AAN 007 REDUCING NOISE WHEN DISPLAYING OXYGEN CONCENTRATION

Introduction
Unstable readings in an oxygen instrument or transmitter may be due to:

- Oxygen sensor intrinsic noise
- Instrument circuit noise
- Noise pick-up (susceptibility)

With the European requirement for CE Approval of EMC Susceptibility and Emissions, electronic engineers have become more adept at isolating and removing noise sources and screening susceptible circuits. This application note gives information for reducing noise in oxygen concentration monitors.

Intrinsic Noise
Oxygen sensors do not add significant noise to the system. The measured noise is less than 3µV for an Alphasense O2-A1 oxygen sensor inside a Faraday cage The intrinsic ("emitted") noise of an oxygen sensor is less than 0.02% of the measured current, which corresponds to 0.005% oxygen concentration. This is 10 times less than the resolution of normally displayed oxygen concentration, so intrinsic noise is not the source of the problem.

Circuit-generated noise is a potential problem with any circuit and is minimised by good practice: isolating analogue and digital signals and grounds, using ground planes and decoupling where appropriate.

Noise Susceptibility
Oxygen sensors have a large capacitance (about 40mF) and include a large metallic anode (lead). These features together provide an opportunity for noise pick-up (susceptibility) through the oxygen sensor.

The internal resistance of oxygen sensors is typically between 5 and 20 ohms; coupled with the large capacitance, the RC decay time of an oxygen sensor is between 1 and 25 seconds, an RC time especially susceptible to 110/230 VAC pick up.

Although each case is different, the typical results below show the magnitude of noise pick-up:

No screening	± 0.75% reading (± 0.15% oxygen at 20%)
Partially screened, near EMC source	± 0.33% reading (± 0.07% oxygen at 20%)
Partially screened, weak EMC source	± 0.2% reading (± 0.04% oxygen at 20%)
Fully screened sensor and circuitry	± 0.02% reading (± 0.004% oxygen at 20%)

Sensor Technology House, 300 Avenue West, Skyline 120, Great Notley. Essex.CM77 7AA. UK
Tel: +44 (0) 1376 556700 - Fax: +44 (0) 1376 335899
Email: sensors@alphasense.com - Web: www.alphasense.com

Design Tips

When screening toxic sensors and accompanying circuitry from RFI/EMI interference, a few points should be considered:

1 The impedance of the accompanying circuit is low around the sensor, so although magnetic fields (H) are not common, if they are present then they will easily couple into the circuit, creating noise. Therefore although Mu Metal is the ideal material, nickel or mild steel screening can be used to magnetically screen if magnetic fields are a problem.

2 The high capacitance of oxygen sensors make them especially susceptible to noise so consider a continuous screen. The mesh size of the screen will affect the maximum attenuated frequency, but screens with up to 2mm spacing should be adequate to cover up to the 100MHz region.

3 If the noise source is external, then screen the entire instrument case. However, if the noise source is coming from the inboard microprocessor then the sensor must be screened separately from the circuitry, and ensure good grounding. The best place to ground is the ground pin on your measuring op amp or A/D converter.

4 Keep the distance between sensor and measuring resistor as short as possible. It is common to mount the measuring resistor directly underneath the sensor.

Summary

Although oxygen sensors do not generate significant noise, their high capacitance and large metal mass make them susceptible to noise pick-up, especially at AC frequencies. Local lighting and equipment supply sources are frequently the culprits. Careful screening of circuitry and good EMC practice are necessary to reduce noise. Software smoothing and anti-aliasing algorithms can also be used to reduce measured noise.

Sensor Technology House, 300 Avenue West, Skyline 120, Great Notley. Essex.CM77 7AA. UK
Tel: +44 (0) 1376 556700 - Fax: +44 (0) 1376 335899
Email: sensors@alphasense.com - Web: www.alphasense.com