BARBEN
Analyzer Technology, LLC

5200 Convair Dr
Carson City, NV 89706
775.883.2500 Fax 775.883.6388
www.BAT4pH.com

PDO_2 Series

OPTICAL DISSOLVED OXYGEN SYSTEM

See us on the WEB at http://www.BAT4pH.com
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Manual PDO_2-E rev 5/11/2010

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LIMITED WARRANTY

ALL PRODUCTS MANUFACTURED BY BARBEN ANALYZER TECHNOLOGY, LLC ARE WARRANTED TO BE FREE OF MANUFACTURING DEFECTS FOR A PERIOD OF ONE YEAR FROM THE DATE OF RECEIPT AT THE CUSTOMER'S RECEIVING AREA. THIS WARRANTY COVERS MATERIALS AND LABOR TO RESTORE ANY PRODUCTS TO ORIGINAL FACTORY SPECIFICATIONS IF A DEFECT IS FOUND WITHIN THE WARRANTY PERIOD.

AN RMA NEEDS TO BE OBTAINED FROM THE FACTORY PRIOR TO RETURNING DEFECTIVE PRODUCT. IT MUST BE SENT, FREIGHT PREPAID, TO THE FACTORY IN CARSON CITY, NEVADA. REPAIRS WILL BE PERFORMED AT THE FACTORY AND RETURNED, PREPAID, BY THE SAME SHIPPING METHOD USED TO SEND THE PRODUCT TO THE FACTORY.

THIS WARRANTY DOES NOT APPLY IF THE EQUIPMENT HAS SUSTAINED DAMAGE DUE TO NEGLECT, MODIFICATION, CORROSION, OR OTHER REASON BEYOND THE SCOPE OF THE NORMAL DEFINITION OF "MANUFACTURING DEFECT".

FURTHER, THIS WARRANTY IS LIMITED TO REPLACING THE DEFECTIVE COMPONENTS AND RETURNING THE EQUIPMENT MANUFACTURED BY BARBEN ANALYZER TECHNOLOGY, LLC TO THE CUSTOMER IN WORKING CONDITION. ANY OTHER CLAIMS ARE OUTSIDE THE SCOPE OF THIS WARRANTY. NO WARRANTIES ARE MADE AS TO THE SUITABILITY OF THE USE OF THE EQUIPMENT IN ANY PARTICULAR APPLICATION OR LOCATION. THE SUITABILITY OF THE USE OF THE EQUIPMENT IS THE RESPONSIBILITY OF THE CUSTOMER AND THE INSTALLING CONTRACTOR.

SERIES PDO2-E	BARBEN Analyzer Technology, LLC 5200 CONVAIR DR CARSON CITY, NV 89706 PHONE: (775) 883-2500 FAX: (775) 883-6388

SPECIFICATIONS

SENSOR:

MEASUREMENT RANGE ..... 0.01 mg/L … 20.00 mg/L DO
OUTPUT TO ANALYZER ..... 4-20mA (0 to 20 mg/L)
ACCURACY (25°C) ..... +/- 0.01 mg/L
DETECTION LIMIT ..... 0.01 mg/L
RESPONSE TIME ..... $t_{98\%}$ < 30 s (25°C, from air to nitrogen)
WARMUP PERIOD ..... 15 min
OXYGEN CONSUMPTION ..... NONE
REQUIRED FLOW ..... NONE
DRIFT UNDER CONSTANT CONDITIONS: ..... <0.02 mg/L per week
TEMPERATURE COMPENSATION ..... (Done Internally)
STORAGE TEMPERATURE ..... 15 to 120 °F (-10 to 50 °C)
OPERATION TEMPERATURE ..... 15 to 175 °F (-10 to 80 °C)
PRESSURE RANGE ..... -14.5 to 100 PSI (-1 to 7 bar)
WETTED MATERIALS ..... POLYPROPYLENE / VITON/SS316L/SILICONE
DIMENSIONS: ..... 9” long x 1” diameter (225 mm x 25 mm)
WEIGHT: ..... 0.44 lb (200 g)
NO INTERFERENCES WITH ..... CO_2, H_2S, SO_2
RESISTANT TO ..... ETHANOL, METHANOL, H_2O_2
NO RESISTANCE TO ..... CHLORINE GAS, ORGANIC SOLVENTS such as chloroform, toluene, acetone

ANALYZER:

STORAGE TEMPERATURE ..... -22 to 158°F (-30 to 70 °C)
OPERATION TEMPERATURE ..... 5 to 150°F (-15 to 65 °C)
HUMIDITY ..... <95% RH, No Condensation
VOLTAGE ..... 90-265 VAC, 48-63 Hz
MAXIMUM INPUT POWER ..... 14 WATTS
ENCLOSURE MATERIAL ..... POLYAMIDE
ENCLOSURE PROTECTION per EN 60529 ..... Surface mounted: IP67
ELECTRICAL CLASSIFICATION ..... GENERAL PURPOSE
ELECTRICAL SAFETY ..... DIN EN61010, Part 1
VIBRATION RESISTANCE ..... EN 60068-2-6
CABLE ENTRY ..... Cable glands, 3x M16 & 2x M12
DIMENSIONS ..... 5.5” x 4.75” x 3” (140 x 120 x 77 mm) hwd
WEIGHT ..... 2 lb (900 g)
MEASUREMENT RANGE ..... 0.01mg/L … 20.00 mg/L
INPUT FROM SENSOR ..... 4-20mA (0 to 20 mg/L)
RESOLUTION 0.01mg/L

Important note:

Table of Contents

1 GENERAL INFORMATION

1.1 Safety Information

Please read this entire manual before unpacking, setting up, or operating this equipment. Pay attention to all danger and caution statements. Failure to do so could result in serious injury to the operator or damage to the equipment. To ensure that the protection provided by this equipment is not impaired, do not use or install this equipment in any manner other than that specified in this manual.

The specifications such as temperature or pressure being defined on page one in Specifications may not be exceeded under any circumstances. Threats are imminent if the sensor is not operated correctly or appropriately.

1.2 PDO_2 System Information

The PDO_2 luminescent (fluorescence) dissolved oxygen System (1401DO analyzer & sensor combination) differs from industry standard polarographic-style DO sensors in several ways. The principal distinguishing factors relate to the durability of the sensing element and the stability of the signal, both of which have been significantly improved in the PDO_2 luminescent dissolved oxygen sensor. These changes mark an important step forward in wastewater and industrial monitoring.

The PDO_2 luminescent dissolved oxygen sensor operates by shining a blue light of the proper wavelength on a luminescent dye which is immobilized in a matrix and formed into a disk about 0.5 inches in diameter. This dye-containing disk will be evident on inspection of the sensor face. The blue light causes the immobilized dye to luminesce and the lifetime of this dye luminescence is measured via a photodiode in the probe.

When there is no oxygen present, the luminescence lifetime of the signal is maximal; as oxygen is introduced to the membrane surface of the sensor, the luminescence lifetime becomes shorter. Thus, the lifetime of the luminescence is inversely proportional to the amount of oxygen present and the relationship between the oxygen concentration outside the sensor and the luminescence lifetime can be quantified.

With PDO_2 luminescent dissolved oxygen Sensor**,** there is only one consumable. Under normal conditions, even with frequent steam sterilizing, autoclaving, and CIPs, the Sensor Cap has a lifetime of more than one year. Furthermore, lifetime is seldom dramatically reduced— even in environmental applications, the Sensor Cap lasts for 1 to 3 years or longer.

1.3 Theory of Operation

The unique design of the PDO_2 luminescent dissolved oxygen Sensor enables it to monitor the status of the sensor's blue LED using one of the photodiodes. The photodiode with the red filter measures the oxygen-dependent red light generated on the luminophore (Optode) through luminescence (fluorescence) caused after excitation by the blue light. Electrons are excited to a higher energy level, and return to their original level after emission of red light.

When the luminophore comes into contact with elemental oxygen, the O2 molecules absorb the energy, resulting in reduced intensity of red light emission. This difference in intensity is analyzed by the instrument's self-monitoring system to pinpoint photobleaching (bleaching of the luminophore). High precision measurement of the optical phase shift between the blue and red light pulses provides accurate indication of oxygen concentration. Normally, the luminophore's excited electrons remain in this state for some time. However, in the presence of oxygen they return to their ground state more quickly. An oxygen dependent time shift occurs between pulsed excitation of the luminophore and the emission of red light, measured as phase angle.

Notice that PDO_2 luminescent dissolved oxygen Sensors measure the partial pressure of oxygen (pO2) just as classical sensors do. This is displayed as concentration in mg/l (ppm). The measurement range is currently limited to 0.01 to 20 mg/L. For most applications this measurement range is more than adequate

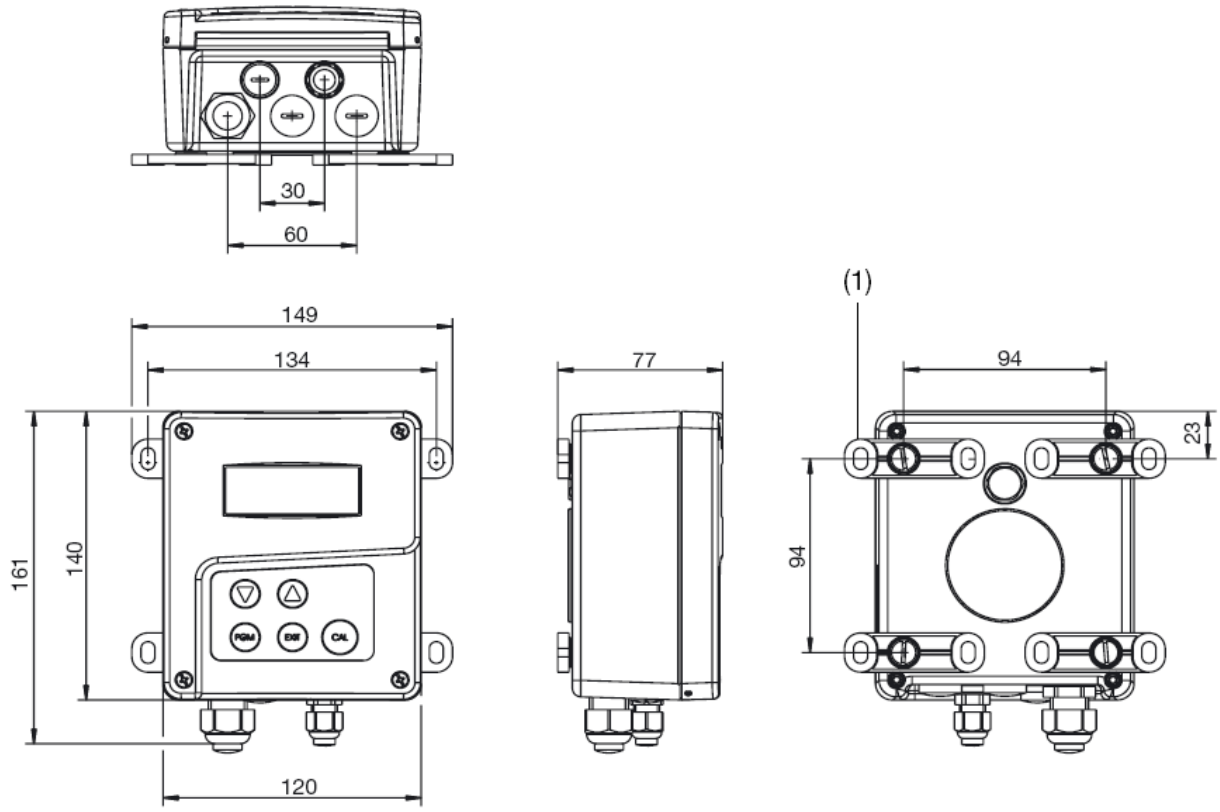
2 MOUNTING

2.1 Controller

The mounting location for the 1401DO analyzer should allow for easy access to view the screen and push buttons. The display screen should be located out of direct sunlight, but can be oriented in any position.

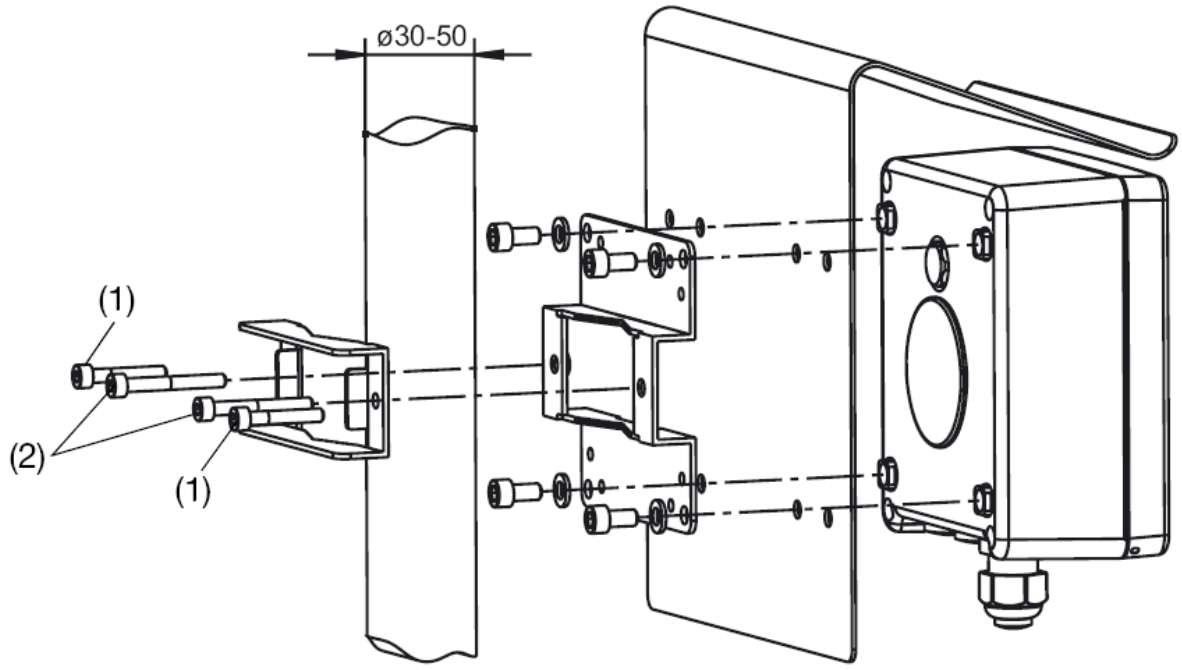
2.1.1 Surface / plate mounting

Mounting tabs are included with shipment. Attach the four mounting tabs onto the enclosure then fasten the enclosure with tabs onto a surface or plate.



2.1.2 Pipe installation set / weather protection roof (Ordered Separately)

The pipe installation set can be used to fasten the instrument and optional protective roof onto pipes or railings either horizontally or vertically with a diameter from 30 to 50 mm.



Screws (1) M5 x 30 for pipe diameters from 30 to 40 mm.

Screws (2) M5 x 40 for pipe diameters from 40 to 50 mm.

2.2 SENSOR

Cross sensitivities and resistances:

Sensor not disturbed by: carbon dioxide, hydrogen sulfide, sulfur dioxide, ethylene oxide or gamma-sterilization.

Sensor resistant to: ethanol, methanol, hydrogen peroxide
Sensor not resistant to: chlorine gas and other organic solvents such as chloroform, toluene, acetone.

Electrical connection: Quick VP8 Connector.
The operating voltage is 7 to 30 VDC; maximum power is 1W, 0.6 W continuous. Keep connector and contacts dry and clean to insure a good signal.

The PDO2 luminescent dissolved oxygen sensor has internal temperature compensation that is done internally in the sensor.

HINT: The sensor requires a preheating period of 10 to 15 minutes after it is switched on. Although measurements are possible during this time, you must wait until preheating is complete to be able to calibrate the sensor optimally. Refer to **drawing 2P0147** for sensor detail.

1.
2.
   2.1.
   2.2.

2.2.1 Installing the sensor in the sample stream

In contrast to the electrochemical oxygen sensors, PDO2 luminescent dissolved oxygen sensors work independently of the installation position. However, at an installation with the sensor cap perpendicularly downward, the ascending gas bubbles may remain at the sensors cap luminophore surface. These gas bubbles easily may falsify the measured values or may lead to easily varying measured values. Refer to **drawing 2P0167** for installation detail.

3 Wiring

3.1 Controller

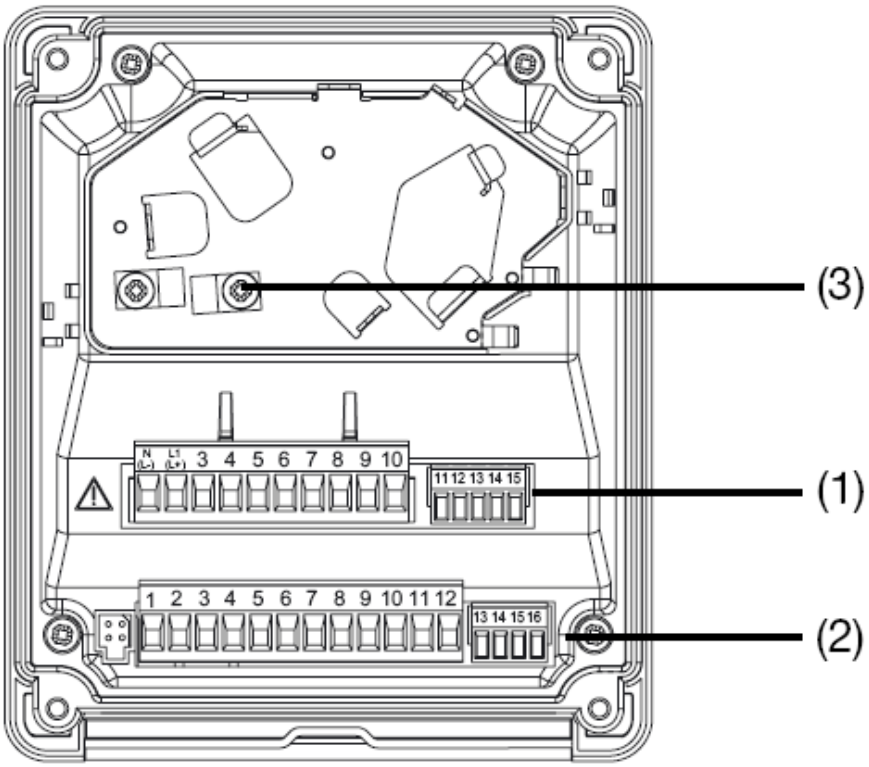
3.1.1 Instructions

- The load circuits must be fused for the maximum load current to prevent relay contacts from welding closed in the event of a short circuit.
- Electromagnetic compatibility meets the requirements of EN 61326.

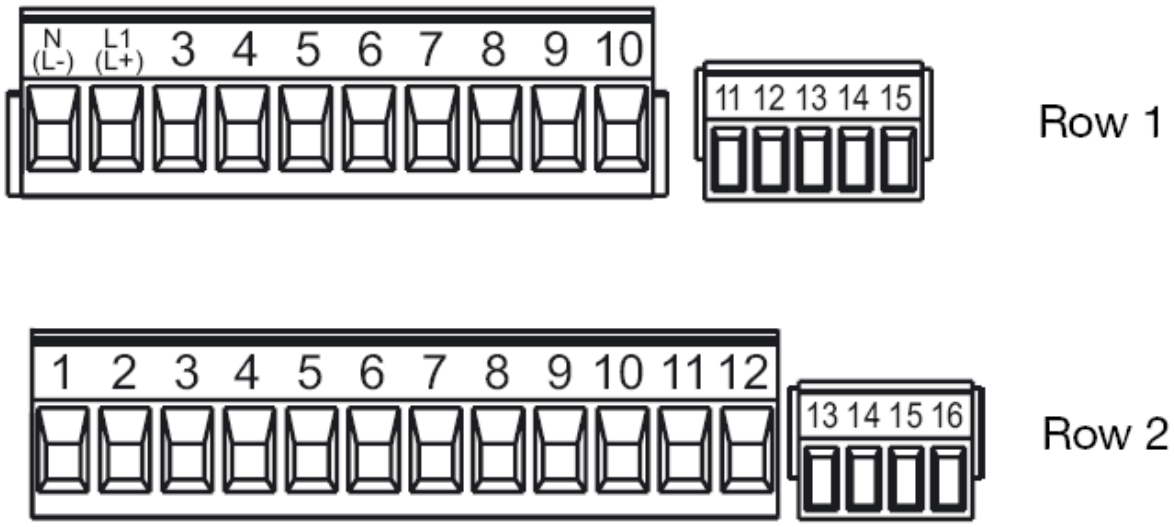
- Lay the input, output, and supply lines so they are physically separated from each other and are not parallel.
- Do not route the sensor cable close to wires or components in which current is flowing.
- The instrument is not suitable for explosion proof classified areas.
- The enclosure protection specified for the instrument (IP67) is only achievable if a cable runs into the instrument thru a cable gland.

3.1.2 Connection

The instrument has a guide plate to ensure optimum cable routing. There must be strain relief for the cables running to the pluggable screw terminals. The clip (3) (see next page) must only be attached by a 3.5x6.5 pan head screw! If the screw is any longer, dangerous voltage could be directed to the cable shielding! Remove pluggable screw terminals (1) and (2) from the control panel to connect the individual core wires. Run the connecting cables through the cable glands (3).



(1) Row 1 terminals
(2) Row 2 terminals
(3) Cable guide clips



3.2 Sensor

3.2.1 Connecting Sensor to Controller

3.2.1.1 Quick VP8 Connector

Mate connector halves by aligning key slot and tighten clasp-ring finger tight. Refer to **drawing 2P0167** for details.

3.2.1.2 Hard Wiring

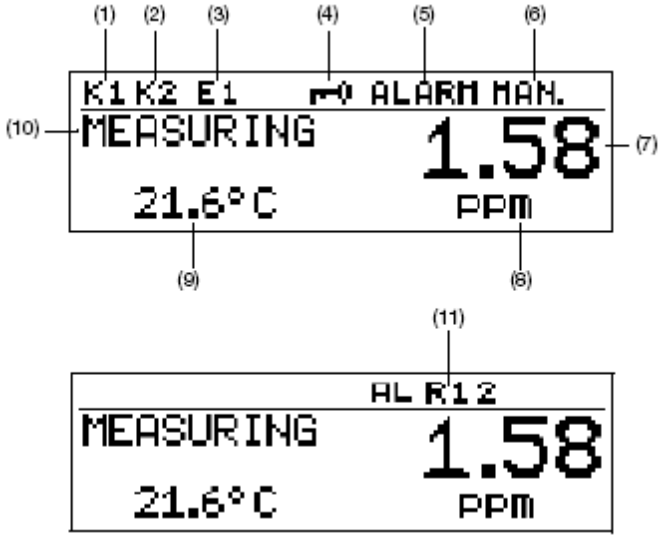
Hard wiring the sensor to the Model 1401DO is currently not supported.

4 User Interface and Navigation

The front panel consists of the backlit graphical display and five membrane keypad buttons. The five buttons and their functions are:

- **CAL key** Start calibration
- **EXIT key** Cancel entry / Exit level
- **PGM key** Change level / Forward or confirm selection
- **Down arrow** Change parameter / Down selection
- **Up arrow** Change parameter / Up selection

4.1 Normal Display



(1) Relay K1 is active
(2) Relay K2 is active
(3) Binary input 1 is triggered
(4) Keypad is locked
(5) Instrument status (notes)
- Alarm (e.g. overrange)
- Calib flashes (calibration timer expired)
- Calib (customer calibration active)

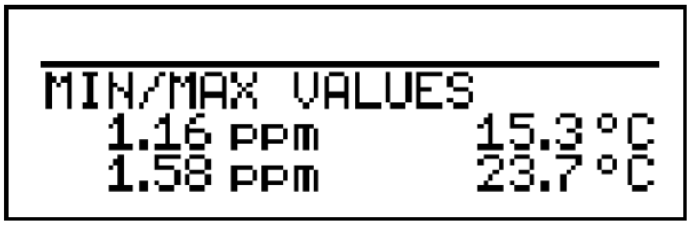
(6) Output mode
- Man (manual mode)
- Hold (hold mode)

(7) Dissolved Oxygen value of process
(8) Measurement unit of process
(9) Temperature of process (NOTE: This feature is not active at this time)
(10) Instrument status e.g.
- Measuring (normal)
- Calibration status

(11) AL R1 = Alarm, controller 1
AL R2 = Alarm, controller 2
AL R12 = Alarm, controllers 1 and 2

4.2 Min / Max Display

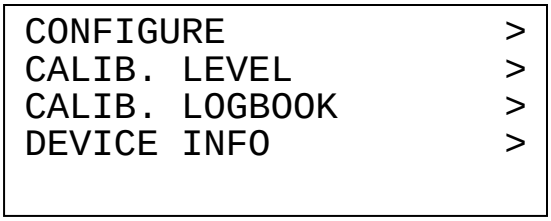
From the main display **Measuring** mode, briefly press PGM to display the following minimum and maximum value information. Press Exit to return to the **Measuring** mode.



- The extreme values of the main measurement variable and the temperature are **not** mutually assigned (e. g. not 1.15 ppm at 15.3 °C). **NOTE: Temperature is not functional at this time.**
- Press EXIT to return to measurement display.
- The Min/Max values can be reset via cycling power to the unit.

4.3 Programming Display

From the main display **Measuring** mode, press PGM longer than 2 seconds to enter program mode and display the first screen shown below.



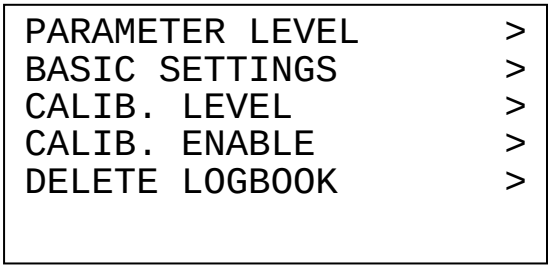
The main password to enter CONFIGURE mode is 411.

- **Configure** – needs a password (411) to enter. All the parameters available can be edited at this level.
- **Calib Level** – displays the calibration methods that are locked and unlocked.
- **Calib Logbook** – shows the last 5 calibration slopes
- **Device Info** – shows the 1401DO input settings from the oxygen sensor.

Press Exit to return to the **Measuring** mode.

4.3.1 CONFIGURE

This program parameter level allows the adjustment of the following parameters.



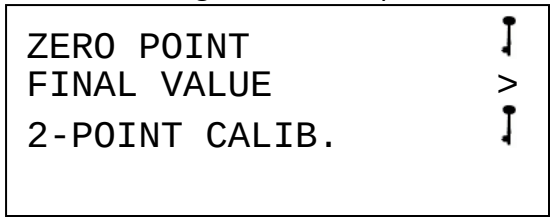
Even though there are only 4 lines available on the display, continue to scroll the cursor down to reveal all available menu items.

- **Parameter Level** – All the parameters available can be edited at this level. **Standard Signal - WARNING: DO NOT CHANGE SIGNAL TYPE, SCALING START, SCALING END, ZERO POINT, OR SLOPE.** These input values need to match the preconfigured oxygen sensor outputs and will change the calibration settings.

- **Basic Settings** – Sets up Analyzer Inputs from oxygen sensor. The 1401DO Analyzer comes preconfigured to accept a 4 - 20mA signal from the oxygen sensor that is equal to 0 - 20 mg/L DO. **WARNING: IT IS VERY IMPORTANT TO NOT CHANGE THESE SETTINGS.**
- **Calib. Level** – This menu lets you select a calibration method and starts a calibration.
- **Calib. Enable** – Default is set for **Final Value** enabled. **This is a signal point calibration. BAT recommends this method.** The other methods are disabled by default and can be enabled from this menu.
- **Delete Logbook** – The last five calibrations are archived in the calibration logbook. This menu lets you delete the information in the logbook.

4.3.2 CALIB. LEVEL

The 1401DO Analyzer comes preconfigured for a single point calibration **(FINAL VALUE)**. Depending on the operating mode configured in the Basic Settings menu, one or more of the following calibration options will be available:



Here is where the user can select more than just the calibration routine that is assigned to the CAL button. The **ZERO POINT** and **2-POINT CALIB** features are locked by default.

4.3.3 CALIB. LOGBOOK

This menu item displays the calculated slope constants for the last five calibration events.

4.3.4 DEVICE INFO

This menu item shows the 1401DO input settings from the oxygen sensor.

5 Operation

5.1 Calibrating the Sensor

The dissolved oxygen sensor has been calibrated at the factory to the specifications listed on page 1. Due to the inherent accuracy and stability of the luminescent dissolved oxygen technology, calibration is not needed very often but it's still a good idea to check calibration every month or so.

THIS CALIBRATION PROCEDURE MUST ONLY BE USED ON A CLEAN SENSOR. IF THE SENSOR IS READING ERRONEOUSLY DUE TO HEAVY BIOLOGICAL FOULING, USE OF THIS CALIBRATION METHOD WILL RESULT IN UNRELIABLE RESULTS.

A single point calibration in either water saturated air, air-saturated water, or a solution whose oxygen content has been determined by Winkler titration or by comparison to a calibrated handheld meter.

It is recommended that the PDO2 sensor be calibrated in either Water Saturated Air or Air-Saturated Water. This requires using a lookup table with the current barometric pressure (mmHg) and temperature (C) value (Appendix B). The DO mg/L value from the table is input into the PDO2 analyzer after the sensor has come to equilibrium in a Saturated Air-Water environment.

It is also possible to carry out a 2-point calibration of the PDO2 sensor with the other point being zero oxygen content.

NOTE: BAT DOES NOT RECOMMEND THE 2-POINT CALIBRATION UNLESS (A) YOU ARE CERTAIN THAT THE SENSOR DOES NOT MEET YOUR ACCURACY REQUIREMENTS AT LOW DO VALUES AND (B) YOU ARE OPERATING UNDER CONDITIONS WHERE YOU ARE CERTAIN TO BE ABLE TO GENERATE A MEDIUM WHICH IS TRULY FREE OF OXYGEN.

The single point calibration method will provide acceptable accuracy for the vast majority of users and it should be used in most cases. The water saturated air calibration is the most accurate single point calibration method. The calibration by comparison method is the least accurate and is therefore not recommended.

5.1.1 Single Point Calibration in Water Saturated Air

In order to ensure an accurate temperature and DO reading, the probe must be exposed to the air for enough time to allow thermal equilibrium to occur. There are often significant temperature differences between the process water and the ambient air. Larger temperature gradients between the two necessitate additional time for thermal equilibrium to take place. For instance, a 20 C difference between ambient air and process water can cause a calibration delay of about 30 minutes in many probes for the probe to fully equilibrate to ambient temperature. Since most temperature gradients will not be this large, allowing approximately 15 minutes is usually a safe assumption. It is common for users to calibrate the unit before the dissolved oxygen meter is reading the stabilized temperature and DO value, which can cause significant error since a difference of even 5 C from actual can cause the reading be off by 5 to 10%.

A solution of known dissolved oxygen content, other than 0%, should be used for the gain calibration. The most practical method is to create a **Water Saturated Air** environment. This can be done by placing a little water on the cotton that comes in the protective plastic cap that ships with the sensor. Place the cap on the sensor making sure that the making sure the luminophore surface does not have droplets of water on it. After around 15 minutes, the air can be assumed to be fully saturated water.

An approximate dissolved oxygen saturation value can be found by altitude. Look up your altitude in feet or meters from the **Altitude to Atmospheric Pressure Conversion Table** in **(Appendix A).** Find the altitude corrected atmospheric pressure in mmHg. Then look up the mmHg and temperature values in the **Solubility of Oxygen at Various Temperatures and Pressures (Appendix B).** It is preferable to use the actual local barometric pressure and temperature with **(Appendix B)** to get the most accurate dissolved oxygen content of **Water Saturated Air or an Air Saturated Water Sample.** Alternatively an **Air Saturated Water Sample** is easily created by fully aerating a water sample with an air stone for 15 min. Place the PDO2 sensor in the aerate water and follow the basic procedure below.

Water Saturated Air Calibration Procedure:

1) Power up the PDO2 sensor and Analyzer.

2) Place the protective plastic cap with damp cotton on the PDO2 sensor, making sure the luminophore surface does not have droplets of water on it. Allow the sensor to equilibrate for at least 15 minutes.

3) Once the measurements have stabilized, press the **"CAL"** button in the main **MEASURING** window to open the Calibration window. **"FINAL VALUE>"** will be displayed on the screen. Press the **"PGM"** button twice to get into the calibration entry mode.

4) Use the **UP** or **DOWN** arrows to enter the pressure/temperature corrected dissolved oxygen value in from the lookup table **(Appendix B).** Press the **"PGM"** button to enter this value. The calibration **SLOPE** value will be displayed. Press the **"PGM"** button again to return to the **MEASURING** mode.

6 Maintenance

6.1 Routine Maintenance

Periodic maintenance remains good practice. Luminescent dissolved oxygen Sensor technology is more stable than membrane-covered sensors, it's still a good idea to check calibration every month or so.

As with all instruments, it is good operating practice to make regular checks on the quality of data being generated by the PDO2. This can be carried out on site, using one of the following two methods:

1. Place a recently calibrated transportable dissolved oxygen sensor next to the PDO2 and compare the measurements. It is important to allow a sufficient period of time for temperature equilibration to occur.

2. Place the PDO2 in a solution of known dissolved oxygen content. A solution of 0% dissolved oxygen saturation can be created by adding a few teaspoons of sodium sulfite to 1 quart of distilled or fresh tap water.

The PDO2 can tolerate some biofouling, however where possible steps should be taken to minimize this; for example shielding the PDO2 sensor from light can reduce the amount of bio-growth.

6.2 Cleaning the Sensor

BAT highly recommends the use of our automatic Jet Cleaner System. Refer to drawing (2P0183) Submersible Jet Cleaner for details.

Visually inspect the sensor cap. Periodically it may be necessary to clean the PDO2 optical window, to remove bio-growth or other accumulated deposits. Use optical tissue or a cotton swab with soapy water to clean the sensor cap. Rinse with fresh water. **DO NOT** use a brush or any object that may scratch or damage the optical window.

6.3 Changing the Sensor Cap

Unscrew the old sensor cap from the shaft. Examine the small O-ring that seals the sensor cap to the sensor shaft. Exchange the O-ring, if any traces of wear are seen. A replacement O-ring is included with each replacement sensor cap. Screw the new sensor cap onto the sensor shaft again.

Examine the measurement values of the sensor in air, and if necessary, in an oxygen-free medium. If the measurement values deviate significantly from operated value, perform a calibration.

7 Troubleshooting

7.1 Error Codes

7.2 Warnings

8 Replacement Parts and Accessories

B5103-1004	Optode Cap Assy Polypropylene
B3907-1000	Cable Assembly 20” VP8 Female
P-V-564-30-c-VP	Sensor Oxygen
1401DO	Analyzer DO 110/240 VAC
B5008K-1012	Mount Kit Analyzer 35 max 7.5mm Din Rail
B5008K-1009	Mount Kit Analyzer 1” to 1.5” Pipe
B5008K-1011	Mount Kit Analyzer >= 1/8” Panel
B5008K-1010	Hood Kit Analyzer (mount Kit for Pipe Required)
C37	Jet Cleaner CPVC/SS
B41-P-C	Distribution Valve Enclosed 115 VAC
B42-P-C	Distribution Valve Enclosed 220 VAC
B9213-0002	Tubing ¼” OD X 1/8” ID Polypropylene
B5008-0018	Mount 1 ½” Standpipe to 1 ½” Handrail

9 Terms

9.1 Pricing

All pricing will be per current price list, as stated or modified in specific quotations provided by BAT LLC to the buyer, Distributor, or agent. Prices are subject to change without notice.

9.2 Payment Terms

Payment is due on delivery. Open account billing may be assigned at the discretion of BAT LLC, which such accounts due 30 days from invoice. No prompt payment discounts are allowed. Late fees will be assessed at the rate of 1-1/2% per month on unpaid balances, or such other rates as allowed and limited by state and federal laws. Payment terms may be stated or modified in specific quotations provided by BAT LLC to the buyer, distributor or agent.

9.3 Freight

All shipments are FOB Carson City, NV. Freight may be allowed on specific orders as stated in specific quotations or terms of distribution agreed and assigned to specific buyers, distributors, or agents.

9.4 Returns

All returns require a Return Material Authorization (RMA) prior to return, which may be obtained by contacting our office via telephone, email, fax, or postal service. All returned products must be shipped freight pre-paid. Collect shipments and shipments without an RMA will not be accepted.

9.5 Limited Warranty

BAT products are warranted against manufacturing or material defects for 1 year from date of purchase, and must be inspected upon receipt to insure that no visible defects exist. No length of service warranty is provided, as service life is dependent upon the chemistry of the process, and the user's operating practices. Probes that fail to function upon installation should be returned via an RMA for inspection by BAT.

10 Drawings:

2P0147 Sensor
2P0148 Mount pipe assy
2P0167 PDO_2 O&M
2P0183 Submersible Jet Cleaner

Appendix A: Altitude to Atmospheric Pressure Conversion

As we go to higher altitudes or elevations, the barometric pressure drops. However, the rate at which it drops is not constant; it drops less per thousand feet at higher altitudes. From data taken from the standard atmosphere, we can determine the average decrease in pressure per 1,000 feet in various altitude ranges, and conversely, the change in altitude required to produce a change in pressure of 1 in/Hg. Here's the result:

Altitude Range	per 1,000 feet	Feet per in/Hg
Sea level to 5,000 ft	1.006 in/Hg	994
5,000 to 10,000	0.862	1,160
10,000 to 15,000	0.740	1,350

At altitudes below 5,000 feet, you won't be in error too much is you simply say 1 in/Hg per 1,000 feet, or, 1,000 feet for each change in pressure of 1 in/Hg. Or even, 10 feet for each 0.01 change in pressure.

Altitude to Atmospheric Pressure conversion			
mmHg	**inHg**	**Altitude (FT)**	**Altitude (m)**
835	32.87	-2,627	-801
830	32.68	-2,458	-749
825	32.48	-2,288	-697
820	32.28	-2,117	-645
815	32.09	-1,946	-593
810	31.89	-1,773	-540
805	31.69	-1,600	-488
800	31.50	-1,426	-435
795	31.30	-1,251	-381
790	31.10	-1,075	-328
785	30.91	-898	-274
780	30.71	-720	-220
775	30.51	-542	-165
770	30.31	-362	-110
765	30.12	-181	-55
760	**29.92**	**0**	**0**
755	29.72	182	56
750	29.53	366	112
745	29.33	550	168
740	29.13	736	224
735	28.94	922	281
730	28.74	1,110	338

Altitude to Atmospheric Pressure conversion			
mmHg	**inHg**	**Altitude (FT)**	**Altitude (m)**
725	28.54	1,298	396
720	28.35	1,488	454
715	28.15	1,679	512
710	27.95	1,870	570
705	27.76	2,063	629
700	27.56	2,257	688
695	27.36	2,452	747
690	27.17	2,648	807
685	26.97	2,846	867
680	26.77	3,044	928
675	26.57	3,244	989
670	26.38	3,445	1050
665	26.18	3,647	1112
660	25.98	3,850	1174
655	25.79	4,055	1236
650	25.59	4,261	1299
645	25.39	4,468	1362
640	25.20	4,677	1425
635	25.00	4,886	1489
630	24.80	5,098	1554
625	24.61	5,310	1619
620	24.41	5,524	1684
615	24.21	5,739	1749
610	24.02	5,956	1815
605	23.82	6,174	1882
600	23.62	6,394	1949
595	23.43	6,615	2016
590	23.23	6,838	2084
585	23.03	7,062	2152
580	22.83	7,287	2221
575	22.64	7,515	2291
570	22.44	7,744	2360
565	22.24	7,974	2431
560	22.05	8,206	2501
555	21.85	8,440	2573
550	21.65	8,676	2644
545	21.46	8,913	2717
540	21.26	9,152	2790
535	21.06	9,393	2863
530	20.87	9,636	2937
525	20.67	9,881	3012
520	20.47	10,127	3087
515	20.28	10,375	3162
510	20.08	10,626	3239

Appendix B: Solubility of Oxygen at Various Temperatures and Pressures

The tables below were generated from the equations of Weiss (1970) and can be customized to cover the range and decimal places needed (see U.S. Geological Survey Quality of Water Branch Technical Memorandum 81.11, 1981). Interactive software to generate a specific range of oxygen-solubility and salinity correction factors can be accessed at:
http://water.usgs.gov/software/dotables.html

Temp.	Atmospheric pressure, mmHg																
C	835	830	825	820	815	810	805	800	795	790	785	780	775	770	765	760	755
0	16.04	15.94	15.84	15.75	15.65	15.55	15.46	15.36	15.26	15.17	15.07	14.97	14.88	14.78	14.68	14.59	14.49
1	15.59	15.50	15.41	15.31	15.22	15.12	15.03	14.94	14.84	14.75	14.65	14.56	14.47	14.37	14.28	14.18	14.09
2	15.17	15.08	14.99	14.90	14.81	14.71	14.62	14.53	14.44	14.35	14.26	14.17	14.07	13.98	13.89	13.80	13.71
3	14.77	14.68	14.59	14.50	14.41	14.32	14.23	14.14	14.06	13.97	13.88	13.79	13.70	13.61	13.52	13.43	13.34
4	14.38	14.30	14.21	14.12	14.03	13.95	13.86	13.77	13.69	13.60	13.51	13.43	13.34	13.25	13.17	13.08	12.99
5	14.01	13.93	13.84	13.76	13.67	13.59	13.51	13.42	13.34	13.25	13.17	13.08	13.00	12.91	12.83	12.74	12.66
6	13.66	13.58	13.50	13.41	13.33	13.25	13.17	13.08	13.00	12.92	12.84	12.75	12.67	12.59	12.51	12.42	12.34
7	13.32	13.24	13.16	13.08	13.00	12.92	12.84	12.76	12.68	12.60	12.52	12.44	12.36	12.28	12.20	12.12	12.03
8	13.00	12.92	12.84	12.76	12.68	12.61	12.53	12.45	12.37	12.29	12.21	12.13	12.06	11.98	11.90	11.82	11.74
9	12.69	12.61	12.54	12.46	12.38	12.30	12.23	12.15	12.07	12.00	11.92	11.84	11.77	11.69	11.61	11.54	11.46
10	12.39	12.32	12.24	12.17	12.09	12.02	11.94	11.87	11.79	11.72	11.64	11.57	11.49	11.42	11.34	11.27	11.19
11	12.11	12.03	11.96	11.89	11.81	11.74	11.67	11.59	11.52	11.45	11.37	11.30	11.23	11.15	11.08	11.01	10.93
12	11.83	11.76	11.69	11.62	11.54	11.47	11.40	11.33	11.26	11.19	11.11	11.04	10.97	10.90	10.83	10.76	10.68
13	11.57	11.50	11.43	11.36	11.29	11.22	11.15	11.08	11.01	10.94	10.87	10.80	10.73	10.66	10.59	10.51	10.44
14	11.31	11.25	11.18	11.11	11.04	10.97	10.90	10.83	10.77	10.70	10.63	10.56	10.49	10.42	10.35	10.28	10.22
15	11.07	11.00	10.94	10.87	10.80	10.73	10.67	10.60	10.53	10.47	10.40	10.33	10.26	10.20	10.13	10.06	9.99
16	10.84	10.77	10.71	10.64	10.57	10.51	10.44	10.38	10.31	10.24	10.18	10.11	10.05	9.98	9.91	9.85	9.78
17	10.61	10.55	10.48	10.42	10.35	10.29	10.22	10.16	10.09	10.03	9.97	9.90	9.84	9.77	9.71	9.64	9.58
18	10.39	10.33	10.27	10.20	10.14	10.08	10.01	9.95	9.89	9.82	9.76	9.70	9.63	9.57	9.51	9.44	9.38
19	10.19	10.12	10.06	10.00	9.94	9.87	9.81	9.75	9.69	9.63	9.56	9.50	9.44	9.38	9.31	9.25	9.19
20	9.98	9.92	9.86	9.80	9.74	9.68	9.62	9.56	9.49	9.43	9.37	9.31	9.25	9.19	9.13	9.07	9.01
21	9.79	9.73	9.67	9.61	9.55	9.49	9.43	9.37	9.31	9.25	9.19	9.13	9.07	9.01	8.95	8.89	8.83
22	9.60	9.54	9.48	9.42	9.37	9.31	9.25	9.19	9.13	9.07	9.01	8.95	8.89	8.84	8.78	8.72	8.66
23	9.42	9.36	9.30	9.25	9.19	9.13	9.07	9.01	8.96	8.90	8.84	8.78	8.73	8.67	8.61	8.55	8.49
24	9.24	9.19	9.13	9.07	9.02	8.96	8.90	8.85	8.79	8.73	8.68	8.62	8.56	8.50	8.45	8.39	8.33
25	9.07	9.02	8.96	8.91	8.85	8.80	8.74	8.68	8.63	8.57	8.52	8.46	8.40	8.35	8.29	8.24	8.18
26	8.91	8.86	8.80	8.75	8.69	8.64	8.58	8.53	8.47	8.42	8.36	8.31	8.25	8.20	8.14	8.09	8.03
27	8.75	8.70	8.64	8.59	8.54	8.48	8.43	8.37	8.32	8.27	8.21	8.16	8.10	8.05	7.99	7.94	7.89
28	8.60	8.55	8.49	8.44	8.39	8.33	8.28	8.23	8.17	8.12	8.07	8.01	7.96	7.91	7.85	7.80	7.75
29	8.45	8.40	8.35	8.29	8.24	8.19	8.14	8.08	8.03	7.98	7.93	7.87	7.82	7.77	7.72	7.66	7.61
30	8.31	8.26	8.20	8.15	8.10	8.05	8.00	7.95	7.89	7.84	7.79	7.74	7.69	7.64	7.58	7.53	7.48
31	8.17	8.12	8.07	8.02	7.96	7.91	7.86	7.81	7.76	7.71	7.66	7.61	7.56	7.51	7.45	7.40	7.35
32	8.03	7.98	7.93	7.88	7.83	7.78	7.73	7.68	7.63	7.58	7.53	7.48	7.43	7.38	7.33	7.28	7.23
33	7.90	7.85	7.80	7.75	7.70	7.65	7.60	7.56	7.51	7.46	7.41	7.36	7.31	7.26	7.21	7.16	7.11
34	7.77	7.73	7.68	7.63	7.58	7.53	7.48	7.43	7.38	7.33	7.29	7.24	7.19	7.14	7.09	7.04	6.99
35	7.65	7.60	7.56	7.51	7.46	7.41	7.36	7.31	7.27	7.22	7.17	7.12	7.07	7.02	6.98	6.93	6.88
36	7.53	7.48	7.44	7.39	7.34	7.29	7.25	7.20	7.15	7.10	7.06	7.01	6.96	6.91	6.86	6.82	6.77
37	7.42	7.37	7.32	7.27	7.23	7.18	7.13	7.09	7.04	6.99	6.94	6.90	6.85	6.80	6.76	6.71	6.66
38	7.30	7.26	7.21	7.16	7.12	7.07	7.02	6.98	6.93	6.88	6.84	6.79	6.74	6.70	6.65	6.60	6.56
39	7.19	7.15	7.10	7.05	7.01	6.96	6.92	6.87	6.82	6.78	6.73	6.69	6.64	6.59	6.55	6.50	6.46
40	7.09	7.04	6.99	6.95	6.90	6.86	6.81	6.77	6.72	6.68	6.63	6.59	6.54	6.49	6.45	6.40	6.36

Solubility of oxygen in water at various temperatures and pressures [In milligrams per liter. Values based on Weiss (1970). C, degrees Celsius; mmHg, millimeters of mercury]

Temp.	Atmospheric pressure, mmHg																
C	760	755	750	745	740	735	730	725	720	715	710	705	700	695	690	685	680
0	14.59	14.49	14.39	14.30	14.20	14.10	14.01	13.91	13.81	13.72	13.62	13.53	13.43	13.33	13.24	13.14	13.04
1	14.18	14.09	14.00	13.90	13.81	13.71	13.62	13.53	13.43	13.34	13.25	13.15	13.06	12.96	12.87	12.78	12.68
2	13.80	13.71	13.62	13.53	13.43	13.34	13.25	13.16	13.07	12.98	12.89	12.79	12.70	12.61	12.52	12.43	12.34
3	13.43	13.34	13.25	13.16	13.08	12.99	12.90	12.81	12.72	12.63	12.54	12.45	12.36	12.27	12.19	12.10	12.01
4	13.08	12.99	12.91	12.82	12.73	12.65	12.56	12.47	12.39	12.30	12.21	12.13	12.04	11.95	11.87	11.78	11.69
5	12.74	12.66	12.58	12.49	12.41	12.32	12.24	12.15	12.07	11.98	11.90	11.81	11.73	11.65	11.56	11.48	11.39
6	12.42	12.34	12.26	12.18	12.09	12.01	11.93	11.85	11.76	11.68	11.60	11.52	11.43	11.35	11.27	11.19	11.10
7	12.12	12.03	11.95	11.87	11.79	11.71	11.63	11.55	11.47	11.39	11.31	11.23	11.15	11.07	10.99	10.91	10.83
8	11.82	11.74	11.66	11.58	11.51	11.43	11.35	11.27	11.19	11.11	11.03	10.96	10.88	10.80	10.72	10.64	10.56
9	11.54	11.46	11.38	11.31	11.23	11.15	11.08	11.00	10.92	10.85	10.77	10.69	10.62	10.54	10.46	10.39	10.31
10	11.27	11.19	11.12	11.04	10.97	10.89	10.82	10.74	10.67	10.59	10.52	10.44	10.37	10.29	10.22	10.14	10.07
11	11.01	10.93	10.86	10.79	10.71	10.64	10.57	10.49	10.42	10.35	10.27	10.20	10.13	10.05	9.98	9.91	9.83
12	10.76	10.68	10.61	10.54	10.47	10.40	10.32	10.25	10.18	10.11	10.04	9.97	9.89	9.82	9.75	9.68	9.61
13	10.51	10.44	10.37	10.30	10.23	10.16	10.09	10.02	9.95	9.88	9.81	9.74	9.67	9.60	9.53	9.46	9.39
14	10.28	10.22	10.15	10.08	10.01	9.94	9.87	9.80	9.73	9.67	9.60	9.53	9.46	9.39	9.32	9.25	9.18
15	10.06	9.99	9.93	9.86	9.79	9.72	9.66	9.59	9.52	9.46	9.39	9.32	9.25	9.19	9.12	9.05	8.98
16	9.85	9.78	9.72	9.65	9.58	9.52	9.45	9.39	9.32	9.25	9.19	9.12	9.06	8.99	8.92	8.86	8.79
17	9.64	9.58	9.51	9.45	9.38	9.32	9.25	9.19	9.12	9.06	9.00	8.93	8.87	8.80	8.74	8.67	8.61
18	9.44	9.38	9.32	9.25	9.19	9.13	9.06	9.00	8.94	8.87	8.81	8.75	8.68	8.62	8.56	8.49	8.43
19	9.25	9.19	9.13	9.07	9.00	8.94	8.88	8.82	8.75	8.69	8.63	8.57	8.51	8.44	8.38	8.32	8.26
20	9.07	9.01	8.95	8.88	8.82	8.76	8.70	8.64	8.58	8.52	8.46	8.40	8.33	8.27	8.21	8.15	8.09
21	8.89	8.83	8.77	8.71	8.65	8.59	8.53	8.47	8.41	8.35	8.29	8.23	8.17	8.11	8.05	7.99	7.93
22	8.72	8.66	8.60	8.54	8.48	8.42	8.36	8.31	8.25	8.19	8.13	8.07	8.01	7.95	7.89	7.83	7.78
23	8.55	8.49	8.44	8.38	8.32	8.26	8.20	8.15	8.09	8.03	7.97	7.92	7.86	7.80	7.74	7.68	7.63
24	8.39	8.33	8.28	8.22	8.16	8.11	8.05	7.99	7.94	7.88	7.82	7.77	7.71	7.65	7.59	7.54	7.48
25	8.24	8.18	8.12	8.07	8.01	7.96	7.90	7.84	7.79	7.73	7.68	7.62	7.56	7.51	7.45	7.40	7.34
26	8.09	8.03	7.98	7.92	7.87	7.81	7.76	7.70	7.65	7.59	7.54	7.48	7.43	7.37	7.32	7.26	7.21
27	7.94	7.89	7.83	7.78	7.72	7.67	7.62	7.56	7.51	7.45	7.40	7.35	7.29	7.24	7.18	7.13	7.07
28	7.80	7.75	7.69	7.64	7.59	7.53	7.48	7.43	7.37	7.32	7.27	7.21	7.16	7.11	7.05	7.00	6.95
29	7.66	7.61	7.56	7.51	7.45	7.40	7.35	7.30	7.24	7.19	7.14	7.09	7.03	6.98	6.93	6.88	6.82
30	7.53	7.48	7.43	7.38	7.32	7.27	7.22	7.17	7.12	7.07	7.01	6.96	6.91	6.86	6.81	6.76	6.70
31	7.40	7.35	7.30	7.25	7.20	7.15	7.10	7.05	7.00	6.94	6.89	6.84	6.79	6.74	6.69	6.64	6.59
32	7.28	7.23	7.18	7.13	7.08	7.03	6.98	6.93	6.88	6.83	6.78	6.73	6.68	6.63	6.58	6.53	6.48
33	7.16	7.11	7.06	7.01	6.96	6.91	6.86	6.81	6.76	6.71	6.66	6.61	6.56	6.51	6.46	6.42	6.37
34	7.04	6.99	6.94	6.89	6.85	6.80	6.75	6.70	6.65	6.60	6.55	6.50	6.45	6.41	6.36	6.31	6.26
35	6.93	6.88	6.83	6.78	6.73	6.69	6.64	6.59	6.54	6.49	6.45	6.40	6.35	6.30	6.25	6.20	6.16
36	6.82	6.77	6.72	6.67	6.63	6.58	6.53	6.48	6.44	6.39	6.34	6.29	6.25	6.20	6.15	6.10	6.05
37	6.71	6.66	6.62	6.57	6.52	6.47	6.43	6.38	6.33	6.29	6.24	6.19	6.14	6.10	6.05	6.00	5.96
38	6.60	6.56	6.51	6.47	6.42	6.37	6.33	6.28	6.23	6.19	6.14	6.09	6.05	6.00	5.95	5.91	5.86
39	6.50	6.46	6.41	6.37	6.32	6.27	6.23	6.18	6.14	6.09	6.04	6.00	5.95	5.91	5.86	5.81	5.77
40	6.40	6.36	6.31	6.27	6.22	6.18	6.13	6.09	6.04	5.99	5.95	5.90	5.86	5.81	5.77	5.72	5.68

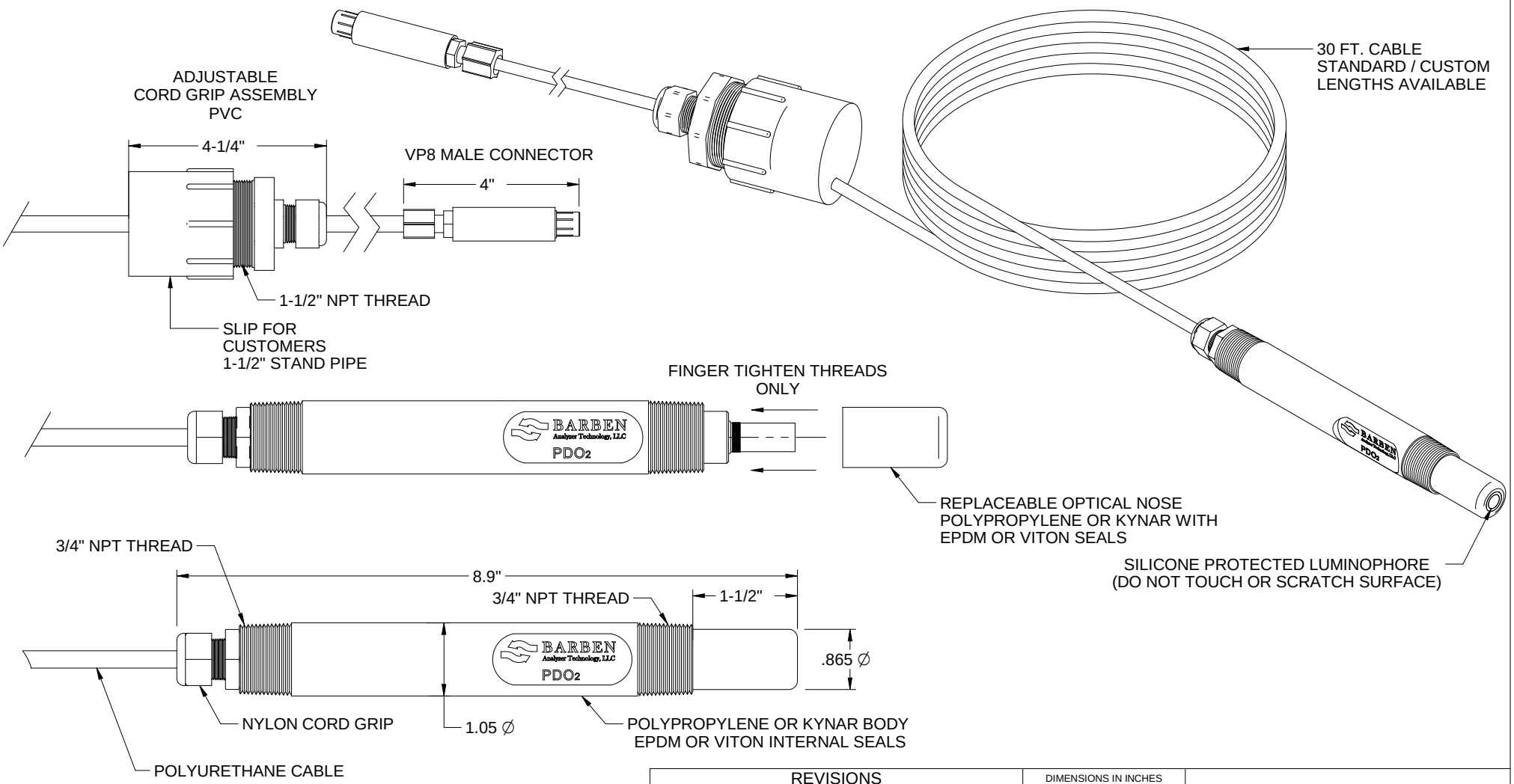
Solubility of oxygen in water at various temperatures and pressures [In milligrams per liter. Values based on Weiss (1970). C, degrees Celsius; mmHg, millimeters of mercury]

Temp.	Atmospheric pressure, mmHg																
C	675	670	665	660	655	650	645	640	635	630	625	620	615	610	605	600	595
0	12.95	12.85	12.75	12.66	12.56	12.46	12.37	12.27	12.17	12.08	11.98	11.88	11.79	11.69	11.59	11.50	11.40
1	12.59	12.49	12.40	12.31	12.21	12.12	12.02	11.93	11.84	11.74	11.65	11.55	11.46	11.37	11.27	11.18	11.08
2	12.25	12.15	12.06	11.97	11.88	11.79	11.70	11.61	11.51	11.42	11.33	11.24	11.15	11.06	10.97	10.87	10.78
3	11.92	11.83	11.74	11.65	11.56	11.47	11.38	11.30	11.21	11.12	11.03	10.94	10.85	10.76	10.67	10.58	10.49
4	11.61	11.52	11.43	11.35	11.26	11.17	11.09	11.00	10.91	10.83	10.74	10.65	10.56	10.48	10.39	10.30	10.22
5	11.31	11.22	11.14	11.05	10.97	10.88	10.80	10.71	10.63	10.55	10.46	10.38	10.29	10.21	10.12	10.04	9.95
6	11.02	10.94	10.86	10.77	10.69	10.61	10.53	10.44	10.36	10.28	10.20	10.11	10.03	9.95	9.87	9.78	9.70
7	10.75	10.67	10.59	10.51	10.42	10.34	10.26	10.18	10.10	10.02	9.94	9.86	9.78	9.70	9.62	9.54	9.46
8	10.48	10.41	10.33	10.25	10.17	10.09	10.01	9.93	9.86	9.78	9.70	9.62	9.54	9.46	9.38	9.31	9.23
9	10.23	10.16	10.08	10.00	9.92	9.85	9.77	9.69	9.62	9.54	9.46	9.39	9.31	9.23	9.16	9.08	9.00
10	9.99	9.92	9.84	9.77	9.69	9.62	9.54	9.47	9.39	9.32	9.24	9.17	9.09	9.02	8.94	8.87	8.79
11	9.76	9.68	9.61	9.54	9.46	9.39	9.32	9.24	9.17	9.10	9.02	8.95	8.88	8.80	8.73	8.66	8.58
12	9.54	9.46	9.39	9.32	9.25	9.18	9.10	9.03	8.96	8.89	8.82	8.75	8.67	8.60	8.53	8.46	8.39
13	9.32	9.25	9.18	9.11	9.04	8.97	8.90	8.83	8.76	8.69	8.62	8.55	8.48	8.41	8.34	8.27	8.20
14	9.12	9.05	8.98	8.91	8.84	8.77	8.70	8.63	8.57	8.50	8.43	8.36	8.29	8.22	8.15	8.08	8.02
15	8.92	8.85	8.78	8.72	8.65	8.58	8.51	8.45	8.38	8.31	8.24	8.18	8.11	8.04	7.97	7.91	7.84
16	8.73	8.66	8.59	8.53	8.46	8.40	8.33	8.26	8.20	8.13	8.07	8.00	7.93	7.87	7.80	7.74	7.67
17	8.54	8.48	8.41	8.35	8.28	8.22	8.15	8.09	8.02	7.96	7.90	7.83	7.77	7.70	7.64	7.57	7.51
18	8.37	8.30	8.24	8.17	8.11	8.05	7.98	7.92	7.86	7.79	7.73	7.67	7.60	7.54	7.48	7.41	7.35
19	8.19	8.13	8.07	8.01	7.95	7.88	7.82	7.76	7.70	7.63	7.57	7.51	7.45	7.39	7.32	7.26	7.20
20	8.03	7.97	7.91	7.85	7.79	7.72	7.66	7.60	7.54	7.48	7.42	7.36	7.30	7.24	7.17	7.11	7.05
21	7.87	7.81	7.75	7.69	7.63	7.57	7.51	7.45	7.39	7.33	7.27	7.21	7.15	7.09	7.03	6.97	6.91
22	7.72	7.66	7.60	7.54	7.48	7.42	7.36	7.30	7.25	7.19	7.13	7.07	7.01	6.95	6.89	6.83	6.77
23	7.57	7.51	7.45	7.39	7.34	7.28	7.22	7.16	7.10	7.05	6.99	6.93	6.87	6.82	6.76	6.70	6.64
24	7.42	7.37	7.31	7.25	7.20	7.14	7.08	7.03	6.97	6.91	6.86	6.80	6.74	6.68	6.63	6.57	6.51
25	7.29	7.23	7.17	7.12	7.06	7.01	6.95	6.89	6.84	6.78	6.73	6.67	6.61	6.56	6.50	6.45	6.39
26	7.15	7.10	7.04	6.99	6.93	6.88	6.82	6.77	6.71	6.66	6.60	6.55	6.49	6.44	6.38	6.33	6.27
27	7.02	6.97	6.91	6.86	6.80	6.75	6.70	6.64	6.59	6.53	6.48	6.42	6.37	6.32	6.26	6.21	6.15
28	6.89	6.84	6.79	6.73	6.68	6.63	6.57	6.52	6.47	6.41	6.36	6.31	6.25	6.20	6.15	6.09	6.04
29	6.77	6.72	6.67	6.61	6.56	6.51	6.46	6.40	6.35	6.30	6.25	6.19	6.14	6.09	6.04	5.98	5.93
30	6.65	6.60	6.55	6.50	6.45	6.39	6.34	6.29	6.24	6.19	6.14	6.08	6.03	5.98	5.93	5.88	5.83
31	6.54	6.49	6.44	6.38	6.33	6.28	6.23	6.18	6.13	6.08	6.03	5.98	5.93	5.87	5.82	5.77	5.72
32	6.43	6.37	6.32	6.27	6.22	6.17	6.12	6.07	6.02	5.97	5.92	5.87	5.82	5.77	5.72	5.67	5.62
33	6.32	6.27	6.22	6.17	6.12	6.07	6.02	5.97	5.92	5.87	5.82	5.77	5.72	5.67	5.62	5.57	5.52
34	6.21	6.16	6.11	6.06	6.01	5.97	5.92	5.87	5.82	5.77	5.72	5.67	5.62	5.57	5.53	5.48	5.43
35	6.11	6.06	6.01	5.96	5.91	5.87	5.82	5.77	5.72	5.67	5.62	5.58	5.53	5.48	5.43	5.38	5.34
36	6.01	5.96	5.91	5.86	5.82	5.77	5.72	5.67	5.63	5.58	5.53	5.48	5.44	5.39	5.34	5.29	5.24
37	5.91	5.86	5.82	5.77	5.72	5.67	5.63	5.58	5.53	5.49	5.44	5.39	5.34	5.30	5.25	5.20	5.16
38	5.81	5.77	5.72	5.68	5.63	5.58	5.54	5.49	5.44	5.40	5.35	5.30	5.26	5.21	5.16	5.12	5.07
39	5.72	5.68	5.63	5.58	5.54	5.49	5.45	5.40	5.35	5.31	5.26	5.22	5.17	5.12	5.08	5.03	4.99
40	5.63	5.59	5.54	5.49	5.45	5.40	5.36	5.31	5.27	5.22	5.18	5.13	5.09	5.04	5.00	4.95	4.90

Solubility of oxygen in water at various temperatures and pressures [In milligrams per liter. Values based on Weiss (1970). C, degrees Celsius; mmHg, millimeters of mercury]

Temp.	Atmospheric pressure, mmHg																
C	590	585	580	575	570	565	560	555	550	545	540	535	530	525	520	515	510
0	11.30	11.21	11.11	11.01	10.92	10.82	10.73	10.63	10.53	10.44	10.34	10.24	10.15	10.05	9.95	9.86	9.76
1	10.99	10.90	10.80	10.71	10.62	10.52	10.43	10.33	10.24	10.15	10.05	9.96	9.86	9.77	9.68	9.58	9.49
2	10.69	10.60	10.51	10.42	10.33	10.23	10.14	10.05	9.96	9.87	9.78	9.69	9.59	9.50	9.41	9.32	9.23
3	10.40	10.32	10.23	10.14	10.05	9.96	9.87	9.78	9.69	9.60	9.51	9.43	9.34	9.25	9.16	9.07	8.98
4	10.13	10.04	9.96	9.87	9.78	9.70	9.61	9.52	9.44	9.35	9.26	9.18	9.09	9.00	8.92	8.83	8.74
5	9.87	9.78	9.70	9.62	9.53	9.45	9.36	9.28	9.19	9.11	9.02	8.94	8.85	8.77	8.69	8.60	8.52
6	9.62	9.54	9.45	9.37	9.29	9.21	9.12	9.04	8.96	8.88	8.79	8.71	8.63	8.55	8.46	8.38	8.30
7	9.38	9.30	9.22	9.14	9.06	8.98	8.90	8.81	8.73	8.65	8.57	8.49	8.41	8.33	8.25	8.17	8.09
8	9.15	9.07	8.99	8.91	8.83	8.75	8.68	8.60	8.52	8.44	8.36	8.28	8.20	8.13	8.05	7.97	7.89
9	8.93	8.85	8.77	8.70	8.62	8.54	8.47	8.39	8.31	8.24	8.16	8.08	8.01	7.93	7.85	7.78	7.70
10	8.71	8.64	8.56	8.49	8.41	8.34	8.26	8.19	8.11	8.04	7.96	7.89	7.81	7.74	7.66	7.59	7.51
11	8.51	8.44	8.36	8.29	8.22	8.14	8.07	8.00	7.92	7.85	7.78	7.70	7.63	7.56	7.48	7.41	7.34
12	8.32	8.24	8.17	8.10	8.03	7.96	7.89	7.81	7.74	7.67	7.60	7.53	7.45	7.38	7.31	7.24	7.17
13	8.13	8.06	7.99	7.92	7.85	7.78	7.71	7.64	7.57	7.50	7.43	7.36	7.29	7.21	7.14	7.07	7.00
14	7.95	7.88	7.81	7.74	7.67	7.60	7.53	7.47	7.40	7.33	7.26	7.19	7.12	7.05	6.98	6.92	6.85
15	7.77	7.71	7.64	7.57	7.50	7.44	7.37	7.30	7.23	7.17	7.10	7.03	6.96	6.90	6.83	6.76	6.70
16	7.60	7.54	7.47	7.41	7.34	7.27	7.21	7.14	7.08	7.01	6.94	6.88	6.81	6.75	6.68	6.62	6.55
17	7.44	7.38	7.31	7.25	7.18	7.12	7.05	6.99	6.93	6.86	6.80	6.73	6.67	6.60	6.54	6.47	6.41
18	7.29	7.22	7.16	7.10	7.03	6.97	6.91	6.84	6.78	6.72	6.65	6.59	6.53	6.46	6.40	6.34	6.27
19	7.14	7.07	7.01	6.95	6.89	6.83	6.76	6.70	6.64	6.58	6.51	6.45	6.39	6.33	6.27	6.20	6.14
20	6.99	6.93	6.87	6.81	6.75	6.69	6.62	6.56	6.50	6.44	6.38	6.32	6.26	6.20	6.14	6.08	6.01
21	6.85	6.79	6.73	6.67	6.61	6.55	6.49	6.43	6.37	6.31	6.25	6.19	6.13	6.07	6.01	5.95	5.89
22	6.72	6.66	6.60	6.54	6.48	6.42	6.36	6.30	6.24	6.19	6.13	6.07	6.01	5.95	5.89	5.83	5.77
23	6.58	6.53	6.47	6.41	6.35	6.29	6.24	6.18	6.12	6.06	6.01	5.95	5.89	5.83	5.77	5.72	5.66
24	6.46	6.40	6.34	6.29	6.23	6.17	6.12	6.06	6.00	5.95	5.89	5.83	5.77	5.72	5.66	5.60	5.55
25	6.33	6.28	6.22	6.17	6.11	6.05	6.00	5.94	5.89	5.83	5.77	5.72	5.66	5.61	5.55	5.50	5.44
26	6.22	6.16	6.11	6.05	6.00	5.94	5.89	5.83	5.77	5.72	5.66	5.61	5.55	5.50	5.44	5.39	5.33
27	6.10	6.05	5.99	5.94	5.88	5.83	5.77	5.72	5.67	5.61	5.56	5.50	5.45	5.40	5.34	5.29	5.23
28	5.99	5.93	5.88	5.83	5.77	5.72	5.67	5.61	5.56	5.51	5.45	5.40	5.35	5.29	5.24	5.19	5.13
29	5.88	5.83	5.77	5.72	5.67	5.62	5.56	5.51	5.46	5.41	5.35	5.30	5.25	5.20	5.14	5.09	5.04
30	5.77	5.72	5.67	5.62	5.57	5.51	5.46	5.41	5.36	5.31	5.26	5.20	5.15	5.10	5.05	5.00	4.95
31	5.67	5.62	5.57	5.52	5.47	5.42	5.36	5.31	5.26	5.21	5.16	5.11	5.06	5.01	4.96	4.91	4.86
32	5.57	5.52	5.47	5.42	5.37	5.32	5.27	5.22	5.17	5.12	5.07	5.02	4.97	4.92	4.87	4.82	4.77
33	5.47	5.42	5.37	5.33	5.28	5.23	5.18	5.13	5.08	5.03	4.98	4.93	4.88	4.83	4.78	4.73	4.68
34	5.38	5.33	5.28	5.23	5.18	5.13	5.09	5.04	4.99	4.94	4.89	4.84	4.79	4.74	4.69	4.65	4.60
35	5.29	5.24	5.19	5.14	5.09	5.05	5.00	4.95	4.90	4.85	4.80	4.76	4.71	4.66	4.61	4.56	4.51
36	5.20	5.15	5.10	5.05	5.01	4.96	4.91	4.86	4.82	4.77	4.72	4.67	4.63	4.58	4.53	4.48	4.43
37	5.11	5.06	5.02	4.97	4.92	4.87	4.83	4.78	4.73	4.69	4.64	4.59	4.54	4.50	4.45	4.40	4.36
38	5.02	4.98	4.93	4.88	4.84	4.79	4.75	4.70	4.65	4.61	4.56	4.51	4.47	4.42	4.37	4.33	4.28
39	4.94	4.89	4.85	4.80	4.76	4.71	4.66	4.62	4.57	4.53	4.48	4.44	4.39	4.34	4.30	4.25	4.21
40	4.86	4.81	4.77	4.72	4.68	4.63	4.59	4.54	4.50	4.45	4.40	4.36	4.31	4.27	4.22	4.18	4.13

Solubility of oxygen in water at various temperatures and pressures [In milligrams per liter. Values based on Weiss (1970). C, degrees Celsius; mmHg, millimeters of mercury]



RATINGS

-10 TO 80 C

POLYPRO → -15 TO 100 PSIG
KYNAR → -15 TO 150 PSIG

REVISIONS				
REV	DATE	DESCRIPTION	DWN	APVD

DIMENSIONS IN INCHES

TOLERANCES
UNLESS OTHERWISE SPECIFIED

DECIMALS	FRACTIONS
.0000 +/- .0005	+/- .015
.000 +/- .005	ANGLES
.00 +/- .010	+/- 30MIN
.0 +/- .15	

DRAWING BY RW

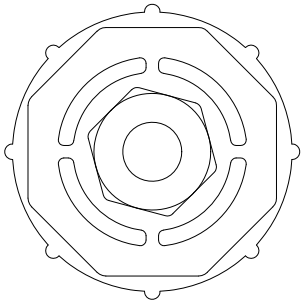
SCALE	DATE	SIZE
NONE	09/21/09	D

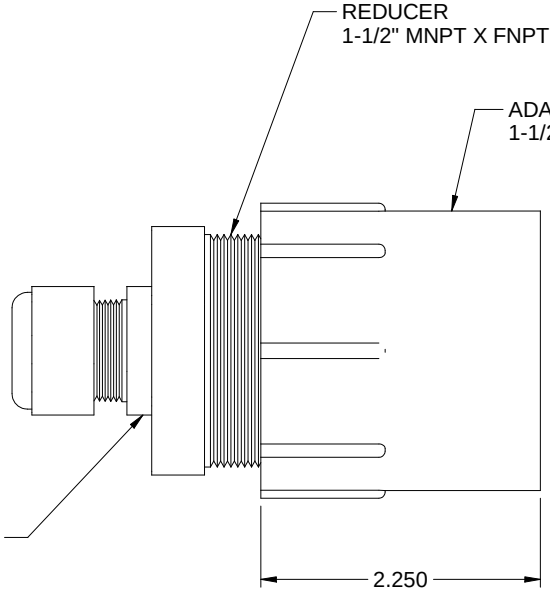
OPTICAL DO SENSOR

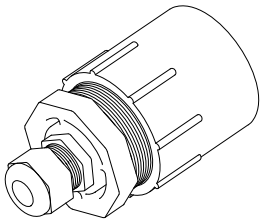
BARBEN ANALYZER TECHNOLOGY

DRAWING NO.	2P0147
CHECKED	H.W.M.
APPROVED	H.W.M.

PH(775)882-7900 FAX(775)883-6388







REVISIONS				
REV	DATE	DESCRIPTION	DWN	APVD

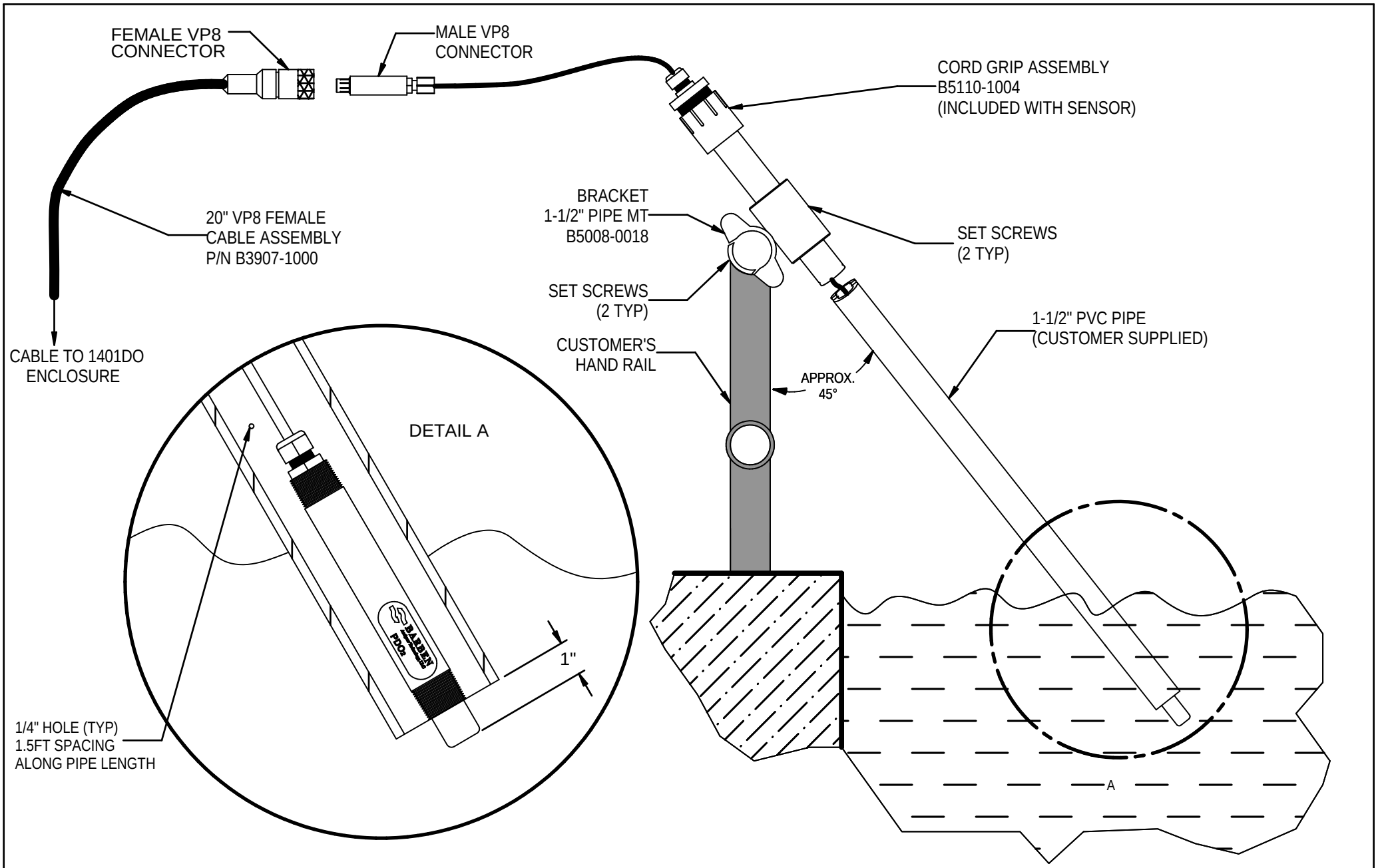
DIMENSIONS IN INCHES		
TOLERANCES UNLESS OTHERWISE SPECIFIED		
DECIMALS		FRACTIONS
.0000 +/- .0005		+/- .015
.000 +/- .005		ANGLES
.00 +/- .010		+/- 30MIN
.0 +/- .15		
DRAWING BY RW		
SCALE	DATE	SIZE
NONE	09/21/09	D

CORD GRIP ASSEMBLY

BARBEN ANALYZER TECHNOLOGY
PH(775)882-7900 FAX(775)883-6388

DRAWING NO.	2P0148
CHECKED	H.W.M.
APPROVED	H.W.M.

P/N B5110-1004



CONNECTION	TERMINAL	PDO2 BAT DO SENSORS
ANODE	ROW 2 #4	BLACK (COAX SHIELD)
SHIELD	GND SCREW	YELLOW / GREEN
-24VDC	ROW 1 #15	RED COAX SHIELD
+24VDC	ROW 1 #14	RED COAX CORE

REVISIONS				
REV	DATE	DESCRIPTION	DWN	APVD
-	03/22/10	Initial Release	WC	HWM
A	05/24/10	Correct Views -Add Conn. Details	WC	TM

DIMENSIONS IN INCHES
TOLERANCES UNLESS OTHERWISE SPECIFIED

DECIMALS	FRACTIONS
.0000 +/- .0005	+/- .015
.000 +/- .005	ANGLES
.00 +/- .010	+/- 30MIN
.0 +/- .15	

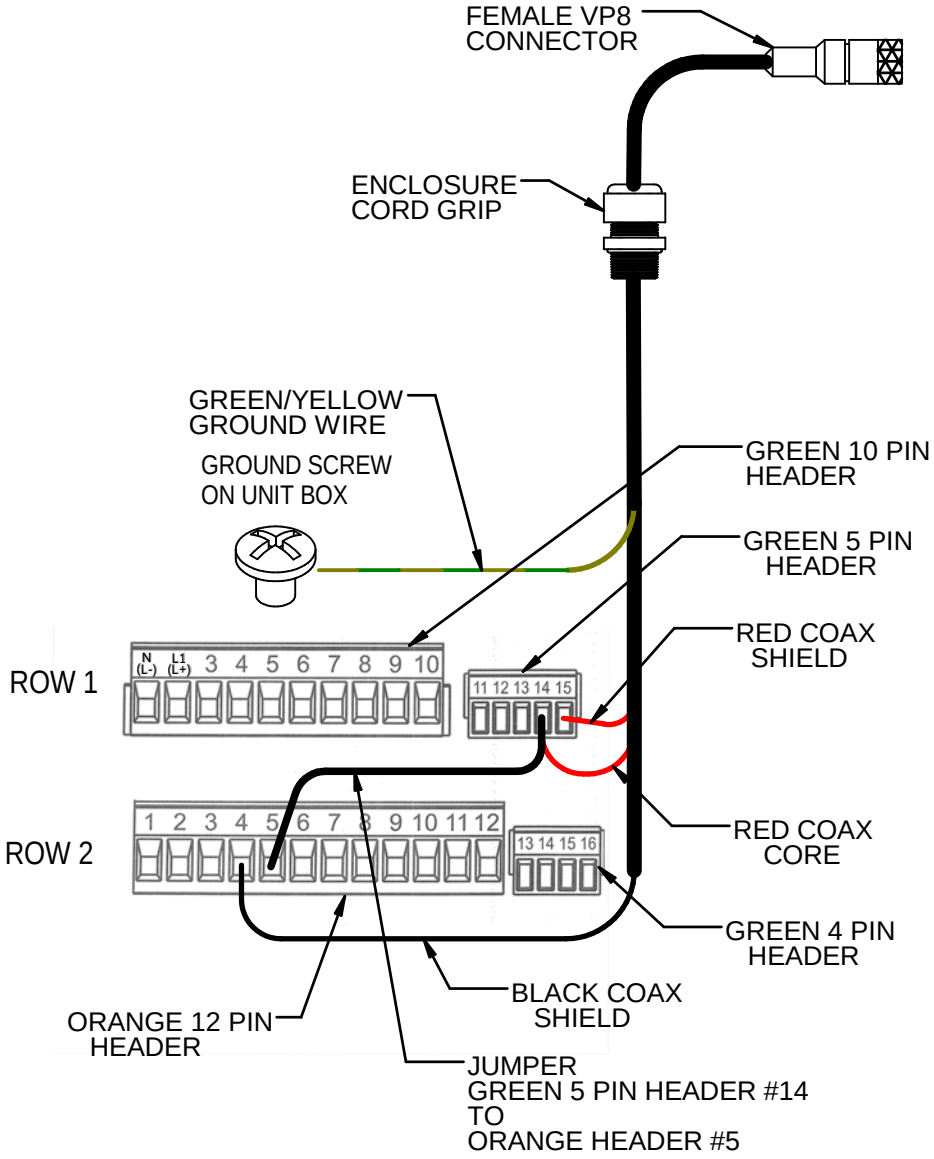
DRAWN BY W. COWAN

SCALE	DATE	SIZE
NONE	03/22/2010	A

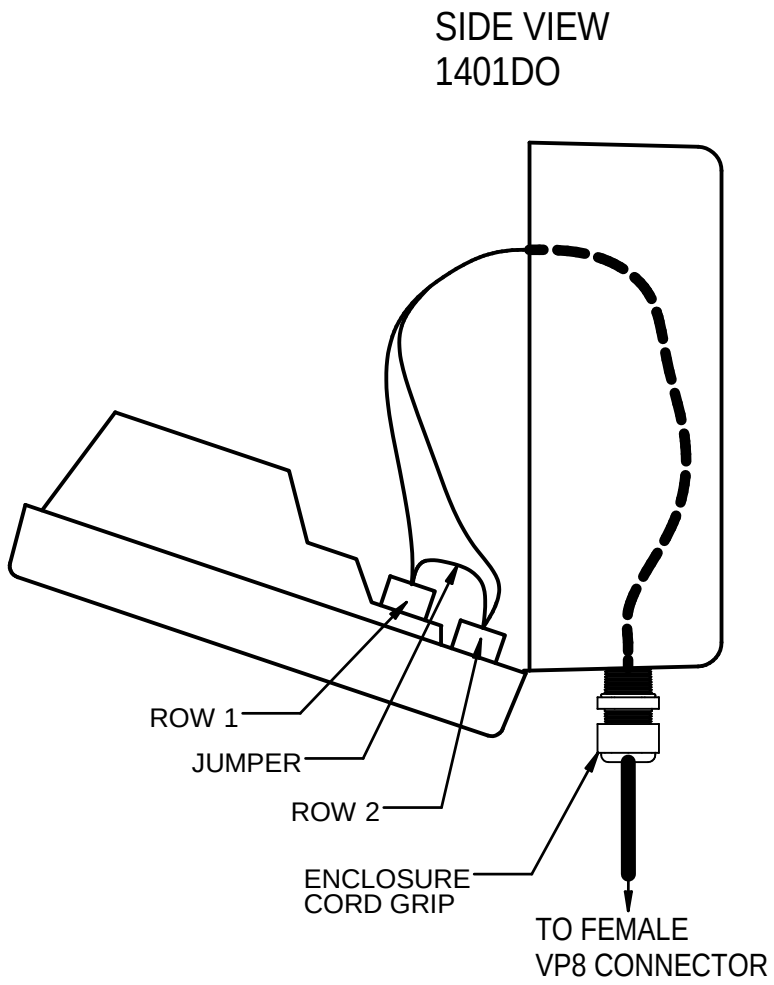
PDO2 DO SENSOR CUSTOMER CONNECTION

BARBEN Analyzer Technology, LLC
5200 Convair Drive
Carson City, NV 89706
PH(775)883-2500 FAX(775)297-4740

DRAWING NO. 2P0167
CHECKED
APPROVED



HEADERS & WIRING CONNECTIONS
WITHIN 1401DO CONTROLLER



CONNECTION	TERMINAL	PDO2 BAT DO SENSORS
ANODE	ROW 2 #4	BLACK (COAX SHIELD)
SHIELD	GND SCREW	YELLOW / GREEN
-24VDC	ROW 1 #15	RED COAX SHIELD
+24VDC	ROW 1 #14	RED COAX CORE

REVISIONS				
REV	DATE	DESCRIPTION	DWN	APVD
-	03/22/10	Initial Release	WC	HWM
A	05/24/10	Correct Views -Add Conn. Details	WC	TM

DIMENSIONS IN INCHES
TOLERANCES UNLESS OTHERWISE SPECIFIED

DECIMALS	FRACTIONS
.0000 +/- .0005	+/- .015
.000 +/- .005	ANGLES
.00 +/- .010	+/- 30MIN
.0 +/- .15	

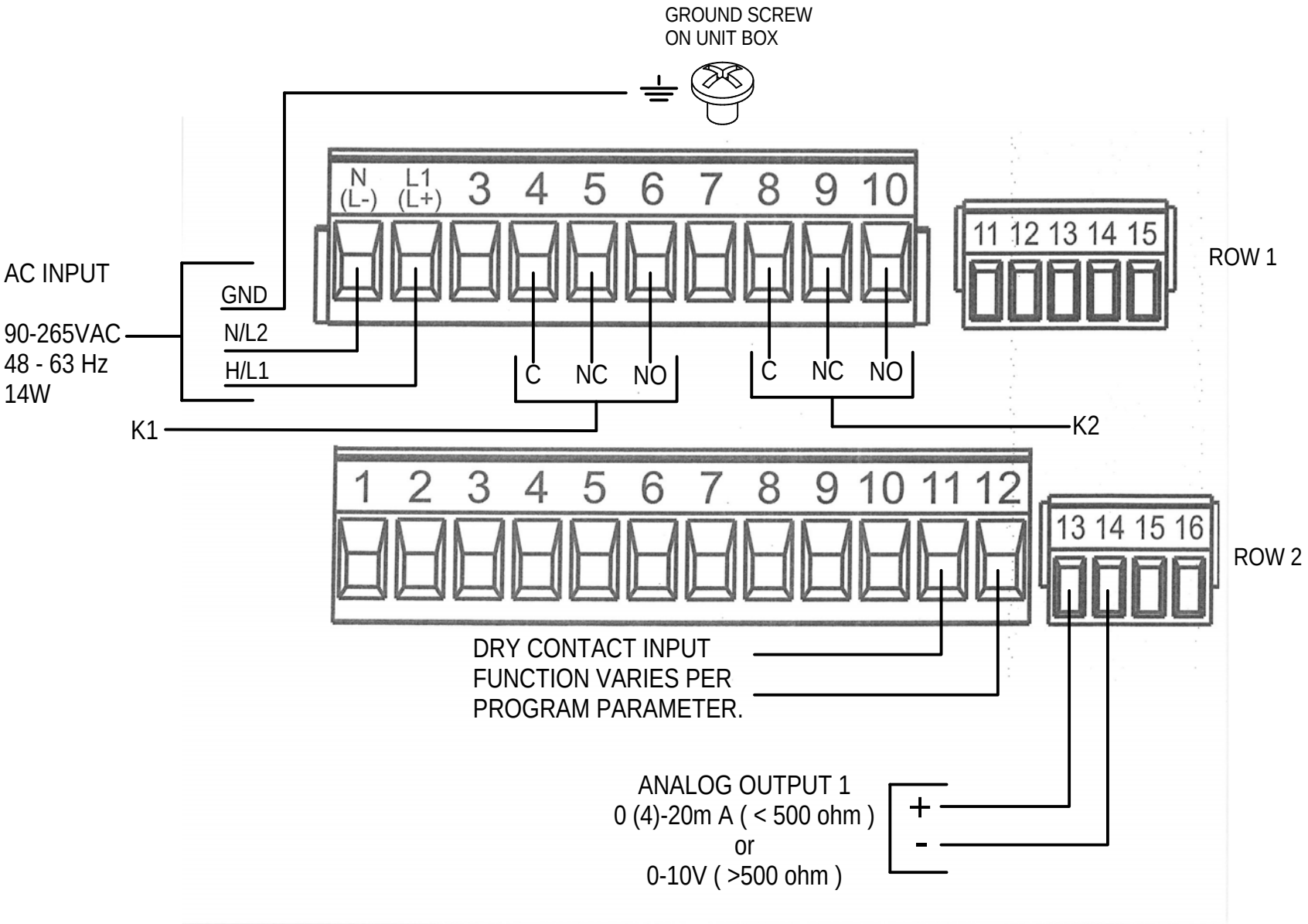
DRAWN BY

SCALE	DATE	SIZE
NONE	03/22/2010	A

PDO2 DO SENSOR CUSTOMER CONNECTION

BARBEN Analyzer Technology, LLC
5200 Convair Drive
Carson City, NV 89706
PH(775)883-2500 FAX(775)297-4740

DRAWING NO. 2P0167
CHECKED
APPROVED



UNLESS OTHERWISE NOTED:

RELAY CONTACTS (K1) & (K2)
RATED FOR 3A / 250VAC (RESISTIVE).

REVISIONS				
REV	DATE	DESCRIPTION	DWN	APVD
-	03/22/10	Initial Release	WC	HWM
A	05/24/10	Correct Views -Add Conn. Details	WC	TM

DIMENSIONS IN INCHES
TOLERANCES UNLESS OTHERWISE SPECIFIED

DECIMALS	FRACTIONS
.0000 +/- .0005	+/- .015
.000 +/- .005	ANGLES
.00 +/- .010	+/- 30MIN
.0 +/- .15	

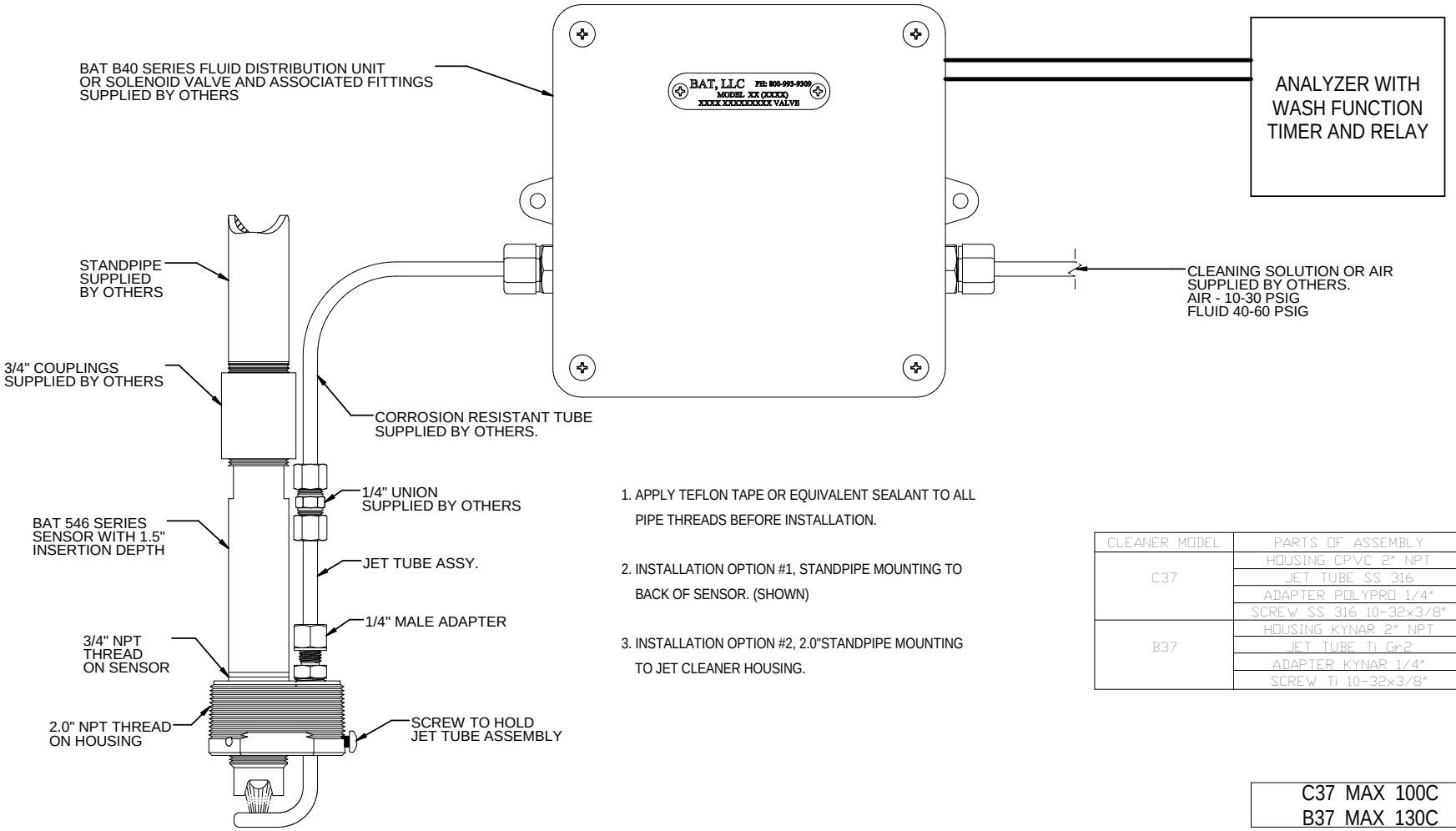
DRAWN BY

SCALE	DATE	SIZE
NONE	03/22/2010	A

CUSTOMER WIRING CONNECTIONS

BARBEN Analyzer Technology, LLC
5200 Convair Drive
Carson City, NV 89706
PH(775)883-2500 FAX(775)297-4740

DRAWING NO. 2P0167
CHECKED
APPROVED



1. APPLY TEFLON TAPE OR EQUIVALENT SEALANT TO ALL PIPE THREADS BEFORE INSTALLATION.

2. INSTALLATION OPTION #1, STANDPIPE MOUNTING TO BACK OF SENSOR. (SHOWN)

3. INSTALLATION OPTION #2, 2.0"STANDPIPE MOUNTING TO JET CLEANER HOUSING.

CLEANER MODEL	PARTS OF ASSEMBLY	PART NUMBER	QTY.
C37	HOUSING CPVC 2" NPT	B5110-0001	1
	JET TUBE SS 316	B5205-0040	1
	ADAPTER POLYPRO 1/4"	B4953-0003	1
	SCREW SS 316 10-32x3/8"	B4704-0001	1
B37	HOUSING KYNAR 2" NPT	B5110-0002	1
	JET TUBE Ti Gr2	B5205-0041	1
	ADAPTER KYNAR 1/4"	B4953-0004	1
	SCREW Ti 10-32x3/8"	B4704-0002	1

C37 MAX 100C
B37 MAX 130C

REVISIONS				
REV	DATE	DESCRIPTION	DWN	APVD
-	05/13/10	SEPARATE DWG'S	WC	HWM

DIMENSIONS IN INCHES
TOLERANCES UNLESS OTHERWISE SPECIFIED

DECIMALS	FRACTIONS
.0000 +/- .0005	+/- .015
.000 +/- .005	ANGLES
.00 +/- .010	+/- 30MIN
.0 +/- .15	

DRAWN BY W. COWAN

SCALE	DATE	SIZE
NONE	XX/XX/2010	B

SUBMERSIBLE JET CLEANER
C37 / B37

BARBEN Analyzer Technology, LLC
5200 Convair Drive
Carson City, NV 89706
PH(775)883-2500 FAX(775)297-4740

DWG # 2P0183
CHKD
APPV'D