BARBEN ANALYTICAL

# OXYvisor™

## OPTICAL OXYGEN PROCESS ANALYZER

AMETEK®
THERMAL PROCESS MANAGEMENT

# OXYvisor™

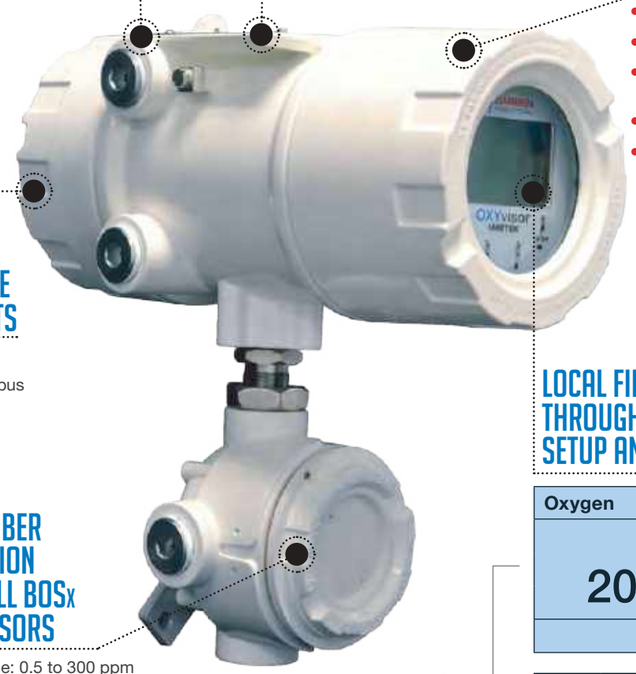
## OPTICAL OXYGEN PROCESS ANALYZER

### TRACE (PPM) TO % LEVEL OXYGEN ANALYZER

### FIELD-MOUNTABLE, RUGGED ENCLOSURE - NEMA 4X, IP66

### REMOTE SUPERVISORY MEASUREMENT

- Auto-Calibration
- Remote Validation
- Insitu or On-Board Ambient Pressure Compensation
- Insitu Temperature Compensation
- Datalogging (process measurement, calibrations and errors)



### PROGRAMMABLE INPUT / OUTPUTS

- Analog mA Output
- Digital RS485 Modbus
- Digital Relays
- USB - Port

### LOCAL FIELD-DISPLAY HMI WITH THROUGH-THE-GLASS OPERATION, SETUP AND CONFIGURATION

### EASY-ACCESS FIBER OPTIC CONNECTION WORKS WITH ALL BOSx OPTICAL $O_2$ SENSORS

- BOS3 - Trace Range: 0.5 to 300 ppm
- BOS1 - Mid Range: 0 to 5% $O_2$
- BOS2 - High Range 0 to 25% $O_2$

CALIBRATION

INPUT/OUTPUT

MEASUREMENT & UNITS

DIAG-TEST SECURITY

DATALOGGING

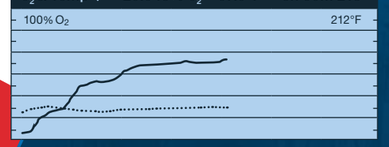
HELP ERROR CODES

| Oxygen | 01/06/2017 10:55 AM | |
|---|---|---|
| 20.946 | % $O_2$ ↕ | 850.9 mBar |
| | | 67.9°F |
| | | Err: 0 |

| Alternate Main Display | | | |
|---|---|---|---|
| Oxy | 20.948% $O_2$ | Phase | 29.34° |
| Sample | 5 sec | Amp | 28,716 |
| Temp | 67.9°F | Error | 0 |
| Pres | 850.9 mBar | Time | 10:55 AM |

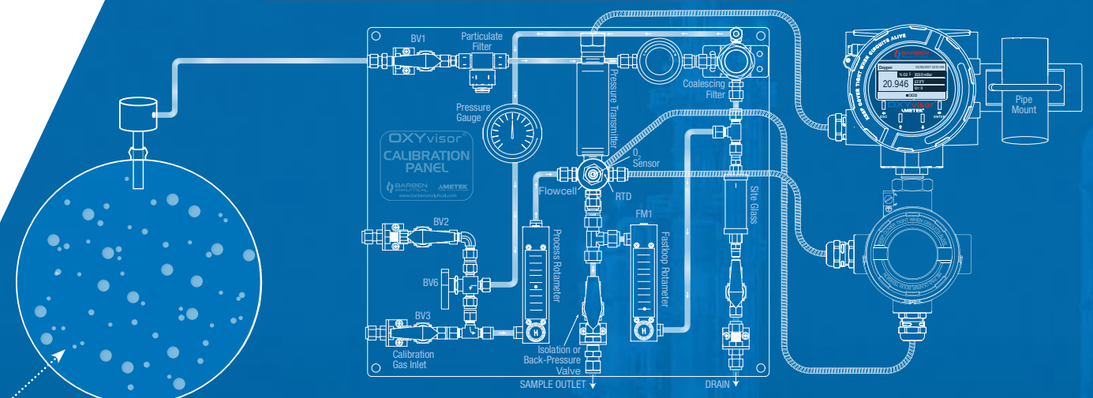
| Input/Output Display | |
|---|---|
| 1. Analog Out 1 | 17.49 mA (Oxy) |
| 2. Analog Out 2 | 0.0mA (N.A.) |
| 3. Analog In | 12.21mA (Temp) |
| 4. Relay Out 1 | Open (Cal) |
| 5. Relay Out 2 | Open (Cal) |

$O_2$ & Temp ↕ 20.948% $O_2$ 67.9°F 3h 50m 21s




**Global Hazardous Area Approvals IEC, ATEX, CEC, NEC**
Class I, Division 2, Groups A, B, C & D, T4A
Zone 1 (Gb) and Zone 2 (Gc) Gas Group IIC T4

## GENERAL EXAMPLE: EXTRACTIVE MEASUREMENT INSTALLATION




SAMPLE PROBE - EXTRACT PROCESS SAMPLE

SAMPLE CALIBRATION PANEL WITH $O_2$, PRESSURE AND TEMPERATURE SENSORS - MANUAL VERSION

OXYGEN ANALYZER

**Gas Phase Applications:**

- Hydrocarbons - w/ $H_2S$ and $CO_2$
- Nitrogen Headers
- Annealing Furnaces - w/ $H_2$
- Biogas
- Upstream Natural Gas Applications

or

**Liquid Phase Applications:**

- Enhanced Oil Recovery (EOR)
  - Waterflood and Floodwaters
- Produced Water
- Deaerators
- Ethanol / Methanol
- Dissolved Oxygen

**NATURAL GAS:** Corrosion Prevention, Upstream (gathering lines, booster stations), Midstream (fractionation plant), Gas Processing, Pipeline (transmission), Metering Stations, Custody Transfer, LNG, Hydraulic Fracturing, Vapor Recovery Units (VRU's), Compressors

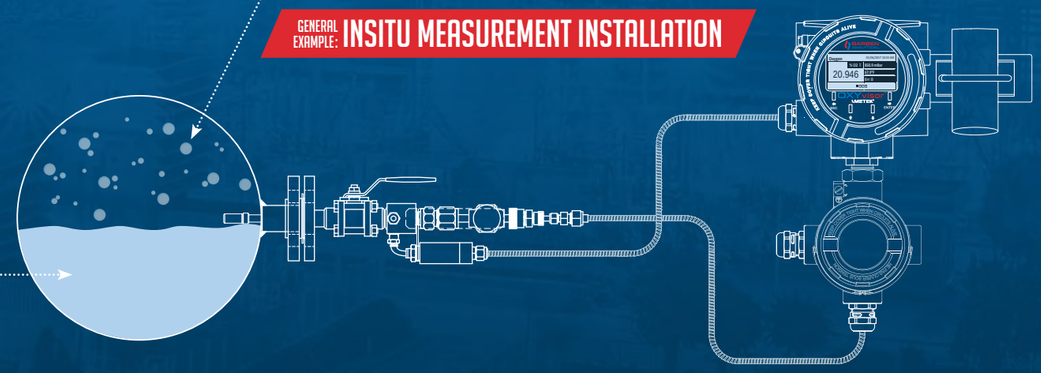
**OFFSHORE:** EOR Waterflood and Floodwater, Minox Nitrogen Generation

**CHEMICAL / PETROCHEMICAL:** Tank Blanketing, Nitrogen Headers, Refrigerants

**REFINERIES:** Merox (disulphide), Flare Systems, Tank Blanketing, Aenerobic Digesters

**MANUFACTURING:** Annealing Furnaces, Fiber Optic

## GENERAL EXAMPLE: INSITU MEASUREMENT INSTALLATION



SAFETAP - INSITU PROBE WITH $O_2$, TEMPERATURE AND PRESSURE SENSORS

OXYGEN ANALYZER

BARBEN ANALYTICAL

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AMETEK®
THERMAL PROCESS MANAGEMENT

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# Precision Optical Oxygen Measurement
# OXYvisor® Oxygen Analyzer

Industrial Process Control & Monitoring

- **Trace (ppm) to % level Oxygen measurement in gas & liquid applications**
- **Measurement accuracy, drift and lifetime not affected by presence of $H_2S$, $CO_2$, $SO_2$ and $H_2$**
- **Auto-Calibration & Remote Validation**
  - Timer-based or user initiated (HMI or RS485)
  - Test Gas Insert (HMI or RS485)
- **Rugged Field Enclosure - Local Display & HMI**
  - IP66 & NEMA 4X
  - Through-the-glass keypad (no tools or permits required)
- **Pressure Compensated Measurement**
  - Ambient (on-board) pressure sensor
  - 4-20 mA active (loop powered input) for optional in-line pressure transmitter
- **Works with BOSx FlexSense I, FlexSense II and SafeTap fiber optic oxygen sensors**
  - Replaceable sensor caps (simple and cost effective)
- **OXYvisor PC software for configuration, set-up, diagnostics and trending**
- **Hazardous Area Approvals**

  IEC Ex, ATEX, NA - Zone 1 & Zone 2 IIC

  cULus (NRTL) - Class I, Div 2, Groups A, B, C, D T4

The OXYvisor optical oxygen Analyzer is Barben Analytical's next generation solution for oxygen measurement in industrial applications. When paired with the BOSx optical oxygen sensor's quenched luminescent technology, the OXYvisor provides the ability to measure oxygen in liquid and gas phase processes.

For more information on Barben Analytical's BOSx Oxygen Sensors and our sample conditioning panel products please refer to the separate data sheets for these products:

**Barben Optical Sensor (BOSx) - Data Sheet**

**Sample Calibration Panel - Data Sheet**

**Typical Applications - Gas Phase (g)**

- **$O_2$ in hydrocarbon streams**
  - Vapor recovery units (VRU's)
  - Gathering lines/headers
  - Gas plant inlets
  - Booster / compressor stations
  - Custody transfer points
  - Transmission and distribution
- **Trace $O_2$ detection in nitrogen headers**
- **Biogas oxygen detection (moisture and $H_2S$)**
- **Pure ethylene and propylene production**
- **$O_2$ in nitrogen tank blanketing**
- **Trace to % level oxygen in syngas gas**
- **Annealing furnaces ($H_2$ and inert gases)**

*Note: Limit of Detection: 0.5 ppm $O_2$ @ 1atm, 20ºC (0.0005 hPa)*

**Typical Applications - Liquid Phase (l)**

- **ppb dissolved $O_2$ for water-flood injection**
- **Produced water dissolved $O_2$**
- **Oxygen in methanol and ethanol**
- **Oxygen in oil separation**
- **$O_2$ in aqueous and non-aqueous solutions**

*Note: Limit of Detection: 1 ppb Dissolved $O_2$*

# Precision Optical Oxygen Measurement
# OXYvisor® Oxygen Analyzer

## Principle of Operation

The OXYvisor analyzer uses an optical quench luminesence technology to measure process oxygen. Phase modulation of the luminescent decay time of an oxygen specific luminophore allows the calculation of the partial pressure of oxygen concentration within the process stream.

The analyzer uses an LED to emit blue light through fiber optic cable down to the luminophore at the sensor tip [Fig 1]. The luminophore absorbs the energy and rises to an excited state indicated by red light returned back through the fiber optic cable. The properties of the emitted light are measured through a photomultiplier tube back at the spectrometer within the analyzer.

In the absence of oxygen, the excited luminophore will fall back to its ground state at a specific intensity and phase angle. When oxygen is present it quenches the fluorescence at a lower rate proportional to the oxygen concentration [Fig 2.]. The phase shift and intensity differences between the excitation source and the fluorescent signal is measured and the oxygen concentration is calculated [Fig 3].

The resulting measurement is specific to oxygen concentration. The luminophore is unaffected by other contaminant gases and flow rate. The measurement is applicable in both gas and liquid phase. Temperature compensation is required to account for quenching efficiency at different temperatures and pressure compensation is required to measure the process pressure when different than the pressure at time of calibration.

**Light transmission through fiber optic to luminophore**

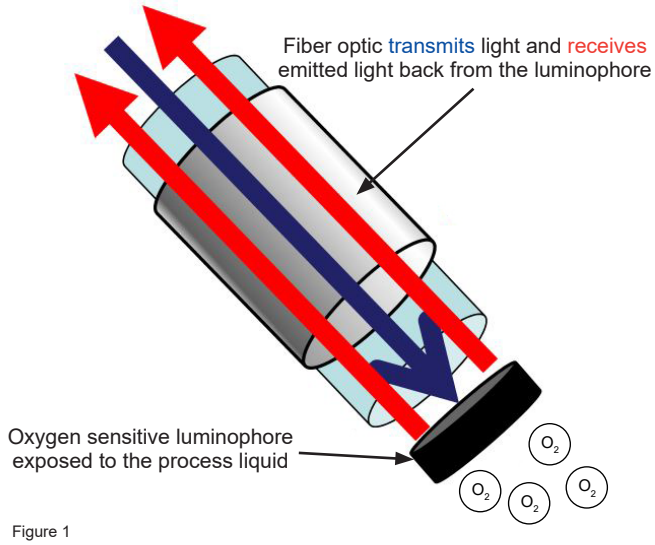
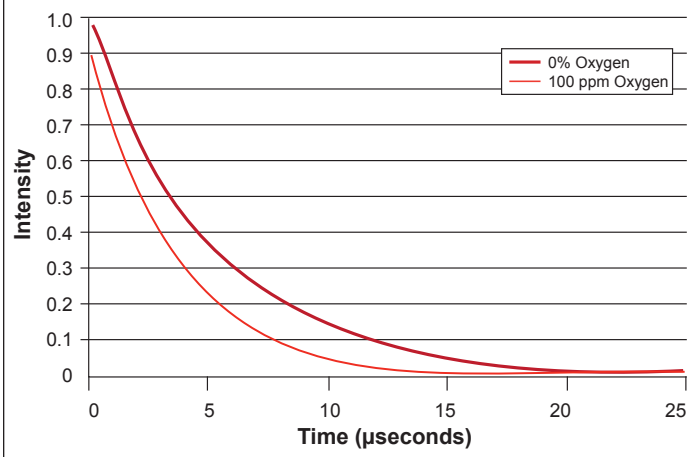



Figure 1

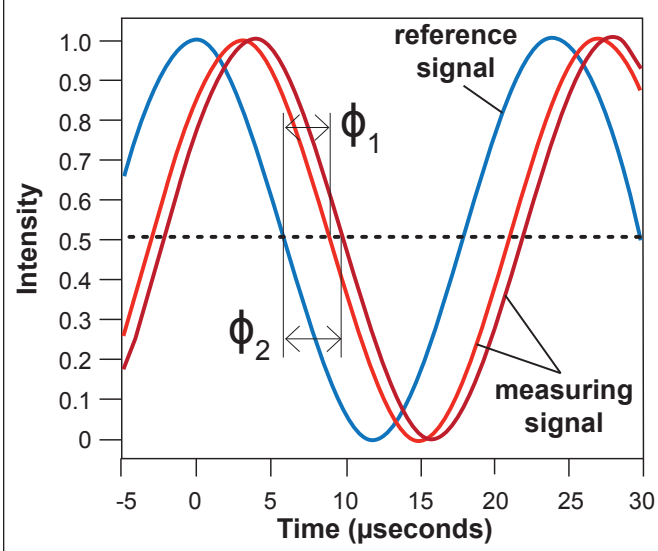
**Effects of 100 ppm oxygen quenching**




The affect of oxygen quenching on light intensity from the luminophore sensor is shown above. Light emitted from the excited luminophore has higher intensity over a longer time period than when oxygen is present. The intensity and time are measured by the spectrometer within the OXYvisor to provide an oxygen measurement.

Figure 2

**AC modulation and the phase shifted output**




AC modulation of the blue light results in a similar waveform of the emitted red light from the luminophore sensor. The presence of oxygen causes a phase shift between $\Phi_1$ and $\Phi_2$ of the red light waveform. Measurement of this phase shift proportionally matches the loss of intensity shown in figure 2 above. The combination of both measurement techniques provides a stable, accurate method to measure oxygen in liquid and gas phase applications.

Figure 3

## OXYvisor Analyzer Features (Hardware/Firmware/Software)

**HMI Touch Keys (thru-the-glass):** Easy to use configuration and calibration menus can be accessed through a touch screen, infrared keypad, protected behind the analyzer window.

**HMI LockOut Screen:** HMI lockout screen prevents any unwanted HMI interaction with critters, debris, or maintenance technicians.

**Sensor Connection Junction Box:** Connection of the BOSx Optical Sensor is easily made through the junction box. In the rare case it is ever needed, this design allows for easy fiber optic sensor replacement, in the field, without exposing the electronics to dust, humidity or human error. Normally the fiber optic cable is installed once and the sensor cap is the standard replacement item.

**Data-Logging (USB Port):** A USB port within the rear compartment, can be used for downloading logs of measurement data, and diagnostic information. Historical time based Oxygen, phase angle, intensity, temperature and pressure measurement, along with error logs and calibration history is stored in .csv format and available for download via USB memory stick.

**Programmable I / O:** The OXYvisor comes with two analog outputs, four isolated digital relay outputs and, one analog input. All I / O's are fully user configurable (variable and range) through the keypad, software or RS485 Modbus. Additionally, an (active) digital input can be used to connect a customer supplied toggle switch or other external contact, to initiate AutoCal or test gas insert (REMOTE VALIDATION).

**MODBUS RTU:** All OXYvisor units have a standard MODBUS RS485 serial output. This 2-wire signal can be used to transmit measurement values, initiate automatic calibration of the device or software configuration of the analyzer.

**Calibration Options:** Several calibration options are available to best suit the customers installation and application requirements.

- **Factory Cal** provides quick startup without test gas. The calibration values found on the sensor certification sheet can be uploaded and good results can be expected. (We recommend to field validation for best results.)
- **Manual One-point** calibration with either zero or span gas, depending on the customer requirements.
- **Manual Two-point** calibration using zero and span gas (recommended for new users).
- **Auto-calibration** (AutoCal) logic in the OXYvisor firmware along with three on-board digital relays (passive) allows for complete AutoCal and validation with known test gases. The AutoCal logic allows user programming of time based calibration, gas selection and the hysteresis criteria for pass / fail evaluation.
  **Auto-calibration requires: AutoCal SCP Panel or three user provided, powered, solenoids & test gases**

**On-Board Diagnostic Memory:** The last ten calibrations as well as the last ten error messages are stored within the analyzer at all times and can be viewed through the firmware at the HMI or via PC software.

**Security:** If operator access control is required then each sub-menu can be locked out using a four digit security pass-code. These codes can be entered through the keypad or via the OXYvisor software.

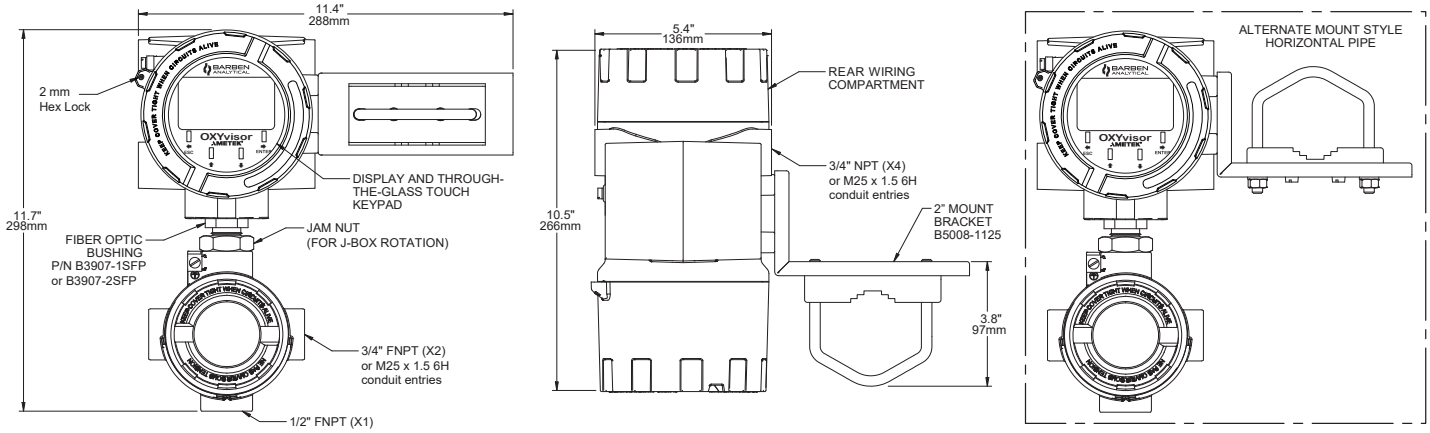



Figure 4

# Precision Optical Oxygen Measurement
# OXYvisor® Oxygen Analyzer

## Barben Oxygen Analyzer - OXYvisor Specifications

| OXYvisor Oxygen Analyzer Specifications | | | |
|---|---|---|---|
| **Power Supply - Selectable as AC or DC via Product Selection Nomenclature** | | | |
| **AC Power** | | 85-264 VAC, 47-63 Hz, 6W (AC, "4-wire," line powered analyzer) | |
| **DC Power** | | 24 V DC +/-10% 5W (Class 2 / LPS source) (DC, "4-wire," line powered analyzer. Not a 2-wire loop powered transmitter) | |
| **Environmental** | | | |
| **Operating Temperature** | | -20 to +55°C (-4 to 131°F) | |
| **Storage Temperature** | | -20 to +65°C (-4 to 149°F) | |
| **Max. Operating Relative Humidity** | | 95%, non-condensing | |
| **Max Altitude** | | Maximum altitude up to 2,000 meters (6,561 ft) | |
| **IEC** | | IEC Installation Category II and Pollution Degree 2 | |
| **Physical** | | | |
| **Main Enclosure and Junction Box** | **Ratings** | IP66 and NEMA 4x, protected against dust and high pressure water ingress. Corrosion resistant. | |
| | **Material Type** | Copper Free Aluminum Alloy, EN 1706 (DIN 1725), pressure die-casting, yellow chromated, chemically resistant polyeurothane primer and coat. | |
| | **Conduit Entries** | Main enclosure = QTY 4, junction box = QTY 2, 3/4" FNPT or M25 x 1.5 6H conduit entries | |
| | **O-Ring Seals** | Silicone VMQ rubber | |
| **Dimensions H x W x D (combined)** | | 12.0 x 5.5 x 11.0 inches (30.5 x 14.0 x 28 cm) | |
| **Weight (total/combined)** | | 13.7 lb (6.2 kg) | |
| **Liquid Crystal Display** | | Viewing = 79 (W) x 40 (H) mm, 240 x 128 dots, FSTN / Positive / Transflective | |
| **HMI Touch-Keys (through-the-glass)** | | (4) proximity switches, infrared contacts for interactive user interface at HMI | |
| **Input Information** | | | |
| **Sensor Inputs** | **Optical $O_2$** | (1) $O_2$ optical input BOS1, BOS2 or BOS3 sensor (SMA connector) | |
| | **RTD - Temp** | (1) Pt100 or Pt1000 4-wire RTD Inputs (isolated) | |
| | **Analog Input** | (1) 4-20 mA input (24 Vdc active from OXYvisor) - User configurable for Temperature or Pressure transmitter | |
| | **Pressure Sensor** | (1) On-board integrated pressure sensor measures and compensates for ambient pressure conditions | |
| **Digital Inputs** | | (2) optically isolated inputs, 5 Vdc powered, remote initiation of automatic calibration and live validation gas | |
| **Output Information** | | | |
| **Analog Outputs** | | (2) Programmable current outputs with galvanic isolation, 4 to 20 mA (Active), Linear or Bi-Linear, 24 Vdc | |
| **Digital Outputs (Alarm/Relays)** | | (4) Programmable relays, optically isolated, passive, 24Vdc, 0.05A pilot duty, 0.45 A general use/ resistive load. | |
| **Digital Communication** | | (1) Modbus RTU serial protocol RS485 - Two way Communication | |
| **User Adjustable Options** | | | |
| **Oxygen Units** | | *Gas Phase:* $\%O_2$, ppm, hPa | *Liquid Phase:* ppm, ppb, hPa |
| **Temperature Units** | | Fahrenheit or Celsius | |
| **Pressure Units** | | mbar, inches $H_2O$, Bar and PSI (absolute pressure) | |
| **Advanced Features** | | | |
| **Automatic Calibration (AutoCal)** | | AutoCal logic controls 3 relays, user programmable with time based schedule or user initiated (requires AutoCal panel) | |
| **Remote Validation (Test Gas Insert)** | | Test gas insert allows for remote or local validation with Test Gas (requires AutoCal panel) | |
| **Auto-Sample Rate** | | Minimizes drift between calibrations, increases sensor lifetime without decreasing performance when needed | |
| **Temperature Compensation** | | Automatic Temperature compensation to account for sensor output & used for DO calculation | |
| **Pressure Compensation** | | Pressure compensates/corrects for concentration calculations due to ambient or process pressure changes | |
| **Analog Input Calibration** | | Allows for correction/matching of Analog Input, either remote temperature or pressure transmitter | |
| **Data & Error Logging Options** | | Last 10 error messages and calibrations time/date stamped (.pdf file), USB data trend storage (.csv file) | |
| **OXYvisor PC Software** | | Configuration, programming, set-up, measurement, diagnostics, and trending (requires RS485 to USB cable) | |

## BOSx - *B*arben *O*xygen *S*ensors (BOS1, BOS2 & BOS3)

Barben Oxygen Sensors (BOSx) are available separately or as part of an integrated Sample Conditioning Package (SCP) with the OXYvisor. BOSx sensors consist of a fiber optic cable with an SMA connector and an oxygen-sensing luminophore. Three sensor ranges are available—BOS1, BOS2, and BOS3—and the selected sensor determines the OXYvisor's measurement range, accuracy, and repeatability. For additional information, refer to the BOSx Sensor Product Data Sheet.

| BOS1 Sensor Specifications - Liquid Phase / Gas Phase | | |
|---|---|---|
| | Dissolved $O_2$ (DO) | Gaseous and Dissolved $O_2$ @ 1 atm, 20 °C |
| **Measurement Range** | 0 - 2 ppm | 0 - 4.2% (over-range of 5%) $O_2$ |
| **Limit of Detection** | 1 ppb | 0.002% $O_2$ (0.02 hPa) |
| **Resolution @ 20 °C and 1013 hPa** | ± 0.30 at 1 ppb<br>± 0.63 at 200 ppb | ± 0.0007% at 0.002% $O_2$ (± 0.0015% at 0.02% $O_2$)<br>± 0.007 hPa at 0.023 hPa (± 0.015 hPa at 2.0 hPa) |
| **Response Time ($T_{90}$)** | < 30 sec. | < 6 sec. |
| **Accuracy @ 20 °C** | ± 1 ppb (l), 0.002%(g) or ± 3% of the respective concentration; whichever is higher | |
| **Drift from Photo-decomposition** | < 2 ppb within 30 days (60 sec. sample interval) | < 0.0042% within 30 days (60 sec. sample interval) |
| **Operating Temperature Range** | 0 to 50 °C (32 to 122 °F) [continuous up to 70 °C, consult factory for special conditions and considerations] | |
| **Allowable Sensor Temperature** | up to 90 °C (194 °F) non-continuous | |

| BOS2 Sensor Specifications - Liquid Phase / Gas Phase | | |
|---|---|---|
| | Dissolved $O_2$ (DO) | Gaseous and Dissolved $O_2$ @ 1 atm, 20 °C |
| **Measurement Range** | 0 - 45 ppm | 0 - 25% (over-range of 100%) $O_2$ |
| **Limit of Detection (LOD)** | 18.1 ppb | 0.03% $O_2$ |
| **Resolution @ 20 °C and 1013 hPa** | ± 4.5 at 90 ppb<br>± 0.15 at 23 ppm | ± 0.01% at 0.21% $O_2$ (± 0.1 hPa at 2 hPa)<br>± 0.1% at 20.9% $O_2$ (± 1 hPa at 207 hPa) |
| **Response Time ($T_{90}$)** | < 30 sec. | < 6 sec. |
| **Accuracy @ 20 °C** | ±290 ppb or ±2 % at 15 ppm O2, whichever is greater (l) | ± 0.4% at 20.9% O2 and ± 0.05% at 0.2% O2 |
| **Drift from Photo-decomposition** | < 24 ppb within 30 days (60 sec. sample interval) | < 0.03% (60 sec. sample interval) |
| **Operating Temperature Range** | 0 to 50 °C (32 to 122 °F) [continuous up to 70 °C, consult factory for special conditions and considerations] | |
| **Allowable Sensor Temperature** | 90 °C (194 °F) non-continuous | |

| BOS3 Sensor Specifications - Gas Phase Only | |
|---|---|
| | Gaseous $O_2$ @ 1 atm, 20 °C |
| **Measurement Range** | 0 - 300 ppm (over-range of 1000 ppm) |
| **Limit of Detection (LOD)** | 0.5 ppm |
| **Resolution @ 20 °C and 1013 hPa** | ± 0.5 at 10 ppm; ± 0.8 at 100 ppm; ± 1.5 at 200 ppm |
| **Response Time ($T_{90}$)** | < 3 sec. based on 0 - 300 ppm measurement range |
| **Accuracy @ 20 °C** | ± 2 ppm or ± 5% of measured value; whichever is greater (± 0.002 hPa) |
| **Drift from Photo-decomposition** | < 1.5 ppm within 30 days (60 sec. sample interval) |
| **Operating Temperature Range** | 0 to 50 °C (32 to 122 °F) continuous |
| **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 ($H_2S$), 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 benzene, chloroform, toluene, acetone, and methylene chloride along with any strong oxidizers such as gaseous chlorine ($Cl_2$) |

| BOS SAFETAP Retractable Optical Oxygen Sensor Specifications | |
|---|---|
| **Valve Options** | 316 stainless steel ball valve W.O.G., Optional 29" Hg full vacuum NACE MR0175 certified ball valve |
| **Operating Pressure Rating** | Up to 750 psig (51.7 barg) |
| **Insertion / Retraction Pressure Rating** | Up to 450 psig (31.0 barg) **Note: physical insertion / retraction may become more difficult over 300 psig** |
| **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
# OXYvisor® Oxygen Analyzer

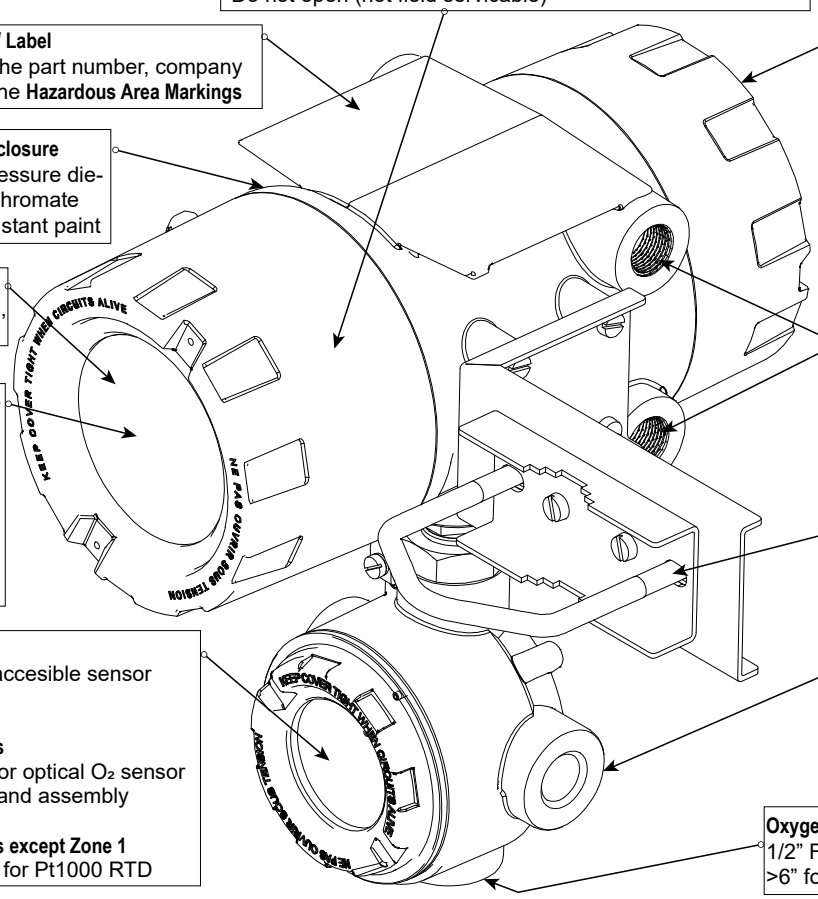
## OXYvisor Configuration

| Analyzer | Power | Agency Approval | Sensor Style | Mounting Orientation | Conduit Entries | |
|---|---|---|---|---|---|---|
| **OXYvisor Base Model Number Prefix** | | | | | | |
| BOA | "Barben Oxygen Analyzer" - OXYvisor | | | | | |
| | **Input Power** | | | | | |
| | DC | 22 to 26.5 VDC, 5W (4-wire, line powered analyzer, this is NOT a loop powered analyzer. Requires two wires for DC power and two separate wires for 4-20 mA output) | | | | |
| | AC | 85 to 260* VAC, 47-63 Hz, 6 W (4-wire, line powered analyzer), (*Zone 1 and CID2 can be up to 264 V) | | | | |
| | | Agency Approval | | | | |
| | | 1 | CE Ex II 2 G Ex db op is IIC T4 Gb | | | \|\| ATEX - |
| | | | IEC IECEx Ex db op is IIC T4 Gb | | | \|\| IEC / EU - |
| | | | Class I Zone 1 AEx db op is IIC T4 Gb | | | \|\| US (NEC 505) - |
| | | | Class I Zone 1 Ex db op is IIC T4 Gb | | | \|\| CA (CEC Section 18) |
| | | 2 | Class I Division 2 Group A, B, C, D T4a | | | \|\| US (NEC 500) and CA (CEC Annex J18) |
| | | 3 | CE Ex II 3 G Ex ec [ic] op is IIC T4 Gc | | | \|\| ATEX |
| | | | IEC IECEx Ex ec [ic] op is IIC T4 Gc | | | \|\| IEC / EU |
| | | | **Sensor Style** | | | |
| | | | SFP | Standard Fiber Patch | | |
| | | | | Mounting Orientation | | |
| | | | | B | Junction Box placed below main enclosure, fiber optic exits bottom (as shown) | |
| | | | | | **Conduit Entries** | |
| | | | | | SI | 25 mm Conduit Entries |
| | | | | | AM | 3/4" FNPT Conduit Entries |
| **Analyzer** | **Power** | **Agency Approval** | **Sensor Style** | **Mount Orientation** | **Conduit Entries** | |
| BOA | DC | 2 | SFP | B | AM | **Typical Analyzer Model Number (Example)** |

## OXYvisor Accessories

| Part Number | Description |
|---|---|
| B5008-1225 | Wall Mount Kit - 316 SS |
| B5008-1125 | Pipe Mount Kit - 316 SS (1-1/2" - 2-1/4" pipe) |
| B5600-1185 | Compact USB memory stick for data logging and firmware upgrades, 8 GB |
| B5008-1140 | Compact sunshade, outdoor use, GRP 7.67"Wx13.98"Dx3.7"H, 316SS Back Plate, 316SS Collar Mount |
| B5500-0025 | Trace Level - AutoCal Kit: Test Gas Bottles (N6 & 25 ppm), analytical grade regulators, pipe/wall stand for bottles, (requires AutoCal SCP) [customer supplied 1/4" 316 SS tubing required] |
| B5500-0050 | Trace Level - AutoCal Kit: Test Gas Bottles (N6 & 50 ppm), analytical grade regulators, pipe/wall stand for bottles, (requires AutoCal SCP) [customer supplied 1/4" 316 SS tubing required] |
| B3905-1100 | RS485 Modbus Cable USB (PC) to 2 Wire OXYvisor connection cable 5m |
| B4951-1142 | Plug 3/4" MNPT CI D1&2 |
| B5003-0002 | 316 SS Tag |

## OXYvisor Analyzer Overview




**Front Cover / Cap**
O-ring sealed and secured with a set-screw and blue Loctite. Do not open (not field servicable)

**Nameplate / Label**
Contains the part number, company info, and the **Hazardous Area Markings**

**Rugged Industrial Enclosure**
IP66 / NEMA4x, pressure die-cast with trivalent chromate and chemically resistant paint

**Flameproof glass (Ex d)**
Protects the HMI, LCD, and other electronics

**Human Machine Interface**
The **HMI**, located behind the flameproof glass, includes backlit LCD and **through-the-glass keypad** for user configuration and full interactive use.

**Junction Box**
Contains easily accesible sensor connection(s)

**All analyzer models**
SMA connector for optical $O_2$ sensor or optical fiber wand assembly

**All analyzer models except Zone 1**
Molex connector for Pt1000 RTD

**Rear (Wiring) Compartment**
Contains the connection terminals for power and all I / Os except oxygen sensor. The cap (cover) is threaded, sealed via O-ring and secured with a set screw. The features allow easy, but controlled, access to wiring terminals.

**Conduit Entries**
There are four 3/4" FNPT or M25x1.5 6H conduit entries (configured during ordering) for the **Rear (Wiring) Compartment.**

**Pipe Mount Bracket**
316 SS, 2" Pipe / field mounting bracket

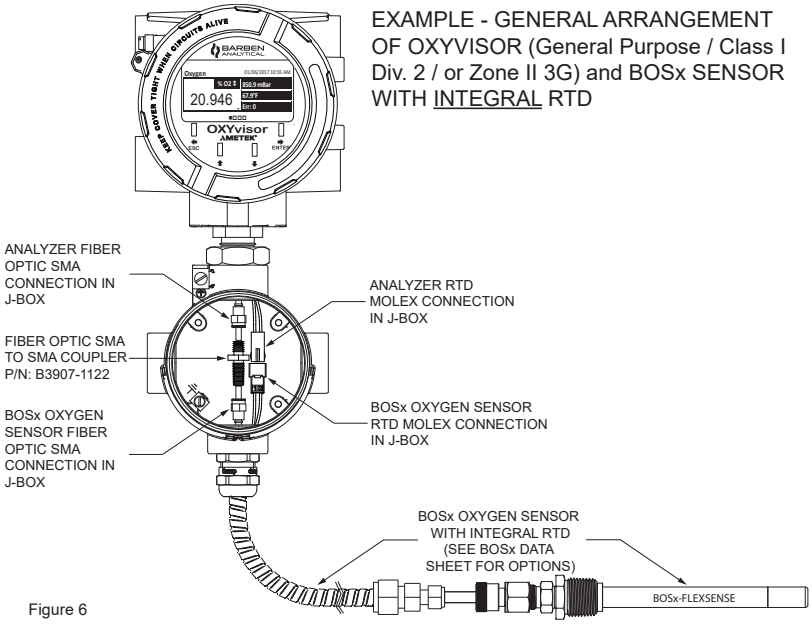
**Conduit Entries (Junction Box)**
There are two 3/4" FNPT or M25x1.5 6H conduit entries (configured during ordering) for the **Junction Box.**

**Oxygen Sensor Entry (BOTTOM ONLY)**
1/2" FNPT for the Oxygen sensor. Allow >6" for conduit clearance and bend radius

Figure 5

## OXYvisor Installation Examples

### BOSx Sensor with Integral RTD (Recommended for Liquid Phase Measurement




EXAMPLE - GENERAL ARRANGEMENT OF OXYVISOR (General Purpose / Class I Div. 2 / or Zone II 3G) and BOSx SENSOR WITH INTEGRAL RTD

Figure 6

### Installation Examples

### BOSx Sensor with External RTD (Recommended for Gas Phase Measurement)

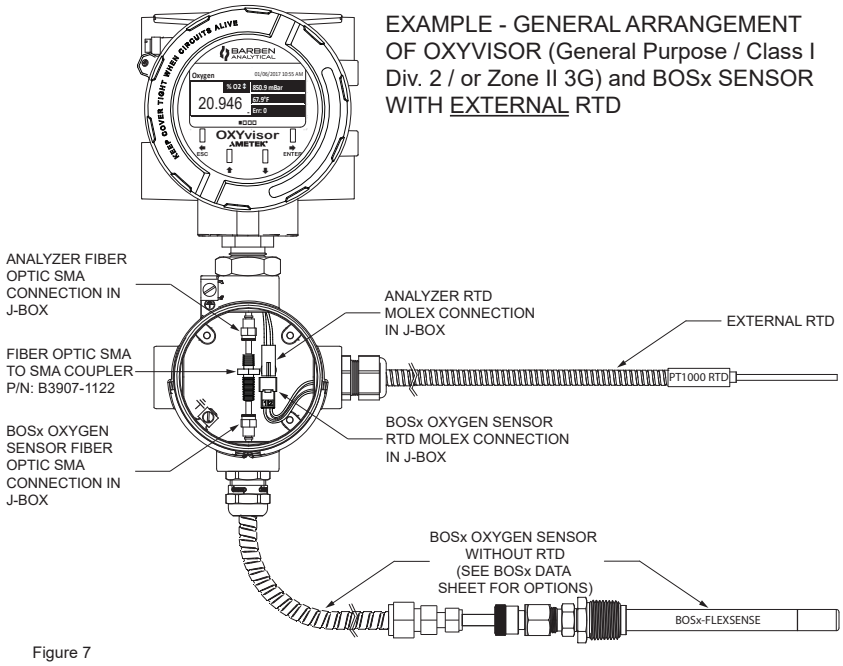



Figure 7

### BOSx Sensor with External RTD (Gas Phase Measurement in Exd Area)

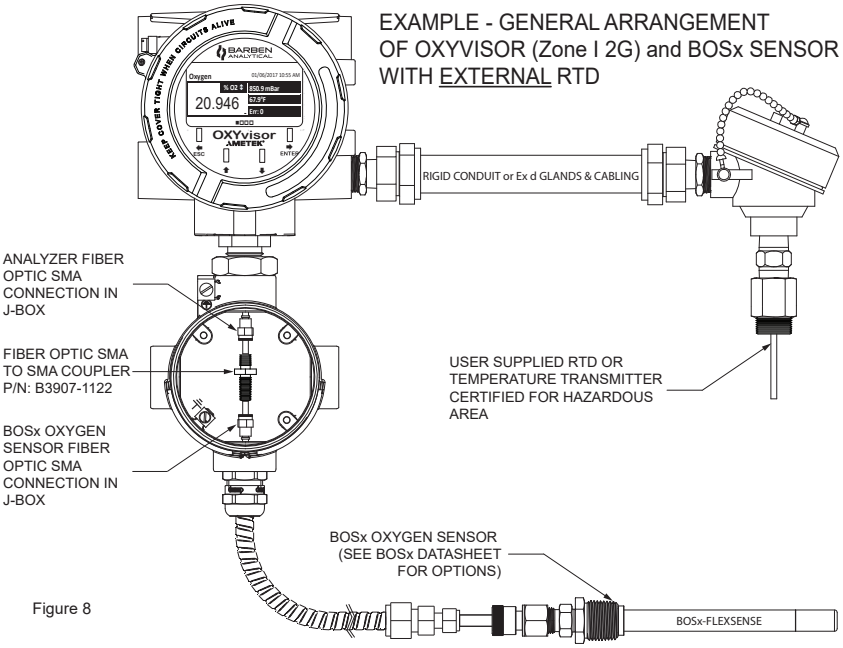



Figure 8

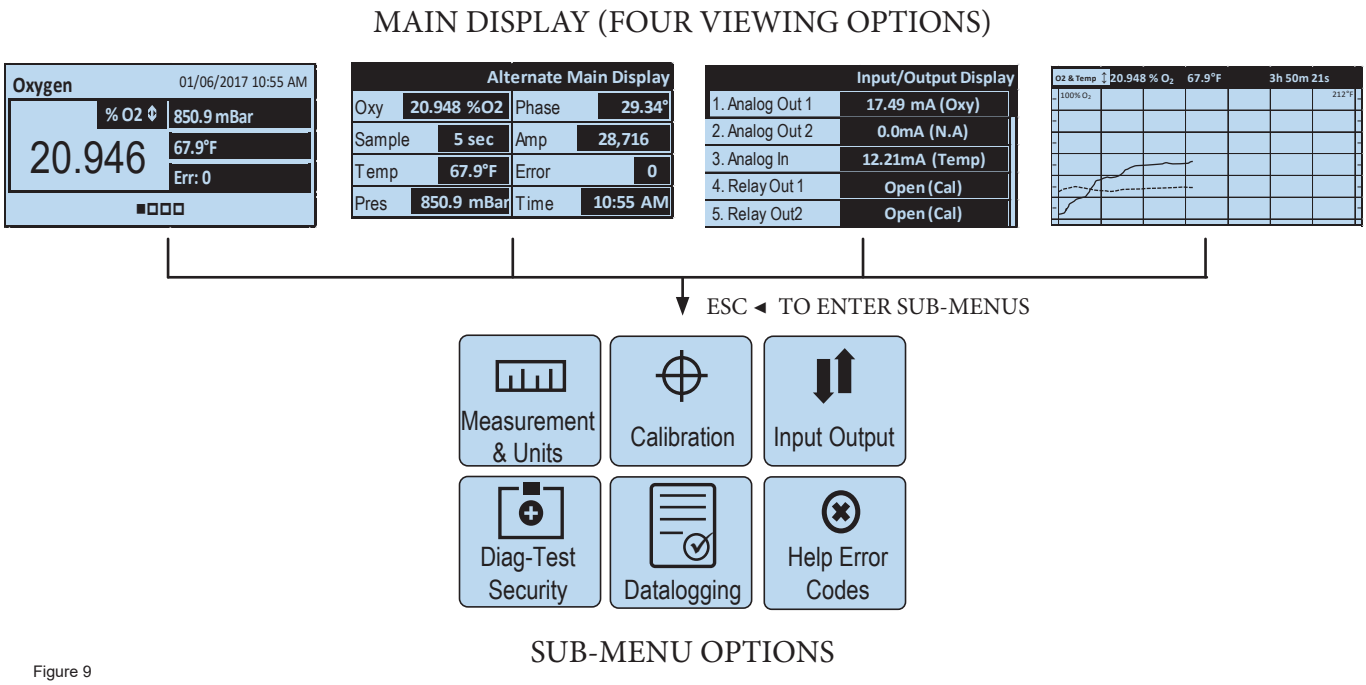
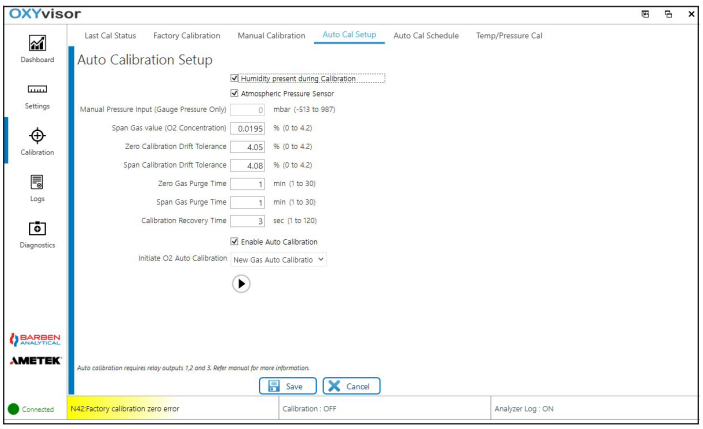


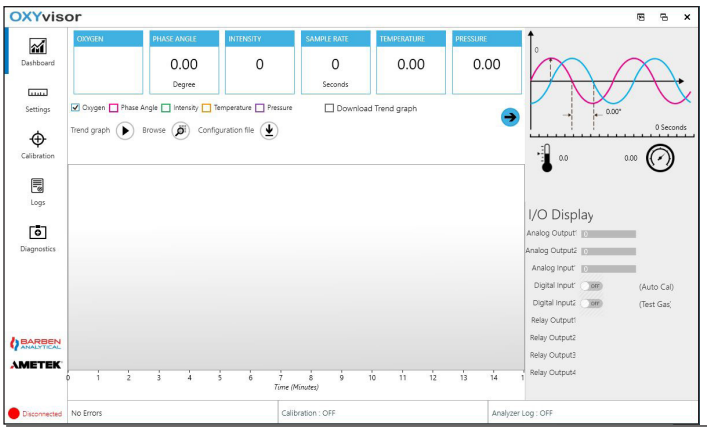

Figure 9

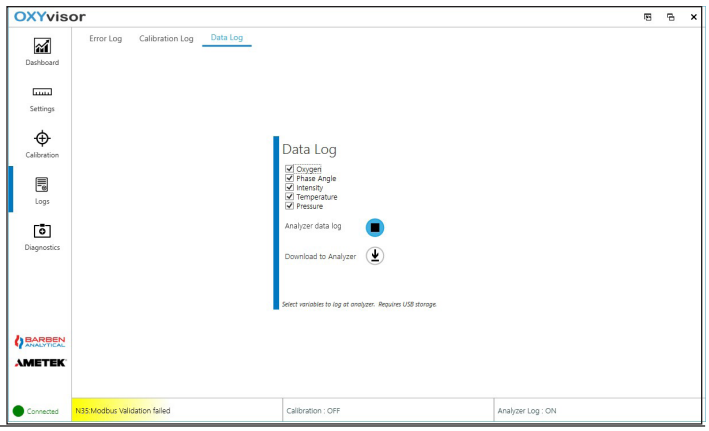
## OXYvisor Software

Quick configuration, troubleshooting, trending and datalogging of the analyzer measurements can be easily accomplished through the OXYvisor Software. The software utilizes the MODBUS RTU protocol to communicate with the analyzer.

Oxygen measurements, temperature, pressure and sensor characteristics such as phase angle and amplitude can be captured on the screen simultaneously or via a .csv file on the host computer.



# Precision Optical Oxygen Measurement
# OXYvisor® Oxygen Analyzer

The device has been tested and approved for use in hazardous areas via a third party OSHA approved NRTL

The OXYvisor is certified as Process Control Equipment for use in hazardous locations (QUZW, QUZW7) Class I, Division 2

c UL us LISTED

**Class I, Division 2, Groups A, B, C, D T4A**

US NEC Standards UL 12.12.01, CAN CEC Standards CSA C22.2 No. 213-17

The OXYvisor is certified as Process Control Equipment for use in Zone 1, Group IIC

**ATEX Zone 1, Group IIC Markings:**

CE 0539 Ex **II 2 G Ex db op is IIC T4 Gb** **Ta = -20° C to +55° C**

Certificate Number: DEMKO 19 ATEX 2031, issued by UL DEMKO International A/S

EN Standards: 60079-0, 60079-1, 60079-28

**IECEx Zone 1, Group IIC Markings:**

IEC IECEx **Ex db op is IIC T4 Gb** **Ta = -20° C to +55° C**

Certificate Number: IECEx UL 19.0040 issued by UL LLC

IEC Standards: 60079-0, 60079-1, 60079-28

**North America Zone 1, Group IIC Markings** (QVAJ/QVAJ7)**:**

c UL us LISTED

**Class I Zone 1 AEx db op is IIC T4 Gb** **Ta = -20° C to +55° C**

**Ex db op is IIC T4 Gb** **Ta = -20° C to +55° C**

The OXYvisor is certified as Process Control Equipment for use in Zone 2, Group IIC

**ATEX Zone 2, Group IIC Markings:**

CE 0539 Ex **II 3 G Ex ec [ic] op is IIC T4 Gc** **Ta = -20° C to +55° C**

Certificate Number: DEMKO 19 ATEX 2036, issued by UL DEMKO International A/S

EN Standards: 60079-0, 60079-7, 60079-11, 60079-28

**IECEx Zone 2, Group IIC Markings:**

IEC IECEx **Ex ec [ic] op is IIC T4 Gc** **Ta = -20° C to +55° C**

Certificate Number: IECEx UL 19.0072 issued by UL LLC

IEC Standards: 60079-0, 60079-1, 60079-28

The OXYvisor complies with the following directives and has passed applicable emissions/immunity testing

CE

| | |
|---|---|
| Electromagnetic Compatibility (EMC) | Directive 2014/30/EU |
| Low-voltage (Safety) | Directive 2014/25/EU |
| Potentially Explosive Atmospheres (ATEX) | Directive 2014/34/EU |
| RoHS | Directive 2011/65/EU |

**EMC Emissions:** EN 61326-1:2013 (IEC 61326-1:2012) Group 1 Class A, EN 61000-3-2:2014 (IEC 61000-3-2:2014), EN 61000-3-3:2013 (IEC 61000-3-3:2013)

**EMC Immunity:** EN 61326-1:2013 (IEC 61326-1:2012) Group 1, Class A, EN 61000-4-2:2009 (IEC 61000-4-2:2009), EN 61000-4-3:2006/A1:2008/A2:2010 (IEC 61000-4-3:2006+A1+A2), EN 61000-4-4:2004/A1:2010 (IEC 61000-4-4:2004+A1), EN 61000-4-5:2006 (IEC 61000-4-5:2006), EN 61000-4-6:2009 (IEC 61000-4-6:2009), EN 61000-4-8:2010 (IEC 61000-4-8:2010), EN 61000-4-11:2004 (IEC 61000-4-11:2004)

## Contact Us

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# BOS SAFETAP II OPTICAL OXYGEN SENSOR

SafeTap II™

SafeTap II - BOSx Oxygen Sensor

| BOSx Oxygen Sensor Ranges | | |
|---|---|---|
| BOS1 Oxygen Range | 0 % to 4.2 % (gas)* | 0 ppb to 1.8 ppm (liquid) |
| BOS2 Oxygen Range | 0 % to 25 % (gas) | 0 ppb to 22 ppm (liquid) |
| BOS3 Oxygen Range | 0 to 300 ppm with 1000 ppm over range (gas) | |

** With over-range to 5 % $O_2$*

## TYPICAL APPLICATIONS

- Biogas - wet digester gas. 100 % compatible with typical stream compositions $CH_4$, $CO_2$, $H_2O$, $H_2S$, $N_2$, $O_2$, $NH_3$ & $H_2$
- Biogas - $H_2S$ removal/sweetening, amines or bio scrubber
- Renewable Natural Gas (RNG) - upgraded biomethane trace $O_2$ (ppm) measurement for transmission quality pipeline gas
- Carbon capture processes in $CO_2$ (trace and % level $O_2$)
- EOR - Enhanced Oil Recovery - Waterflood PPB Dissolved $O_2$ for seawater down hole injection
- General replacement of E-Chem (electrochemical / fuel) cells for Trace $O_2$ ppm to % level measurement.
  1. Not affected by typical e-chem poisons ($H_2S$, $CO_2$, $H_2$)
  2. Measurement accuracy independent of flow rate
  3. Not affected with exposure to air or high $O_2$
  4. Accurate measurement in particulate (dirty) streams

## PRODUCT OVERVIEW

The Barben Analytical SafeTap II is a retractable or “hot tap” Optical Oxygen Sensor. It is used with the OXYvisor Oxygen Analyzer for in situ sampling methods. Designed for use in liquids and dry or wet gases, the SafeTap II can be manually inserted and retracted from the process line. The SafeTap II provides the capability of in situ installation of a selectable BOSx Oxygen sensor ranges into the process pipe or vessel.

## FEATURES & BENEFITS

- Uses optical quench luminescent technology, no cross-sensitivity to $CO_2$, $SO_2$, $NH_3$, and $H_2S$, not affected by high $O_2$ levels and moisture, as compared to an E-Chem sensor
- Eliminates sample handling conditioning systems typical in extractive sampling methods. Lowers installation costs, complexity and maintenance.
- Adjustable BOSx sensor insertion length for variety of process pipe diameters
- RTD integrated at sensor tip for accurate temperature measurement and compensation
- Optional pressure transmitter allows for automatic compensation for accurate in-line measurements
- T-Handle and safety hook prevents blow-outs in-case of unplanned overpressure and ensures safe operation during insertion and retraction
- Replaceable BOSx sensor cap—simple and quick sensor cap service replacement design
- Approved for Hazardous Location installations
  - Fiber Optic $O_2$ light energy is certified “op is” (optically inherently safe)
  - RTD is simple apparatus for C1D2 or Zone 2 and carries OXYvisor specifications**
  - RTD in Zone 1, requires special Exd considerations

*** See OXYvisor datasheet or drawings for hazardous location*

# BOS SAFETAP II OPTICAL OXYGEN SENSOR

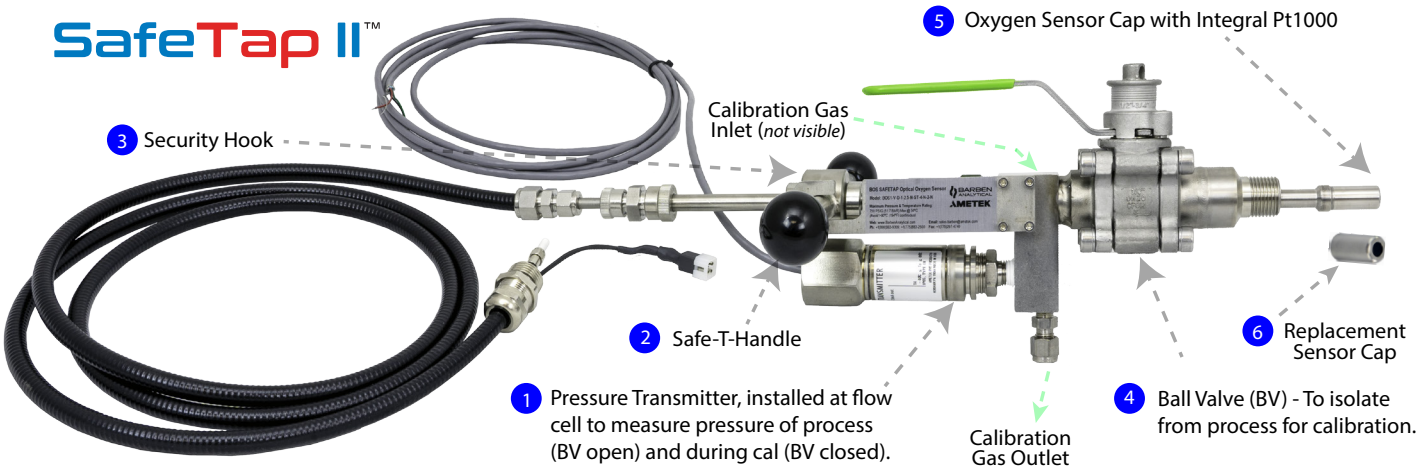



**Figure 1**
**BOS SAFETAP II, retractable or "hot-tap" Optical Oxygen Sensor**

## PRINCIPAL OF OPERATION

Figure 1 above illustrates the SafeTap II assembly with optional pressure transmitter (1) installed on the flow cell for continuous measurement of pressure in the process line and during calibration process for gas phase measurements. The BOS SafeTap II oxygen sensor comes standard with integral Pt100 RTD (5) temperature sensor suitable for Class 1 Div 2, or without using an external RTD for Zone 1. The SafeTap II is rated up to pressures of 750 psig (51.7 Bar). Built in tubing ports are included as part of the welded retraction housing so that purge and complete in situ calibration, in normal process operating conditions, and 450 psig (31.0 Bar) during Insertion and Retraction of the SafeTap II, may be performed without removal of the oxygen sensor.

For inserting and retracting, the free rotating Safe-T-Handle (2) provides a secure gripping surface to manually insert and retract the optical sensor assembly into the process. The SafeTap II includes a security hook (3) that catches the safe-T-handle to prevent unintended retraction. The 316SS Ball Valve (4) eliminates the need for a secondary isolation valve for retracting or maintenance of the sensor. Optional calibration gas inlet and outlet 316SS needle valves provide ease of manual calibration.

The SafeTap II is supplied with a replaceable luminophore window sensor cap (6), making sensor service simple and low cost. When sensor cap replacement is required, the removable luminophore tip can be retracted through the ball valve (4), which is used to isolate the sensor from the process. The sensor cap can be simply unscrewed with your fingers or hand and the replacement screwed back on hand tight, do not use any tools.

For a more thorough and detailed process on inserting, retracting the sensor assembly, calibration, and sensor cap replacement, please review the SafeTap II Oxygen Sensor Manual.

## EFFECTIVE FORCE VS PROCESS PRESSURE

The SafeTap II utilizes a 3/8" insertion rod for insertion/retraction. The small diameter rod helps to significantly reduce the force required during normal operation, insertion /retraction or during process upsets.

For example, Figure 2, shows the Effective Force (lbf) required to insert the sensor into process with various Process Pressure (psig).

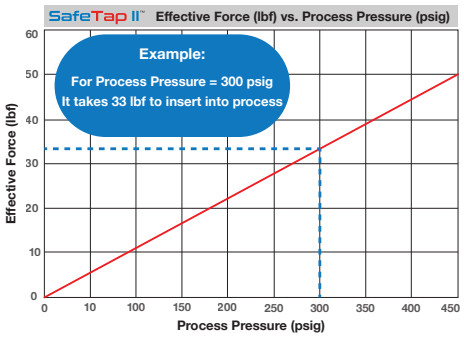



**Figure 2**

## INSTALLATION EXAMPLES

This section references hazardous location installation examples (see Figure 3 and 4) with measurements for liquid or gas phases. The OXYvisor oxygen analyzer with SafeTap II has agency approvals for Zone 1, Zone 2, and Class 1 Div 2 installation locations, see below for listed approval agencies. The SafeTap II is rated up to pressures of 750 psig (51.7 Bar) in normal process operating conditions, and 450 psig (31.0 Bar) during insertion and retraction of the SafeTap II.

OXYvisor Analyzer is shown in both Figure 3 and 4 are mounted in a hazardous location with the pipe mount kit and optional sunshade accessory. The recommended cable length is 5 meters with options to 10 meters (for greater lengths please consult the factory). For all installation requirements, review the OXYvisor and SafeTap II manuals mentioned in the Standard Documentation section.

Agency approvals for OXYvisor Oxygen Analyzer with SafeTap BOSx Optical Oxygen Sensor

OXYvisor® SafeTap II™

**Hazardous Area Approvals***

IEC Ex, ATEX, NA - Zone 1 & Zone 2 IIC
cULus (NRTL) - Class I, Div 2, Groups A, B, C, D T4

*For complete list of agency approvals, refer to the OXYvisor Datasheet.

**Typical Zone 2 and Class 1 Div 2 - installation in a pipe or vessel.**
The pressure transmitter (not required for Liquid Phase) and RTD are integrated to the SafeTap II flow cell and rated for Zone 2 and Class 1 Div 2 locations.

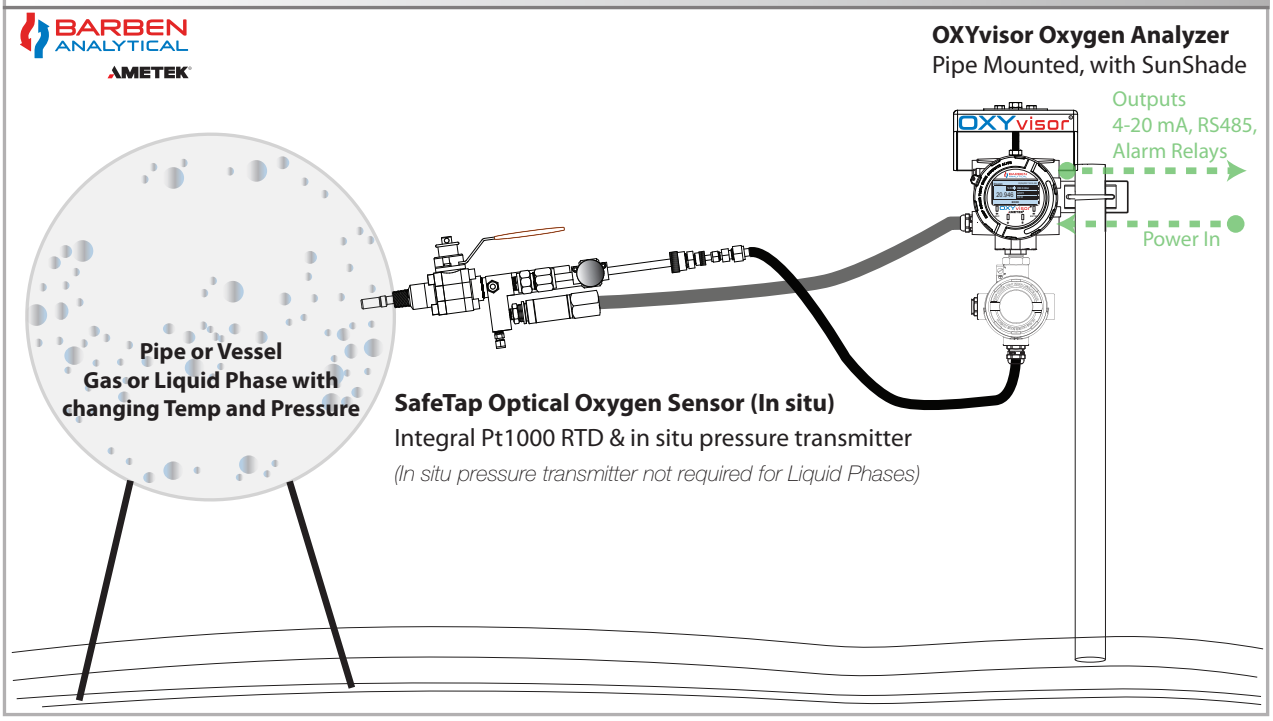



**Figure 3:** Zone 2 and Class 1 Div 2 Installation Examples

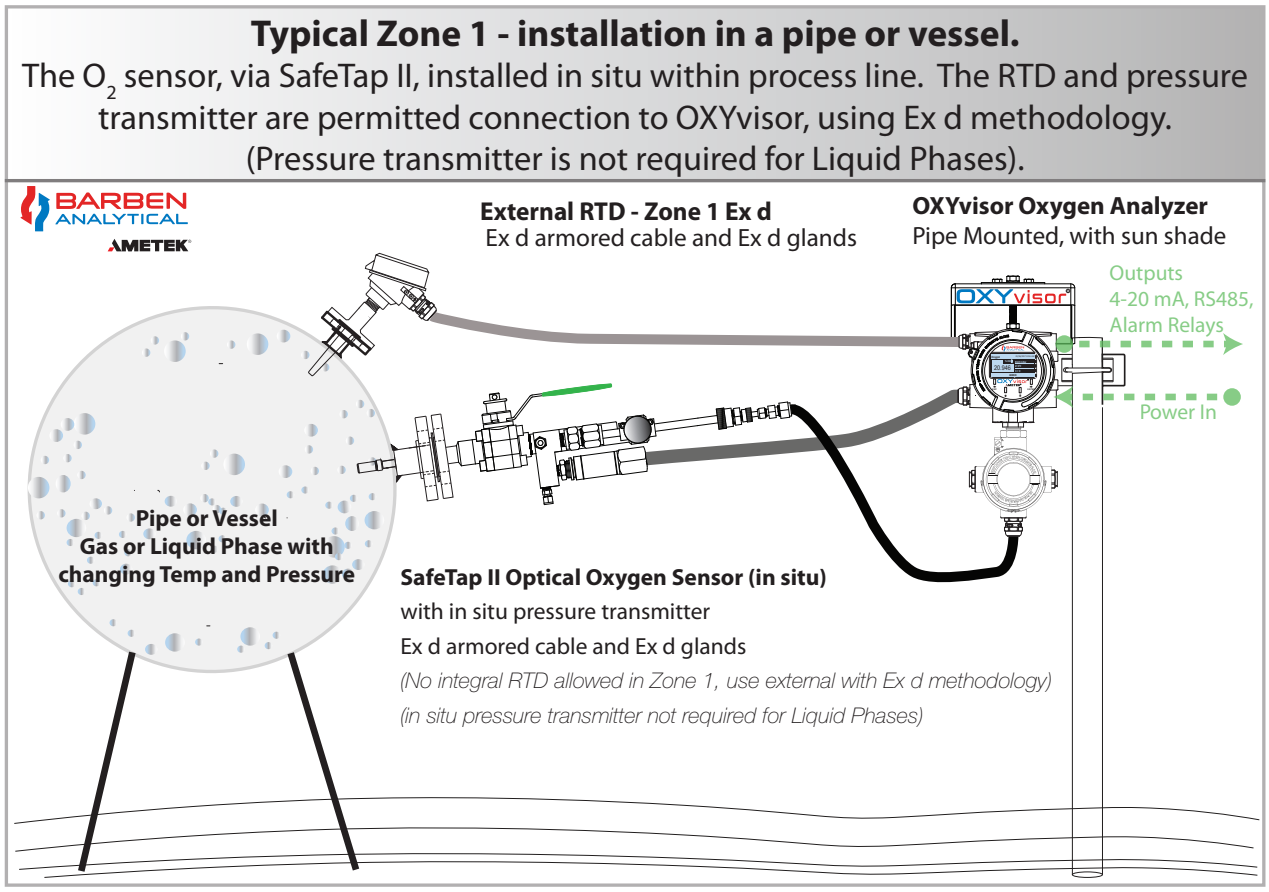



**Figure 4**: Zone 1 Installation Example

## STANDARD DOCUMENTATION

Table 1 references our standard documentation for the OXYvisor oxygen analyzer and BOS SafeTap II optical oxygen sensor. Barben recommends referring to our standard documentation as it serves as a comprehensive resource in providing detailed product information, installation, and guidelines for best practices. If you encounter any specific questions, please call us +1-775-883-2500 or visit our website: https://www.barbenanalytical.com/

| Document | Document Type | Description |
|---|---|---|
| **BA-DAT-OXY** | OXYvisor Datasheet | Technical overview of OXYvisor Oxygen Analyzer |
| **BA-MAN-OXY-IM** | OXYvisor Installation Manual | Installation, operation & maintenance information for the OXYvisor Oxygen Analyzer |
| **BA-MAN-OXY-SW** | OXYvisor Software Manual | Provides setup, configuration, data logging, calibration, diagnostics and more via PC software |
| **BA-MAN-BOSST-IM** | SafeTap II Installation Manual | Installation, operation & maintenance information for the SafeTap II |

**Table 1**: Standard Documentation

## PRODUCT NOMENCLATURE

| Sensor Range | Sensor & Seals | Body Material | Process Connection | Cable Armor | Sensor Length | Lead Length | Agency Approval | ID | FC | PT | Padlock |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **BOSx Sensor Element / Range (optode selection)** | | | | | | | | | | | |
| BOS1<br>BOS2<br>BOS3 | Mid Range Sensor: Gas Phase: 0-5.0 % $O_2$, 0-50 hPa with LOD 20 ppm $O_2$ and/or Liquid Phase Dissolved Oxygen: 0-1.8 ppm with LOD of 1 ppb<br>High Range Sensor: Gas Phase: 0-25.0 % $O_2$, 0-250 hPa with LOD 300 ppm $O_2$ and/or Liquid Phase Dissolved Oxygen: 0-22 ppm with LOD of 15 ppb<br>Trace Range: Gas Phase: 0-300 ppm with 1000 ppm over-range, with LOD of 0.5 ppm $O_2$ (0.0005 hPa) [Dissolved $O_2$ reading not avail. for this sensor] | | | | | | | | | | |
| | **Sensor & Seals (wetted elastomers)** | | | | | | | | | | |
| | V<br>E<br>K | Viton O-ring seals - Standard<br>EPDM O-ring seals<br>FFKM (perfluoroelastomer) O-ring seals | | | | | | | | | |
| | | **Body Material (wetted metallics)** | | | | | | | | | |
| | | 1<br>2<br>3<br>4 | 316 Stainless Steel (Standard)<br>Titanium Grade 2<br>Hastelloy C-276<br>Stainless Steel 2507 Super Duplex | | | | | | | | |
| | | | **Sensor Type & Process Connection** | | | | | | | | |
| | | | D | SafeTap: 1/2" MNPT Nipple for Process Connect, Insert/retract with 1/2" MNPT BV, Class 800, Vacuum = $10^{-6}$ Torr, Nace MR0175 | | | | | | | |
| | | | **F = 150#/G = 300# RF Flange, Process Connect, Insert/retract with 1/2" Full Port BV, Class 800, Vacuum = $10^{-6}$ Torr, Nace MR0175** | | | | | | | | |
| | | | F10/G10<br>F15/G15<br>F20/G20<br>F30/G30 | SafeTap - 1.0"<br>SafeTap - 1.5"<br>SafeTap - 2.0"<br>SafeTap - 3.0" | | | | | | | |
| | | | | **Cable Armor** | | | | | | | |
| | | | | 1 | Armor Jacketing Protection | | | | | | |
| | | | | | BOS Sensor Overall Length (Refer to "OXYvisor Oxygen Analyzer & BOS Sensors Datasheet") | | | | | | |
| | | | | | 2.5<br>5.0<br>10<br>X | 2.5 m (8.2')<br>5 m (16.4')<br>10 m (32.8') (BOS1 & BOS2 Sensors only)<br>Special Length (If > 10 m, consult factory) (BOS1 & BOS2 sensors only) | | | | | |
| | | | | | | PVC Jacket Length, Select "N" for BOS SafeTap Sensors. | | | | | |
| | | | | | | N | Standard - direct connect to OXYvisor Analyzer | | | | |
| | | | | | | | **Agency Approval** | | | | |
| | | | | | | | ST<br>SN | Standard, Integral RTD for SafeTap<br>No integral TC, and Zone 1 (see accessories for external RTD options) | | | |
| | | | | | | | | **Insertion Depth** | | | |
| | | | | | | | | 4<br>F<br>X | Std SafeTap Insertion Depth = 4" past end of nipple or Flange<br>SafeTap insertion depth = 12" past end of nipple or Flange<br>Customer defined insertion depth | | |
| | | | | | | | | | **Fittings & Cal Valves - 316 Stainless Steel** | | |
| | | | | | | | | | N<br>C | None - 1/4" T (Open)<br>Calibration Valves Included and Fittings | |
| | | | | | | | | | | **Pressure Transmitter - 316 Stainless Steel** | |
| | | | | | | | | | | N<br>1<br>2<br>3<br>4<br>5<br>X | None - Plug 1/4" NPT<br>0-15 psia - Pressure Transmitter<br>0-30 psia - Pressure Transmitter<br>0-60 psia - Pressure Transmitter<br>0-100 psia - Pressure Transmitter<br>0-150 psia - Pressure Transmitter<br>>200 psia - Pressure Transmitter - consult factory |
| | | | | | | | | | | | **Padlock** |
| | | | | | | | | | | | N<br>V<br>H<br>None<br>Padlock 3/16"<br>Padlock 5/16" |
| | Seals | Body MTL | Sensor Type | Cable | Length | Cut | Agency | ID | FC | PT | P |
| **BOS3** | **V** | **1** | **D** | **1** | **2.5** | **N** | **ST** | **4** | **N** | **N** | **N** **<--- SafeTap II - Typical Sensor Configuration** |

# BOS SAFETAP II OPTICAL OXYGEN SENSOR

## PRODUCT SPECIFICATIONS

| BOS1 Sensor Specifications - Liquid Phase / Gas Phase | | |
|---|---|---|
| | **Dissolved $O_2$ (DO)** | **Gaseous and Dissolved $O_2$ @ 1 atm, 20 °C** |
| **Measurement Range** | 0 - 2 ppm | 0 - 4.2% (over-range of 5%) $O_2$ |
| **Limit of Detection** | 1 ppb | 0.002% $O_2$ (0.02 hPa) |
| **Resolution @ 20 °C and 1013 hPa** | ± 0.30 at 1 ppb<br>± 0.63 at 200 ppb | ± 0.0007% at 0.002% $O_2$ (± 0.0015% at 0.02% $O_2$)<br>± 0.007 hPa at 0.023 hPa (± 0.015 hPa at 2.0 hPa) |
| **Response Time ($T_{90}$)** | < 30 sec. | < 6 sec. |
| **Accuracy @ 20 °C** | ± 1 ppb (l), 0.002%(g) or ± 3% of the respective concentration; whichever is higher | |
| **Drift from Photo-decomposition** | < 2 ppb within 30 days (60 sec. sample interval) | < 0.0042% within 30 days (60 sec. sample interval) |
| **Operating Temperature Range** | 0 to 50 °C (32 to 122 °F) [continuous up to 70 °C, consult factory for special conditions and considerations] | |
| **Allowable Sensor Temperature** | up to 90 °C (194 °F) non-continuous | |

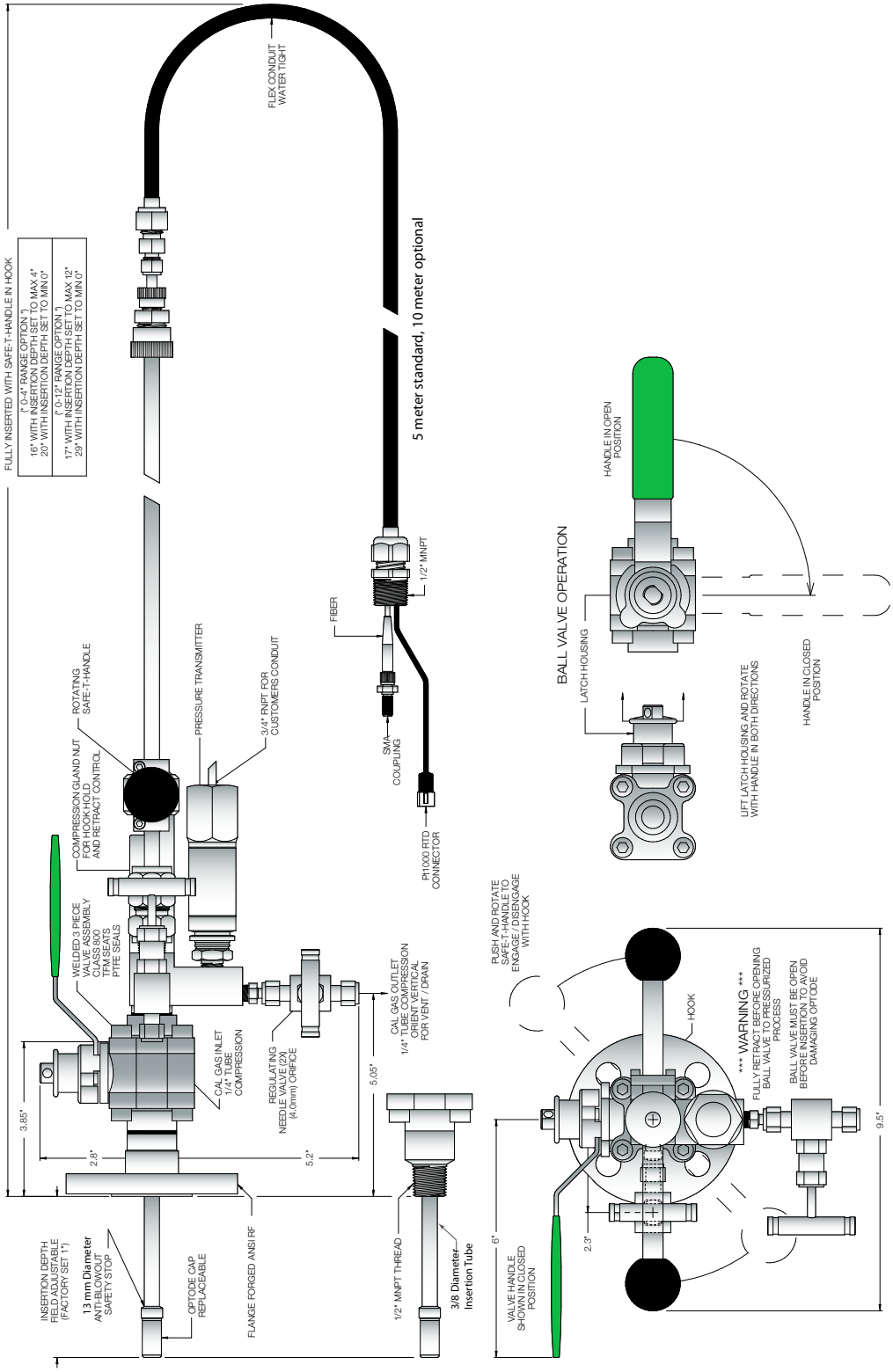
| BOS2 Sensor Specifications - Liquid Phase / Gas Phase | | |
|---|---|---|
| | **Dissolved $O_2$ (DO)** | **Gaseous and Dissolved $O_2$ @ 1 atm, 20 °C** |
| **Measurement Range** | 0 - 45 ppm | 0 - 25% (over-range of 100%) $O_2$ |
| **Limit of Detection (LOD)** | 18.1 ppb | 0.03% $O_2$ |
| **Resolution @ 20 °C and 1013 hPa** | ± 4.5 at 90 ppb<br>± 0.15 at 23 ppm | ± 0.01% at 0.21% $O_2$ (± 0.1 hPa at 2 hPa)<br>± 0.1% at 20.9% $O_2$ (± 1 hPa at 207 hPa) |
| **Response Time ($T_{90}$)** | < 30 sec. | < 6 sec. |
| **Accuracy @ 20 °C** | ±290 ppb or ±2 % at 15 ppm O2, whichever is greater (l) | ± 0.4% at 20.9% O2 and ± 0.05% at 0.2% O2 |
| **Drift from Photo-decomposition** | < 24 ppb within 30 days (60 sec. sample interval) | < 0.03% (60 sec. sample interval) |
| **Operating Temperature Range** | 0 to 50 °C (32 to 122 °F) [continuous up to 70 °C, consult factory for special conditions and considerations] | |
| **Allowable Sensor Temperature** | 90 °C (194 °F) non-continuous | |

| BOS3 Sensor Specifications - Gas Phase Only | |
|---|---|
| | **Gaseous $O_2$ @ 1 atm, 20 °C** |
| **Measurement Range** | 0 - 300 ppm (over-range of 1000 ppm) |
| **Limit of Detection (LOD)** | 0.5 ppm |
| **Resolution @ 20 °C and 1013 hPa** | ± 0.5 at 10 ppm; ± 0.8 at 100 ppm; ± 1.5 at 200 ppm |
| **Response Time ($T_{90}$)** | < 3 sec. based on 0 - 300 ppm measurement range |
| **Accuracy @ 20 °C** | ± 2 ppm or ± 5% of measured value; whichever is greater (± 0.002 hPa) |
| **Drift from Photo-decomposition** | < 1.5 ppm within 30 days (60 sec. sample interval) |
| **Operating Temperature Range** | 0 to 50 °C (32 to 122 °F) continuous |
| **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 ($H_2S$), 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 benzene, chloroform, toluene, acetone, and methylene chloride along with any strong oxidizers such as gaseous chlorine ($Cl_2$) |

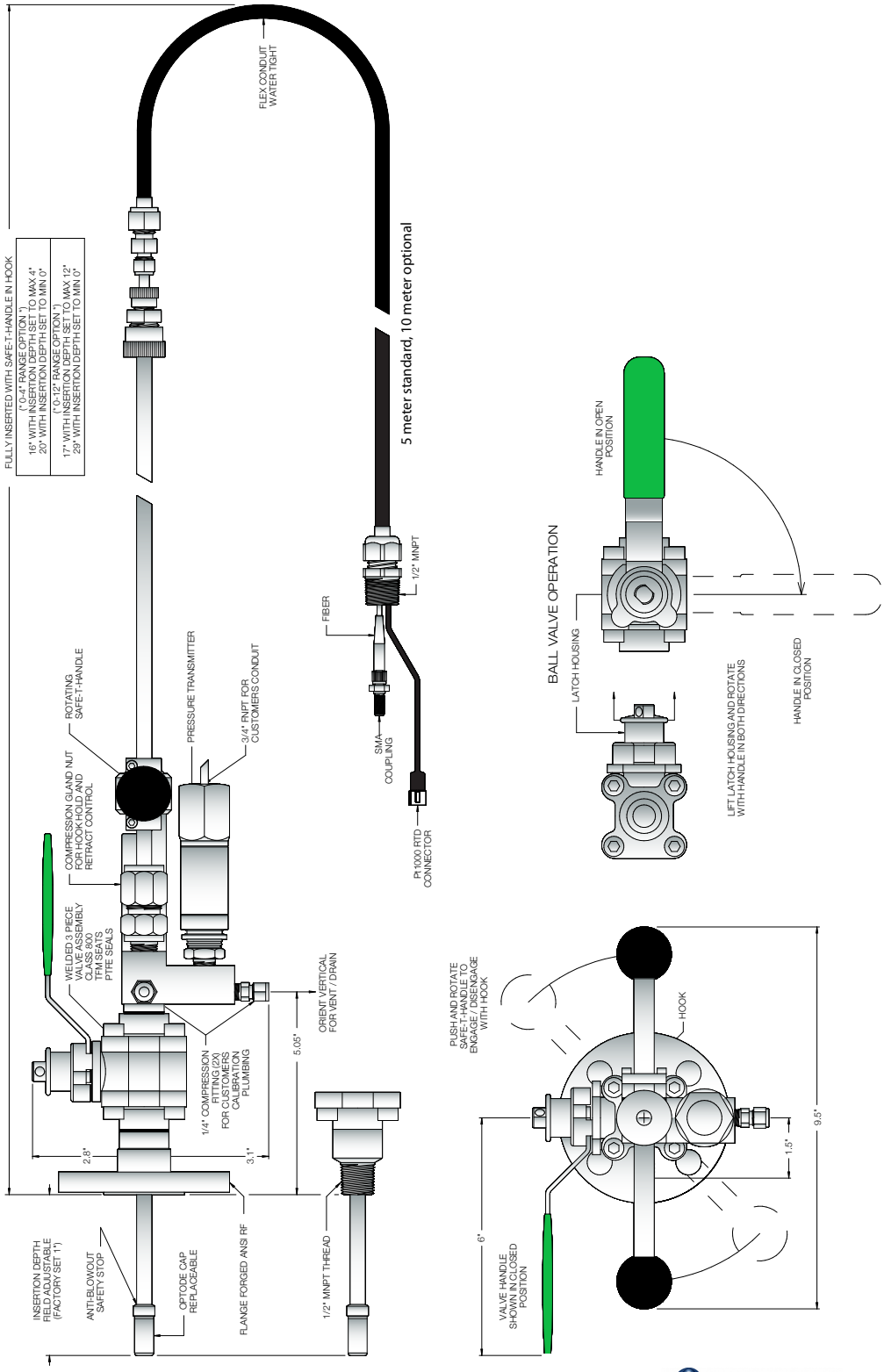
| BOS SAFETAP Retractable Optical Oxygen Sensor Specifications | |
|---|---|
| **Valve Options** | 316 stainless steel ball valve W.O.G., Optional 29" Hg full vacuum NACE MR0175 certified ball valve |
| **Operating Pressure Rating** | Up to 750 psig (51.7 barg) |
| **Insertion / Retraction Pressure Rating** | Up to 450 psig (31.0 barg) **Note: physical insertion / retraction may become more difficult over 300 psig** |
| **Temperature Rating** | 0 to 50 °C (32 to 122 °F) operating, 90 °C (194 °F) non-continuous |
| **Internal Seal Options** | Viton, EPDM, FFKM (Kalrez) |

## PRODUCT DIMENSIONS - SAFE TAP II WITH MANUAL CALIBRATION VALVE



# BOS SAFETAP II
# OPTICAL OXYGEN SENSOR

## PRODUCT DIMENSIONS - SAFETAP II WITHOUT MANUAL CALIBRATION VALVE

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www.adaptiveind.com

# Precision Optical Oxygen Measurement
# PSC3-OXY Portable Oxygen Analyzer

Industrial Process Control & Monitoring

- **Portable carrying case option for the 4401OXY Oxygen Analyzer**
- **FAST - Measures natural gas samples from % level to trace ppm $O_2$ in minutes.**
- **Includes sample system with filtration and drain for wet gas measurements**
- **Quick-connect sample bulkhead inlet and outlet tubing**
- **LOD = 0.5 ppm $O_2$ gas phase**
- **No membranes to foul; No electrolytes to poison; No consumption of $O_2$**
- **No harmed by: $CO_2$, $H_2S$ or hydrocarbons. No amines scrubbers required!**
- **Ready to use. Stays calibrated between short and longterm use.**

The PSC3-OXY provides a portable carrying case for trace level oxygen measurement in the field. The self-contained rugged and weather resistant case includes sample conditioning for wet, dirty natural gas with quick connect fittings for the sample inlet and outlet. The PSC3-OXY seamlessly integrates with the reliable Barben 4401OXY optical oxygen analyzer, BOSx FiberSense oxygen sensor, and PT1000 RTD (all included).

Barben Analytical's 4401OXY analyzer optically measures oxygen by utilizing the quenched luminescence of an oxygen specific luminophore. It provides a NEMA 4X rating and is suitable for hazardous areas (Class I, Div 2 Groups A, B, C, D).

BOS optical oxygen sensors are impervious to typical $O_2$ poisons ($H_2S$) and interferences (combustibles, magnetic, $CO_2$ and $H_2$) with quick response, high accuracy and long-term stability. Accurate measurements are achieved without the need for scrubbers or other advanced sample conditioning systems. The quick response allows for use from ambient down to trace ppm within a few minutes.

## Typical Applications

- **$O_2$ measurements in natural gas pipelines**
- **$O_2$ leak detection at compressors**
- **Vapor Recovery Unit (VRU) testing**
- **Trace level oxygen in flare gas**

*Limit of Detection: 0.5 ppm $O_2$ @ 1atm, 20ºC (0.0005 hPa)*

## Features

- **All-in-one analyzer, sensors and sample system**
- **Hooks directly to natural gas sampling port (1/4" T) and exhaust at a distance with tubing outlet**
- **UL rated power cord plug with locking engagement**
- **Detachable door for easy use**
- **Sample System for wet, dirty gases**
  - 15µ particulate filter
  - 0 to 30 PSIG pressure regulator with gauge
  - Coalescing filter with visible drain and valve
  - 0 to 8 SLPM flow-meter
  - Inlet: Quick connect stem SS-QC4-D1-400
  - Outlet: Quick connect female SS-QC4-B1-400

# Precision Optical Oxygen Measurement
# PSC3-OXY Portable Oxygen Analyzer

## Principle of Operation

The PSC-OXY includes Barben's proven 4401OXY optical oxygen analyzer. The 4401OXY 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.

**Light transmission through fiber optic to luminophore**

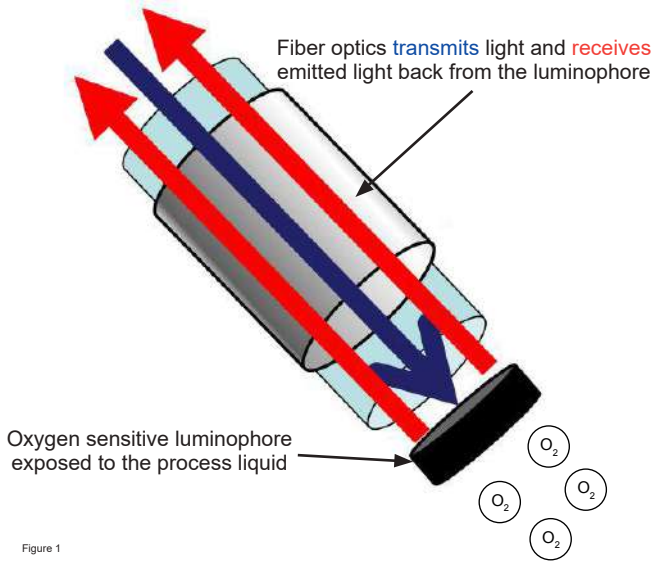


Figure 1

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].

**Effects of 100 ppm oxygen quenching**

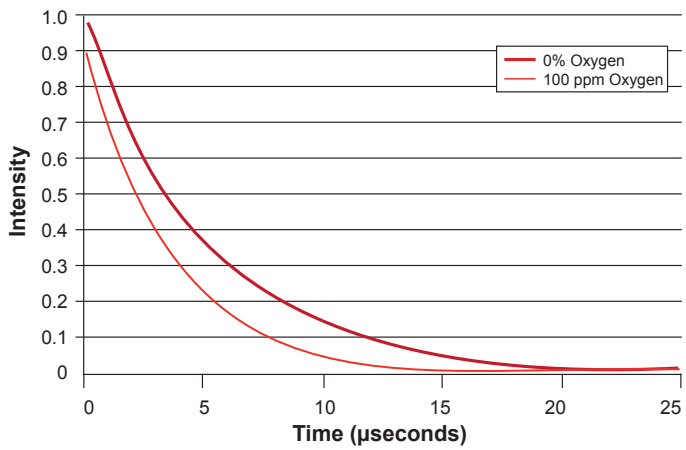


Figure 2

**Sinusoidal Modulation and the phase shifted output**

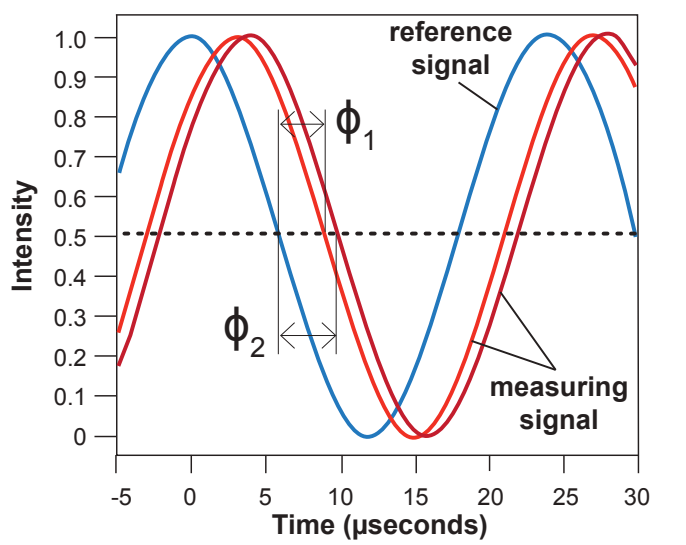


Figure 3

# Precision Optical Oxygen Measurement
# PSC3-OXY Portable Oxygen Analyzer

| PSC3-OXY Specifications | |
|---|---|
| **Part Numbers (Ordering Information)** | |
| **PSC3-OXY-BOS3-DC** | 12-24VDC* Operational Power, 4401OXY with FM / CSA Approval, 0 to 300 ppm Range |
| **PSC3-OXY-BOS3-AC** | 100-240VAC Operational Power, 4401OXY with FM / CSA Approval, 0 to 300 ppm Range |
| **PSC3-OXY-BOS1-DC** | 12-24VDC* Operational Power, 4401OXY with FM / CSA Approval, 0 to 4.2% Range |
| **PSC3-OXY-BOS1-AC** | 100-240VAC Operational Power, 4401OXY with FM / CSA Approval, 0 to 4.2% Range |
| | ** Input power must not exceed 24VDC* |
| **Input Information** | |
| **Sensor Input** | (1) $O_2$ optical input BOS FIBERSENSE sensor, (1) PT1000 input (Part# B1150-1005) |
| **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 |
| **Sampling Rate** | Programmable from 3 seconds to 1 hour |
| **Environmental (Based on ratings for 4401OXY Analyzer)** | |
| **Environmental Rating** | NEMA 4X |
| **Operating Temperature** | 0 to +50ºC (32 to 122ºF) |
| **Storage Temperature** | -10 to +65ºC (14 to 149ºF) |
| **Max. Operating Relative Humidity** | 95% |
| **Physical** | |
| **Dimensions H x W x D (Inches)** | 18 x 12 x 17 inches (21.3 x 25.4 x 21.3 cm) |
| **Weight (lb)** | 28 lb (12.7 kg) |

| BOS FIBERSENSE Specifications | | |
|---|---|---|
| | **BOS1 - % Level Gas Phase $O_2$ @ 1atm, 20ºC** | **BOS3 - ppm Level Gas Phase $O_2$ @ 1atm, 20ºC** |
| **Measurement Range** | 0 - 4.2 % $O_2$<br>0 - 41.4 hPa | 0 - 300 ppm with over-range of 1000 ppm |
| **Limit of Detection** | 0.002 % $O_2$ | 0.5 ppm $O_2$ |
| **Resolution @ 20ºC and 1013 hPa** | ± 0.0007% at 0.002 %$O_2$ ± 0.007 hPa at 0.023 hPa<br>± 0.0015% at 0.02%$O_2$ ± 0.015 hPa at 2.0 hPa | 10 ± 0.5 ppm; 100 ± 0.8 ppm; 200 ± 1.5 ppm |
| **Response Time ($T_{90}$)** | < 6 sec. | < 3 sec. based on 0 - 300 ppm measurement range |
| **Accuracy @ 20ºC** | 0.002 % $O_2$ (g), or 3% of the measured value whichever is greater | ± 2ppm or ± 5% of measured value whichever is greater (or as partial pressure, +/- 0.002 hPa) |
| **Drift from Photodecomposition** | < 2.0 ppb within 30 days (1 min sample rate) | < 2.0 ppm within 30 days (1 min sample rate) |
| **Operating Temperature Range** | 0 to 50ºC (32 to 122ºF) | |
| **Allowable Sensor Temperature** | 90ºC (194ºF) non-continuous | |
| **Cross Sensitivity for BOS1 & BOS3 Sensors Listed above** | | |
| No cross-sensitivity for carbon dioxide ($CO_2$), hydrogen sulfide ($H_2S$), 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 ($Cl_2$). | | |

## Agency Approvals (for 4401OXY Optical Oxygen Analyzer)

FM C US APPROVED

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)

# Precision Optical Oxygen Measurement
# PSC3-OXY Portable Oxygen Analyzer

### Power Options

The PSC-OXY comes pre-wired for either AC or DC power. A male quick connect plug on a short length of cable [fig 5] is included within the carry case. A female receptacle is supplied to allow the customer to wire to their own power supply. Both plug and receptacle are UL rated for full load.

Barben Analytical highly recommends that power conditioning be used if the external power supply could have variable voltage.

**Plug & Receptacle**

Figure 4

### PSC3-OXY Dimensions (with cover)

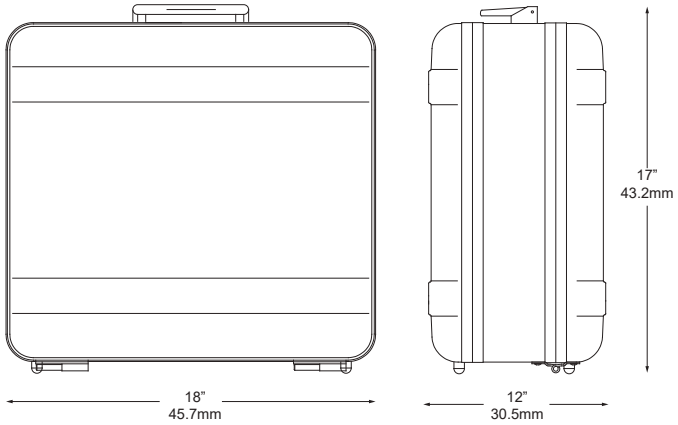


Figure 5

## 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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**Your Barben Analytical Representative**



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# Precision Optical Oxygen Measurement
# 4401OXY Oxygen Analyzer & BOS Sensors

Industrial Process Control & Monitoring

- **Excellent long term stability and low drift**
- **Measurement inherently fails high if sensor damaged (no false zero)**
- **LOD = 0.5 ppm $O_2$ gas phase**
- **No membranes to foul; No electrolytes to poison; No consumption of $O_2$**
- **Hazardous area approvals: FM, CSA, ATEX, UL and CE**
- **No cross-sensitivity or damage caused by: $CO_2$, $H_2S$, $NH_3$, $NO_2$, heavy metals, ethanol, methanol or ionic species pH, $S_2^-$, $SO_4^{2-}$, $Cl^-$, 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 $O_2$ poisons ($H_2S$) and interferences (combustibles, magnetic, $CO_2$ and $H_2$) 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 % $O_2$) for the gas phases along with hPa, ppm or ppb for dissolved oxygen in liquid phase.

**Typical Applications - Gas Phase (g)**

- **$O_2$ in hydrocarbon streams**
- **$O_2$ detection in nitrogen headers**
- **$O_2$ in process streams**
- **$O_2$ in nitrogen tank blanketing**
- **Trace level oxygen in flare gas**

*Limit of Detection: 0.5 ppm $O_2$ @ 1atm, 20ºC (0.0005 hPa)*

**Typical Applications - Liquid Phase (l)**

- **High pressure produced water Dissolved $O_2$**
- **ppb dissolved $O_2$ for waterflood injection**
- **Oxygen in methanol and ethanol**
- **Oxygen in oils**
- **Dissolved $O_2$ in liquid process streams**
- **Dissolved $O_2$ in product streams**

*Limit of Detection: 1 ppb Dissolved $O_2$*

# 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].

**Effects of 100 ppm oxygen quenching**

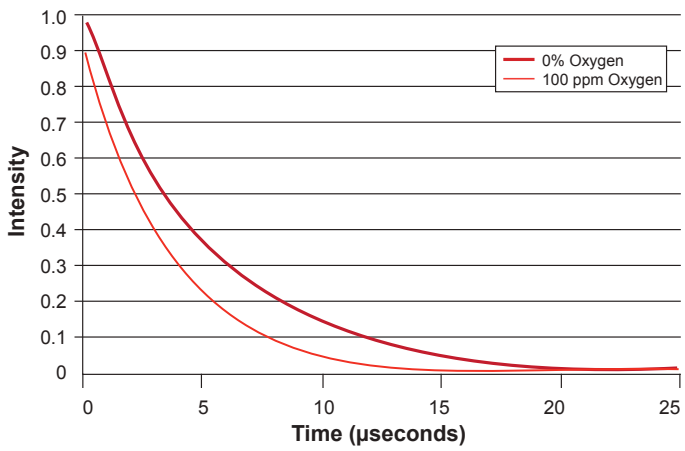



Figure 2

**Light transmission through fiber optic to luminophore**

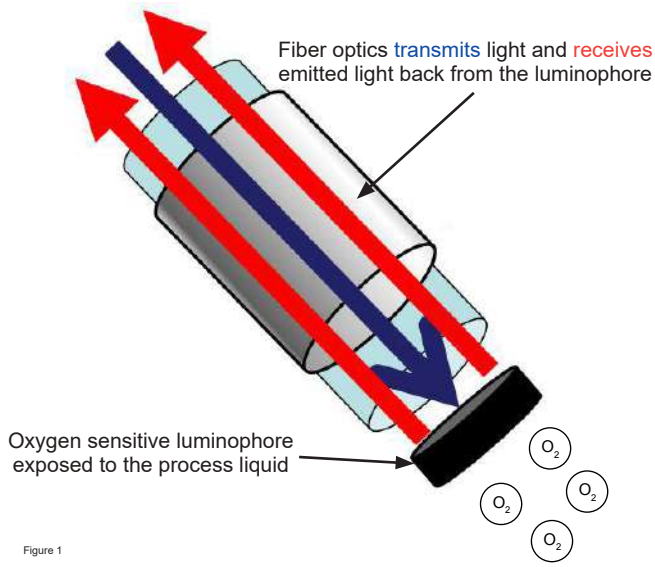



Figure 1

**Sinusoidal Modulation and the phase shifted output**

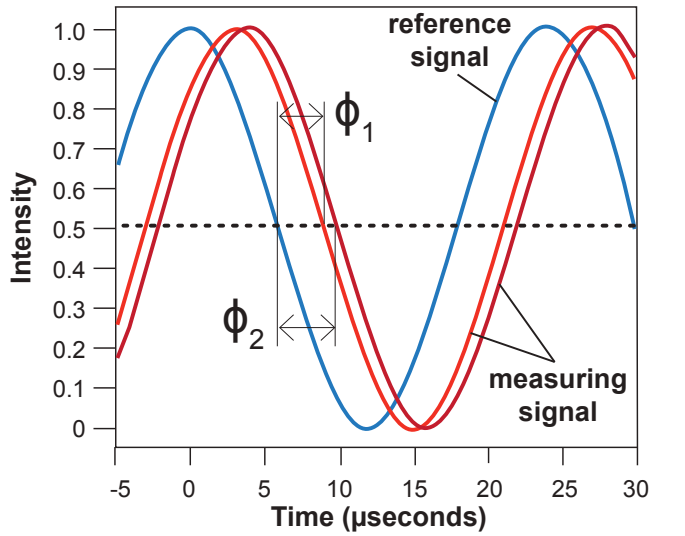



Figure 3

# 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<br>(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 +50ºC (32 to 122ºF) |
| **Storage Temperature** | -10 to +65ºC (14 to 149ºF) |
| **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

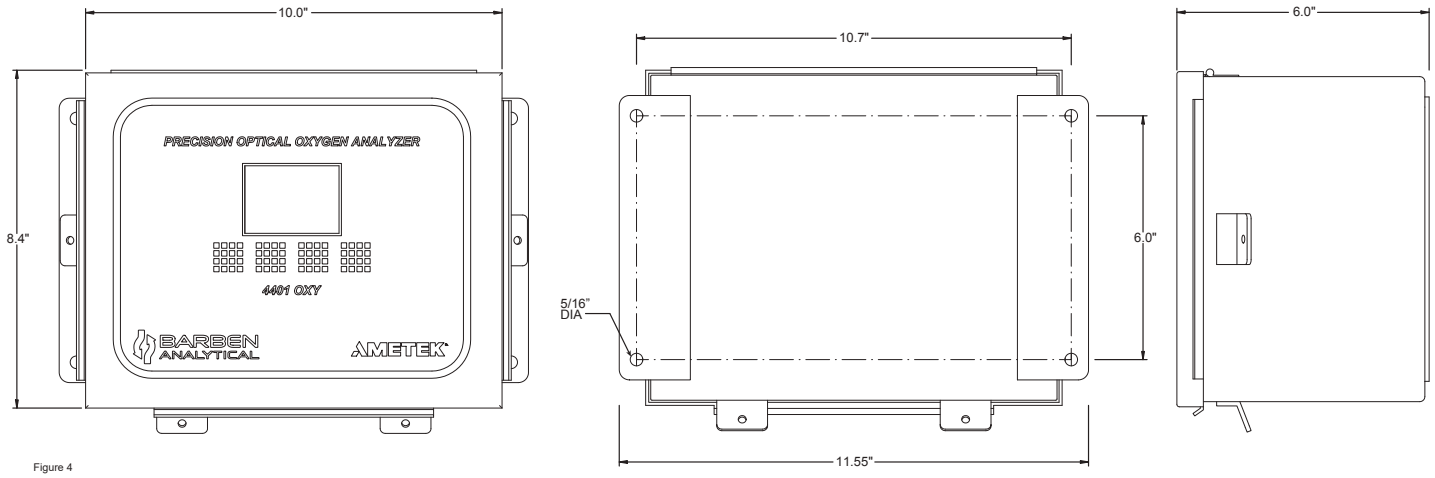



Figure 4

# 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**

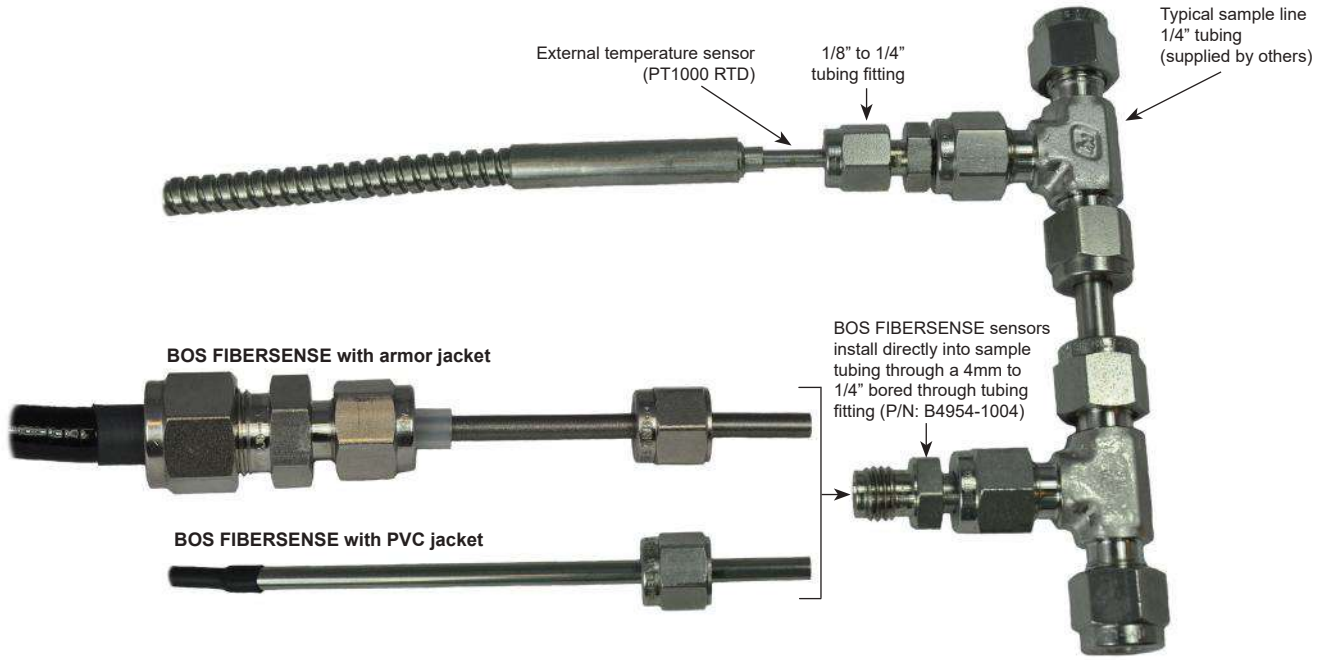



Figure 5

**BOS FIBERSENSE - Dimensions**

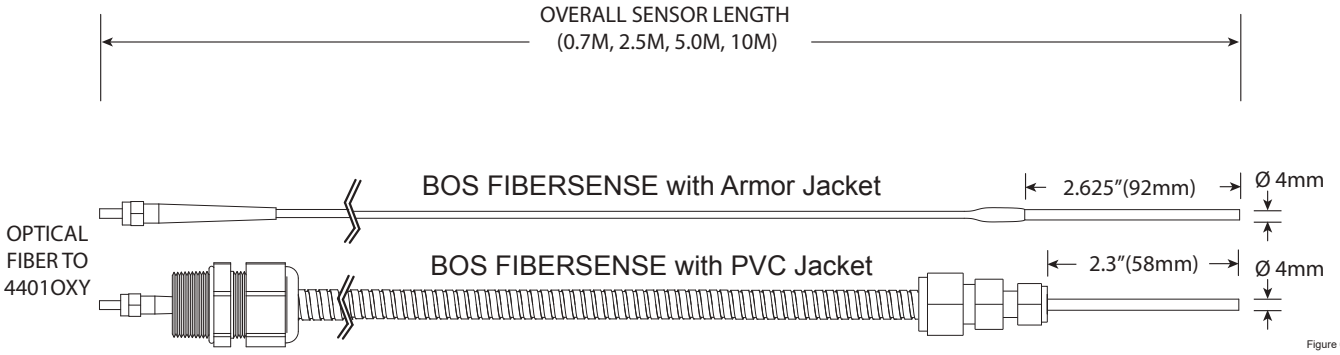



Figure 6

## 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**

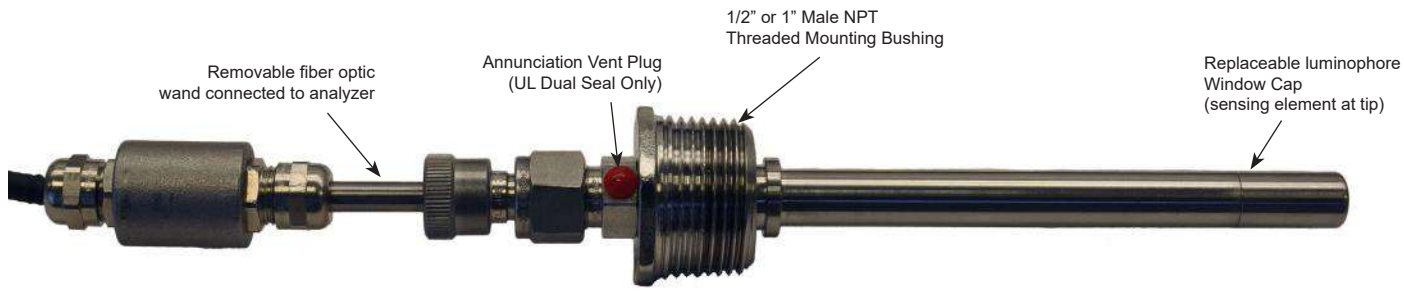



Figure 7

**BOS FLEXSENSE - Standard Dimensions**

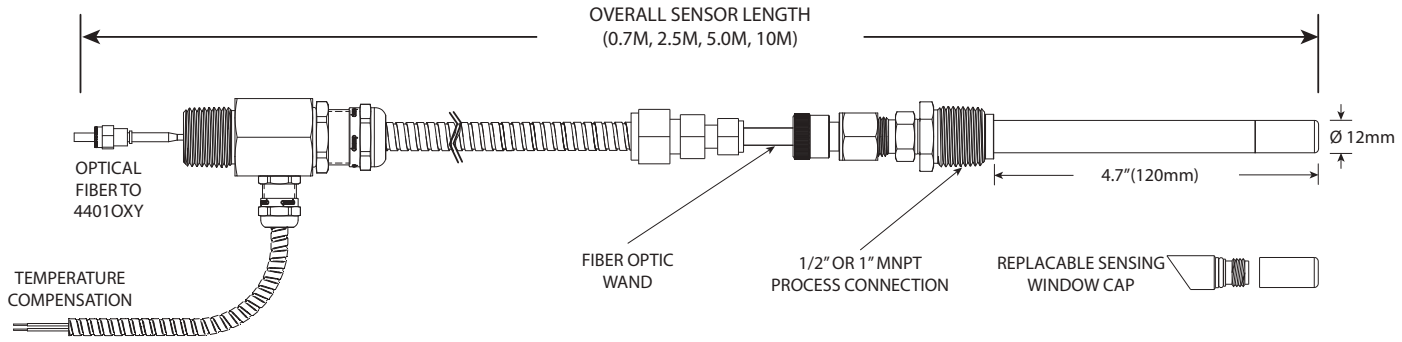
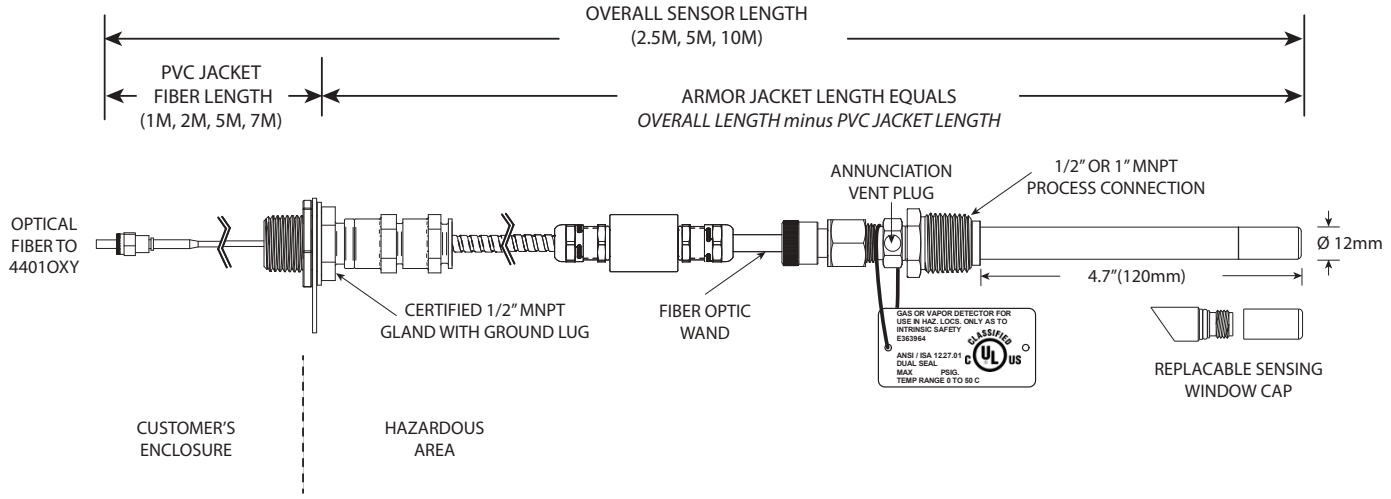



Figure 8

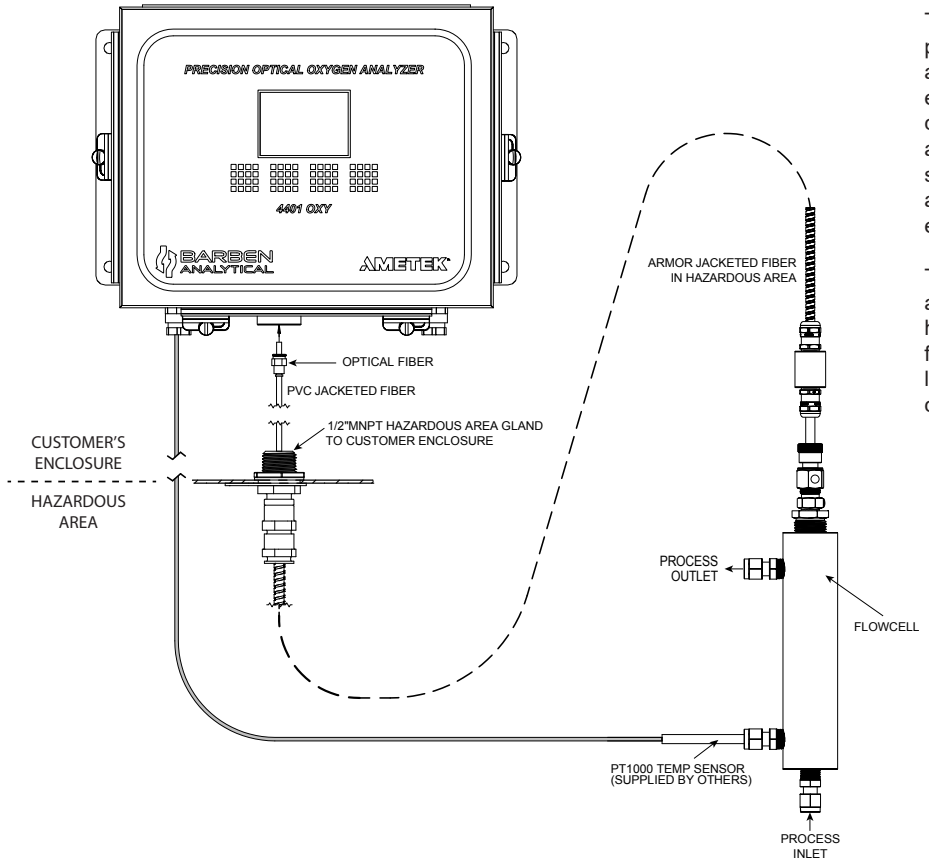
| BOS FIBERSENSE Optical Oxygen Sensor Specifications | |
|---|---|
| **Pressure Rating** | 30 PSIG (2.1 Bar) Maximum Pressure |
| **Temperature Rating** | 0 to 50ºC (32 to 122ºF) Operating, 90ºC (194ºF) non-continuous |
| **BOS FLEXSENSE Optical Oxygen Sensor Specifications** | |
| **Pressure Rating** | 1200 PSIG (82.7 Bar) for BOS1 & BOS2 sensing caps, 800 PSIG (55.1 Bar) for BOS3 sensing caps |
| **Temperature Rating** | 0 to 50ºC (32 to 122ºF) operating, 90ºC (194ºF) 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 boundries. 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.

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

↑ARMOR JACKET LENGTH↑

OVERALL BOS SENSOR LENGTH
\- PVC JACKETED FIBER LENGTH
= ARMOR JACKET LENGTH

Figure 9

## 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**

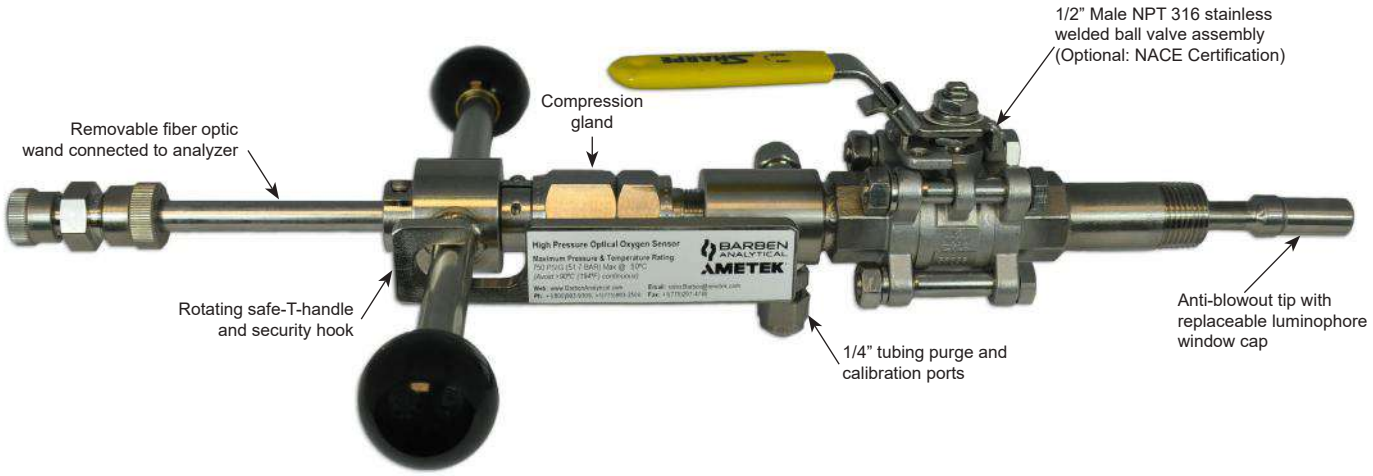



Figure 10

| 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 50ºC (32 to 122ºF) operating, 90ºC (194ºF) non-continuous |
| **Internal Seal Options** | Viton, EPDM, FFKM (Kalrez) |

## BOS SAFETAP - Dimensions

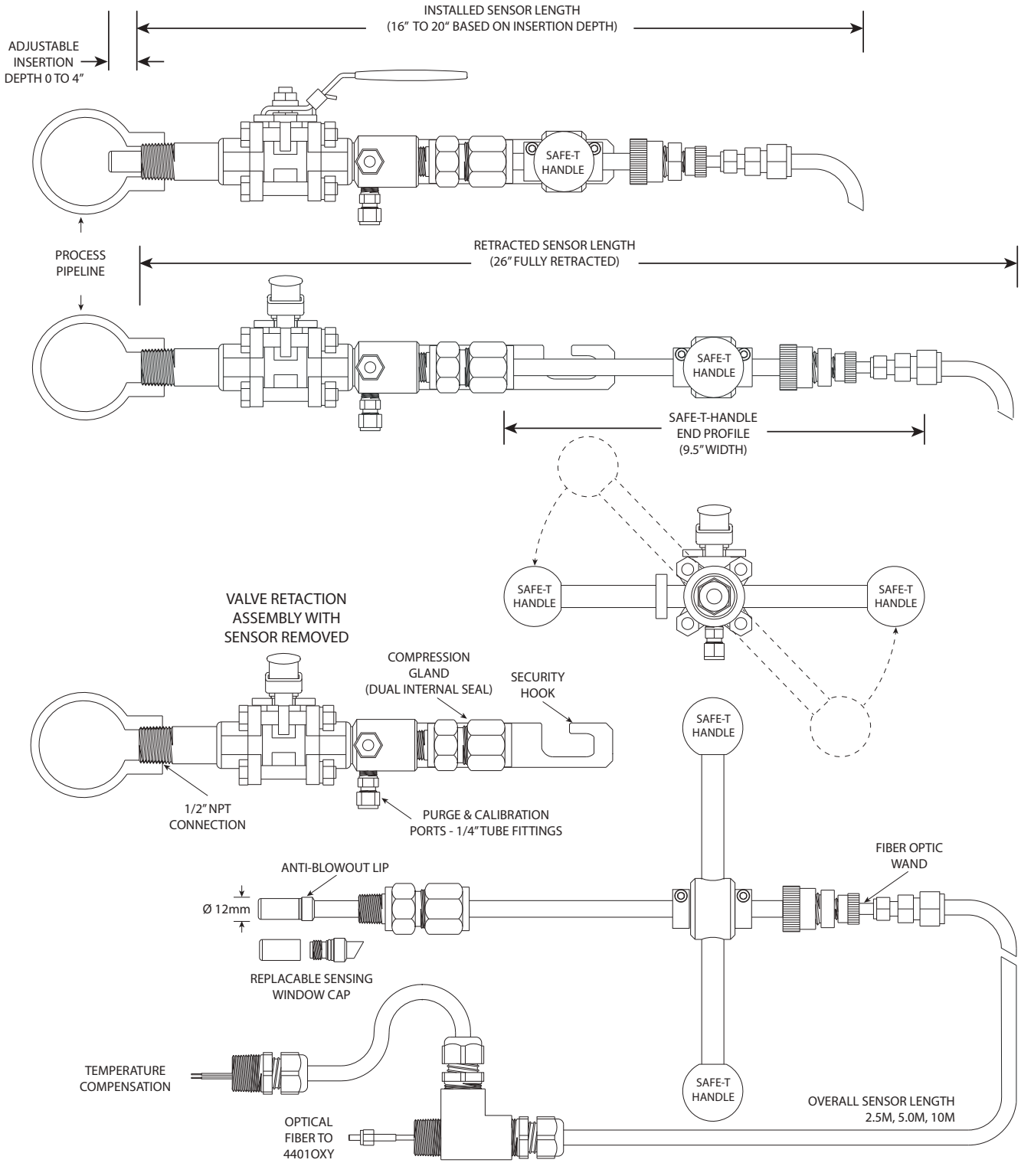



Figure 11

## 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 % $O_2$<br>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)<br>± 0.41 at 10 µg/L (ppb)<br>± 0.63 at 200 µg/L (ppb) | ± 0.0007 % $O_2$ at 0.002 % $O_2$ ± 0.007 hPa at 0.023 hPa<br>± 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 % $O_2$<br>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)<br>± 45 at 9060 µg/L (ppb)<br>± 0.15 at 23 mg/L (ppm) | ± 0.01 % $O_2$ at 0.21 % $O_2$ ± 0.1 hPa at 2 hPa<br>± 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 ($H_2S$), 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 FIBERSENS & 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 |

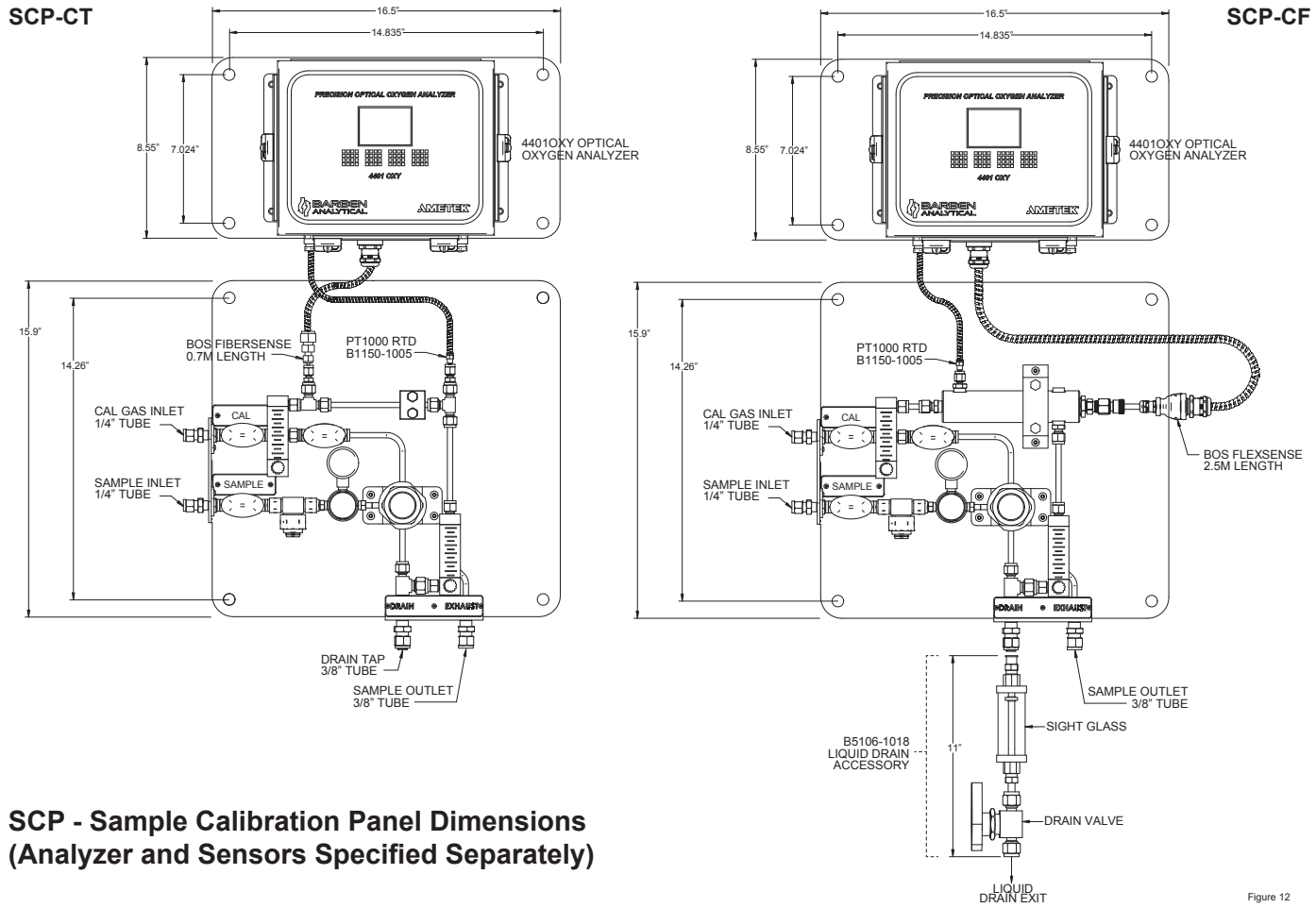
## SCP Oxygen Sample Calibration Panel - Gas Phase

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) & coelescing (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<br>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<br>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 (62.3.8 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) @ 100ºC *(Note - Sensor Max. 90ºC (194ºF) non-continuous)* |
| **Accessories** | |
| **B5106-1018** | Liquid Drain Option. Provides sight window for manual drain in high moisture applications. |




**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 135ºC (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 exlosive 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

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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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