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Engine Diagnosis for Detecting Errors

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Abstract: *Fuel consumption and emissions of vehicles are two main critical aspects considered in the transportation industry. It's because of lack of more efficient vehicles, better fault diagnosis and an advanced Driver Information System (DIS). It is necessary to announce fuel consumption of the vehicle in present driving condition to driver. By this drivers can aware of consumption level of fuel at their present driving condition. However, most motor companies are unwilling to reveal the vehicle information. Therefore, easily obtained diagnostic information can be used to estimate the fuel consumption roughly. Road accidents are also happening with poor knowledge in vehicle fault diagnosis. Casualties are mainly caused by automobile component malfunctions and human negligence. It is thus important to ensure the healthy status of each component of the vehicle. However, the inspection of an engine's health status of and the corresponding internal combustion processes are usually time consuming and expensive because they must require experienced mechanics and expensive equipment. Experienced mechanics available only at cities for scanning and diagnosing errors. So it's very difficult and quite expensive to take the vehicles to cities even for simple errors. In the majority of cases even the parts are repaired, the problem may not be resolved, because poor understanding of error codes. However the mechanics recommend only that automobile owners purchase and replace components even at unnecessary conditions to resolve errors. Consequently, numerous components are thrown away and wasted. Hence, a low-cost, real-time fault diagnostic for running automobiles is in need. Our objective is to educate and train the village residency drivers and owners about scanning and diagnosing vehicles. This paper provides effective and better diagnosis to detect errors by using OBD-II (On Board Diagnosis-2nd generation) protocol.*

Key words: *OBD-II, Engine Diagnosis, Scan Tools, Vehicle health monitoring, Driver Information System, DIS.*

I. INTRODUCTION

A new standard introduced in the 1990s, provides almost complete engine control and also monitors parts of the chassis, body and accessory devices, as well as the diagnostic control network of the car is called OBD-II. All 1996 and newer model year passenger cars and light trucks are OBDII-equipped, but the first applications were actually introduced back in '94 on a limited number of vehicle models. What makes OBDII different from all the self-diagnostic systems that proceeded it is that OBDII is strictly emissions oriented.In other words, it will illuminate the Malfunction Indicator Lamp (MIL) anytime a vehicle's emissions exceed 1.5 times the federal test procedure (FTP) standards for that model year of vehicle. That includes anytime random misfires causes an overall rise in HC emissions, anytime the operating efficiency of the catalytic converter drops below a certain threshold, anytime the system detects air leakage in the sealed fuel system, anytime a fault in the EGR system causes NOX emissions to go up, or anytime a key sensor or other emission control device fails. In other words, the MIL light may come on even though the vehicle seems to be running normally and there are no real drivability problems.

II. OBD-II FEATURES

The main purpose of OBDII is to alert you with MIL, when your vehicle is running with problem related to any component of the vehicle and polluting so you'll get their emissions and problems fixed. But as we all know, it's easy to ignore warning lamps— until steam is belching from under the hood or the engine is making horrible noises. That's why regulators want to incorporate OBDII into existing and enhanced vehicle emissions inspection programs. If the MIL lamp is found to be on when a vehicle is tested, it doesn't pass even if its tailpipe emissions are within acceptable limits. In present days MI Lamp is also called as OBD-II lamp (On Board Diagnosis II lamp)

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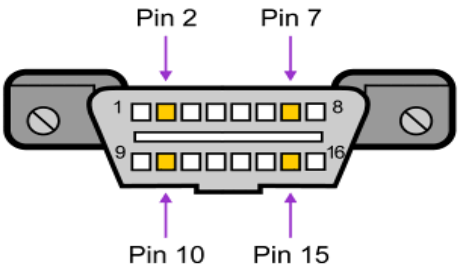
III. HISTORY OF OBD

The origins of OBD-I actually raised from 1982 in California, when the California Air Resources Board (CARB) began developing regulations that would require all vehicles sold in that state starting in 1988 to have an onboard



PIN	FUNCTION	PIN	FUNCTION
1	Manufacturer's discretion	9	Manufacturer's discretion
2	Bus+ Line, SAE J1850	10	Bus- Line, SAE J1850
3	Manufacturer's discretion	11	Manufacturer's discretion
4	Chassis ground	12	Manufacturer's discretion
5	Signal ground	13	Manufacturer's discretion
6	2002–earlier: Manufacturer's discretion 2003–later: ISO 15765-4 CAN	14	2002–earlier: Manufacturer's discretion 2003–later: ISO 15765-4 CAN
7	K-line, ISO 9141	15	L-line, ISO 9141
8	Manufacturer's discretion	16	Vehicle battery positive

Fig.1 OBD-II DLC **Fig.2 Description of Each Pin.**

-diagnostic system to detect emission failures. The original onboard diagnostic system (which has since become known as OBDI) was relatively simple and only monitored the oxygen sensor, EGR system, fuel delivery system and engine control module. OBD-I was a step in the right direction, but lacked any requirement for standardization between different makes and models of vehicles. You still had to have different adapters to work on different vehicles, and some systems could only be accessed with costly "dealer" scan tools. So when CARB set about to develop standards for the current OBD system. In this development standardization was a priority and standardized 16-pin data link connector (DLC) with specific pins assigned for specific functions was developed. The standard OBD-II port is shown and below.

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This 16 pin OBD-II port is presented in vehicle, location of this port is changing from one vehicle to another. By connecting to this OBD-II port, the diagnosis scan tool is communicates with vehicle's ECU (Engine Control Unit). After communicating with ECU, it reads the all error codes in ECU. These error codes are called as DTC (Diagnostic Trouble Code).

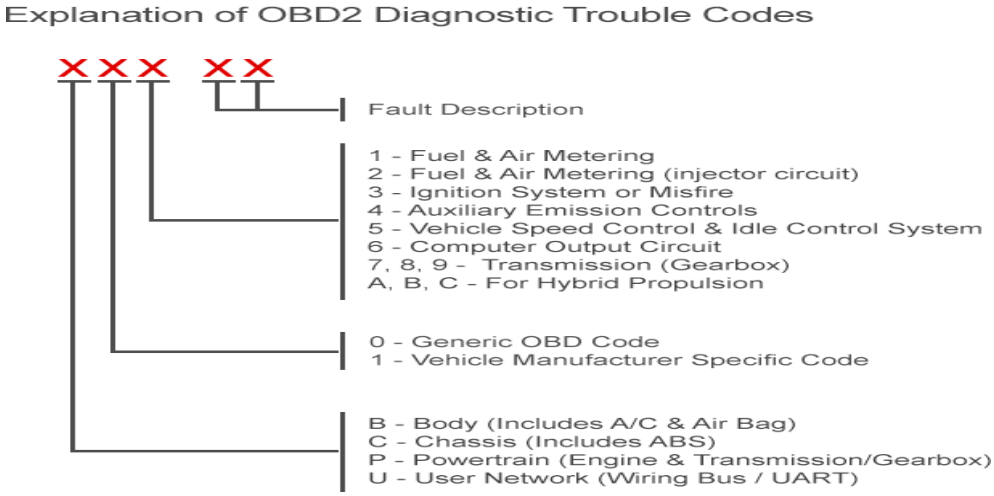

Fig.3- Structure of DTC

*DTC:*OBD-II gives us standardized Diagnostic Trouble Codes (DTC) which are almost similar in all vehicles from 2010 in India. A DTC is an error code that describes us the full information about type of faults and location of faults presented in the vehicle. A simple Structure of a DTC is shown below.Trouble codes are how OBDII identifies and communicates to technicians where and what on-board problems exist. The first number in the DTC indicates whether the code is an SAE generic code (applies to all OBDII systems) or is specific tothe vehicle manufacturer.The remaining three numbers provide information regarding the specific vehicle system and circuit.

IV. TYPES OF ERRORS

1) TEMPORARY ERRORS: These errors are often generated and can be simply cleared by switching off and restart the engine.

2) SEMI TEMPORARY: This type of errors can be cleared by removing the battery connection and connecting after some time.(Minimum of 20 minutes).

3) PERMANENTE ERRORS: These errors are only cleared by proper inspection and diagnosing with efficient scan tool.

V. SCAN TOOLS USED

- Scan Master ELM 327
- Mahindra Smart Tester
- Mahindra i-Smart.
- BOSCH KTS 570
- BOSCH KTS 520.
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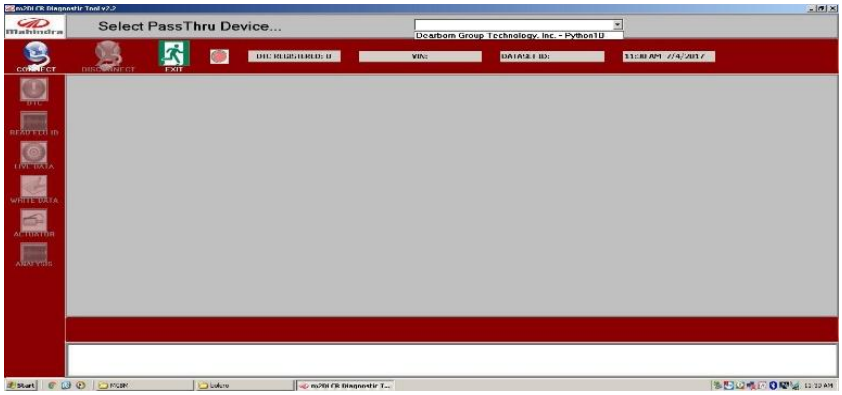
VI. MAHINDRA DIAGNOSIS SCAN TOOLS

1. Smart Tester
2. I-smart

SMART TESTER: In this scan tool, separate software for each different model vehicles are exist , for example separate for Scorpio, Bolero, Genio and so on.
I-SMART: This scan tool does not required any separate software for different models, in this, there is an option to choose the required model and variant.
EQUIPMENT REQUIRED: PC, Connection cable, Smart locker. These equipment are similar for both Smart Tester and I-Smart except Smart Locker. I-Smart does not required smart locker.
At *MG Brothers Mahindra*, dealer service center,*Anantapur*, smart tester is allotted for Commercial section and i-smart is for only Personal vehicles section. Commercial section covers the models Bolero, Bolero Pickup, Genio, Thaar, Supro, Jeeto, Alfa, where the personal section covers remaining all Mahindra four wheeler models such as Scorpio, XUV, TUV, KUV, XYLO, Renault, Logan etc.

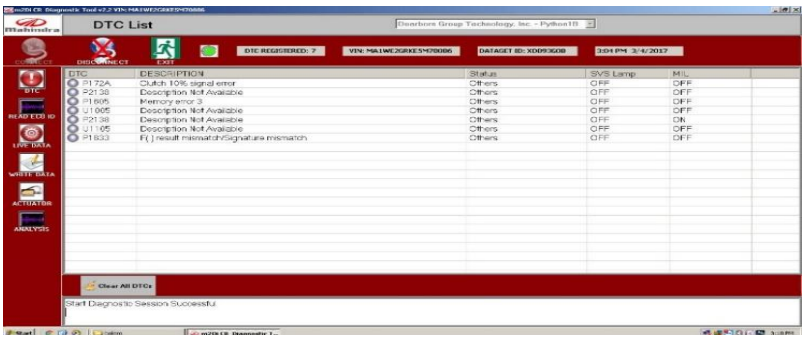
VII. WORKING OF SMART TESTER

After connecting the cable to the Vehicle OBD-II port, after Switching on the Ignition key of the vehicle and connect the USB port of the cable to the PC, by selecting on the required software icon like Bolero, a window appears like shown below.

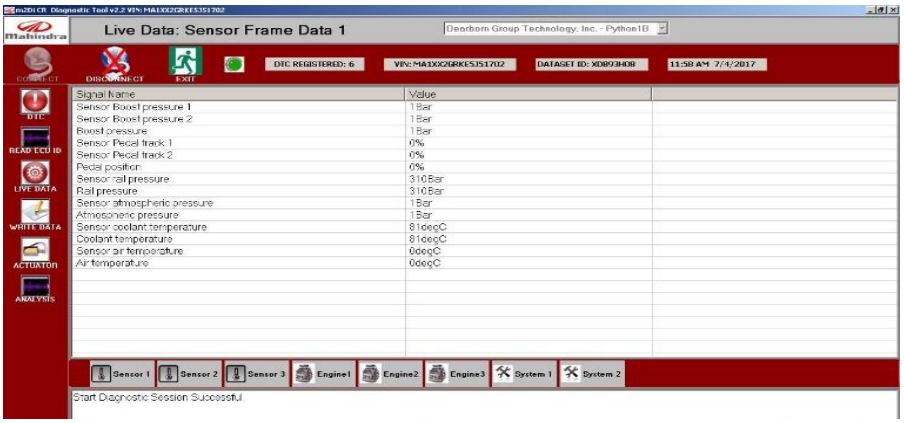


As shown in above figure, the main menu consists of six options. They are as follows
1. DTC
2. Read ECU ID
3. Live Data
4. Write Data
5. Actuators
6. Analysis.

1. *DTC:* In this option, DTC (Diagnostic Trouble Codes) are obtained for the connected vehicle. This DTC consists of 5 digits like P2138. An example of this option is shown below.



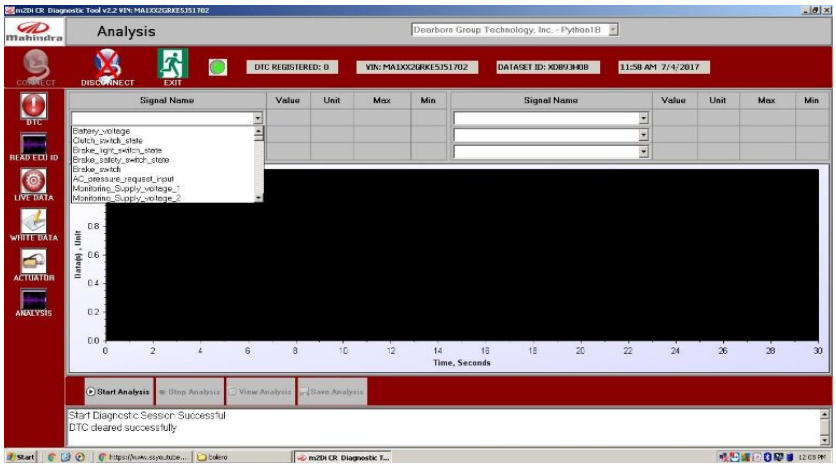
*2) Read ECU ID:*This option provides the entire information of the vehicle such as VIN (Vehicle Identification Number), Part Number, Hardware version, ECU serial Number, Dataset ID and Model Number.
*3) Live Data:*This option shows all live data both in Graphical and Numerical form. Following fig shows the Live Data option. Here, live data such as Engine RPM, vehicle total speed, Battery voltage fluctuations etc. are available.



*4) Write Data:*In this option, can write injector coding. Injector coding like as follows.By writing exact injector codes in this option, EMS ECU can take and register correct codes in it.
This results proper functioning of the nozzles by providing required quantity and pressure of diesel. This eliminates unnecessary knocking and all other noises.

*5) Actuators:*This option facilitates to check whether the components are working properly or not. This checking is limited for only some components based up on the Model and Variant of the model.

*6) Analysis:*In this option, analyzing of data is available. Comparison the data with another relevant data is also available. An example is shown below.



VIII. MAIN SENSORS USED IN VEHICLES

1. Fuel Temperature Sensor (FTS).
2. Rail Pressure sensor (RPS).
3. Mass Air flow sensor (MAF).
4. Crankshaft Position Sensor (CKP).
5. Camshaft Position Sensor (CMP).
6. Throttle position sensor (TPS).
7. Vehicle Speed Sensor (VSS).
8. Engine Coolant Temperature Sensor (ECT).
9. Brake Switch Sensor.
10. Clutch Pedal Switch Sensor.
11. Oxygen Sensor(Lambda Sensor) (in Petrol).

1. *Fuel Temperature Sensor:*It is fitted in the return fuel line so as to monitor the fuel temperature as the viscosity of the fuel is to be maintained for lubricating the high pressure pump.
2. *Rail Pressure sensor:* It is fitted in the common rail line so as to it regulates the fuel pressure in the common rail depending up on the pressure required in the injectors.
3. *Mass Air flow sensor:*A hot film air mass meter is selected for this purpose. It is fitted to the induction manifold so as to understand the incoming air density. It is incorporated with IAT sensor for measuring the intake temperature as well.
4. *Crankshaft Position sensor:*It is the most important sensor and is fitted on the crankshaft either at front or rear. It measures the engine speed and also the TDC position of no.1 and 4 cylinders and sends signals to ECU. Generally this sensor will be of induction type. If this sensor fails the vehicle will never start.
5. *Camshaft Position sensor:*This is to indicate the TDC position of all cylinders of an engine as per firing order. It is generally mounted on the camshaft and triggered by a pin or unequal slots. Generally Hall Effect sensors used for this purpose. Even this sensor fails the vehicle will continue to run until switched off.
6. *Throttle Position Sensor:*It is incorporated with brake switch signal and it controls the quantity of the fuel supplied to the injectors.
7. *Vehicle Speed Sensor:*This is fitted at the output shaft of the gear box to send the signals to the ECU about the speed of the vehicle. This is generally of Hall IC type.
8. *Engine coolant Temperature Sensor:*The ECT sensor is a negative temperature coefficientthermistor which is placed in the water jacket of the engine cylinder head. It is basically a resistor which changes its value depending up on temperature changes and is one of the most important inputs to the ECU. In case the ECT sensor fails ECU fixes a temperature value for calculation of the injection.
9. *Brake Switch:*Brake switch signal is also used to control injection when brake and accelerator both arepressed simultaneously. When the brake is released TPS signal is returned and injection operation is normal. This applies only when the vehicle is running.
10. *Clutch Pedal Switch:*This is fitted to prevent the engine RPM from increasing when clutch pedal is pressed. For changing the gears. The ECM adjust the injector fuel quantity.
11. *Oxygen sensor (Lamda 'λ' Sensor):*The O2 sensor is used in the petrol vehicles which measures the amount of oxygen still present in the exhaust gas and transmits this information to ECU in the form of Voltage. Accordingly the injection quantity will be corrected by the ECU. It is fitted in the Exhaust pipe system.

IX. FREQUENT ERROR CODES OCCURRED IN BOLERO

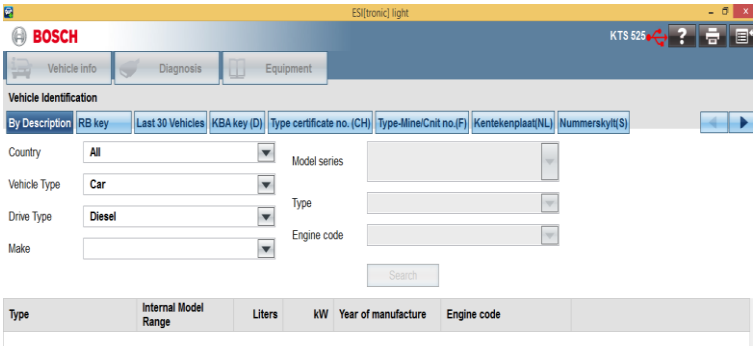
Main DTC's and frequently getting DTC's in Mahindra Standards.

- P1832-AuthenticationFailed\Immobilized condition
- P183F- EMS in locked state.
- P0405 – EGR valve short circuit to ground**.**
- P172A-- Clutch 10% signal Error.
- P2138 – Plausibility Error b\w APP1 and APP2.
- P1605 – Volatile Memory Error.
- P1833 – Signature mismatch.
- P0204 – 4th injector open load Error.
- P8044-Signal from EMS ECU is not received by ICU.
- P8048- Signal from EMS ECU is not received by ICU.
- P0501 -- Vehicle Speed Sensor Error**.**
- U1417 – Invalid format for Immobilizer key Message.
- U1105 – No CAN communication b/w EMS ECU and ICU.
- U1005 -- Partial Communication b/w EMS ECU and ICU.

X. BOSCH DIAGNOSIS SCAN TOOL (KTS 520)

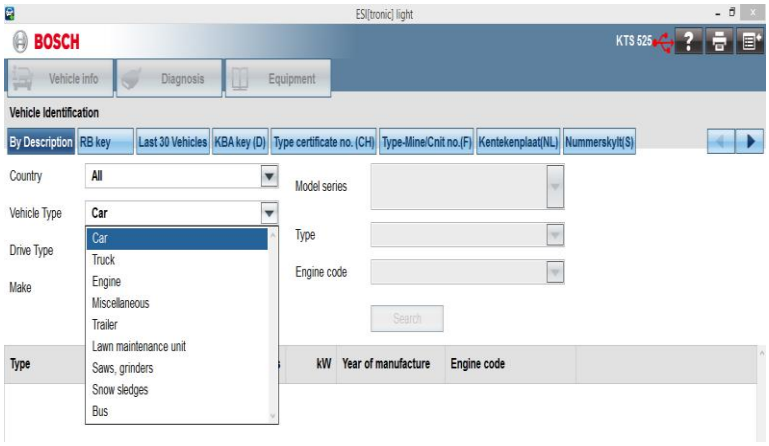
KTS scan tools: In Bosch KTS series, several types of scan tools available such as KTS 510, KTS520, KTS570, and KTS590. Among these variants KTS590 is latest version and it has so many upgraded features like Immobilizer unlocking, Actuators testing and so on where in previous versions actuators testing is limited to only some important components and no Immobilizer deactivator in them. In this study KTS 520 is used to scan and detect errors in vehicles. The clear procedure of detecting errors with KTS520 is shown below.

KTS520: By clicking the icon ES [tronic] 2.0, 520 is opened and some options are appeared.
*Vehicle Identification:*First it is required to select the vehicle. The Identification takes in 8 ways as shown below.



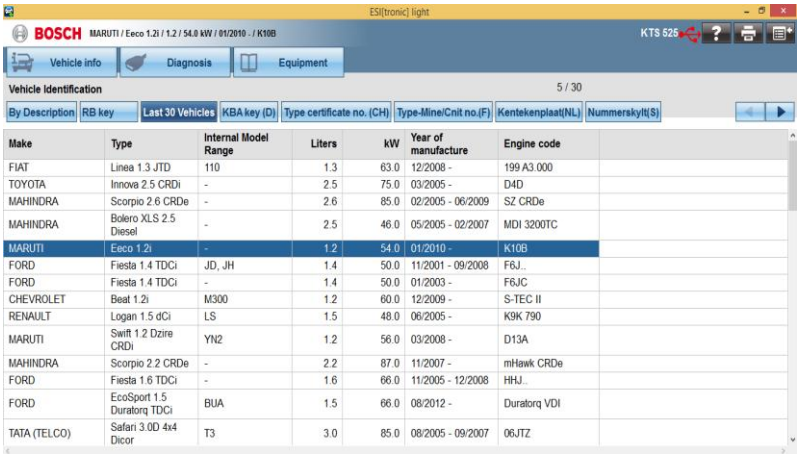
1) By Description
2) RB key
3) Last 30 vehicles
4) KBA key{D}
5) Type certificate no.{CH}
6) Type mine/cnitno.{F}
7) Kentekenplaat(NL)
8) Nummerskylt(S).

Among the above all options, our Indian users mainly use first and third options only.
1) By Description:In this vehicle identification type, several information's are required to identify the vehicle such as country, manufacturing company, type of fuel, model, variant and so.
*Vehicle Type:*In Vehicle type option, selection goes either it is Car or Truck or any other type.

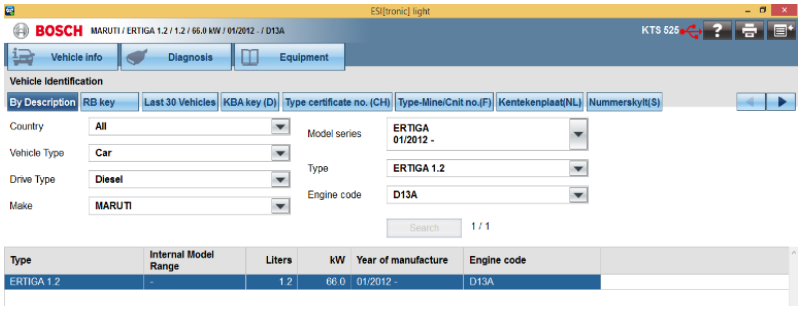


*Manufacturer:*In this, selection of Manufacturer Company of the vehicle is required.
Model Series: After mfg. company selection, vehicle model selection required.
*Series Type:*In selected model, there is a chance to present multiple variants depending on the year of release.
*Engine code:*In general, Mfg. companies may change engines from previous year to recent year. In those situations it is required.By providing all above information, required vehicle can be select.

*Last 30 Vehicles:*If a previous customer wants to re connect his\her vehicle with in the limited period, then this identification option is used. In By Description type of identification, by providing all information software itself finds required vehicle as shown below.



On selecting the searched model, another three main options will be highlight and they are the main options to get in to the actual diagnosis



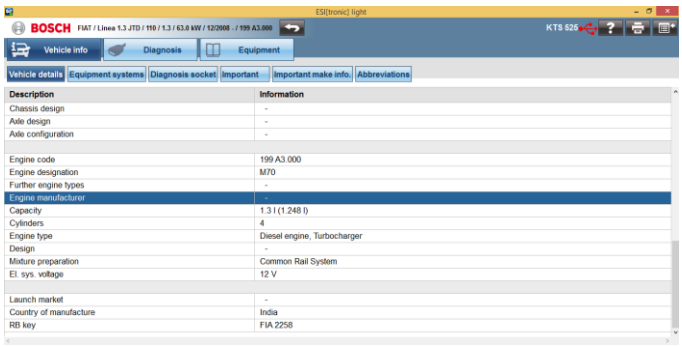
Three main options are

1) Vehicle Info
2) Diagnosis
3) Equipment.

*1) Vehicle Info:*In vehicle info option, again there are six options. They are

1) Vehicle Details
2) Equipment System
3) Diagnosis Socket.
4) Important
5) Important Make Info
6) Abbreviations.

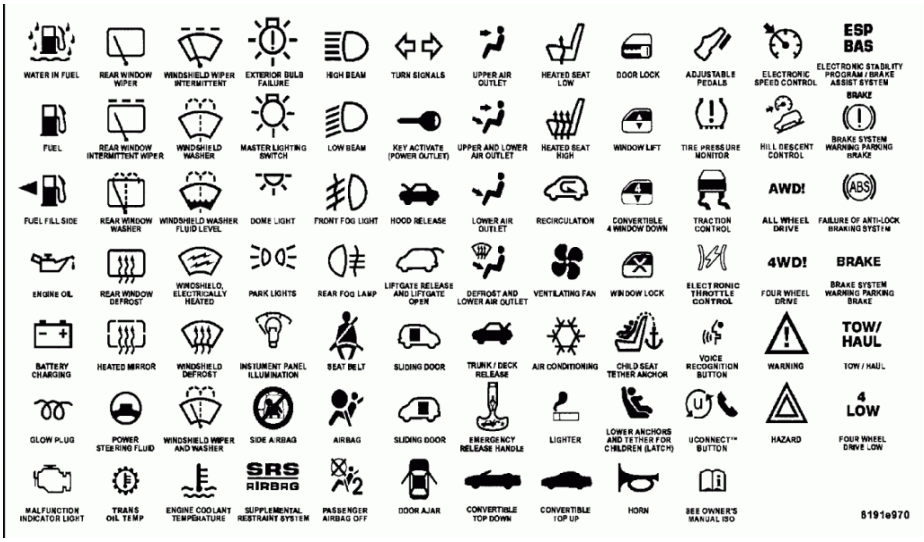
Vehicle Details:
In this option, the entire information about the selected vehicle is displayed such as Engine number, engine description, capacity, cylinders, and engine type and so on as follows.



Vehicles Tested with KTS 520:

- Linea(FIAT)
- Safari(TATA)
- Innova(TOYOTA)
- Ertiga(MARUTI SUZUKI)
- Eco Sport(FORD)
- Beat(CHEVROLET)
- Bolero(MAHINDRA)
- Fiesta(FORD)

Different types of Warning Symbols are shown below:



XI. CONCLUSION

This Engine Diagnosis for Detecting Errors project provides effective knowledge about the scanning and diagnosing the vehicles with simple scan tools like Scan Master ELM 327, Bosch KTS-520, and KTS-570. By this project even village drivers and owners also easily scan and diagnosis their vehicles without taking their vehicles to cities and experienced mechanics. By better health monitoring of vehicles, unnecessary replace of spare components is eliminated. Good Health monitoring system results in decrease in emissions and fuel consumption. It also eliminates to carry out different types of OBD cables (Data Link Connectors) by standardization of OBD-II protocol with universal Diagnostic Trouble Codes (DTC). Awareness about low cost diagnosing process and economical scan tools can be achieved.

XII. REFERENCES

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