A Hamilton optical oxygen sensor is shown in a blue liquid environment, surrounded by numerous small bubbles. The sensor is a cylindrical device with a blue ring at its tip. The background is a gradient of blue, and the overall scene is illuminated from above, creating a bright spot near the sensor's tip.

# Optical Oxygen Sensors

VisiFerm, VisiTrace

**HAMILTON** 



# The Real Cost of Dissolved Oxygen Measurement

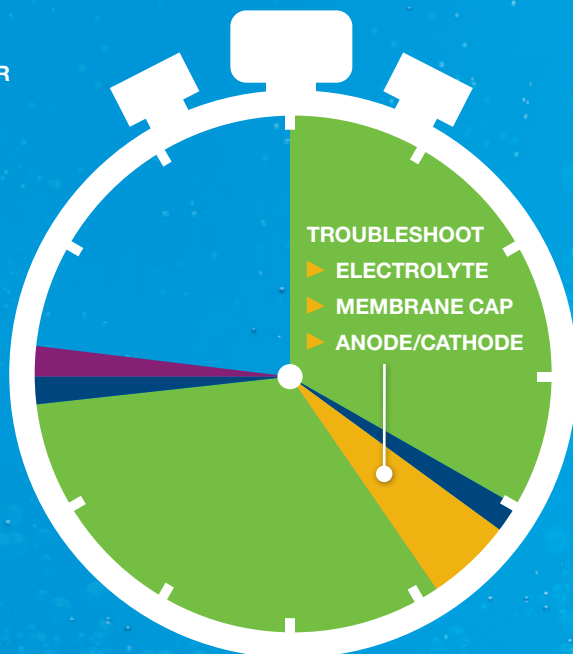
80% of sensor costs come after the initial purchase

## Polarographic Sensors

Traditional polarographic membrane sensors use a chemical reaction to generate a small electrical current that is correlated to oxygen concentration in the sample. Keeping the sensor in top condition requires skilled troubleshooting, expensive replacement parts, and considerable time waiting for the sensor to polarize.

### TROUBLESHOOT IN 3-8 HOURS

- ▶ POLARIZE
- ▶ TEST IN 100% AIR
- ▶ SERVICE
- ▶ CALIBRATE



# CALIBRATING OPTICAL SENSORS

One point, two point, and product calibrations can all be performed using existing polarographic procedures.

## Optical Sensors

Optical sensors measure using an oxygen-sensitive fluorescent dye. The dye requires no equilibration time so it is instantly ready for use. A quality indicator displays the health of the sensor cap, and maintenance is as simple as removing and reinstalling the cap.

### TROUBLESHOOT IN $\leq 20$ MINUTES

- ▶ WARM UP
- ▶ SERVICE
- ▶ CALIBRATE

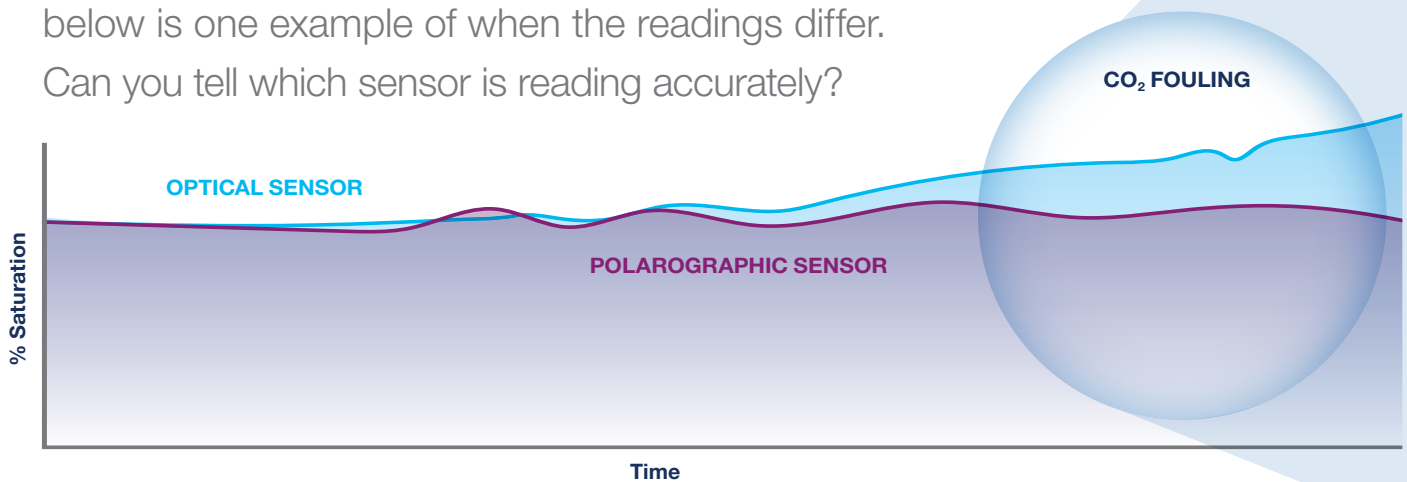


No Polarization  
Required

# Can You Trust Your Oxygen Measurement?

## Are polarographic and optical measurements comparable?

Yes, when run in parallel, the data gathered from optical and polarographic sensors is often identical. However, below is one example of when the readings differ. Can you tell which sensor is reading accurately?



The graph above shows data from a side-by-side comparison of optical (monitoring) and polarographic (controlling) values over a long fermentation run. The divergence at the end of the run is a result of CO<sub>2</sub> fouling of the polarographic control sensor, causing the mass flow control to add too much O<sub>2</sub> during of the run.

## ADDITIONAL ADVANTAGES OF OPTICAL MEASUREMENT



### Low DO and No Flow

More accurate measurement because optical sensors do not consume oxygen



### Inverted Installations

Without electrolyte the sensor reading is not affected by mounting orientation

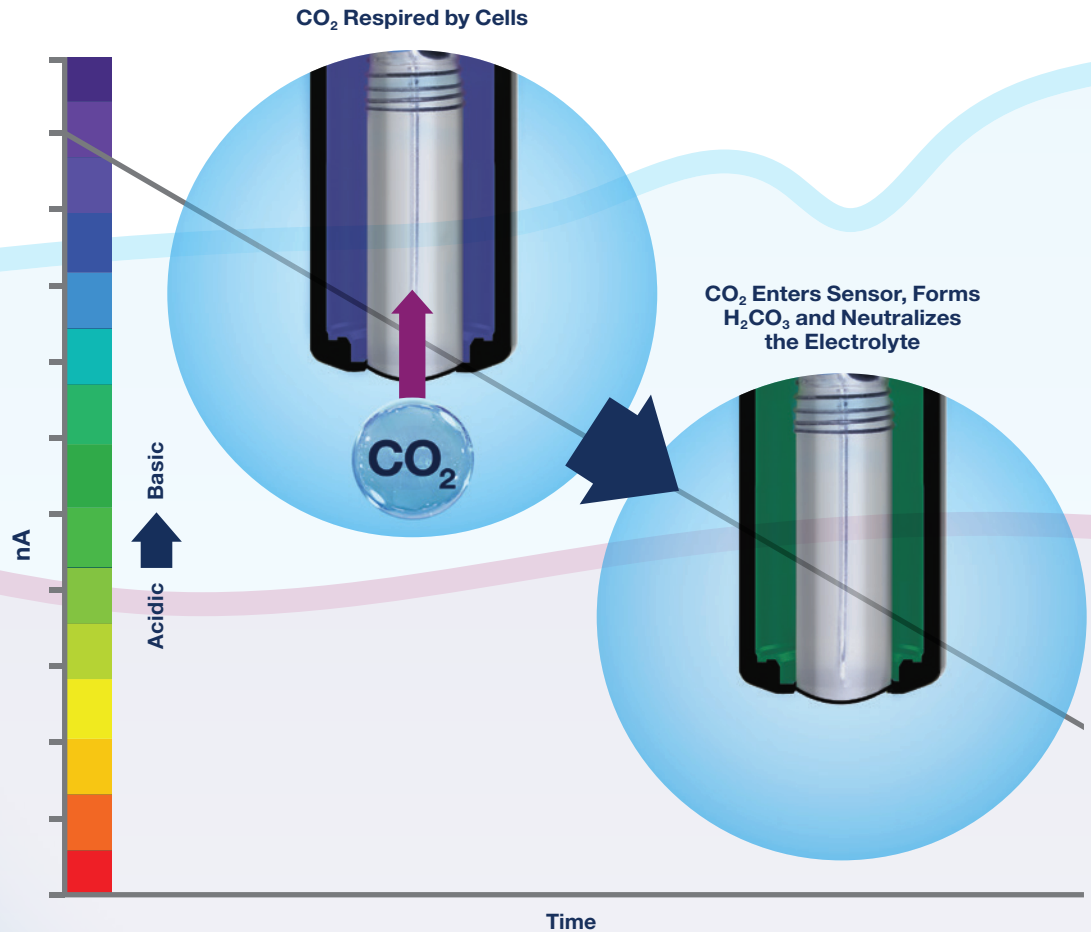


### Response Time

Quicker response time results in less wasted product

## WHAT IS CO<sub>2</sub> FOULING?

Over long fermentation runs, sensors are exposed to CO<sub>2</sub> gas used for pH control or resulting from cellular respiration. The gas travels through the membrane of a polarographic sensor and changes the pH of the electrolyte. This change results in a lower nA reading.



### Pressure Spikes

Improved mechanical and measurement stability with a glass window instead of a membrane



### nA Noise

Signal is not influenced by electrostatics and mechanical stress



### H<sub>2</sub>S Fouling

No impact on measurement or sensor life



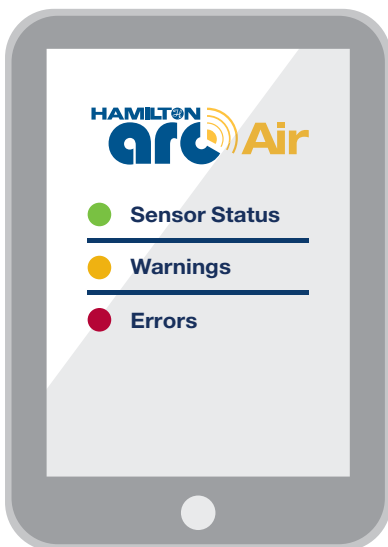
# Intelligent Sensors

## Eliminate more than costly transmitters

The integrated micro transmitter eliminates signal noise and enables predictive estimates of sensor life, calibration and troubleshooting.

These can be conducted in a controlled lab or at line, and documentation is simplified with automatic report generation.

### WIRELESS CALIBRATION & DIAGNOSTICS



Up to 30 Sensors



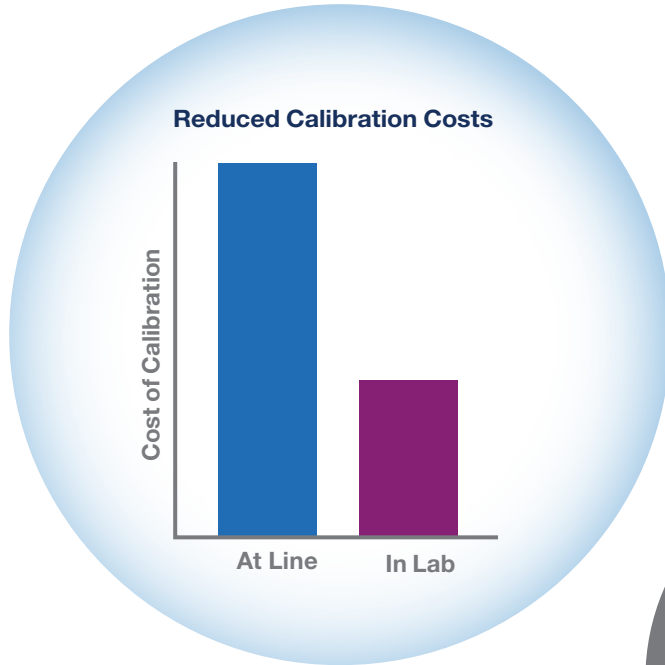
### Automatic Calibration & GMP Documentation



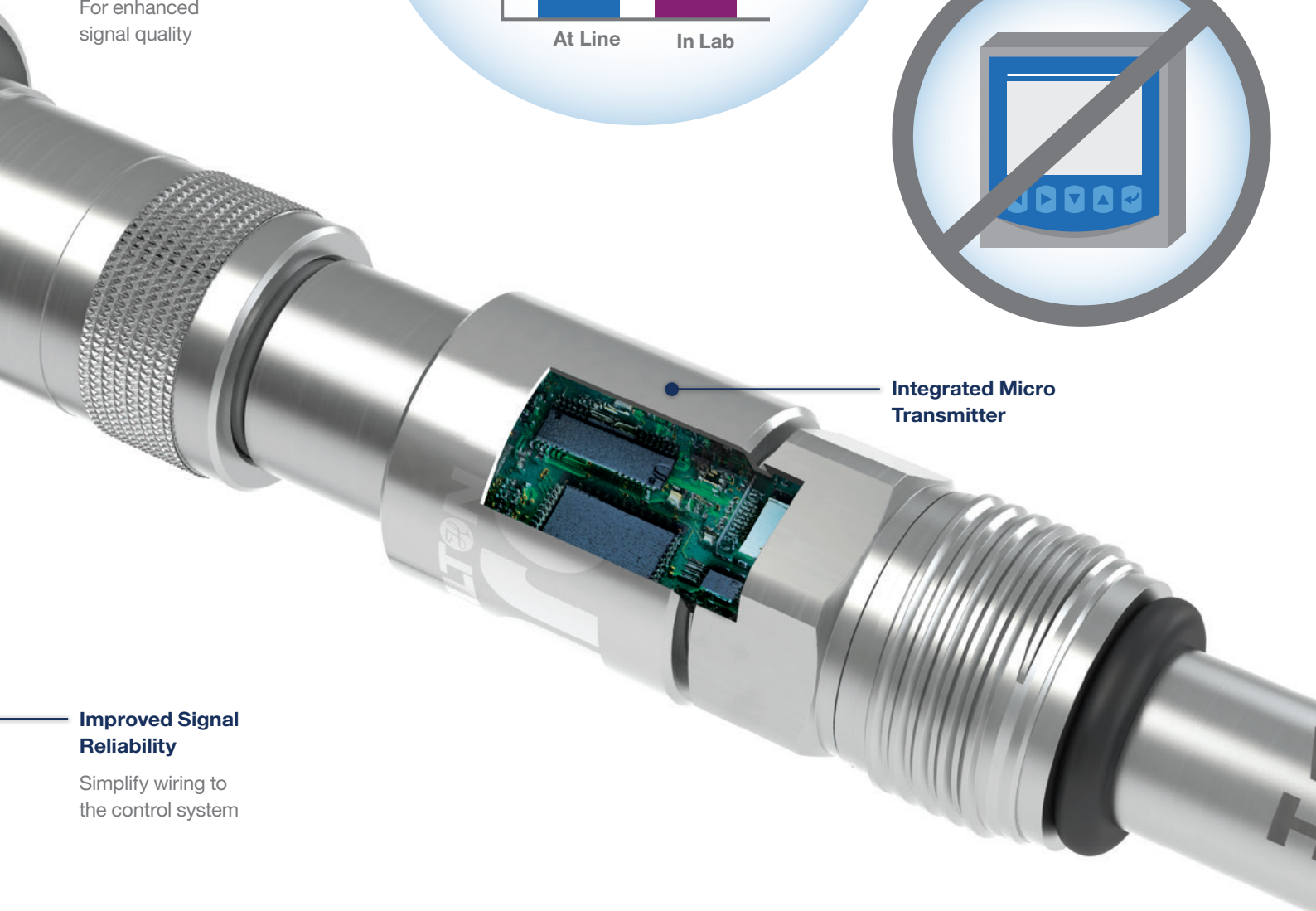
**Optional Wireless Adapter**

**Galvanic Isolator**

For enhanced signal quality



**Eliminate Costly Transmitters**



**Integrated Micro Transmitter**

**Improved Signal Reliability**

Simplify wiring to the control system

# The Visi Family of Sensors

## The right tool for the job

The optical VisiFerm sensors are available in a variety of configurations to meet the needs of your challenging application. The core measurement principal is consistent across all models with various electrical connections, sensor caps, and firmware versions to ensure superior performance and reliability.

### SIGNAL PROCESSING & TRANSMISSION

#### VisiFerm DO

Seamless integration with existing analog bioreactors and transmitters

Output: ECS, 4-20 mA, and Modbus outputs



#### VisiFerm DO Arc

Improve signal with direct connection to the control system

Output: 4-20 mA and Modbus output



#### VisiFerm mA

Less frequent calibration and longer lifetime. Two wire loop powered 4-20mA / HART for GMP production environments. Rated for explosive environments.

Output: 2 wire 4-20 mA, HART, and Bluetooth integrated



#### VisiTrace mA

Detect from 0 to 2 ppm with a stability of < 1% week @ 100 ppb and accuracy of  $\pm 0.5$  ppb or 2%, whichever is greater (@ 25°C)

Output: 2 wire 4-20 mA, HART and Bluetooth integrated





# SENSOR CAP OPTIONS

## H0 Cap

The fastest response time and compatibility with most fermentation and culture media



## H2 Cap

Chemically resistant with hygienic design to simplify cleaning and minimize bubble accumulation



## L0 Trace Cap

Optimized for trace measurement from 1 to 2,000 ppb and stable against active chlorine and chlorine dioxide



Only compatible with VisiTrace mA

## H3 Cap

Strengthened luminophore matrix for better temperature stability with fast response time. The perfect cap for most biopharmaceutical applications



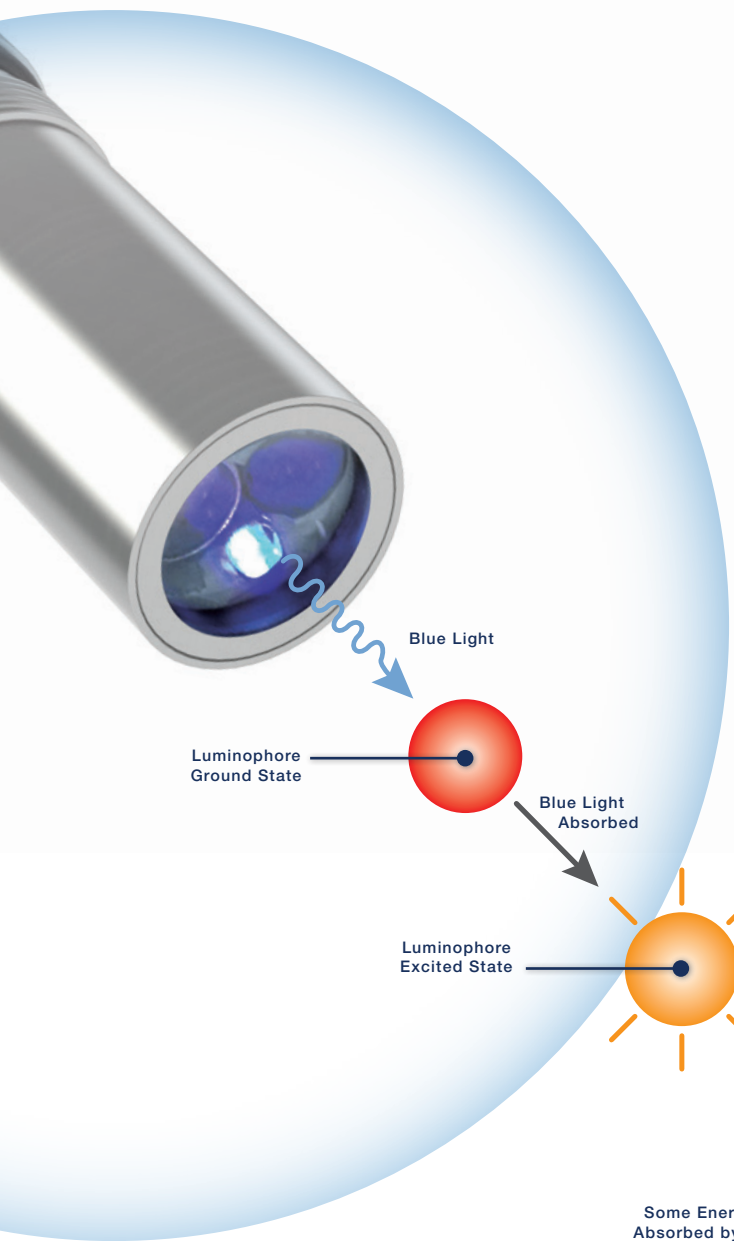
Only compatible with the VisiFerm mA sensor

## H4 Cap

Strengthened luminophore matrix for better temperature stability with chemically resistant and hygienic design

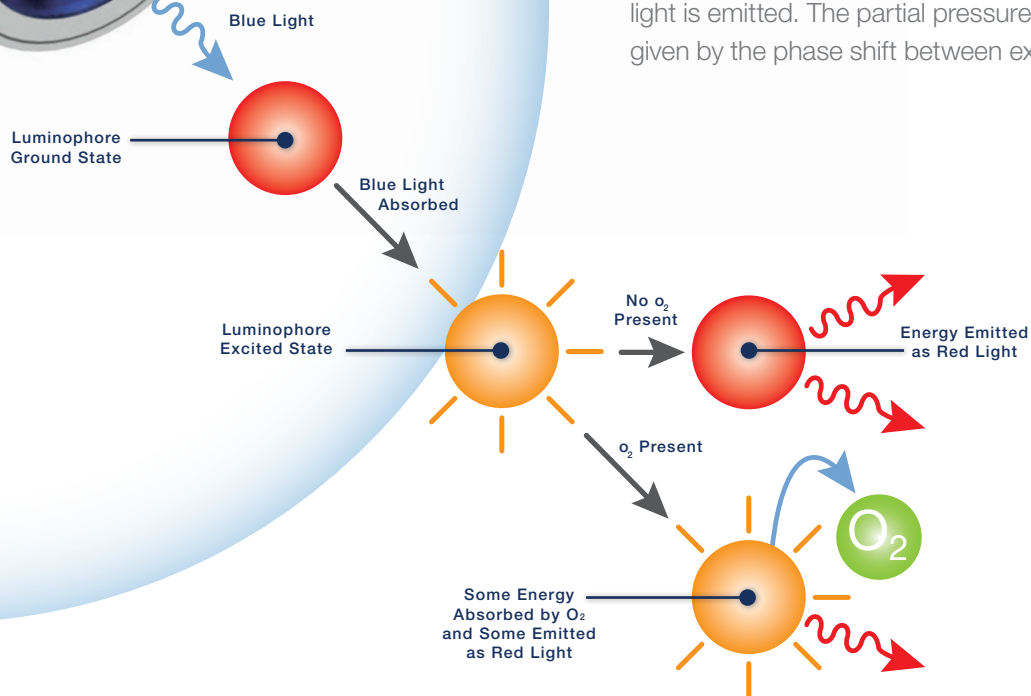


Only compatible with the VisiFerm mA sensor



## HOW IT WORKS MEASURING PRINCIPAL

Blue light excites a fluorescent dye (luminophore) in the sensor cap. In the absence of oxygen the energy is fluoresced as red light. In the presence of oxygen some energy is transferred to the oxygen molecule and less red light is emitted. The partial pressure of oxygen is reliably given by the phase shift between excitation and emission.



# Unprecedented Connectivity

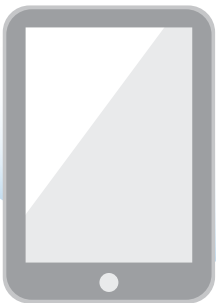
Eliminate the middle man;  
talk directly to the sensor

New installations are abandoning dedicated transmitters in favor of computer screens. The Visi family of sensors transitions seamlessly with analog options for existing installations and a variety of digital protocols for future needs.

## CALIBRATION & DIAGNOSTICS

Wirelessly communicate with the sensor via Bluetooth. Setup, troubleshoot, and calibrate multiple sensors from a single handheld device or PC.

**BLUETOOTH** 



**TABLET**



**SMARTPHONE**

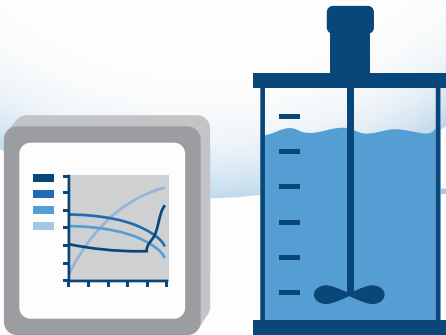


**USB WIRELESS  
CONVERTER**



# REPLACE TRADITIONAL OXYGEN SENSORS

Enjoy the benefits of optical oxygen measurement with your existing equipment. VisiFerm DO can simulate the output of a traditional polarographic sensor (ECS Mode, ElectroChemical Signal) for integration into any system with minimal effort.



**BIO CONTROLLER**

## Validated Cables for Most Bioreactors\*

### LEMO



Bioreactor Manufacturer:

- ▶ Sartorius
- ▶ Bioengineering

### BINDER



Bioreactor Manufacturer:

- ▶ Applikon
- ▶ DASGIP (Eppendorf)

### BNC



Bioreactor Manufacturer:

- ▶ Applikon

### AMP



Bioreactor Manufacturer:

- ▶ New Brunswick (Eppendorf)

\* All Cables have integrated power supplies with selectable country specific plugs

**nA, ECS**

**4-20, PROFIBUS DP, MODBUS, HART**

## FLEXIBILITY AND SIGNAL INTEGRITY

All process data is communicated through a hard wired connection. The Visi family communicates with a variety of open communication protocols enabling connection directly to a PCS or computer. Hamilton provides control software, FDT drivers, and a programmer's guide for custom development.



**PCS**



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