

Engine Control Systems

M4X02197

Electronic Ignition and Fuel Injection Systems

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Introduction

The electronic fuel injection systems have improved engines in performance and efficiency compared to the older carburettor system. In fuel injection systems the air and fuel is typically mixed in the intake prior to being draw into the combustion chamber through the intake valve. The amount of fuel needed to be sprayed into the intake is dependent on a few different variables such as the load and speed of the engine. Electronic control systems use an engine control unit known as an ECU or engine management system to decipher what the engine needs to run efficiently. ECU's typically monitor the engine constantly with different sensors to ensure the engine runs as it should. Injection time is the time that is required for injection based on the different variables which the ECU calculates.

Our aim for this project is to analyse and evaluate the operation of two different types of Electronic Ignition & Electronic Fuel Injection Systems using the correct testing equipment. The two Engines used for this project were the both Vauxall 2litre engines however one with a Bosch Motronic system and one with an LE3 jetronic system. Both of these engines use some kind of ECU in order to change the injection time and spark depending on the engines different sensors such as the throttle, the coolant temperature, intake and crank position. The LE3 engines system runs a 12Volt supply whereas the motronic uses a 5Volt supply. In this assignment I shall be discussing the different stages of the testing on these two systems, analysing the results and then proceed to suggest any changes I feel I could make to one of these systems in order to improve it more efficiently.

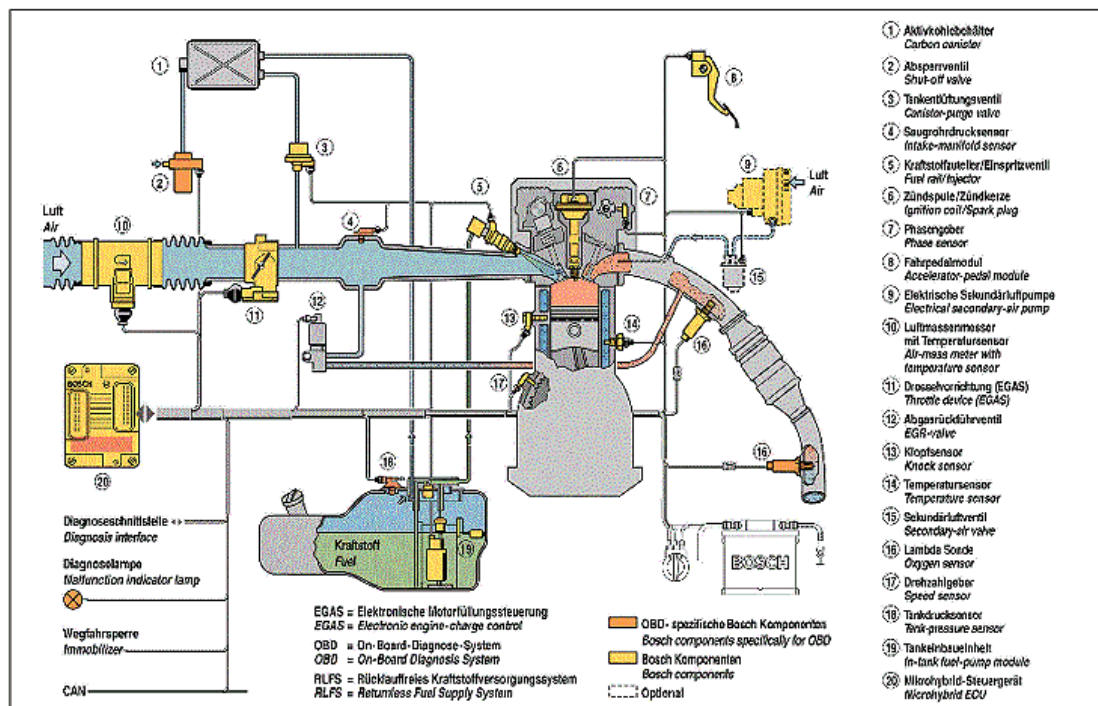
Research

Motronic electronic system was used to control the GM 8 valve engines which were made between 1987 and 1990 and is a fully integrated EMS that controls primary ignition, fuelling and idle control from within the same ECU. In addition the ignition point and injection duration are jointly processed by the ECU so that the best moment for ignition and fuelling are determined for every operating condition. The injection function of the Motronic system is based on the well-tried 'L' jetronic system, although a number of refinements have improved operation. A 35 pin connector and multi-plug connects the ECU to the battery, sensors and actuators. Basic ECU operation A constant voltage supply comes from the vehicles battery to pin number 18 on the ECU. This lets the self-diagnostic system know, to hold the intermittent nature data. A voltage supply is sent once the ignition is on to the ignition coil and to pin 35 on the ECU which is made from terminal 87 of the relay on the main fuel injection. The majority of sensors now come with a 5.0 volt reference supply from the ECU. When the engine is cranked or run, a speed signal from the CAS causes the ECU to earth pin 20 so that the fuel pump will run. Ignition and injection functions are also activated. All actuators (Injectors, ISCV, FTVV etc), are supplied with nbv from the main relay and the ECU completes the circuit by pulsing the relevant actuator wire to earth. Signal processing Basic ignition timing is stored in a two dimensional map and the engine load and speed signals determines the ignition timing. **Bosch Motronic 4.1: GM**
Copyright Equiptech

Below shows a diagram and a list of components of the motronic system.

Motronic ME 7

Mit EGAS, OBD und RLFS / With EGAS, OBD and RLFS



BOSCH

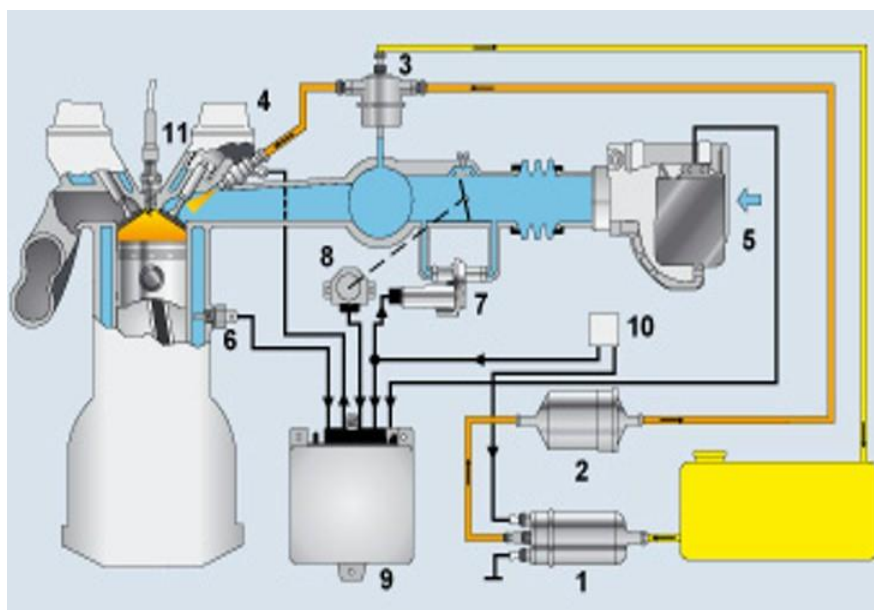
K3/VSA 9032

(http://www.msr-wg.de/medoc/download/literature/sgml_europe_98/msr-tr-sgml_europe_98_documentation/html/index.htm?msr-tr-SGML_Europe_98_documentation15.htm)

LE3

Released between 1967 and 1985. The system works by injecting the fuel straight into the intake manifold. The amount of fuel needed is based upon throttle and load. The command unit receives input signals from different sensors that send data on the engines operating conditions. Such as, starting in cold temperatures requires for more fuel to be put into the system in order to warm up. The ECU processes the information that has been sent to it and works out the correct fuel injection time. This system also has injection valves which spray fuel as the the inlet valve opens. The slight difference between the two systems is that the LE3 injection ECU controls only the fuel system as well as the LE3 system being analogue it is not able to hold memory of any faults in the system which means that it also has no limp mode feature. © Robert Bosch Ltda.

Below shows a diagram and a list of components for the LE3 Jetronic system



- 1 - Fuel pump
- 2 - Fuel filter
- 3 - Pressure gauge
- 4 - Injection valve
- 5 - Air flow meter
- 6 - Temperature sensor
- 7 - Air injector
- 8 - Butterfly switch
- 9 - Command unit
- 10 - Command relay
- 11 - Spark plug

(http://br.bosch-automotive.com/en/internet/parts/parts_and_accessories_2/motor_and_sytems/benzin/injection_system/le_jetronic_1/le_jetronic.html)

Methodology

To firstly begin the testing we were put into two groups of four and each given an allocated job. After selecting to work on the LE3 engine first, we then put on our PPE and proceeded to begin testing on the Engine. Beginning with the ignition on and the engine not running. Then with the Engine cranking from cold. Engine warm-up will also be a point in which testing will take place, then once the engine had warmed up we would then test it at acceleration, deceleration and idle speed.

Equipment / PPE

Oscilloscope

Multimeter

Goggles

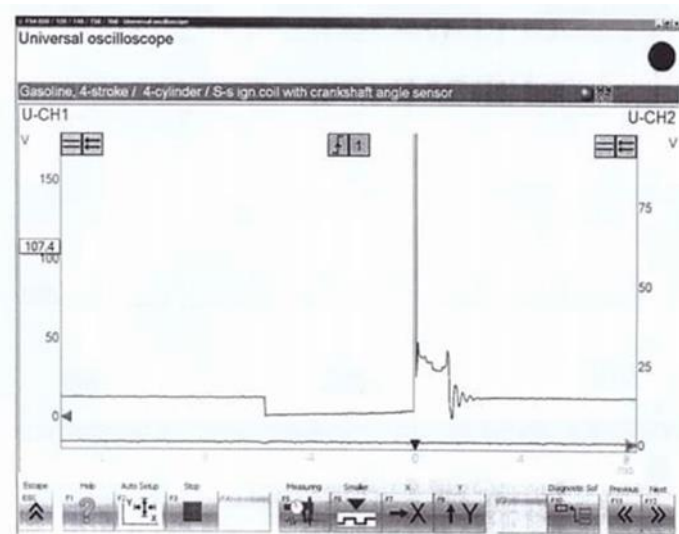
The reason for this choice of test equipment was simply because it is very versatile and effective at reading signals/waveforms. A multimeter allows for recordings of the voltage and resistance located on the systems circuits. The Bosch diagnostic oscilloscope will show us the waves (pulsing) and be able to record them, so that we are able to analyse them afterwards. This scopes system also allows for changes to be made to the different units of measurement as well as being able to pause the graph so that we may analyse a certain wave.

Results

LE3 test results

Graph 1

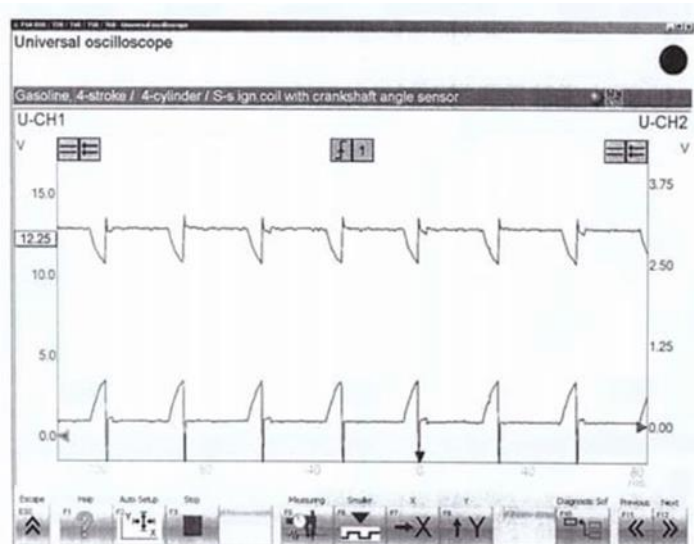
Pin 1 Primary – counter for RPM



Graph 2 NTC2

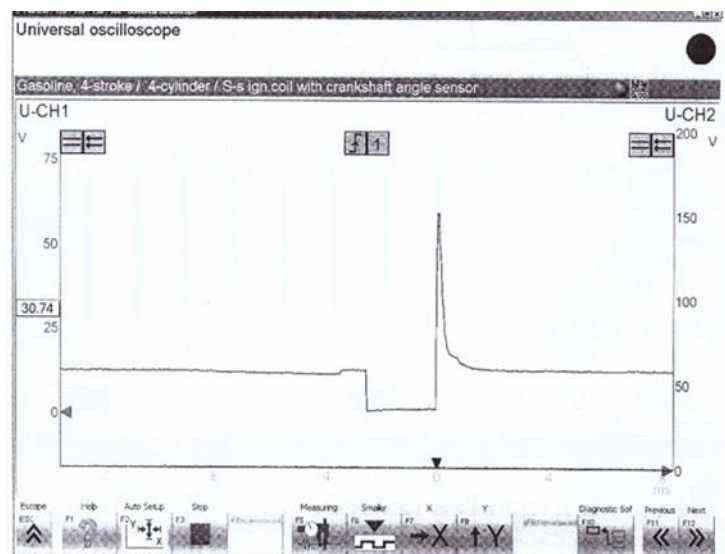
Pin 2 Earth

Pin 3 supply



Graph 3

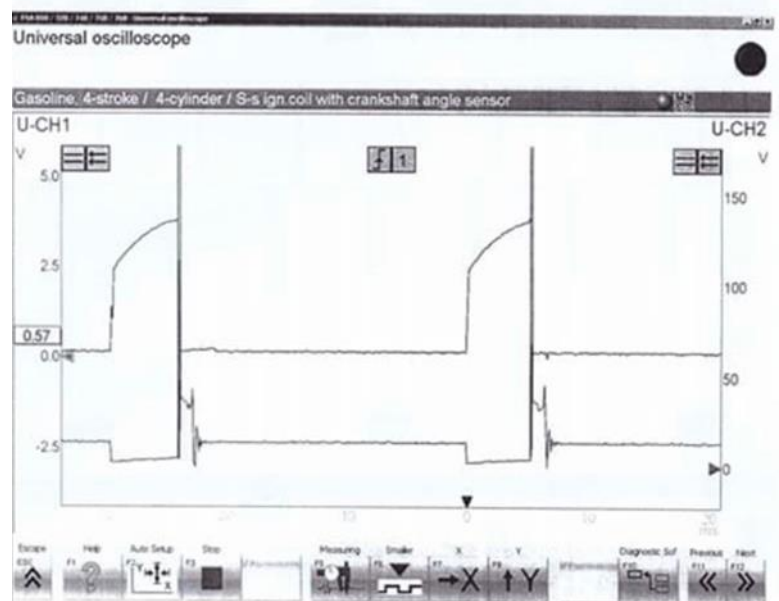
Pin 3 – Idle for the injector



Graph 4

Pin 1 – Primary

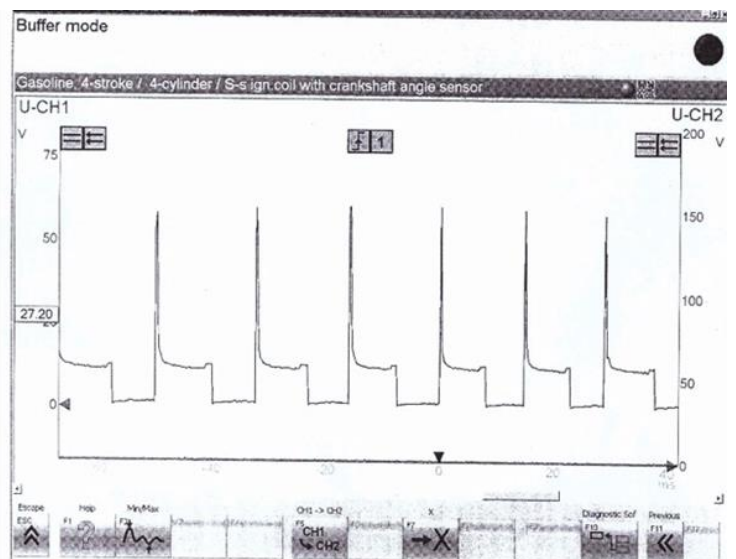
Pin 4 – signal for Spark advance



Graph 5

Acceleration

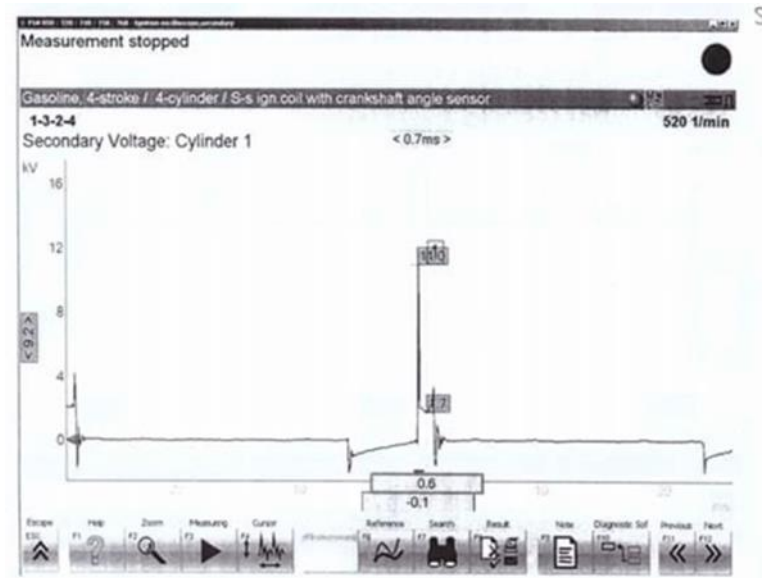
Pin 3 – Crank sensor



Graph 6

During Idle

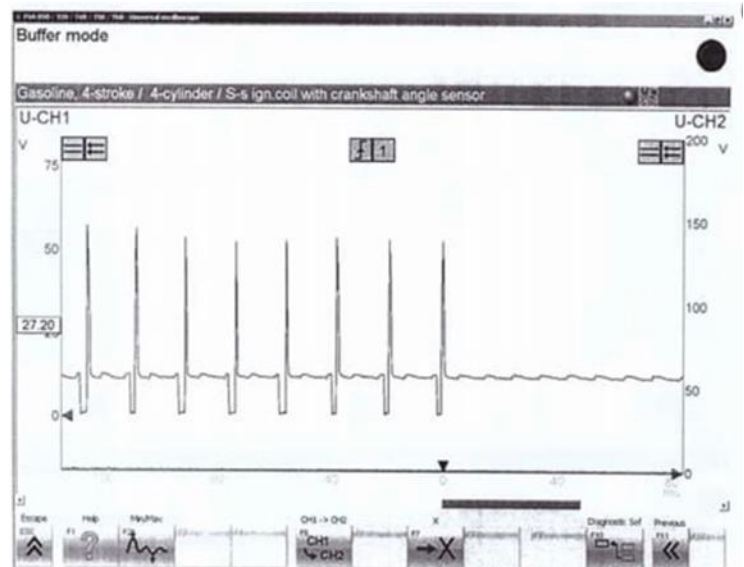
Cylinder 1 – secondary voltage



Graph 7

Deceleration

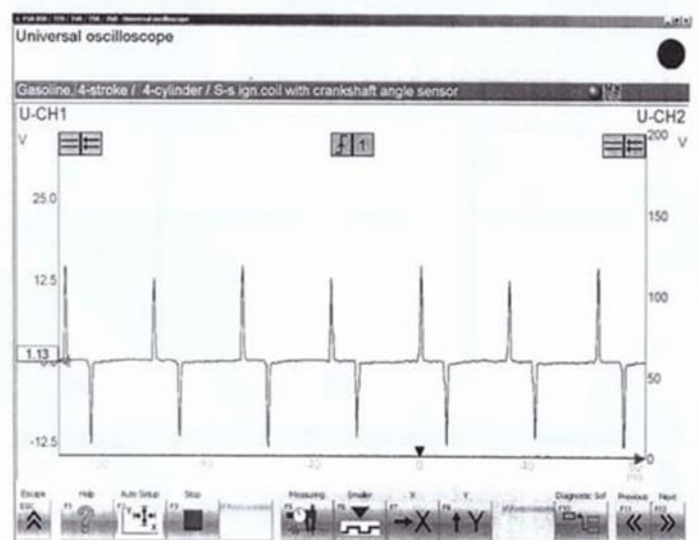
Pin 3 – Crank sensor



Graph 8

Crank shaft signal

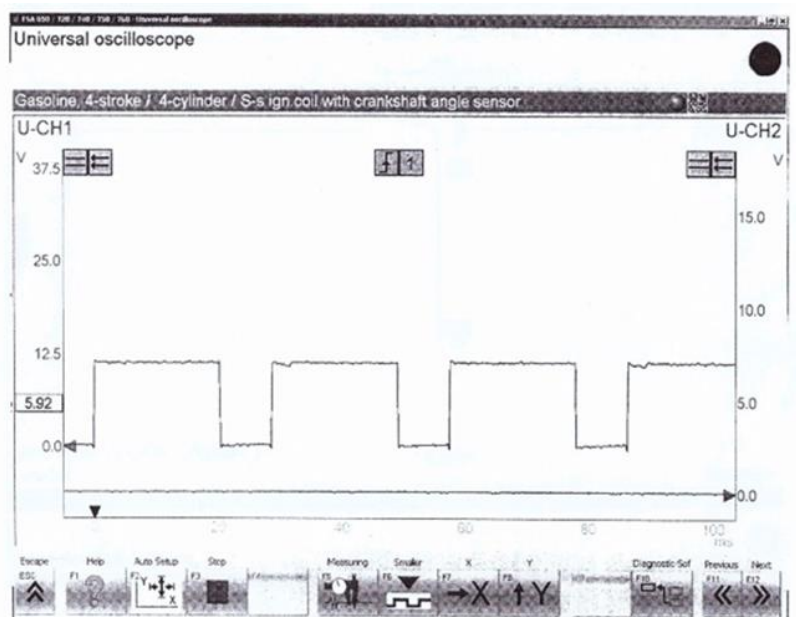
Pin 3 – Crank sensor



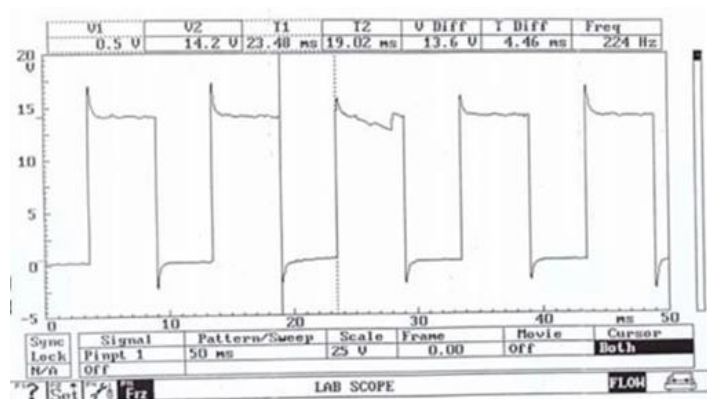
Graph 9

Signal for speed reference for the fuel

Pin 5

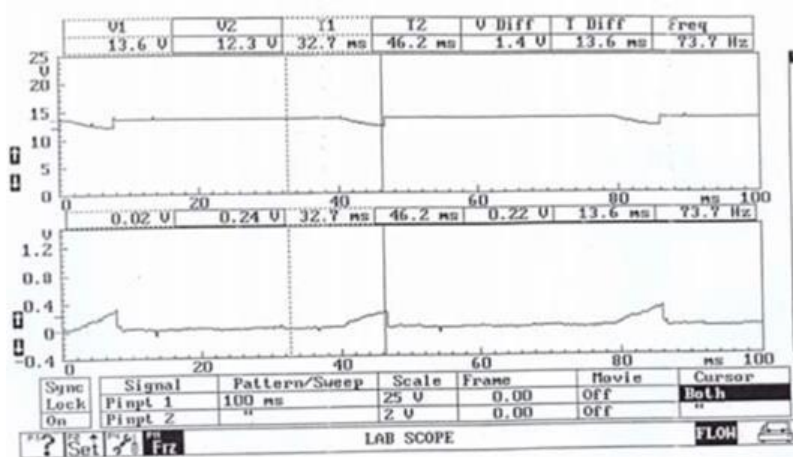


Motronic



Graph 1

Pin 4 – Rotary idle valve
at 80 degrees

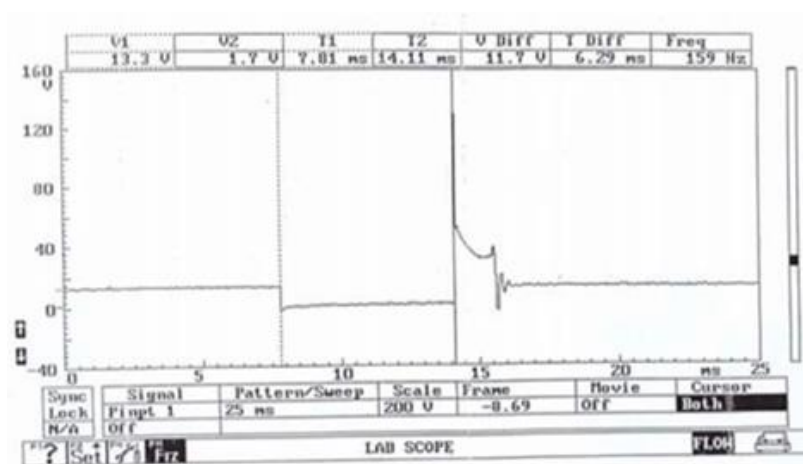


Graph 2

Ignition on

Top. Pin 27 – ignition supply

Bottom. Pin 2 – earth return.

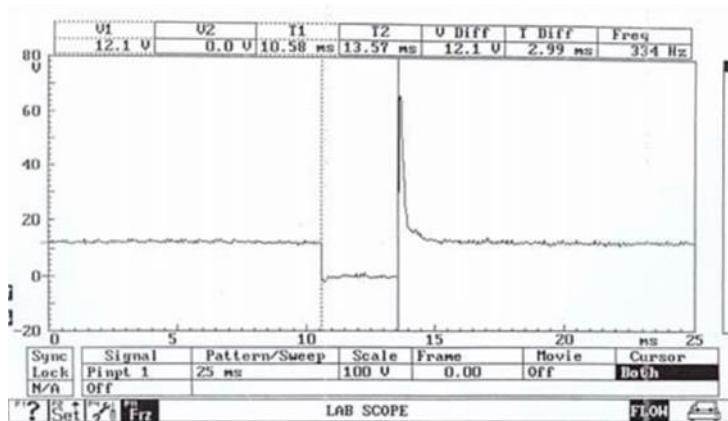


Graph 3

Pin 1 – negative side of coil

Spark duration 1.47 m/s

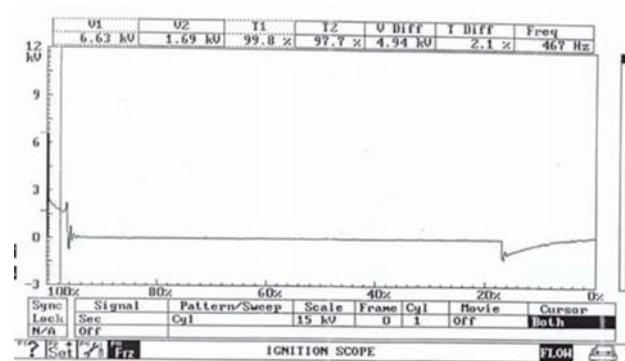
Back EMF signal 129.2 volts



Graph 4

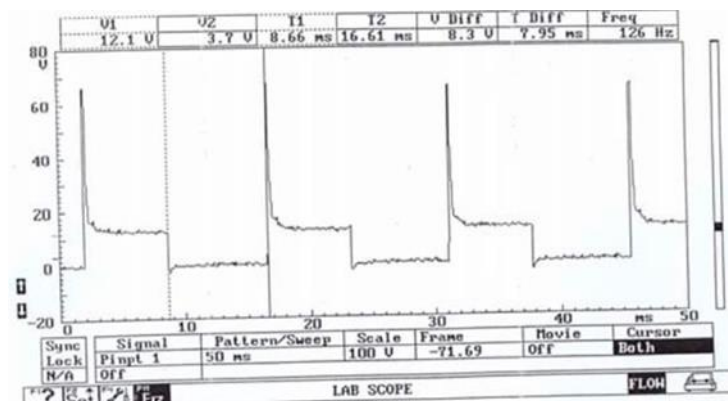
Pin 16 – Pulsing side of the injector

At 80 degrees



Graph 5

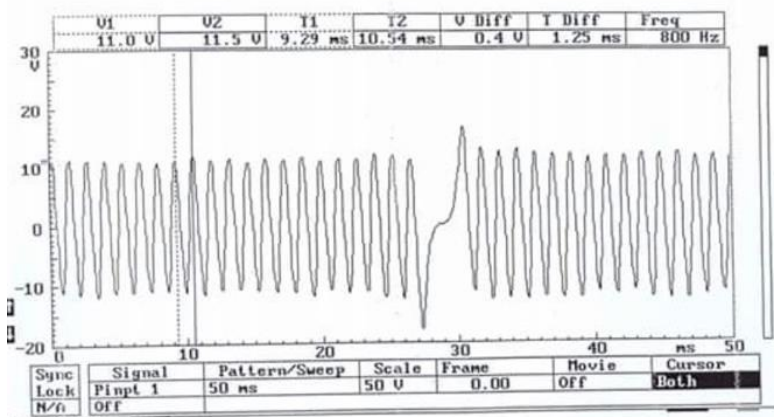
Secondary wave pattern.



Graph 6

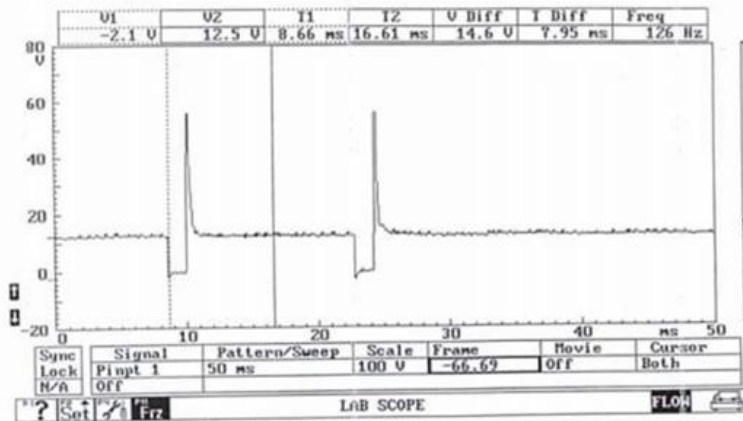
Pin 16 – pulsed side of the injector

During acceleration



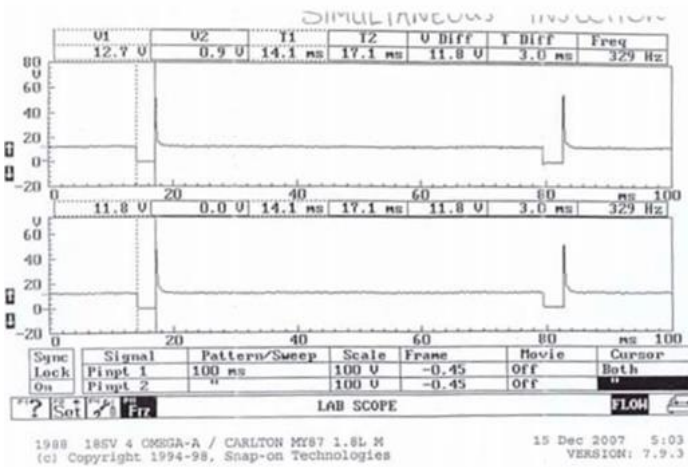
Graph 7

Pin 49 – speed sensor



Graph 8

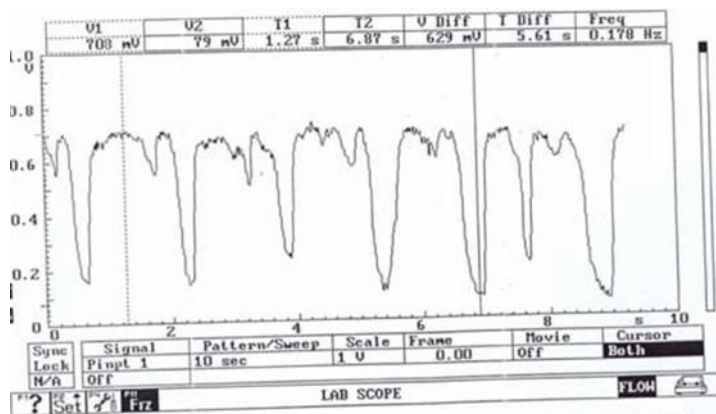
Pin 16 – Pulsed side of the injector
During deceleration



Graph 9

Top. Pin 16 – pulsed side of the injection

Bottom. Pin 17 – pulsed side of the injection



Graph 10

Pin 28 – Lambda sensor
Exhaust gas

Plug leads:

- 1 – 1870
- 2 – 1770
- 3 – 1470
- 4 – 20 000

King Lead – possibly faulty Coil Primary – 600 Secondary – 750

Summary

Summary of Both Systems

The fuel injection system has a range of signals being delivered from different points around the engine so that it is able to execute the perfect output signals for the injectors. Some of the differences in these engines are listed below.

In order to achieve a cold start an enrichment of the fuel mixture is to be made through pulsing the injectors for a longer duration, this can be seen in the testing we did. The system also reduces the cold start time whereby it reduces the time needed typically for the engine to warm up to optimum temperature, the system is also different to the LE3 as it has a constant energy ignition system this means the dwell time remains a constant throughout the whole rev range achieved by the engine is always between firings recharging each coil to the same energy level.

The LE3 is different from the Motronic by having the electronic ignition system inside of the command unit which has a Lambda Sensor that connects to the ignition system which enables it to be placed within the exhaust pipe and used to measure the gases from the exhaust.

The digital system on the Motronic engine comes with something known as an adaptive memory and that allows the system to remember the fault codes. These codes can be read via fault code reader. Should a sensor circuit develop a fault the ECU will recognise this and send the system into limp mode. This retards the engine to basic running speed to ensure no damage is done to the engine. Both systems are similar in that they both achieve optimum temperature after a cold start phase. The two systems have the same injection system and use Simultaneous injection timing just controlled differently with different ECU's and sensors. A huge difference these two systems have is that the sensors on the Motronic engine use 5V where as the LE3 engine has 12V supply. This is most likely an advancement made so that the engine runs smoothly whether or not voltage drops. Another big factor that differs these two engines is that the Motronic system is a self-diagnosing system to some extent. The Motronic overall delivers a number of advantageous variables and features over the Jetronic system to allow it to run the engine as efficiently as possible given the technology in the system.

Conclusion

In order for these two systems to deliver the right amount of air to fuel mixture and when to ignite it is dependent on a few different measures. The volume of air, crankshaft position and load. From the oscilloscope we used we were able to see the wavelengths formed from spark and signals being sent from sensors to the ECU. We were able to see the system work correctly from the patterns. We were able to see that the signal was sent to trigger the spark at the correct moment

In conclusion I feel both of these systems are very reliable compared to newer systems as there is likely less things to go wrong. However I feel these engines could be much more efficient with some enhancements made to the fuelling system.

Improvements

For improvements I shall look at the LE3 jetronic engine system.

I would firstly reposition the airflow meter closer to the throttle body in order to reduce the time taken to analyse the airflow. Therefore creating a quicker throttle response. Another improvement I would possibly make is swap out the hot wire mass sensor in the intake for a volume sensor. This is because a hot wire mass sensor requires to be hot to ensure no dust or dirt sticks to the system causing damage, on short journeys the hot wire does not reach peak temperature for operating and over time can fail

References

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