BARBEN ANALYTICAL

AMETEK®

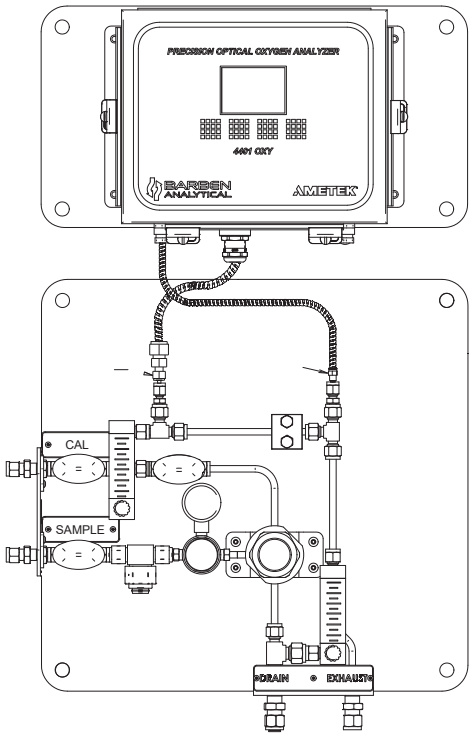
Operation & Maintenance Manual

4401OXY

Optical Oxygen Analyzer

for use with BOSx Optical Sensors

Optical O_2 Products



Operation & Maintenance Manual
4401OXY Optical Oxygen Analyzer

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Disclaimer

This operations and maintenance manual is a guide. The information in this manual has been carefully checked and is believed to be accurate for the intended use of this analyzer. However, Barben Analytical assumes no responsibility for any inaccuracies that may be contained in this manual. In no event will Barben Analytical be liable for direct, indirect, incidental, special or consequential damages resulting from any defect or omission in this manual, even if advised of the possibility of such damages. Barben Analytical reserves the right to make improvements in this manual and to the products it describes at any time, without notice or obligation.

Table of Contents

Section 4 - Theory of Operation and Measurement

Section 5 - Operation of 4401OXY

Section 6 - Error Codes and Troubleshooting

Section 7 - Agency Documentation

Section 8 - 4401OXY PC Software - OxyView

Section 9 - Warranties

Section 1 - General Information & Safety

1.1 Introduction

Thank you for your purchase of the 4401OXY optical oxygen analyzer. Barben Analytical is a market leading analytical supplier that designs, manufactures and sells analytical measurement products for the process industries. Our core products consist of pH and ORP electrochemical sensors along with gas and liquid phase optical oxygen analyzers. These products help our customers achieve higher levels of productivity, efficiency and quality and are designed to meet the most difficult and robust applications found in the industrial process markets such as; Chemical, Refining, Petrochemical, Oil & Gas, Pulp & Paper, Power and Semiconductor. Barben Analytical is an Ametek company, within the Thermal Process Management business unit (TPM BU). Ametek is a US company, operating globally in 30 countries throughout the world, with revenues exceeding $4.5 Billion.

For additional product and services related to this use and installation of this 4401OXY product, such as field start-up services, classroom product trainings, wet-gas sample probes, heated sample lines, pressure reduction stations or other needs please contact us at Barben Analytical.

- **Sample Probes**
- **Pressure Reduction Stations (PRS)**
- **Heated Sample Lines (HSL)**
- **Sample Conditioning Panels (SCP)**
- **Manual & AutoCal Panels**
- **Field Start-Up Services**
- **Product and Applications Training**

1.2 About the 4401OXY Product - (Overview)

The 4401OXY is Barben Analytical's first generation optical oxygen analyzer. The analyzer measures from trace level (ppmv) oxygen to percent level oxygen in both the gas and liquid phases (range and application are dependent on sensor selection). It's intended for indoor and outdoor use, as a continuous analytical measuring device, in manufacturing and industrial processes, along with laboratories. The device has been tested and approved for use in hazardous areas via a third party OSHA approved NRTL, Factory Mutual (FM), with North American (NEC and CEC). It has additionally been investigated by TUV NA and assigned global (ATEX) certifications.

The analyzer is wall mounted in the proximity of the measuring point. The analyzer has a local display and can be operated (configuration, calibration, etc.) with the HMI via the keypad or via the 4401 software on a PC. The analyzer connects to a fiber optic cable, via a fiber optic SMA connection located at the bottom of the analyzer. The fiber optic cable links the analyzer to the process sensor, which is mounted directly into the process or within an extractive sample system. The analyzer is fully compatible with all of the Barben Optical Sensors (BOSx) which are sold separately or included with integrated Sample Calibration Panels (SCP).

The analyzer uses a quench fluorescence technique with a sensor optically isolated from the process, using the absorbency as a diagnostic function and analyzing the phase angle in the time domain for measurement of the analyte, oxygen, in the modulated time domain. This gives the analyzer the ability to measure accurately and precisely under various and changing ambient and process conditions.

1.3 Definition of Symbols

Definition of the symbols for hazardous, cautionary, precautionary and general information are found and defined here below.

WARNING

Safety warning indicates a potentially or imminently hazardous situation which, if not avoided, may result in personal injury or environmental contamination.

CAUTION

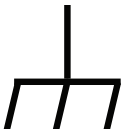
General warning, caution, that if an operating procedure which, if not strictly observed, may result in damage or malfunction of the analyzer.

CAUTION

Caution, possibility of electric shock may occur if an operating procedure which, if not strictly observed, may occur.

IEC 60417-5019

Protective conductor terminal.



IEC 60417-5020

Frame or chassis terminal.

IEC 60417-5032

Alternating Current (AC)

IEC 60417-5031

Direct Current (DC)

Useful and/or important information that should not be overlooked

1.4 Safety Summary

The 4401OXY is designed for use in manufacturing, industrial and laboratory analytical applications. Individual installations may vary in scope. The installer should consult national and local codes along with any site specific installation requirements to ensure that governing regulations are met.

The 4401OXY goes through functional, quality and performance testing prior to leaving the factory. For safe operation, prior to installation or operation, please read the entire manual and adhere strictly to all the **WARNINGS, CAUTIONS, and NOTES** contained within this manual. Failure to do so could result in serious injury to the operator, the equipment or property.

If the equipment is used in a manner not specified, the protection provided by the equipment may be impaired!

1.4.1 Electrical Safety

Up to 240 VAC may be present in the analyzer housings. Always shut down power source(s) before performing maintenance or troubleshooting. Only a qualified electrician should make electrical connections and ground checks.

1.4.2 Grounding

Instrument grounding is mandatory. Performance specifications and safety protection are void if instrument is operated from an improperly grounded power source.

Verify ground connections and continuity of all equipment before applying power.

1.4.3 General Installation Precautions

When installing optional electronic measurement or control equipment, general installation precautions should be observed:

- **Select a site that is free from direct sunlight, extreme temperatures, or abrupt temperature variations.**
- **Select a site where the ambient air is free from corrosive gases, or abrasive materials.**

The equipment should not be connected to surfaces or enclosures subjected to severe vibration or conductive heat. Protective shock absorbent, non-thermally conductive mounts should be installed to isolate the equipment from excessive vibration and thermal conduction.

- **Do not install analyzer near equipment emitting electromagnetic interference (e.g. AC pumps, motors, etc).**
- **Electrical wiring should be installed according to the National Electrical Code, local regulations and codes along with and in addition to any other applicable industry codes and regulations.**
- **The supply voltage should strictly adhere to the instrument specifications, be supplied from a stable reliable source, and be provided with proper ground connection(s).**
- **Signal connections should be made using shielded wiring.**
- **Signal , control, and interface wiring should be located separately from power supply lines.**

1.5 4401OXY - Important Safety Instructions

*Warning - **Explosion Hazard** - Do not disconnect equipment unless power has been switched off or the area is known to be non-hazardous.*

*Warning - **Explosion Hazard** - Substitution of components may impair suitability for hazardous area installation.*

The supply circuit must include an overprotection device with a maximum rating of 20 A. A disconnect switch must be located in close proximity to the analyzer.

If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired per clause 5.4.4(i) STANDARD EN 61010-1

Per 60079-15:2005, DC powered units installed in Zone II Hazardous areas must be installed with transient voltage protection rated at a maximum of 140% of the supply voltage.

DC Powered units must NOT exceed 25.5 Volts or damage to the analyzer may result.

When appropriate, use sunshade and/or enclosures, heated sample lines or other means necessary to avoid extreme temperature differences between the sample tubing and gas sample.

The 4401OXY analyzer is suitable for installation outdoors. Do not install in direct sunlight or on a metal plate in direct sunlight. The top ambient temperature is 122 F (50C). Use a sunshade or other area protected from direct solar heating.

The 4401OXY analyzer is suitable for industrial, manufacturing and laboratory purposes. The analyzer is not for medical, therapeutic or any type of physiological use.

Section 2 - Technical Product Specifications

2.1 4401OXY - Oxygen Analyzer Part Number (Models) and Specifications

4401OXY Oxygen Analyzer Specifications	
Part Numbers (Ordering Information)	
4401OXY	Oxygen Analyzer with 100-240VAC Operational Power, FM / CSA Approval
4401OXY-CE	Oxygen Analyzer with 100-240VAC Operational Power, ATEX / CE Approval
4401OXY-DC	Oxygen Analyzer with 9-24VDC* Operational Power, FM / CSA Approval
4401OXY-DC-CE	Oxygen Analyzer with 9-24VDC* Operational Power, ATEX / CE Approval
Input Information	
Sensor Input	(1) O_2 optical input BOS1, BOS2 or BOS3 sensor (SMA connector), (1) PT1000 input
Digital Interface	
Analog Outputs	(2) Programmable voltage outputs with galvanic isolation, 0 to 10 V (2) Programmable current outputs with galvanic isolation, 4 to 20 mA
Sampling Rate	Programmable from 3 seconds to 1 hour
User Adjustable Options	
Units: User Selectable	Gas Phase: % air-saturation, % oxygen, hPa, Torr, ppm. Liquid Phase: hPa, Torr, ppm, ppb, µmol
Calibration	Conventional two-point calibration
Environmental	
Environmental Rating	NEMA 4X / IP66
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)
Enclosure Material	304 SS Enclosure
Power Supply	
AC Power ~	100-240 VAC, 50/60Hz, 8 Watts, (0.08 A @ 110 V)
DC Power ⎓ ⚠	9-24 VDC[1], 7 Watts, (0.6 A @ 12 V and 0.3 A @ 24 V)

Table 1

Note 1 - Power to DC powered analyzers, models, OXY4401-DC or 4401-DC-CE must NOT exceed 25.5 volts or permanent damage to the analyzer may result.

2.1.1 4401OXY - Oxygen Analyzer Data-Logger Specs

Sample Rate	Data-Logger Run Time		
(Seconds)	Days	Hours	Minutes
3	0	21	46
5	1	12	17
10	3	0	35
30	9	1	47
60	18	3	34
600	181	11	38
3600 (max)	1088	21	12

Table 2

2.2 BOS Sensor Technical Performance Specifications (determines operating range for 4401OXY)

Barben Oxygen Sensors (BOS), are sold separately or as parts of an integrated (SCP) package with the 4401OXY. The sensors consist of a fiber optic cable with SMA termination at one end, for connection to the 4401OXY and the other end, integrated with a oxygen sensing luminophore to be placed into the process or sample stream. There are three BOS sensor ranges, that can be used with the 4401OXY, BOS1, BOS2 and BOS3. Their selection and pairing with the 4401OXY will define the range, accuracy and repeatability of the 4401OXY analyzer. For additional information on BOS sensors please refer to the BOS sensor product data sheet.

BOS1 Sensor Specifications - Aqueous Phase / Gas Phase		
	Dissolved Oxygen (DO)	**Gas Phase @ 1atm, 20ºC**
Measurement Range	0 - 2.0 mg/L (ppm)	0 - 5.0% O_2 (0 - 50.7 hPa)
Limit of Detection	1.0 µg/L (ppb)	0.002 % O_2 (0.02 hPa)
Resolution @ 20ºC and 1013 hPa	± 0.30 at 1 µg/L (ppb) ± 0.63 at 200 µg/L (ppb)	± 0.0007 % O_2 at 0.002 % O_2 , ± 0.0015 % O_2 at 0.02 % O_2 , ± 0.007 hPa at 0.023 hPa, ± 0.015 hPa at 2.0 hPa
Response Time (T_{90})	< 30 sec.	< 6 sec.
Accuracy @ 20ºC	1 ppb (l), 0.002 % O_2 (g), or 3% of the measured value whichever is greater	
Drift from Photo-decomposition	< 1.0 ppb within 30 days (1 min sample rate)	
Operating Temperature Range	0 to 50ºC (32 to 122ºF)	
Allowable Sensor Temperature	90ºC (194ºF) non-continuous	
BOS2 Sensor Specifications - Liquid Phase / Gas Phase		
	Dissolved Oxygen (DO)	**Gaseous & Dissolved Oxygen @ 1atm, 20ºC**
Measurement Range	0 - 45 mg/L (ppm)	0 - 100 % O_2 (0 - 1013 hPa)
Limit of Detection (LOD)	15 ppb dissolved oxygen	0.03 % O_2
Resolution @ 20ºC and 1013 hPa	± 4.5 at 90 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 @ 20ºC	± 0.4 % O_2 at 20.9 % O_2, ± 0.05 % O_2 at 0.2 % O_2	
Drift from Photo-decomposition	< 0.03 % O_2 within 30 days (1 min sample rate)	
Operating Temperature Range	0 to 50ºC (32 to 122ºF)	
Allowable Sensor Temperature	90ºC (194ºF) non-continuous	
BOS3 Sensor Specifications - Gas Phase Only [sensor is not intended for continuous use in liquids]		
	Gas Phase Oxygen @ 1atm, 20ºC	
Measurement Range	0 - 300 ppm with over-range of 1000 ppm	
Limit of Detection (LOD)	0.5 ppm O_2	
Resolution @ 20ºC & 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 @ 20ºC,1 atm	± 2ppm or ± 5% of measured value whichever is greater (or as partial pressure, +/- 0.002 hPa)	
Drift from Photo-decomposition	< 1.5 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, 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).		

Table 3

2.2.1 - BOS Sensor Technical Performance Discussion

High Temperatures > 50 C (122 F)

The published specification of 0 to 50 C (122F) is not a strict rule but helps us to precisely define the published specifications with regards to LOD, accuracies and drift. The sensor is not immediately harmed at temperatures > 122 F (50C). The sensor is actual capable of handling intermittent temperatures up to 212 F (100 C) without issue. However, if continuous operations occur above 122C the measurement may experience slightly higher drift, some small non-linearities in the measurement accuracy over the range and ultimately a shorter lifespan.

2.3. - Electrical Hazardous Area Classifications (Markings)

Markings: NI/I/2/ABCD/T4; 0 C < Ta < 55C; Type 4x
Equipment Ratings: Nonincendive for use in Class I, Division 2, Groups A, B, C and D Hazardous (Certified) Locations

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

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

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 explosive gas atmospheres - Part 15: Construction, test, and marking of type of protection “n” electrical apparatus

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

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

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

Section 3- Installation (Dimensions, Wiring, Connections)

3.1 Installation - General Description and Features

The 4401OXY is a precision, temperature compensated stand-alone oxygen analyzer with a NEMA4x (IP65) stainless steel enclosure. It is designed for use with Barben Optical Sensors (BOS).

Analyzer Features:

- Measurement based on Quench Fluorescence.
- FM/CSA Class I, Division 2 Groups A, B, C, D T(4) and ATEX Zone II 3G
- No poisoning or effect from CO_2 or H_2S
- Fiber optic oxygen analyzer with temperature compensation
- Programmable sample rate from every 3 seconds to 1 hour (output is continuous).
- Backlit LCD display
- Two programmable (O_2, Temp, Phase Angle, Amplitude) outputs with galvanic isolation
    - 4-20 mA or 0 to 10 Volts
- 110/230VAC or 9 to 24 VDC Power
- Software connection via RS232 ASCII
- On-board data-logger stores measurement and error data (only off-line, without 4-20 mA)
- No relays however alarm function for critical faults will have the 4-20 mA output FAIL HIGH.

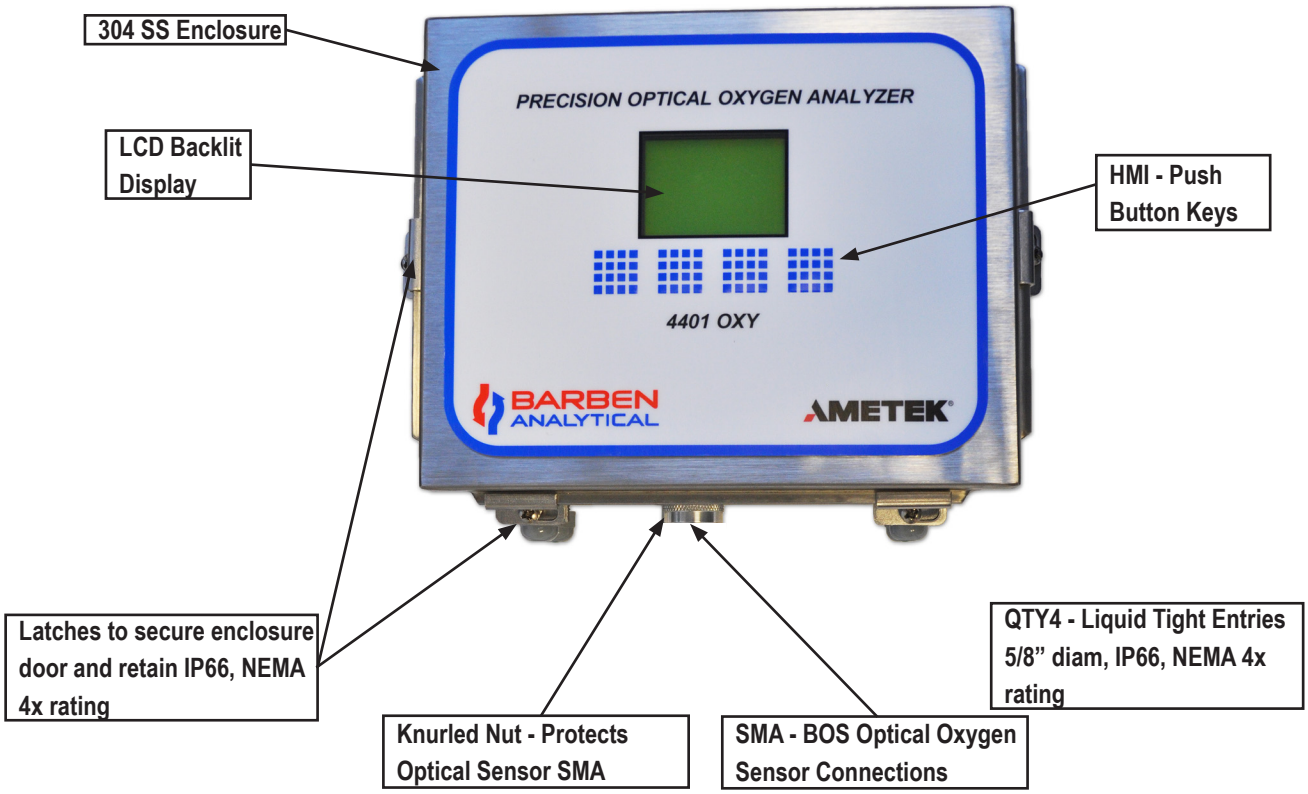
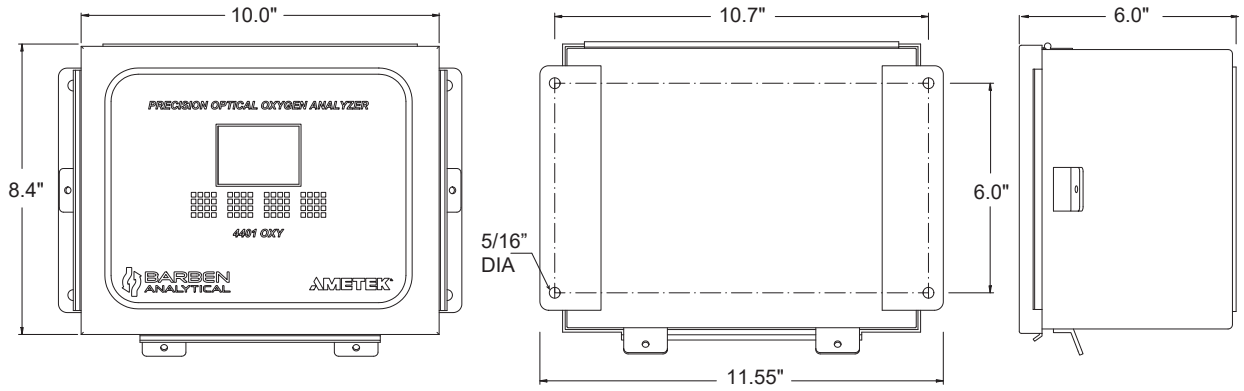


Figure 1

3.2 Installation - Analyzer Dimensions (Mounting)

The 4401OXY enclosure is intended for wall mounting. Four mounting holes 5/16” diameter are available for this purpose. The nominal dimensions of the holes are 10.7” (27.2 cm) x 6.0” (15.24 cm).



Figure

3.3 Installation - Electrical Entries - Factory Installed

The 4401OXY standard enclosure has QTY 4, 5/8” electrical entries located at the bottom of the box. These are fitted from the factory with liquid tight cable glands (PG9) for up to (8mm) instrumentation cables. It is common to run the Pt1000 RTD with armored cable through one of these glands.

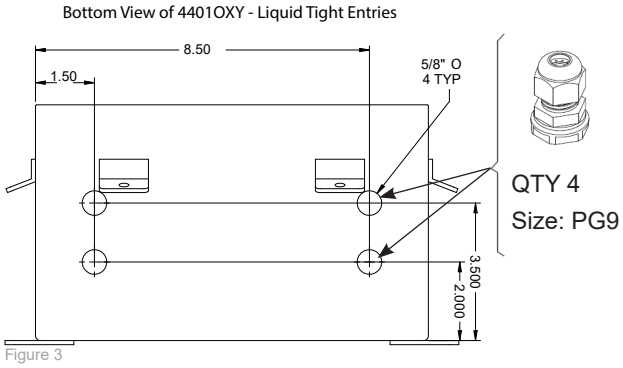


Figure 3

3.4 Installation - Electrical Entries - Field Punched

Installations may require for 3/4” conduit runs into the analyzer enclosure for the power and I/O’s. For this case, larger holes can be “punched” or “drilled” into the enclosure without changing electrical classifications. This can be done from either side or in the existing smaller holes from the bottom.

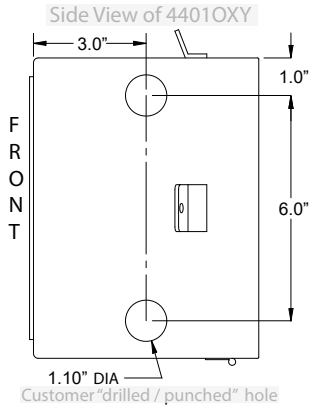


Figure 4

CAUTION

It is not recommended to run conduit in from the top of the analyzer. Also take care that any condensation has a place to go outside of the analyzer enclosure.

CAUTION

Please take care that any metal shavings from drilling the enclosure are removed. Loose metal shavings could cause electrical shorts on the electronics boards, causing damage.

CAUTION

IP Ratings should meet protection level of the instrument, minimum IP65.

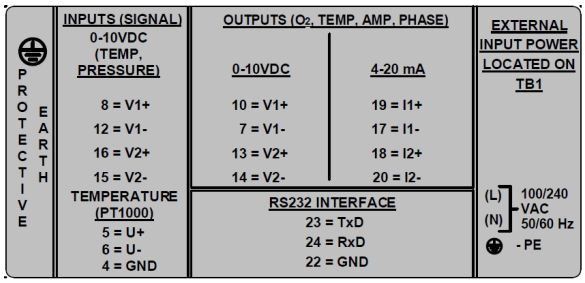
3.5 Installation - Electrical Wiring - Power

Please check the label on the side of your unit for model number. 4401OXY is an AC model and the 4401OXY-DC is the DC powered model. There will be additional markings for the appropriate power on the side label.

AC Powered Analyzers - (4401OXY & 4401OXY-CE)

The 120/240 VAC enters the analyzers and is wired to the Input Power located on the power supply module. The Line (L), Neutral (N) and Protective Earth (PE) are clearly labeled.

Terminal Pin Connection	DESCRIPTION	FUNCTION
SMA Connector	SMA fiber connector	Connect the fiber optic oxygen cable to SMA connector located on the bottom of the OXY4400.
Wire to Power Supply	Line adapter for power supply	110/220 Vac power supply or optional 24 Vdc powered. (note; must be ordered as 24 Vdc)
Ground (4) Positive (5) Negative (6)	Connector for PT 1000 temperature sensor	Connect the PT 1000 temperature sensor for temperature compensated measurements here.
TxD (23) RxD(24) Gnd (22)	RS232 interface	Connect the device with a RS232 data cable to your PC/Notebook here (optional).
Ch 1 +10/-7 Ch 2 +13/-14	Analog out/input (channel 1/2)	Voltage Output (0-10 V) from terminal board to external recording device or DCS system
Ch 1 +19/-17 Ch 2 +18/-20	Analog out (channel 1/2)	Current Output (4-20 mA) from terminal board to external recording device or DCS system. Note that this is a powered output



The "External Power Supply" is located in the analyzer enclosure and to the left of the terminal strip.

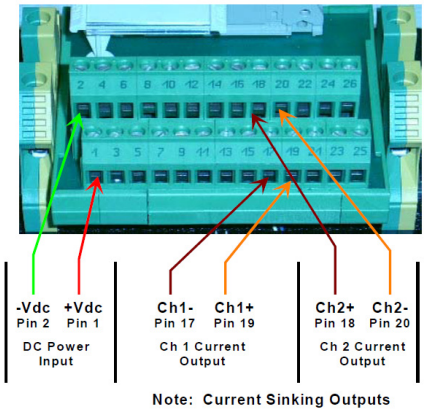
WARNING

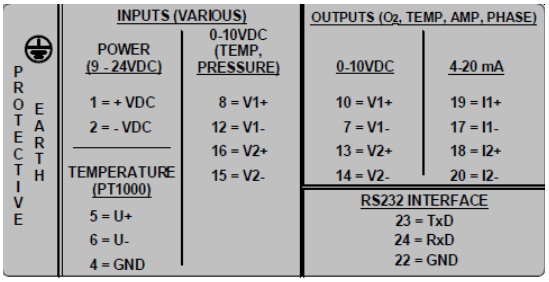
Protective Earth must be utilized. *The mains supply circuit must include an overprotection device with a maximum rating of 20 A. A disconnect switch must be located in close proximity to the analyzer.*

Figure 5

DC Powered Analyzers - (4401OXY-DC & 4401OXY-DC-CE)

The 12 - 24 VDC enters the analyzers and is wired to 1 (+VDC) and 2 (-VDC) terminals.





CAUTION

Do not apply AC power to the analyzer terminals. Permanent damage will occur

WARNING

Per 60079-15:2005, DC powered units installed in Zone II Hazardous areas must be installed with transient voltage protection rated at a maximum of 140% of the supply voltage.

CAUTION

DC Powered units must NOT exceed 25.5 Volts or damage to the analyzer may result.

Figure 6

3.6 Installation - Electrical Wiring - I/O's

Temperature Sensor (Pt1000 RTD) Wiring

The oxygen measurement requires temperature compensation to meet the published accuracies. The analog temperature input accepts a two-wire Pt1000 RTD. There is no polarity and only the two wires are required.

TEMPERATURE
(PT1000)

5 = U+
6 = U-
4 = GND

Analog Outputs (4-20 mA or 0 to 10 V)

The Analog Outputs are active outputs (self-powered). Therefore any receiving device, must be passive and non-powered. The connecting terminals are 19 (I1+) and 17 (I1-) for Analog Output 1 (AO1). The connecting terminals are 18 (I2+) and 20 (I2-) for Analog Output 2 (AO2). Polarity should be observed for proper readings.

4 - 20 mA

19 = I1+
17 = I1-
18 = I2+
20 = I2-

CAUTION

Analog outputs are "active outputs" that are self-powered. The receiving device must be a passive device.

RS232 - ASCII Serial Comm

The RS232 Serial communication port is commonly used to connect the analyzer to a PC. This is required for using the 4401OXY software and also useful for downloading a Data Log file. The RS232 can be run to either a 9-pin serial port or USB. Both cable details are shown here. You can use any RS232 USB cable with 0.0V on the power supply (red wire). The factory uses FTDI's:
P/N USB-RS232-WE-1800-BT_0.0

RS232-Wiring Pin-Out guide with BL-830 Serial cable

Pin No#	Color	Function	4401 Term No.
5	Yellow	Ground	22
2	Red	Txd	23
3	Orange	Rxd	24

Pin 1	RI
Pin 2	TXD
Pin 3	RXD
Pin 4	DSR
Pin 5	GND
Pin 6	DTR
Pin 7	CTS
Pin 8	RTS
Pin 9	Power Input /DCD

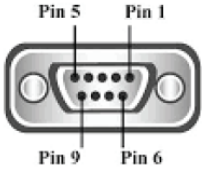


Figure 7

RS232 USB COMM Cable

Pin No#	Color	Function	4401 Term No.
1	Black	Ground	22
5	Yellow	Txd	23
4	Orange	Rxd	24

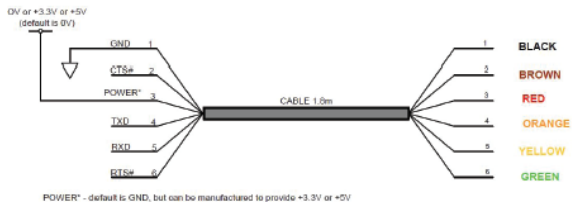


Figure 8

3.7 Installation - Oxygen Sensor - SMA Connection

Barben Oxygen Sensors (BOS)

All of the BOS sensor types connect to the 4401OXY via the bottom SMA port. The actual SMA connector is protected from physical damage via the knurled nut. The fiber end of the sensor with SMA will need to be connected to the analyzer SMA port. It should be hand tight. It is difficult to reach and a flat head screw driver or needle nose pliers may be used to finish the connection, but make certain it is not over-tightened. After the SMA connection is secured the BOS armored cable fitting , 1/2" MNPT should be attached to keep things dry and protected from physical damage. The knurled nut should be secured against turning when the BOS armored cable fitting is attached.

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.

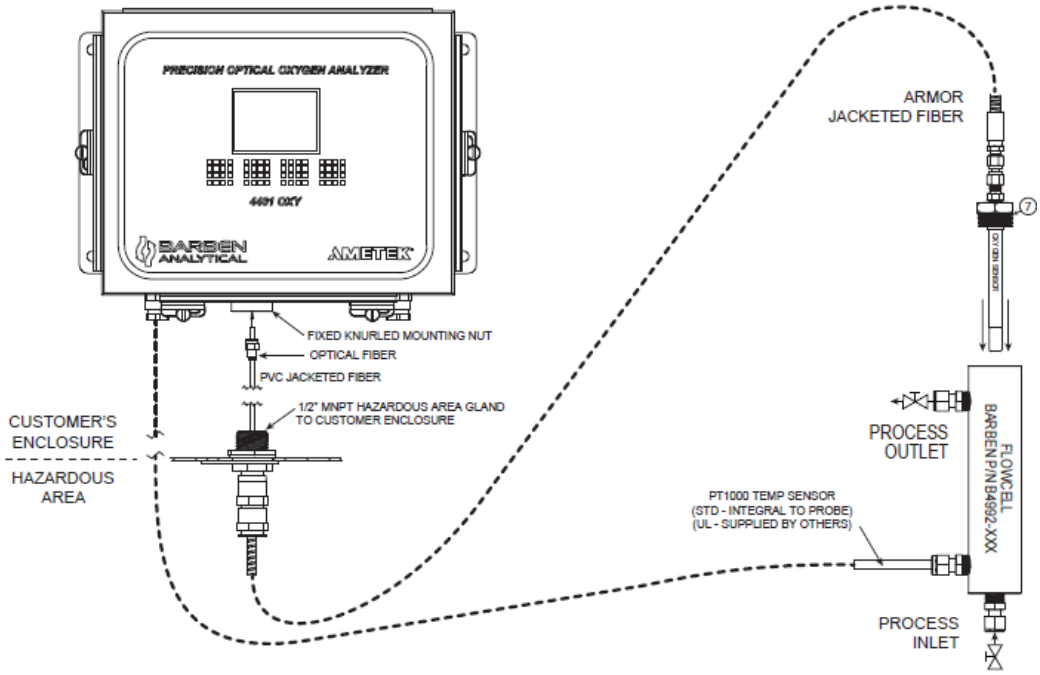


Figure 9

Take care to secure the knurled nut from spinning. The knurled nut protects the SMA connection that directly enters the electro-optical board.

CAUTION

BOSx Fiber Optic Sensor SMA Connection

Figure 10

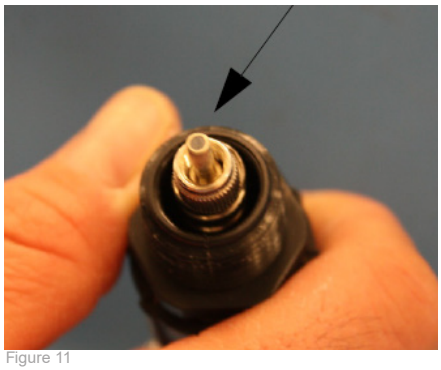
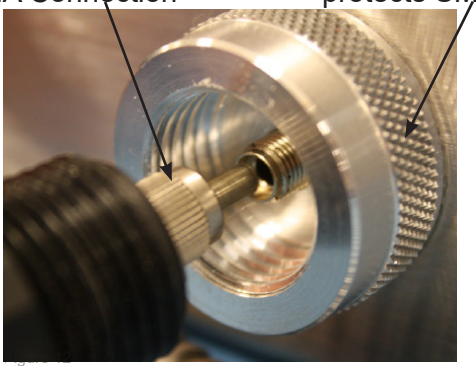


Figure 11

BOSx Fiber Optic Sensor SMA Connection

Knurled Nut on Analyzer protects SMA



Do not allow the knurled nut to spin! Hold in place when installing or removing the BOSx sensor

CAUTION

Barben Oxygen Sensors (BOS) - Overview

There are three main types of oxygen sensor platforms. They are mostly differentiated by their physical size and how they go into the process. The FiberSense is the smallest at 4 mm diameter that commonly is used in 1/4" Tube fittings. The FlexSense is larger at 12mm x 120 mm length and goes into Flow-cells with 1/4" T inlet/outlets. The SafeTap has it's own isolation valve and is intended for use directly in process. The main advantage of the FlexSense and SafeTap is that they have a replaceable sensor cap that contains the sensing element. This allows for quick and lower costs replacement, since the maintenance personnel will not have to remove and install the fiber optic at the SMA.

This is intended as a brief overview of the sensors. For additional information please consult the sensor manuals: http://www.BarbenAnalytical.com

BOS FiberSense - Overview

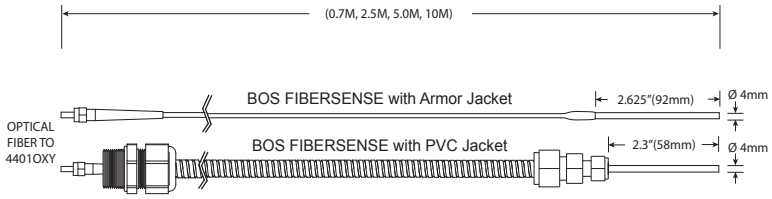


Figure 13

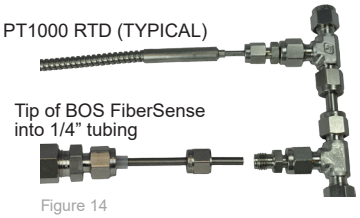


Figure 14

BOS FlexSense - Overview

Figure 15

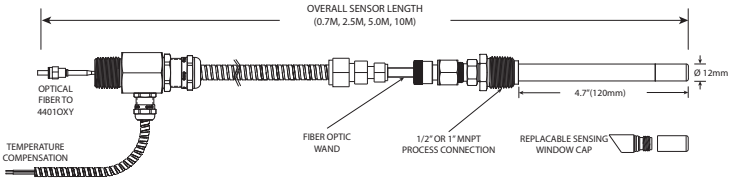


Figure 16

BOS Safe-Tap - Overview

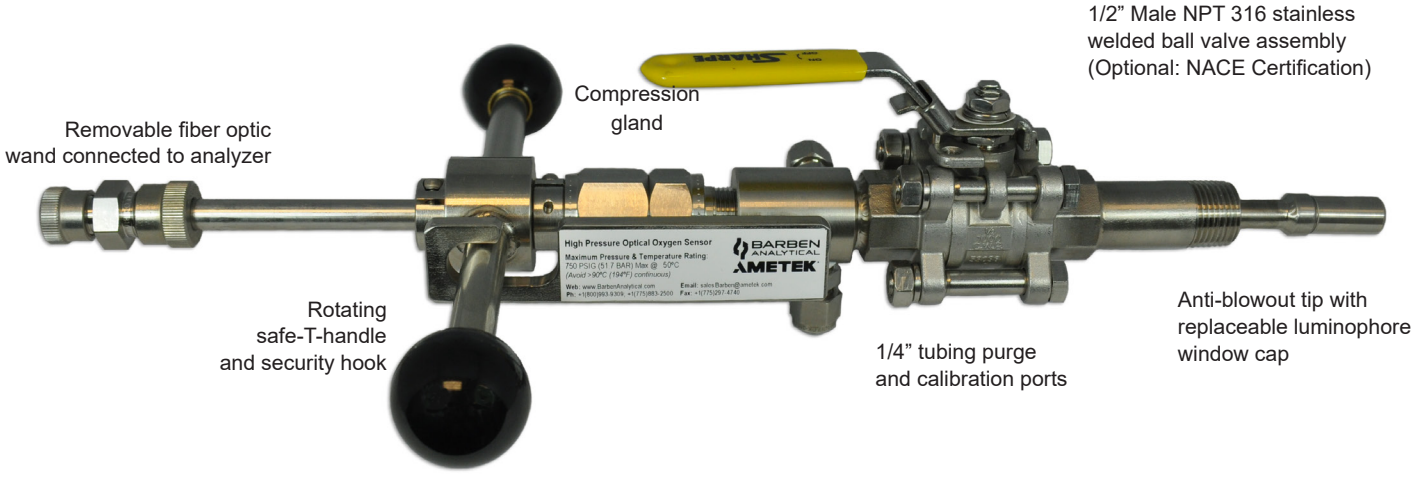


Figure 17

3.9 Installation - Sample Calibration Panels - SCP

Sample Calibration Panels - SCP-CF and SCP-CT

The SCP Sample Calibration Panel [Fig. 12] provides an easy, pre-engineered solution for gas phase applications. All related tubing, flow meters, valves, and gauge come pre-installed on the SCP panel. Specify the panel, analyzer, BOS sensor, and RTD to get up and running quickly. A significant benefit is that it allows to isolate from the sample stream and perform calibration without sensor removal. Really important for trace level measurement.

Features

- **Manual calibration without removing sensor**
- **Fast loop 10 LPM max (total capacity of 12 LPM)**
- **Filters: particulate (0.5µm) & coalescing (0.3µm)**
- **Inlet pressure regulation (Max. inlet 300 PSIG*)**
  ***(Pressure regulator rates for 3,000 psig, max was set based on natural gas to avoid JT without analysis.)**
- **304 stainless steel mounting panel**

SCP - Sample Calibration Panel Specifications	
Part Numbers	**Applications**
SCP-CT	Designed for dry gas applications Specify with 4401OXY, BOS FIBERSENSE (0.7m) and B1150-1005 RTD
SCP-CF	Use in wet gas applications or when ease of tip replacement is required Specify with 4401OXY, BOS FLEXSENSE (2.5m) and B1150-1005 RTD.
Physical	
Dimensions H x W x D	24.5 x 16.5 x 6.33 inches (62.3.8 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.

Table 4

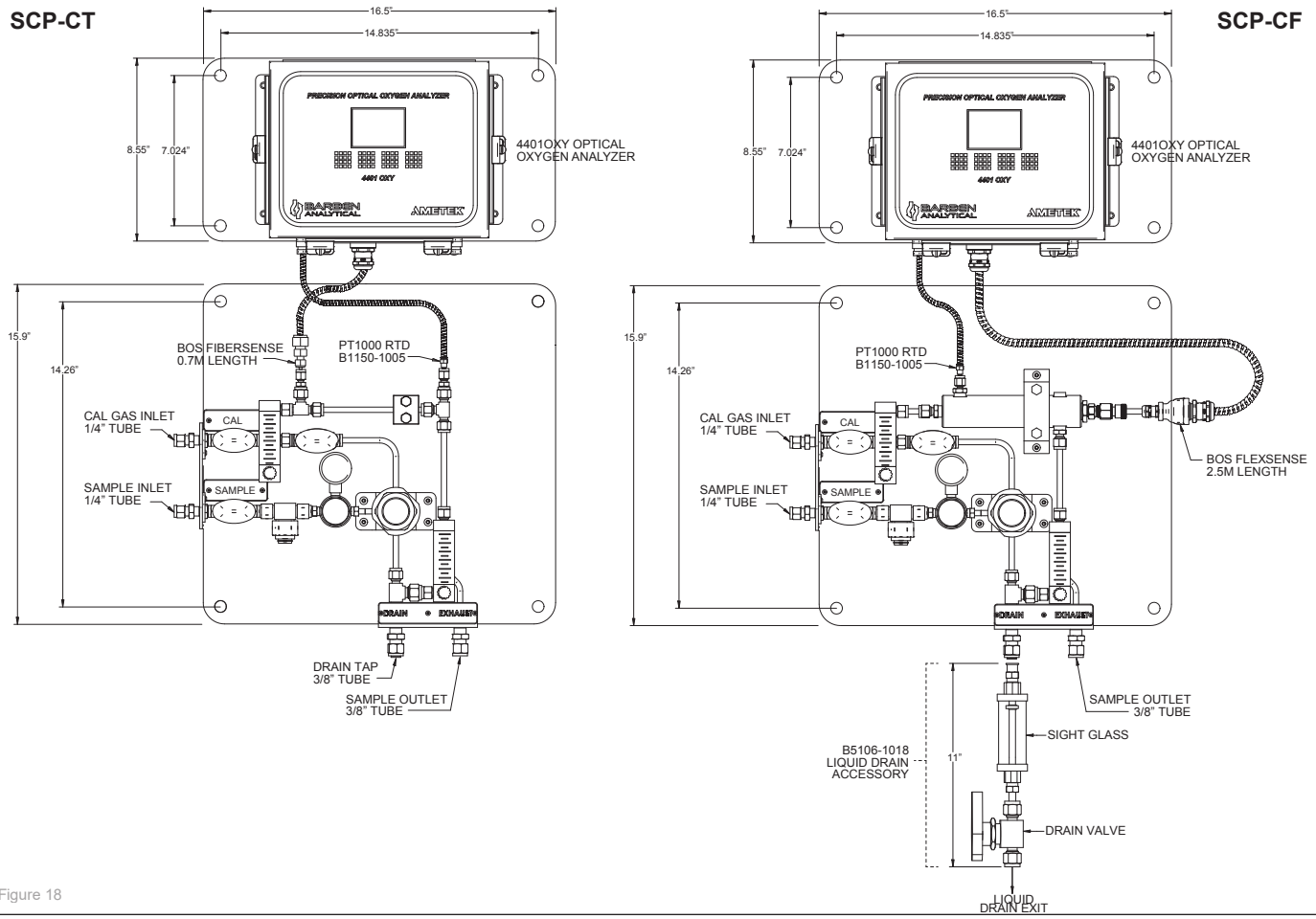


Figure 18

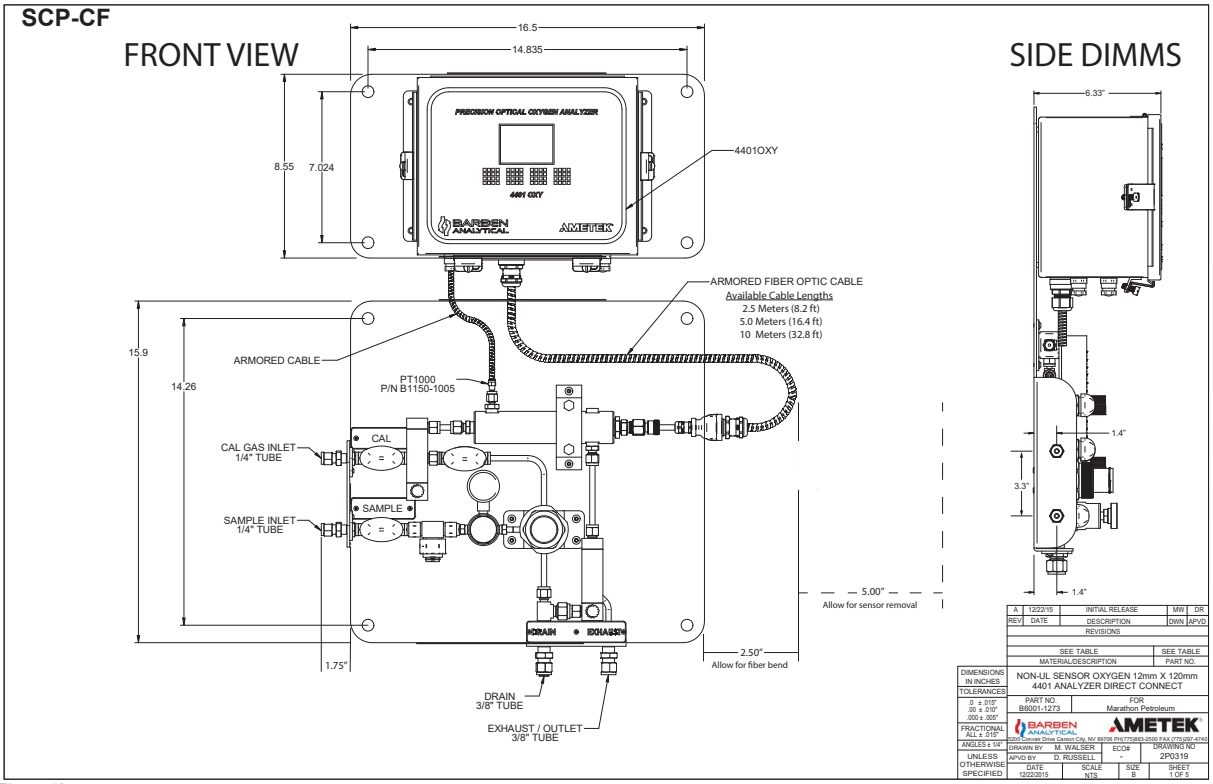


Figure 19

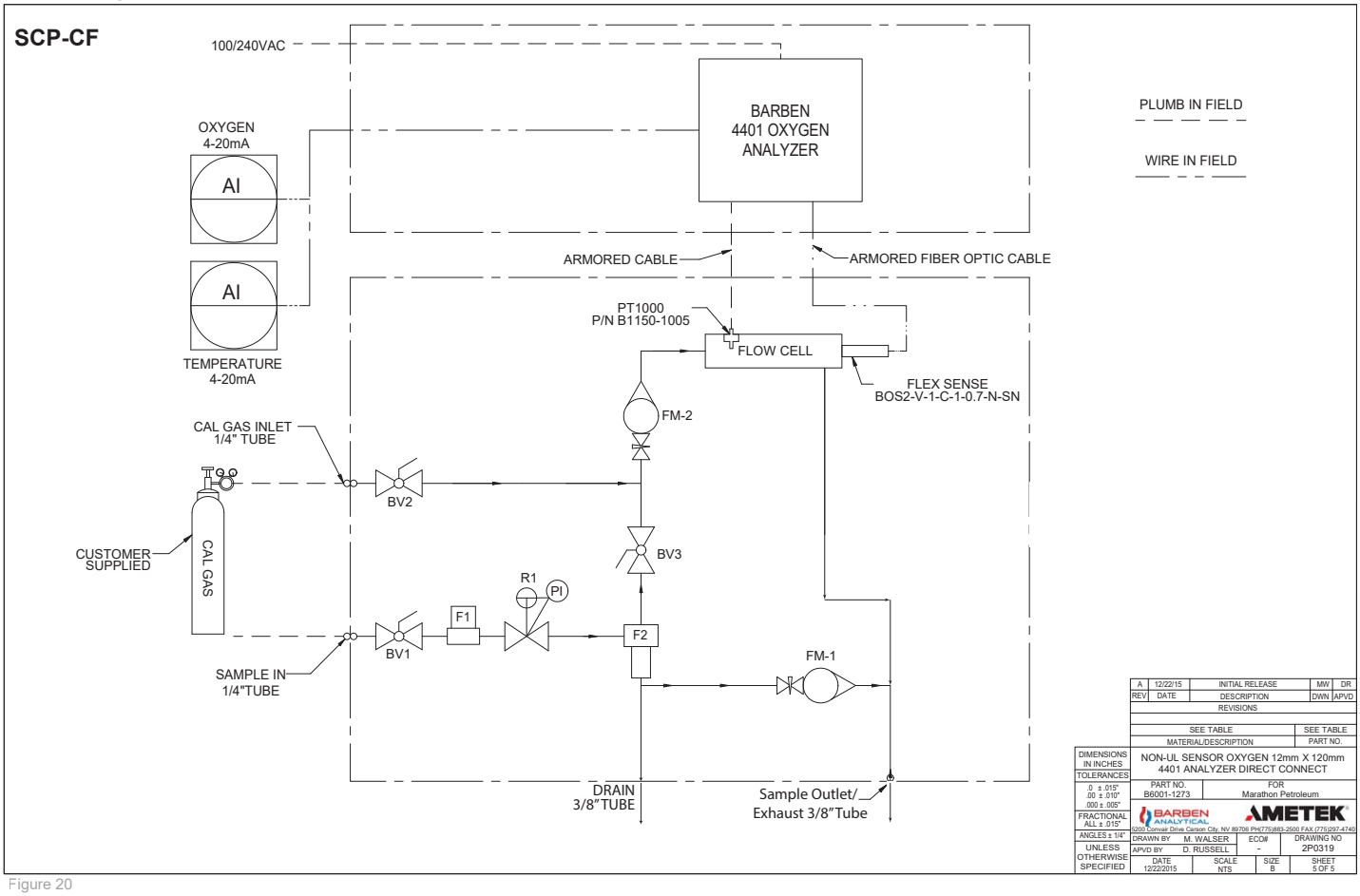


Figure 20

Section 4 - Theory of Operation and Measurement

4.1 Theory of Operation and Measurement

The 4401OXY analyzer uses a quench fluorescence technique with a sensor optically isolated from the process, using the absorbency as a diagnostic function and analyzing the phase angle for measurement of the analyte, oxygen, in the modulated time domain. This gives the analyzer the ability to measure accurately and precisely under various and changing ambient and process conditions.

The analyzer uses an LED to emit blue light through fiber optic cable down to the luminophore which resides at the sensor tip [Fig 21]. 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 22.]. The phase shift and intensity differences between the excitation source and the fluorescent signal is measured and the oxygen concentration is calculated [Fig 23].

The resulting measurement is specific to oxygen concentration. The luminophore is unaffected by other constituent 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 at process pressured different than the pressure at time of calibration.

Light transmission through fiber optic to luminophore

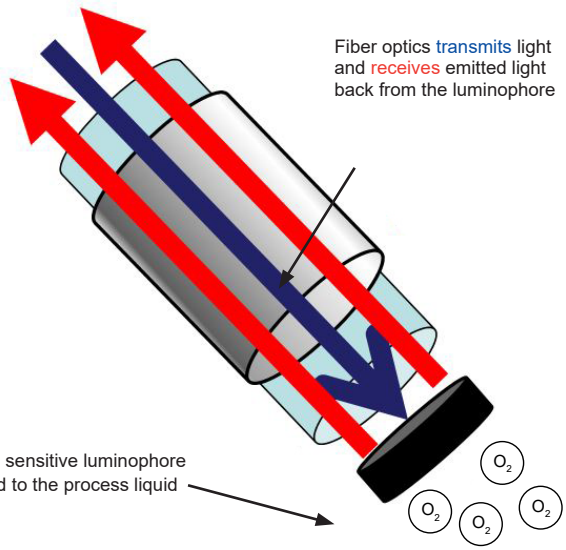


Figure 21

Effects of 100 ppm oxygen quenching

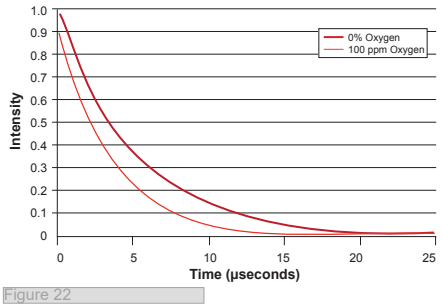


Figure 22

The effect of O2 quenching on light intensity from the luminophore sensor is shown above. Light emitted from the excited luminophore has higher intensity over a longer period than when oxygen is present. The intensity and time are measured by the spectrometer withing the 4401OXY to provide an oxygen measurement.

AC modulation and the phase shifted output

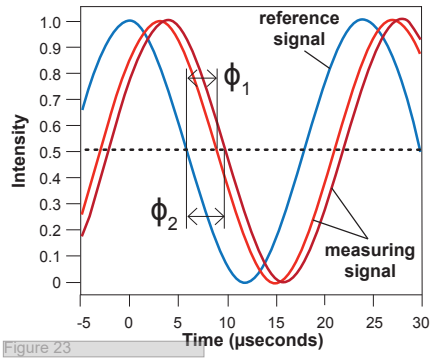
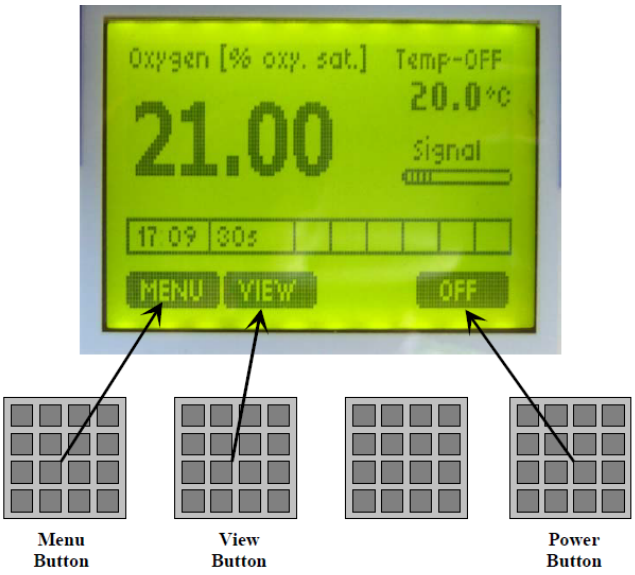


Figure 23

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 Φ1 and Φ2 of the red light waveform. Measurement of this phase shift proportionally matches the loss of intensity shown in Fig 2 above. The combination of both measurement techniques provides a stable, accurate method to measure oxygen in liquid and gas phase applications.

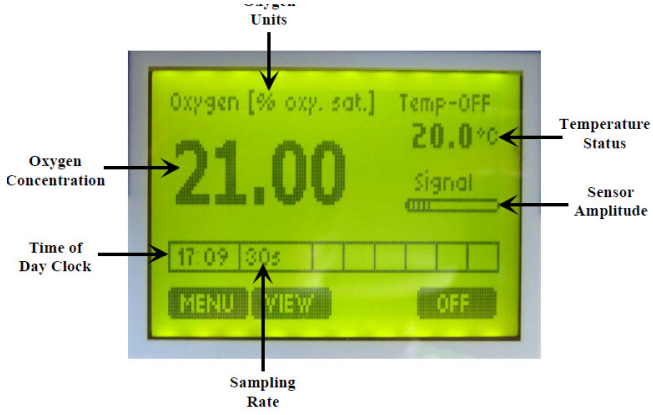
Section 5 - Operation of 4401OXY

5.1 - Overview and Keypad navigation



Soft Keys - Keypad Navigation

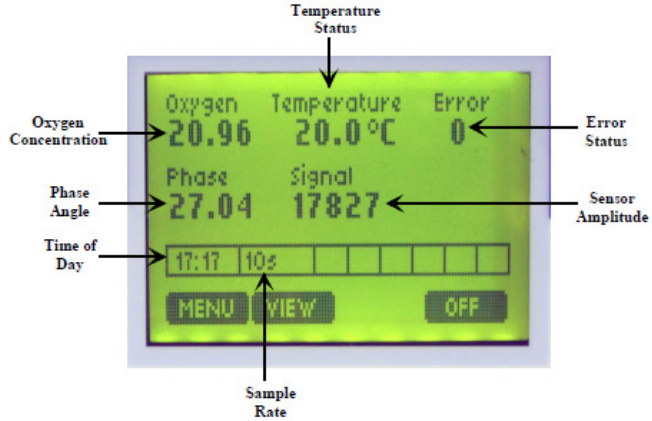
The 4401OXY analyzer has four tactile push-buttons to interact with the analyzer. These are considered "soft keys" since their functions can change depending on menu location. Their actual function will be shown above each key (relative) on the display.



MAIN DISPLAY VIEW

Main Display - Overview

Main display shows the **Oxygen reading** and **oxygen units** along with the temperature, time and **sample rate**. The sensor amplitude is shown in a bar graph.



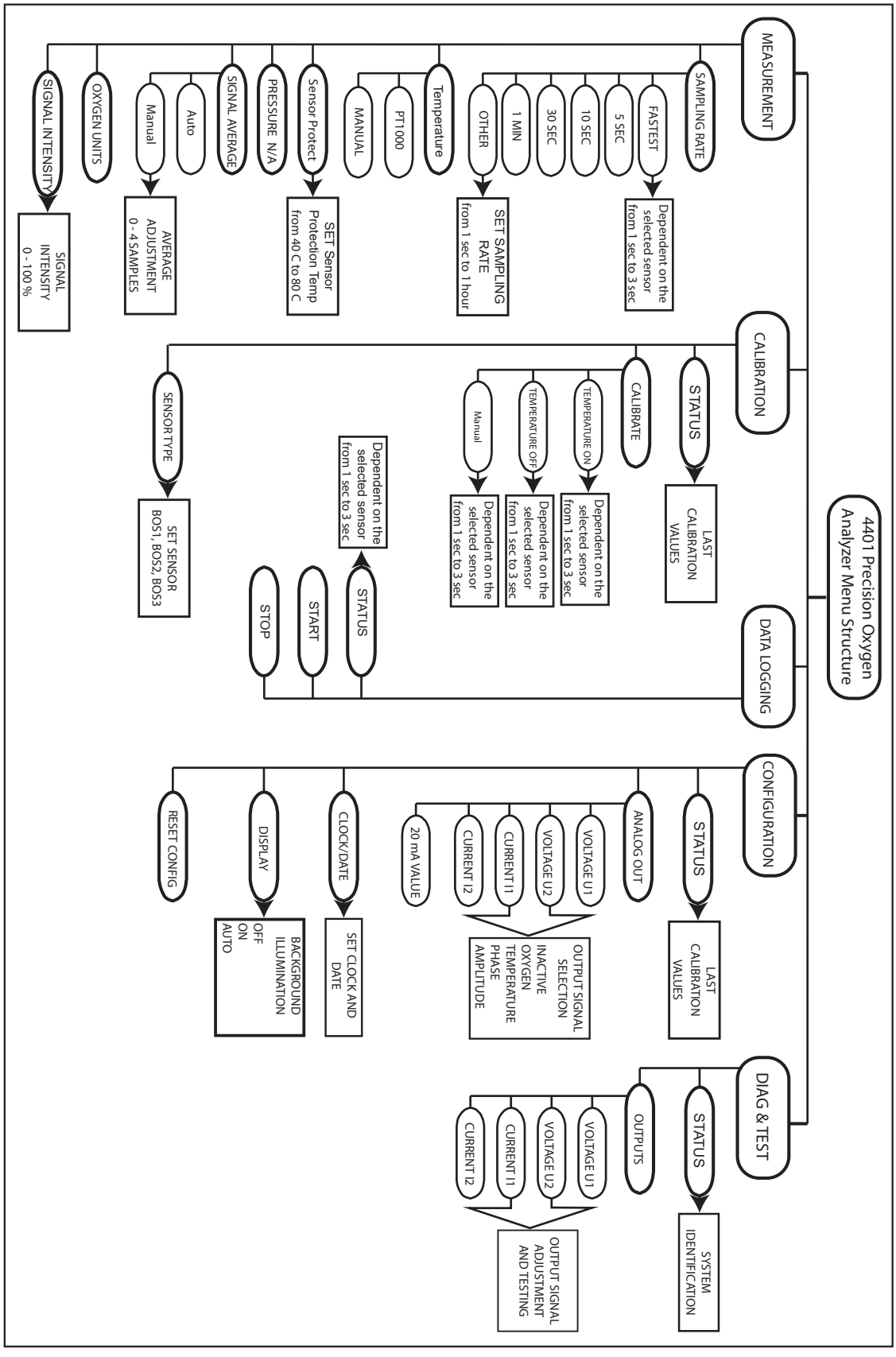
ALTERNATE DISPLAY VIEW

Alternate Display - Overview

Alternate display shows the **sample rate, Oxygen readings, temperature, error status, sensor amplitude, time** and **phase angle**.

5.2 - Menu Structure

Figure 24



5.3 - Configuration - Setup (Programming the Analyzer)

This section covers the configuration and setup of the 4401OXY. Each subsection will follow the 4401OXY's Analyzer Menu Structure shown on the previous page: Measurement, Calibration, Data Logging, Configuration and Dig&Test.

5.3.1 - Config/Setup - MEASUREMENT (Sample Rate, Temp, Sensor Protection, Signal Average, Oxygen Units, Signal Intensity)

Sample Rate - [Menu Structure: Measurement/Sampling Rate]

The sample rate determines how often the measurement will be taken. The rate can be set to take a measurement every 3 seconds to once every hour. It is beneficial to set the sample rate as slow as possible to minimize measurement drift between calibrations and extending the life of the sensor. Measurement drift and sensor life are directly affected by the sample rate due to the photo-bleaching of the measurement element. Photo-bleaching occurs every time the blue LED light flashes to take a measurement. The factory recommends a sample rate of every 60 seconds unless the application requires a quicker measurement. A table is shown here as an example of estimated drift between calibrations as a function of sample rate. Please note, that this is just an estimation based on common operating conditions.

BOS3 Sensor (ppm gas phase)		
Sample Rate Time (seconds)	Estimated shift from Zero (ppm)	Estimated Time between Calibrations (days)
300	< 1.5 ppm	135
60		28
30		15
10		5
5		2.5
3		1.5
300	< 3 ppm	270
60		56
30		30
10		10
5		5
3		3

Table 6

BOS2 - Sensor		
Sample Rate Time (seconds)	Estimated shift from Zero (% O2, gas phase)	Estimated Time between Calibrations (days)
60	0.05%	35
30		17
15		8
60	0.10%	140
30		30
15		15

Table 7

BOS1 - Sensor Calibration Frequency			
Sample Rate Time (seconds)	Estimated shift from Zero (ppb, aqueous)	Estimated shift from Zero (% O2, gas phase)	Estimated Time between Calibrations (days)
60	< 2	< 0.0042%	30
30			15
15			7
60	< 4	< 0.0084%	60
30			30
15			15

Table 8

Sample Rate is recommended at 60 seconds unless the application requires a faster response.

Temperature - [Menu Structure: Measurement / Temperature]

The measurement accuracy is dependent on an accurate temperature measurement. To ensure the best accuracy, the factory recommend that a Pt1000 RTD is placed into the sample stream very close to where the oxygen measurement is made. Selecting Pt1000 sets the analyzer for automatic temperature compensation. If you select MANUAL the analyzer will let you set the expected temperature of the process in degree Celsius.

Sensor Protect - [Menu Structure: Measurement / Temperature]

The analyzer is equipped with a high temp sensor alarm. When triggered the analyzer will display an error value 256, with a message of "Sensor Protection" and the 4-20 mA will fail high at 22 mA. The parameter can be adjusted in the field from 30 C (86 F) to 80 C (176).

Pressure - [Menu Structure: Measurement/Pressure]

This feature is not available.

Signal Average - [Menu Structure: Measurement / Signal Average]

This is a technical adjustment to the measurement itself that should only be changed in advice from the factory. This setting should be left in AUTO.

Oxygen Units- [Menu Structure: Measurement / Oxygen Units]

Allows for selection of the units to be used for oxygen measurement. These options are only available for the BOS1 and BOS2 sensor selections. BOS3 trace oxygen sensor is always PPM (gas phase). The available units are:

% Air Saturation: standard comparing to % oxygen in ambient air, 100% Air sat = 20.95 % O_2

% oxygen Sat: concentration of oxygen in % O_2 by vol otherwise referred to as mol%

hPa: partial pressure of oxygen in hectare-pascals

Torr: partial pressure of oxygen in Torr

ppm (liquid): concentration measurement of dissolved oxygen in aqueous solution (mg/L)

Note: For ppm liquid phase measurements, the analyzer will auto-range the displayed units from ppm to ppb when appropriate. The 4-20 mA output will always remain the same.

Signal Intensity - [Menu Structure: Measurement / Signal Intensity]

Allows for adjustment of the LED intensity. The factory sets this value at 50% and it is uncommon for this parameter to be changed in the field. The parameter may be adjusted if the sensor amplitude is low due to an aged sensor. Too high of a signal intensity can lead to higher than usual drift and a shorter sensor life. Target values in a ZERO test gas should be >10,000 and no more than 50,000.

5.3.2 - Config/Setup - Calibration

Status - [Menu Structure: Calibration / Status]

The Status screen will show the sensor calibration values recorded during the last successful calibration.

Calibrate - [Menu Structure: Calibration / Calibrate]

The analyzer allows for a two-point, zero and span calibration in test gases. The Zero gas should be high quality Nitrogen or any other non-reactive gas with zero oxygen content. Depending on the sensor selection, the range and the application, the nitrogen should be of high purity. The Span gas should be selected based on the sensor type see TABLES 10 and 11 for general factory recommendations.

Sensor Type	Low Limit of Detection	Zero Gas Purity Recommendation
BOS2	300 ppm	99.99% Nitrogen
BOS1	20 ppm	99.999% Nitrogen
BOS3	0.5 ppm	99.9999% Nitrogen

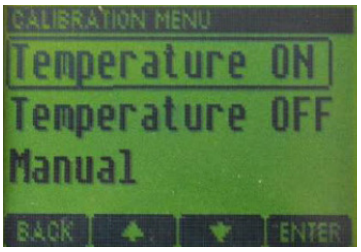
Table 10

Sensor Type	Full Range	Span Gas Recommendation
BOS2	0 to 25% O_2	20.95% O_2
BOS1	0 to 5% O_2	1 to 2% O_2 or 80 - 100% Critical Value
BOS3	0 to 300 ppm O_2	80 - 100% Critical Value

Table 11

Calibrate - [Menu Structure: Calibration / Calibrate / Temp ON/OFF]

The analyzer allows for the calibration to be performed with the **Temperature ON** or **OFF**.

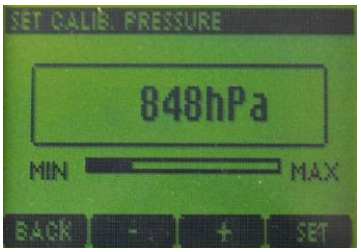


Temperature ON: Will utilize the temperature measured by the Pt1000 RTD during the calibration. This is preferred method and recommended.

Temperature OFF: Will utilize a manually inputted temperature for the calibration. This is preferred if there is no Pt1000 RTD installed and if the oxygen sensor has been removed and to be at a known temperature different than the RTD.

Calibrate - [Menu Structure: Calibration / Calibrate / SET CALIB. PRESSURE]

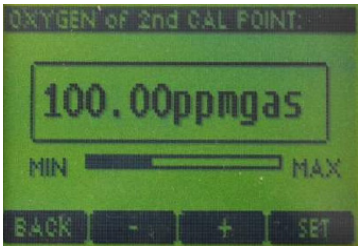
This analyzer feature is not enabled. Press Set to continue.



NOTE: The calibration should be performed at the same pressure as the measurement. This is usually easily accomplished by leaving the sensor in the sample system and keeping the test gas at the same flow rate as the measurement flow rate. Dissolved oxygen measurement in aqueous liquids are unaffected by pressure due to their non-compressibility. Variations of barometric pressures during calibration are negligible to the measurement accuracy.

Calibrate - [Menu Structure: Calibration / Calibrate / OXYGEN of 2nd CAL POINT]

The screen is used to input value of the Span calibration test gas. Range is dependent on sensor.



Enter the span gas value and press **SET**

BOS3 - Span Calibration Gas Range [10 to 300 ppm]

BOS1 - Span Calibration Gas Range [0.01 % to 5% O_2]

NOTE: For best accuracy over full range factory recommends 1 to 2% O_2

BOS2 - Span Calibration Gas must be 20.95% O_2 (Air)

Calibrate - [Menu Structure: Calibration / Calibrate / Insert Cal0]

Isolate the sample system from process and start flowing the Zero Gas (Cal0) oxygen free test gas.

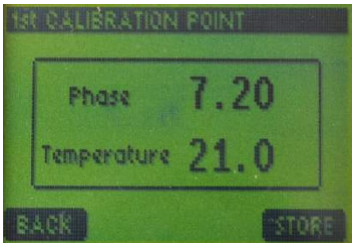
Once the Process stream has been stopped and the Zero Gas is flowing, Press **OK**.

(calibration is not performed until next step)

The measurement itself is unaffected by flow-rate. However, for trace level measurements we recommend at least 1.5 LPM to overcome oxygen ingress into sample gas tubing and components seals.

Calibrate - [Menu Structure: Calibration / Calibrate / 1'st Calibration Point]

Continue flowing the Zero Gas (Cal0) oxygen free test gas.



For high accuracy wait until the displayed values are stable:

Phase Angle: +/- 0.1 degree

Temperature: +/- 0.2 degree

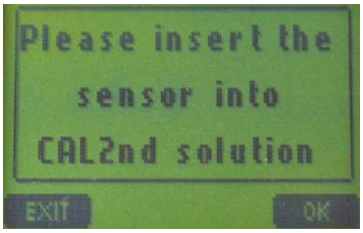
Generally take 2 to 3 minutes to reach zero with suggested stability. Once stability is reach, press **STORE**.

USEFUL INFORMATION

To test for true zero, apply back-pressure for 6 to 10 seconds to the outlet (stop the flow), while observing the phase angle. If the Phase Angle stays stable while increasing the back pressure it 100% verifies that there is no oxygen in the system.

Calibrate - [Menu Structure: Calibration / Calibrate / insert CAL2nd]

Stop the flow of the Zero gas and insert (start flowing) the span calibration test gas.



Once the Zero Gas has been stopped and the Span Gas is flowing, Press **OK**.

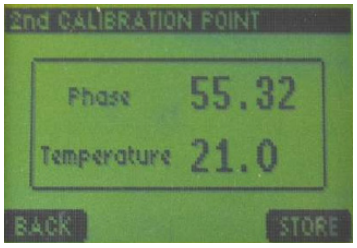
(calibration of Span Gas is not performed until next step)

USEFUL INFORMATION

For highest accuracy, the span gas should flow at the same rate as the process sample rate. Factory recommends ~ 0.5 to 2 LPM sample flow-rate.

Calibrate - [Menu Structure: Calibration / Calibrate / 2nd Calibration Point]

Continue flowing the span calibration test gas.



For high accuracy wait until the displayed values are stable:

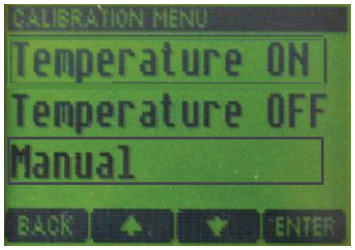
Phase Angle: +/- 0.1 degree

Temperature: +/- 0.2 degree

Generally take 2 to 3 minutes to reach the suggested stability. Once stability is reach, press **OK.**

Calibrate - [Menu Structure: Calibration / Calibrate / Manual]

Selecting the Manual calibration allows user to input factory calibration info from a new sensor



A Manual calibration can be performed when the end user does not have proper calibration gases available. Common calibration values for the different sensor types are shown here below. Scroll to **Manual** and press **ENTER**.

FiberSense			
		Phase Signal [°]	Temperature [C°]
BOS3	Zero Gas	64.8	21.5
	Span Gas (85.5 PPM)	47.61	21.5
BOS1	Zero Gas	66.72	21.0
	Span Gas (2.014 %O_2)	27.35	21.0
BOS2	Zero Gas	64.8	21.5
	Span Gas (20.95 %O_2)	29.86	21.5

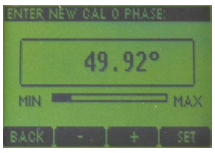
Table 12

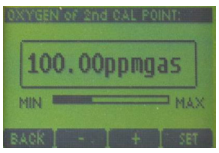
FlexSense and SafeTap			
		Phase Signal [°]	Temperature [C°]
BOS3	Zero Gas	64.8	21.5
	Span Gas (85.5 PPM)	47.61	21.5
BOS1	Zero Gas	65.6	20.6
	Span Gas (2.014 %O_2)	24.78	20.5
BOS2	Zero Gas	59.93	21.5
	Span Gas (20.95 %O_2)	27.72	21.5

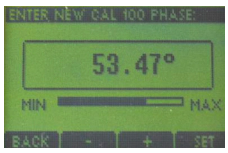
Table 13

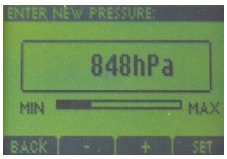
Calibrate - [Menu Structure: Calibration / Calibrate / Manual]

After selecting Manual, the analyzer will ask for the Phase, Temp and Pressure for the Zero and Span.



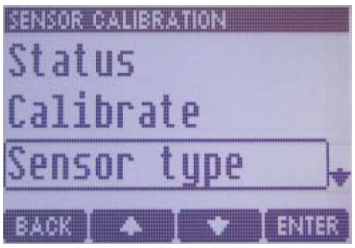






Calibrate - [Menu Structure: Calibration / Sensor Type]

If the analyzer and sensor were purchased together, they were calibrated together. If they were purchased separately or if you needed to change sensor types the proper sensor selection will need to be made.



Within the Calibration Menu, scroll down and select the proper sensor type. Then Press **ENTER**.

If you are uncertain of the sensor type check the sensor label.

5.3.3 - Config/Setup - Data Logging

Data Logging - [Menu Structure: Data Logging / Status]

The Status screen will give the current data log status such as: **Start time, Start date, Sampling Rate, Data in memory, Free memory (%), Max Memory Size**.

Data Logging - [Menu Structure: Data Logging / Data Logging]

After scrolling and selecting **Data Logging** the screen will come up with **OFF**. Select **EDIT**. The next screen will come up with options for START or STOP.

Selecting **START** will give the following message:

"This will erase previously stored data"

Select **O**K to proceed.

The analyzer will then display a message showing how long it can log based on the chosen Sample Rate.

"Max log time 9d 1h 46m 54s" **-** based on a 30 second **Sample Rate**

Once selected, **OK**, the previous files will be erased and the 4-20 mA output will no longer output. Programming functions cannot be performed until the Data Logger is turned off. When the Data Logger is STOPPED, the file is save as a TXT file, ready for download via the RS232.

Complete the setup and calibration of the analyzer prior to starting the Data Logging. Once the Data Logging has been started programming parameters cannot be accessed until the Data Logging has **STOPPED.**

Download and Save previous Data Logs prior to beginning a new one. The analyzer will automatically overwrite any previous logs. It only stores one file.

If the max data limit is reached the file will treat the data as "first in, first-out." Meaning the oldest existing data will fall off to accommodate new data.

5.3.4 - Config/Setup -CONFIGURATION

CONFIGURATION - [Menu Structure: Configuration]

The configuration in commonly used to set-up the Analog Outputs, set the Clock/Date, options for the display back-light or to reset configuration.

CONFIGURATION - [Menu Structure: Configuration / Status]

This contains information about the analyzer's firmware, serial number, and specific board level information.

CONFIGURATION - [Menu Structure: Configuration / Analog Out / Current I1 (Oxygen)]

This is where to set-up the Analog outputs and to range the 4-20 mA signals. The 4401OXY analyzer has two isolated, 4-20 mA outputs that are actively powered. These can be configured to the following Process variable parameters: **Oxygen, Temperature, Amplitude** or **Phase Angle**.

From the Configuration menu, select the **Analog Out** menu

Scroll down to **Current I1**, and select **EDIT** - (for Analog Output 1)

Choose the parameter for the output (e.g. Oxygen), Press **ENTER**

While still in the parameter menu, scroll down to 20 mA point, select and choose your range.

Note: The units will be the same as your chosen oxygen units.

The 4 mA point is zero oxygen so the 20 mA point will define you range.

CONFIGURATION - [Menu Structure: Configuration / Analog Out / Current I2 (Oxygen)]

If oxygen is selected as the parameter for output on Analog Output 2 (Current I2), it will have the same range as I1. It is not independently programmable.

CONFIGURATION - [Menu Structure: Configuration / Analog Out / Current I1 or I2 (other parameters]

If parameter other than Oxygen is selected for output on either channel 1 or channel 2 then he 4-20 mA output for those parameters are as follows:

Temperature:	4-20 mA = 0 to 60 C (140 F)
Phase Angle:	4-20 mA = 0 to 89 degrees
Amplitude:	4-20 mA = 0 to 160,000

If the actual oxygen measurement exceeds the 20 mA output point then the analyzer will have an error. **ERROR 64**, "**Output Overflow**." The **Analog Output** will go to **20.5 mA** under this condition.

If the analyzer detects a serious or **Critical Fault** that may significantly impact the oxygen reading, the analyzer will **FAIL HIGH**, and the **Analog Output** will default to **22.5 mA**

CONFIGURATION - [Menu Structure: Configuration / Clock/Date]

Use this menu to set the local time and date. This is recommended if using the Data Logging function.

CONFIGURATION - [Menu Structure: Configuration / Display]

Use this menu for setting the back-light options. The back-light can be set to

OFF - The back-light is always off

ON - The back-light is always on

Auto - The back-light turns on whenever the menu keys are touched and automatically turn off once the analyzer menu is not being activated by user.

5.3.5 - Diag & Test

Diag & Test - [Menu Structure: Diag & Test]

This is the Diagnostic and Test menu that allows the end user to simulate the 4-20 mA outputs. This is useful for testing the outputs and also for confirming both devices sending and receiving are scaled and calibrated properly.

Diag & Test - [Menu Structure: Diag & Test / Status]

This contains information about the analyzer's firmware, serial number, and specific board level information.

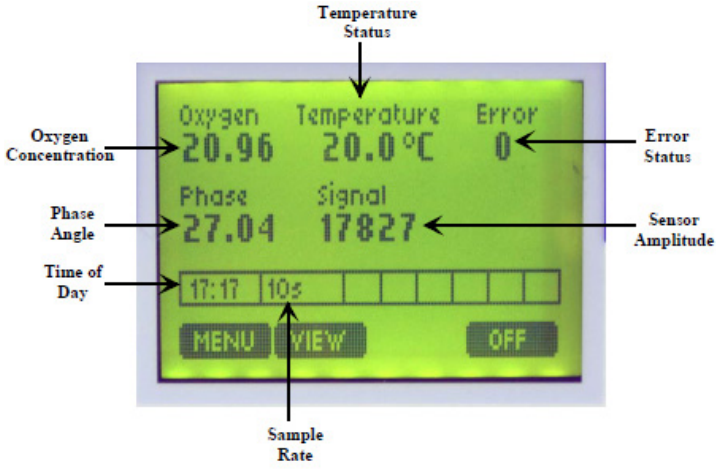
Diag & Test - [Menu Structure: Diag & Test / Outputs]

Simulates the 4-20 mA output. User can check the output to another device within this menu.

Section 6 - Error Codes and Troubleshooting

6.1 - Error Codes and Troubleshooting

When the 4401OXY analyzer detects an error the display back-light will blink on and off (If the back-light option was chosen as **OFF**, it will not blink). Depending on the error type the analyzer output can be affected. If the error is determined as a critical error that could affect the measurement value, then the Analog Output will **FAIL HIGH**, to 22.5 mA. This is to **ALARM** the end user that a critical fault has occurred and the analyzer should be inspected.



ALTERNATE DISPLAY VIEW

CAUTION

If the analyzer detects a serious or **Critical Fault** that may significantly impact the oxygen reading, the analyzer will **FAIL HIGH**, and the **Analog Output** will default to **22.5 mA**

Understanding the Error Codes

The Error Codes will flash the Error Value and then the description. Use the Error Codes Sheet found on the next page to identify the Error, the action the analyzer will take (4-20 mA output Action), understand the error and notes the possible steps to rectify the error.

Once an the cause of the problem is remedied, the error will go away and the analyzer will continue measurement and output as previously programmed without any user intervention required.

Common Error Code for BOS3 During Startup

When preparing to start up a BOS3 trace level O2 sensor, and the sensor is exposed to air, you will receive an Error Code 4, "No oxygen sensor." This alarm occurs because the trace level oxygen sensor is fully quenched around 3% Oxygen. When it is exposed to air the analyzer can no longer detect the sensor and gives this error. The error will automatically go away once the sensor is exposed to its trace level process, zero or proper span gas.

Error Codes (R2)

4401 OXY Optical Oxygen Analzyer

(Definitions, Possible Causes and Possible Action)

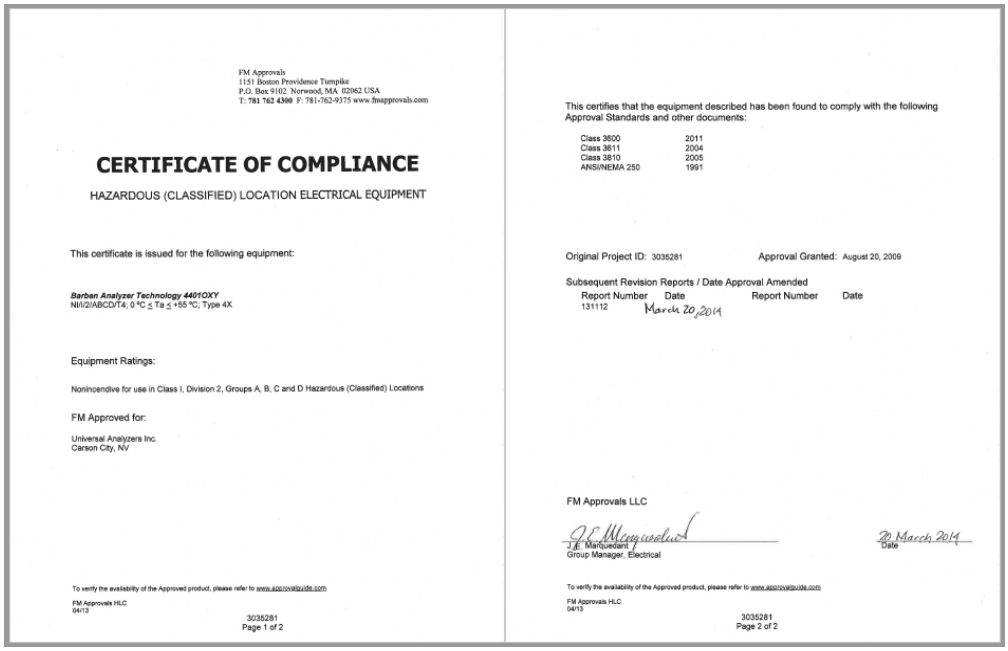
Error Value	Warning Message	4-20 mA Action	Definition	Possible Causes	Possible Action
1	ADC OverFlow	Fail High (22 mA)	Analog to Digital Overflow	Possible cause by other faults (2) Ambient Light or (4) No Oxygen Sensor. Otherwise possibly an electronics issue.	Remove other possible faults; perform steps for Error Values 2 & 4.
2	Ambient Light	Fail High (22 mA)	Too much ambient light illuminating the sensor	Sensor tip, fiber tip or analyzer SMA connector is exposed to sunlight.	Check that sensor is properly connected at analyzer via the SMA connector. Check that sensor tip is in flow cell or pipeworks.
4	No Oxygen Sensor	Fail High (22 mA)	BOSx Oxygen Sensor is not recognized by the electronics.	Sensor not connected. Sensors selection (BOS1, BOS2 or BOS3) in 4401 is not correct. Low range sensor (e.g. BOS3, 0 to 1000 ppm) is in much higher concentration Oxygen (such as air).	Check that sensor is properly connected at analyzer via the SMA connector. Check the sensor selection via the configuration menu matches the actual range (BOS1, BOS2 or BOS3) sensor being used. Make certain the sensor tip is in adequate oxygen range (e.g. A BOS3 O2 sensor which has a 0 to 1000 ppm range will show Error 4 in air. Fault occurs when Amplitude < 1,000)
8	No Pt1000 Sensor	Actual Reading (Temp is defaulted to 20C)	Pt1000 sensor is selected for Auto TC via menu and is not detected	Bad Wiring, Broken Pt1000 RTD.	Check TC for functionailty. Check TC is wired properly. If Pt1000 is not availible, select Manual mode via programming until Pt1000 RTD is installed.
16	Ch1 Loop Open	Open	Analog Ouput Channel 1 is open loop	AO Ch1 has been activiated via programming selection and the Loop current is not wired or completed.	Check Loop wiring. Turn channel to inactive if not ready to complete the loop wiring.
32	Ch2 Loop Open	Open	Analog Ouput Channel 2 is open loop	AO Ch2 has been activiated via programming selection and the Loop current is not wired or completed.	Check Loop wiring. Turn channel to inactive if not ready to complete the loop wiring.
64	Output Overflow	20.5 mA	Oxygen reading is greater than the selected 20 mA point	High Oxygen reading from process upset. 20 mA point is set lower than measured values.	Fix the process upset conditions or extend the 20 mA point.
128	System Restarted	0 mA with no power 4 mA during initialization (3 seconds) Returns to Actual reading (or other fault alarm action if existing)	The system was in the "ON" position when it lost power.	Intermittent or intended Power Loss at analyzer.	Fix power supply issues.
256	Sensor Protection	Fail High (22 mA)	The sensor protection value (max process temperature) user selectable has been exceeded.	High Process Temeprature. Value for Protection set lower than intended. Bad Pt1000.	Check Actual Process Temperature. Check Pt1000 Value. Extend the permissible max temp on the Sensor Protection via the menu.

Table 14

Section 7 - Agency Documentation

7.1 - FM Certification - USA

The 4401OXY product has been investigated by FM for the following standards [Class 3600:2011, Class 3611:2004, Class 3810:2005, ANSI/NEMA 250:1991] and approved for use in Class I, Division 2, Groups A, B, C and D Hazardous (Classified) Locations.



FM Approvals
1151 Boston Providence Turnpike
P.O. Box 9102 Norwood, MA 02062 USA
T: 781 762 4300 F: 781-762-9375 www.fmapprovals.com

CERTIFICATE OF COMPLIANCE

HAZARDOUS (CLASSIFIED) LOCATION ELECTRICAL EQUIPMENT

This certificate is issued for the following equipment:

Barben Analyzer Technology 4401OXY
NI/I/2/ABCD/T4; 0 °C ≤ Ta ≤ +55 °C; Type 4X

Equipment Ratings:

Nonincendive for use in Class I, Division 2, Groups A, B, C and D Hazardous (Classified) Locations

FM Approved for:

Universal Analyzers Inc.
Carson City, NV

To verify the availability of the Approved product, please refer to www.approvalguide.com

FM Approvals HLC
04/13

3035281
Page 1 of 2

This certifies that the equipment described has been found to comply with the following Approval Standards and other documents:

Class 3600	2011
Class 3611	2004
Class 3810	2005
ANSI/NEMA 250	1991

Original Project ID: 3035281 Approval Granted: August 20, 2009

Subsequent Revision Reports / Date Approval Amended

Report Number	Date	Report Number	Date
131112	March 20, 2014		

FM Approvals LLC

J.E. Marquedant
Group Manager, Electrical

20 March 2014
Date

To verify the availability of the Approved product, please refer to www.approvalguide.com

FM Approvals HLC
04/13

3035281
Page 2 of 2

7.2 - FM Certification - Canada (CSA)

The 4401OXY product has been investigated by FM for the following standards [CSA C22.2 No. 142:1987, CSA C22.2 No. 213:1987, ANSI/NEMA 250:1991] and approved for use in Class I, Division 2, Groups A, B, C and D Hazardous (Classified) Locations.

FM Approvals
1151 Boston Providence Turnpike
P.O. Box 9102 Norwood, MA 02062 USA
T: 781 762 4300 F: 781-762-9375 www.fmapprovals.com

CERTIFICATE OF COMPLIANCE

HAZARDOUS (CLASSIFIED) LOCATION ELECTRICAL EQUIPMENT
PER CANADIAN REQUIREMENTS

This certificate is issued for the following equipment:

4401OXY
NI/I/2/ABCD/T4; 0 °C ≤ Ta ≤ +55 °C; Type 4X

Equipment Ratings:

Nonincendive for use in Class I, Division 2, Groups A, B, C and D Hazardous (Classified) Locations

FM Approved for:

Barben Analyzer Technology
Carson City, NV

3035281C
Page 1 of 2

This certifies that the equipment described has been found to comply with the following Approval Standards and other documents:

CSA C22.2 No. 142	1987
CSA C22.2 No. 213	1987
ANSI/NEMA 250	1991

Original Project ID: 3035281C Approval Granted: August 20, 2009

Subsequent Revision Reports / Date Approval Amended

Report Number	Date	Report Number	Date

FM Approvals LLC

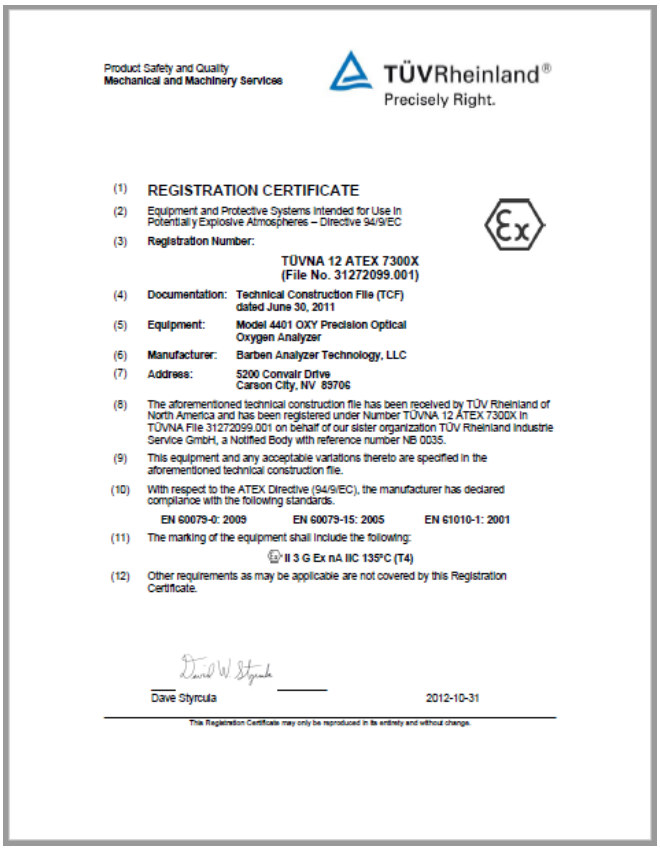
J.E. Marquedant
Group Manager, Electrical

20 August 2009
Date

3035281C
Page 2 of 2

7.3 - TUV NA - ATEX & CE Declaration of Conformity

The 4401OXY product has been investigated by TUVRheinland for the following standards [EN 60079-0:2009, EN 60079-15: 2005, EN 61010-1:2001] and approved for use in Zone 2 hazardous locations.



Product Safety and Quality
Mechanical and Machinery Services

TÜVRheinland®
Precisely Right.

(1) **REGISTRATION CERTIFICATE**

(2) Equipment and Protective Systems intended for Use in Potentially Explosive Atmospheres – Directive 94/9/EC

(3) **Registration Number:**

TÜVNA 12 ATEX 7300X
(File No. 31272099.001)

(4) **Documentation:** **Technical Construction File (TCF) dated June 30, 2011**

(5) **Equipment:** **Model 4401 OXY Precision Optical Oxygen Analyzer**

(6) **Manufacturer:** **Barben Analyzer Technology, LLC**

(7) **Address:** **5200 Convair Drive Carson City, NV 89706**

(8) The aforementioned technical construction file has been received by TÜV Rheinland of North America and has been registered under Number TÜVNA 12 ATEX 7300X in TÜVNA File 31272099.001 on behalf of our sister organization TÜV Rheinland Industrie Service GmbH, a Notified Body with reference number NB 0035.

(9) This equipment and any acceptable variations thereto are specified in the aforementioned technical construction file.

(10) With respect to the ATEX Directive (94/9/EC), the manufacturer has declared compliance with the following standards.

EN 60079-0: 2009 **EN 60079-15: 2005** **EN 61010-1: 2001**

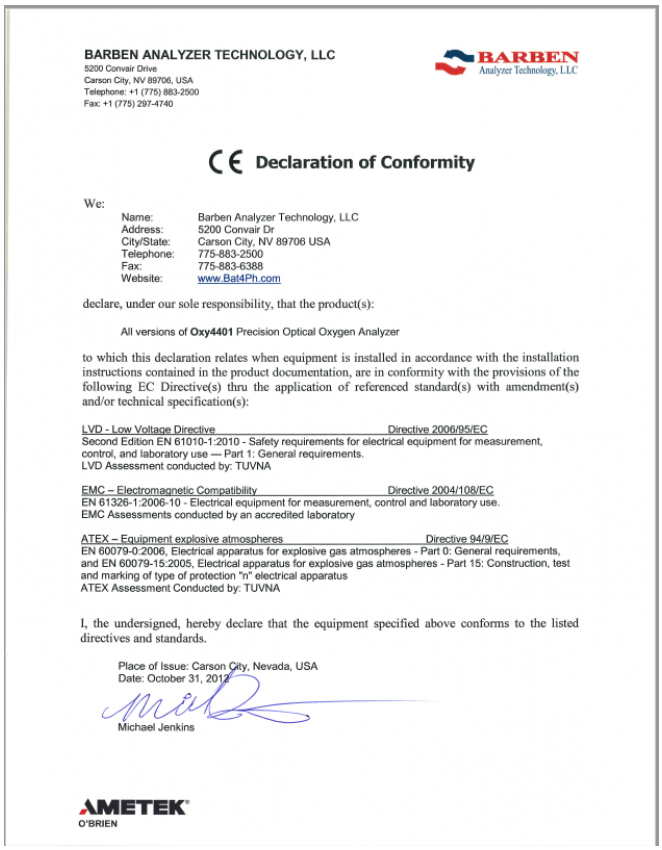
(11) The marking of the equipment shall include the following:

II 3 G Ex nA IIC 135°C (T4)

(12) Other requirements as may be applicable are not covered by this Registration Certificate.

Dave Styrcula 2012-10-31

This Registration Certificate may only be reproduced in its entirety and without change.



BARBEN ANALYZER TECHNOLOGY, LLC
5200 Convair Drive
Carson City, NV 89706, USA
Telephone: +1 (775) 883-2500
Fax: +1 (775) 297-4740

BARBEN Analyzer Technology, LLC

CE Declaration of Conformity

We:

Name: Barben Analyzer Technology, LLC
Address: 5200 Convair Dr
City/State: Carson City, NV 89706 USA
Telephone: 775-883-2500
Fax: 775-883-6388
Website: www.Bat4Ph.com

declare, under our sole responsibility, that the product(s):

All versions of **Oxy4401** Precision Optical Oxygen Analyzer

to which this declaration relates when equipment is installed in accordance with the installation instructions contained in the product documentation, are in conformity with the provisions of the following EC Directive(s) thru the application of referenced standard(s) with amendment(s) and/or technical specification(s):

LVD - Low Voltage Directive — Directive 2006/95/EC
Second Edition EN 61010-1:2010 - Safety requirements for electrical equipment for measurement, control, and laboratory use — Part 1: General requirements.
LVD Assessment conducted by: TUVNA

EMC – Electromagnetic Compatibility — Directive 2004/108/EC
EN 61326-1:2006-10 - Electrical equipment for measurement, control and laboratory use.
EMC Assessments conducted by an accredited laboratory

ATEX – Equipment explosive atmospheres — Directive 94/9/EC
EN 60079-0:2006, Electrical apparatus for explosive gas atmospheres - Part 0: General requirements, and EN 60079-15:2005, Electrical apparatus for explosive gas atmospheres - Part 15: Construction, test and marking of type of protection "n" electrical apparatus
ATEX Assessment Conducted by: TUVNA

I, the undersigned, hereby declare that the equipment specified above conforms to the listed directives and standards.

Place of Issue: Carson City, Nevada, USA
Date: October 31, 2012

Michael Jenkins

AMETEK
O'BRIEN

Section 8 - 4401OXY PC Software - OxyView

8.1 - 4401OXY PC Software Overview

The 4401OXY includes supporting software. The OxyView software is capable for logging and graphing performance, configuration of the analyzer and calibration of the analyzer. This section covers the most basic features of the software. For more in depth information consult the OxyView software manual.

8.2 - Basic PC Requirements for the 4401OXY

The 4401OXY PC software is compatible with the following operating systems:

Windows 98, Windows 2000, Windows Millennium, Windows NT 4.0, Windows XP, Vista, Windows 7

8.3 - Loading and Connecting the Software

The 4401OXY PC software has been provided on a CD.

1. Copy the software onto your hard drive or double click the icon
2. Connect the 4401OXY to the PC via the RS 232 Cable and power on the analyzer
3. The software show the screen “Collecting the Sensor Info” Note: If it fails to load in a timely manner, check the proper COM port has been selected.

8.4 - Overview of OxyView - Interface

The program has four main areas shown in blue below. Menu Bar, Graphical Window, Status Bar, Control Bar; divided into numerical display, control buttons and warning lights.

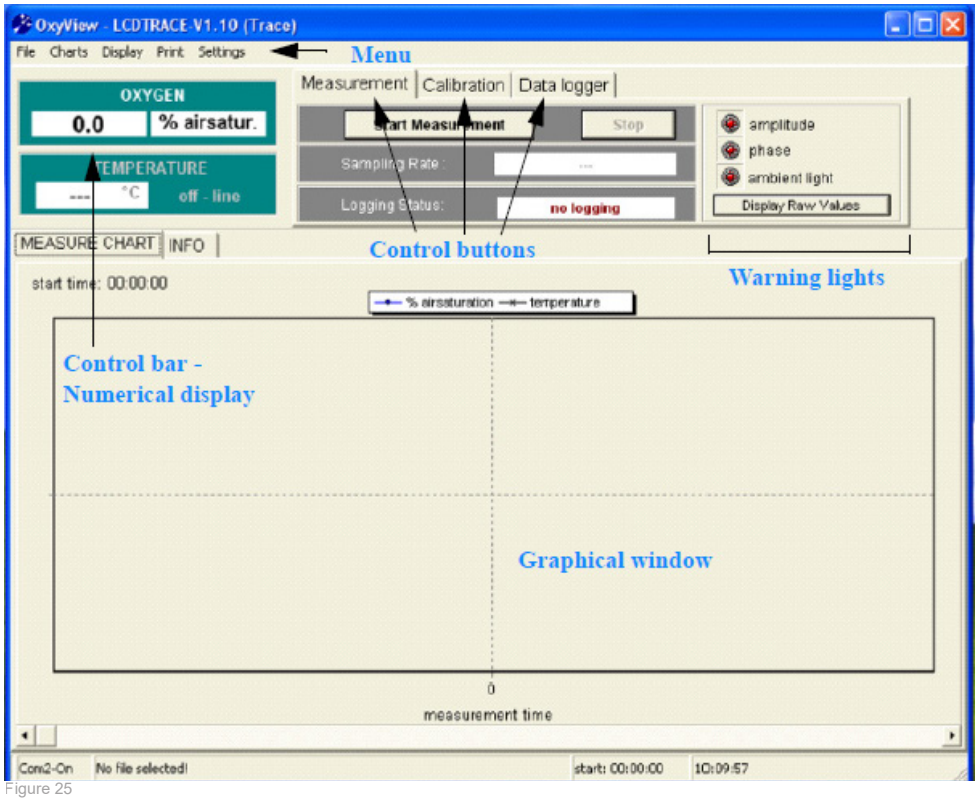


Figure 25

8.5 - OxyView - Graphical Outputs

The software can produce graphs via the graphical window. It will also log the data in a text file that can be used for export into Excel for additional graphing

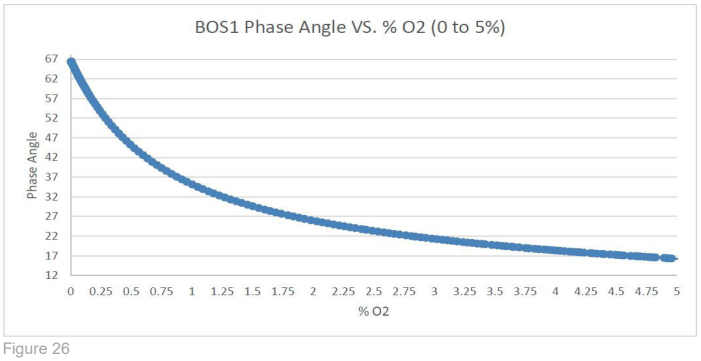


Figure 26

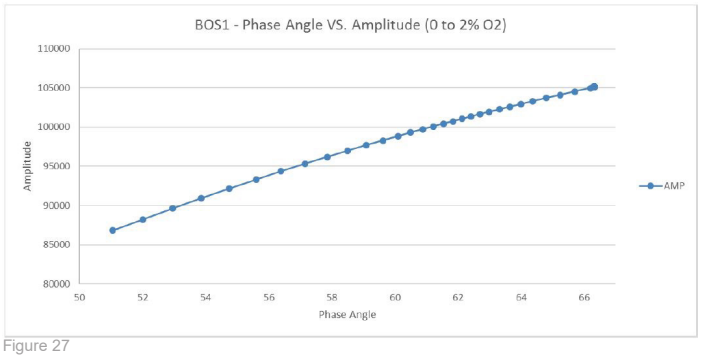


Figure 27

8.6 - OxyView

Consult the OxyView Software Manual for more detailed instructions.

Section 9 - Warranties

9.1 - Warranties

Seller warrants that Products manufactured by Seller, when delivered, shall be free from defects in material/workmanship. Seller warrants that Services shall be performed in accordance with generally accepted industry practice. Seller's obligations under this warranty shall be limited exclusively to repairing or replacing, at Seller's option, any part of Products which, if properly installed, used and maintained, proved to have been defective in material or workmanship within 1 year from the date of shipment, or re-performing the Services. Seller warrants for a period of 1 year from the date of shipment that software or firmware, when used with Products, shall perform in accordance with Seller's published specifications. Seller makes no warranty, express or implied, that the operations of the software or firmware shall be uninterrupted or error-free, or that functions contained therein shall meet or satisfy the Buyer's intended use/requirements. Buyer shall notify Seller of any defect in the quality or condition of Products (including software/firmware) or Services within 7 days of the date of delivery or performance, unless the defect was not apparent on reasonable inspection, in which case, within 7 days after discovery of the defect. If Buyer does not provide such timely notification, it shall not be entitled to reject Products (including software/firmware) or Services, and Seller shall have no liability for such defect.

Seller's warranty obligations shall not apply to Products which (1) have been altered or repaired by someone other than Seller, or (2) have been subjected to misuse, neglect, or improper use or application, or (3) are normally consumed in operation, or (4) have a normal life inherently shorter than the warranty period stated therein.

No Products may be returned unless authorized in advance by Seller, and then only upon such conditions to which Seller may agree. Buyer must obtain a Return Material Authorization (RMA) number from Seller prior to any return shipment, and such RMA number must appear on the shipping label and packing slip. Buyer shall be responsible for returned Products until such time as Seller receives the same at its facility, and for all charges for packing, inspection, shipping, transportation or insurance associated with returned Products.

Exclusive remedies and obligations for claims based upon defects in or nonconformity of Products/Services, whether the claim is in contract, warranty, tort (including negligence of any degree or strict liability) or otherwise. THE FOREGOING WARRANTIES ARE IN LIEU OF ALL OTHER WARRANTIES, WHETHER ORAL, WRITTEN, EXPRESS, IMPLIED OR STATUTORY. NO IMPLIED OR STATUTORY WARRANTIES OF MERCHANTABILITY OR FITNESS FOR PARTICULAR PURPOSE SHALL APPLY.

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