SNS COLLEGE OF ENGINEERING

Kurumbapalayam (Po), Coimbatore – 641 107

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE NAME : 19OE120 AUTOMOTIVE ELECTRONICS I YEAR /I SEMESTER

MECHATRONICS ENGINEERING

Unit 2 – Sensors & Actuators

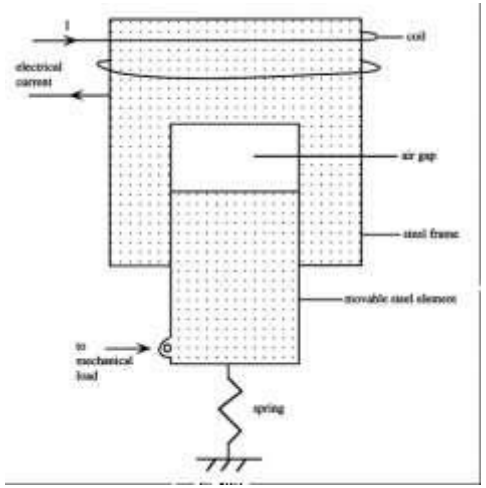
Topic - Solenoid

❖ Syllabus:

- Working principle of sensors, Types of sensors, Airflow rate sensor, Position sensor, Throttle angle sensor, Temperature sensor, MAP sensors, Knock/Detonation Sensor, Load cell, Lambda Sensor(Exhaust gas O2 Sensor), yaw rate sensor, sensor feedback control, Electronic Control Unit (ECU), Principle of actuator, Types of actuators, engine control actuators, Solenoid actuators, motorized actuators (Stepper motors).

❖ Solenoid Valves:

- A fuel injector is (in essence) a solenoid-operated valve. The valve opens or closes to permit or block fuel flow to the engine. The valve is attached to the movable element of the solenoid and is switched by the solenoid activation.
- In a fuel injector with no current flowing, the solenoid movable element is held down against the stop, covering the aperture or nozzle.
- Fuel is thereby blocked from flowing from the pressurized fuel chamber into the aperture. When current flows through the solenoid coil, the movable element is switched upward, the aperture is exposed, and fuel (under pressure) sprays through this aperture.



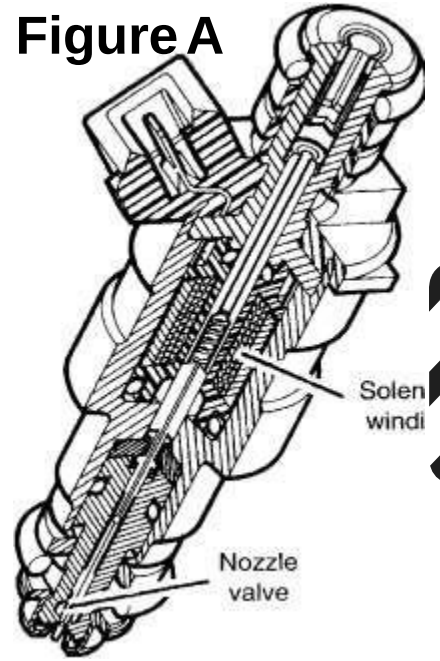


Figure A

- The fuel flow rate through the nozzle is constant for a given regulated fuel pressure and nozzle geometry; therefore, the **quantity of fuel injected into the air stream is proportional to the time the valve is open.**
- The control current that operates the fuel injector is pulsed on and off to deliver precise quantities of fuel.

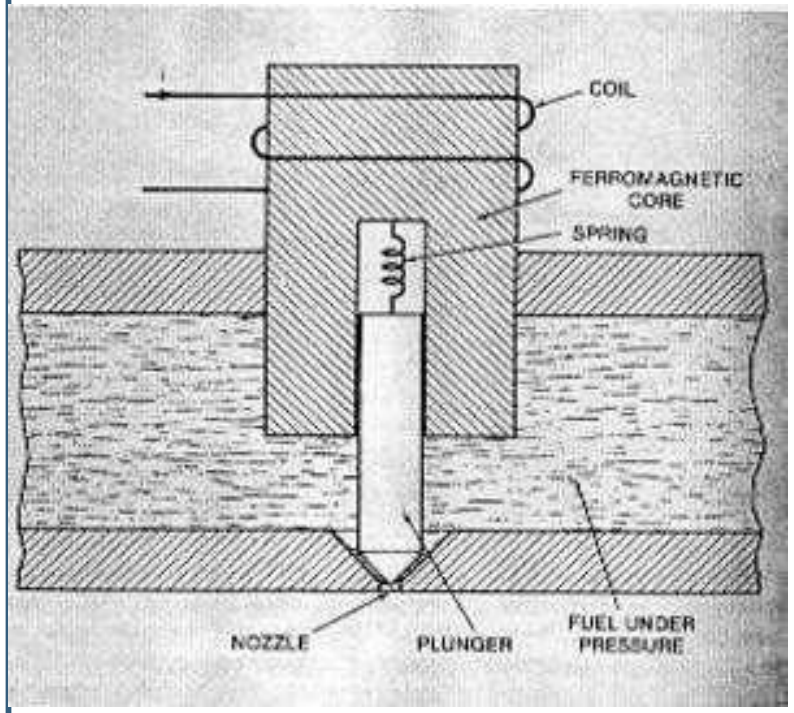


Figure B

❑ Fuel Injector Signal

- Consider an idealized fuel injector a e
  Figure B, in which the t
  injector is op applied
  voltage is on and is closed when voltag
- In this idealization, the control the fuel injector is

  a binary pulse train (i.e., ***either on or off***).
  - For a pulse train signal, the ratio of on time *t* to the period of the pulse *T* (on time + off time) is called the *duty cycle*.

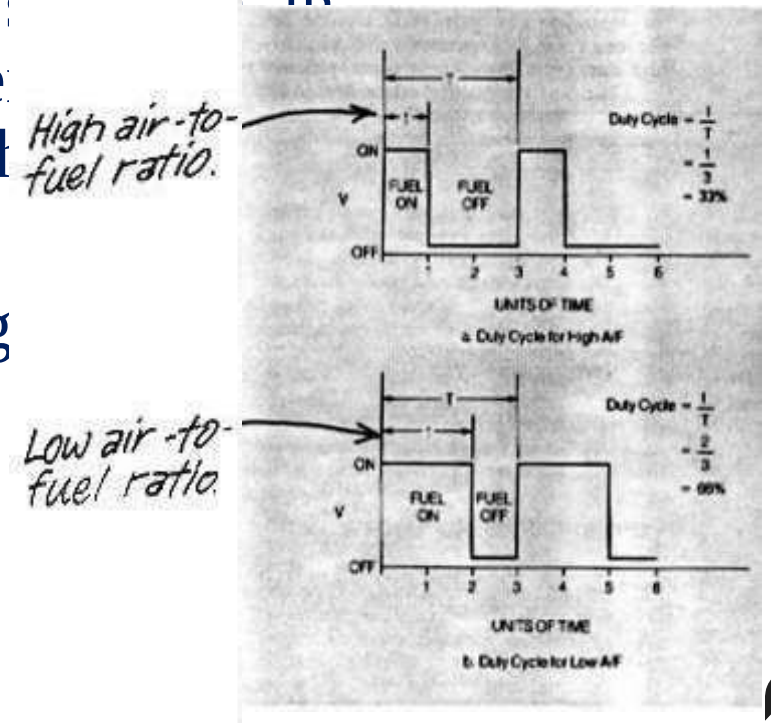


Figure C

- This is shown in Figure C. The fuel injector is energized for time *t* to allow fuel to spray from the nozzle into the air stream going to the intake manifold. The injector is de-energized for the remainder of the period.
- Therefore, a low duty cycle, as seen in Figure C-a, is used for a high air/fuel ratio (lean mixture), and a high duty cycle (Figure C-b) is used for a low air/ fuel ratio (rich mixture).

❖STEPPER MOTOR-OPERATED VALVE

- Figure 6.12 shows a simplified arrangement of the extra air (air by-pass) valve that is built into the throttle body of some petrol injection systems.
- The ECU pulses the transistor bases, in the correct sequence, so that the stepper motor moves the air valve to provide the correct air supply, for any given condition.
- In addition, other sensor signals will enable the ECU to provide the correct amount of fuel to ensure that the engine continues to run smoothly. Figure 6.13 shows the stepper motor with the air valve attached.
- The multiple pin connection is typical of the type of connection that is used to electrically connect the stepper motor to the ECU. The stepper motor can normally be checked by operating it with the diagnostic tool connected to the serial communication port of the ECM.

- An oscilloscope can also be used to check the pulses that are sent to the motor from the ECM. Figure 6.14 gives an impression of the type of result that is to be expected from the PMS 100 oscilloscope when used to test a stepper motor.

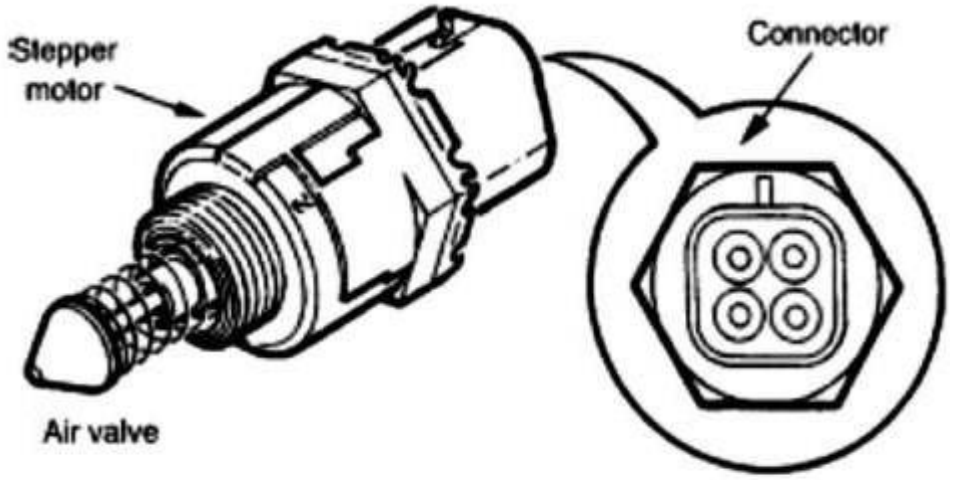
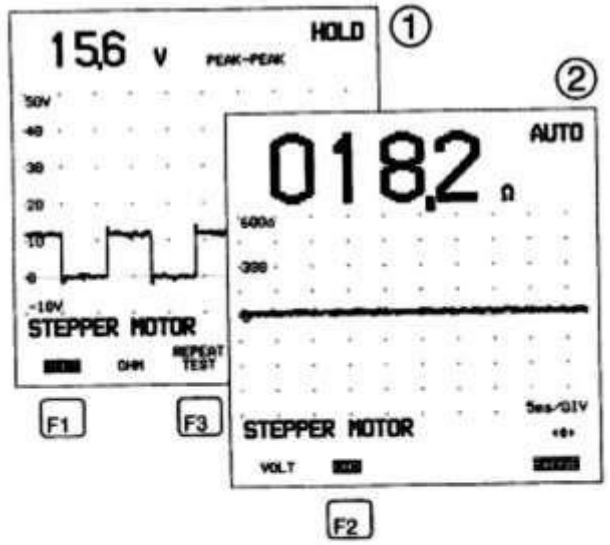


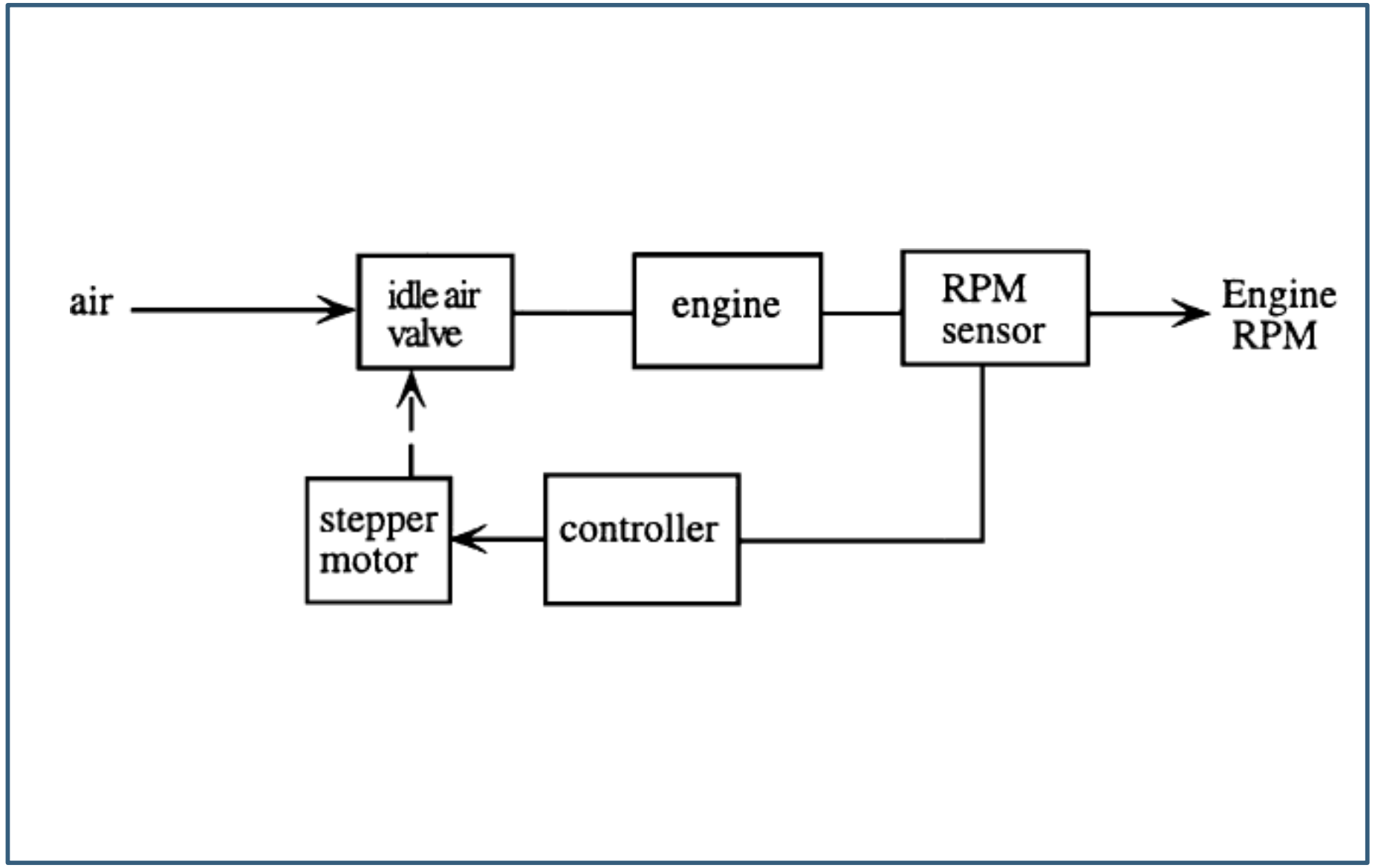
Fig. 6.13 The stepper motor and extra air valve (Lucas)



① **PEAK-PEAK** Indicates the difference in voltage between the lowest and the highest value of the displayed waveform.

② This screen displays the measured resistance in ohms (Ω).

Fig. 6.14 Voltage trace from a stepper motor test


air
idle air valve
engine
RPM sensor
Engine RPM
stepper motor
controller

❖ *SOLENOID-OPERATED VALVE*

- This type of valve regulates the amount of air that by-passes the throttle valve through the medium of a solenoid-operated valve of the type shown in Fig. 6.15.
- In the rest position shown, the valve (4) is closed by the spring (5) and the armature of the solenoid (2) is pushed back inside the solenoid coil (3). When operating, the energized solenoid opens the valve (4) and admits air to the induction system. The quantity of air admitted is controlled by duty cycle pulses that are sent from the ECM.

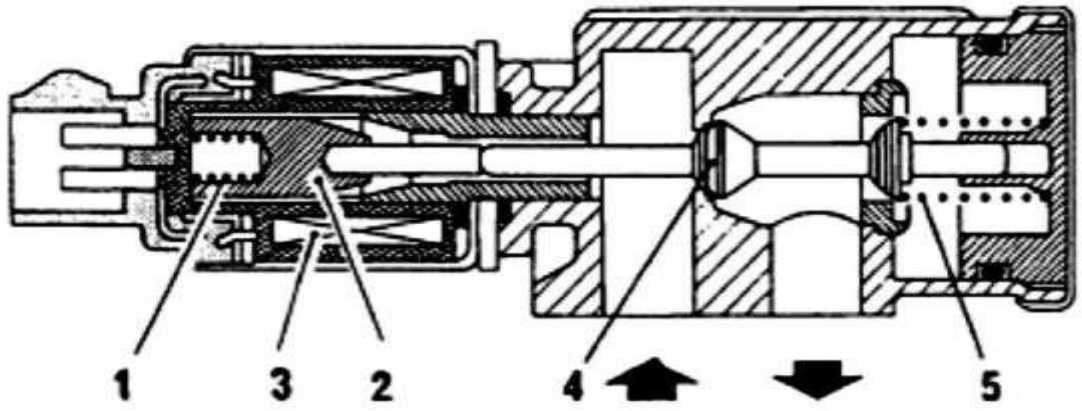


Fig. 6.15 A solenoid operated idle speed control valve