SNS COLLEGE OF ENGINEERING

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE NAME : 19OE120 AUTOMOTIVE ELECTRONICS

I YEAR /I SEMESTER MECHATRONICS ENGINEERING

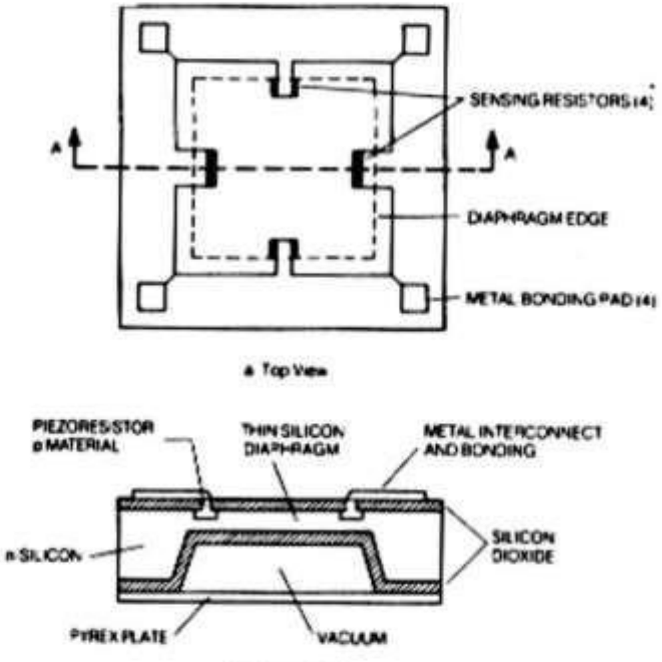
Unit 1 – Introduction to ECU

❖ Manifold Absolute Pressure (MAP) Sensor:

- Several MAP sensor configurations have been used in automotive applications.
- The earliest sensors were derived from aerospace instrumentation concepts, but these proved more expensive than desirable for automotive applications and have been replaced with more cost-effective designs.
- It is interesting to note that none of the MAP sensors in use measure manifold pressure directly, but instead measure the displacement of a diaphragm that is deflected by manifold pressure.
- The details of the diaphragm displacement and the measurement of this displacement vary from one configuration to another.

❖ Strain Gauge MAP Sensor

- One relatively inexpensive MAP sensor configuration is the silicon diaphragm diffused strain gauge sensor shown in Figure.
- This sensor uses a silicon chip that is approx millimeters square. Along the outer edges, h approximately 250 micrometers (1 microm millionth of a meter) thick, but the center are 25 micrometers thick and forms a diaphragm.
- The edge of the chip is sealed to a pyrex pl vacuum, thereby forming a vacuum chamber the plate and



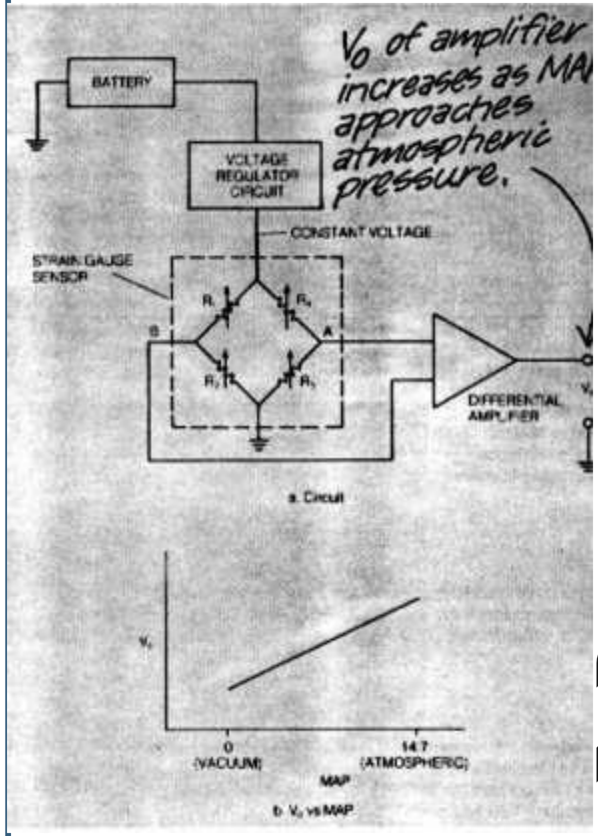
a Top View

b Section A-A

the center area of the silicon chip.

- A set of sensing resistors is formed around the edge of this chamber, as indicated in Figure. The resistors are formed by diffusing a doping impurity into the silicon.
- External connections to these resistors are made through wires connected to the metal bonding pads. This entire assembly is placed in a sealed housing that is connected to the intake manifold by a small-diameter tube.
- Manifold pressure applied to the diaphragm causes it to deflect.
- The resistance of the sensing resistors changes in proportion to the applied manifold pressure by a phenomenon that is known as **piezoresistivity**.
- Piezoresistivity occurs in certain semiconductors so that the actual resistivity (a property of the material) changes in proportion to the strain (fractional change in length).

- The strain induced in each resistor is proportional to the diaphragm deflection, which, in turn, is proportional to the pressure on the outside surface of the diaphragm. This pressure is the manifold pressure.
- An electrical signal that is proportional to the manifold pressure is obtained by connecting the resistors in a circuit called a Wheatstone bridge, as shown in the schematic of Figure a.
- The voltage regulator holds a constant dc voltage across the bridge.



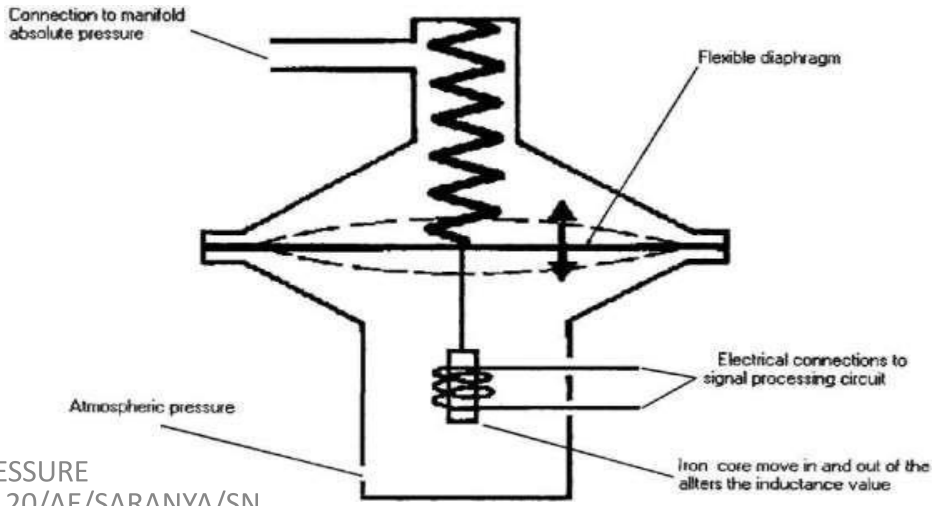
- The resistors diffused into the diaphragm are denoted R_1, R_2, R_3, and R_4 in Figure a.
- When there is no strain on the diaphragm, all four resistances are equal, the bridge is balanced, and the voltage between points A and B is zero. When manifold pressure changes, it causes these resistances to change in such a way that **R_1 and R_3 increase by an amount that is proportional to pressure; at the same time, R_2 and R_4 decrease by an identical amount**.
- This unbalances the bridge and a net difference voltage is present between points A and B. The differential amplifier generates an output voltage proportional to the difference between the two input voltages (which is, in turn, proportional to the pressure), as shown in Figure b.

❖Variable-Capacitance type MAP Sensor

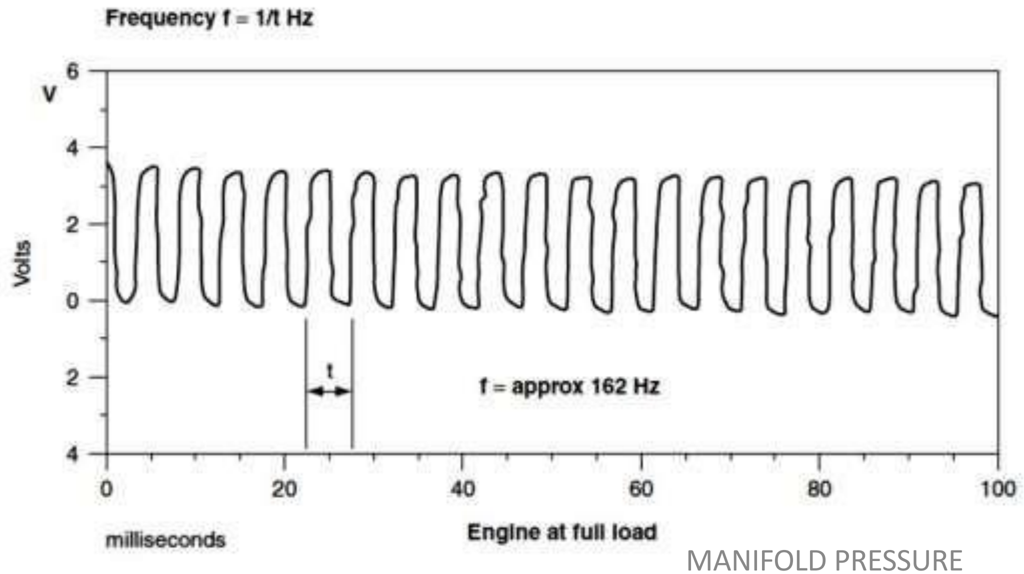
- Figure below gives an indication of the principle of operation of the variable capacitance type of MAP sensor.
- Capacitance $C = e_o A/d$, where e_o = permittivity in a vacuum, A = area of the metallized plates and d = the distance between the plates.
- The metallized plates of the capacitor are placed on each side of an evacuated capsule.
- This capsule is placed in a chamber which is connected to manifold pressure and, as the manifold pressure changes, the distance d between the capacitor plates changes.
- This change in distance between the capacitor plates causes the value of the capacitance C to change. The capacitor is connected into an electronic circuit that converts changes in capacitance into an electrical signal.

❖ Variable-Inductance type MAP Sensor:

- The variable-inductance type of MAP sensor relies on the principle that the inductance of a coil is altered by varying the position of an iron cylinder placed in the center of the coil. Figure illustrates the principle involved.
- In this simplified version, the iron cylinder moves in or out of the coil under the influence of the diaphragm and spring.



- Variations in manifold absolute pressure increase or decrease the ‘suction’ force acting on the diaphragm and the resultant changes in inductance are related to the manifold absolute pressure.
- The coil (inductance) forms part of an electronic circuit and this circuit is designed so that the changes in frequency of the square-wave output are accurate representations of manifold absolute pressure. Figure shows the approximate form of the variable frequency output of sensors of this type.



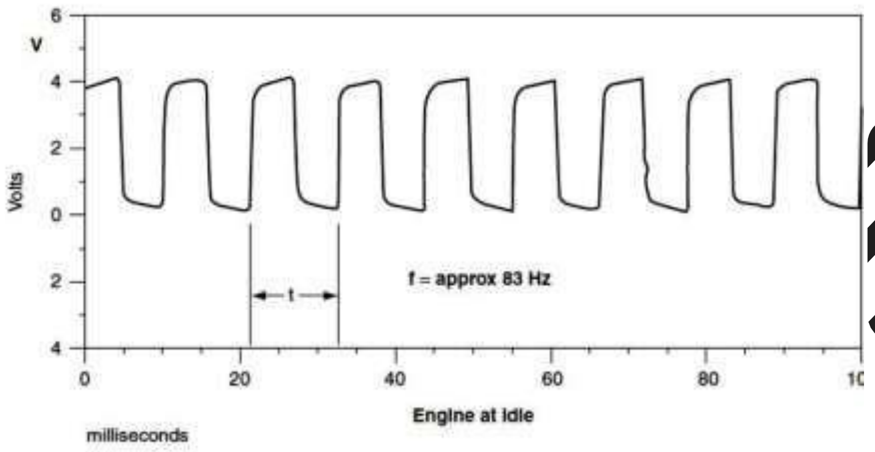


Fig. 5.25 Frequency patterns for a MAP sensor at full load and idle