## OXYGEN SENSOR

An oxygen sensor (or lambda sensor) is an electronic device that measures the proportion of oxygen ($O2$) in the gas or liquid being analysed.It was developed by Robert Bosch GmbH during the late 1960s under the supervision of Dr. Günter Bauman. The original sensing element is made with a thimble-shaped zirconia ceramic coated on both the exhaust and reference sides with a thin layer of platinum and comes in both heated and unheated forms. The planar-style sensor entered the market in 1990, and significantly reduced the mass of the ceramic sensing element as well as incorporating the heater within the ceramic structure. This resulted in a sensor that started sooner and responded faster.

The most common application is to measure the exhaust gas concentration of oxygen for internal combustion engines in automobiles and other vehicles. Divers also use a similar device to measure the partial pressure of oxygen in their breathing gas.

Oxygen sensors are also used in hypoxic air fire prevention systems to monitor continuously the oxygen concentration inside the protected volumes.

There are many different ways of measuring oxygen and these include technologies such as zirconia, electrochemical (also known as Galvanic), infrared, ultrasonic and very recently laser methods. Each method has its own advantages and disadvantages.

## FUEL QUANTITY MEASUREMENT

During a measurement of fuel quantity, the MUX switch functionally connects the computer input to the fuel quantity sensor, as shown in Figure T his sensor output is converted to digital format and then sent to the computer for signal processing. (Note: In some automotive systems the analog sensor output is sent to the instrumentation subsystem, where the A/D conversion takes place.

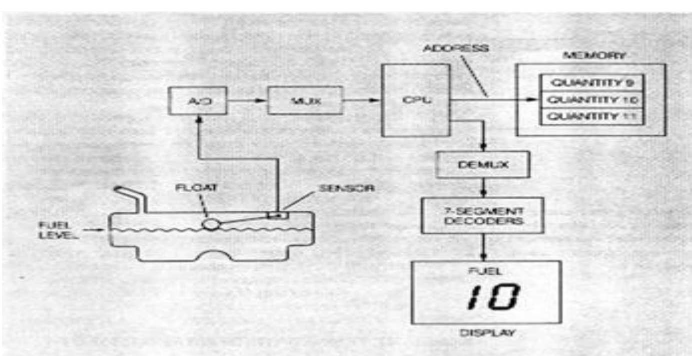


**FIGURE :BLOCK DIAGRAM OF FUEL MEASURING SYSTEM**

Several fuel quantity sensor configurations are available. Figure 9.10illustrates the type of sensor to be described, which is a potentiometer connected via mechanical linkage to a float. Normally, the sensor is mounted so that the float remains laterally near the center of the tank for all fuel levels. A constant current passes through the sensor potentiometer, since it is connected directly across the regulated voltage source. The potentiometer is used as a voltage divider so that the voltage at the wiper arm is related to the float position, which is determined by fuel level. The sensor output voltage is not directly proportional to fuel quantity in gallons because of the complex shape of the fuel tank. The computer memory contains the functional relationship between sensor voltage (in binary number equivalent) and fuel quantity for the particular fuel tank used on the vehicle. The computer reads the binary number from the A/D converter that corresponds to sensor voltage and uses it to address a particular memory location. Another binary number corresponding to the actual fuel quantity in gallons for that sensor voltage is stored in that memory location. The computer then uses the number from memory to generate the appropriate display signal—either analog or digital, depending on display type—and sends that signal via DEMUX to the display.

**VEHICLE SPEED MEASUREMENT**

A cruise sensor can be used for car speed measurements. The output of this sensor is a binary number,

*P*, that is proportional to car speed *S*. This binary number is contained in the output of a binary counter .A block diagram of the instrumentation for vehicle speed measurement that uses this digital speed sensor is shown in Figure .

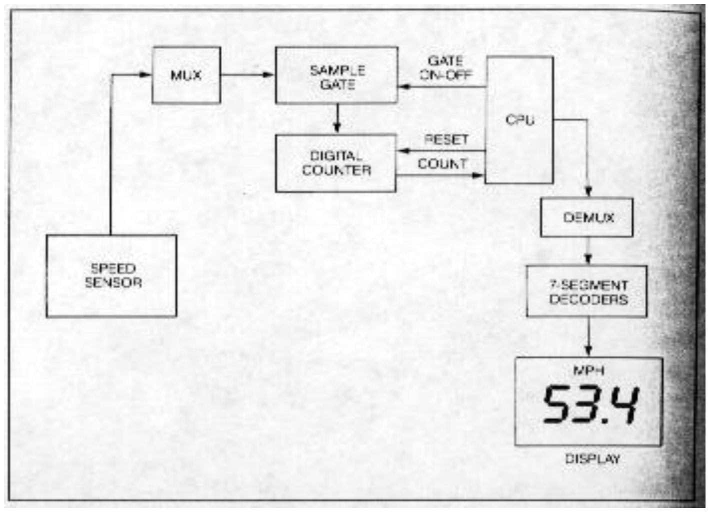


**FIGURE: BLOCK DIAGRAM OF DIGITAL SPEED SENSOR**

The computer reads the number *P* in the binary counter, then resets the counter to zero to prepare it for the next count. After performing computations and filtering, the computer generates a signal for the displayto indicate the vehicle speed. A digital display can be directly driven by the computer. Either mph or kph may be selected. If an analog display is used, aD/A converter must drive the display. Both mph and kph usually are calibrated on an analog scale.

## THROTTLE POSITION SENSOR

A throttle position sensor (TPS) is a sensor used to monitor the throttle position of a vehicle. The sensor is usually located on thebutterfly spindle/shaft so that it can directly monitor the position of the throttle. More advanced forms of the sensor are also used, for example an extra closed throttle position sensor (CTPS) may be employed to indicate that the throttle is completely closed. Some engine control units (ECUs) also control the throttle position electronic throttle control (ETC) or "drive by wire" systems and if that is done the position sensor is used in a feedback loop to enable that control.

Related to the TPS are accelerator pedal sensors, which often include a wide open throttle (WOT) sensor. The accelerator pedal sensors are used in electronic throttle control (ETC) or "drive by wire" systems, and the most common use of a wide open throttle sensor is for the kick-down function on automatic transmissions.

Modern day sensors are non contact type. These modern non contact TPS include Hall effect sensors, Inductive sensors ,magnetoresistive and others. In the potentiometric type sensors, a multi-finger metal brush/rake is in contact with a resistive strip, while the butterfly valve is turned from the lower mechanical stop (minimum air position) to WOT, there is a change in the resistance and this change in resistance is given as the input to the ECU.

**CRANK ANGLE POSITION SENSOR**

The Camshaft Position Sensor is GENERALLY used in all modern Sequentially Fuel Injected engines to fine tune ignition timing and fuel injection timing after the vehicle has started. Although this article concentrates on the basics of Crankshaft Position Sensors, you can apply most of this info to the Camshaft Position Sensors too.

Since the Crankshaft Position Sensor's Signal triggers the Ignition Module (or Fuel Injection Computer) to start switching the Ignition Coil's Primary Current ground path On and Off... I usually refer to the sensor's signal as the Triggering Signal. Since the Crank Sensor (or Cam Sensor) is the one producing this Triggering Signal, I refer to it as the Triggering Device.

The signal that the Ignition Module (or Fuel Injection Computer) sends the Ignition Coil for it to start sparking is the Switching Signal. So, guess what... the Ignition Module (or the Fuel Injection Computer) is therefore the Switching Device.

Now, the Ignition Control Module really doesn't send a physical signal (like the Crank or Cam Sensor does to the Switching Device) to the Ignition Coil(s). Why? Well, because the term ‘Switching Signal’ is just a descriptive name for the turning on and off of the primary current passing thru' the Ignition Coil. And as stated above, this turning on and off only happens after the Ignition Module (or Fuel Injection Computer) receives the Crankshaft Position Sensor's Signal. As you may already know, it's this action that causes the Ignition Coil to start firing Spark.

**SOLENOID**

A solenoid is a coil of insulated or enameled wire wound on a rod-shaped form made of solid iron, solid steel, or powdered iron. Devices of this kind can be used as electromagnets, as inductors in electronic circuits, and as miniature wireless receiving antennas.

In a solenoid, the core material is ferromagnetic, meaning that it concentrates magnetic lines of flux. This increases the inductance of the coil far beyond the inductance obtainable with an air-core coil of the same dimensions and the same number of turns. When current flows in the coil, most of the resulting magnetic flux exists within the core material. Some flux appears outside the coil near the ends of the core; a small amount of flux also appears outside the coil and off to the side.

A solenoid chime is wound on a cylindrical, hollow, plastic or phenolic form with a movable, solid iron or steel core. The core can travel in and out of the coil along its axis. The coil is oriented vertically; the core normally rests somewhat below the coil center. When a current pulse is applied to the coil, the magnetic field pulls the core forcefully upward. Inertia carries the core above the center of the coil, where the core strikes a piece of metal similar to a xylophone bell, causing a loud "ding".

**STEPPER MOTOR**

Stepper motors are DC motors that move in discrete steps. They have multiple coils that are organized in groups called "phases". By energizing each phase in sequence, the motor will rotate one step at a time.
With a computer controlled stepping you can achieve very precise positioning and/or speed control. For this reason, stepper motors are the motor of choice for many precision motion control applications. Some of them are

- **Positioning** – Since steppers move in precise repeatable steps, they excel in applications requiring precise positioning such as 3D printers, CNC, Camera platforms and X,Y Plotters. Some disk drives also use stepper motors to position the read/write head.
- **Speed Control** – Precise increments of movement also allow for excellent control of rotational speed for process automation and robotics.
- **Low Speed Torque** - Normal DC motors don't have very much torque at low speeds. A Stepper motor has maximum torque at low speeds, so they are a good choice for applications requiring low speed with high precision.

**RELAYS**

A relay is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relays. Relays are used where it is necessary to control a circuit by a separate low-power signal, or where several circuits must be controlled by one signal. The first relays were used in long distance telegraph circuits as amplifiers: they repeated the signal coming in from one circuit and re-transmitted it on another circuit. Relays were used extensively in telephone exchanges and early computers to perform logical operations.

A type of relay that can handle the high power required to directly control an electric motor or other loads is called a contactor. Solid-state relays control power circuits with no moving parts, instead using a semiconductor device to perform switching. Relays with calibrated operating characteristics and sometimes multiple operating coils are used to protect electrical circuits from overload or faults; in modern electric power systems these functions are performed by digital instruments still called "protective relays".

Magnetic latching relays require one pulse of coil power to move their contacts in one direction, and another, redirected pulse to move them back. Repeated pulses from the same input have no effect. Magnetic latching relays are useful in applications where interrupted power should not be able to transition the contacts.

Magnetic latching relays can have either single or dual coils. On a single coil device, the relay will operate in one direction when power is applied with one polarity, and will reset when the polarity is reversed. On a dual coil device, when polarized voltage is applied to the reset coil the contacts will transition. AC controlled magnetic latch relays have single coils that employ steering diodes to differentiate between operate and reset commands.

***Refer the class notes for the following topics***

***ALTITUDE SENSOR,***

***FLOW SENSOR***