BARBEN ANALYTICAL

AMETEK®

Operation & Maintenance Manual

BOS FLEXSENSE
Optical Oxygen Sensor
for use with 4401OXY Analyzer

Optical O_2 Products

Operation & Maintenance Manual
BOS FLEXSENSE Optical Oxygen Sensor

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Receiving & Storage

WARNING!! DO NO DISCARD UV PACKAGING.

Barben oxygen sensors are light sensitive devices. Avoid prolonged exposure to UV light, as this will minimize the effectiveness of the luminophore dye, leading to limited life or failure of the sensor.

Carefully inspect the products immediately upon arrival. If there are missing or damaged items contact the factory or shipping insurance company immediately.

Storage: The storage location should be protected from the elements. Although all components provided are designed to resist corrosion, additional protection from heat (>140°F/ 60°C) and humidity is recommended. Store the sensor caps in factory supplied UV resistant packaging when not in use.

Safety Instructions

Read complete manual to understand operation BEFORE Install & Operation. Please consult factory support for any questions

WARNING: Always wear protective equipment (e.g. face shield, gloves and other protective clothing) and follow safety rules when clearing the line, installing or removing sensor.

Products Covered in this Manual

This product manual provides information about Barben Analytical's BOS FLEXSENSE oxygen sensor and the replaceable oxygen window cap assembly, B3907-XXXX. The B3907-XXX cap assembly includes a pre-assembled replacement cap and an o-ring replacement for the BOS FLEXSENSE optical oxygen sensor. The scope of this manual also covers the installation and replacement for the B3907-XXX replacement cap assembly.

Product Nomenclature and Specifications

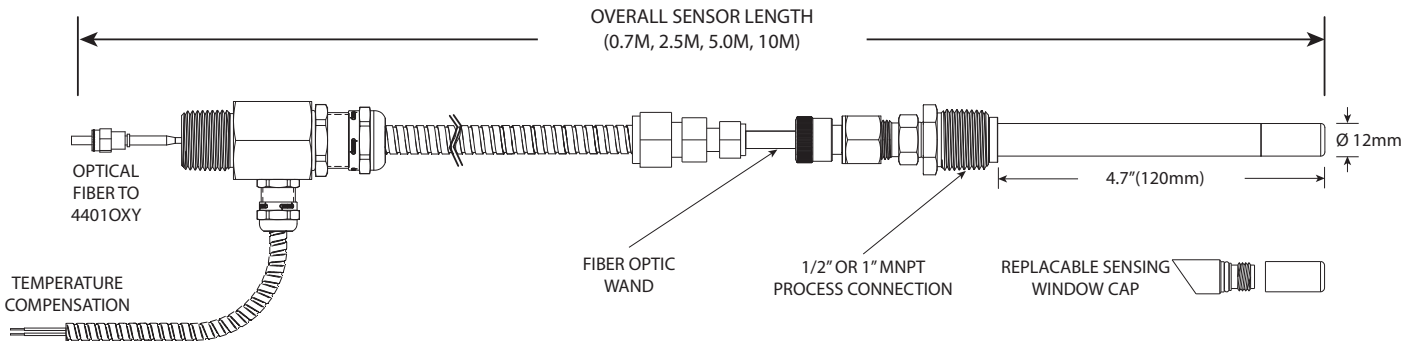
Sensor Range	Sensor and Seals	Body Material	Process Connection	Cable Armor	Sensor Length	Lead Length	Agency Approval	
Luminophore								
BOS1	Gas (0 - 4.2% O_2, 0 - 41.4 hPa) or Liquid (0 - 1.8 ppm)							
BOS2	Gas (0 - 25% O_2, 0 - 250 hPa) or Liquid (0 - 22 ppm)							
BOS3	Gas only (0 - 300 ppm with 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)		
					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
							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**

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)

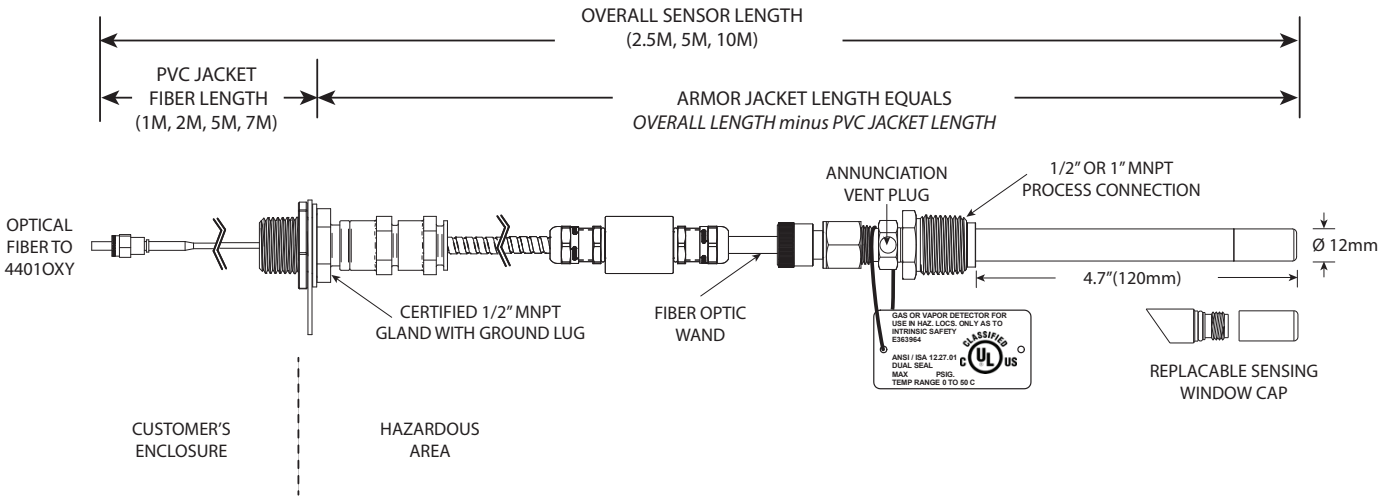
BOS Range Specifications For All Products

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_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).		

BOS FLEXSENSE - Standard Dimensions



BOS FLEXSENSE - UL Dual Seal Version Dimensions



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 to the right.

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 2

Operation & Maintenance Manual
BOS FLEXSENSE Optical Oxygen Sensor

Basic Installation And Replacement Guidelines

WARNING!! ALWAYS WEAR PERSONAL PROTECTION EQUIPMENT (PPE)
Use appropriate safety equipment before working on the sensor. Have the proper tools laid out before performing any work.

WARNING!! KEEP THE OPTICAL WINDOW CLEAN. DO NOT TOUCH.
Do not introduce dirt, debris, condensate or other foreign contaminants on to the optical window.
The Luminophore and optical isolation on the optical window are delicate. **DO NOT SCRATCH OR DAMAGE THE OPTICAL WINDOW.**

WARNING!! DO NOT OVER TIGHTEN THE SENSOR CAP. The sensor cap should be firmly tightened by hand only. Over tightening the cap may result in damage to the cap housing or to the o-ring on the sensor body. Keep the optical window inside the UV resistant bag until the time of installation.

Installation of New BOS FLEXSENSE Sensor

1. Ensure that any isolation valves are closed prior to sensor installation.
2. Optical fiber should be threaded onto the fiber connector at the 4401OXY Analyzer. The fixed knurled nut on the 4401OXY should not be turned.
3. Thread new sensor into the process using the assembly mounting nut (#7). Use Teflon tape or other thread locker to properly seal the sensor from leaks. The most common installation will be directly into a flowcell (B4992-XXX). See figure 3.
4. Open isolation valves to expose the sensor to the process.
5. Refer to 4401OXY manual for sensor menu setup or any wiring that may need to occur.

BOS FLEXSENSE - Typical Install - (UL Dual Seal Illustrated below)

The close-up picture above shows the fiber optic connection on the bottom of the 4401OXY Oxygen Analyzer. The fiber connector protrudes through the middle of the fixed knurled nut. Finger tighten the optical fiber to the connector in the middle of the knurled nut. Once the optical fiber is connected, tighten armored gland (if present) into the female threads on the knurled nut. In UL Dual Seal installations the armored gland will be threaded into the customer's enclosure.

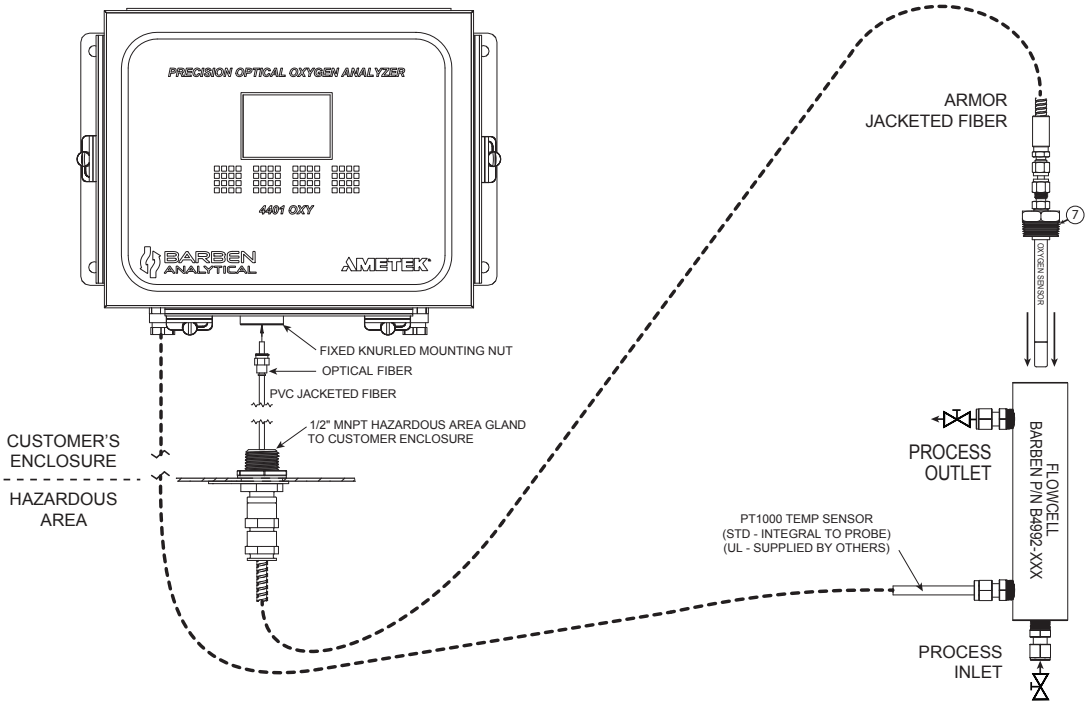


Figure 3

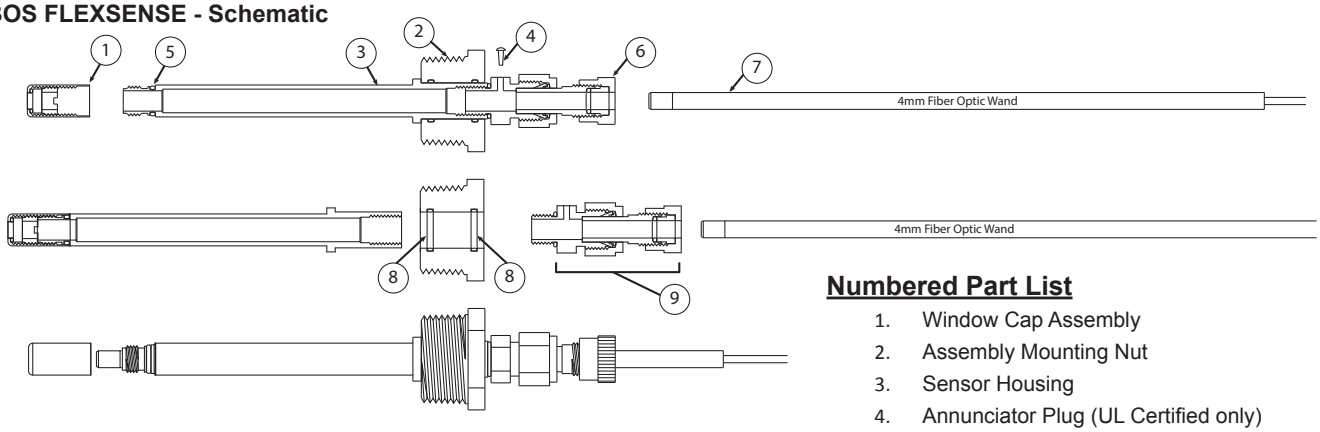
Regular Maintenance

- Ensure that the sensor is clean and free of debris. Clean the sensor window cap assembly (#6) with clean water (tap or distilled). Heavier accumulations can be cleaned by soaking the sensor in water and cleaning with a cotton swab.
- Ensure that the soft, black portion of the window cap assembly is free of damage. Damage to the cap may render the sensor inoperable or may affect the accuracy of the readings from the analyzer.
- **UL VERSION** - Annunciator plug (#4) should be affixed in pressure relief vent. The plug should be pliable to the touch. If the plug will not stay mounted in the vent or has become brittle it should be replaced.
- Ensure that the window cap assembly of the sensor is secured to the sensor housing. An accumulation of moisture inside the sensor may create errors..
- **DO NOT attempt to clean the window cap assembly with the use of a wire brush, screwdriver, sand paper or other method that may damage the tip of the sensor.**

Replacement of Window Cap Assembly (figure 4)

1. Note that removal of the window cap assembly (#1) will generate an error at the analyzer (e.g. Error Code 2). Communicate actions and appropriate response with the control room per facility procedures.
2. Isolate the oxygen sensor from the process by closing isolation valves. Follow appropriate procedures to ensure against the release of process materials into the environment.
3. Remove the oxygen sensor from the flowcell by unthreading the assembly mounting nut (#2).
4. Inspect the sensor window cap (#1). Look for visible damage (e.g. deformation, cuts, corrosion) on the metal housing of the cap. Inspect the optical luminophore on the tip of the sensor for damage (e.g. scratches) to ensure the integrity of the reading.
5. Clean the sensor and the housing (#3) with a damp cloth to remove residual process material.
6. **UL VERSION** - Inspect annunciator plug (#4). Replace if plug is brittle, loose fitting, or otherwise damaged.
7. Unscrew the nose assembly (#1) from the tip of the sensor.
8. Inspect the o-ring (#5) on the sensor stem for damage. Replace the o-ring if necessary.
9. Loosen the knurled compression fitting (#6) until the 4mm fiber optic wand (#7) can slide freely inside of the sensor housing (#3).
10. Slide the wand of the sensor forward, through the sensor housing (#3), towards the direction of the cap. NOTE: The wand tip should protrude from the open end of the sensor housing (#3).
11. Hand tighten the replacement window cap assembly (#1) on to the sensor housing (#3). The cap assembly will contact the 4mm fiber optic wand (#7) tip. They should be in contact.
12. Fasten the sensor cap “hand-tight”. Avoid using pliers or other tools.
13. Keep the fiber optic wand (#7) in contact with the window cap assembly (#1) and tighten the knurled compression fitting (#6) “hand-tight”. NOTE: Avoid swaging or over-tightening the knurled compression fitting (#6).
14. Carefully reinstall the sensor assembly into the process line or flowcell. Avoid contact and damage to the tip.
15. Tighten the sensor assembly at the mounting nut (#2), and open the valve to the process line.

BOS FLEXSENSE - Schematic



Tools Required

- Crescent Wrench (2)
- Water
- Clean, Damp Cotton Cloth (for cleaning housing)
- Cotton Swab (for cleaning luminophore)

Numbered Part List

1. Window Cap Assembly
2. Assembly Mounting Nut
3. Sensor Housing
4. Annunciator Plug (UL Certified only)
5. O-Ring (BODY)
6. Knurled Compression Fitting
7. 4mm Fiber Optic Wand
8. O-ring kit for assembly mounting nut
9. Complete wand adjustment nut

Figure 4

Replacement of Assembly Mounting Nut (figure 4)

1. Loosen knurled compression fitting (#6). Remove 4mm Fiber Optic Wand (#7) from sensor assembly. Note that removal of the cap will generate an error at the analyzer (e.g. Error Code 2). Communicate actions and appropriate response with the control room per facility procedures.
2. Hold the sensor housing (#3) and unthread wand adjustment nut (#9) from the housing.
3. The mounting nut (#2) can now be slid away from the sensor housing (#3) by hand.
4. Inspect o-rings (#8). If leaking or damage replace as needed. Two o-rings are required.
5. Slide new mounting nut (#2) back onto the body. If the fit is tight a lubricant such as Dow Corning Silicone 111 can be used on the sensor housing to help decrease friction. Avoid getting it into any internal threads as it could affect the optical reading.
6. Hold the sensor housing (#3) by hand and reinstall the wand adjustment nut (#9).
7. Gently insert wand through the adjustment nut into the sensor housing until it bottoms out.
8. Hand tighten the knurled compression fitting (#6) to hold wand in place.
9. If UL version of the product, inspect annunciator plug (#4) and gently push into the vent hole if loose.
10. Reinstall sensor back into flowcell for process measurement.

Spare Parts

Replacement window cap assemblies can be ordered as new with the part numbers listed below. Additionally, Barben offers a refurbishment program for used window cap assemblies. The refurbishment includes replacement of the luminophore window and internal seals. Refurbished cap assemblies use the same part numbers below with an R- prefix (R-B3907-XXX). Call factory support for additional details.

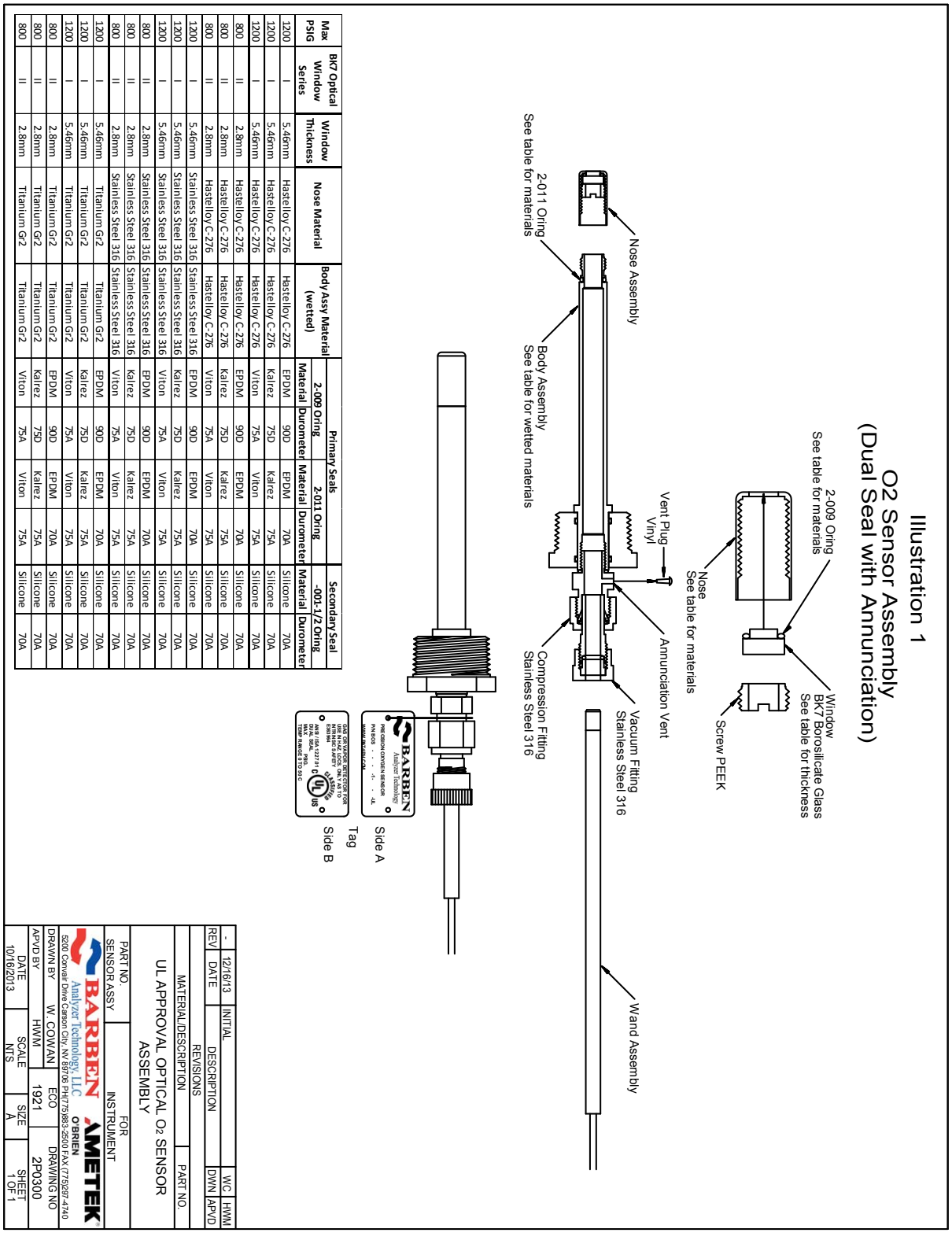
Optional Spare Parts - BOS FLEXSENSE Sensor Asembly (Reference figure 4)		
Drawing #	**Part #**	**Description and Materials (wetted)**
2	B4951K-0171	Mounting Nut, 1/2" Male NPT, 316 Stainless (o-rings separate)
2	B4951K-0173	Mounting Nut, 1" Male NPT, 316 Stainless (o-rings separate)
2	B4951K-1113	Mounting Nut, 1/2" Male NPT, Titanium Gr2 (o-rings separate)
2	B4951K-1110	Mounting Nut, 1" Male NPT, Titanium Gr2 (o-rings separate)
2	B4951K-1114	Mounting Nut, 1/2" Male NPT, Hastelloy-C 276 (o-rings separate)
2	B4951K-1115	Mounting Nut, 1" Male NPT, Hastelloy-C 276 (o-rings separate)
8	B4904K-1013	Viton o-ring kit for mounting nut
8	B4904K-1012	EPDM o-rings kit for mounting
8	B4904K-1014	FFKM (perfluoroelastomer) o-rings kit for mounting
9	B4954K-1029	Wand Adjustment Nut (standard)
9	B4954K-1028	Wand Adjustment Nut (UL version only)
4	B4919K-1005	Annunciator Plug (UL version only)

Recommended Spare Parts - Replacement Window Cap Assembly (Item #1 in figure 4)			
Part #	**Optode**	**Body Material (Wetted)**	**O-Ring Seals (Wetted)**
B3907-1051	BOS1	316 Stainless	Viton
B3907-1052	BOS1	Titanium Gr2	Viton
B3907-1086	BOS1	Hastelloy-C 276	Viton
B3907-1087	BOS1	316 Stainless	EPDM
B3907-1074	BOS1	Titanium Gr2	EPDM
B3907-1082	BOS1	Hastelloy-C 276	EPDM
B3907-1088	BOS1	316 Stainless	FFKM (perfluoroelastomer)
B3907-1080	BOS1	Titanium Gr2	FFKM (perfluoroelastomer)
B3907-1084	BOS1	Hastelloy-C 276	FFKM (perfluoroelastomer)
B3907-1053	BOS2	316 Stainless	Viton
B3907-1054	BOS2	Titanium Gr2	Viton
B3907-1089	BOS2	Hastelloy-C 276	Viton
B3907-1090	BOS2	316 Stainless	EPDM
B3907-1075	BOS2	Titanium Gr2	EPDM
B3907-1083	BOS2	Hastelloy-C 276	EPDM
B3907-1091	BOS2	316 Stainless	FFKM (perfluoroelastomer)
B3907-1081	BOS2	Titanium Gr2	FFKM (perfluoroelastomer)
B3907-1085	BOS2	Hastelloy-C 276	FFKM (perfluoroelastomer)
B3907-1041	BOS3	316 Stainless	Viton
B3907-1058	BOS3	Titanium Gr2	Viton
B3907-1072	BOS3	Hastelloy-C 276	Viton
B3907-1040	BOS3	316 Stainless	EPDM
B3907-1057	BOS3	Titanium Gr2	EPDM
B3907-1071	BOS3	Hastelloy-C 276	EPDM
B3907-1042	BOS3	316 Stainless	FFKM (perfluoroelastomer)
B3907-1070	BOS3	Titanium Gr2	FFKM (perfluoroelastomer)
B3907-1073	BOS3	Hastelloy-C 276	FFKM (perfluoroelastomer)

Operation & Maintenance Manual
BOS FLEXSENSE Optical Oxygen Sensor

Agency Certification

ANSI / ISA 12.27.01 Dual Seal certified by UL
(BOS series sensor with UL selection installed per drawing 2P0300 below)



Max PSIG	BK7 Optical Window Series	Window Thickness	Nose Material	Body Assy Material (wetted)	Primary Seals				Secondary Seal	
					2-009 Oring		2-011 Oring		-001-1/2 Oring	
					Material	Durometer	Material	Durometer	Material	Durometer
1200	I	5.46mm	Hastelloy C-276	Hastelloy C-276	EPDM	90D	EPDM	70A	Silicone	70A
1200	I	5.46mm	Hastelloy C-276	Hastelloy C-276	Kalrez	75D	Kalrez	75A	Silicone	70A
1200	I	5.46mm	Hastelloy C-276	Hastelloy C-276	Viton	75A	Viton	75A	Silicone	70A
800	II	2.8mm	Hastelloy C-276	Hastelloy C-276	EPDM	90D	EPDM	70A	Silicone	70A
800	II	2.8mm	Hastelloy C-276	Hastelloy C-276	Kalrez	75D	Kalrez	75A	Silicone	70A
800	II	2.8mm	Hastelloy C-276	Hastelloy C-276	Viton	75A	Viton	75A	Silicone	70A
1200	I	5.46mm	Stainless Steel 316	Stainless Steel 316	EPDM	90D	EPDM	70A	Silicone	70A
1200	I	5.46mm	Stainless Steel 316	Stainless Steel 316	Kalrez	75D	Kalrez	75A	Silicone	70A
1200	I	5.46mm	Stainless Steel 316	Stainless Steel 316	Viton	75A	Viton	75A	Silicone	70A
800	II	2.8mm	Stainless Steel 316	Stainless Steel 316	EPDM	90D	EPDM	70A	Silicone	70A
800	II	2.8mm	Stainless Steel 316	Stainless Steel 316	Kalrez	75D	Kalrez	75A	Silicone	70A
800	II	2.8mm	Stainless Steel 316	Stainless Steel 316	Viton	75A	Viton	75A	Silicone	70A
1200	I	5.46mm	Titanium Gr2	Titanium Gr2	EPDM	90D	EPDM	70A	Silicone	70A
1200	I	5.46mm	Titanium Gr2	Titanium Gr2	Kalrez	75D	Kalrez	75A	Silicone	70A
1200	I	5.46mm	Titanium Gr2	Titanium Gr2	Viton	75A	Viton	75A	Silicone	70A
800	II	2.8mm	Titanium Gr2	Titanium Gr2	EPDM	90D	EPDM	70A	Silicone	70A
800	II	2.8mm	Titanium Gr2	Titanium Gr2	Kalrez	75D	Kalrez	75A	Silicone	70A
800	II	2.8mm	Titanium Gr2	Titanium Gr2	Viton	75A	Viton	75A	Silicone	70A

REV	DATE	INITIAL	DESCRIPTION	DWN	APVD
-	12/16/13	HWM	REVISIONS	WC	HWM

UL APPROVAL OPTICAL O2 SENSOR ASSEMBLY

PART NO. SENSOR ASSY — FOR INSTRUMENT

BARBEN Analyzer Technology, LLC — AMETEK O'BRIEN
8200 Convair Drive Carson City, NV 89706 PH(775)883-2500 FAX (775)297-4740

MATERIAL/DESCRIPTION		PART NO.	
DRAWN BY	W. COWAN	ECO	1921
APVD BY	HWM	DRAWING NO	2P0300
DATE	SCALE	SIZE	SHEET
10/16/2013	NTS	A	1 OF 1

Operation & Maintenance Manual
BOS FLEXSENSE Optical Oxygen Sensor

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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