



## iGAS® Performance Tests – Ozone and NOx

**iGAS®** is a revolutionary new gas monitor from Turnkey®. It has multiple gas sensors that are capable of simultaneously measuring ppb concentrations of up to 8 different gas species. The individual gas sensors are housed in a shielded manifold and aspirated with an ultra-quiet pump. It is suitable for outdoor and indoor air pollution monitoring.

iGAS uses 4-electrode electrochemical cells to measure various gas species including NOx, ozone, carbon monoxide and sulphur dioxide. Carbon dioxide is measured by a nondispersive infrared (NDIR) sensor and VOCs (isobutylene) by a 10.6 eV photoionization detector (PID).

Electrochemical cells have previously had a poor record when measuring ppb concentrations of gas species. All are prone to zero drift with changes in ambient temperature and humidity. Even small changes of a few % in relative humidity can cause their output to change by 10's of ppb.

They also respond to carbon dioxide albeit with low sensitivity but, given that the CO<sub>2</sub> concentration at roadside may vary by several 100 ppm above ambient, the response to the pollutant species of interest can be masked. They also have cross sensitivity to other gas species. See Lewis et al. [1] for more details.

Attempts to correct their response by following the trends of a nearby reference sensor are not entirely successful and such correction of necessity takes time and means the readings are not available in real time.

For iGAS, Turnkey have developed a unique measurement system for electrochemical and photo-ionisation VOC detectors. This system corrects drift due to changes in temperature and humidity and for the presence of varying ambient concentrations of carbon dioxide. Corrections for smaller concentrations of interfering pollutant species are accomplished by using a matrix inversion technique. Results are available in real-time and can be updated as fast as every 2 minutes.

**iGAS** connects to Turnkey's [AirQWeb](#) cloud server, and can be used alongside our range of [dust and vibration & noise](#) measuring instruments to allow of a wide range of environmental measurements to be recorded by one integrated installation that is small and rugged enough to be fixed to a lamp-post.

For these trials, three iGAS instruments were co-located in a ventilated environmental cabinet with the following reference equipment:

- Thermo Scientific™ Model 49i Ozone Analyzer
- Thermo Scientific™ Model 42i (NO-NO<sub>2</sub>-NO<sub>x</sub>) Analyzer
- Thermo Scientific™ Enhanced Trace Level SO<sub>2</sub> Analyzer Model 43i-TLE
- Thermo Scientific™ Model 48i-TLE Enhanced Trace Level CO Analyzer

The site is a small industrial estate in Essex, close to the A131 road.

This report demonstrates the performance of iGAS when measuring oxides of nitrogen and ozone. Insufficient data were available from the reference instruments to illustrate the performance for carbon monoxide and sulphur dioxide. This will be the subject of a subsequent report once data are available.

Data collection started on the 14<sup>th</sup> Sept 2020 and is still ongoing. Here we present a typical 10-day period from the 10<sup>th</sup> to 19<sup>th</sup> of October. The following charts are self-explanatory, the iGAS serial numbers are G0009, G0010 and G0011. Readings are reported every 15 minutes and each report is the average over the previous 15 minutes.

These results clearly confirm the efficacy of the iGAS measurement scheme developed by Turnkey. They clearly demonstrate that iGAS produces stable and accurate readings in real time, even at low ppb levels. For NO<sub>2</sub> and O<sub>3</sub>, the measurement correlation coefficient R<sup>2</sup> exceeds 0.95 and the time series charts track each other and the reference instruments with excellent accuracy. The correlation is less good (R<sup>2</sup>=0.77) for Nitric Oxide but then the majority of readings are < 2 ppb for this gas.

[1] *Performance of low-cost sensors, Lewis et al., Faraday Discuss., 2016, 189, 85*

Turnkey Instruments would like to thank Alphasense ([www.alphasense.com](http://www.alphasense.com)) for the use of their environmental cabinet and reference instruments.

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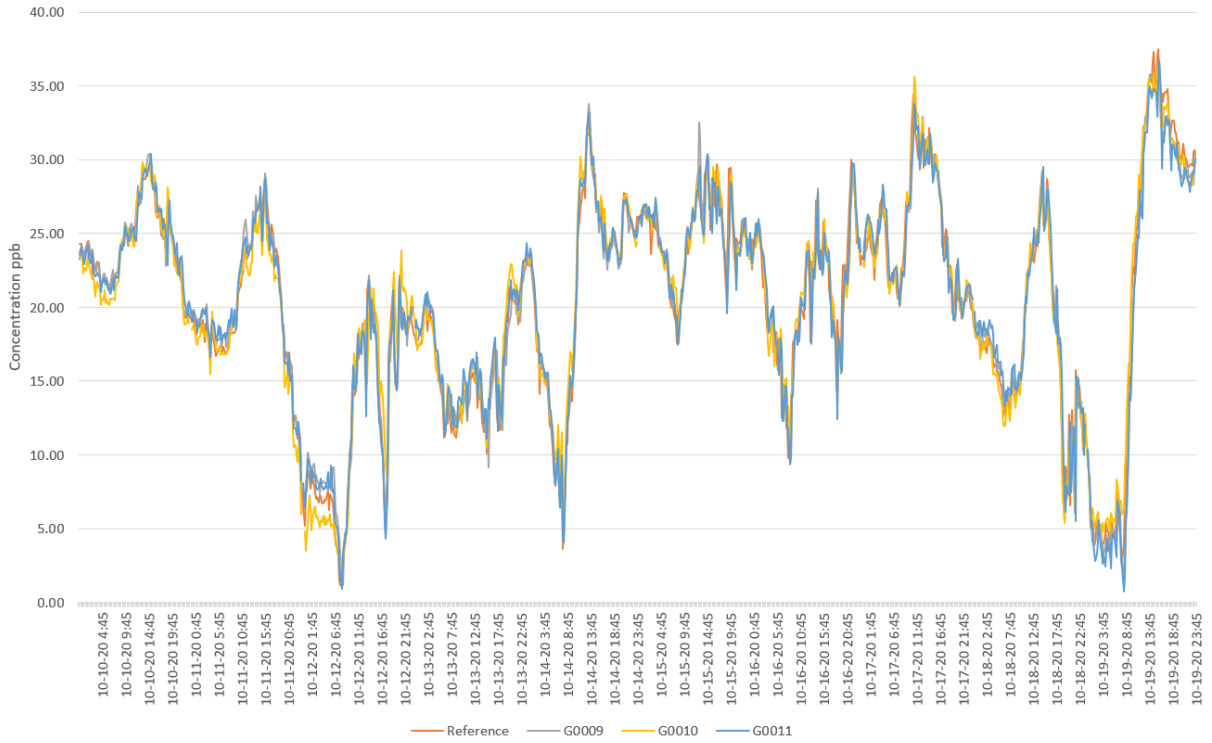
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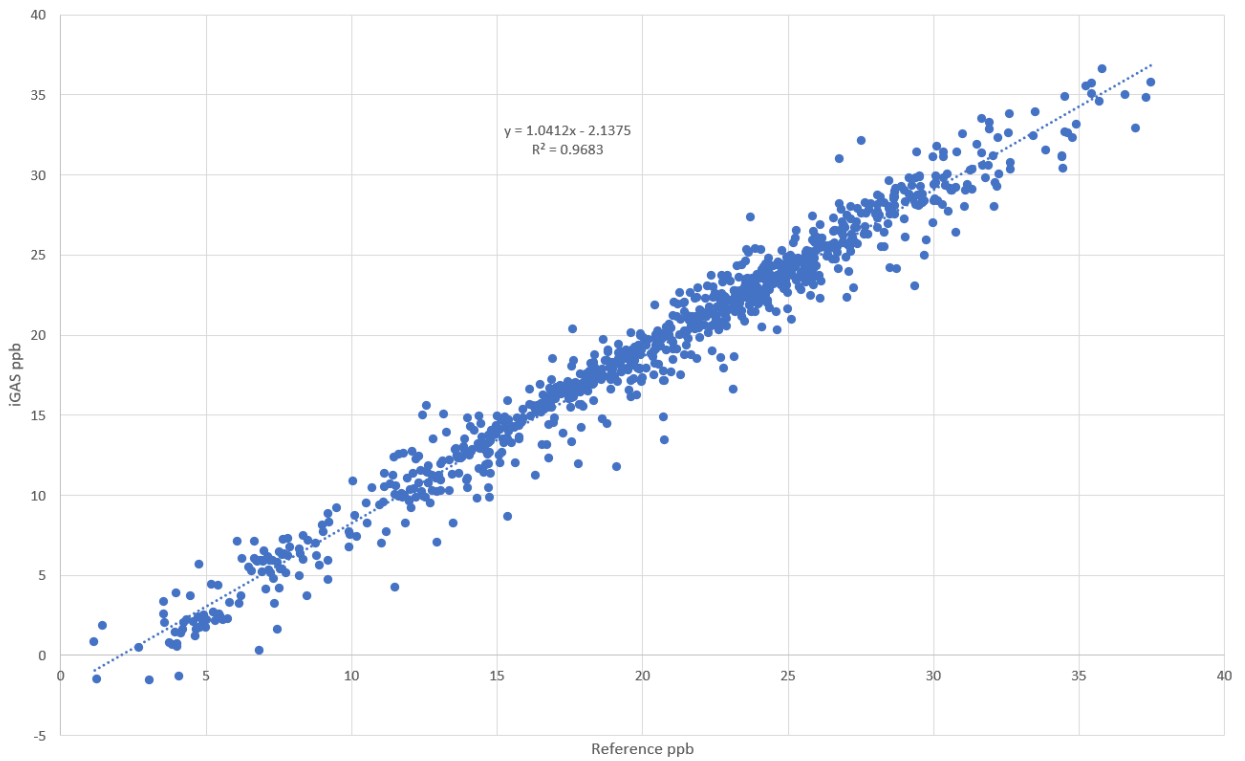
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# OZONE

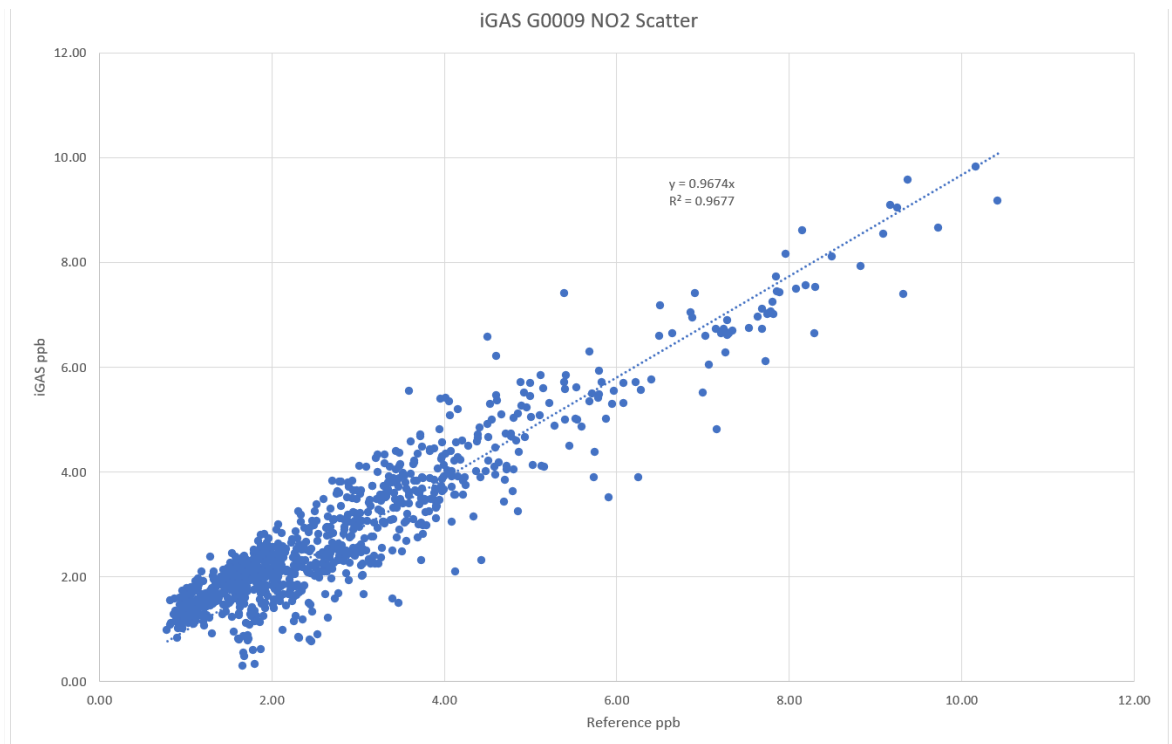
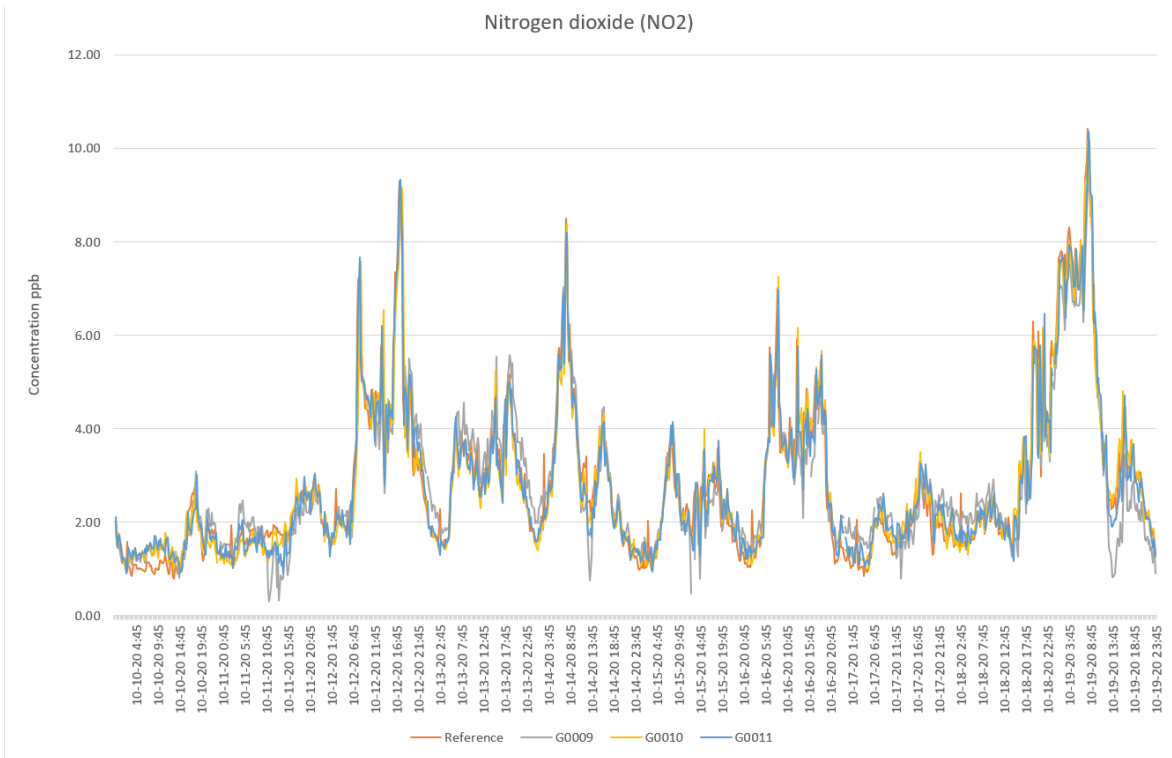
Ozone (O3)



iGAS G0009 O3 Scatter



# NITROGEN DIOXIDE



# NITRIC OXIDE

