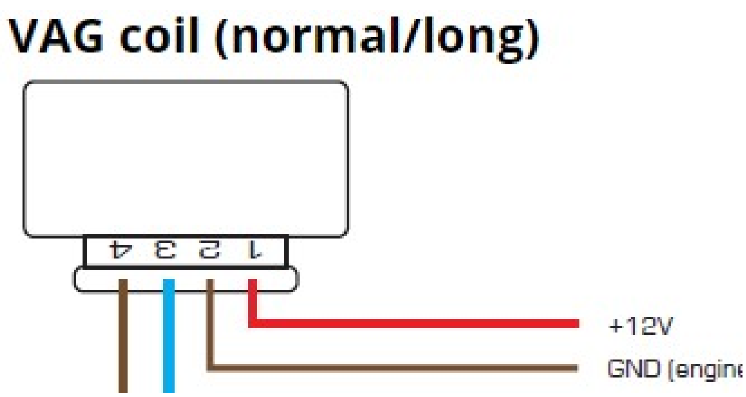


Fig 4.5 VAG Coil

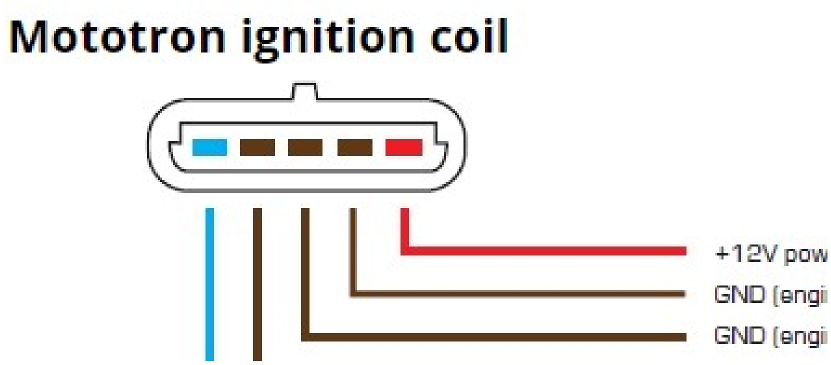


Fig 4.6 Mototron Ignition Coil Pack

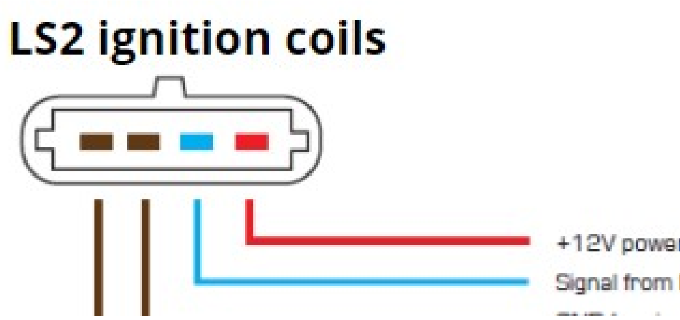
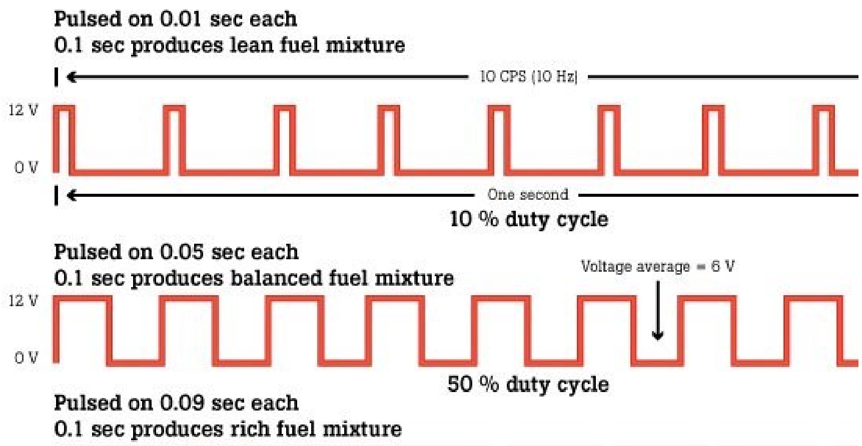


Fig 4.7 LS2 Ignition Coil Pack

The different types of the ignition coil of the are shown above in the figure but the most common type of the ignition coil in Pakistan Automobiles used is the Bosch/Huco ignition coil pack but if any other connector is used instead of the conventional one then the connector's connection can be changed according to the required one. The peak current on which the fuel injector starts operating the current rating is 3 Amps which is usually the manufacturer of the fuel injector.



In order to generate the PWM like shown above in the figure we need to replicate the PWM externally. The main issue described above before is the fuel injector will be drawing the current almost equivalent to the 3 Amps and we need to control the test duration for the each injector to be the same so we proposed a solution comprising on 555 timer IC in a-stable mode cascaded to a 555 timer IC circuit in mono-stable mode. The figure of the circuit is shown below.

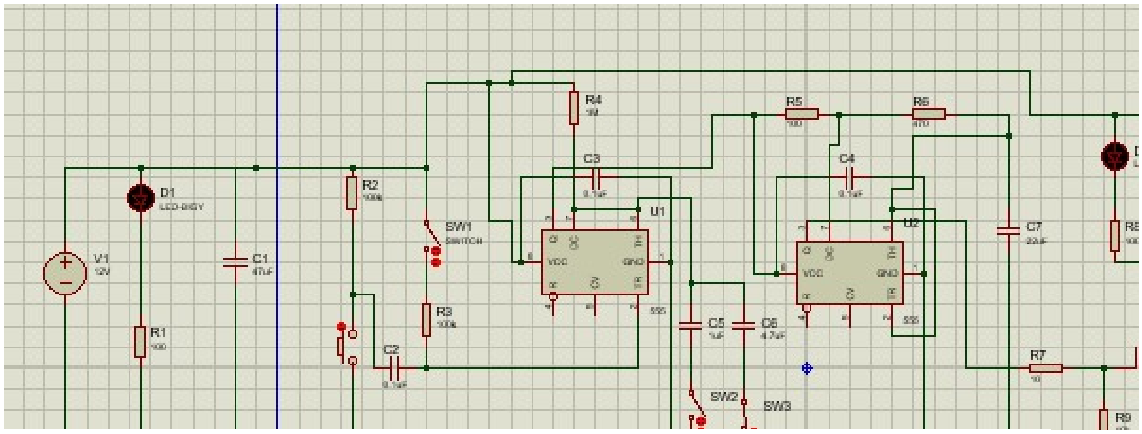


Fig 4.6 Fuel Injector driver Circuit.

The first 555 timer IC circuit will be generating the 1sec or 5sec pulse which will be the input of the second IC. When the input from the first IC is received the second IC will generate a signal of 8ms duty cycle for the period during which the output of the first 555 timer IC remains high. One wire is directly connected to the battery 12v terminal and the injector's Vcc terminal and the other terminal which will be the output from 2nd 555 timer IC is connected to high current rating N-type mosfet then N type mosfet is driving the fuel injector PWM control. Figure shows the output of the above shown circuit.

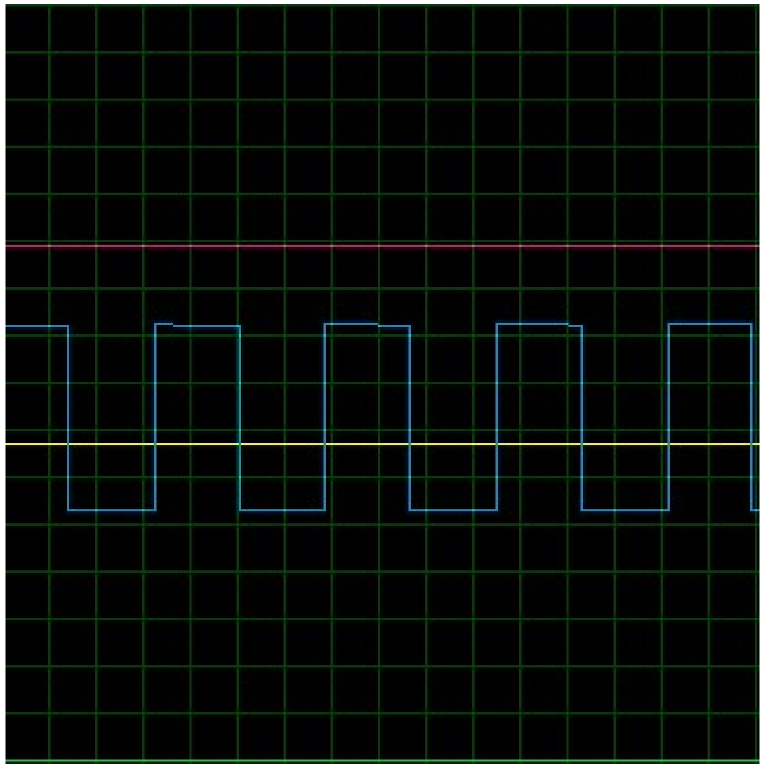


Fig 4.7 Fuel injector PWM

A fuel pump and an external fuel rail is used to drive the supply the fuel to the fuel injector and then connected to output of the above circuit and the fuel emitted by all the fuel injector is collected in medical grade test tubes for the comparison of the fuel levels if the fuel level in any test-tube is less or more than the other test tubes then it is said to be faulty.

4.2 Design Constraints

In engines the electronic systems are mainly responsible for the ignition spark timing and fuel injector PWM depending upon the signal data acquired by the sensors depending upon its type and followed by the ECU on the basis of maps. The proper mixing and air to flow mixture and proper spark/ignition timing will not only be economically efficient but it also reduce the pollution in air by controlled emissions.

The upper paragraph concludes that the ignition system are meant to control the timing of the high voltage spark in the respective chamber. The ignition in the chamber occurs before the end of the compression stroke so that its positon needs to continuously measure by the sensors. There are the two mechanical methods were used before the introduction of the electronic systems.

Vacuum Advanced Mechanism (VAM) was used to advance the ignition angle with respect to the load at the engine and the Cam Advanced Mechanism (CAM) was used to advance the ignition angle with respect the speed of the engine [3]. Disadvantages of mechanical Ignition systems mentioned below:

1. No precise adjustments in conventional mechanical methods
2. Less life span as they depends on the life of mechanical parts
3. Adjustment were very complex and was not still accurate

The ECU based ignition system was introduced to eliminate the above mentioned issue as there were less or no mechanical parts were involved in it. The advantages of the ECU based ignition system over conventional mechanical systems are discussed below:

1. Accurate and precise ignition timing as well as the accurate ignition angle.
2. The excessive emission was reduced due to the controlled emission.
3. The efficiency was improved as there was no excessive burning of the fuel.

4. Life span of these devices were comparatively more than the conventional mechanical systems as it was purely microcontroller based systems.

4.2.1 Ignition Timing

The electronic ignition system depends on the sensors, on the response of sensors the ignition timing is calculated. In order to calculate the ignition timing we at least need the sensor to monitor the engine cycle. This sensor will give a signal every 7200 or 3600 revolution depending upon the certain conditions. These sensor are usually placed at the crankshaft in order to determine the engine cycle with respect to the rotation of the crankshaft [4]. There are two chances depending upon the position of the sensor, at first the engine can be in induction stroke or in combustion stroke. In many cases this problem will not occur because the induction valve begins to open when TDC occurs [5].

Factors affecting Ignition timing of a vehicle are

1) Engine speed of the vehicle

2) The burning rate of air to fuel mixture

3) The charge density in the mixture

4) Mixture's Homogeneity

5) Air to fuel mixture quality

6) Residual Fuel

4.2.2 Speed Vs Ignition angle

The Speed of vehicle and the ignition angle are directly linked as increasing the speed will also increase the ignition angle and the spark in chamber needs to take place as early as possible matching the speed. The load and ignition angle are indirectly related so we can say the values for the angle is less than the half load.

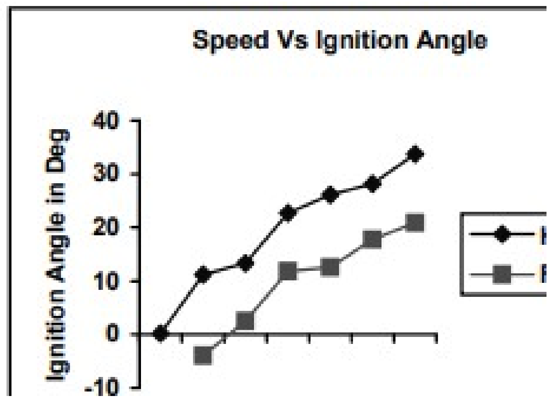


Fig 4.8 Speed Vs Ignition Angle

4.2.3 Load Vs Output Ignition angle

The load and the ignition angle have indirect relations as the increase in the load decreases the ignition angle because the fuel burn do not remain constant as it was on the idle conditions. It is also affected by the load at the engine and as well as the air to fuel mixture. When the engine load is light and air to fuel mixture is lean, an advanced spark is needed and when the engine is driving heavy load and air to fuel mixture is rich then a delayed spark is required [2]

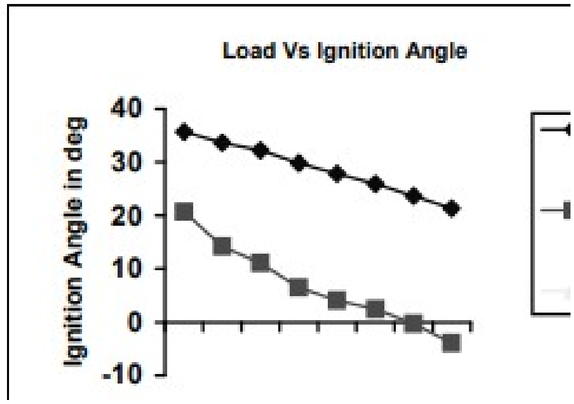


Fig 4.9 Load Vs Ignition Angle

The variation of ignition of ignition angle with respect to the load is justified in above figure. The graph lines in the above figure shows the higher and the lower speed. The variation of ignition angle at speed 6800 Rpm is comparatively straighter than the variation at 1000 Rpm [6].

4.2.4 Results by Inspection

We have inspected a car using Picoscope. Picoscope is a device that is used as a diagnostic tool. It works with laptop and is used to practically demonstrate waveforms of circuits including the followings

- Primary coil and secondary coil resistance
- Fuel Injectors and Fuel pump
- The charging circuit and the inrush currents
- Alternators
- Airflow, ABS and MAP sensors
- Electronic throttle control
- CAN Bus System
- Noise Vibration and Harshness

We connected picoscope a car and observed different waveforms like of ignition coils, fuel injcetors etc.

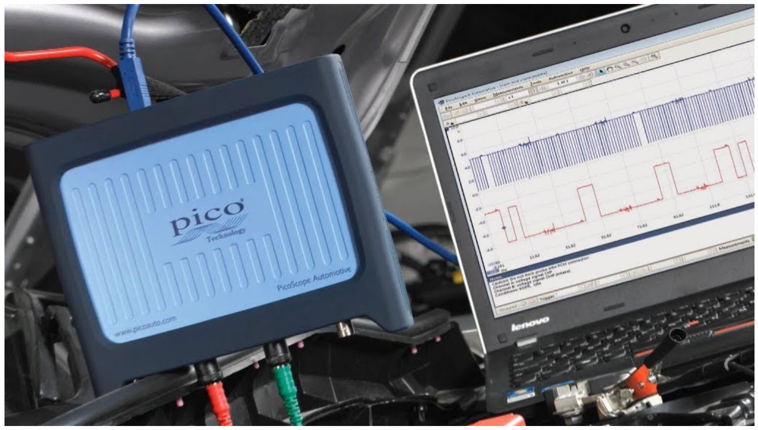


Fig4.10 Picoscope connected to car engine

Then we observed the fuel to map ratios. On the basis of observation we came to know that the pwm signals of fuel injectors are dependent on RPM [7]. The frequency for the fuel injectors are linked with the RPM and the speed of the vehicle. The increase in the RPM and the speed will increase the frequency of the fuel injector.

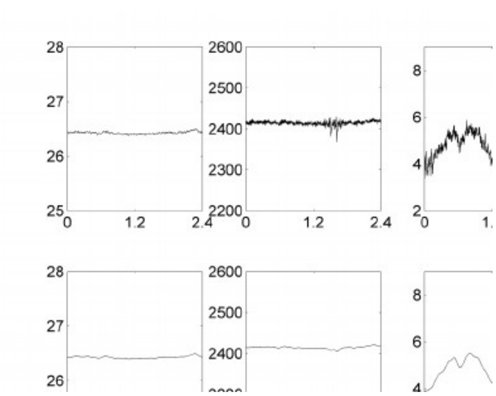


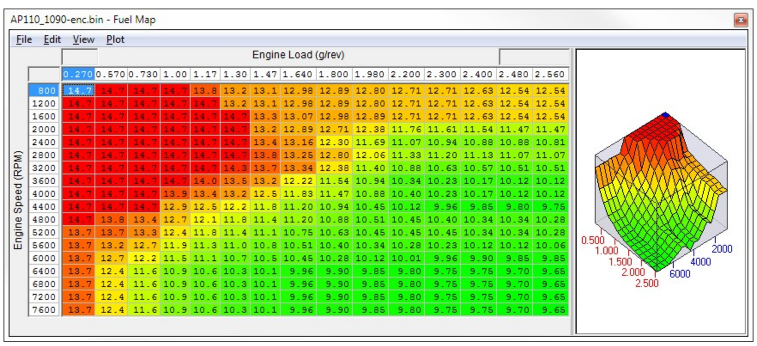
Fig4.12.speed (m/s), engine rpm, and fuel injector pulse width (ms) graph

Similarly the signals from ignition coils are also dependent on RPM of engine.

4.2.5 Fuel mapping

Fuel mapping is checking that the fuel amount in the chambers are accurate supplied according to the required amount if the level of fuel in the chamber increases or decreases than the certain limits then the ignition will not work efficiently. Mapping is the act of going through each area and finding a suitable value for the fueling (typically an injector pulse width).

The table is known as map because it contains numerous values based on speed of engine and engine load that is measured by either throttle position or intake manifold pressure.



Engine Speed (RPM) \ Engine Load (g/rev)	0.270	0.570	0.730	1.00	1.17	1.30	1.47	1.640	1.800	1.980	2.200	2.300	2.400	2.480	2.560
800	14.7	14.7	14.7	14.7	13.8	13.2	13.1	12.98	12.89	12.80	12.71	12.71	12.63	12.54	12.54
1200	14.7	14.7	14.7	14.7	14.7	13.2	13.1	12.98	12.89	12.80	12.71	12.71	12.63	12.54	12.54
1600	14.7	14.7	14.7	14.7	14.7	14.7	13.3	13.07	12.98	12.89	12.71	12.71	12.63	12.54	12.54
2000	14.7	14.7	14.7	14.7	14.7	14.7	13.2	12.89	12.71	12.38	11.76	11.61	11.54	11.47	11.47
2400	14.7	14.7	14.7	14.7	14.7	14.7	13.4	13.16	12.30	11.69	11.07	10.94	10.88	10.88	10.81
2800	14.7	14.7	14.7	14.7	14.7	14.7	13.8	13.25	12.80	12.06	11.33	11.20	11.13	11.07	11.07
3200	14.7	14.7	14.7	14.7	14.7	14.3	13.7	13.34	12.38	11.40	10.88	10.63	10.57	10.51	10.51
3600	14.7	14.7	14.7	14.7	14.0	13.5	13.2	12.22	11.54	10.94	10.34	10.23	10.17	10.12	10.12
4000	14.7	14.7	14.7	13.9	13.4	13.2	12.5	11.83	11.47	10.88	10.40	10.23	10.17	10.12	10.12
4400	14.7	14.7	14.7	12.9	12.5	12.2	11.8	11.20	10.94	10.45	10.12	9.96	9.85	9.80	9.75
4800	14.7	13.8	13.4	12.7	12.1	11.8	11.4	11.20	10.88	10.51	10.45	10.40	10.34	10.34	10.28
5200	13.7	13.7	13.3	12.4	11.8	11.4	11.1	10.75	10.63	10.45	10.45	10.45	10.34	10.34	10.28
5600	13.7	13.2	12.7	11.9	11.3	11.0	10.8	10.51	10.40	10.34	10.28	10.23	10.12	10.12	10.06
6000	13.7	12.7	12.2	11.5	11.1	10.7	10.5	10.45	10.28	10.12	10.01	9.96	9.90	9.85	9.85
6400	13.7	12.4	11.6	10.9	10.6	10.3	10.1	9.96	9.90	9.85	9.80	9.75	9.75	9.70	9.65
6800	13.7	12.4	11.6	10.9	10.6	10.3	10.1	9.96	9.90	9.85	9.80	9.75	9.75	9.70	9.65
7200	13.7	12.4	11.6	10.9	10.6	10.3	10.1	9.96	9.90	9.85	9.80	9.75	9.75	9.70	9.65
7600	13.7	12.4	11.6	10.9	10.6	10.3	10.1	9.96	9.90	9.85	9.80	9.75	9.75	9.70	9.65

Fig 4.13. Fuel map of engine

We observed the relation of ignition coils vs RPM. By using an external circuit we have replicated the signal from car engine in ideal condition and obtained the values from it. With help of external circuit we were able to perform the test externally.

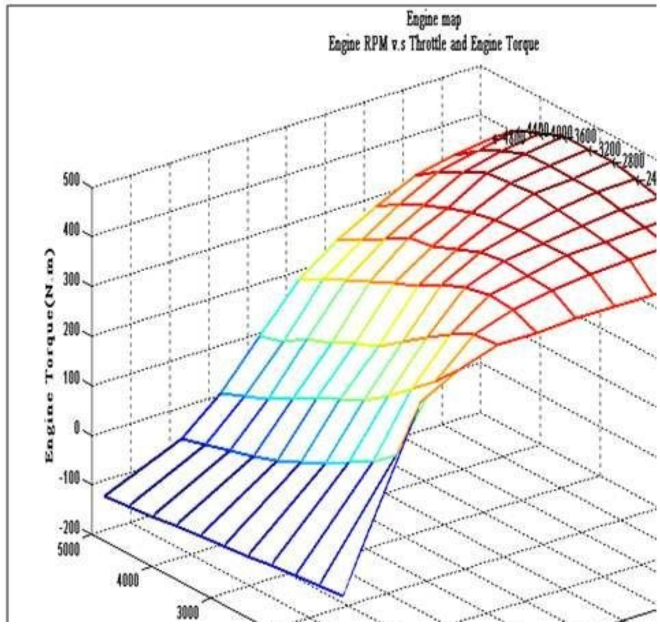


Fig4.14 Engine RPM vs torque graph

4.3 Design methodology

4.3.1 Fuel injectors

The 555 timer is the IC used to generate PWM signals, timer and as well as it is used as oscillator as well.

It has three state of operation

1) Bi-stable mode
2) Mono-stable mode
3) A-stable mode.

4.3.1.1 Monostable Mode

Monostable multivibrator mode of 555 timer IC is also called single shot mode. In this mode the 555 timer IC remains in the stable state until an external voltage is applied to trigger the circuit. The external interrupt will cause the transition from stable to unstable mode. The stability state duration of the driven 555 timer IC is determined by the RC constant in the circuit network.

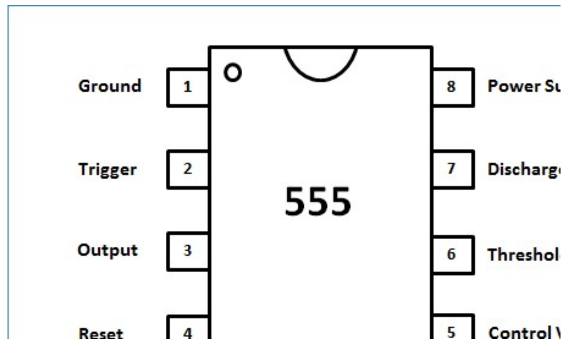


Fig 1. Pin configuration diagram

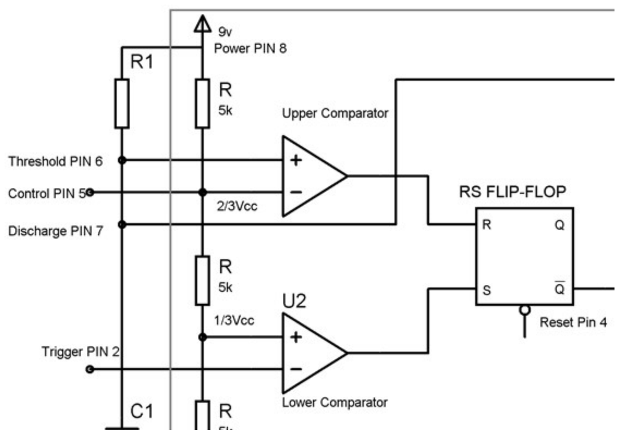


Fig 2. Operation of monostable mode of 555 timer IC

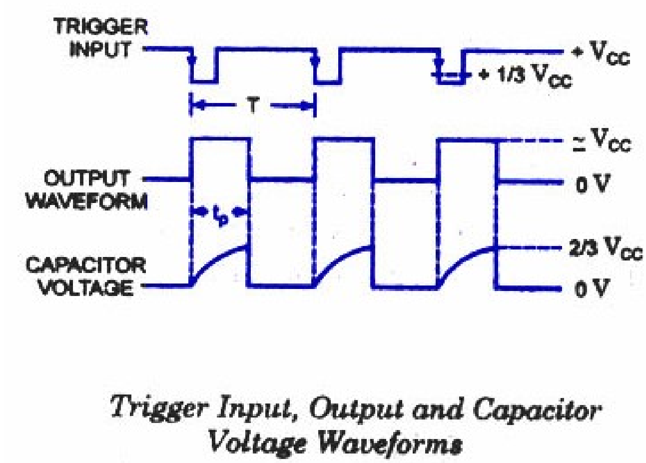


Fig 3. Graph of monostable mode

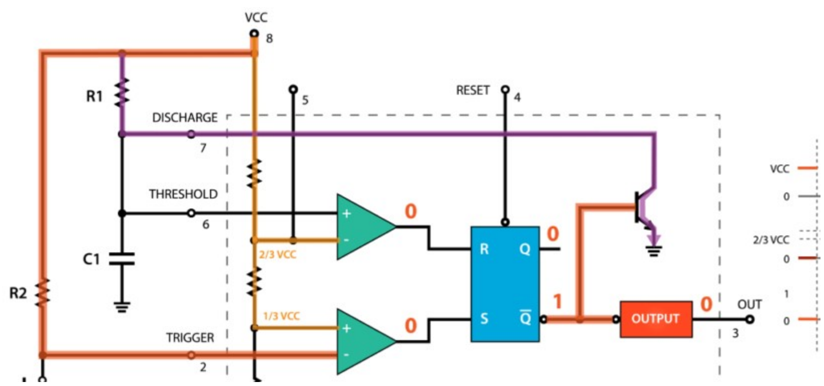


Fig 4. circuit diagram of monostable mode

4.3.1.2 Stable mode of 555 timer IC

Astable Multivibrator mode is also known as the self-triggering mode. It generally transit between high and low state. Unlike the monostable mode there was no external voltage required for triggering the transition state in high to low. It automatically transits between the states of high and low depending by the network of the resistors and capacitors. This mode works as a frequency, oscillator and the rectangular forms.

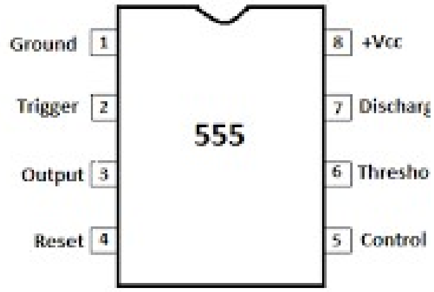


Fig 6. Pin configuration of astable 555 timer IC

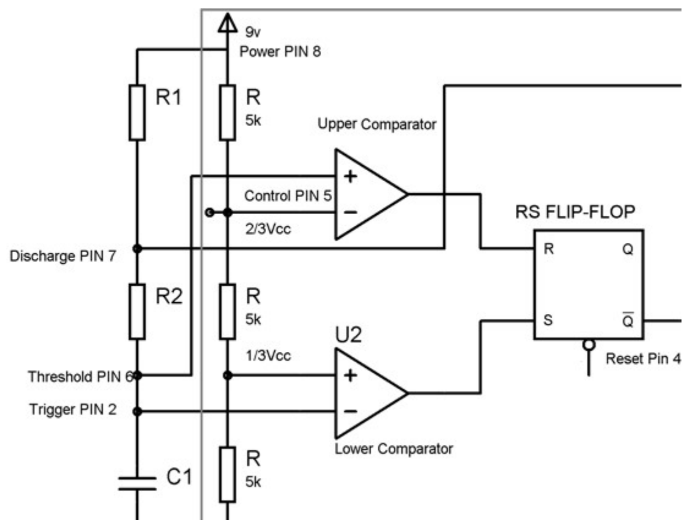


Fig 7: Operation of astable multivibrator mode of 555 timer IC

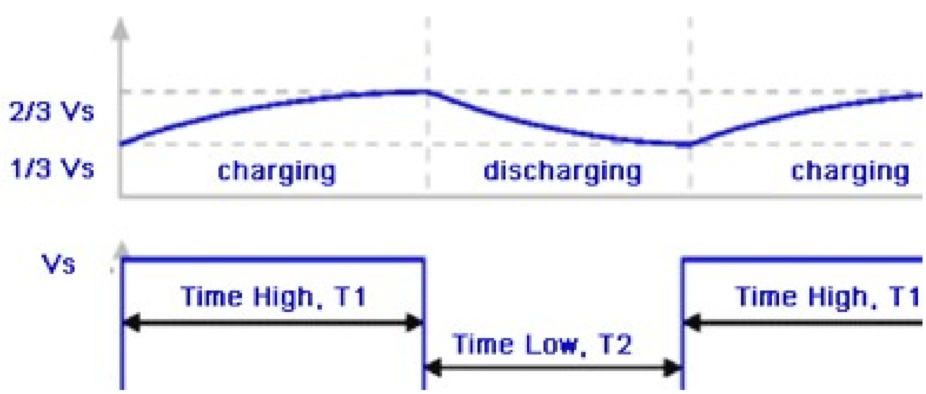


Fig 8. Graph of astable 555 timer IC

4.3.1.2.1 Charging and discharging of capacitors:

The discharging and the charging of the capacitors and the rectangular and oscillating output wave is generated. During the duration of the capacitors getting charged the output of the 555 timer IC remains high and the duration in which capacitor is discharging the output of the IC remains low. This mode is called Astable Mode because of output is not dependent on the any external interrupt or any external voltage, the 555 Timer IC changes its states from higher to lower and vice versa automatically.

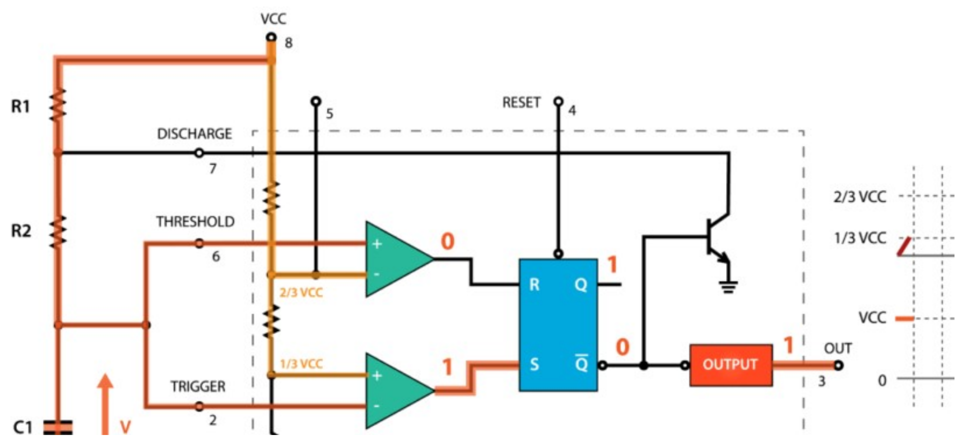


Fig 9. Circuit diagram of astable mode

4.3.2 Ignition coils

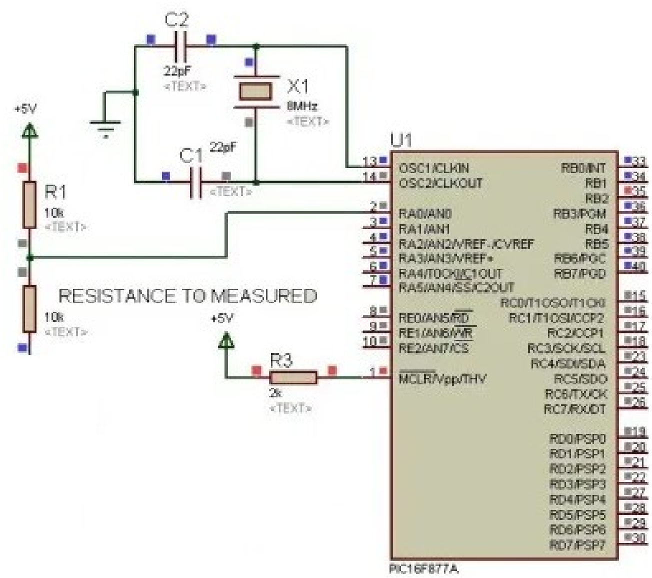


Fig 10. Circuit diagram

In the circuit diagram the three pins one is connected to 12volts battery, the other is connected to the ground and the third is connected to the controlling signal from ECU. So the 12volts and ground are connected to the battery and the third pin to the ignition coils. 12volts are coming directly from the battery but our main purpose is to generate ECU signal. When there is positive edge of signal the pwm signal will be high and it will produce spark. When the pwm signal is low it won't produce any spark. So the ignition timings are matched and we have replicated this signal artificially using microcontroller and transistors as an amplifier in cascaded stage.

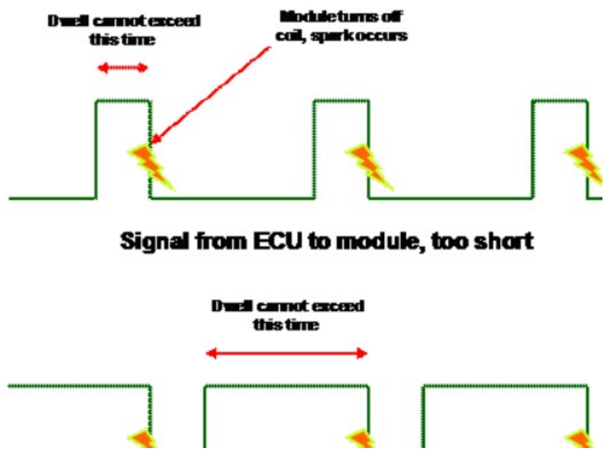


Fig 11. ECU for ignition coil waveform

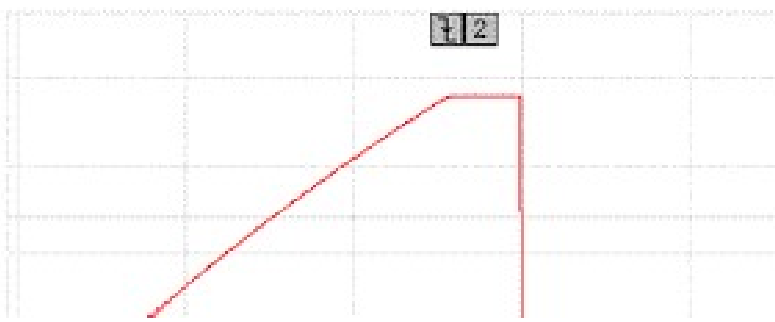


Fig 12. Ignition coil dwell time graph

4.4 High Level Design

In this discussion we will be concluding project in a detailed manner and will be discussed in logical flow manner using supporting flow diagrams.

4.4.1 Logical Flow

As we have the discussed the project in the heading 4.1 in an overview manner now we will discuss the flow of the project. The below given image is the logical flow for the under discussion project

4.4.1.1 Logical Flow for Ignition Coil Tester

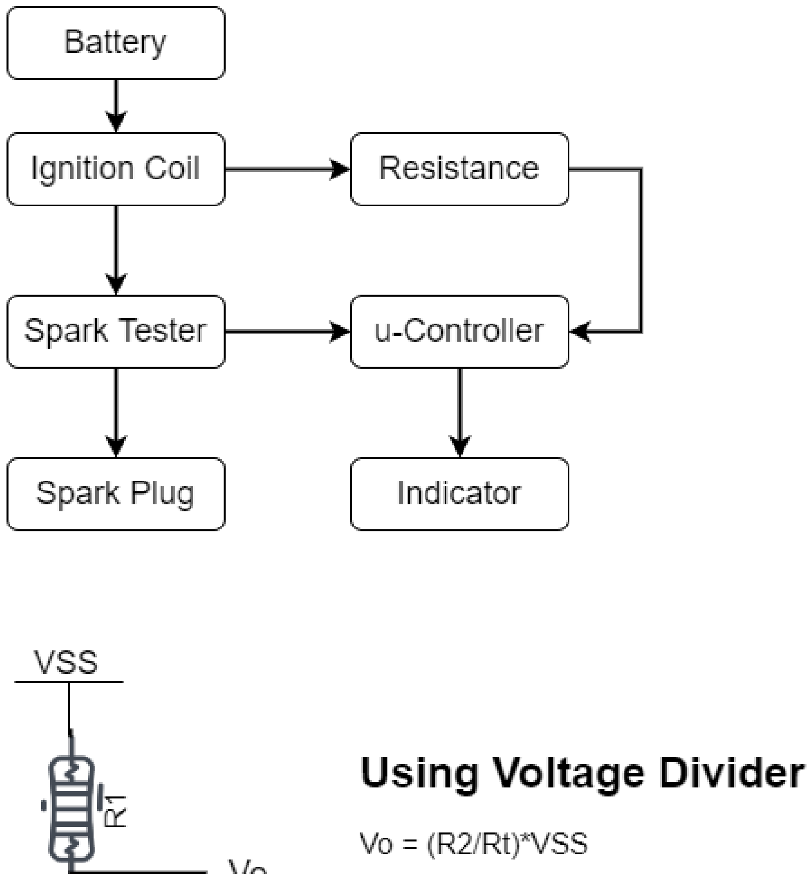


Fig 4.8 Logical Flow (Ignition Coil Tester)

In the above figure we can see the power to the ignition coil is supplied directly from the microcontroller and the resistance is monitored at the microcontroller in loaded and unloaded conditions. The spark plug there represents any ground body it can be the ground of the battery or can be attached to vehicle's ground. The spark tester there mentioned is shown in the figure below:

Fig 4.9 Spark Tester

The spark tester will produce the spark so that the spark is visible to the user which helps to identify the spark whether the spark produced by the coil is healthy or not. The resistance of the coil will deal with the loaded and unloaded conditions of the ignition coils. Then based on the sparks and the produced and the loaded and unloaded condition the microcontroller will turn on/off the indicator led on the project.

4.4.1.2 Logical Flow for Fuel Injector Tester

The fuel injector and the fuel injector are directly getting 12 volts supply from the car's battery as well as the fuel injector driver circuit. The fuel pressure will maintain the 60 psi pressure in the fuel rail [1]. The driver circuit then generate the PWM for some specific time and the injector will emit the fuel in the all four test tubes for the precise same duration and then based on their emission and the fuel level, If all the test tube levels are the same then we can say that all the fuel injector are emitting the same fuel and hence are working fine and if the level of any test tube is lower or above, then we can say that particular fuel injector is faulty.

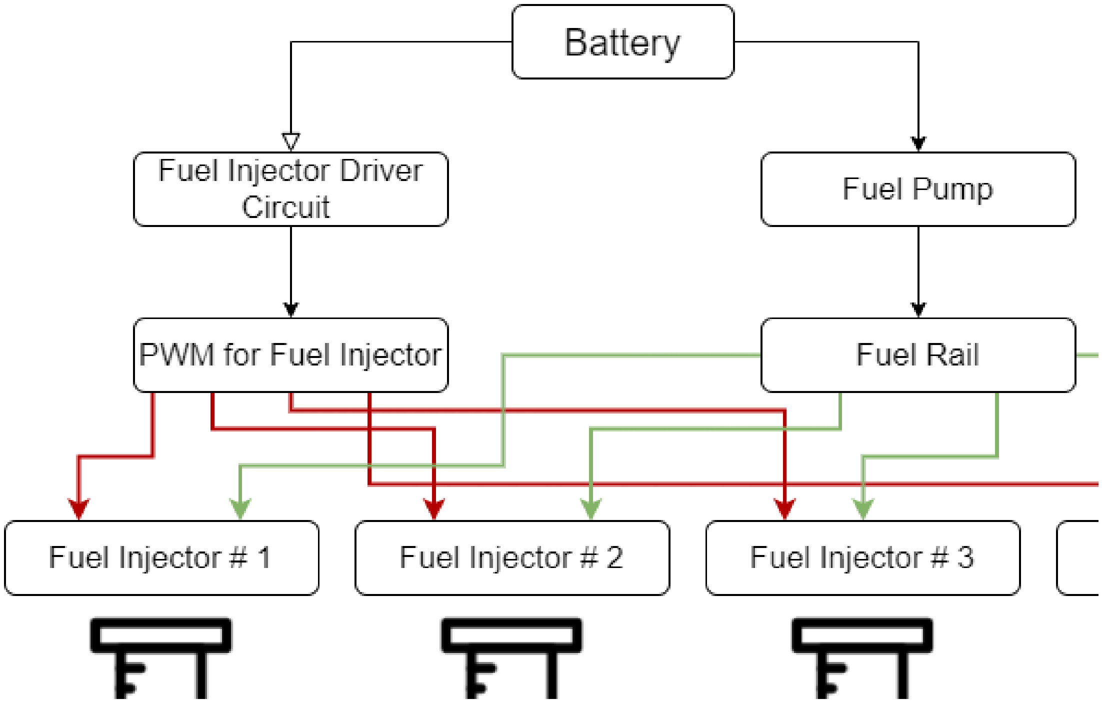


Fig 4.10 Flow Diagram Fuel Injector Tester

The figure for a conventional common rail fuel injector system is shown below:

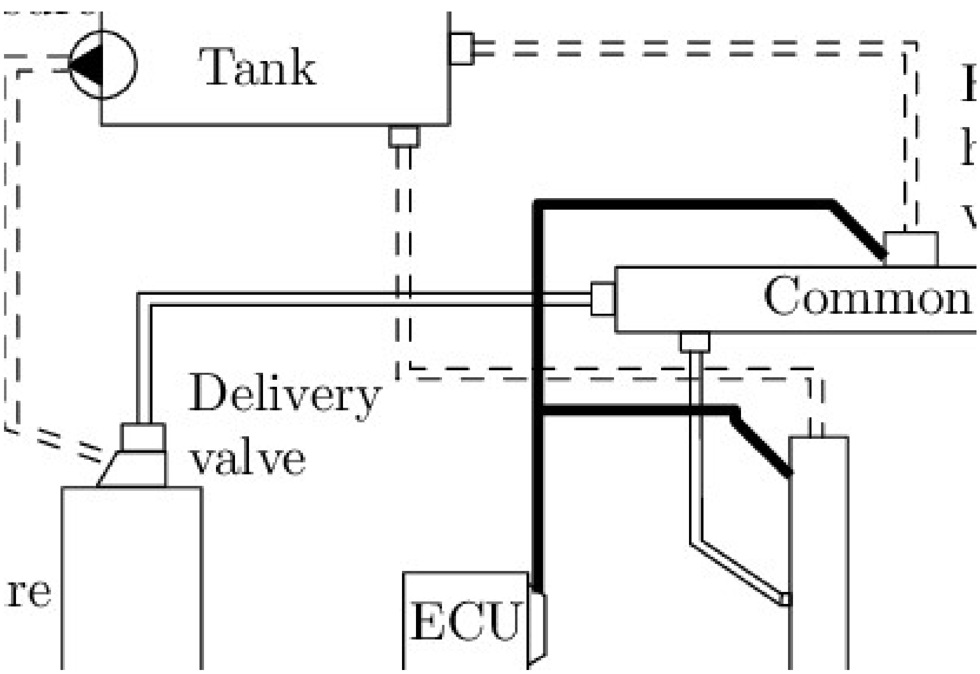


Fig 4.11 Common Rail fuel injector

4.5 Low Level Design

4.5.1 Ignition coil

As ignition coil work on the principle of transformer. Ignition coils consists of primary winding, a secondary winding and the iron core. The primary side is made up of thick copper wire with less number of windings. The secondary side is made up of thin copper wire and a lot number of windings approximately 20,000 windings [10]. A magnetic field is generated on the primary side of coil. By Self Induction principle, a high voltage is generated at secondary side.

Fig 4.12 Ignition coil

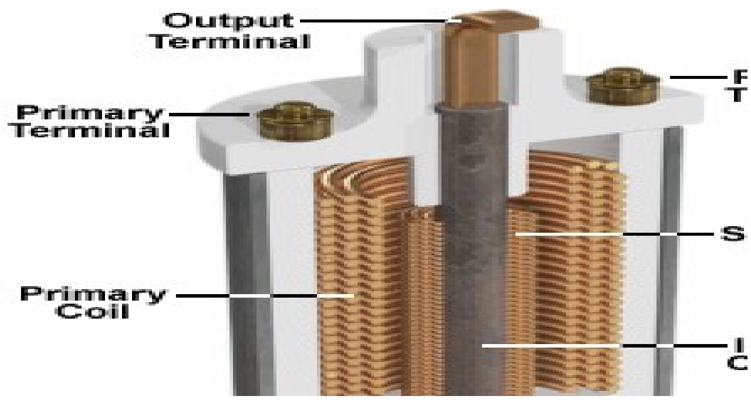


Fig 4.13 Ignition coil internal structure

Primary resistance of Ignition coil is typically 0.5ohms. The secondary resistance of ignition coil is 5 to 20 kilo ohm.

We have used these values as a standard and stored them in microcontroller. We have used these values as standard in programming. If any ignition coil has a resistance other than the standard value, then it means that the particular ignition coil is faulty.

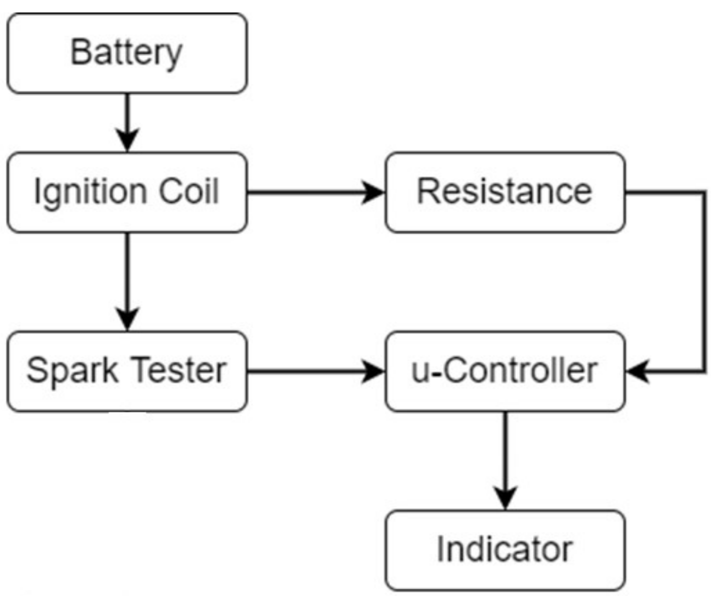


Fig 4.14 Ignition coil tester diagram

4.5.2 Ignition coil Primary and secondary voltage

The primary voltage of ignition coil is 12Volts same as that of battery's voltage and the secondary voltage is between 40KV to 45KV (Kilo volts). It depends on the type of ignition coil. We have used these values as standard in our programming for microcontroller.

4.5.3 Ignition coil current:

COP (coil-over-plug) ignitions require 7 amperes of primary current in order to produce 40KV-60KV of spark ouput.

We have used the primary side current as standard. If while testing the ignition coil, the range deviates from the standard range then it means that Ignition coil is faulty.

4.5.4 Fuel Injectors

The injector consist of a small tank, pump, pressure, test tubes,gauge. There is a separate assembly for receiving the sprayed fuel from the fuel injectors [8]. The assembly consists of

- Battery
- Fuel pump
- Fuel rail
- Fuel injectors
- Test tubes

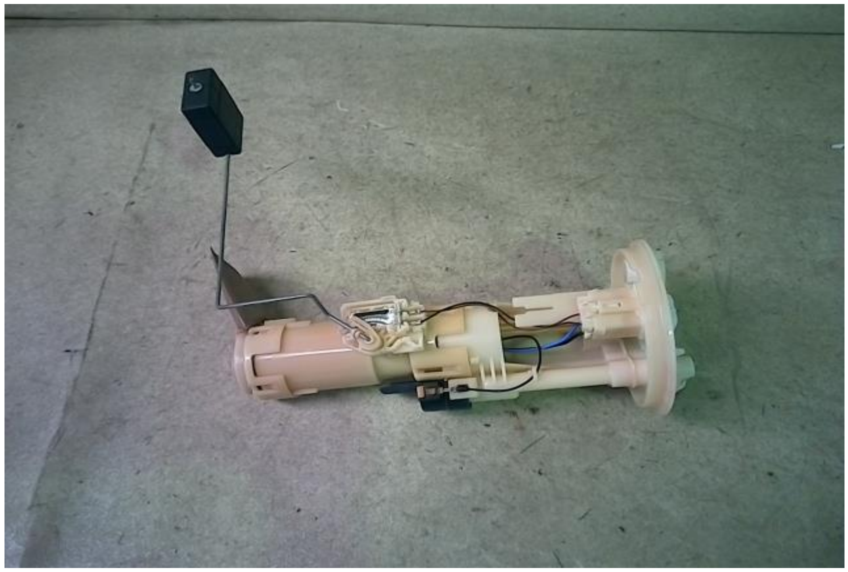


Fig 4.15 Fuel Pump

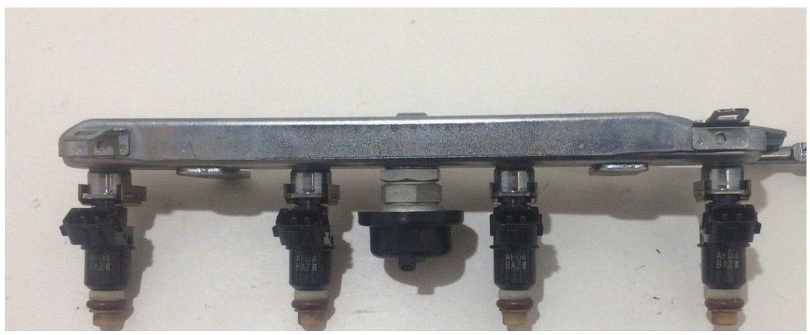


Fig 4.16 Fuel Rail

Fig 4.17 Fuel Injector

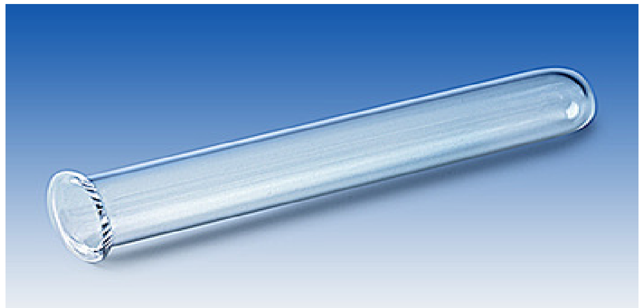


Fig 4.18 Test tube

The fuel injector driver circuit is used to generate Pulse width modulation (PWM) for fuel injectors. The fuel will go into the fuel rail and from fuel rail the fuel is being provided to the fuel injectors. The test tubes are placed so that the fuel that is sprayed by the fuel injectors are stored in the test tubes.

The level of fuel in the test tubes is measured. If the level in all the test tubes is equal then it means that all the fuel injectors are good. But if one of the level differs then it means that particular fuel injector is not spraying proper fuel.

4.6 Interfacing

Our Final Year Project mainly comprises of two parts i.e. Ignition coil tester and Fuel Injector tester that will be interfaced with two different parts of automobile individually. Ignition coils of Electronic Fuel Injector (EFI) system interfaced through CAN (Controller Area Network). CAN (Controller Area Network) is an International Standardization Organization (ISO) defined serial communication bus. It is developed mainly for the purpose of automotive industry to replace complex wiring with a CAN topology. It has high immunity to electrical interference and ability to diagnose errors. We have used CAN topology for interfacing purpose. The CAN protocol eliminates the need of excessive wiring by allowing the electronic devices to communicate with each other. There are many advantages of CAN protocol e.g. it is very low cost, it has built in error detection, robustness, flexibility. We have designed a system that works in the similar way as the ECU (Electronic control unit) of car does. ECU operates on CAN topology, we have designed our system in a similar manner. Fuel injectors are also interfaced in a similar like CAN bus topology.

Chapter # 5

System Implementation

5.1 System Architecture

The main components of our project are as follows

- PIC microcontroller
- Ignition coils
- Fuel injectors
- Fuel Pump
- Fuel Rail
- Power supply
- Test tube

5.1.1 PIC microcontroller:

It is family of microcontrollers made by Microchip technology. The controller we have used in our project is PIC 16F866.

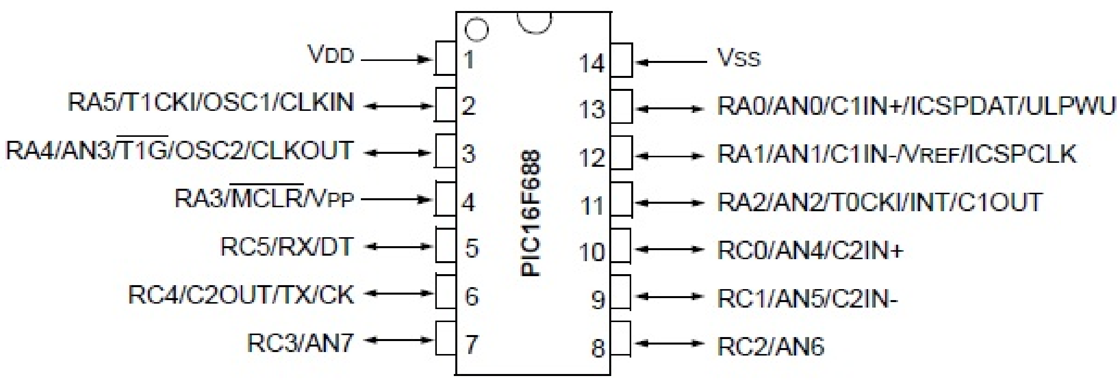
It is a 14 pin microcontroller. We have used PIC because of its fast performance as it uses RISC architecture. Comparing it with other microcontrollers, its power consumption is very less. It is very reliable as it is less likely to malfunction when built into a device. PIC microcontrollers are simple to program. Due to the flexibility of 8-bit, 16-bit and 32-bit PIC microcontrollers, we can scale the design up or down.

The PIC 16f688 has a built in 10 bit ADC with 8 input channels. That means the range is from 0 to 1023 or 0 to 2^10-1.

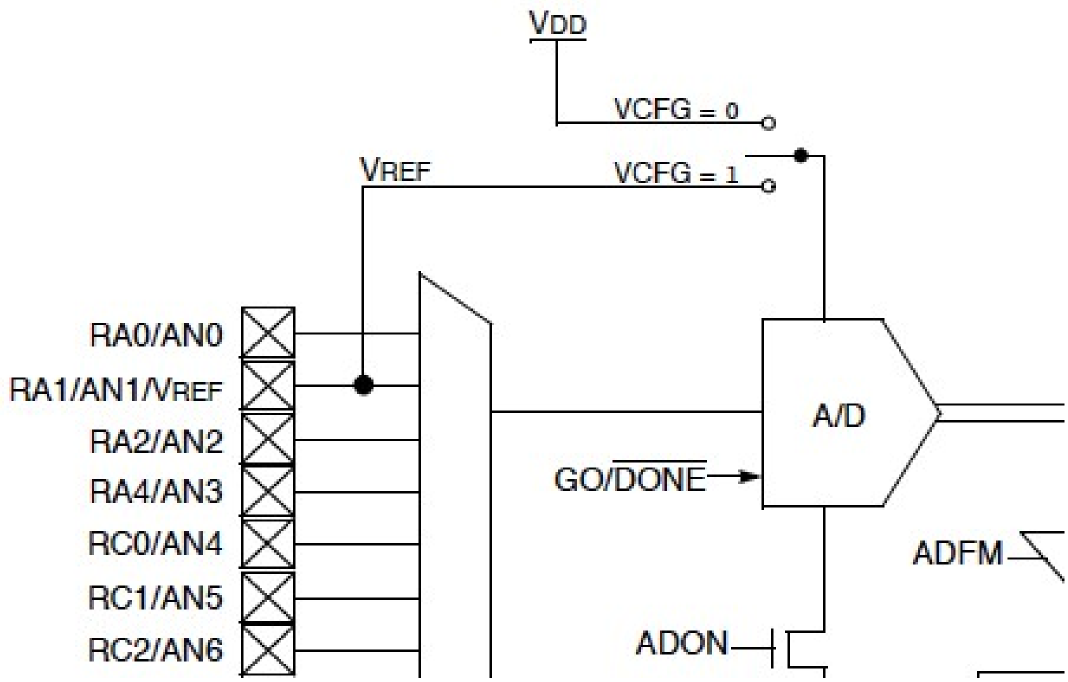
The resolution of PIC 16f688 can be calculated as

$$X= 5V/1023$$

Where X is the resolution and 5V is the reference voltage. The microcontroller would measure a minimum change of 4.8mv and below 4.8mv the controller will be insensitive.



The eight channels are available at RA0, RA1, RA2, RA4, RC0, RC1, RC2 and RC3. The ADC 10 bit result is stored in ADRESH (A/D higher byte) and ADRESL (A/D lower byte). These registers are 8 bit.



ADC is controlled by three registers ANSEL, ADCON0, ADCON1.

The below table shows the registers associated with PIC16F877A ADC.

In ADC of PIC there is some error between the actual value and measured value. Like if we have measured 30Volts then in PIC the measured value will be 29.9987.

Absolute error=Measured value- actual value

=29.887- 30

=-0.113

Absolute error=0.113

Percentage error= (Measured value-actual value/ actual value)|* 100%

Percentage error= 0.37%

So when we use ADC, error is 0.37% for 30Volts.

5.1.2 Ignition coils:

An ignition coil is an induction coil in an automobile. It transforms the battery's 12 volts into thousands of volts that are needed by the spark plug to produce spark.

5.1.3 Fuel Injectors:

The fuel is sprayed into the intake manifold or the cylinder with the help of fuel injector.

5.1.4 Fuel pump:

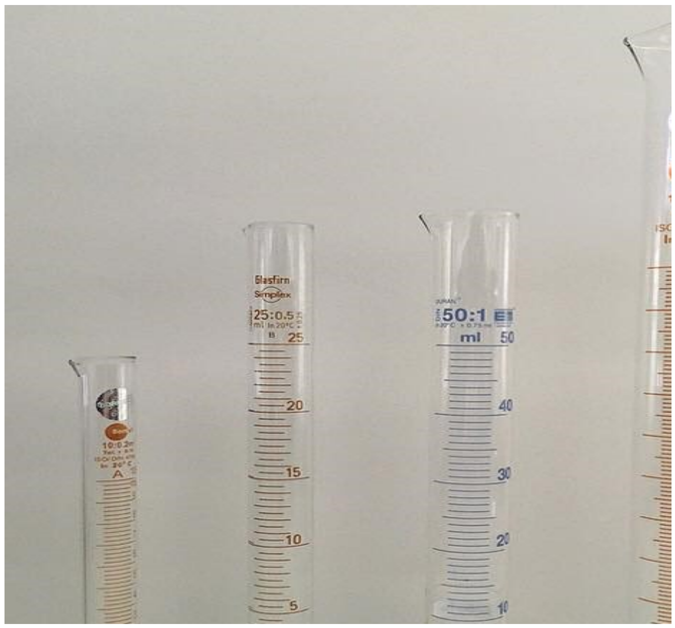
Fuel pump is used to deliver fuel to the engine at appropriate pressure.

5.1.5 Fuel rail:

It is basically a pipe that supplies pressurized fuel to the fuel injectors.

5.1.6 Test tubes:

We will use the test tubes for fuel injector tester. By using test tubes we will measure and see the level of fuel and then we can diagnose which injector is faulty.



5.2 Components Working

For the ignition coils current is dependent on primary resistance. It works on the two conditions; loaded and unloaded.

- Loaded condition:

  When ignition coils produce spark

- Unloaded condition:

  When ignition coils do not produce spark

Hence in unloaded condition the resistance of coil is lower than that in loaded condition.

Vo is obtained at the RA2 and Vin is the 12 Volts from the car supply to the V+ of the ignition coil terminals and the ground as well. The resistance of the primary side is measured using the following formula which is the manipulation of the voltage divider.

$$Vo = (R2 / (R1+R2))*Vin$$

$$Vo/Vin=R2 / (R1+R2)$$

$$R2 = \frac{Vo(R1+R2)}{Vin} \qquad \text{……}\textit{Equation 1}$$

As shown in the circuit below 5volts supply voltage is connected to the circuit. Two resistors R1 and R2 of 10kilo ohms are connected in parallel combination. So across each 10kilo ohms resistor voltage drop is of 2.5volts.

Now if the two resistors are of 20kilo ohms then voltage drop across them is 1.25volts. So we will make calibration chart in which we define different levels of voltages and obtain the resistances corresponding to voltage levels.

Secondly we will find the primary current of ignition coils. The values will be fed into the microcontroller we can continuously measure the resistance and the current of the ignition coil for this we used ohms law,

$$I=V/R \qquad \text{……Equation 2}$$

The voltage is as supplied from car's battery and that is equal to 12 volts and the resistance is monitored from the above equation 1 at the pin RA0 of the microcontroller. So by using the primary loaded and unloaded conditions, we can predict the condition of the ignition coil.

Both of these conditions primary resistance and primary current is measured in real time. The microcontroller will generate the pwm signal to the ignition coil which will be responsible for driving the ignition coil. Microcontroller will monitor the primary current which will be different in both loaded and unloaded conditions. The real time primary current will be dependent on real time resistance of the ignition coils. Also the microncontroller will monitor the resistance of the coil. Components list are as follow:

- Pic 16f877A
- Resistors 10kilo ohms (2)
- Resistor 2kilo ohms (1)
- Crystal oscillator
- 5volt supply voltage

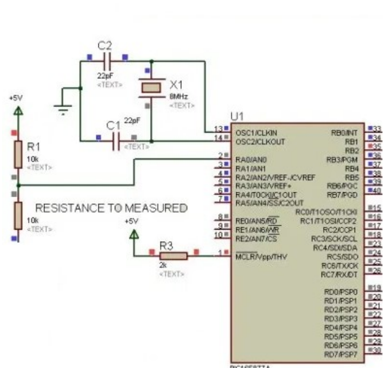


Fig1. Ignition coil circuit diagram

To test the fuel injectors we are going to toggle the switch between 1 second and 5 second (nearly 4.7 seconds). So the first 555 timer IC will turns its output high either for 1 second or 5 second depending upon position of toggle switch. When the output of 555 timer IC is high it will become the input for the second 555 timer IC. For the duration of 5 seconds the second 555 timer IC will generate pulses of 8 milliseconds duty cycle. Similarly if the duration is of 1 second then the 555 timer IC will generate pulses of 8miliseconds duty cycle and toggle it.

1. Astable 555 timer IC:

   The one that is not dependent on other circuit.

2. Monsostable 555 timer IC:

The one that is dependent on other circuit. The second 555 timer IC is monostable type.

The 555 timer IC of Astable circuit will drive the circuit when the push button is pressed. The signal duration is of 5 seconds. The flag signal will be input for the monostable circuit which will generate the pwm signal of 8miliseconds duty cycle during this 5seonds flag signal. The monostable circuit will generate the 8 miliseconds signals on the gate of N type mosfet. The gate signal of mosfet is connected to the negative side of fuel injector. The drain of mosfet is responsible for generating the pulse at the injector. The positive side of injector is directly connected to the positive terminal of battery. So we will vary the negative side of injector on different voltage levels.

The capacitor is going to filter the voltage across the LED.

There are two modes of signals continuous and discontinuous.

- Continuous mode:

If the switch s1 is closed then positive side of capacitor will get 2volts as resistances of R2 and R3 resistors is same (100kilo ohms) each. So at both terminals of capacitors there is 2volts voltage appearing. Hence net voltage is 0volts that will appear on pin 2 of first 555 timer IC.

- Discontinuous mode

  If switch s1 is open the 2 volts will appear only on one terminal of capacitor and at the other terminal no voltage will appear. Hence pin 2 of first 555 timer IC will get 2volts.

5.2.1 Time calculation

First 555 timer IC, as seen from the diagram there are two switches connected to the first 555 timer IC S2 and S3. If S2 is turned on it will generate the pulse of 1 second duration at the first 555 timer IC. If S3 in connected then it will generate the pulse of 4.7 seconds duration at pin 3of first 555 timer IC. Pin 3 is connected to the input of second 555 timer IC. It will generate 8miliseconds pulses for second 555 timer IC.

Now we will use formula to find time,

$$Tou=RC$$

By substituting the value of those capacitor in equation that are connected to S2 and S3 and multiplying with R4 resistor resistance we will find the time.

$$Tou1=(1\text{micro Farad}*1\text{ mega ohms})$$

$$Tou1=1\text{second}$$

$$Tou2 = (4.7\text{micro Farad}*1\text{ mega ohms})$$

$$Tou2 = 4.7\text{seconds}$$

In second 555 timer IC, two resistors are connected in series R5 (100 ohms) and R6 (470 ohms). The combination of their resistance at threshold (TH) is with C7 (22micro Farad) capacitor.

Tou=RC

Tou3 = (100+470)*(22^{-6})

Tou3 = 5.03 micro seconds

For the duration of 5.03 microseconds it will turn on/off pulses.

Now the output of 555 timer IC act as an input to mosfet. Mosfet acts like a switch. This switch is then connected to pin 2 which will become pwm for the injector. The monostable 555 timer IC is dependent on astable 555 timer IC. The purpose of resistors R6 and R5 is to limit the current. The RC combination for time calculation is connected to pin 6 as discussed above. The ground pin is connected to the input voltage and drain of mosfet. Led will glow only when the path of circuit is completed that is when the injector is connected to it. Diode is connected to make sure current flows in unidirectional path and no reverse current flows. First IC won't turn on until and unless the push button is pressed. The trigger pin (TR) of first 555 timer IC is connected to a push button. The push button is pressed only when the trigger pin is activated. Trigger pin is activated when 5volts of timer IC as provided to it. So the first IC is activated only when the push button is pressed and the output of first IC goes into the trigger pin of second IC.

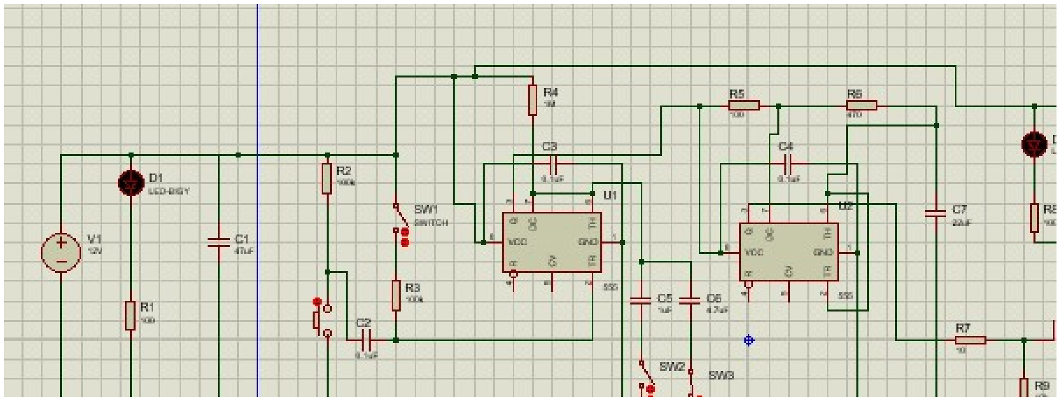


Fig2. Fuel injector driver circuit

The above circuit is based on following components

- 12volts battery
- Led of 12 volts (2)
- Switches (3)
- Capacitor 47micro Farads (2)
- Capacitor 0.1micro Farads (4)
- Capacitor 22micro Farads (1)
- Resistor 100kilo ohms (2)
- Resistor 100 ohms (3)
- Resistor 1mega ohms (1)
- Resistor 470 ohms (1)
- Resistor 10 ohms (1)
- Resistor 10k (1)
- 555 timer IC (2)
- Push button (1)
- Diode 1Amps (1)
- N type mosfet (1)

Chapter # 6

System Testing and Evaluation

5.1 PCB Designs

The first figure shows the PCB for the Fuel injector driver circuit and the trace of the PCB is kept higher than the conventional T10 trace so that it can handle the minimum current of 5 Amps which in most of the case is the normal inrush current for the fuel injector when they are operating. The trace used in this PCB is T30 along with the conventional through hole components. The figure for the PCB is shown below:

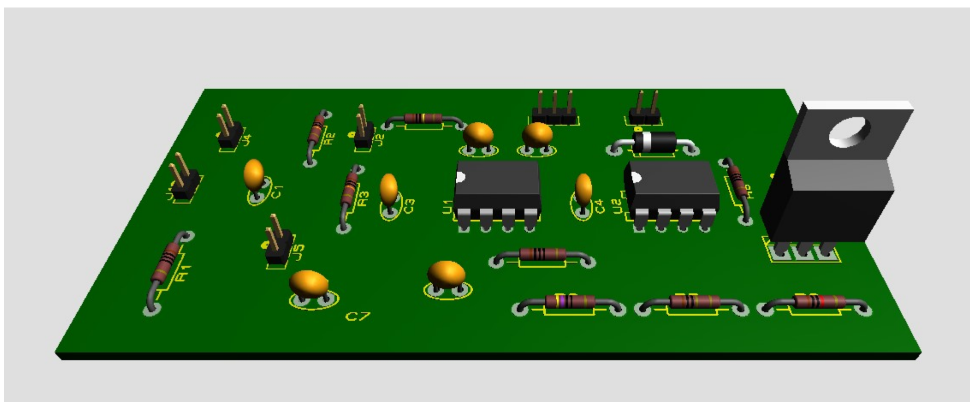


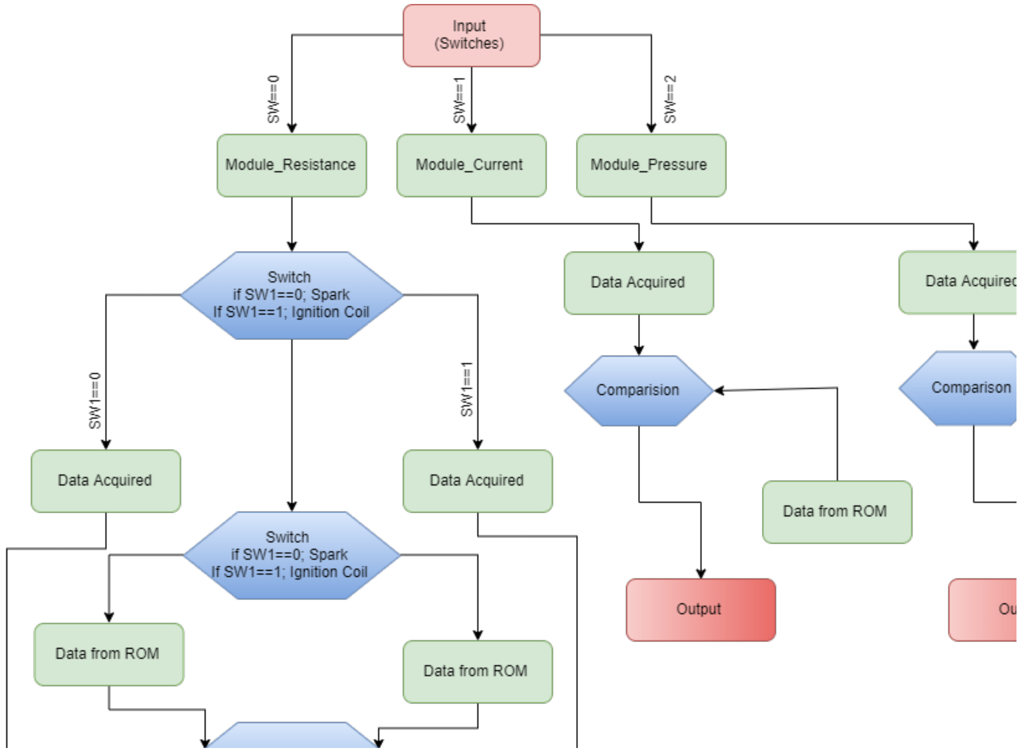
Fig 1 PCB for fuel injector Driver

The second figure shows the PCB for the Ignition Coil Tester and the trace of the PCB is kept T20 trace so that it can handle the minimum current of 2 Amps which in most of the case is the normal current for the GFI pin of the Ignition system to communicate with the ECU when they are operating. The trace used in this PCB is T30 along with the conventional through hole components. The figure for the PCB is shown below:

Fig 2 PCB for ignition Coil Tester

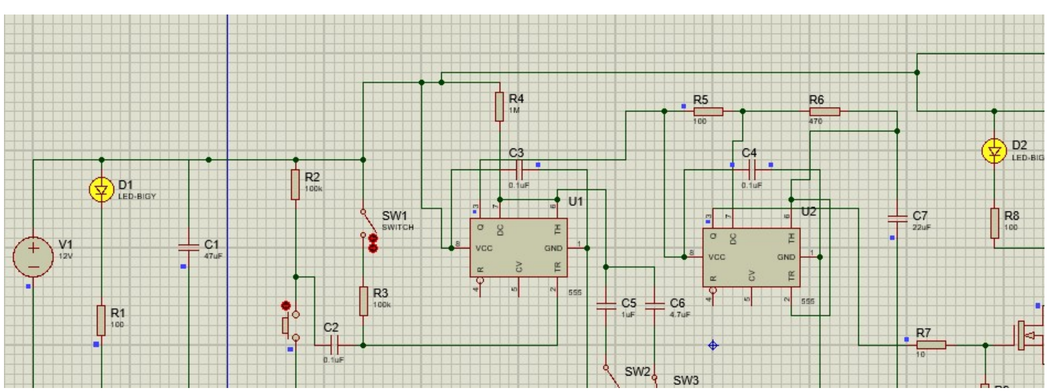
5.2 Overall Logical Project Review

This device is powered by Microchip PIC16F877A, 555 timer circuits for PWM, and many other basic components. The PIC16877A will be the brain of the system which will monitors all the obtained data such as like load current, load resistance, idle resistance and startup current for the ignition coil and the fuel emission will be monitored by the gauges at the medical grade test tubes scale so that emission of all the fuel injector will remain smooth and the fuel emitted by all the injectors are the same in each cylinder.

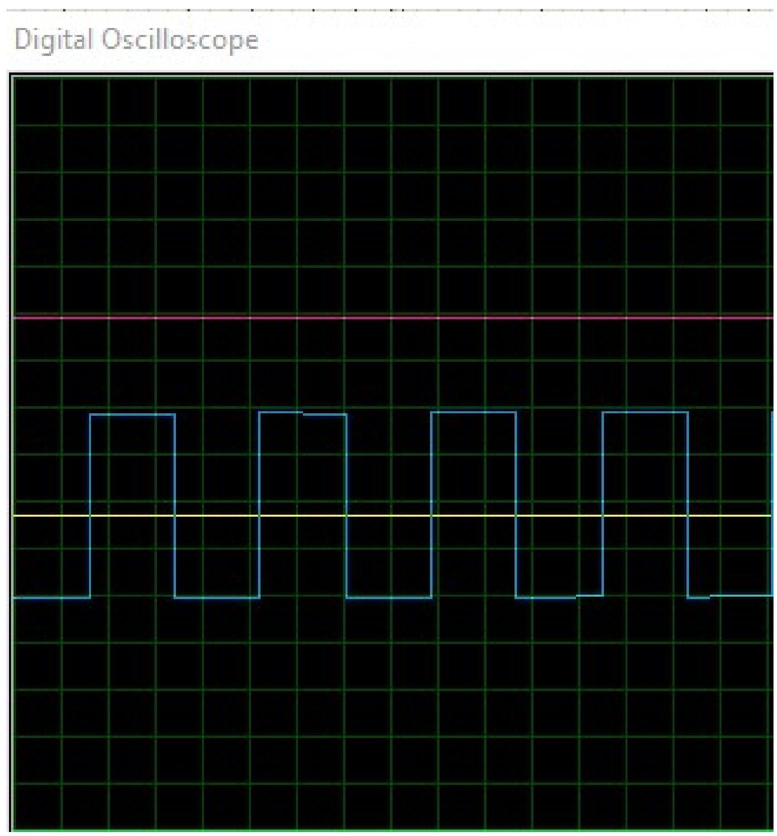


5.3 Results

The injector driver circuit is the one which generates the PWM signal for the fuel injector and the power source for the fuel injector the whole circuit is driven by the battery of the car. The circuit is shown below:



The DC voltmeter is the connected to the supply voltage pin of the fuel injectors and the second signal is the PWM signal for triggering the fuel injector. The output for the PWM signal is shown below:



The PWM signal shown above is the 5volts peak signal which trigger the fuel injector. The ignition coil driver circuit monitors the resistance and the current of igntion coil in loaded and unloaded condition. The test has been carried out under the observation of Sir Abdul Hadi at National Institute of Electronics on the ignition coil of Toyota Corolla ignition coil with one faulty and one working coil. The test was successful and the module was successfully able to differentiate in between the faulty and the working module. The below images are shown in which the test of module conducted in NIE.

Figure 3 Testing of module 1

Figure 4 Testing of module 2

Chapter # 7

Conclusion

This project is based on the testing of ignition system. The project was targeted to reduce the cost of repair and unnecessary labor cost in the identification of the errors related to the ignition systems. The device has been successfully tested and its results has been verified on different vehicle such as the Toyota Corolla and Honda City. The system identifies the problem in the system without any major issue. The points that were kept under focus while testing the device.

- Identification of faulty ignition coil
- Spark Tester proper gapping
- Proper Fuel Pressure at rail
- Proper operation of the fuel injector

The system works to seem fine for local industry i.e. Honda, Toyota and Suzuki that was targeted for the project. For imported vehicles, the project may or may not as the protocols, the values that are kept for cross matching and the voltage level for the operations may differs.

References

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[10] McDougal, John A. "Ignition coil." U.S. Patent No. 4,514,712. 30 Apr. 1985.

Appendices

Report Formatting Details

Major Heading

Font Size should be 16 Bold.

1.1 Minor Heading 1

Size for text should be 12 only and should be justified. Each page shall have a footnote giving the title of the project only. In case of long titles shorter versions should be used. There shall be a line over the footnote.

1.1.1 Sub Heading

References are to be placed in square brackets and interlaced in the text. "Example: The boiling point of water is 100 degrees Celsius [12]." This implies that the information being given in the statement has been recorded from the book or journal article given in serial 12 in the references list given at the end of the report. It is scientifically and ethically correct to record all the references. <u>A project report/thesis shall not be accepted without references</u>.

1.1.2 Sub Heading

1.2 Minor Heading 2

Each figure shall be numbered as for example, "Figure 2.3" which would imply that it is the third figure of chapter 2. It shall be placed as normal text with figure number and title at the bottom of the page or sideways with figure title coming on the opening side of the paper and not on the binding side. The same format shall be used for tables.

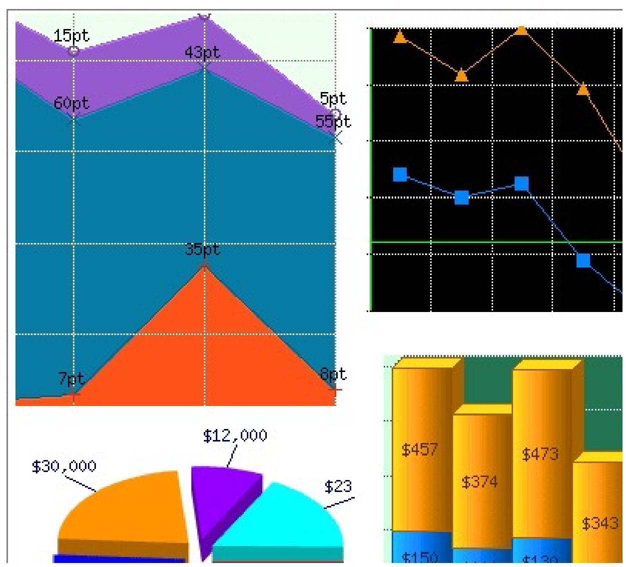

Figure 1.1: Graphical Data Representation

1.2.1 Sub heading ….

Use Case Template

Title	Module1	
Version No.	1.0	
Actors	Administrator	
Description	This is the Use Case used for Logging into Google.	
Trigger	User enter google.com in the browser url.	
Main Success Scenario	**Step**	**Action**
	1.	
	2.	
	3.	
	4.	a. b. c.
Alternate Flows	**Step**	**Action**
	1a.	
	2a.	
	3a.	
	3b.	
Special Requirements	Any Special Requirements	
Assumptions	Assumptions if any.	
Pre-conditions	Pre-Conditions if any.	
Post-conditions	Post-Conditions if any.	
User interface	Google	
Business Rules	1.	
	2.	
Issues		

Test Case Template

Title here

Special Instructions

NONE

Test Case ID	TC_FUNCT_01		
Description	Tests the Login Screen		
Applicable for	IE6, Firefox		
Requirements	REQ_FUNCT_01		
Initial Conditions	Equipment is set up as per Equipment Setup section.		
Step	**Full / Regr**	**Task & Expected Result**	
1		Open the login screen/menu.	
2		Verify that the login screen is displayed on both IE6 and Firefox.	**Pass / Fail**
3		Enter Username and Passowrd.	
4	R	Verify that the username can be entered.	**Pass / Fail**
5	R	Verify that the password is masked and can be entered.	**Pass / Fail**
6	R	Verify that an ok and reset button is displayed.	**Pass / Fail**
7			