Product Bulletin
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Product Information Sensors

Air/fuel ratio sensors and oxygen sensors – what's the difference?

Despite the rise in popularity of pure electric powertrains, vehicle manufacturers (VMs) are still under intense pressure to improve the ecological performance of their combustion engines to comply with evermore strict emissions targets. As a result, monitoring the engine's exhaust emissions takes central stage and the air/fuel ratio sensor is a special type of oxygen sensor that can support more sophisticated emission control processes.

Figure 1: cross section of a A/F sensor

To comply with current and future emissions targets, engine management technology never rests, as leading original equipment (OE) component manufacturers such as DENSO, continue to develop more sophisticated sensors to satisfy the needs of the VMs. As a result, the trusted oxygen sensor, more commonly referred to as Lambda sensor, has had to be supported with the addition of many other sensors, including air/fuel ratio sensors.

In principle both these sensors serve a similar purpose: to monitor the exhaust gases and communicate the results to the vehicle's engine management system (EMS). Based on that, the ECU can take corrective measures, such as optimizing the fuel injection timing or quantity. The graph below shows the typical signal output of a traditional "switching" oxygen sensor: It clearly acts as a the binary signal (either high or low voltage around the 'stochiometric ratio', which is the ideal air/fuel mixture to enable most efficient combustion).

However, compared to such a "narrow band" sensor, the air/fuel ratio sensor provides both a wider sensing range and a higher level of sensitivity. So compared to a traditional oxygen sensor, an A/F sensor can not only judge if an air/fuel mixture is too rich or too lean, it can also tell precisely by how much. This means it can quantify the mixture and therefore it is called a linear (or wideband) sensor.

This ability is a very valuable added functionality that allows the EMS to respond to the needs of the engine quicker, with higher accuracy and in all driving conditions (rich and lean). A wider mixture control range enables a more efficient and cleaner combustion, resulting in better performance, fuel savings and lower CO2 emissions.

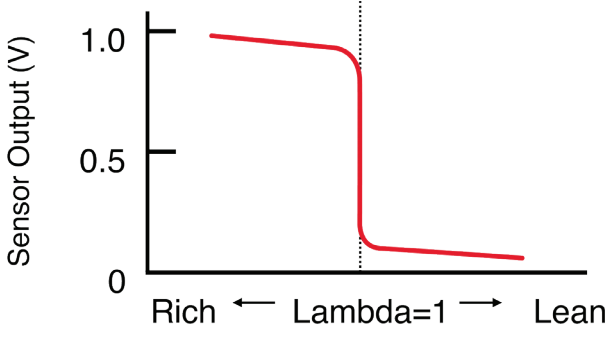

Figure 2: typical O2 signal

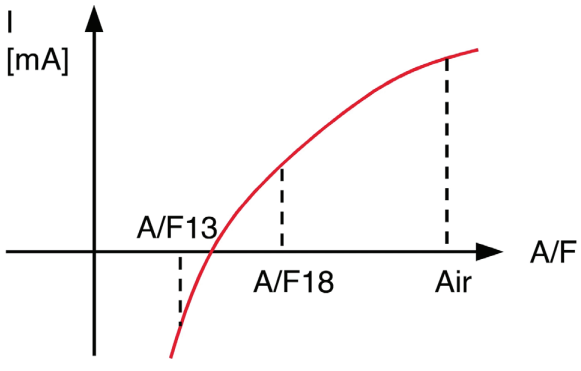

Figure 3: typical A/F signal

Besides an increase in engine efficiency, the EMS can work with a narrower catalytic window (figure 4) and consequently it can be better optimized to work with a smaller sized catalytic converter, which reduces the need to use rare-earth elements or noble metals. Also, in case of a cold start, the engine can reach a closed loop control much quicker, which reduces the emission of unburned hydrocarbons and CO (see figure 5).

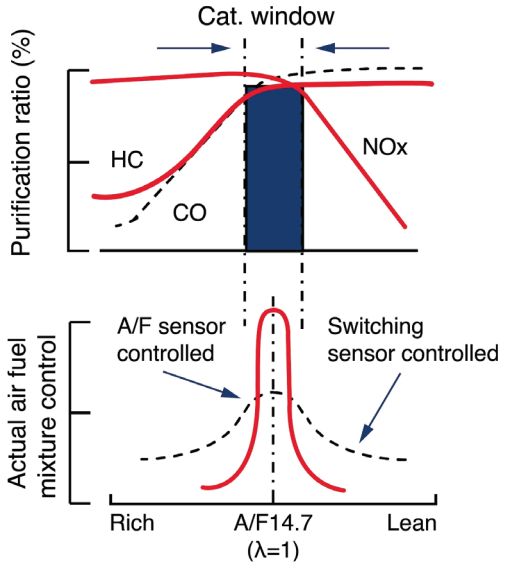

Figure 4:
more efficient utilisation of the catalytic converter

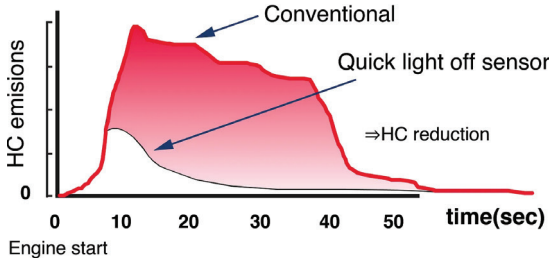

Figure 5:
quick "light-off" means great reduction of cold start emissions

It goes without saying that the signals that these two types of sensors produce are very different from each other, therefore, they cannot be exchanged. In fact, there are many different varieties of air/fuel ratio sensors. Although some differences are visible from the outside, most crucial differences are invisible; hidden inside the dozens of layers out of which the ceramic element is constructed, or even the specific recipe of its protective coatings.Therefore, it is very important to always choose the exact same original design specifications, when replacing an air/fuel ratio sensor.

DENSO has recently witnessed a few examples of imitation sensors appearing on the market. Our laboratory and vehicle tests of these products have revealed very poor performance levels and lifetime. Also, we saw an over-consolidation of vehicle applications. Both tests would certainly lead to premature failure and re-occurring engine warning lights on the dashboard should they be fitted to a customer's vehicle.

The message is clear - gambling on imitation parts is a risk that is simply not worth taking. Choosing original, genuine DENSO OE quality parts provides vehicles with the very best components while ensuring the safety and peace of mind of all drivers and passengers.

Further details of the DENSO Aftermarket programme are available online at: **www.denso-am.co.uk**

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