

- Excellent long term stability and low drift
- Measurement inherently fails high if sensor damaged (no false zero)
- LOD = 0.5 ppm O₂ gas phase
- No membranes to foul; No electrolytes to poison; No consumption of O₂
- Hazardous area approvals: FM, CSA, ATEX, UL and CE
- No cross-sensitivity or damage caused by: CO₂, H₂S, NH₃, NO₂, heavy metals, ethanol, methanol or ionic species pH, S₂⁻, SO₄²⁻, Cl⁻, salinity or turbidity
- Measurement independent of flow velocity

The 4401OXY analyzer optically measures oxygen in either the gas or liquid phase by utilizing quench luminescence of an oxygen specific luminophore.

The analyzer is suitable for direct field installation (NEMA 4X) in hazardous area (Class I, Division 2). The optical fiber sensor platform allows small inline sensors to be installed into sample tubing lines (1/4"), flow cells using NPT fittings, or directly into tanks or process lines using our retractable "hot tap" sensor design. BOS optical oxygen sensors are impervious to typical O₂ poisons (H₂S) and interferences (combustibles, magnetic, CO₂ and H₂) with high accuracy and long-term stability measurements without the need for complex or advanced sample conditioning systems. The threaded version of the optical sensor has optional Dual Seal (ANSI/ISA 12.27.01) classification for high pressure applications up to 1200 PSIG (82.7 BAR).

The analyzer display and output units can be setup in either partial pressure (hPa or Torr) or in concentration (ppm or % O₂) for the gas phases along with hPa, ppm or ppb for dissolved oxygen in liquid phase.



Typical Applications - Gas Phase (g)

- O₂ in hydrocarbon streams
- O₂ detection in nitrogen headers
- O₂ in process streams
- O₂ in nitrogen tank blanketing
- Trace level oxygen in flare gas

Limit of Detection: 0.5 ppm O₂ @ 1atm, 20°C (0.0005 hPa)

Typical Applications - Liquid Phase (l)

- High pressure produced water Dissolved O₂
- ppb dissolved O₂ for waterflood injection
- Oxygen in methanol and ethanol
- Oxygen in oils
- Dissolved O₂ in liquid process streams
- Dissolved O₂ in product streams

Limit of Detection: 1 ppb Dissolved O₂

Precision Optical Oxygen Measurement

4401OXY Oxygen Analyzer & BOS Sensors

Principle of Operation

The 4401 OXY is a phase fluorometric analyzer that utilizes phase modulation to evaluate the luminescent decay time of an oxygen specific luminophore to calculate oxygen concentration. The sensor comprises of a small luminophore embedded in a polymeric matrix at the end of a fiber optic cable allowing for an extremely sensitive and accurate measurement of the partial pressure of oxygen that is applicable in both gas phase and liquid phase.

The analyzer uses an LED to emit blue light through fiber optic cable down the sensor tip [Fig 1]. The sensor tip contains the luminophore which absorbs the energy and rises to an excited state. In the absence of oxygen the excited luminophore will fall back to its ground state at a specific rate and in the process emits a red shifted light which is transmitted to the analyzer (spectrometer) via the optic cable where it is detected by a photomultiplier tube. When oxygen is present it quenches the fluorescence at a rate proportional to the oxygen concentration [Fig 2.]. The phase shift between the excitation source and the fluorescent signal is measured and the oxygen concentration is calculated [Fig 3].

Light transmission through fiber optic to luminophore

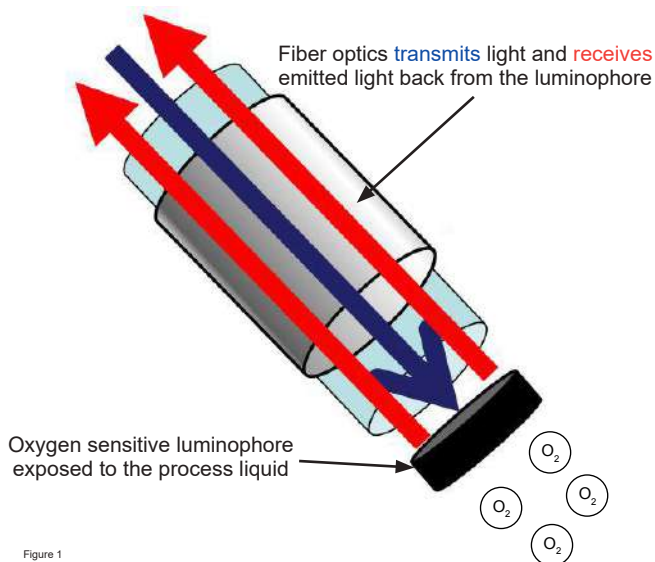


Figure 1

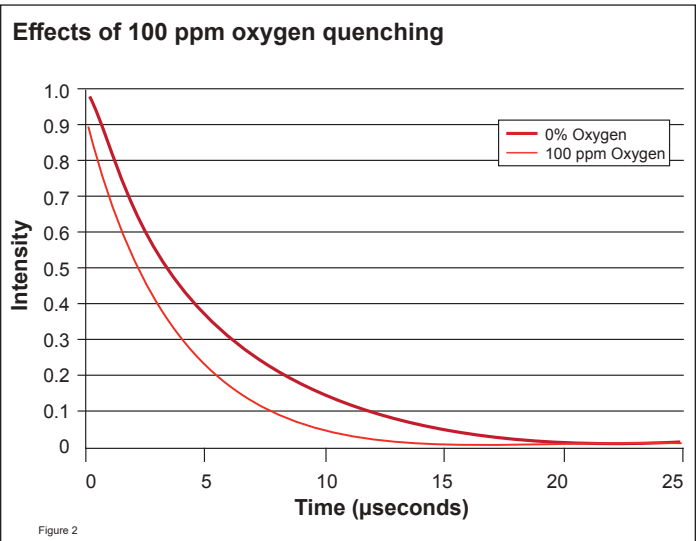


Figure 2

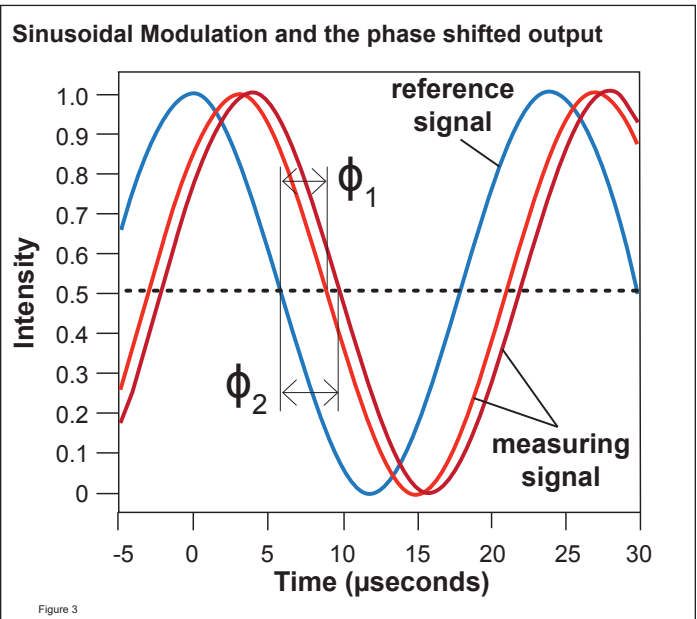


Figure 3

Precision Optical Oxygen Measurement 4401OXY Oxygen Analyzer & BOS Sensors

4401OXY Oxygen Analyzer Specifications	
Part Numbers (Ordering Information)	
4401OXY	Oxygen Analyzer with 100-240VAC Operational Power, FM / CSA Approval
4401OXY-CE	Oxygen Analyzer with 100-240VAC Operational Power, ATEX / CE Approval
4401OXY-DC	Oxygen Analyzer with 9-24VDC* Operational Power, FM / CSA Approval
4401OXY-DC-CE	Oxygen Analyzer with 9-24VDC* Operational Power, ATEX / CE Approval
Input Information	
Sensor Input	(1) O ₂ optical input BOS1, BOS2 or BOS3 sensor (SMA connector), (1) PT1000 input
Digital Interface	
Analog Outputs	(2) Programmable voltage outputs with galvanic isolation, 0 to 10 V (2) Programmable current outputs with galvanic isolation, 4 to 20 mA
Sampling Rate	Programmable from 3 seconds to 1 hour
User Adjustable Options	
Units: User Selectable	Gas Phase: % air-saturation, % oxygen, hPa, Torr, ppm. Liquid Phase: hPa, Torr, ppm, ppb, μmol
Calibration	Conventional two-point calibration
Environmental	
Environmental Rating	NEMA 4X
Operating Temperature	0 to +50°C (32 to 122°F)
Storage Temperature	-10 to +65°C (14 to 149°F)
Max. Operating Relative Humidity	95%
Physical	
Dimensions H x W x D (Inches)	8.4 x 10 x 8.4 inches (21.3 x 25.4 x 21.3 cm)
Weight (lb)	13.7 lb (6.2 kg)
Power Supply	
Power	100-240 VAC, 50/60Hz or 9-24 VDC*

* Input power must not exceed 24VDC

Analyzer Dimensions

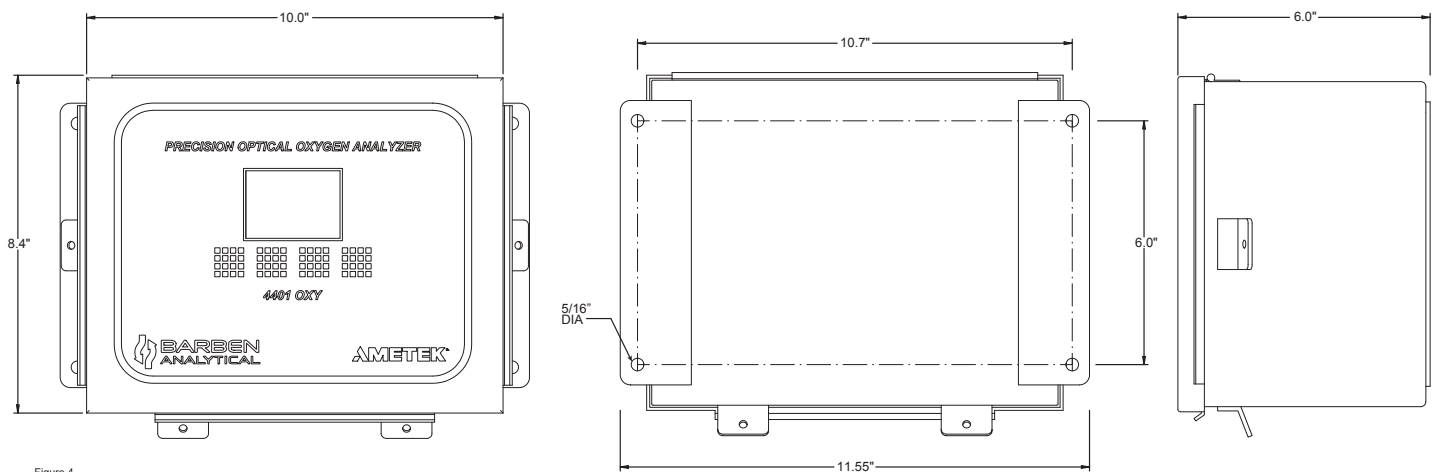


Figure 4

Precision Optical Oxygen Measurement

4401OXY Oxygen Analyzer & BOS Sensors

BOS Optical Oxygen Sensor Family

The BOS optical sensors are available in three installation styles:

- BOS FIBERSENSE - 4mm sensor for small tubing installations
- BOS FLEXSENSE - Threaded sensor with removable luminophore sensor cap
- BOS SAFETAP - Retractable "hot tap" sensor

All three sensor styles can be built in any measurement range (BOS1, BOS2, BOS3).

BOS FIBERSENSE Optical Oxygen Sensors

The BOS FIBERSENSE is a 4mm wand-style optical oxygen sensor that offers high precision in a small package. The small sensing tip can be installed directly into a tube fittings which makes it the ideal choice for oxygen measurement on sample line installations. The fiber optic tip is encased in a stainless steel wand and can be supplied bare or with optional armored conduit (figure 5 & 6). The BOS FIBERSENSE product is commonly used in gas phase sample line installations. An external temperature sensor is required for compensation.

BOS FIBERSENSE - Overview

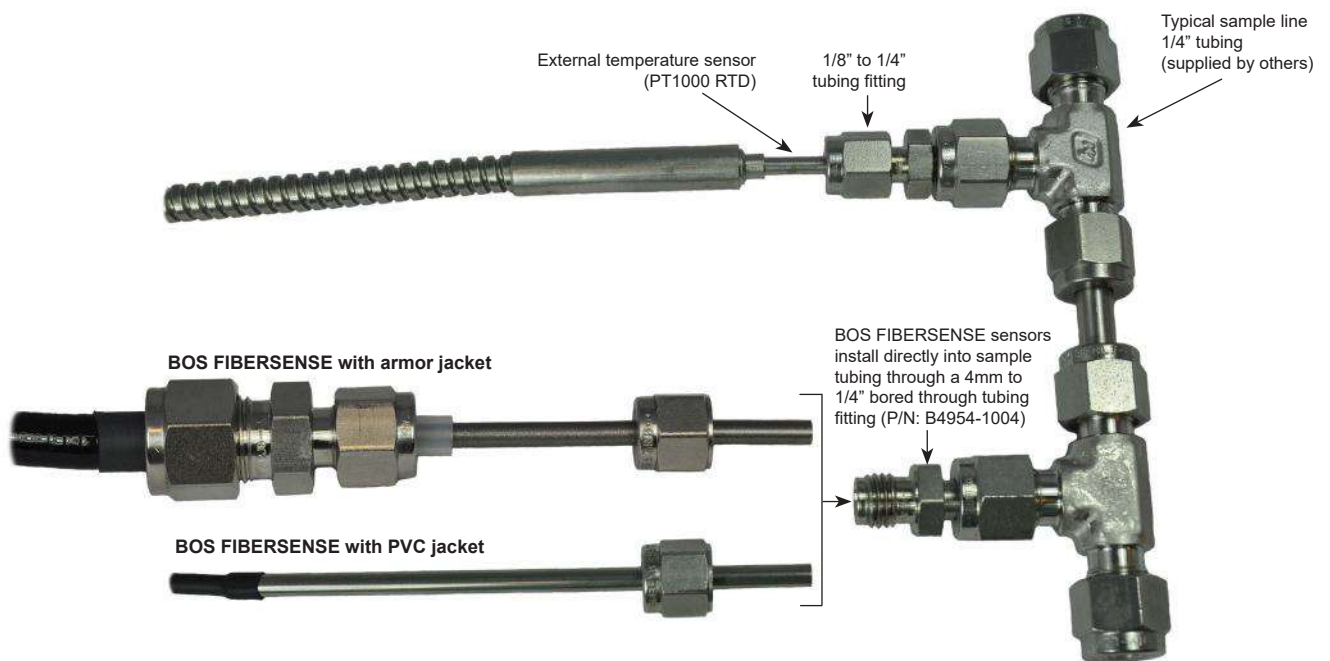


Figure 5

BOS FIBERSENSE - Dimensions

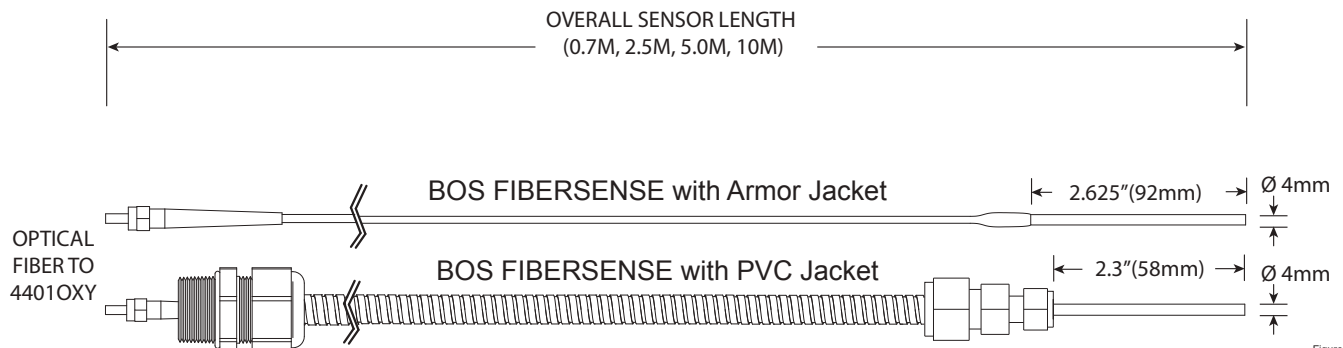


Figure 6

Precision Optical Oxygen Measurement 4401OXY Oxygen Analyzer & BOS Sensors

BOS FLEXSENSE Optical Oxygen Sensors

The BOS FLEXSENSE is our most versatile optical oxygen sensor. The sensor is based on the DIN 19263 dimensions commonly used with pH and conductivity sensors. 1/2" and 1" Male NPT connections make this sensor best suited for flowcell installations where frequent access to the sensor is required. Oxygen measurement is accomplished through a replaceable luminophore sensing cap. A removable fiber optic wand is used to transmit the optical signal to/from the window. The BOS FLEXSENSE

is rated for pressures up to 1,200 PSIG making it well suited for applications such as produced water. The BOS FLEXSENSE can be specified with ANSI/ISA 12.27.01 Dual Seal Certification (figure 9 & 10). This design is specified when the distance between the oxygen analyzer and the measurement point crosses different hazardous zones. If this option is specified, then a separate direct contact temperature sensor should be installed.

BOS FLEXSENSE - Overview

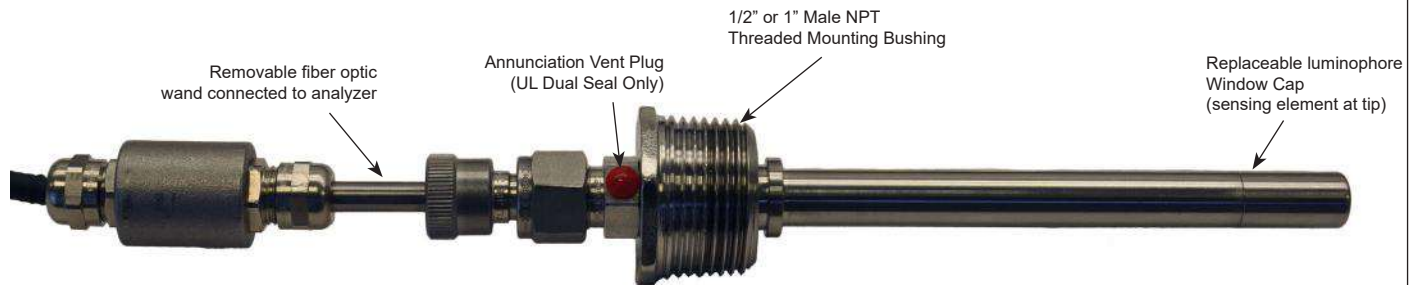


Figure 7

BOS FLEXSENSE - Standard Dimensions

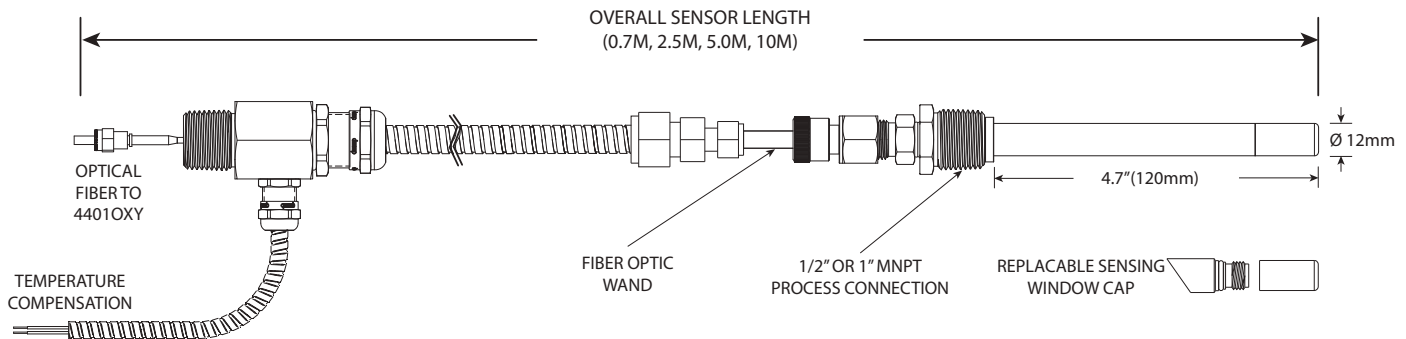


Figure 8

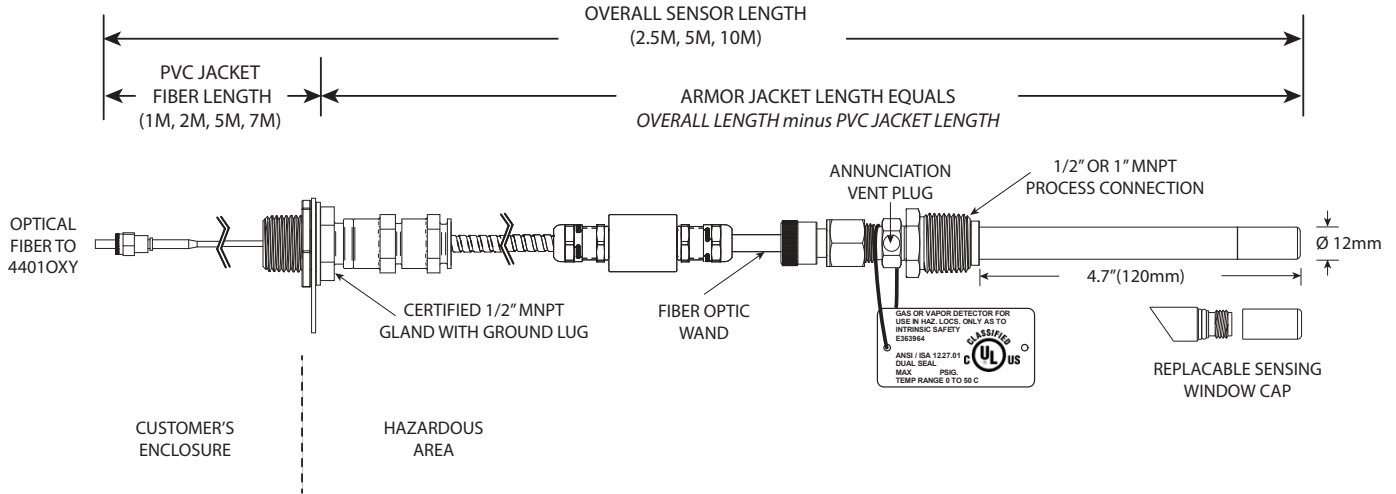
BOS FIBERSENSE Optical Oxygen Sensor Specifications

Pressure Rating	30 PSIG (2.1 Bar) Maximum Pressure
Temperature Rating	0 to 50°C (32 to 122°F) Operating, 90°C (194°F) non-continuous
BOS FLEXSENSE Optical Oxygen Sensor Specifications	
Pressure Rating	1200 PSIG (82.7 Bar) for BOS1 & BOS2 sensing caps, 800 PSIG (55.1 Bar) for BOS3 sensing caps
Temperature Rating	0 to 50°C (32 to 122°F) operating, 90°C (194°F) non-continuous
Body Materials	316 Stainless Steel, Titanium, Hastelloy C-276
Internal Seal Options	Viton, EPDM, FFKM (Kalrez)

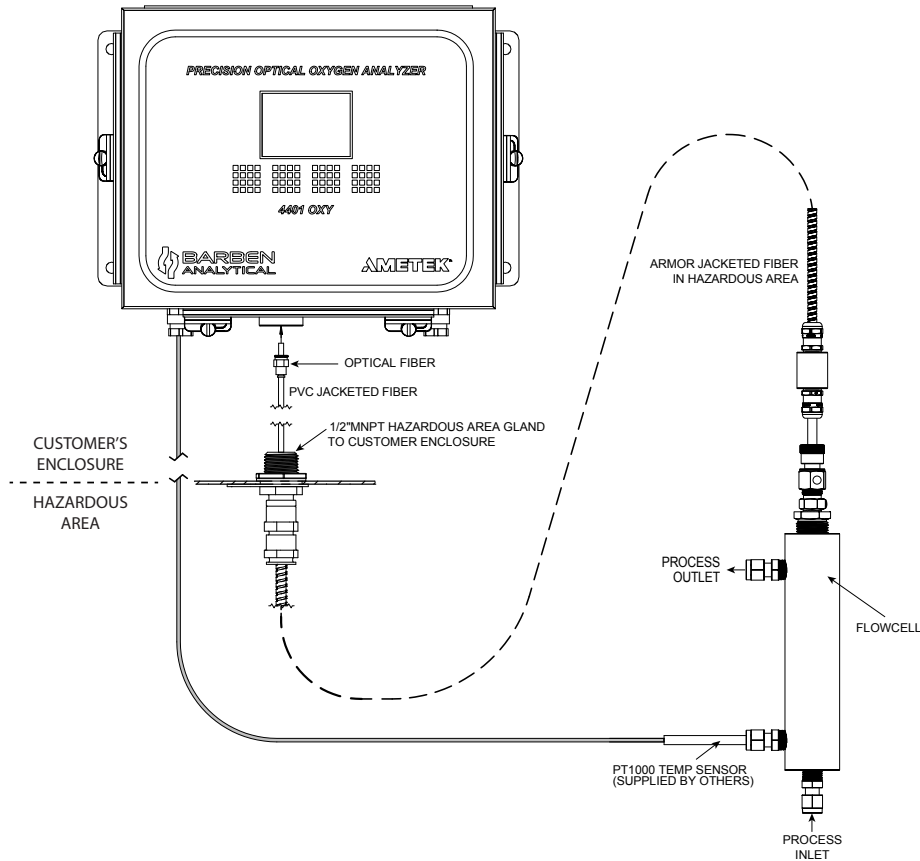
Precision Optical Oxygen Measurement

4401OXY Oxygen Analyzer & BOS Sensors

BOS FLEXSENSE - UL Dual Seal Version



BOS FLEXSENSE - UL Dual Seal Version - Typical Install



The BOS FLEXSENSE UL Dual Seal version prevents process pressure from migrating across hazardous area boundaries. In the event of a primary sensor seal failure all process pressure is vented in the hazardous area and cannot reach the analyzer. A secondary seal and certified gland are part of the sensor assembly to provide proper sealing between each area.

The overall length of the dual seal sensor is a combination of an armor jacketed length (in hazardous area) and a PVC jacketed length of fiber that mates to the 4401OXY Oxygen Analyzer. Calculation of the armor jacketed length can be determined from the chart below.

PVC JACKET LENGTH	ARMOR JACKET LENGTH	OVERALL BOS SENSOR LENGTH		
		2.5M	5M	10M
1M		1.5M	4M	9M
2M		0.5M	3M	8M
5M		-	-	5M
7M		-	-	3M

↑ ARMOR JACKET LENGTH ↑

$$\frac{\text{OVERALL BOS SENSOR LENGTH} - \text{PVC JACKETED FIBER LENGTH}}{\text{ARMOR JACKET LENGTH}}$$

Figure 9

Precision Optical Oxygen Measurement 4401OXY Oxygen Analyzer & BOS Sensors

BOS SAFETAP Retractable Optical Oxygen Sensors

Often oxygen measurement on external sample lines are not feasible. For in-line applications Barben Analytical offers the BOS SAFETAP retractable optical oxygen sensors. The BOS SAFETAP is designed to manually insert and retract (*hot tap*) from the process through a ball valve assembly. The free rotating safe-T-handle provides a secure gripping surface to manually insert the optical sensor into applications up to 450 PSIG. The BOS SAFETAP includes a security hook that catches the safe-T-handle to prevent unintended retraction. An additional compression gland using proven Conax® sealing technology provide additional insurance against unintended retraction.

In normal operation the BOS SAFETAP is rated up to pressures of 750 PSIG (51.7 Bar). When sensor calibration or replacement is required the removable luminophore tip can be retracted through the ball valve which is used to isolate the sensor from the process. Tubing ports are included as part of the welded retraction housing so that purge and complete insitu calibration can be performed without removal of the oxygen sensor. The BOS SAFETAP oxygen sensor includes an integral PT100 RTD temperature sensor and replaceable luminophore window cap so that sensor service is simple and low cost.

BOS SAFETAP - Overview

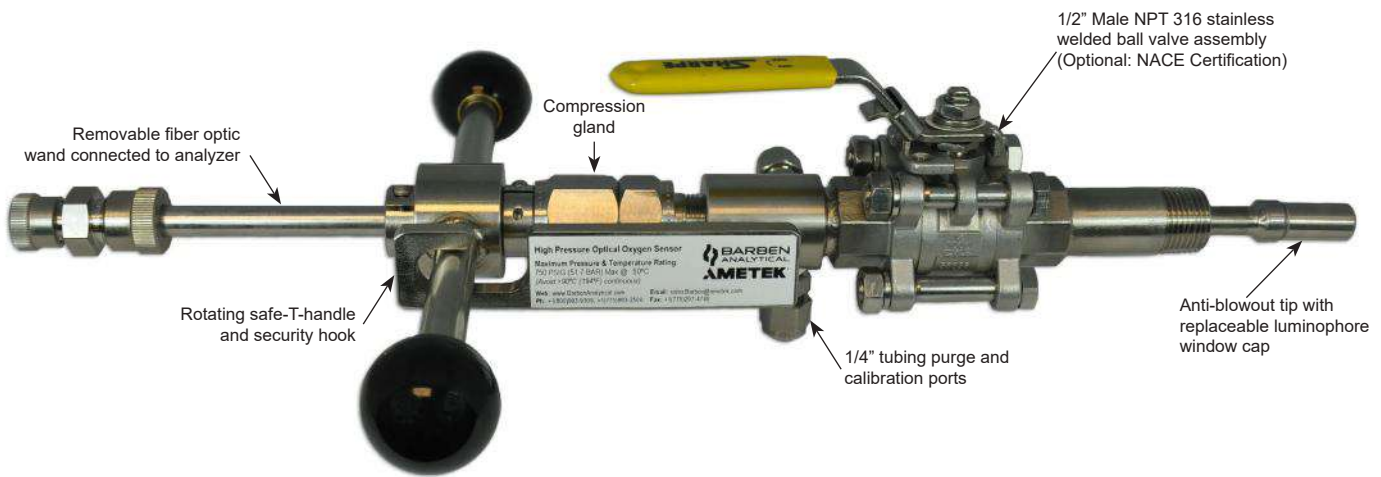


Figure 10

BOS SAFETAP Retractable Optical Oxygen Sensor Specifications

Valve Options	316 stainless ball valve W.O.G., Optional 29" Hg full vacuum NACE MR0175 certified ball valve
Operating Pressure Rating	750 PSIG (51.7 Bar)
Insertion / Retraction Pressure Rating	450 PSIG (31.0 Bar)
Temperature Rating	0 to 50°C (32 to 122°F) operating, 90°C (194°F) non-continuous
Internal Seal Options	Viton, EPDM, FFKM (Kalrez)

Precision Optical Oxygen Measurement

4401OXY Oxygen Analyzer & BOS Sensors

BOS SAFETAP - Dimensions

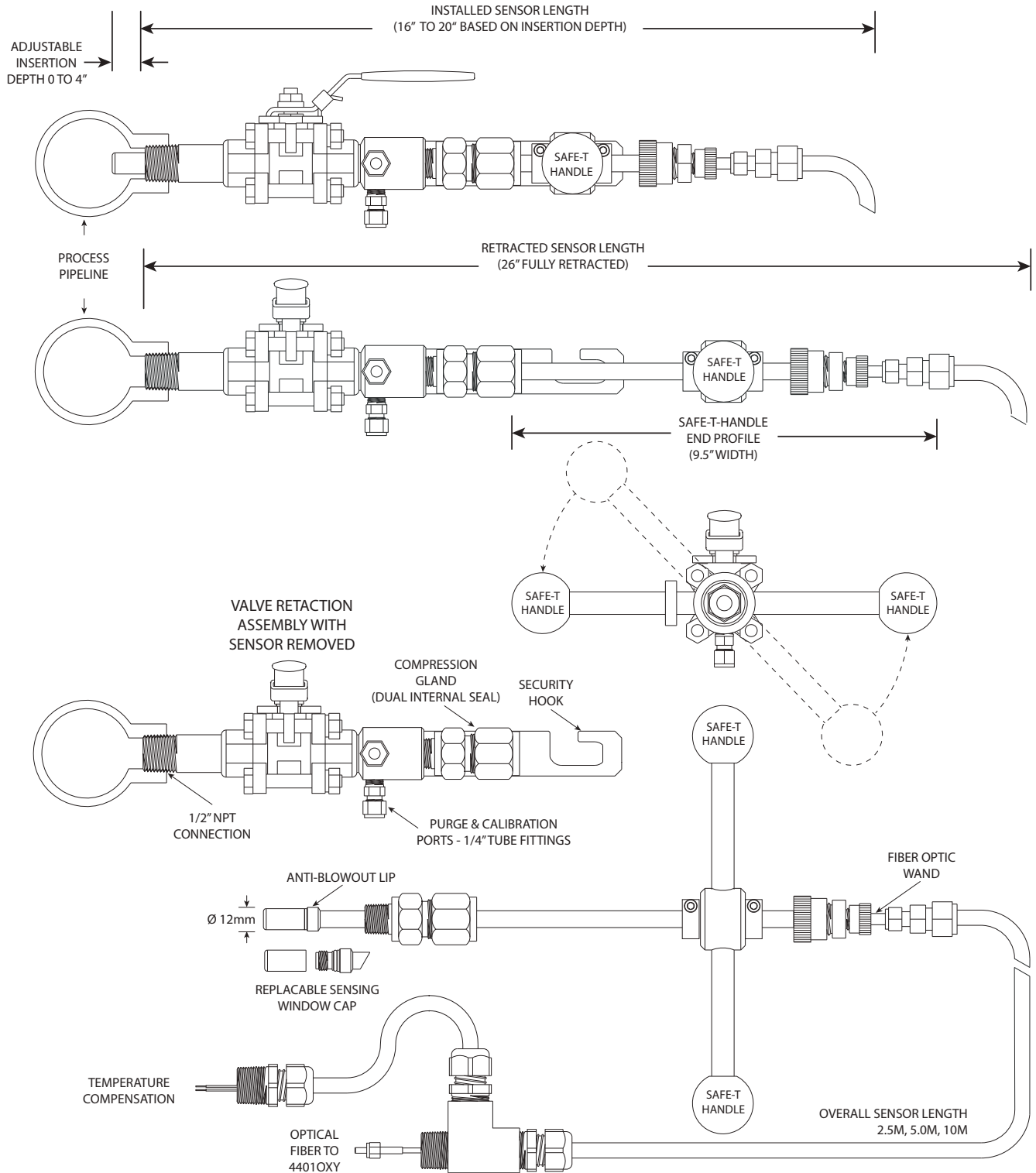


Figure 11

Precision Optical Oxygen Measurement 4401OXY Oxygen Analyzer & BOS Sensors

BOS Range Specifications For All Products

BOS1 Gas or Liquid		
	Dissolved Oxygen	Gaseous & Dissolved Oxygen @ 1atm, 20°C
Measurement Range	0 - 1.8 mg/L (ppm)	0 - 4.2 % O ₂ 0 - 41.4 hPa
Limit of Detection	1 ppb dissolved oxygen	0.002 % O ₂
Resolution @ 20°C and 1013 hPa	± 0.30 at 1 µg/L (ppb) ± 0.41 at 10 µg/L (ppb) ± 0.63 at 200 µg/L (ppb)	± 0.0007 % O ₂ at 0.002 % O ₂ ± 0.007 hPa at 0.023 hPa ± 0.0015 % O ₂ at 0.02 % O ₂ ± 0.015 hPa at 2.0 hPa
Response Time (T ₉₀)	< 30 sec.	< 6 sec.
Accuracy @ 20°C	1 ppb (l), 0.002 % O ₂ (g), or 3% of the measured value whichever is greater	
Drift from Photodecomposition	< 2.0 ppb within 30 days (1 min sample rate)	
Operating Temperature Range	0 to 50°C (32 to 122°F)	
Allowable Sensor Temperature	90°C (194°F) non-continuous	
BOS2 Gas or Liquid		
	Dissolved Oxygen	Gaseous & Dissolved Oxygen @ 1atm, 20°C
Measurement Range	0 - 22 mg/L (ppm)	0 - 25 % O ₂ 0 - 250 hPa
Limit of Detection (LOD)	15 ppb dissolved oxygen	0.03 % O ₂
Resolution @ 20°C and 1013 hPa	± 4.5 at 90 µg/L (ppb) ± 45 at 9060 µg/L (ppb) ± 0.15 at 23 mg/L (ppm)	± 0.01 % O ₂ at 0.21 % O ₂ ± 0.1 hPa at 2 hPa ± 0.1 % O ₂ at 20.9 % O ₂ ± 1 hPa at 207 hPa
Response Time (T ₉₀)	< 30 sec.	< 6 sec.
Accuracy @ 20°C	± 0.4 % O ₂ at 20.9 % O ₂ , ± 0.05 % O ₂ at 0.5 % O ₂	
Drift from Photodecomposition	< 0.03 % O ₂ within 30 days (1 min sample rate)	
Operating Temperature Range	0 to 50°C (32 to 122°F)	
Allowable Sensor Temperature	90°C (194°F) non-continuous	
BOS3 - Gas Phase Only		
	Gas Phase Oxygen Only @ 1atm, 20°C	
Measurement Range	0 - 300 ppm with over-range of 1000 ppm	
Limit of Detection (LOD)	0.5 ppm O ₂	
Resolution @ 20°C & 1013 hPa	10 ± 0.5 ppm; 100 ± 0.8 ppm; 200 ± 1.5 ppm	
Response Time (T ₉₀)	< 3 sec. based on 0 - 300 ppm measurement range	
Accuracy @ 20°C	± 2ppm or ± 5% of measured value whichever is greater (or as partial pressure, +/- 0.002 hPa)	
Drift from Photodecomposition	< 2.0 ppm within 30 days (1 min sample rate)	
Operating Temperature Range	0 to 50°C (32 to 122°F)	
Allowable Sensor Temperature	90°C (194°F) non-continuous	
Cross Sensitivity for BOS1, BOS2, BOS3 Sensors Listed above		
No cross-sensitivity for carbon dioxide (CO ₂), hydrogen sulfide (H ₂ S), ammonia (NH ₃), gaseous sulfur dioxide (SO ₂), no cross-sensitivity to pH (1-14), ionic species like sulfide, sulfate or chloride. Usable in methanol, ethanol-water mixtures, and in pure methanol & ethanol. Avoid organic solvents like chloroform, toluene, acetone, and methylene chloride along with any gaseous chlorine (Cl ₂).		

Precision Optical Oxygen Measurement

4401OXY Oxygen Analyzer & BOS Sensors

BOS Optical Oxygen Sensor Configuration

Sensor Range	Sensor and Seals	Body Material	Process Connection	Cable Armor	Sensor Length	Lead Length	Agency Approval
Luminophore							
BOS1	Gas (0 - 4.2% O ₂ , 0 - 41.4 hPa) or Liquid (0 - 1.8 ppm)						
BOS2	Gas (0 - 25% O ₂ , 0 - 250 hPa) or Liquid (0 - 22 ppm)						
BOS3	Gas only (0 - 300 ppm with 1000 ppm over-range)						
Sensor and Seals							
N	BOS FIBERSENSE 4mm wand-style sensor (no integral temperature compensation, sold separately)						
V	Viton O-ring seals (BOS FLEXSENSE & BOS SAFETAP Sensors only)						
E	EPDM O-ring seals (BOS FLEXSENSE & BOS SAFETAP Sensors only)						
K	FFKM (perfluoroelastomer) O-ring seals (BOS FLEXSENSE & BOS SAFETAP Sensors only)						
Body Material							
1	316 Stainless (all versions)						
2	Titanium Gr2 (BOS FLEXSENSE Sensors only)						
3	Hastelloy-C 276 (BOS FLEXSENSE Sensors only)						
Process Connection							
A	4mm Wand (BOS FIBERSENSE Sensors only)						
B	1" Male NPT Assembly Mounting Nut (BOS FLEXSENSE Sensors only)						
C	1/2" Male NPT Assembly Mounting Nut (BOS FLEXSENSE Sensors only)						
D	1/2" Male NPT Ball Valve 750 PSIG Max (BOS SAFETAP sensors only)						
E	1/2" Male NPT Ball Valve 29" Hg Vacuum / 750 PSIG Max. NACE MR0175 (BOS SAFETAP sensors only)						
Fiber Protection							
1	Armor Jacketing Protection						
2	PVC Jacketed Fiber - BOS FIBERSENSE sensors only (Use "N" For PVC Jacket Length)						
BOS Sensor Overall Length (Refer to figures 6 to 11 depending on body style)							
0.7	0.7M (2.3ft) ("N" Standard lead length only)						
2.5	2.5M (8.2ft)						
5.0	5.0M (16.4ft)						
10.	10M (32.8ft) BOS1 and BOS2 Only						
XXX	Special Length (If >10M consult factory)						
PVC Jacket Length (fig. 10). Select "N" for BOS FIBERSENSE & SAFETAP Sensors. Options 1, 2, 5, 7 for BOS FLEXSENSE UL Dual Seals sensors ONLY. These options allow PVC jacket fiber length specified separate from the overall jacket fiber length.							
N	Standard - direct connection to 4401OXY Analyzer - Required for BOS FIBERSENSE & SAFETAP Sensors						
1	PVC Jacket Fiber Length 1M (Temperature Compensation separate, with certified 1/2" NPT cable gland)						
2	PVC Jacket Fiber Length 2M (Temperature Compensation separate, with certified 1/2" NPT cable gland)						
5	PVC Jacket Fiber Length 5M (Temperature Compensation separate, includes certified 1/2" NPT cable gland, 10M length only)						
7	PVC Jacket Fiber Length 7M (Temperature Compensation separate, includes certified 1/2" NPT cable gland, 10M length only)						
X	Special PVC Jacket Fiber Length (If >10M consult factory)						
Agency Approval							
ST	Standard						
SN	Standard with no integral TC (Uses B1150-1005 below)						
UL	UL Dual Seal Approval (12mm only, No integral Temperature Compensation available)						
Sensor	Seals	Body	Connection	Armor	Length	Leads	Agency
BOS1	V	1	B	1	2.5	N	UL
							Typical Sensor Configuration

Accessories for BOS FIBERTAP Optical Oxygen Sensors

SCP-CT	Sample Calibration Panel (specify with BOS FIBERSENSE, 4401OXY, and B1150-1005 Temperature Sensor)
B4954-1004	4mm wand compression fitting 316 Stainless for 1/4" tubing fittings (customer supplied)

Accessories for BOS FLEXSENSE Optical Oxygen Sensors

SCP-CF	Sample Calibration Panel (specify with BOS FLEXSENSE, 4401OXY, and B1150-1005 Temperature Sensor)
B5106-1018	Liquid Drain Option for SCP Panels. Provides sight window for manual drain in high moisture applications
B4992-1006F	Flow Cell Assembly, 316SS for BOS FLEXSENSE sensor with 1/2"NPT Thread, 1/4" Compression Inlet/Outlet 1000 PSIG max pressure
B4992-1007F	Flow Cell Assembly, Titanium for BOS FLEXSENSE sensor with 1/2"NPT Thread, 1/4" Compression Inlet/Outlet 1000 PSIG max pressure
B4992-1008F	Flow Cell Assembly, Hastelloy C-276 for BOS FLEXSENSE sensor with 1/2"NPT Thread, 1/4" Compression Inlet/Outlet 1000 PSIG max pressure

General Accessories for Optical Sensors

B1150-1005	External Temperature Compensation - PT1000 Sensor - 1/8" Dia x 4" 316SSS Body - 2ft Cable with Armor (For SCP Panels)
B4965-1000	Flowmeter 0.2 - 2.5 LPM w/SS Valve, Acrylic body

Precision Optical Oxygen Measurement 4401OXY Oxygen Analyzer & BOS Sensors

SCP Oxygen Sample Calibration Panel - Gas Phase

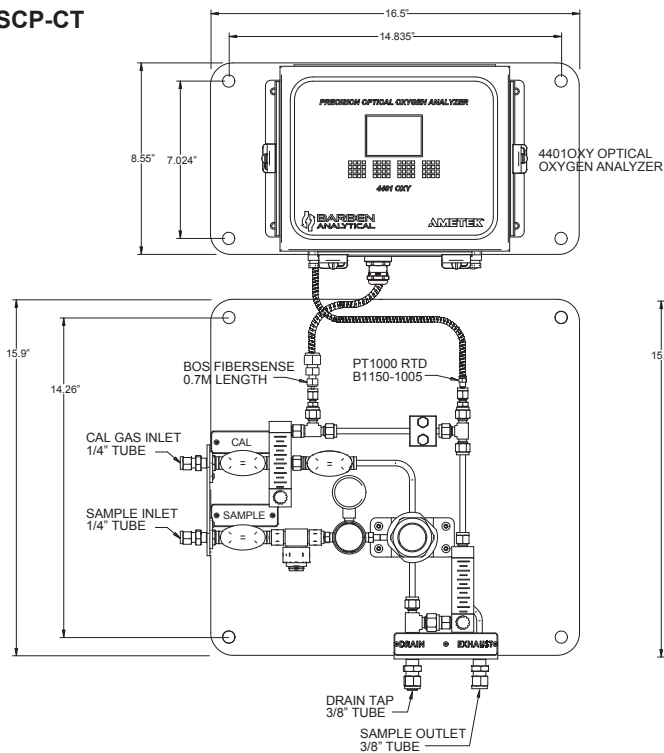
The SCP Sample Calibration Panel [Fig. 12] provides an easy, pre-engineered solution for gas phase applications. All related tubing, flow meters, valves, and gauges come pre-installed on the SCP panel. Specify the the panel, analyzer, BOS sensor, and RTD to get up and running quickly.

Features

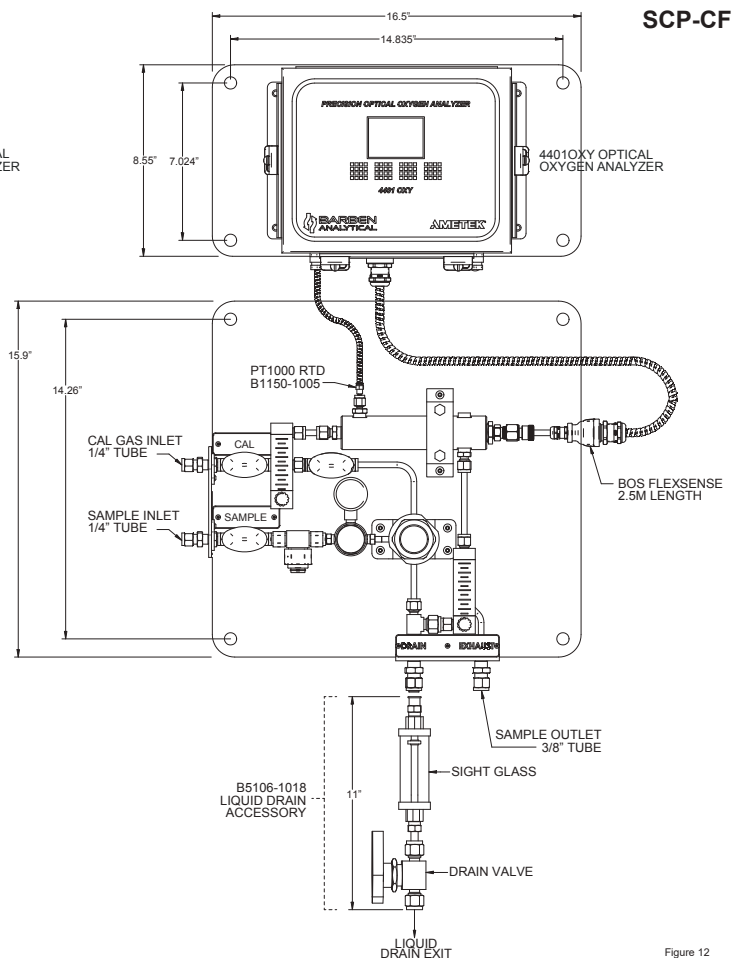
- Manual calibration without removing sensor
- Fast loop 10 LPM max (total capacity of 12 LPM)
- Filters: particulate (0.5µm) & coalescing (0.3µm)
- Inlet pressure regulation (Max. inlet 300 PSIG)
- 304 stainless steel mounting panel

SCP - Sample Calibration Panel Specifications	
Part Numbers	Applications
SCP-CT	Designed for dry gas applications Specify with 4401OXY, BOS FIBERSENSE (0.7m) and B1150-1005 RTD
SCP-CF	Use in wet gas applications or when ease of tip replacement is required Specify with 4401OXY, BOS FLEXSENSE (2.5m) and B1150-1005 RTD.
Physical	
Dimensions H x W x D	24.5 x 16.5 x 6.33 inches (62.38 x 41.9 x 16.4 cm) Note - Split panel design provides some mounting flexibility
Weight (lb)	39 lb (17.7 kg) when supplied with sensors and analyzer.
Process Connections	1/4" Tubing for Sample Inlet and Calibration Gases. 3/8" Tubing for Drain and Sample Outlet.
Sample	Gas phase, Sample Inlet 300 PSIG (20 BAR) @ 100°C (Note - Sensor Max. 90°C (194°F) non-continuous)
Accessories	
B5106-1018	Liquid Drain Option. Provides sight window for manual drain in high moisture applications.

SCP-CT



SCP-CF



SCP - Sample Calibration Panel Dimensions
(Analyzer and Sensors Specified Separately)

Figure 12

Precision Optical Oxygen Measurement

4401OXY Oxygen Analyzer & BOS Sensors

Agency Approvals

LVD Low Voltage Directive

Directive 2006/95/EC

Second Edition EN 61010-1:2001 - Safety requirements for electrical equipment for measurement, control and laboratory use - Part 1: General requirements.



EMC - Electromagnetic Compatibility

Directive 2004/108/EC

EN 61326-1:2006 - Electrical equipment for measurement, control, and laboratory use.

Exception: Electrical Fast Transient / Burst Test Procedure EN 61000-4-4

II 3 G Ex nA IIC 135°C (T4)

ATEX - Equipment explosive atmospheres

Directive 94/9/EC

EN 60079:2006 - Electrical apparatus for explosive gas atmospheres - Part 0: General requirements

EN 60079-15:2005 - Electrical apparatus for explosive gas atmospheres - Part 15: Construction, test, and marking of type of protection "n" electrical apparatus



Class 3600 - Electrical Equipment for Use in Hazardous (Classified) Locations - General Requirements

Class 3611 - Non-Incendive Electrical Equipment for Use in Class I & II Division 2, and Class III, Divisions 1 & 2 Hazardous Locations

Class 3810 - Electrical Equipment for Measurement, Control, and Laboratory Use

CSA C22.2 No. 142-M1987 (R2004) - PROCESS CONTROL EQUIPMENT - Industrial Products

CSA STD C22.2 No. 213-M1987 (R2004) - Non-Incendive Electrical Equipment for Use in Class I, Division 2 Hazardous Locations

ANSI/NEMA-250 - Enclosures for Electrical Equipment (1000 Volts Maximum)



Dual Seal Classification of Fiber Optic Oxygen Sensor per ANSI/ISA 12.27.01

(Applies to Sensor Only. Refer to sensor manual for more information)



Contact Us

Barben Analytical is a leading supplier of analytical measurement technology targeting the industrial marketplace. It is a wholly owned subsidiary of Ametek.

Ametek has nearly 14,000 colleagues at over 120 manufacturing locations around the world. Supporting those operations are more than 80 sales and service locations across the United States and in more than 30 other countries around the world.

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