TRUSTED HYDROGEN SULFIDE MEASUREMENT FROM **APPLIED ANALYTICS™**

APPLIED™ ANALYTICS

OMA
Hydrogen Sulfide Analyzer

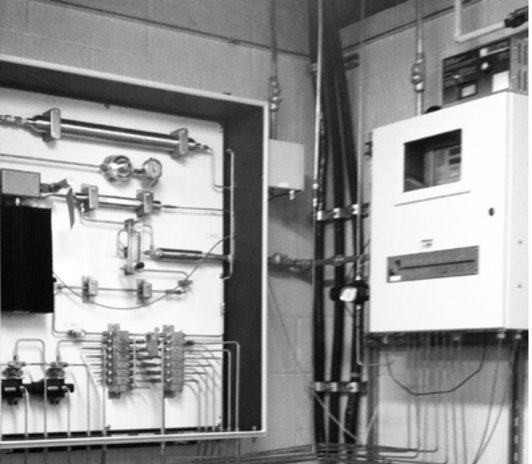
The world's **safest** continuous H_2S analyzer.

» UV-Vis 200-800 nm spectrophotometer
» Solid state with no moving parts
» Analyzes liquid or gas stream
» Zero cross-interference from other chemicals
» Measures up to 5 total stream components
» Xenon light source with 5 year lifespan
» Wide dynamic range — 0-10 ppm to 0-100%
» Direct analysis of hot/wet sample

Multi-Component Measurement:

H_2S

Up to 4 additional software benches



H_2S IN BIOGAS — USA, 2009

H_2S IN SWEET GAS — PHILIPPINES, 2012

H_2S IN NATURAL GAS — USA, 2012

H_2S IN SOUR GAS — QATAR, 2005

The Notorious H_2S

Hydrogen sulfide is **toxic** at 10 ppm, entirely **lethal** at 800 ppm, highly **corrosive** to equipment, **flammable** when in excess of 4.3% by volume in air, and unpleasantly **odorous** at a threshold of less than 1 ppb.

Unfortunately, H_2S occurs abundantly in the world's fossil fuel reserves and also forms as a by-product in various industrial and biological processes. In order to produce clean-burning fuels, prevent acid rain, protect pipelines and equipment from corrosion, and — most importantly — protect workers from imminent disasters, H_2S levels are highly regulated using scrubbers, scavengers, sulfur recovery units, and other removal technologies.

To properly control the level of H_2S in fuel, wastewater, or emissions, you need a reliable method of measuring the H_2S concentration. Since safety is a major concern, only highly proven solutions are considered. For many years, that meant that customers were stuck with archaic paper tape technology, a maintenance headache with toxic consumables and frequent moving-part hardware failures.

Since its launch in 1994, OMA technology has rapidly replaced the old methods by providing the customer with solid state reliability and superior performance in an affordable package.

What is the OMA H_2S Analyzer?

The OMA is an industrial device which measures a high-resolution absorbance spectrum in a continuously drawn sample from a liquid or gas process stream. Harvesting this rich data, the OMA H_2S Analyzer isolates the H_2S absorbance curve and provides a real-time value for H_2S concentration in your process.

» What is Absorbance Spectroscopy?

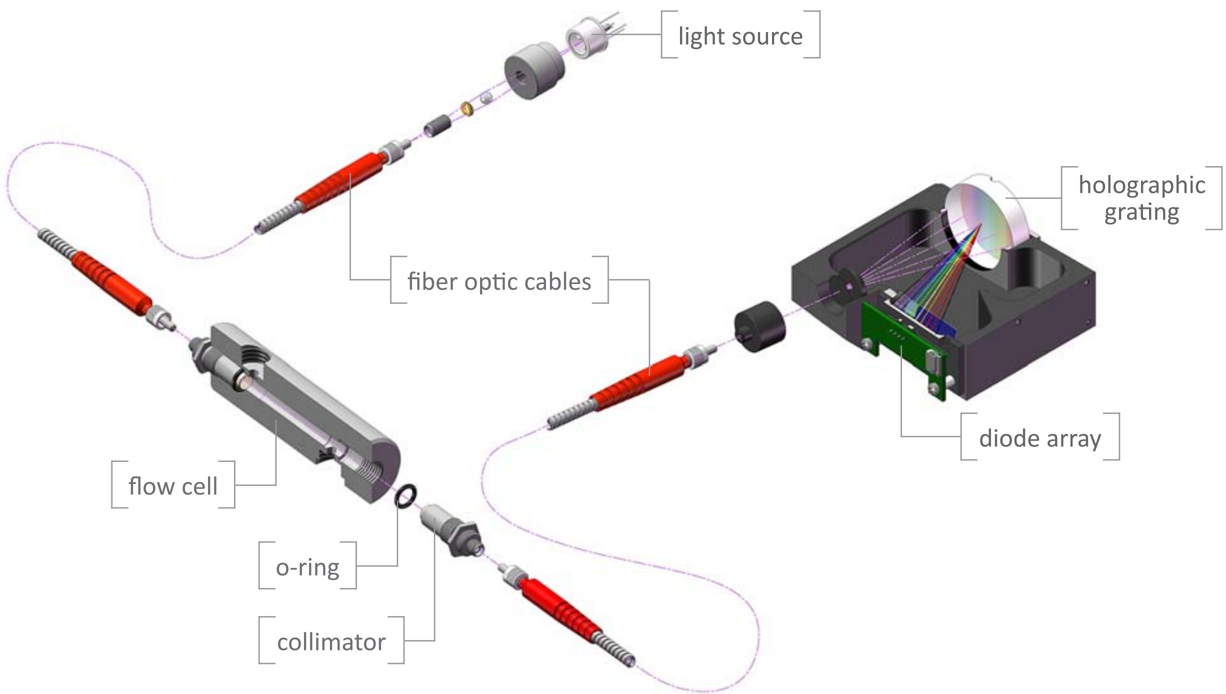
One of the ways in which light interacts with matter is *absorption*: a molecule absorbs specific wavelengths of radiation as a function of its unique electronic and molecular structures. The energies (wavelengths) of radiation that are absorbed match the energy quanta that are required to move that molecule between two quantum mechanical states. This is why each molecule absorbs radiation in a unique, recognizable way.

Absorption is quantified as *absorbance*, or the difference between intensity of the radiation entering the substance and the intensity of the radiation exiting the substance. Plotting the absorbance against wavelength creates an *absorbance spectrum*, which allows us to observe the shape (curve) of the absorbance. Each chemical species has a natural identifier in its absorbance curve that can be detected like a fingerprint.

According to Beer-Lambert law, the absorbance of a chemical in a mixture is directly proportional to its concentration. By measuring the height of a chemical's absorbance curve, an instrument can determine that chemical's concentration.

» OMA Principle of Operation

The optical assembly of the OMA is depicted below, illustrating the complete path of the signal.

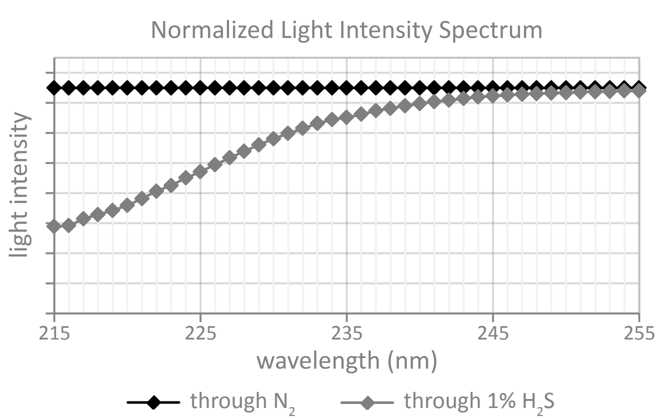


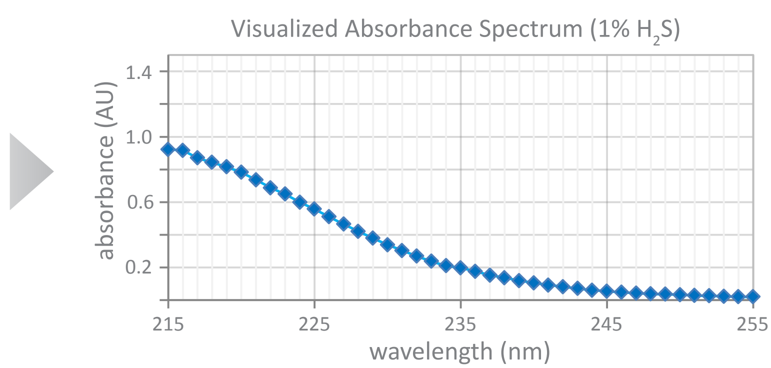
The signal originates in the light source and travels via fiber optic cable to the sample flow cell. Passing through the length of the flow cell, the signal picks up the absorbance imprint of the continuously drawn sample fluid.

Exiting the flow cell on the opposite end, the signal travels by fiber optic cable to the spectrophotometer, where a holographic grating separates the signal into its constituent wavelengths, focusing each wavelength onto a corresponding photodiode on a 1024-diode array. This is known as ***dispersive*** spectrophotometry.

» Producing an Absorbance Spectrum

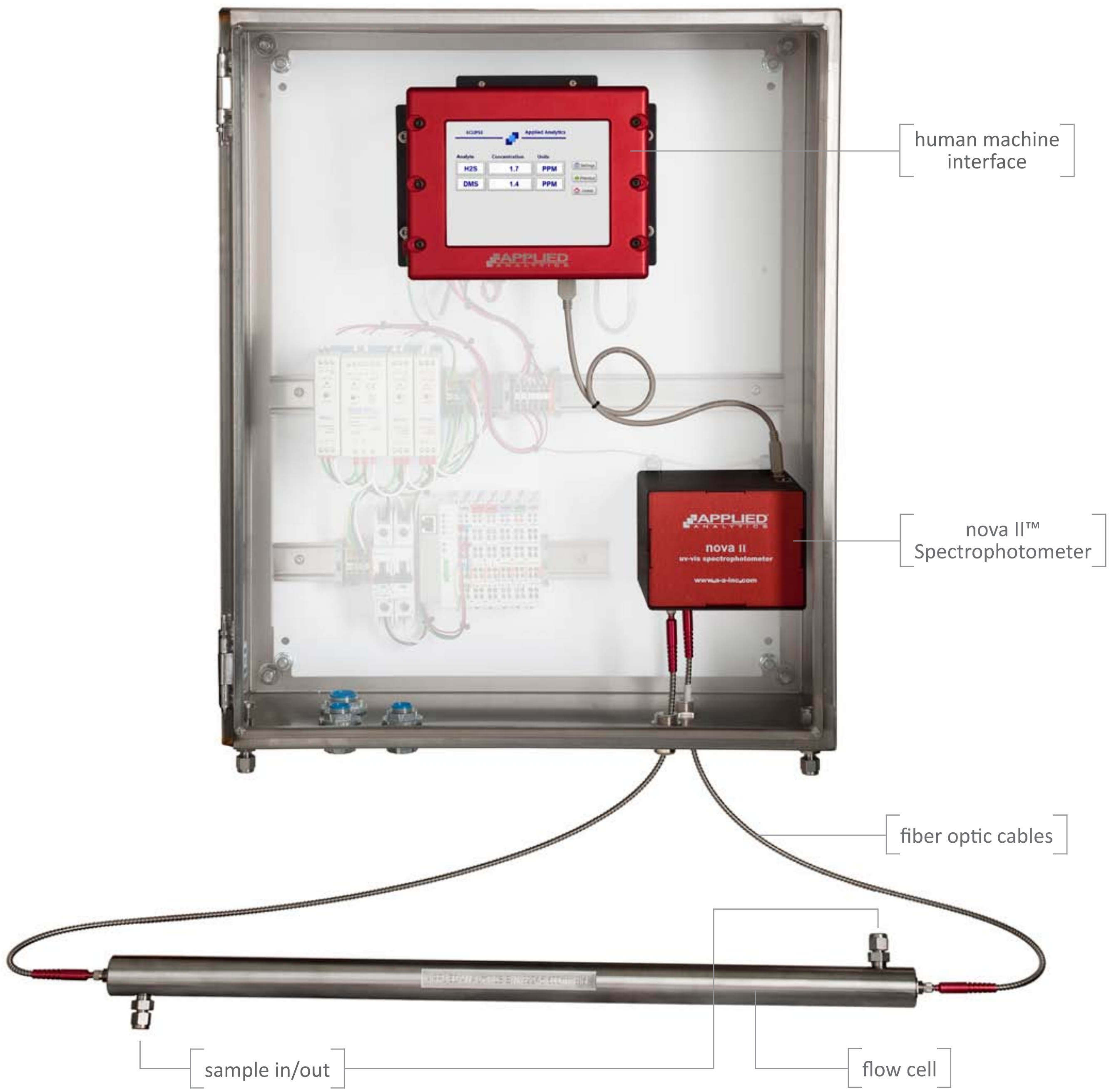
The intensity baseline of the signal is continuously refreshed by the Auto Zero, which stores an intensity spectrum while the flow cell is purged with zero-absorbance fluid (e..g nitrogen). During analysis, when running process sample through the flow cell, the OMA measures the difference in intensity from this baseline at each wavelength in order to produce an *absorbance spectrum*:





System Overview

Each version of the OMA uses the same basic components. These components are indicated below inside the model OMA-300 (door removed):



» **nova II™ Spectrophotometer**

The heart of the OMA is the diode array spectrophotometer. This device contains the light source as well as the detector which measures the absorbance spectrum.

A highly evolved device, the nova II has several distinctive features which allow it to excel in demanding OMA applications:

- Solid state build with excellent wavelength stability
- CMOS analog circuitry reduces noise and power consumption
- 1024-element diode array with ~1nm resolution
- Strong light throughput in low UV region
- Very low stray light due to design without mirrors or filters
- Ethernet interface for remote access

» **Human Machine Interface**

The HMI controlling the spectrophotometer and communication provides a simple, touch-screen visual interface. Running our proprietary ECLIPSE software, the HMI offers the user several display choices (e.g. standard numeric display, trendgraph, bar graph).

From this interface, the user can quickly adjust settings like how frequently the Auto Zero is performed, the unit of concentration for each measurement, the analog output range, and much more.

» **Flow Cell**

The sample (gas or liquid) from the process stream continuously cycles through the flow cell via 1/4" Swagelok tube fittings. The standard flow cell is rated up to 3,000 psi / 150 °C and made from stainless steel 316L for corrosion-proof durability.

The path length of the flow cell is specified by our engineers to optimize the measurement for the expected concentration ranges of your analytes.

2 mm path

600 mm path

» **Fiber Optic Cables**

Our fibers are all manufactured in-house to ensure spectroscopic-grade quality. The stainless steel cladding provides proven durability in the field. Before shipment, each fiber is tested to ensure it meets transmission benchmarks, Exceptional UV light transmission is achieved through our presolarization technique.

The fibers connect to the flow cell through rugged steel collimators, and are thus not wetted to the sample fluid. Optional cooling extensions provide further protection from hot samples.

Choose Your Form Factor

The OMA H_2S Analyzer is available in three different models:

MODEL OMA-300
WALL-MOUNTED ANALYZER

Available in a variety of enclosure materials.

MODEL OMA-206P
PORTABLE ANALYZER

A rugged copolymer suitcase enclosure.

MODEL OMA-406R
RACKMOUNT ANALYZER

Designed for a standard 19"rack.

Explosion-Proof Your OMA

The OMA-300 is available in two explosion-proof formats:

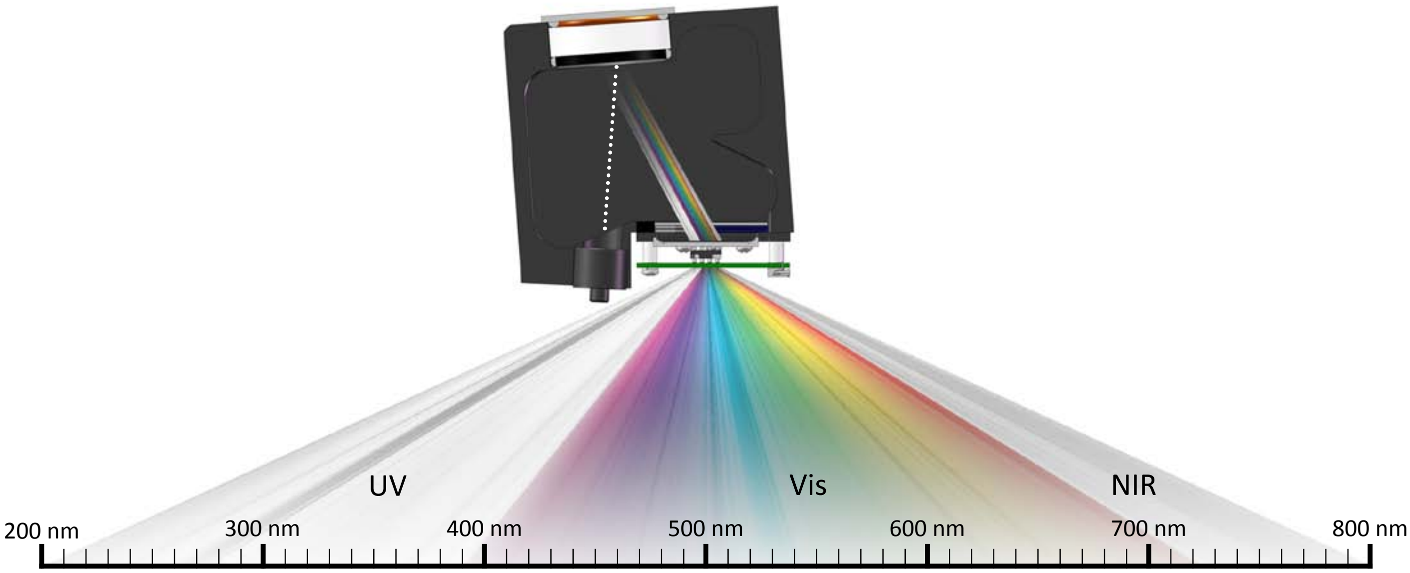
Ex p Purged Enclosure (X/Z Purge)

Ex d Cast-Aluminum NEMA 4X Enclosure

Full-Spectrum Analysis

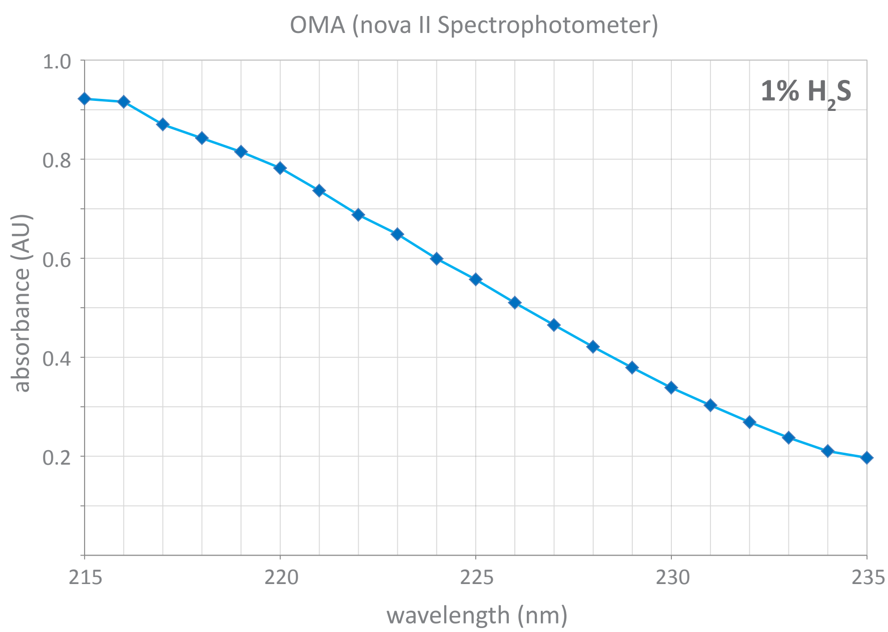
A conventional 'multi-wave' photometer measures a chemical's absorbance at one pre-selected wavelength with one photodiode. This 'non-dispersive' technique uses an optical filter or line source lamp to remove all wavelengths but the pre-selected measurement wavelength.

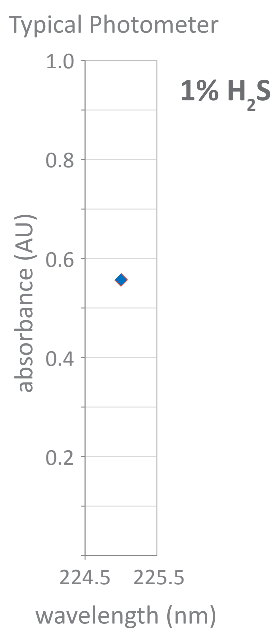
By contrast, the OMA uses a dispersive spectrophotometer to acquire a full, high-resolution spectrum. Each integer wavelength in the spectral range is individually measured by a dedicated photodiode.



» **The Accuracy Advantage of Collateral Data**

A single photodiode is susceptible to noise and signal clipping. As accepted in the lab community for decades, the only way to eradicate this source of error is to use many photodiodes measuring at many wavelengths. Compiling the data from all these photodiodes produces an absorbance spectrum instead of a single data point:

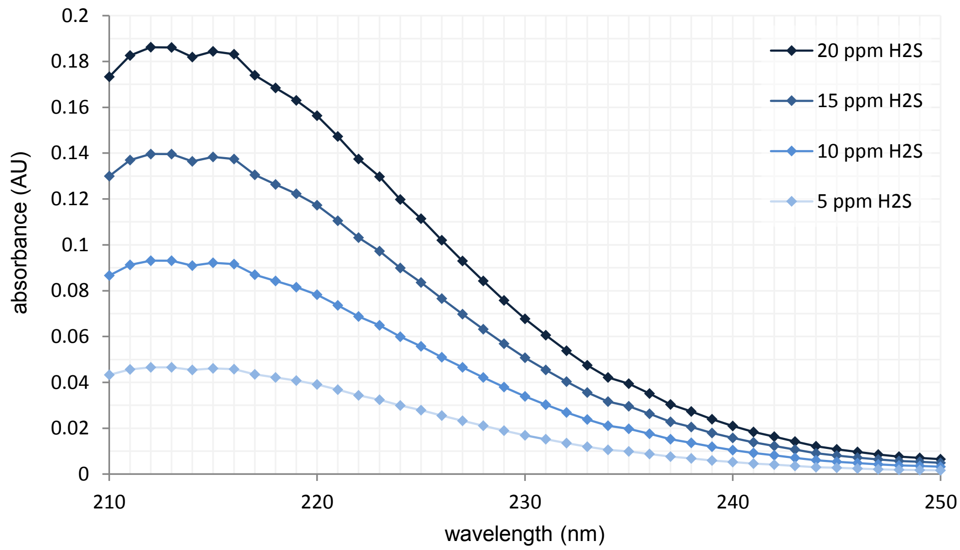




While the single-wavelength photometer has only one data point and no contextual curve with which to verify the accuracy of that data point, the OMA uses statistical averaging of all the data points along the curve to immediately detect and ignore erroneous data from a single photodiode. By detecting the actual structure of the curve instead of peak absorbance, the OMA avoids false positives and provides superior accuracy.

» Visualizing the H_2S Absorbance Curve

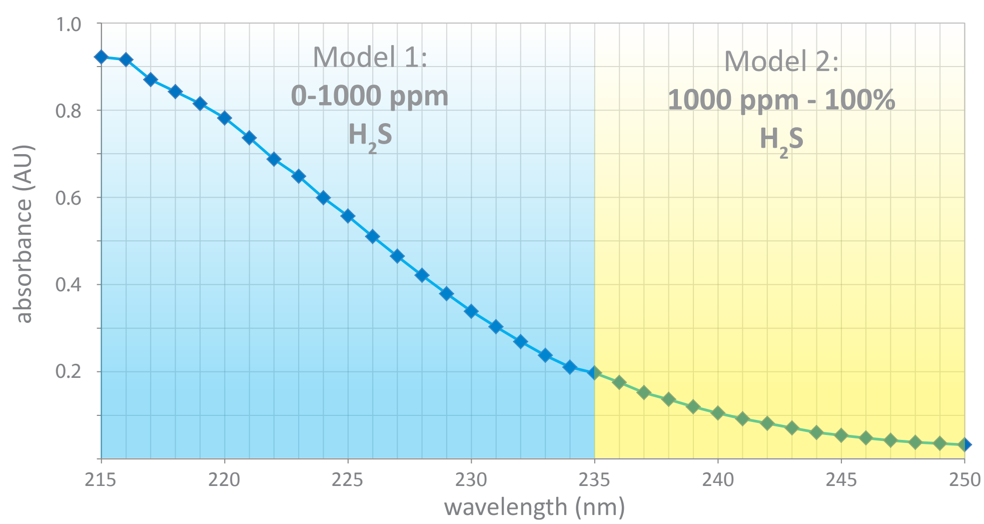
In calibration, the OMA 'learns' the absorbance curve of each measured analyte and how to isolate this curve from the total sample absorbance spectrum. Technically, the calibration procedure stores molar absorption coefficients for each wavelength while running a calibration standard (mixture of known concentration) through the flow cell.



» Massive Dynamic Range

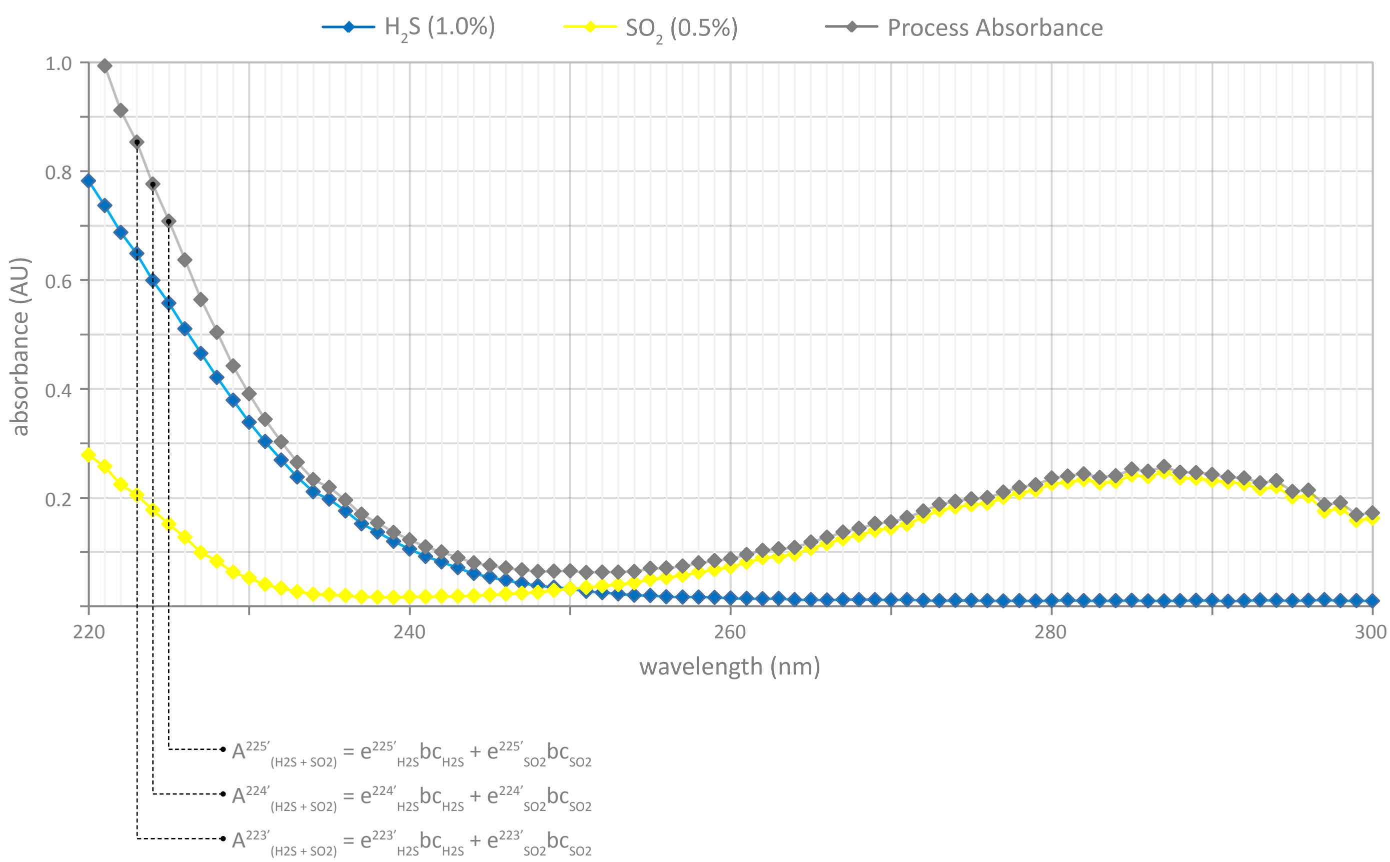
The reason that most photometers measure a limited concentration range is because the signal gets clipped when absorbance gets too low (indistinguishable from noise) or too high (zero light detected).

Through full-spectrum acquisition, the OMA has access to many measurement wavelengths. In order to constantly optimize the signal, the OMA runs parallel analysis models, each differentiated by their wavelength range and each suited for a specific concentration range. This concept is illustrated below, where the the low-absorbance region (235-250 nm) of the curve is used at the high concentration range to avoid low-light signal clipping.



Multi-Component Analysis

The ECLIPSE software is capable of measuring up to 5 chemical species simultaneously by de-convoluting the absorbance curve of each analyte from the total sample absorbance structure.



As illustrated above, each measurement wavelength contributes an equation to a matrix which is continuously solved by the ECLIPSE multi-component algorithm. Due to the resolution of the spectrophotometer, this procedure isolates the absorbance curve of H_2S with very high accuracy and is not susceptible to cross-interference. Each equation takes the form:

$$A'_{(x+y)} = A'_x + A'_y = e'_x bc_x + e'_y bc_y$$

Where *A'* is the absorbance at wavelength ', *e'* is the molar absorptivity coefficient at wavelength ', *c* is concentration, and *b* is the path length of the flow cell.

Photometers that offer multi-component analysis will often use crude techniques like rotating “chopper” filter wheels or a group of line source lamps. These solutions implement moving parts that are prone to malfunction and multiple light sources that all require replacement, while delivering inferior accuracy.

Through the power of rich data, the OMA provides robust multi-species measurement using a solid state design and a single light source.

» **Benefit Summary**

- Measure up to 5 chemical species simultaneously with a single OMA
- Add or remove analytes at any time
- Full subtraction of background absorbance (for avoidance of false positives)

The Safety of OMA

The major safety flaw of many H_2S analyzers is that they bring the toxic sample fluid into the analyzer enclosure for analysis. Not only does this expose system electronics to higher corrosion effects, it also poses a lethal threat: if there is any leak in the instrument, especially inside a shelter, the human operator is placed at enormous risk.

Applied Analytics design centers on inherent safety. The key difference between the OMA and other optical H_2S analyzers is the use of fiber optic cables: **we bring the light to the sample instead of bringing the sample to the light**. The toxic sample fluid is only required to circulate through the dedicated flow cell, and never enters the analyzer electronics enclosure.

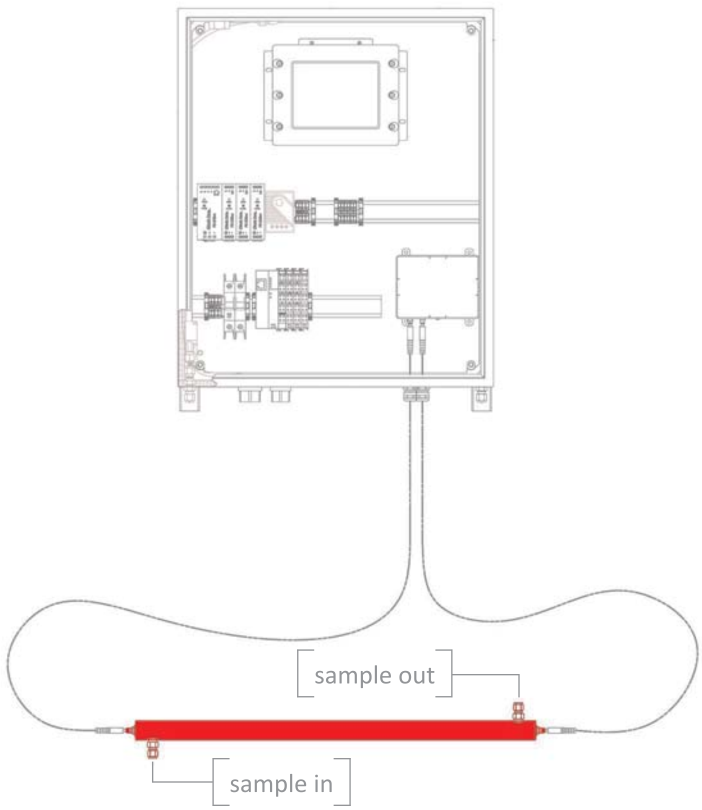
» **Wetted Parts**

The flow cell is sealed on each end by an extremely solid one-piece collimator inserted into an o-ring. No other parts of the analyzer assembly ever come into contact with the sample.

» **Safety Benefits**

- No danger of leaks inside the analyzer because the sample fluid does not enter the analyzer enclosure
- Standard SS316 flow cell is rated up to 3000 psi and pressure-tested at factory
- Custom fiber length up to 7 meters allows for distance between analyzer and flow cell
- User can safely perform service on the analyzer while process is running

(wetted parts colored in red)



This OMA system was installed outside of the enclosed area that contained the sampling point. The wall separates the analyzer from the flow cell and the fiber optics are wired through the wall. This system is being used to safely monitor H_2S and odorants at a natural gas custody transfer station.

Experienced Applications

The OMA has been used in many distinct H_2S applications since its launch in 1994. Below we highlight some of our most experienced, time-tested applications:

» H_2S in Crude Oil

Our highly proven solution for H_2S monitoring in crude oil uses an advanced headspace sample conditioner. Since oil is too opaque to transmit the OMA's light signal, this system exploits Henry's Law to produce a highly representative headspace vapor sample by heating the crude.

» H_2S in Offshore Environment

The offshore model OMA is specified for corrosive maritime conditions with NEMA 4X SS316 enclosures and super duplex steel wetted parts.

» H_2S in Flue Gas / Emissions

The 'close-coupled' OMA H_2S Analyzer is an elegant hybrid of cross-stack and extractive methods which combines the best of both. The system is mounted on the stack via a sintered metal probe which draws the sample.

» H_2S in Natural Gas

The most common H_2S application for the OMA is natural gas analysis, e.g. in pipeline corrosion prevention, wellhead, custody transfer stations, and more. The SCS design varies by specific application.

» H_2S in Water

The OMA is ideal for measuring H_2S in water specifically because H_2O has no absorbance in the 200-300 nm UV measurement wavelength range, allowing for direct 'wet' analysis.

Applied Analytics™

We are a global manufacturer of industrial process analysis equipment. Our customers depend on our systems to keep a vigilant watch over the quality of their product, illuminate hidden phenomena occurring in their process, reduce their harmful emissions into the environment, and ensure the safety of their workers in hazardous industrial environments.

We are proud to serve the industries that keep the world running — the oil refineries, the power plants, the wastewater treatment facilities, the chemical producers, the pharmaceutical innovators, the breweries, the environmental protection agencies — and meet their analysis needs with modern, automated solutions.

Applied Analytics has been operating in the greater Boston area since our incorporation in 1994. All of our products are designed and manufactured in the USA.

Comparison of H_2S Measurement Technologies

	Lead Acetate Tape	Tunable Diode Laser	Gas Chromatograph	OMA
Interference from moisture in sample?	**NONE**	**HIGH** Moisture absorbance is a serious problem at the laser wavelength.	**NONE**	**NONE** Water has no absorbance in the UV.
Response time?	**SLOW** 20-180 seconds. Actual response time depends on H_2S level.	**FAST** <10 seconds	**SLOW** 5-10 minutes	**FAST** <10 seconds
Dynamic range?	**LIMITED** Only suitable for low level H_2S. Tape saturation occurs above 1000 ppm and requires error-prone dilutions.	**LIMITED** Designed for levels under 500 ppmv. Signal saturation occurs at higher levels w/ no alternate wavelengths.	**WIDE**	**WIDE** 0-10 ppm and 0-100% in the same system.
Moving parts?	**YES** Users report frequent jamming of tape drive.	**NO**	**YES**	**NO** Totally solid state.
Additional chemical measurements?	**NO** The special tape is only sensitive to H_2S.	**NO** Each TDL unit measures one chemical.	**YES**	**YES** Up to 4 additional analytes.
Pressure range in the sample?	**LOW** Sample must be at atmospheric pressure	**LOW** Typical: 20 psig max.	**LOW** Sample must be at atmospheric pressure	**HIGH** 0-3,000 psig with standard flow cell.
Temperature range in the sample?	**HIGH**	**LOW** Significant error due to temperature sensitivity; sample temperature cannot exceed 50-60 °C.	**LOW**	**HIGH** 150 °C with standard flow cell. Software performs temperature compensation. Direct measurement of hot/wet sample.
Consumables? (other than zero gas)	**YES** Each paper tape reel lasts 1 month and must be manually replaced.	**YES** Copper nanoparticle H2S scrubber replaced each 18 months; high-volume cell consumes a lot of process fluid.	**YES** Carrier gas, separation columns, and detectors.	**NO** Xe light source has an average 5 year lifetime.
Maintenance cost?	**HIGH** New tape reel needed each month; frequent tape drive jams; manual dilutions for overload	**LOW** Optics require cleaning.	**HIGH** Famously expensive to operate and maintain.	**LOW** Optics require cleaning once per month -- 60 second procedure.

Note: specifications found in product literature from mainstream manufacturers.

Technical Specifications

Note: All performance specifications are subject to the assumption that the sample conditioning system and unit installation are approved by Applied Analytics. For any other arrangement, please inquire directly with Sales.

General	
Measurement Principle	Dispersive UV-Vis absorbance spectrophotometry
Detector	nova II™ diode array spectrophotometer
Spectral Range	200-800 nm
Light Source	Pulsed xenon lamp (average 5 year lifespan)
Signal Transmission	Standard: 600 µm core 1.8 meter fiber optic cables
Sample Phase	Gas or liquid
Sample Introduction	Standard: stainless steel 316L flow cell with application-dependent path length
Sample Conditioning	Custom design if needed
Analyzer Calibration	If possible, analyzer is factory calibrated with certified calibration fluids; no re-calibration required after initial calibration; measurement normalized by Auto Zero.
Reading Verification	Simple verification with samples or neutral density filters
Human Machine Interface	Industrial controller with touch-screen LCD display running ECLIPSE™ Software
Data Storage	32GB Solid State Drive
Available Certifications	CSA Class I, Division 1; CSA Class I, Division 2; ATEX Exp II 2(2) GD. *Please inquire for other certifications.*

Measuring Parameters		
Accuracy	**H_2S (liquid phase)** 0-10 mg/L: ±0.1 mg/L 0-100 mg/L: ±1% full scale or 0.1 mg/L*	**H_2S (gas phase)** 0-10 ppm (@10 bar): ±0.1 ppm 0-10 ppm (@1 bar): ±1 ppm 0-100 ppm: ±1% full scale or 1 ppm* 0-10,000 ppm: ±1% full scale 0-100%: ±1% full scale
		*Whichever larger.

Sample Conditions	
Sample Temperature	Using immersion probe: -20 to 150 °C (-4 to 302 °F) Using standard flow cell: -20 to 150 °C (-4 to 302 °F) Using optional sample cooling: up to 1000 °C (1832 °F)
Sample Pressure (max)	Using immersion probe: 100 bar (1470 psig) Using standard flow cell: 206 bar (3000 psi)

Ambient Conditions	
Analyzer Environment	Indoor/Outdoor (no shelter required)
Ambient Temperature	Standard: 0 to 35 °C (32 to 95 °F) With optional temperature control: -20 to 55 °C (-4 to 131 °F) *To avoid radiational heating, use of a sunshade is recommended for systems installed in direct sunlight.*

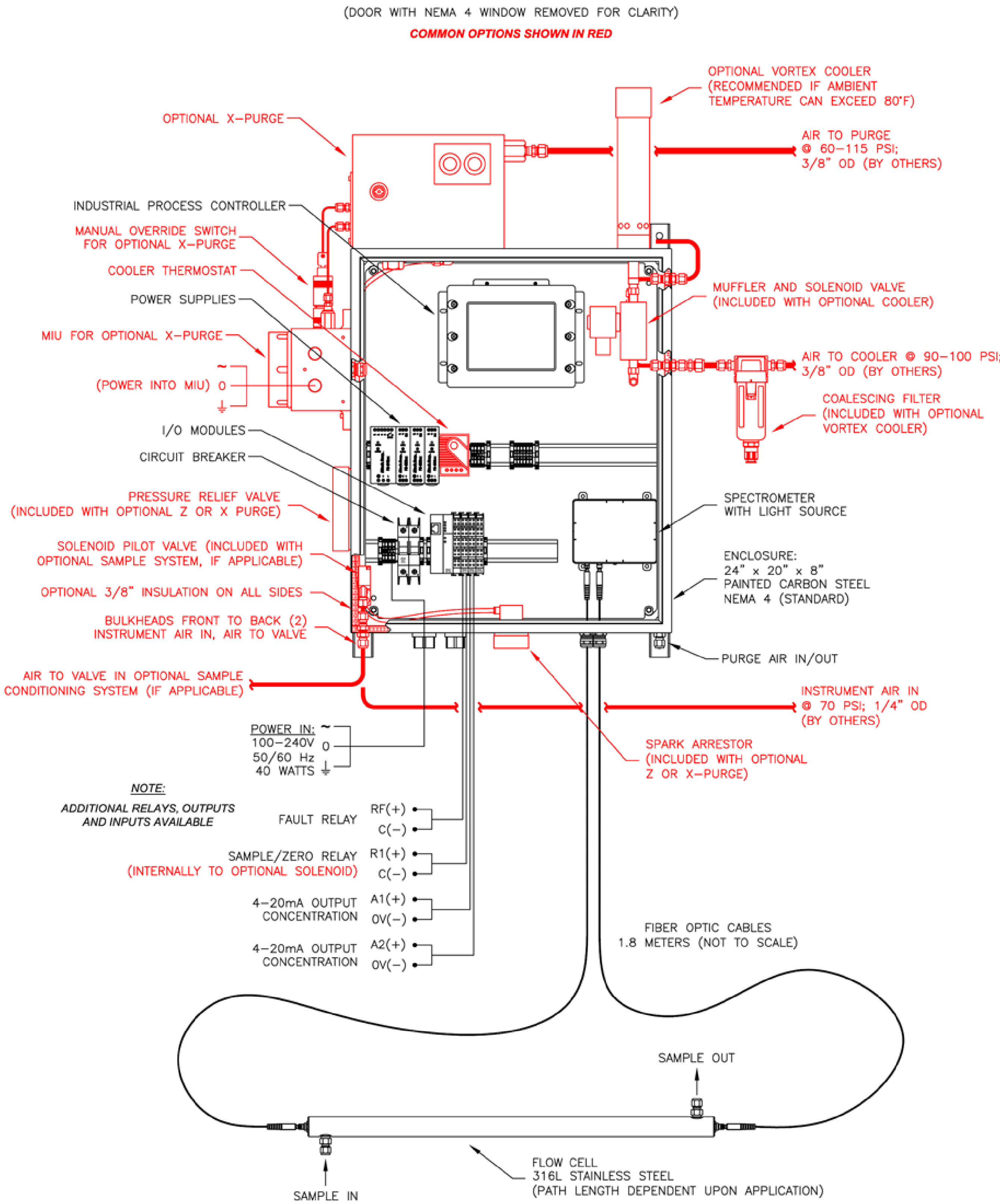
Utility Requirements	
Electrical	85 to 264 VAC 47 to 63 Hz
Power Consumption	45 watts

Outputs/Communication
1x galvanically isolated 4-20mA analog output per measured analyte (up to 3; additional available by upgrade) 2x digital outputs for fault and SCS control Optional: Modbus TCP/IP; RS-232; RS-485; Fieldbus; Profibus; HART; more

Physical Specifications	Model OMA-300	Model OMA-206P	Model OMA-406R
Analyzer Enclosure	Standard: wall-mounted, carbon steel NEMA 4 enclosure	Ultra High Impact structural copolymer suitcase	Steel rackmount enclosure for standard 19″ rack
Analyzer Dimensions	24″ H x 20″ W x 8″ D (610 x 508 x 203 mm)	16.87″ H x 20.62″ W x 8.12″ D (428 x 524 x 206 mm)	8.75″ H x 19″ W x 11.46″ D (222 x 483 x 291 mm)
Analyzer Weight	32 lbs. (15 kg)	25 lbs. (11 kg)	30 lbs. (14 kg)
Wetted Materials	Standard: K7 glass, Viton, stainless steel 316L		

Model OMA-300 Technical Drawing

See data sheets for drawings of OMA-206P and OMA-406R.



Applied Analytics™ is a registered trademark of Applied Analytics Group BV.

Headquarters + Manufacturing
Applied Analytics, Inc.
Burlington, MA, USA
sales@a-a-inc.com

North America Sales
Applied Analytics North America, Ltd.
Houston, TX, USA
sales@appliedanalytics.us

Brazil Sales
Applied Analytics do Brasil
Rio de Janeiro
sales@aadbl.com.br

Europe Sales
Applied Analytics Europe, SpA
Milan, Italy
sales@appliedanalytics.eu

Middle East Sales
Applied Analytics Middle East (FZE)
Sharjah, UAE
sales@appliedanalytics.ae

India Sales
Applied Analytics (India) Pte. Ltd.
Mumbai
sales@appliedanalytics.in

Asia Pacific Sales
Applied Analytics Asia Pte. Ltd.
Singapore
sales@appliedanalytics.com.sg

BUILD A WINDOW INTO YOUR PROCESS

WWW.A-A-INC.COM