Analyzer Specifications Technical Bulletin

1. Introduction

At Tiger Optics, we provide comprehensive specifications to give a detailed understanding of our instruments' performance. Each analyzer goes through a rigorous qualification procedure to ensure compliance with these highly stringent requirements. In this way, we guarantee product uniformity in keeping with our most exacting customers' expectations.

2. Specifications

2.1 Most analyzers

Lowest detection limit (LDL, 3σ/24h)	3σ (3 standard deviations) over 24 hours of zero gas data*
Accuracy	Relative deviation of analyzer reading from nominal intrusion level (at any given time)
Precision	±1σ (1 standard deviation) of intrusion data (not smaller than 1σ of zero gas data)
Range	The minimum and maximum measurable concentration of the analyte (lowest reading limited by LDL)

*includes any instrument drift over the 24-hour period

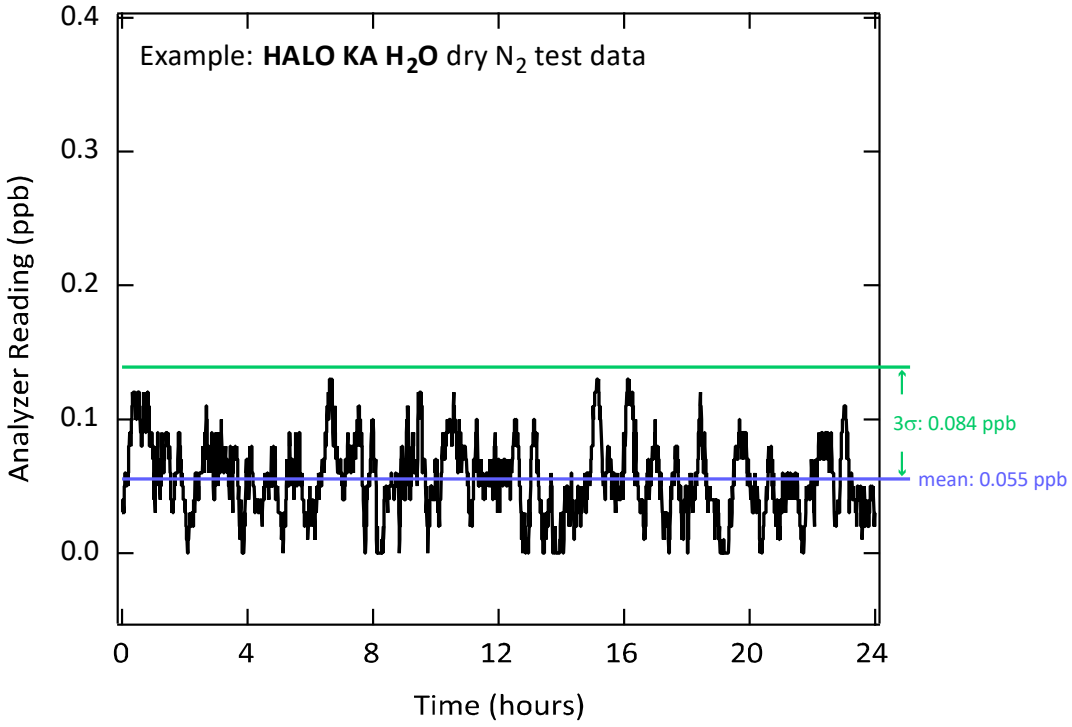
2.2 T-I Max series analyzers

Lowest detection limit (LDL, 3σ@100s)	3 times the value of the (Modified) Allan Deviation† of the raw zero gas data at an averaging time of 100 seconds
Accuracy	Relative deviation of analyzer reading from nominal intrusion level (at any given time)
Precision	±1σ (1 standard deviation) of intrusion data (not smaller than 1σ of zero gas data)
Range	The minimum and maximum measurable concentration of the analyte (lowest reading limited by LDL)

†for a general definition of Allan Deviation see https://en.wikipedia.org/wiki/Allan_variance

3. Testing with zero gas

3.1 24-hour test data

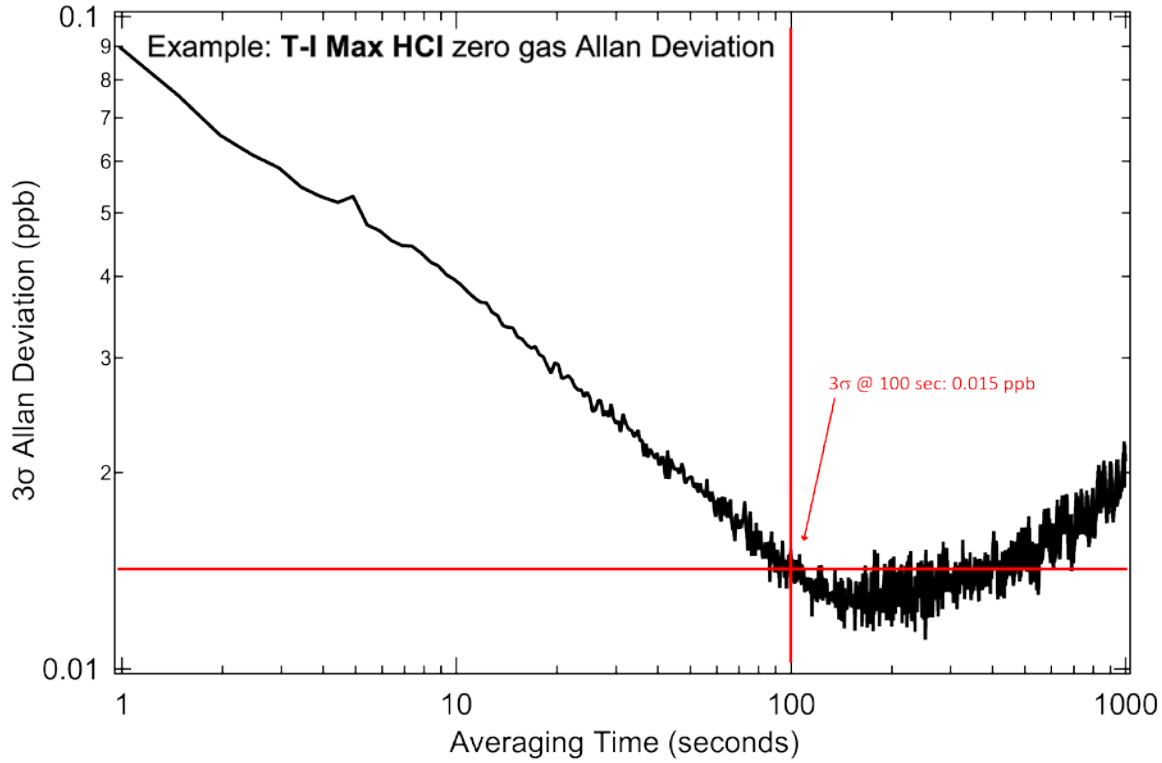


Qualification criteria:

3σ variation‡	Must be lower than LDL, 3σ/24h
Mean reading‡	Must also be lower than LDL, 3σ/24h

‡24h testing is only performed to derive specifications; qualification tests may be less than 24h; qualification criteria may vary for non-standard matrices and analyzers

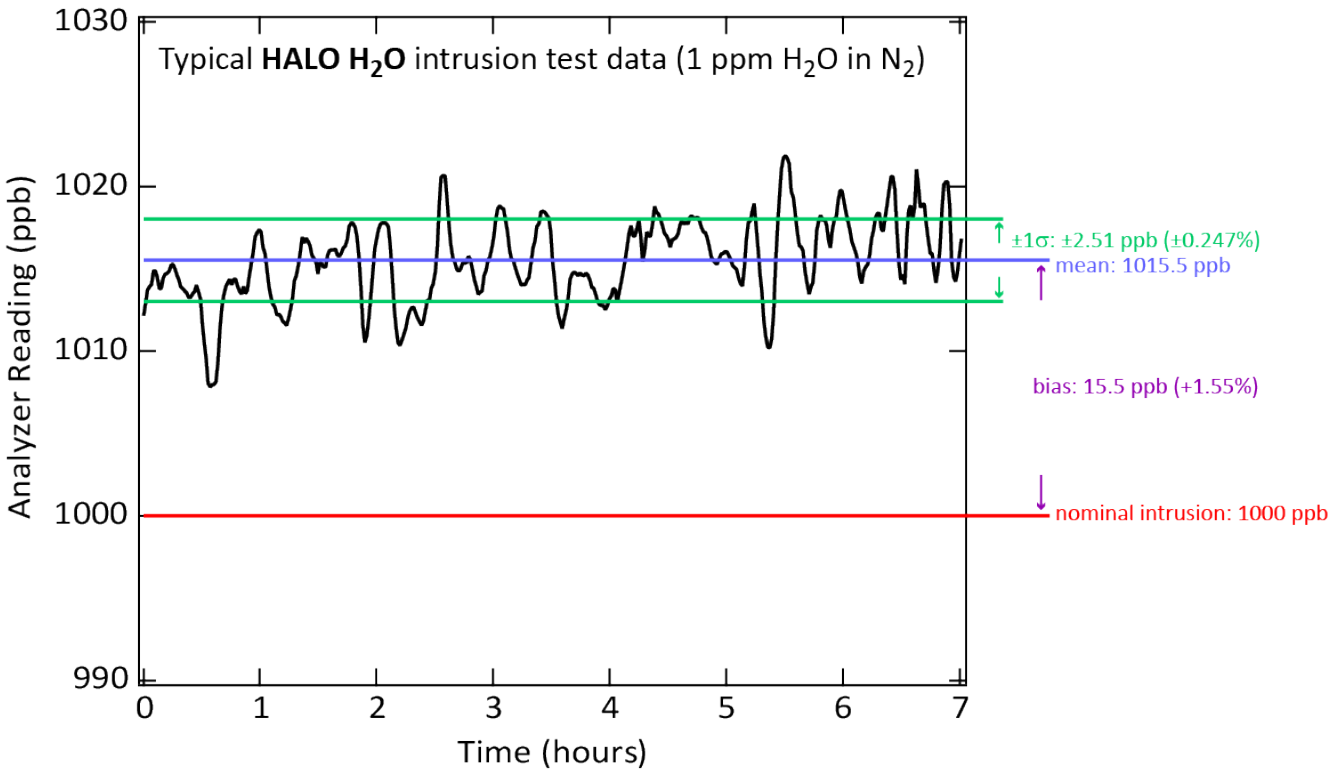
3.2 Allan deviation analysis



Qualification criteria:

3σ Allan Deviation	Must be lower than LDL, 3σ@100s

4. Testing with analyte intrusion



Qualification criteria:

Reading deviation	The deviation of the analyzer reading at any given time must be within Accuracy
1σ variation	±1 standard deviation relative to mean reading must be within Precision

5. Frequently Asked Questions

Why do I see different definitions of LDL for some products on the Tiger Optics website?

Tiger Optics CRDS analyzers serve many diverse markets, applications and detection ranges; we have implemented the most appropriate, industry-standard definition for each application. Traditionally, Tiger Optics has defined detection limits on a 24-hour measurement basis; however, this requires extremely stable and very clean gas.

Some of our newest systems, e.g. the T-I Max series, are designed for extremely low detection limits into the part-per-trillion range; however, they are used in environments where the sample gas is always not clean enough to achieve a true zero gas. Therefore, determining the true detection limit of the analyzer becomes challenging. Many customers desired a way to calculate the noise of an analyzer in such a situation. Looking at a large time window of data, which may still contain trace levels of analyte above the LDL, may result in artificially high noise calculations. Therefore, the Allan Deviation was adopted as a way to determine the analyzer's detection limit in a specific time window, independent of the presence of any residual analyte in the gas sample.

What does an Allan Deviation LDL of 3σ@100s mean?

An LDL of 3 sigma at 100 seconds references the measurement stability independent of long-term changes and/or residual amounts of analyte in the gas stream. This noise calculation takes a large time window and breaks it down into smaller time segments. It then compares the variation of readings in adjacent time segments. This allows us to calculate the actual noise of the readings, even if residual analyte exists in the gas stream.

How does a 3σ@100s compare to a peak-to-peak or 3σ/24h LDL?

Peak-to-peak LDL or 3σ/24h LDL can still be calculated from the same data set. However, if the analyte level is above the LDL and/or is changing, these calculations will be higher than the actual noise of the data. There is not a direct correlation between the two measurements. The difference will depend upon the rate of change of analyte in the gas stream.

I bought my analyzer many years ago. The specs I see on the website are now different than when I purchased my analyzer. Which specifications do I use?

Due to market demand, we may improve analyzer performance and specifications over time. The specifications applicable to your analyzer are the ones that were given to you at the time of purchase and can be found in the User's Manual that was originally shipped with your analyzer.

Can Tiger Optics also provide the specifications in other definitions, for instance, Peak-to-Peak noise?

Test data can be analyzed in different ways, depending on your requirements. Peak-to-Peak noise or other noise definitions can be provided upon request.

I have several Tiger Optics analyzers in use. Which LDL calculation goes with which analyzer?

Any definition of LDL can be calculated from a set of data, regardless of the analyzer. Tiger's specifications typically use the definition that is most applicable to the analyzer's target market. You should use the definition that is best suited to your application.