

# Thermo Scientific SOLA II Sulfur Online Analyzer

Determine sulfur content in liquid or gas with unparalleled accuracy and precision

The Thermo Scientific™ SOLA II sulfur online analyzer determines the total sulfur content of liquid or gas phase samples to ensure process optimization and maximum uptime. Features include:

- Superior performance from 0.25 ppm to 5000 ppm sulfur
- Pure O<sub>2</sub> is not required, eliminating the risks associated with oxygen use in a process environment
- Semi-continuous operation; direction of change in sulfur concentration indicated at every injection
- Automatic density compensation for ppm sulfur wt/wt measurements
- 99%+ online uptime
- Automatic control of UV light intensity ensures calibration is maintained over a long period of time



Thermo Scientific™ SOLA II Sulfur Online Analyzer



The Thermo Scientific SOLA II sulfur online analyzer replaces labor-intensive laboratory grab samples with online analysis for rapid determination of sulfur contamination. With a worldwide installation base and a number of applications, this industry-leading instrument ensures maximum product yield, optimum product quality and improved operational efficiencies.

#### Clean Fuels

Producers of low-sulfur motor fuels use the SOLA II analyzer to ensure diesel and gasoline are produced within the targeted sulfur content. The superior analytical capability, including detection in parts per million (ppm), enables petroleum refiners to make timely process adjustments to enhance the economic efficiency of desulfurization and fuel blending operations.

#### Catalyst Protection

With detection in parts per billion (ppb), the Thermo Scientific™ SOLA II Trace analyzer controls the sulfur level of the hydrocarbon feed into the reactor catalyst, minimizing costly catalyst replacements and shutdowns.

#### Flare Feed Gas & Condensable Vapor

The highly accurate Thermo Scientific™ SOLA II Flare analyzer features a dynamic measuring range from 10 ppm to 95% S by volume with fast high-to-low response time, enabling reliable flare stack sulfur emission monitoring.

#### Dual Calibration/Dual Stream

The Thermo Scientific™ SOLA II Dual Calibration/Dual Stream analyzer enables two streams of radically different sulfur concentrations (i.e., batch processing, inlet/outlet of reactors, etc.) to be measured by a single analyzer, simplifying the process and reducing capital expenditures.

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## Theory of Operation

### Detection Limits as Low as 0.25 ppm sulfur

The SOLA II analyzer determines total sulfur by using pulsed ultraviolet fluorescence (PUVF) spectrometry. To determine the total sulfur content of hydrocarbon samples by PUVF, all organically bound sulfur must be converted to sulfur dioxide,  $\text{SO}_2$ . At a specific wavelength of ultraviolet light,  $h\nu_1$ , the  $\text{SO}_2$  molecules enter an excited state,  $\text{SO}_2^1$ . The  $\text{SO}_2^1$  will relax to its ground state,  $\text{SO}_2$ , by emission (fluorescence) of light at a slightly different wavelength,  $h\nu_2$ . The intensity of the emitted light,  $h\nu_2$ , is directly proportional to the total sulfur content of the sample.

An automated sample injection valve is used to introduce the sample. An air carrier gas is used to deliver the sample from the injection valve to the air bath oven. The air bath oven provides the necessary heat to fully vaporize all components of liquid samples. The hydrocarbon/air mixture next enters the mixing chamber where additional air is added. Upon exiting the mixing chamber, the sample is fully combusted to  $\text{CO}_2$ ,  $\text{H}_2\text{O}$  and  $\text{SO}_2$  in the 1100°C pyrolyzer. At the measurement cell, the sample is exposed to ultraviolet light. The photomultiplier tube (PMT) measures the intensity of the resulting fluorescence. Finally, the PMT signal is processed by the electronics to provide data communications to the process control system. The photodiode serves as the heart of a feedback circuit to ensure that the intensity of the ultraviolet, UV, flashlamp remains constant. Maintenance of a constant UV light intensity is a feature unique to the SOLA II analyzer to ensure calibrations are held stable over a long period of time. The unique SOLA II PUVF spectrometer delivers detection limits as low as 0.25 ppm sulfur. Sample flow can be seen in Figure 1.

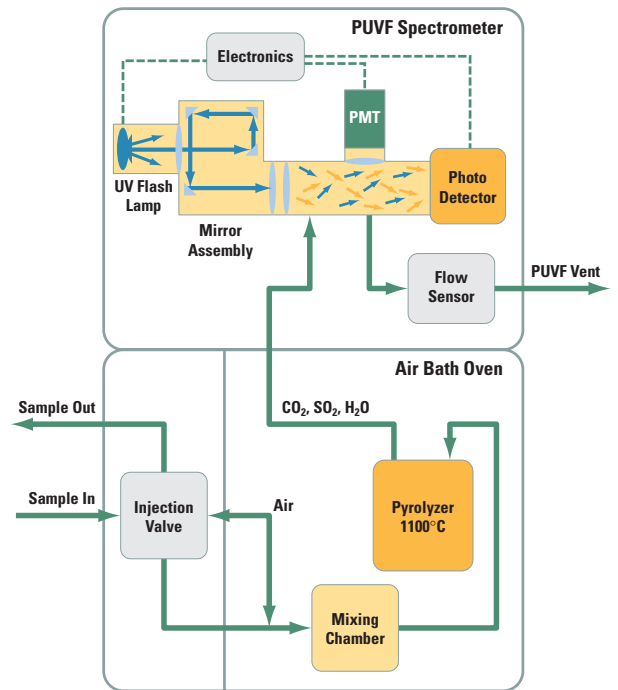
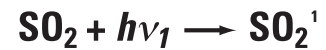


Figure 1. Schematic of sample flow through the SOLA II analyzer and PUVF reactions.

### Unparalleled Precision and Accuracy

With unparalleled accuracy and precision, the SOLA II analyzer rapidly indicates changes in total sulfur, enabling users to make process adjustments that ensure product yields are at targeted sulfur specification. Precision is measured in terms of standard deviation. Long-term repeatability runs of diesel, gasoline, and natural gas samples indicate excellent measurement precision (Table 1).

The analyzer's accuracy was evaluated by comparing its data to lab analyses by ASTM D5453 (Figure 2). The SOLA II analyzer has regularly demonstrated excellent agreement with all laboratory total sulfur measurement methods, including:

- ASTM Method D5453 for liquid phase samples; an adaptation of "Determination of Total Sulfur in Light Hydrocarbons, Motor Fuels and Oils by Ultraviolet Fluorescence"
- ISO Method 20846; an adaptation of "Petroleum Products – Determination of Sulfur Content of Automotive Fuels – Ultraviolet Fluorescence Method"
- ASTM Method D6313 for lead acetate colorimetry
- ASTM Method D2622 for XRF wavelength dispersion.

Sample	Diesel, EBP <400°C	Gasoline	Natural Gas
Length of Continuous Run	30 days	7 days	8 hours
Average Value for Run	18.76 ppm S	77.35 ppm S	4.97 ppm S
Standard Deviation for Run	0.15	0.83	0.03

Table 1. Typical measurement precision from the SOLA II analyzer for various energy substances.

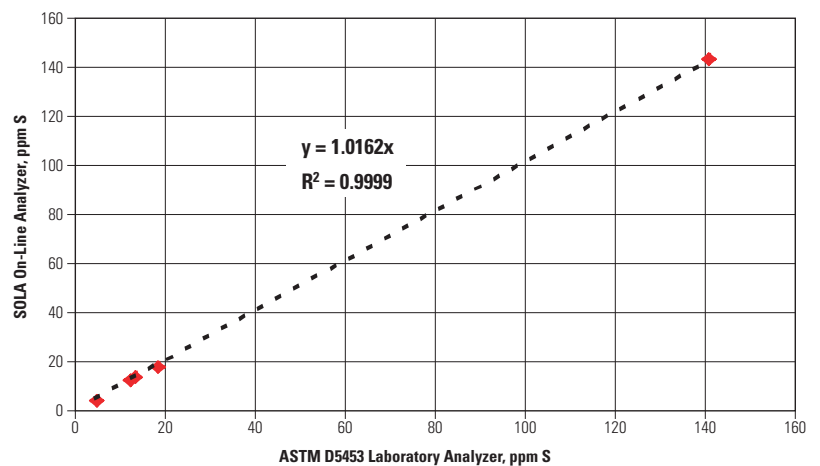


Figure 2. SOLA II analyzer data vs ASTM D5453.

## Rapid Response



As a semi-continuous online total sulfur analyzer, it responds to change in total sulfur concentration following sample injection, providing the user with a rapid indication of the rate of total sulfur concentration change. While the SOLA II analyzer requires three-to-five minutes to establish itself at 90% of a new value, the user has the benefit of knowing the direction of change in total sulfur concentration at every injection, typically every 30 seconds (Figure 3).

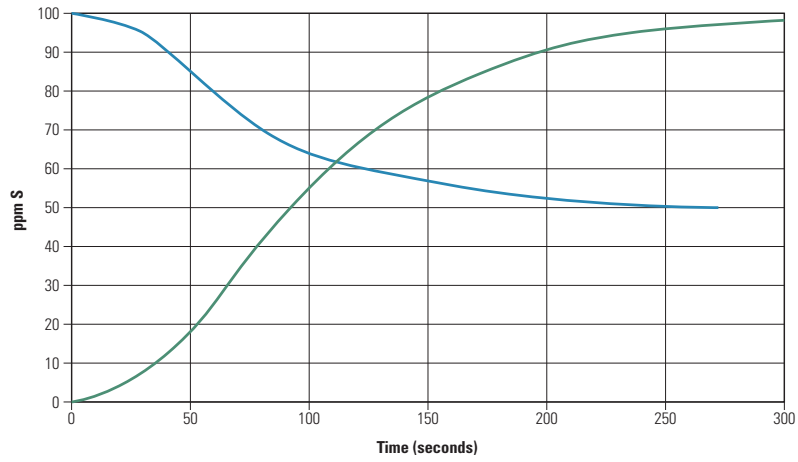


Figure 3. Sola II analyzer response time to sulfur concentration.

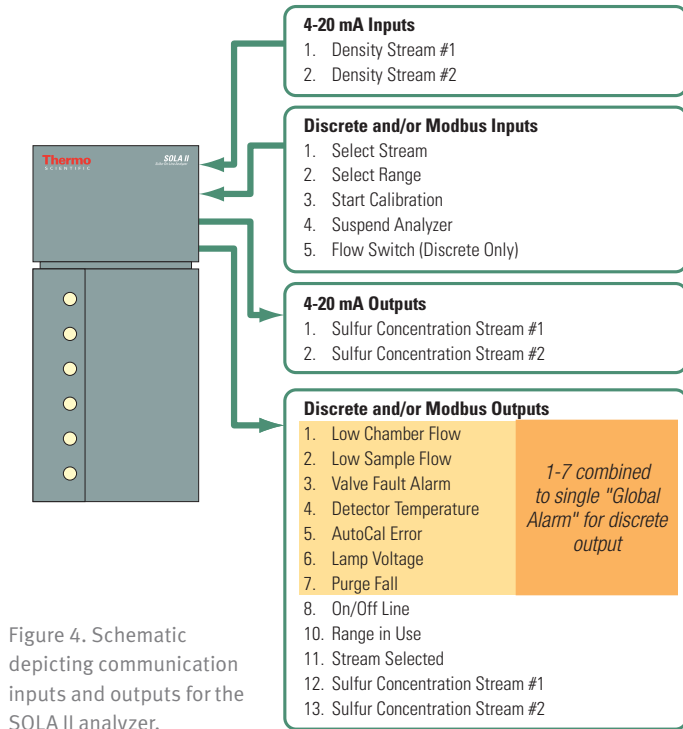


Figure 4. Schematic depicting communication inputs and outputs for the SOLA II analyzer.

## Communications and Diagnostics (Figure 4)

The SOLA II analyzer has auto-calibration capability. Data communications from the analyzer to the control system are enabled by 4-20 mA and discrete I/O or Modbus. A unique feature of the analyzer is its ability to accept 4-20 mA inputs from densitometers to provide automatic density compensation when the ppm S (wt/wt) unit of measure is used. The well known Thermo Scientific Sarasota FD910 densitometer can be supplied with the SOLA II analyzer for purposes of density compensation.

When using Modbus communications, the user benefits from detailed alarm information, which not only indicates a fault condition but tells the user exactly what condition caused the fault. Additionally, the detailed fault information is available on the analyzer's local display. It has the unique ability to automatically detect sample injection valve leaks. Should a leaking injection valve be detected, the analyzer automatically diverts sample flow from the injection valve and annunciates the condition through a latching alarm, preventing damage due to coke or soot formation. Comprehensive diagnostics deliver value by significantly reducing the meantime to repair.

## Thermo Scientific SOLAWeb Software

Thermo Scientific SOLAWeb software enables users to communicate with the SOLA II analyzer via a standard LAN connection. No vendor-specific software is needed. If the PC is connected to the Internet, it can access the analyzer.

SOLAWeb software provides access to all functions available at the local MMI plus the user can download 24-hour historical data, including analysis results and analyzer operating parameters (i.e., lamp voltage, PMT voltage, air flow, the raw detector signal, lamp intensity and detector cell temperature).

A link to the SOLAWeb workstation via modem can be installed to provide invaluable technical support. An optional interface board is all that is required to provide a complete end-to-end solution.

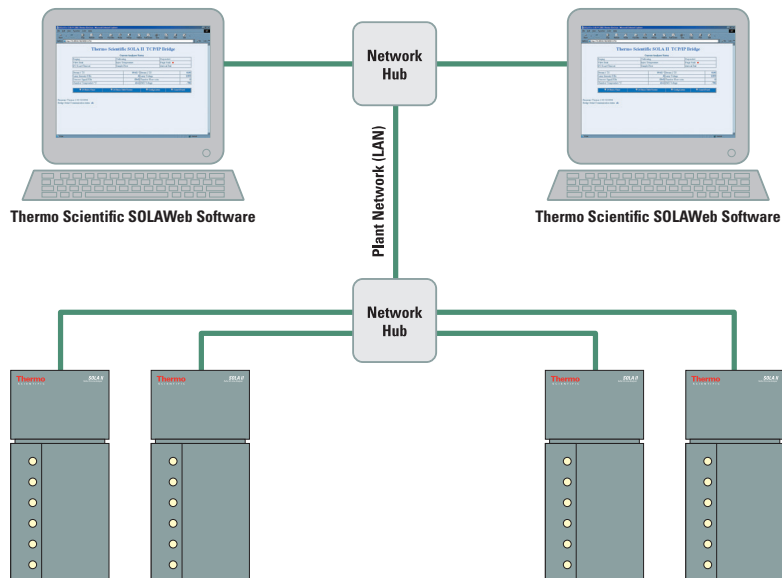


Figure 5. SOLAWeb software communication with SOLA II analyzers.

## Thermo Scientific SOLA II Sulfur On-Line Analyzer

### Analytical Performance

Detector	Pulsed UV Fluorescence (PUVF) with Pyrolyzer for Total Sulfur Measurement <sup>1</sup>
Measuring Ranges	SOLA II: Full scale ranges from 0-5 ppm S to 0-5000 ppm S (greater than 5000 ppm, consult Thermo Fisher Scientific) SOLA Trace: Full scale ranges from 0-2 ppm S to 0-500 ppm S SOLA Flare DI (low and high range analyzer system): 10 ppm to 95% S by volume SOLA Dual Calibration/Dual Stream: Same ranges available as on the SOLA II
Repeatability	SOLA II: $\pm 2\%$ of full scale, one sample injection per minute <sup>2</sup> ; $\pm 1\%$ of full scale, two sample injections per minute <sup>2</sup> SOLA Trace: $\pm 1\%$ of full scale, fixed at two sample injections per minute SOLA Flare DI (low and high range analyzer system): $\pm 1\%$ of full scale SOLA Dual Calibration/Dual Stream: Refer to SOLA II
Linearity	$\pm 2\%$ of full scale, one sample injection per minute <sup>2</sup> ; $\pm 1\%$ of full scale, two sample injections per minute <sup>2</sup>
Response Time	Semi-continuous, outputs updated every 1 second, 3-5 minutes to 90% of new value
Number of Process Streams	Dual streams with auto stream select (optional)
Calibration/Validation	Automatic or manual

### Analog/Discrete Data Communications

Analog Outputs	4-20 mA DC for each stream (standard)
Alarm Outputs	One global dry contact triggered by one or more of the following: Low sample flow alarm (optional); Low detector flow alarm; Oven/Pyrolyzer temperature fault; Injection valve fault; Purge failure; Calibration fault; Detector temperature fault; Detector lamp voltage fault One out of service dry contact triggered by: Analyzer in calibration; Suspension of analyzer
Analog Inputs	Optional 4-20 mA DC inputs from density meter for automatic density compensation of ppm S (w/w) Optional 4-20 mA DC input from sample flowmeter
Digital Data Communications	Dual channel with the following optional configurations: RS-232 Modbus & RS-485 Modbus Dual channel RS-485 Modbus TCP/IP encapsulated Modbus & RS-485 Modbus
Local MMI	Status of all analyzer parameters (e.g., furnace & oven temperatures, PMT and lamp voltage, detector flow rate, etc.) and analytical results available on front mounted displays, push button menu access, hazardous area classification remains intact while operating local display
SOLA II Modbus Remote Interface	Provides complete remote control; Automatic logging of analysis results and analyzer parameters; Communication to SOLA II analyzer via serial or TCP/IP encapsulated Modbus enables remote diagnostics
SOLAWeb Remote Interface	Provides complete remote control; Ability to download 24 hours of analysis results and analyzer parameters; Communication to SOLA II analyzer via local area network (TCP/IP) enables remote diagnostics

### Utility Requirements

Ambient Temperature	+12°C to +40°C (+54°F to +104°F)
Power	110 VAC, 50/60 Hz at 2000 watts; 220 VAC, 50/60 Hz at 2000 watts
Instrument Air	55-100 psig (5.5 barg), 8 SCFM, Oil Free, -40°C (-40°F) dew point
Zero Grade Air	80 psig (5.5 barg), 200-300 SCCM

### Dimensions

Zone 1; Div. 1 Configurations	1581.15 mm (62.25 in) high x 647.70 mm (25.50 in) wide x 476.25 mm (18.75 in) deep
Zone 2; Div. 2 Configurations	1104.39 mm (43.48 in) high x 647.70 mm (25.50 in) wide x 476.25 mm (18.75 in) deep
Certifications	(Built to) NEC Class I, Division 2, Groups B, C & D (Built to) NEC Class I, Division 1 (optional), Groups B, C & D CSA with associated "C/US Mark" Class I, Division 2, Groups B, C & D CSA with associated "C/US Mark" Class I, Division 1, Groups B, C & D ATEX Zone 2, EEx p IIC T2 (T3, T4 optional) ATEX Zone 1 (optional), EEx p IIC T2 (T3, T4 optional) IEC Ex Zone 1 Ex px IIC T2 (T3 optional) CE Mark

<sup>1</sup>Online adaptation of ASTM Method D5453 for liquid phase applications and ASTM Method D6667 for LPG and gas phase applications.

<sup>2</sup>The number of sample injections per minute is user definable.

For more information, visit our website at [thermoscientific.com](http://thermoscientific.com)

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