

# RDO<sup>®</sup> Optical Dissolved Oxygen Sensor and Analyzer

## SINGLE OR DUAL INPUT ANALYZER

- OXYGEN SENSOR uses the fluorescence quenching method
- ACCURATE READINGS:  $\pm 0.1$  ppm between 0.0 and 8.0 ppm
- LOW MAINTENANCE: sensing cap only requires replacement every two years

## APPLICATIONS

The RDO<sup>®</sup> sensor and analyzer is intended for the determination of dissolved oxygen in water. It is ideal for use in wastewater aeration basins and ponds. The sensor uses the fluorescence quenching method. Unlike polarographic oxygen sensors, the RDO sensor does not require a flowing sample. It is also less affected by fouling than polarographic sensors.

## FEATURES

The RDO sensor is available with either integral or quick-disconnect cable. The maximum cable length is 4000 ft (1219 m). A 1- $\frac{1}{4}$  in FNPT fitting at the rear of the sensor allows a threaded pipe to be screwed into the sensor so it can be submerged in tanks or basins.

Calibration is simple. The sensor can be calibrated either against a referee instrument or in water-saturated air. Air calibration is completely automatic. A barometric pressure sensor inside the analyzer measures the air pressure, and a thermistor in the sensor measures temperature. The analyzer automatically calculates the equilibrium solubility of atmospheric oxygen in water under the prevailing temperature and pressure. A manually-entered correction for salinity is also available.

Maintenance is fast and easy and consists primarily of replacing the sensing cap every two years. No special tools required.

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The analyzer accepts one or two sensors. It has a two line display, which can be customized to display mg/L (ppm) oxygen, % saturation, oxygen partial pressure, or temperature for either sensor. The display can also be configured to display the current barometric pressure. The analyzer has two loop-powered 4-20 mA analog outputs assignable to either sensor and to any measurement (concentration, temperature, or partial pressure). Modbus/RS485 serial communication is also available through the analyzer or direct from the sensor. Two high voltage and two low voltage alarm relays are standard. The alarms are assignable to any measurement and can be programmed for high/low logic, setpoint, and deadband.

## THEORY

The RDO sensor uses fluorescence quenching to measure dissolved oxygen. Fluorescence is an optical property of certain molecules. When a molecule absorbs light, its energy increases, and the molecule is said to be excited. Because

the excited molecule is unstable, it quickly loses the absorbed energy typically as heat or light. If the latter occurs, the emitted light, called fluorescence, is always of lower energy (longer wavelength) than the absorbed light. (Some of the absorbed light is lost as heat.) An excited molecule can also lose energy by colliding with another molecule, notably oxygen. Because a collision with oxygen provides a path out of the excited state that does not emit light, oxygen reduces the intensity of (or quenches) the fluorescence. The greater the concentration of oxygen, the greater is the reduction in fluorescence intensity.

Quenching also reduces the fluorescence lifetime. If no oxygen is present, fluorescence will persist for a certain amount of time after the exciting light is shut off. If oxygen is present, the lifetime decreases because quenching provides an additional path out of the excited state, leaving fewer molecules to fluoresce. Unlike intensity measurements, lifetime measurements do not depend on the intensity of the exciting light, and, thus, are less subject to drift. The fluorescence lifetime can be conveniently measured by modulating the exciting light, which causes the emitted light to be modulated at the same frequency, but shifted in phase. The amount of phase shift is a measure of the fluorescence lifetime and the oxygen concentration.

The RDO sensor consists of a sensing foil impregnated with the fluorescent material and covered with an opaque film to keep out sunlight. Oxygen from the sample diffuses into the sensing foil. Inside the sensor, light from a blue LED falls on the foil. The fluorescent molecules absorb the blue light and re-emit it as red light. A photodiode measures the red light. A red filter in front of the photodiode blocks any scattered blue light and allows only the red fluorescence to reach the detector. Circuitry inside the sensor modulates the exciting light and measures the phase shift between the exciting light and the fluorescence. The microprocessor converts the phase shift into fluorescence lifetime and calculates the concentration of oxygen in the sample. The result is sent as digital signal to the analyzer, which displays the oxygen concentration.

Fluorescence quenching by oxygen is strongly dependent on temperature. A thermistor inside the RDO sensor measures the temperature, and the microprocessor applies an empirical correction factor.

## SPECIFICATIONS – RDO SENSOR

**Wetted Materials:** Delrin<sup>1</sup>, ABS, Viton<sup>2</sup>, titanium, polycarbonate/poly(methyl methacrylate) blend

**Dimensions:** length 8.0 in (203 mm) diameter 1.9 in (47 mm)

**Rating:** IP-67 with cap off; IP-68 with cap installed

**Process connection:** 1-1/4 inch FNPT

**Integral cable length:** 32 ft (10 m)

**Maximum cable length (quick disconnect cable only):** 4000 ft (1219 m)

**Pressure:** up to 314 psig (2060 kPa abs)

**Temperature:** 32 to 122°F (0 - 50°C)

**Range:** 0 to 20 ppm (mg/L) or 0 to 200% saturation

**Accuracy:** ±0.1 ppm between 0 and 8 ppm; ±0.2 ppm between 8 and 20 ppm

**Resolution:** 0.01 ppm (mg/L)

**Digital output:** Modbus/RS485

**Response time:** 30 sec to 90% of final value; 37 sec to 95% of final value (at 25°C)

**Operating life of sensing cap:** 2 years from first reading

**Safety directive:** 73/23/EEC

**EU directives:** 2004/108/EC for Electromagnetic Compatibility (EMC) and 72/23/EEC for Safety



**Immunity:** EN 61000-6-2, Electromagnetic Compatibility (EMC) part 6-2

**Emissions:** Class A requirements of CISPR 11:2004

## SPECIFICATIONS – RDO ANALYZER

**Enclosure:** Polycarbonate, rated NEMA 4X, IP67

**Dimensions (W x H x D):** 6.3 x 6.3 x 3.6 in (16 x 16 x 9.0 cm)

**Display:** liquid crystal; character height 0.4 in (6 mm)

**Mounting:** suitable for pipe or wall mounting

**Conduit openings:** six; PG 13.5 (½ inch); three gland fittings and five plugs ship with the analyzer

**Ambient temperature and humidity:** -4 to 158°F (-20 to 70°C); 95% RH (non-condensing)

**Power:** 100 to 240 VAC, approximately 0.15 A, 50-60 Hz

**Analog Outputs:** two fully scalable 4-20 mA outputs, each loop-powered (9-36 VDC)

**Digital Output:** Modbus/RS485

**Relays:** two low voltage relays, <50 VAC or VDC, maximum current 2 A (resistive or inductive) two high voltage relays, 264 VAC max, maximum current 5 A (resistive or inductive)

**Barometric pressure range:** 8.86 to 29.53 in Hg (300 to 1000 mbar)

**Barometric pressure accuracy:** ±0.09 in Hg (±3 mbar)

**EU directive:** 2004/108/EC for Electromagnetic Compatibility (EMC)

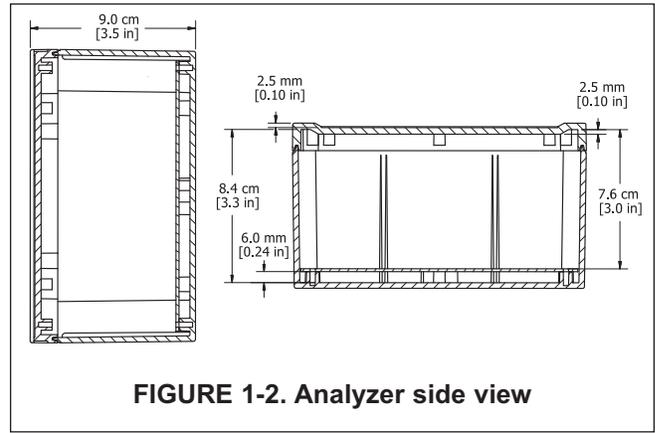
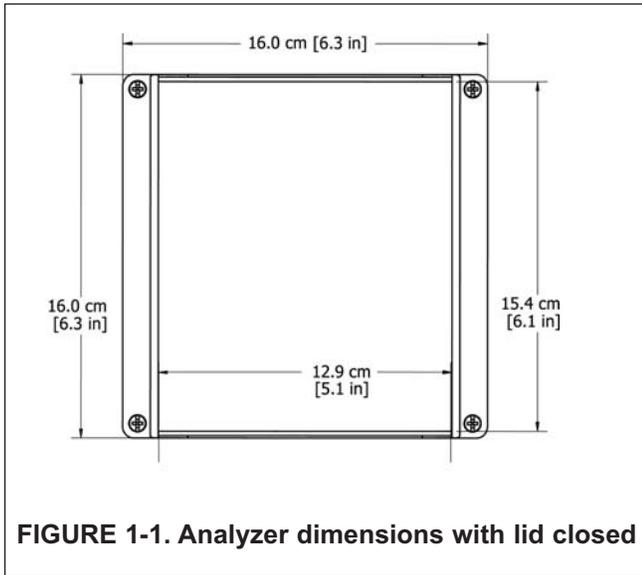
**Immunity:** EN61000-6-2, Electromagnetic Compatibility (EMC) part 6-2

**Emissions:** EN61000-6-4 Electromagnetic Compatibility; includes IEC/EN 61000-3-2 and IEC/EN61000-3-3, where applicable

**Safety:** UL 61010-1 and CAN/CSA C22.2 #61010-1

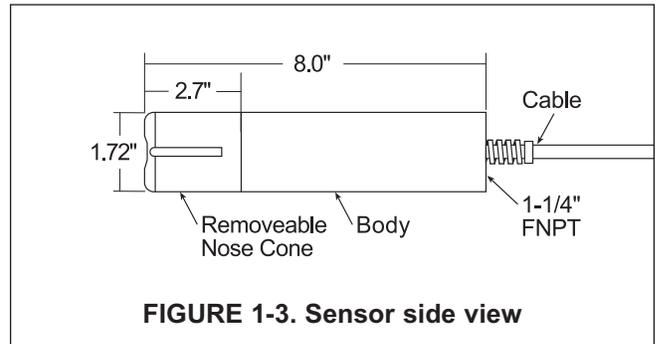
1 Delrin is a registered trademark of DuPont DeNemours, LLC

2 Viton is a registered trademark of DuPont Dow Elastomers, LLC



## ORDERING INFORMATION

The basic system consists of one or two sensors, the analyzer, and mounting hardware. **All items must be ordered separately.** See the tables below. A calibration cup to facilitate air calibration is included with the sensor. The sensor is available with 32 ft (10 m) of integral cable. If longer cable is needed, order the sensor with twist-lock connector and the desired cable length. For cable lengths longer than 96 ft (30 m) call the factory.



## ANALYZER

Part number	Description	Weight*	Shipping weight*
R0094030	RDO Pro analyzer, AC power, no data logging (includes three cable gland fittings and five plugs)	3 lb (1.5 kg)	4 lb (2.0 kg)

## SENSORS

Part number	Description	Weight*	Shipping weight*
R0086460X	RDO PRO-X sensor with 32 ft (10 m) integral cable	2 lb (1.0 kg)	3 lb (1.5 kg)
R0082490X	RDO Pro-X sensor with twist lock connector for use with twist-lock connector cable (see Accessories)	1 lb (0.5 kg)	2 lb (1.0 kg)

## ACCESSORIES

Part number	Description	Weight*	Shipping weight*
R0087560	RDO analyzer pipe and wall mounting kit	1 lb (0.5 kg)	2 lb (1.0 kg)
R00CBL10	Twist-lock connector cable, 32 ft (10m)	2 lb (1.0 kg)	3 lb (1.5 kg)
R00CBL20	Twist-lock connector cable, 64 ft (20m)	3 lb (1.5 kg)	4 lb (2.0 kg)
R00CBL30	Twist-lock connector cable, 96 ft (30m)	4 lb (2.0 kg)	5 lb (2.5 kg)
R0084230	RDO sensor cap replacement kit	1 lb (0.5 kg)	1 lb (0.5 kg)
R0080810	RDO O-ring replacement kit	1 lb (0.5 kg)	1 lb (0.5 kg)
R0080820	RDO replacement nose cone kit	1 lb (0.5 kg)	1 lb (0.5 kg)
R0088890	RDO replacement calibration cup	1 lb (0.5 kg)	1 lb (0.5 kg)
R0087630	Replacement desiccant bag for analyzer	1 lb (0.5 kg)	1 lb (0.5 kg)
R0084230X	RDO Pro-X sensor cap replacement kit	1 lb (0.5 kg)	1 lb (0.5 kg)

\* Weights and shipping weights are rounded up to the nearest 1 lb (0.5 kg).



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2400 Barranca Parkway  
Irvine, CA 92606 USA  
Tel: (949) 757-8500  
Fax: (949) 474-7250

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