Five Types of Oxygen Sensors

Unheated Thimble-type O2 Sensors (LS)

Bosch introduced this design in 1976 for feedback fuel control on automotive engines. The zirconia ceramic "thimble" is encased in a protective tube which extends into the exhaust manifold. Slots in the protective tube allow hot exhaust gases to reach the thimble. Reference outside air for the interior of the thimble comes from a hole in the sensor shell, or through the wiring connector. Unheated O2 sensors rely only on the heat of the exhaust gases to reach operating temperature, therefore they might cool off while the engine is idling and revert back to a fixed air/fuel ratio setting. This type of sensor generally has a single wire connector, though some have two.

Heated Thimble-type O2 Sensors (LSH)

Introduced by Bosch in 1982, this sensor adds a heater element to the original design so that the sensor achieves operating temperature in 30-60 seconds, instead of being heated by exhaust gases. It has a separate electric circuit for the heater, so look for 3 or 4 wire connectors to distinguish this unit. The heater reduces cold start emissions, as well as prevents the sensor from cooling off at idle.

Heated Titania-type O2 Sensors

Titania sensors use a different type of ceramic and instead of generating a voltage signal that changes with the air/fuel ratio, the sensor's electrical resistance changes. The resistance is less than 1000 ohms when the air/fuel ratio is rich, and more than 20,000 ohms when the air/fuel ratio is lean. The ECU provides a base reference voltage and then rmonitors the sensor return voltage as the sensor's resistance changes. Titania O2 sensors are used on *less than 1%* of O2 sensor-equipped vehicles:

- '86-'93 Nissan 3.0L trucks
- '91-'94 Nissan 3.0L Maxima, 2.0L Sentra
- '87-'90 Jeep Cherokee, Wrangler, and Eagle Summit

Heated Planar-type O2 Sensors (LSF)

Introduced by Bosch in 1997, this O2 sensors uses a laminated flat strip of conductive ceramic, electrodes, insulation, and heater. This sensor is smaller and lighter, and more difficult to contaminate. The new heater uses less electricity and brings the sensor to the proper temperature in 10 seconds. Outside reference air is supplied by a small port in the center of the ceramic strip where the 4 electrical wires connect. By model year 2004, planar O2 sensors are expected to account for 30%

Heated Planar-type O2 Sensors (LSF) cont.

- 1998: VW 2.0L New Beetle
- 1999: Cadillac Catera, Saturn 3.0L LS, VW 2.0L Jetta
- 2000: All Audis exc. A4 1.8L turbo and A6 2.8L; California Dodge 2.0L Neon; Ford 4.0L and 5.0L Explorer; Ford 2.5L LEV Ranger; Ford 3.8L Windstar; MBZ 3.2L ML320 and 4.3L ML430; Mercury 4.0L & 5.0L Mountaineer; Saab 2.0L & 2.3L; and all VW and Volvo models
- 2001: Porsche 911 3.6L Turbo; all MBZ models exc. SL500 and SL600
- 2002: All Audis, All Dodge Neons, all Ford F-Series trucks (4.2L, 4.6L, 5.4L), all Ford Ranger trucks, Mazda B-Series pickups (2.5L, 3.0L & 4.0L), all MBZ models and Saturn 3.0L SUV

Heated Wide-Band O2 Sensors (LSU)
(from the November 2001 Bosch Reporter)

The newest O2 sensor technology from Bosch builds upon the planar design and adds the ability to actually measure the air/fuel ratio directly for the first time. Instead of switching back and forth like all previous sensor designs, the new wide-band O2 sensor produces a signal that is directly proportional to the air/fuel ratio.

The wide-band sensor uses a "dual sensing element" that combines the Nernst effect cell in the planar design with an additional "oxygen pump" layer and "diffusion gap" on the same strip of ceramic. The result is a sensor element that can precisely measure air/fuel ratios from very rich (10:1) to extremely lean (straight air). This allows the engine computer to use an entirely different operating strategy to control the air/fuel ratio. Instead of switching the air/fuel ratio back and forth from rich to lean to create an average balanced mixture, it can simply add or subtract fuel as needed to maintain a steady ratio of 14.7:1.

Like a zirconia thimble or planar-type sensor, the wide-band sensor produces a low-voltage signal when the air/fuel ratio goes lean, and a high-voltage signal when the mixture is rich. But instead of switching abruptly, it produces a gradual change in the voltage that increases or decreases in proportion to the relative richness or leanness of the air/fuel ratio. So, at a perfectly balanced air/fuel ratio or 14.7:1, a wide-band O2 sensor will produce a steady 450 mv. If the mixture goes a little richer or a little leaner, the sensor's output voltage will only change a small amount instead of rising or dropping

of all O2 sensor applications and by 2008, for up to 75%. The following list shows the inclusion of more and more models:

dramatically.

Another difference in the wide-band O2 sensor is the heater circuit. Like a planar sensor, it is printed on the ceramic strip. But the heater circuit is pulse-width modulated to maintain a consistent operating temperature of 1292 to 1472 degrees F. the sensor takes about 20 seconds to reach operating temperature.