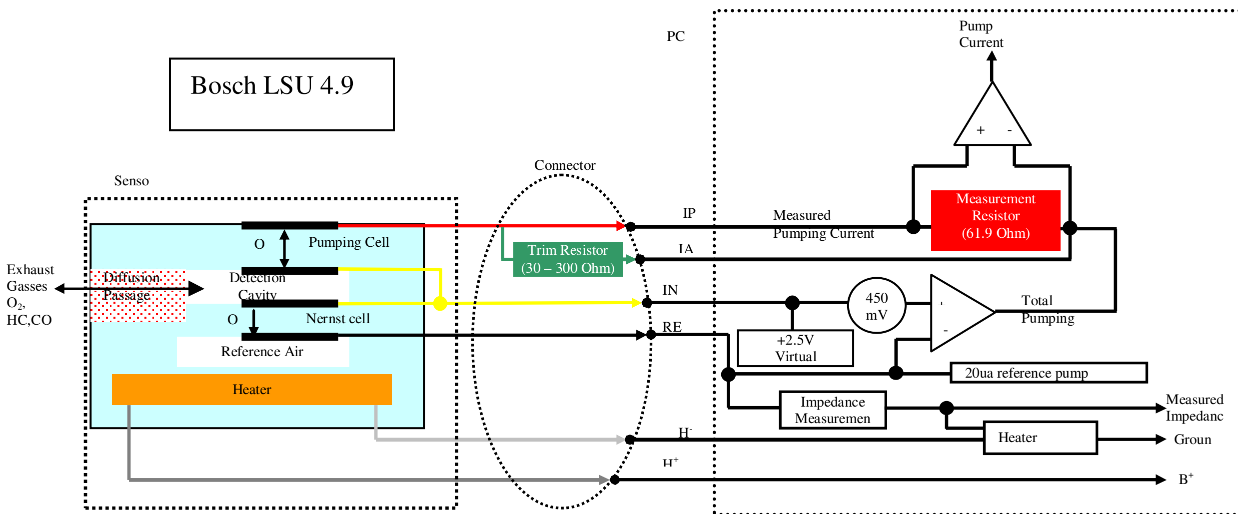
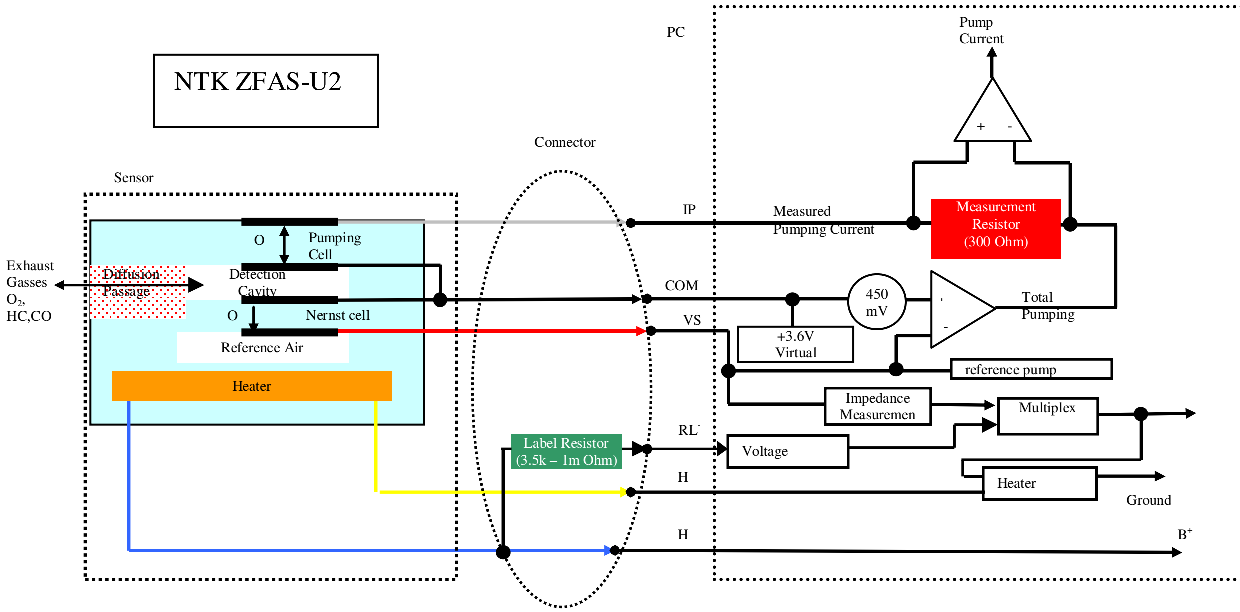
Front UEGO Signal

The UEGO sensor infers an air fuel ratio relative to the stoichiometric (chemically balanced) air fuel ratio by balancing the amount of oxygen pumped in or out of a measurement chamber. As the exhaust gasses get richer or leaner, the amount of oxygen that must be pumped in or out to maintain a stoichiometric air fuel ratio in the measurement chamber varies in proportion to the air fuel ratio. By measuring the current required to pump the oxygen in or out, the air fuel ratio (lambda) can be estimated. Note that the measured air fuel ratio is actually the output from the UEGO ASIC pumping current controller and not a signal that comes directly from the sensor.



Bosch UEGO sensor interface:

- IP – primary pumping current that flows through the sensing resistor
- IA – current flow through trim resistor in parallel with sense resistor.
- VM – Virtual ground, approximately 2.5 volts above PCM ground.
- RE – Nernst cell voltage, 450mv from VM. Also carries current for pumped reference.
- H+ – Heater voltage – to battery.
- H- – Heater ground side – Duty cycle on/off to control sensor temperature.



NTK UEGO sensor interface:

- IP – primary pumping current that flows through the sensing resistor
- COM – Virtual ground, approximately 3.6 volts above PCM ground.
- VS – Nernst cell voltage, 450mv from COM. Also carries current for pumped reference.
- RL - Voltage input from label resistor.
- H+ – Heater voltage – to battery.
- H- – Heater ground side – Duty cycle on/off to control sensor temperature.

The primary component of a UEGO sensor is the diffusion passage that controls the flow of exhaust gasses into a detection cavity, a Nernst cell (essentially an EGO sensor inside the UEGO sensor) that measures the air fuel ratio in the detection cavity. A control circuitry in the ASIC chip (mounted in the PCM) controls the pumping current (IP) to keep the detection cavity near stoichiometry by holding the Nernst cell at 450 mV. This Nernst cell voltage (RE, VS) is 450mV from the virtual ground (VM, COM), which is approximately 2.5V (Bosch UEGO) or 3.6V (NTK UEGO) above the PCM ground. For the Nernst cell to generate a voltage when the detection cavity is rich, it needs an oxygen differential across the cell. In older UEGO (and HEGO) sensor designs, this was provided by a reference chamber that was connected to outside air through the wire harness that was subject to contamination and "Characteristic Shift Down (CSD)". The new UEGO sensor uses a pumped reference chamber, which is sealed from the outside to eliminate the potential for contamination. The necessary oxygen is supplied by supplying a 20 uA pumping current across the Nernst cell to pump small amounts of oxygen from the detection cavity to the reference chamber. The pumping cell pumps oxygen ions in and out of the detection cavity from and to the exhaust gasses in response to the changes in the Nernst cell voltage. The pumping current flows through the sense resistor and the voltage drop across the sense resistor is measured and amplified. Offset volts are sent out of the ASIC to one of the PCM's A/D inputs. The PCM measures the voltage supplied by the ASIC, determines the pumping current, and converts the pumping current to measured lambda. In general, the circuitry that measures the pumping current is used to estimate the air fuel ratio in the exhaust system.

The UEGO sensor also has a trim (IA) or label resistor (RL). The biggest source of part to part variability in the measured air fuel ratio is difference in the diffusion passage. This source of variation is simply the piece-to-piece differences from the manufacturing process. To compensate for this source of error, each sensor is tested at the factory and a trim or label resistor is installed in the connector. The value of this resistor is chosen to correlate with the measured difference between a particular sensor and a nominal sensor.

For NTK UEGO, the variation in the Ip signal value is corrected for by a compensation coefficient (CC), and then processed by the PCM. The value of CC (Ip rank) is determined by the value of RL. The PCM must command the ASIC to read the value of RL, so CC can be determined. After measuring the value of the label resistor, the PCM software will multiply the measured pumping current (Ip) by a compensation coefficient and determine a corrected pumping current that is used to calculate the measured exhaust air fuel ratio. During each power up, the PCM will briefly turn the UEGO heater power off, measure the output voltage from the voltage divider several times, average it, and estimate the resistance of the label resistor. The PCM will do this estimation multiple times, and if all samples are consistently within one resistor "rank", then the RL compensation coefficient determination is completed and the resistor "rank" compensation coefficient value will be stored in keep alive memory. On the other hand, if the several readings are not consistently within one rank for some amount of time, then the PCM A/D input is considered not reliable/RL erratic, and a trim circuit erratic malfunction (P164A, P164B) will be set. Conversely, if the estimated resistance is too high, then the software in the PCM will indicate RL circuit shorted to ground or open, and a trim circuit low malfunction (P2627, P2630) will be set. If the estimated resistance is too low, then the software will indicate RL circuit shorted to power, and a trim circuit high malfunction (P2628, P2631) will be set. Once a trim circuit malfunction is detected, then the compensation coefficient of the label resistor "rank" stored in KAM will be used.

For Bosch UEGO, the trim resistor is connected in parallel to the pumping current sense resistor and the pumping current flows through both. The trim resistor adjusts the measured pumping current back to the expected nominal value at any given air fuel ratio (correcting for the sensor to sensor variations in the diffusion passage). Small trim resistors are required for sensors that require more pumping current at any particular lambda. Conversely, for sensors with lower diffusion rates than average, less pumping current is required, so a higher than average impedance trim resistor is installed. When IA circuit is open, all of the pumping current flows through the measuring resistor which increases the measured voltage. Since the pumping current is amplified, the UEGO pumping current to lambda transfer function will reflect the error. The slope of the UEGO sensor transfer function changes, which results in the wrong output of the UEGO signal (the slope of the pumping current to lambda relationship can increase or decrease). For "stoichiometric" air/fuel control applications, an open IA circuit is not monitored since the lambda error is minimal in "stoichiometric" mode. A worst case (40 ohm resistor) open IA was tested on a 2008 MY 3.5L Taurus PZEV and showed no impact on tailpipe emissions.