

# VISIFERM™ DO



## Optical Oxygen Sensors with Integrated Transmitter



**HAMILTON** 

# VISIFERM™ DO: intelligent, optical, dissolved-oxygen

## Optical oxygen measurement with built-in analyzer, in 12 mm format

With VISIFERM™ DO, HAMILTON is the first company to offer a self-contained oxygen measurement in the popular 12 mm format similar to standard process pH electrodes and classical sterilizable oxygen sensors. Combined in the VISIFERM™ sensor shaft are: high-temperature-resistant optical electronics, microprocessor, 4 to 20 mA analog output, digital RS 485 interface with ModBus protocol, and ECS interface. The Electro-Chemical Sensor (ECS) interface allows VISIFERM™ DO to be connected to existing classical measurement amplifiers designed for sterilizable oxygen sensors, such as the HAMILTON OXYFERM™. Use of the 4 to 20 mA analog output or the digital RS 485 interface (both integrated into the 12 mm shaft) makes an external measurement amplifier unnecessary, allowing measurement signals to be fed directly into a process control system.

## Clear favorite in comparison

HAMILTON has successfully manufactured steam-sterilizable, autoclavable, CIP-compatible sensors for pH, oxidation/reduction, conductivity, and oxygen measurement for many years. These classical oxygen sensors are based, as is common in the industry, on Clark Cell technology, in which oxygen diffuses through a membrane and is reduced electrochemically on a precious metal. The electrons involved in this process generate a very small current (nanoamperes) which is converted to an oxygen measurement signal by a measurement amplifier.

Sensors such as these have served well for decades, but have their limitations. VISIFERM™ DO optical sensors demonstrate a number of substantial advantages. This is because users of the VISIFERM™ DO receive more than just a sensor based on a new measurement principle. VISIFERM™ DO is a symbiosis of sensor and measurement amplifier - an intelligent sensor.

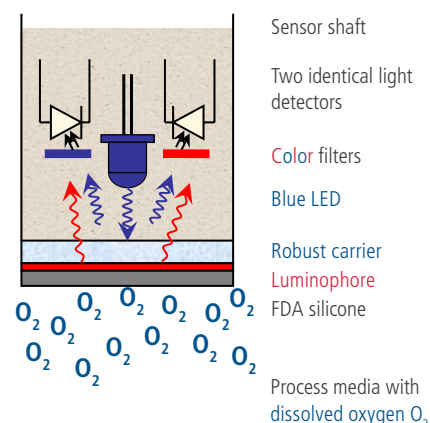
## Application fields

VISIFERM™ DO sensors have been evaluated in a variety of applications:

- Biotechnology. VISIFERM™ DO sensors are developed to be steam-sterilized and autoclaved without difficulty. CIP cleaning is also tolerated very well. These properties, along with the standard design form of a classical 12 mm sensor with PG 13.5 thread, make VISIFERM™ DO superior for use in fermenters and similar demanding applications.
- Waste water treatment.
- Ground water monitoring.
- River water monitoring.
- Breweries. VISIFERM™ DO is already being used to monitor carbon dioxide recovery, and is finding further application in the wort tank. Installations in the area of beer and beverage bottle filling are still in various test runs.
- Cooling water cycles, found in power plants and other applications for trace measurements, are also performing reliably and well.
- Gas monitoring applications depend on the composition of specific samples. All installations are satisfactory.

## Lightning bright optics

While other suppliers of optical oxygen sensors utilize fragile optical fibers, a single light channel, or two different LEDs, HAMILTON prefers a mechanically- and thermally-stable symmetrical design.



Symmetrical dual channel optics for perfect function and diagnostics

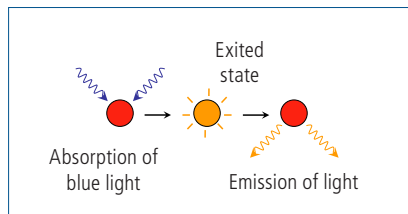
## VISIFERM™ DO measurement principles

The unique design of the VISIFERM™ DO enables HAMILTON 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 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.

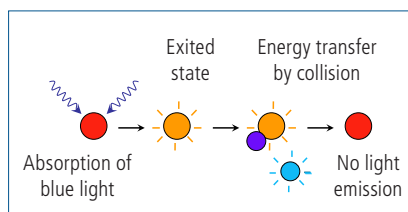


Comparison of optical dissolved oxygen (top) and a classical (bottom) Clark Cell sensor

# en sensor with integrated transmitter functions



When the luminophore comes into contact with elemental oxygen, the  $O_2$  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. Between the pulsed excitation of the luminophore with blue light and the emission of red light, there is an oxygen-dependent time shift which can be measured as an angle of phase. Measurement, calculation, and output of the measured value occur entirely inside the sensor.

Notice that VISIFERM™ DO sensors measure the partial pressure of oxygen ( $pO_2$ ) just as classical sensors do. This can be displayed as % air saturation, concentration in mg/l, ppm, or even as ppb.

The measurement range is currently limited to 0.05% to 300% air saturation (4 ppb to 25 ppm). For most applications this measurement range is more than adequate. When calibrating the sensor well, the limit is even below 1 ppb.

## Operational reliability is paramount

### A comparison with classical measurement technology

The most common malfunction of classical Clark Cells is caused by damage to the mechanically sensitive oxygen membrane. If a membrane is seriously damaged, the chances are good that a visual check will catch the problem. However, if a small, unnoticeable defect develops on the membrane, this becomes apparent only when the electrolyte starts to leak, and the sensor stops working.

VISIFERM™ DO does not suffer from this problem, because it has no fragile membrane and no electrolyte; instead, it has a robust, solid Sensor Cap.

Cable transmission of very low Clark Cell currents to amplifiers represents a further problem in demanding industrial environments, because of the risk of chaotic or non-reproducible signals caused by dirty or moist contacts from perspiration on fingers. In addition, vibrations and small fluctuations in temperature can alter cable resistance noticeably. Damp cables - and especially, damp connections - are often the cause of problems in oxygen and other measurements, such as pH.

Measurement results of VISIFERM™ DO can be sent from the sensor as robust 4 to 20 mA analog, or digital signals. Both are far more tolerant of difficult process conditions than the sensitive (nA) signals of a classical electrochemical dissolved oxygen sensor.

### Signal availability

A measuring point that delivers no signal can cause great damage. The signal for process control depends on all the components necessary for that signal. For classical oxygen measurement these are: sensor, sensor cable, measurement amplifier, its power source, and the cable from the measurement amplifier to process control. The weakest link

## Technology that sets new standards

### Intelligent Sensor

VISIFERM™ DO gives the designation "intelligent sensor" new significance:

- Innovative measurement optics, stable to 130°C, with symmetrically-oriented diagnostic and measurement design.
- Temperature-resistant electronics built into a 12 mm shaft.
- Replaceable Sensor Cap containing the sensing element.
- Digital or analog communication by proven VP 8.0 connector head, complete with PG 13.5 process thread connection.
- Monitoring of all sensor functions, including status diagnosis of the replaceable Sensor Cap, with corresponding signals to the 4 to 20 mA and digital interfaces. A history of self-monitoring is recorded in the sensor.
- Configurable using the RS 485 interface with notebook, PC or by using the ModBus RTU connection from the process control system, with HAMILTON VISICAL™, or ARC View Handheld.

contributes the most to system failure. In classical systems this is clearly the membrane-covered sensor first, and the cable to the measurement amplifier second. With VISIFERM™ DO, critical small currents are dispensed with, and a robust (milliamperes, not nanoamperes) analog or digital signal is supplied to the measurement amplifier in the sensor. Instead of a disturbance-vulnerable membrane, VISIFERM™ DO has a robust, replaceable Sensor Cap that is both sensitive and highly selective.

# VISIFERM™ DO: intelligent, optical, dissolved-oxygen

## VISIFERM™ DO all-in-one sensor: function blocks

**Interfaces**

- Modbus Fieldbus
- 4-20 mA (Namur)
- ECS (Clark cell simulation)
- Power supply

**Memory**

- Calibration data
- Cap wear
- CIP & SIP counter
- Alarm history
- TAG#, Serial#, ...

**Processor**

- Calibration
- Sensor health
- Password check
- Watch dog

**Optics**

- Dual channel
- Self diagnostics
- Diagnostics for luminophore

**Cap**

- Replaceable
- Robust, sensing Luminophore
- FDA conform materials only

VISIFERM DO 120  
HAMILTON P/N: 242450

## Users love the VISIFERM™ DO:

### Application:

- No fragile membrane solid Sensor Cap, instead
- Instantly stable values
- Low drift, quick response
- Flow-independent
- Electrolyte-free, so no leakage & polarisation time
- No H<sub>2</sub>S or CO<sub>2</sub> effect

### Maintenance:

- Just one single, simple, replaceable spare part the robust Sensor Cap
- Convenient calibration in the laboratory, because calibration data are stored in the sensor
- Precalibrated, ready-to-use sensors from stock minimize service time and costs

### Installation:

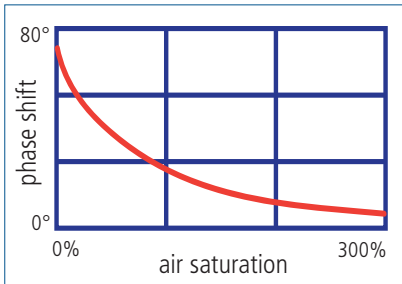
- Backwards compatible with classical oxygen sensors, operates with traditional transmitters and SOP's
- Can be connected directly to a PLC or PCS using a 4 to 20 mA or Modbus RTU interface

# Open sensor with integrated transmitter functions

## Safe trace measurements

Trace measurements with classical sensors are not considered particularly accurate or safe, since in the absence of oxygen, no O<sub>2</sub> molecules are reduced, so no electrical current can flow. The same happens when a cable breaks.

VISIFERM™ DO does not suffer from these problems because it is at low oxygen concentrations that the greatest amount of red light is emitted, and the measured phase shift is at its greatest.



## Operational reliability and simple maintenance

User friendliness is a critical quality in a sensor. Every procedure made redundant signifies an increase in operational reliability. Achieving simple maintenance is of particular value.

So when a problem occurs during the night shift, with only limited personnel available to perform maintenance and calibration, VISIFERM™ DO really helps. All you have to replace is a Sensor Cap, and it is as quick and easy as opening and closing a bottle of soda: the Sensor Cap twists off, and the new one twists on. Job done. You need only perform calibration in air, although ideally, also in nitrogen or carbon dioxide. The sensor can be conveniently calibrated in the laboratory and remains calibrated for the next process run.

## Three options to connect Fieldbus:

VISIFERM™ DO offers the widely-used Modbus RTU interface, enabling up to 32 sensors or other devices to be wired onto the same bus, in a highly cost-effective installation. The Modbus interface offers users comprehensive information, including input from the sensor's diagnostics and health indicator. Numerous gateways are available to interface Modbus to Foundation Fieldbus, Profibus, and others.

### Robust 4 to 20 mA current:

Connects VISIFERM™ DO directly to a PLC or PCS, with no transmitter.

### ECS:

The Electro-Chemical Sensor interface connects VISIFERM™ DO to traditional transmitters/analyzers for electrochemical oxygen sensors. ECS option can be selected using the VisiConfigurator™.

## VISIFERM™ DO accessories

### Sensor Cap



With VISIFERM™, 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.

### Sensor cable VP 8.0



### USB-RS485 Modbus converter



Connects a PC with a USB port to the world of Modbus.

### VISICAL™ calibration tool



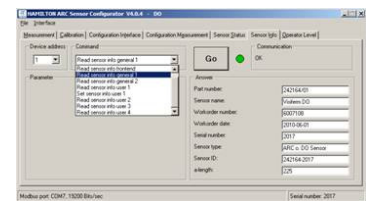
Simplifies air and zero point calibration when using the 4 to 20 mA interface, or when precalibrating the sensor in a laboratory. It also displays overall sensor status, and indicates when a Sensor Cap needs to be replaced soon.

### VISIFERM-D4 power adapter



Connects VISIFERM™ DO in ECS mode to the cable of classical sterilizable oxygen sensor with four-pole plug (D4, T82) such as HAMILTON's OXYFERM FDA. Includes a wall plug power supply.

### ARC Sensor Configurator freeware



PC sensor interface for Modbus communication

### ARC View Handheld Package



For mobile sensor monitoring, calibration and configuration.

### ARC Wi Sensor Adapter



Sensor adapter for wireless connection.

## Technical data

- Optical oxygen sensor with integrated optoelectronics, measuring-devices functionality, and self-diagnosis.
- Steam-sterilizable, autoclavable, and CIP-resistant (tested with 1.0 M NaOH, 90°C, 60 minutes).
- Measurement principle: oxygen-dependent change of phase-angle of FDA silicone-protected luminophore.
- No minimum flow required, because sensor does not consume oxygen.
- Always immediately ready for measurement.
- Shaft diameter: 12 mm, PG 13.5 thread.
- Different lengths of shaft, from 120 mm (see part description: VISIFERM™ DO 120 where 120 indicates the shaft length).
- Replaceable Sensor Caps.
- Various modes of operation, adjustable by means of software. For example:
  - 4 to 20 mA interface.
  - ECS interface.
  - Device address and transmission rate for operation with Modbus RTU fieldbus. Several sensors can be read by the same two RS-485 interface conductors, for a process control system or a personal system.
- Cross sensitivities and resistances:
  - Not sensitive to: CO<sub>2</sub>, H<sub>2</sub>S, SO<sub>2</sub>, ethylene oxide, and gamma sterilization.
  - Not harmed by: ethanol, methanol, H<sub>2</sub>O<sub>2</sub>.
  - Not resistant to: chlorine gas and organic solvents such as chloroform, toluene, acetone.

### Specific data

- Storage temperature: -10 to 50°C.
- Operational temperature: -10 to 130°C; disconnection of optical oxygen measurement above 80°C as standard (others on request); electrical interfaces and temperature measurement active up to 130°C.
- Process pressure: -1 to 12 bar (174 psi); pressure impulses up to 80 bar.
- Range of measurement: 4 ppb, 0.05% to 300% oxygen/air saturation; measurement unit can be configured by software according to:
  - % oxygen/air saturation (% saturation).
  - Volume-% oxygen (Vol-%).
  - mg/L or ppm.
  - µg/L or ppb.
- Resolution: 0.1 ppb
- Response time at 25°C, air to nitrogen:  $t_{98\%} < 30$  s.
- Detection limit: 0.01 Vol-%.
- Drift: lower than 0.2 Vol-% oxygen per week in air at 30°C and constant conditions.
- Electrical connection with VP 8.0 socket head:
  - Operating voltage: 7 to 30 VDC, maximum 1000 mW.
  - Continuous power: approximately 0.6 W.
  - Start-up power: maximum 1 W.
  - Freely scalable, 4 to 20 mA current interface (current sink) for a temperature-compensated oxygen-measurement signal. Fed by external 24 VDC supply (for example), allowing a standard 4 to 20 mA current signal to be used for process control or recording. In the sensor, the current flows towards the ground of the operating voltage.
  - ECS interface for the simulation of a classical, electrochemical sensor (cathode, anode, NTC 22 kΩ temperature sensor) for operation with classical measuring devices.
  - Fieldbus interface: digital, serial, 2-wire, RS-485 interface, with Modbus RTU protocol.
- Modbus:
  - Modbus RTU; 2-wire RS-485; maximum of 32 addresses.
  - Transmission / baud rate: 4800 to 115000 (factory standard: 19200 Bd).
- Wetted parts materials: SS 316L / DIN 1.4435, EPDM (FDA), silicone (FDA).

# Open sensor with integrated transmitter functions

## VISIFERM™ DO - ordering information

Order number	Description
242450-02	VISIFERM™ DO 120
242451-02	VISIFERM™ DO 160
242452-02	VISIFERM™ DO 225
242453-02	VISIFERM™ DO 325
242454-02	VISIFERM™ DO 425
242427	VISIFERM™ DO replacement Sensor Cap (spare part)
242410	VISICAL™ calibration tool
242411	USB-RS-485 Modbus converter
242412	4-20 mA galvanic isolating amplifier M1
242413	VISIFERM™-D4 power adapter
355194	Demo cable (1m, open end, power pack)
238999-2766	Demo cable (1m, for Sartorius fermenter, power pack)
238999-2767	Demo cable (1m, e.g. for Applikon fermenter, BNC plug, power pack)
238999-2768	Demo cable (1m, for New Brunswick fermenter, power pack)
238999-2394	Sensor cable VP 8.0, 1m
238999-1953	Sensor cable VP 8.0, 3m
238999-2395	Sensor cable VP 8.0, 5m
238999-2396	Sensor cable VP 8.0, 10m
238999-2403	Sensor cable VP 8.0, 15m
238999-2505	Sensor cable VP 8.0, 20m
242170	ARC Wi Sensor Adapter
242180	ARC View Handheld Package

For armatures, pH and conductivity sensors, patented and certified DURACAL™ pH buffers, and conductivity standards, please check the HAMILTON website, or consult your HAMILTON process sensors distributor.



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