HAMILT⊕N

VisiFerm™ RS485-ECS Sensors

Operating Instructions

Table of Contents

Hamilton Warranty

Please refer to the General Terms of Sales (GTS).

Important note

1 General Information

1.1 Intended Use

The VisiFerm RS485-ECS sensors are intended for the measurement of dissolved oxygen (DO).

If the sensor is used in contact with gaseous or liquid organic solvents, the resulting measurement accuracy in this application must be separately checked and validated by the customer.

> ⚠ **CAUTION! VisiFerm RS485-ECS is not intended for hazardous atmospheres.**

> ⚠ **CAUTION! The VisiFerm RS485-ECS sensor has a built-in temperature sensor (NTC 22 kOhm). This temperature sensor is to be used only for monitoring the sensor conditions, not for controlling the process temperature.**

> ⚠ **CAUTION! The measurement values transmitted over wireless communication are not intended to be used for process control.**

1.2 About this Operating Instruction

These Operating Instructions are designed to support the integration, operation and qualification of the VisiFerm RS485-ECS.

To achieve this, it will describe the features of VisiFerm RS485-ECS and its integration in Process Control Systems (PCS). Both the hardware and the communication between the VisiFerm RS485-ECS and Process Control Systems are detailed in this manual. After reading this manual the user should be capable of installing and operating VisiFerm RS485-ECS sensors.

> ⚠ **CAUTION! Essential information for avoiding personal injury or damage to equipment.**

> 🗐 NOTICE: Important instructions or interesting information.

2 Liability

The liability of Hamilton Bonaduz AG is detailed in the document «General Terms and Conditions of Sale and Delivery».

Hamilton is expressly not liable for direct or indirect losses arising from use of the sensors. It must in particular be insured in this conjunction that malfunctions can occur on account of the inherently

limited useful life of sensors contingent upon their relevant applications. The user is responsible for the calibration, maintenance and regular replacement of the sensors. In the case of critical sensor applications, Hamilton recommends using back-up measuring points in order to avoid consequential damages. The user is responsible for taking suitable precautions in the event of a sensor failure.

> 🗐 NOTICE: The VisiFerm RS485-ECS sensor is not intended and specified as a safety device. A SIL (Safety Integrity Level) certification is not available. It is in the sole responsibility of the user to validate the VisiFerm RS485-ECS sensor according the safety requirements of his application.

3 Safety Precautions and Hazards

> ⚠ **CAUTION! Read the following safety instructions carefully before installing and operating the VisiFerm RS485-ECS sensor.**

3.1 General Precautions

For safe and correct use of VisiFerm RS485 -ECS, it is essential that both operating and service personnel follow generally accepted safety procedures as well as the safety instructions given in this document, the VisiFerm RS485 -ECS operation instruction manual.

The specification given in the «Specification Sheet» as regards temperature, pressure etc. may under no circumstances be exceeded. Inappropriate use or misuse can be dangerous.

The lifetime of the VisiFerm RS485 -ECS highly depends on the specific conditions of the application. Temperature, pressure, chemicals used may accelerate the ageing of both the sensor and its ODO cap. See chapter 7 for replacement conditions.

Cleaning, assembly and maintenance should be performed by personnel trained in such work. Before removing the sensor from the measuring setup, always make sure the no process medium can be accidentally spilled. When removing and cleaning the sensor, it is recommended to wear safety goggles and protective gloves.

The sensor can not be repaired by the operator and has to be sent back to Hamilton for inspection.

Necessary precautions should be taken when transporting the sensors. For repair or shipment the sensor should be sent back in the original reusable packaging box. Every VisiFerm RS485-ECS sent back for repair must be decontaminated.

If the conditions described in these operating instructions manual are not adhered to or if there is any inappropriate interference with the equipment, all of our manufacturer's warranties become obsolete.

3.2 Operation of VisiFerm RS485-ECS Sensor

When using the VisiFerm RS485-ECS sensors in process environment suitable protective clothing, safety glasses and protective gloves must be worn, particularly when dealing with a malfunction where the risk of contamination from spilled liquids exists. Installation and maintenance of sensors must be performed only by trained personnel. The mobile devices and sensors must be used for their intended applications, and in optimum safety and operational conditions.

Use only wired digital or analog ECS connection for the process control. The RS485 interface is designed for sensor monitoring, maintenance and service purposes.

Make sure that the PG13,5 thread and the O-ring are not damaged when screwing the sensor into the process. O-rings are consumable parts which must be exchanged regularly (at least once per year). Even when all required safety measures have been complied with, potential risks still exist with respect to leaks or mechanical damage to the armature. Wherever there are seals or screws, gases or liquids may leak out undetected. Always make sure that no process medium can be accidentally spilled before removing the sensor from its measurement setup. Make sure that no air or gas bubbles sticks to the sensitive part of the sensor. As a consequence, the measurement value could be unstable. Do not put stress on the system by vibration, bending or torsion. Before use, verify that the sensor is properly configured for your application.

Failure to observe and carry out the maintenance procedures may impair the reliability and correct functioning of the measurement system.

⚠ **CAUTION! When unscrewing the PG13,5 thread connection never turn the sensor at the connector head because you can loosen the ODO Cap from the sensor shaft and fluid can reach the interior of the sensor.**

⚠ **CAUTION! To avoid humidity problems, make sure that the ODO Cap is always attached firmly to the sensor shaft, and that the O-ring between the shaft and cap is undamaged.**

You can find full details, including serial number and most important specifications, on the certificate provided with each sensor. Before use, verify that the sensor is properly configured for your application.

Make sure that following cross sensitivities and resistances of ODO Caps are respected.

Cross sensitivities and resistances of ODO Cap

Measurement not influenced by	ODO Cap H0 / H3	Carbon Dioxide
	ODO Cap H2 / H4	Carbon Dioxide lipophilic compounds

Cross sensitivities and resistances of ODO Cap

Wetted parts resistant to	ODO Cap H0 / H2	Standard cleaning and disinfectant solutions (NaOH, Ethanol, Isopropyl alcohol)
	ODO Cap H3 / H4	Standard cleaning and disinfectant solutions (NaOH, Ethanol and Isopropyl alcohol, active chlorine, chlorine dioxide)
Wetted parts not resistant to	All ODO Caps	Ozone Organic Solvents*

The contact with gaseous or liquid organic solvents for several minutes should be avoided with ODO Caps H0 and H2 (impact on quality indicator and luminophore). If ODO Caps H3 and H4 are used in contact with gaseous or liquid organic solvents, the resulting measurement accuracy in this application must be separately checked and validated by the customer.

3.3 Electromagnetic Compatability

3.3.1 EMC Environment

🗐 NOTICE: The sensor is intended for use in an industrial grade electromagnetic environment and comply with the requirements of IEC / EN 61326-1 (2020). Class B for Emissions. Immunity to proximity fields from RF wireless communications equipment: exceeding to IEC /EN 61326-1 requirements, immunity to cell phone et. Al. frequencies have been tested and passed.

3.3.2 Earthing

The sensor has to be mounted at the mounting location electrostatically conductive (< 1MΩ). It is recommended to assign the sensor shaft and VP 8 cable shield to earth (PE potential equalization) especially in electromagnetically noisy environments. This significantly improves noise immunity and signal quality. The VP 8 thread is connected to the metallic housing of the VisiFerm RS485-ECS sensor. Two options for connecting the sensor to the process environment are available.

Option 1: The Metal tank is connected to earth

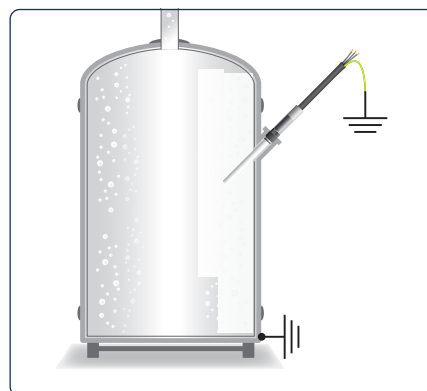The sensor shaft is connected to the metal tank over the PG13,5 thread.

Figure 1: Metal tank with earth connection.

▢ NOTICE: If the tank is not connected to earth, Option 2 has to be applied.

Option 2: Glass or plastic tank (not connected to earth)

The glass or plastic tank has no connection to earth and therefore it is necessary to connect the sensor shaft via a screw clamp or VP 8 cable to earth.
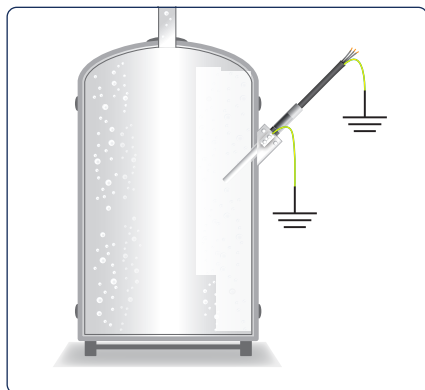

Figure 2: Glass or plastic tank without earth connection.

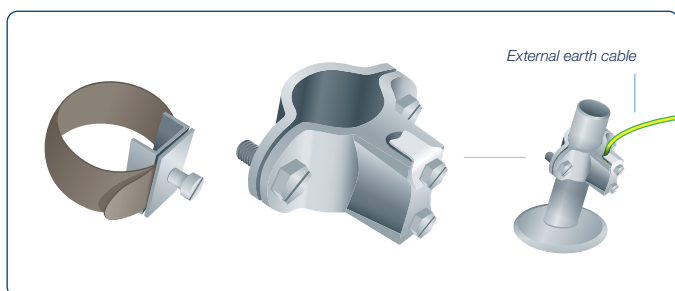Below are shown several examples how to connect the shaft of the sensor directly to earth as required in Figure 2.

External earth cable

Figure 3: Example clamps for connecting the earth to armature and metallic housing of the tank.

3.4 Electrical Safety Precautions

Do not connect the sensor to a power source of any voltage beyond the range stated in the power rating Technical Specifications (www.hamiltoncompany.com).

Always use Hamilton VP 8 cables for safe connection. Cables are available in a broad range of lengths (chapter 10). Make sure the cable is intact and properly plugged to avoid any short circuit.

Keep VisiFerm RS485-ECS away from other equipment which emits electromagnetic radio frequency fields, and minimize static electricity in the immediate environment of the optical measuring parts. Carefully follow all the instructions in chapter 5.3 to avoid electrical damage to the sensor. The contacts must be clean and dry before sensor is connected to the cable.

⚠ **CAUTION! Switch off the power supply and unplug the connector before dismounting the VisiFerm RS485-ECS.**

⚠ **CAUTION! If the power supply (230VAC/24VDC) is switched off or disconnected the reading on the PCS is wrong.**

3.5 Chemical, Radioactive or Biological Hazard Precautions

Selection of the appropriate safety level and implementation of the required safety measures for working with VisiFerm RS485-ECS is the sole responsibility of the user.

If working with hazardous liquids observe and carry out the maintenance procedures, paying particular attention to cleaning and decontamination. If VisiFerm RS485-ECS becomes contaminated with biohazardous, radioactive or chemical material, it should be cleaned. Failure to observe and carry out the maintenance procedures may impair the reliability and correct functioning of the measuring module.

4 Product Description

4.1 General Description

The VisiFerm™ was the first optical dissolved oxygen (DO) sensor for process measurement. With their micro-transmitter, VisiFerm RS485-ECS sensors enable direct communication to the process control system via 4-20 mA standard signal with Arc 2G Adapter or digital Modbus. Wireless communication with the Arc Wireless Adapter may be used for monitoring, configuration and calibration, and saves time without compromising the quality of the wired connection.

VisiFerm RS485-ECS optical technology improves the measuring performance and simplifies maintenance. Improvements compared to conventional electrochemical (amperometric) sensors include flow independence, rapid start-up with no polarization time, and simplified maintenance.

With the transmitter integrated, VisiFerm RS485-ECS sensors provide more reliable measurements directly to your process control system. The micro-transmitter located in the sensor head stores all relevant sensor data, including calibration and diagnostic information, simplifying calibration and maintenance. The integrated quality indicator predicts the remaining sensor and cap life time.

Key benefits include:

- Optical measurement
- No separate transmitter needed
- Simple maintenance with robust industrial design

- Easy to install
- Direct digital Modbus or analog communication to the process control system via 4-20mA standard signal (via Arc Wi 2G Adapter)

4.2 Hardware Description

The VisiFerm RS485-ECS sensor consists of a sensor head with integrated electronic and a sensor shaft in contact with the measured medium. The sensor shaft is terminated by the optical dissolved oxygen (ODO) cap, carrying the oxygen sensitive luminophore. During development, special attention was paid to an optimum sanitary design. All materials in contact with the solution meet the FDA requirement.

VP8 Connector

Sensor Head with micro-transmitter

Process connection PG 13,5 stainless steel

O-ring

Sensor shaft with stainless steel heat number and REF

ODO Cap H3
REF 10068400
LOT 111066955
SN 1143
2019-05-07
HAMILTON

ODO Cap with oxygen-sensitive luminophore (sensing element), ODO Cap serial number, Ref number and stainless steel heat number
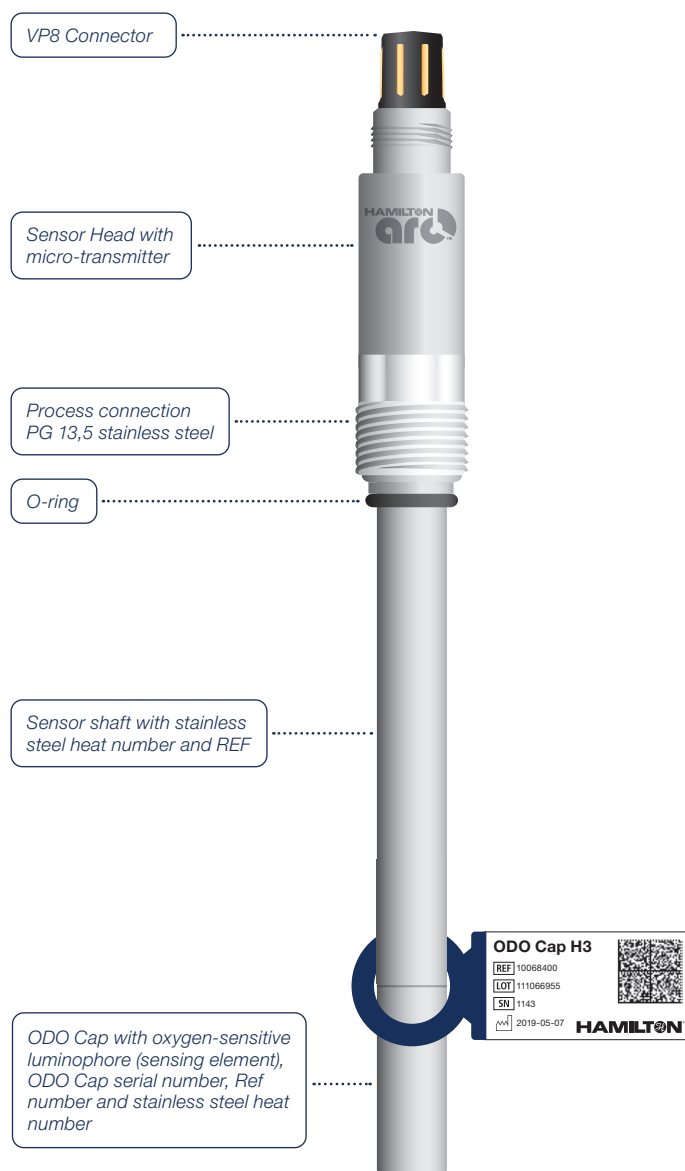
Figure 4: VisiFerm RS485-ECS hardware description.

4.3 Optical DO measurement

The optical measurement principle is based on the so-called luminescence quenching. The luminescence of certain organic pigments (luminophore) is quenched in the presence of oxygen. The luminophore absorbs the excitation light and release a part of the absorbed energy by emission of fluorescence. In the presence of oxygen, energy transfer takes place from the excited luminophore to oxygen. The luminophore does not emit fluorescence and the measurable fluorescence signal decreases.

1 **Fluorescence process (without oxygen)**

Light (excitation)

Luminophore

Light Absorption   Excited State   Fluorescence (emission)

2 **Quenching in the presence of oxygen**

Energy transfer

Light Absorption   Excited State   No fluorescence
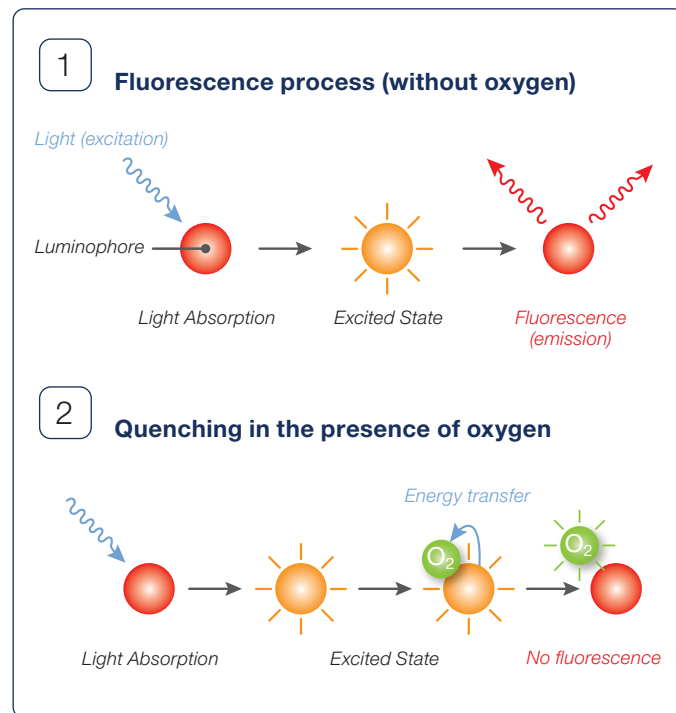
Figure 5: Fluorescence quenching by oxygen.

4.4 VisiFerm RS485-ECS with micro-transmitter inside

With the micro-transmitter integrated, VisiFerm RS485-ECS sensors offer fully compensated signal directly to the process control system. Communication protocols include analog 4-20mA (via Arc Wi 2G Adapter). The micro-transmitter located in the sensor head stores all relevant sensor data, including calibration and diagnostic information, simplifying calibration and maintenance.

5 Installation

5.1 Unpacking

1) Unpack carefully the VisiFerm RS485-ECS sensor. Enclosed you will find the VisiFerm RS485-ECS sensor, the Declaration of Quality, the VisiFerm RS485-ECS Instruction Manual, and the Stainless Steel material Certificate.

2) Inspect the sensor for shipping damages or missing parts.

Figure 6: VisiFerm RS485-ECS delivery package.

5.2 Configuring the VisiFerm RS485-ECS with ArcAir

Arc sensors require application specific configuration. Following parts are required to configure and calibrate Arc sensors:

- Arc View Mobile (Ref 10071113) or ArcAir computer Software Solution
- External Power supply with Arc USB Power Cable (Ref 243490-xx)

To configure and set up the Arc sensors at least ArcAir Basic is required. Below in this table you will find the different ArcAir licenses and its functionality:

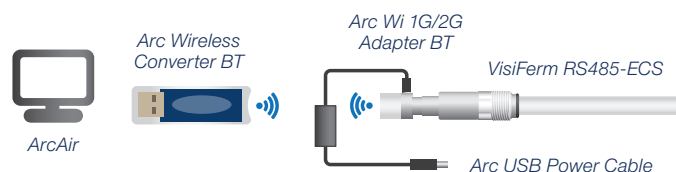| ArcAir	Read	Calibrate	Configure	Documentation
Basic	✓	✓	✓	–
Advanced	✓	✓	✓	✓

Figure 7: VisiFerm RS485-ECS configuration with ArcAir.

5.2.1 Installing ArcAir Basic on the Computer

1) Download the Zip file «ArcAir» from the Hamilton webpage www.hamiltoncompany.com (search for ArcAir).

2) Unpack the ZIP-File.

3) Do not plug in the Wireless Converter before the installation of ArcAir is completed.

4) Install «ArcAir» by double clicking «ArcAir.exe» and follow the instructions on the screen.

5.2.2 Connecting an VisiFerm RS485-ECS Sensor to ArcAir

1) Connect a sensors with the power supply, e.g. Arc USB Power Cable Ref 243490-xx

2) Switch on the mobile's Bluetooth connection or connect a Wireless Converter BT to USB Port of your computer (only for wireless connection

3) The ArcAir application (see Figure 7) recognizes and displays the connected sensors automatically

⚠️ **CAUTION! For automatic sensor login a unique and global Operator Level S password for all intelligent sensors is required. Please make sure you have added the same Operator Level S Password for all Arc sensors in the ArcAir application under Backstage/Settings/Operator Level S Password.**

5.2.3 Create User Accounts

1) Start ArcAir application on computer

2) Click on «Backstage» left upper corner

3) Select «User Management»

4) Click the «Add» Button for opening the user editor

5) Type in the user details and password

6) Select the specific rights for the user

⚠️ **CAUTION! First user is the administrator and all user rights are assigned as default.**

📄 NOTICE: Initial operation of ArcAir is in the laboratory mode as long as no user account is created. Laboratory mode does not require a login password and enable all features in the installed license version.

5.2.4 Configuring the VisiFerm RS485-ECS Sensor Parameters

1) Start the ArcAir application

2) Select the desired sensor

3) Open the drawer «Settings» (make sure you have the «Sensor Settings» user right)

4) Configure the sensor

A description of the available settings is given below:

Parameter Name	Description	Default Value	Configuration	Location
DO Unit	These are the measurement physical units	%vol. %sat. ug/l ppb mg/l ppm mbar ppm gas*	Required	Measurement/ Values
T unit	These are the temperature physical units	K °F °C	Required	Measurement/ Values
Salinity	The concentration of dissolved oxygen in saturated water is dependent on the salinity	0 mS/cm	Default parameter recommended	Measurement/ Parameter
Air Pressure	The partial pressure of oxygen is proportional to the atmospheric pressure or the pressure of the air supply to the process	1013 mbar	Required, application dependent	Measurement/ Parameter
Measuring interval	The measuring interval can be set between 1-300 sec. The LED flashes once in the set measure interval	3 sec.	Default parameter recommended	Measurement/ Parameter
Moving average	The sensor uses a moving average over the measuring points	10	Default parameter recommended	Measurement/ Parameter
Sensing Material	Sensing Material are different types of ODO Cap which can be set by entering the REF of the ODO Caps	243515	Must application dependent	Measurement/ Parameter
Resolution	The resolution interval can be set between 8-16. The measuring interval is on itself an average over 8-16 individual sub-measurements.	8	Default parameter recommended	Measurement/ Parameter

In calibration mode the sensor will automatically switch to 3 sec sampling rate after the first calibration.

5.2.5 Configuring the calibration settings

Parameter Name	Description	Default Value	Configuration	Location
Drift DO	High drift will interrupt the calibration process. Warning comes up «drift oxygen»	0.05%/ min	Default parameter recommended	Calibration / Calibration Settings
Drift T	High drift will interrupt the calibration process. Warning comes up «drift temperature	0.05K/ min	Default parameter recommended	Calibration / Calibration Settings

5.2.6 Configuring the temperature settings of SIP / CIP process

Parameter Name	Description	Default Value	Configuration	Location
Customer temperature range	User defines temperature range for DO reading. No DO reading above 85°C possible	-20°C to 85°C	Default parameter recommended	Status / Quality, Counters and Tempe-ratures
SIP process definition	User defines conditions for the SIP counter	Temp. min: 120°C Temp. max: 140°C Time: 20min	Default parameter recommended	Status / SIP / CIP
CIP process definition	User defines conditions for CIP counter	Temp. min: 80°C Temp. max. 100°C Time: 20min	Default parameter recommended	Status / SIP / CIP

5.2.7 Configuring the analog settings for your process control system

Parameter Name	Description	Default Value	Configuration	Location
Interface Mode	The output of the ECS/4-20 mA can be configure linear, bilinear or with a fix value	ECS mode/ 4–20 mA	Default parameter recommended	Interface / Analog
Value at 0 nA / 4 mA	Defined measurement value for 0 nA / 4 mA output	0 %sat.	Must application dependent	Interface / Analog Output
Value at 60 nA / 20 mA	Defined measurement value for 60 nA / 20 mA output	300 %sat.	Must application dependent	Interface / Analog Output

Parameter Name	Description	Default Value	Configuration	Location
Mode in event of warning	Current output mode in case of warnings	No output	Default parameter recommended	Interface / Analog Output
Mode in event of error	Current output mode in case of errors	Continuous output	Default parameter recommended	Interface / Analog Output
Output in event of warning	Current output in case of warnings	433 nA / 3.5 mA	Default parameter recommended	Interface / Analog Output
Output in event of error	Current output in case of error	466 nA / 3.5 mA	Default parameter recommended	Interface / Analog Output
Output for T out of limit	Current output in case of temperature out of limit	499 nA / 3.5 mA	Default parameter recommended	Interface / Analog Output

5.2.8 Defining a measuring point name for identification of the process

Parameter Name	Value	Default Settings	Location	Descriptions
Measuring point	User can define a sensor name for better identification of the measuring point	10118255-1111-123	Optional	Information / Info Userspace

5.3 Install VisiFerm RS485-ECS in your Measuring Loop

5.3.1 Mechanical Process Connection

The VisiFerm RS485-ECS mechanical design is compatible with all Hamilton process housings, including FlexiFit, Retractex, RetractoFit and Hygienic Sockets.

Before installing the armatures, you should test that the seal is tight and the parts are all in working order. Ensure that there is no damage to the sensor or the armature. Check whether all O-rings are in place in the appropriate grooves and are free of damage. To avoid any mechanical damage to O-rings on assembly, they should be slightly greased.

Please note that O-rings are wetted parts and greasy compounds must comply to your FDA application needs.

5.3.2 VP8 Pin Designation

Always use Hamilton VP 8 sensor cables for safe connection, which are available in different lengths (chapter 10). For easy identification of each pin on the VP8, the head has a notch between pin A and pin B.
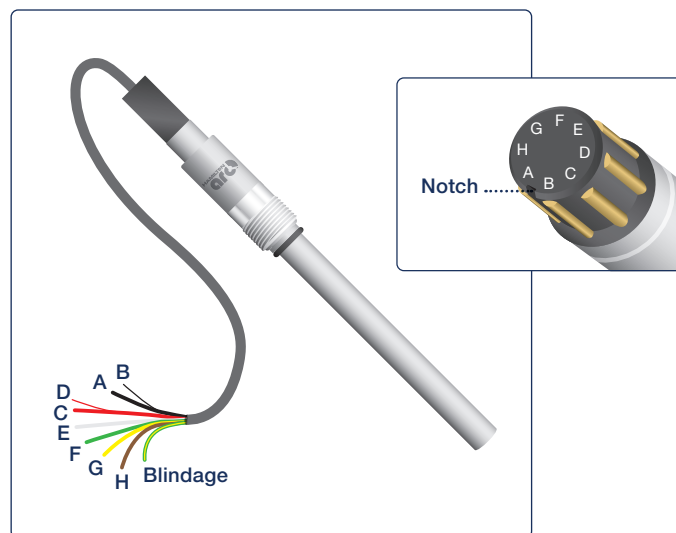

Figure 8: Requirements for electrical connection of VisiFerm RS485-ECS sensors.

VP PIN	Function	Double Coaxial Cable for ECS Mode	Color Data Cable
A	ECS cathode	Coaxial core black transparent	Yellow
B	ECS Anode (Voltage range may not exceed -2V ... +2V)	Coaxial shield black	Green
C	Power supply: + 24 VDC (10 to 27 VDC) Start-up power: 1.5 W Continuous power consumption: 250 mW	Coaxial core red transparent	Red
D	Power supply: Ground	Coaxial shield red	Blue
E	Temperature sensor NTC 22 kOhm for ECS	White	Brown
F	Temperature sensor NTC 22 kOhm for ECS	Green	White
G	RS485 (A)	Yellow	Gray
H	RS485 (B)	Brown	Pink
Shaft	Sensor shaft connected to earth	Green/Yellow	Green/Yellow

> 🗎 NOTICE: Always use Hamilton sensor cables for safe connection.

5.3.3 Connect via 4-20 mA

By adding an Arc Wi 2G Adapter BT (Ref 243470) on top of the VisiFerm RS485-ECS sensor head, it is possible to output an analog 4-20 mA signal from the digital Modbus. Always use Hamilton M12 sensor cables for safe connection, which are available in different lengths (chapter 10).
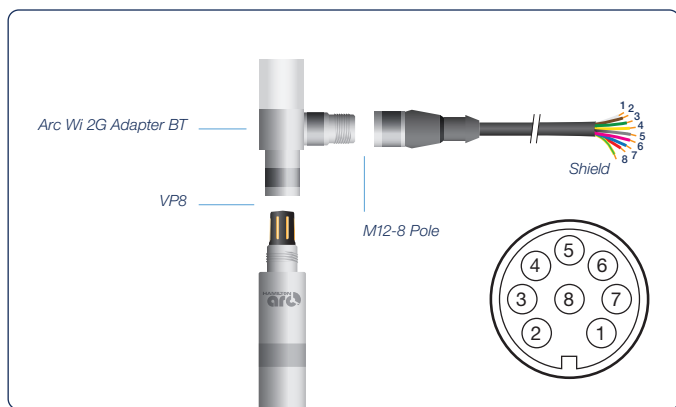
Figure 9: Arc sensor with Arc Wi 2G Adapter and M12-8 pole open-end cable.

M12 (A coded) Pin Designation with Respect to Hamilton M12-8 Pole Sensor Cable Conductor Colors (for further specifications check the Hamilton website):

M12 Pin	Function	Color	Description
1	+4-20 mA # 1	White	4-20 mA two-wire interface, functions as a current sink and needs to be powered. It regulates the input current according to the sensor measurements and galvanically isolated from the power supply.
2	-4-20 mA # 1	Brown	
3	+4-20 mA # 2	Green	
4	-4-20 mA # 2	Yellow	
5	RS485 (A)	Gray	Modbus RTU RS485
6	RS485 (B)	Pink	Modbus RTU RS485
7	GND	Blue	Ground
8	+ 24 VDC	Red	Power supply: +10 V to +27 V (Power supply can be external; not from PCS)
Housing	Shield	Green/Yellow	Connected to the housing including the VP8 female connector

5.3.4 Electrical Connection for Analog 4-20 mA Connection

The 4–20 mA interface enables connection of the VisiFerm RS485-ECS sensor to a data recorder, indicator, control unit or PCS with analog I/O. VisiFerm RS485-ECS requires the Arc Wi 2G Adapter BT (Ref 243470) for a 4-20 mA interface connection. In combination with the Arc Wi 2G Adapter BT (Ref 243470) the sensor works as a current sink and is passive. Connect the sensor according to the pin designations (see chapter 5.3.2). The 4–20 mA interface of the Arc Wi 2G Adapter BT (Ref 243470) in combination with the Arc sensor is pre-configured with default values for the 4–20 mA range and measurement unit. Configure the 4–20 mA interface according to individual requirements for a proper measurement in ArcAir.
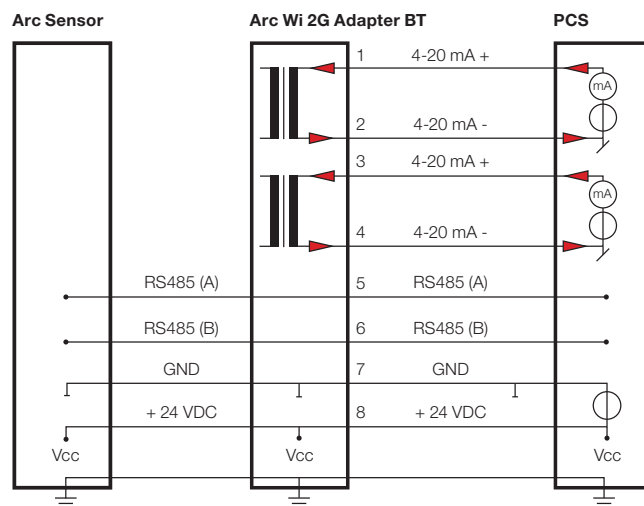

Figure 10: Typical connection to PCS using the Arc Wi 2G Adapter BT (Ref 243470). This is the safest form of wiring an Arc sensor. The Arc Wi 2G Adapter BT (Ref 243470) provides internal galvanic isolators for enhanced analog signal quality. Connection to the process control system is simplified.
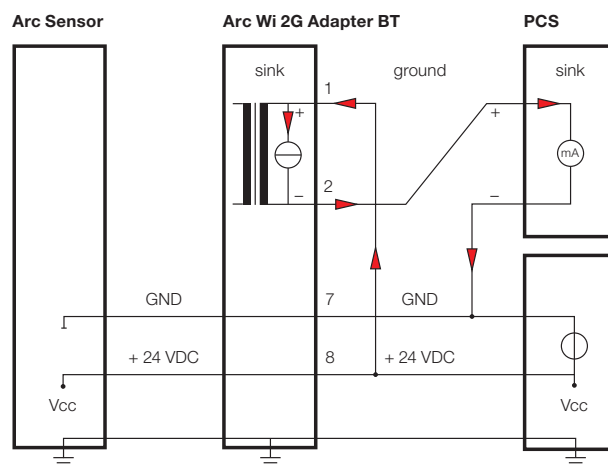
Figure 11: Typical connection to PCS using the Arc Wi 2G Adapter BT (Ref 243470)

5.3.5 Electrical connection for the ECS interface

The ECS mode enables the simulation of an electrochemical sensor. Thus a VisiFerm RS485-ECS sensor can be connected to classical measuring devices instead of amperometric oxygen sensors (Clark cells). Furthermore only the power supply of the VisiFerm RS485-ECS sensor is necessary.

NOTICE: ECS signal is only compatible with Arc Wi 1G Adapter.

⚠ **CAUTION! Do not apply any high voltage (max. 2 VDC) at pin B (anode)! This can result in a destruction of the sensor in ECS mode!**

In an electromagnetically noisy environment, it is advisable to assign the sensor's shaft and/or VP cable shield to earth. This significantly improves noise immunity and signal quality.

The NTC temperature sensor attached to the pins E and F is isolated from the integrated electronics and is used for the temperature compensation of the oxygen signal in the measuring device.

Usually classical sensors are operated with a polarization voltage between anode and cathode. This polarization voltage is supplied by the measuring device. VisiFerm RS485-ECS can be operated with polarization voltages usual for electrochemical sensors. The sensor is optimized for a polarization voltage of -675 mV.

For adjustment to different measuring devices and/or for simulation of different amperometric sensors the current can be adjusted between 0 and 500 nA.

When using the ECS interface, pins have the following designations with respect to VP cable conductor colors:

VisiFerm RS485-ECS	VP pin	Double Coaxial Cable for ECS Mode
ECS Cathode	A	Coaxial core black transparent
ECS Anode (Voltage range may not exceed -2V ... +2V)	B	Coaxial shield black
Power supply: + 24 VDC (10 to 27 VDC) Start-up power: 1.5 W Continuous power consumption: 250 mW	C	Coaxial core red transparent
Power supply: Ground	D	Coaxial shield red
NTC 22 kOhm	E	White
NTC 22 kOhm	F	Green
Sensor shaft (connect with the mass of the power supply)	Shield	Cable shield Green/Yellow

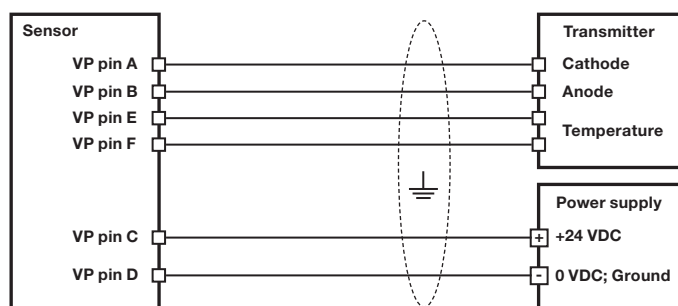## Example of circuit arrangement

Figure 12: Wiring diagram for the ECS interface.

5.3.6 Electrical connection for the digital RS485 interface

The digital RS485 interface enables communication with VisiFerm RS485-ECS sensor for performing measurements, for calibrating the sensor and for changing the sensor's configuration parameters. VisiFerm RS485-ECS sensors are always connected to digital controlling devices. To function, they require a power supply (VP 8 pins C and D, see below). The section entitled «Configuring the VisiFerm RS485-ECS parameters» describes operation in digital mode.

Additional information:

The Modbus RTU communication protocol corresponds to the Modbus-IDA standard (see www.modbus.org). VisiFerm RS485-ECS uses an open register set developed by Hamilton. Additional information about the register content and structure can be found in the programmers manual under www.hamiltoncompany.com

The Modbus physical layer is described in detail with requirements on cabling and line termination in the «Modbus Serial line Protocol and Implementation Guide» www.modbus.org > Technical Resources / Modbus Specifications / Modbus Serial line Protocol and Implementation Guide.

⚠ **CAUTION! Because all sensors are delivered with factory-default settings, each sensor must be configured for its specific application before first use (see the section entitled «Configuring VisiFerm RS485-ECS»).**

The pins for digital the RS485 interface have the following designation with respect to VP cable conductor colors:

VisiFerm RS485-ECS	VP pin	Double Coaxial Cable for ECS Mode	Color Data Cable
Power supply: + 24 VDC (10 to 27 VDC) Start-up power: 1.5 W Continuous power consumption: 250 mW	C	Coaxial core red transparent	Red
Power supply: Ground	D	Coaxial shield red	Blue
RS485 (A)	G	Yellow	Gray
RS485 (B)	H	Brown	Pink
Sensor shaft	Shield	Green/Yellow	Green/Yellow

In an electromagnetically noisy environment, it is advisable to connect the VP cable shield to the earth. This significantly improves noise immunity and signal quality.
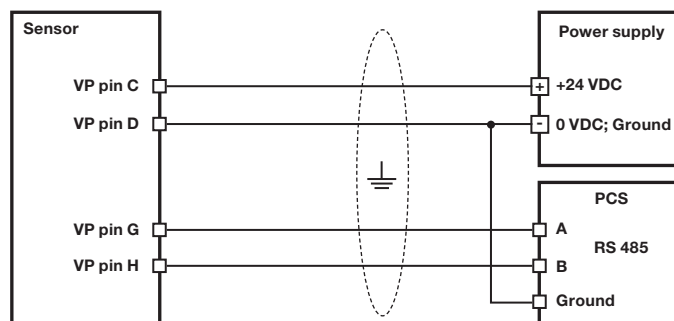
Example of circuit arrangement

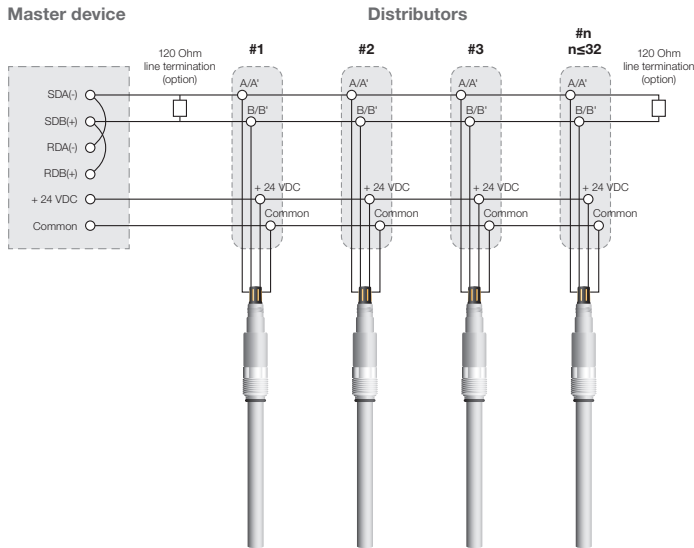*Figure 13: Wiring diagram for the RS485 interface.*

Figure 14: Multi-drop bus wiring for the Modbus two-wire mode. Each sensor functions as a Modbus slave.

🗍 NOTICE: In order to avoid signal reflection on the lines the use of line termination resistors (120 Ohm each) is recommended. The effect of signal reflections becomes more relevant with long cable length and/or high baud rates.

🗍 NOTICE: In the connection scheme shown above, each sensor must have the unique Modbus device address for proper communication.

The serial Modbus connection between the RS485 port of the master and the corresponding interfaces of the sensors has to be ensured according to the EIA/TIA RS485 standard. Only one sensor can communicate with the master at any time.

6   Operation

⚠ CAUTION! Only use the sensor within the speci-fications (chapter 10). Failure to do so may lead to damages or measurement failure.

1) Remove the protective caps from the VisiFerm RS485-ECS shaft, and from the VP 8 sensor head

2) Check the O-ring on the sensor shaft and verify if the ODO Cap is screwed firmly to the sensor shaft (chapter 7.2)

3) Verify if the sensing material is correct for the ODO Cap type which can be set by entering the Ref number of the ODO Caps

4) Verify the functionality of the sensor including the ODO cap (chapter 7.1)

5) Calibrate the sensor (chapter 7.3)

6) Connect the sensor to the process control system (chapter 5.3)

7) Verify the measurement in air on your control system

8) Mount the sensor to the armature or process connection (chapter 5.3)

🗍 NOTICE: No oxygen measurement is performed at a temperature higher than 85°C to protect the optoelec-tronics and enhanced the sensor lifetime.

🗍 NOTICE: To ensure a correct measurement by changing a ODO Cap type e.g. ODO Cap H3 the reference number of the ODO Cap should be configured in the Sensing Material register (See chapter «Configuring the VisiFerm RS485-ECS Sensor Parameters». Firmware version ODOUM101 (initial start Version) hex or higher is required.

7   Maintenance

Periodic maintenance routines need to be run in order to ensure safe and reliable operation and measurement of sensor and the accessories.

⚠ CAUTION! Avoid any contact of the equipment with corrosive media.

7.1   Verify Sensor Status and ODO Cap Functionality

1) Power the sensor with the Sensor Power Cable and connect the sensor to ArcAir.

2) Control the traffic lights (Figure 15).

3) Please refer to the troubleshooting (chapter 8) for the next steps if the traffic light is not green.

4) Control the quality of the ODO cap in Sensor Status / Quality Counter and Temperature / Quality Indicator and change the ODO Cap or sensor if required (chapter 7.2).

🗍 NOTICE: The lifetime of the VisiFerm RS485-ECS highly depends on the specific conditions of the application. Temperature, pressure, chemicals used may accelerate the ageing of both the sensor and its ODO cap. A warning «DO Replace Sensor Cap» remains active as long as the sensor quality is below 40%. The quality indicator takes sensor and cap into account.

The sensor is performing correctly.
No errors or warnings have been registered.

At least an error or a warning has been registered.
Verify the sensor errors and warnings in Sensor Status.

No communication between the sensor and ArcAir.
This may be due to a hardware failure.

Figure 15: Description of the traffic lights on ArcAir.

7.2 Replacing the ODO Cap

The exchange of ODO Cap can be performed very easily:

1) Unscrew the ODO Cap from the shaft (Figure 16).

2) Exchange the O-ring.

3) Screw firmly the new ODO Cap onto the sensor shaft again.

4) Perform sensor calibration (chapter 7.3).

⬚ NOTICE: If the ODO Cap is mounted very firmly on the shaft, and if you cannot obtain a good grip on the stainless steel with your fingers, a silicone tube between your fingers and metal may supply a better grip.
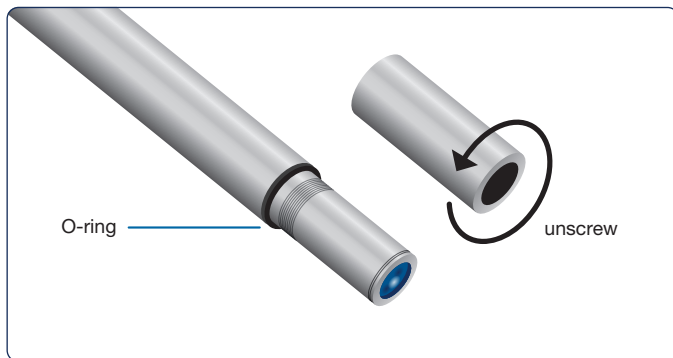

O-ring ——————— unscrew

Figure 16: Replacing the ODO Cap.

7.3 Calibration

The VisiFerm RS485-ECS sensors provide two kinds of sensor calibration: automatic standard calibration, and product calibration. The automatic standard calibration and the product calibration may be performed using ArcAir (see chapter 5.2).

7.3.1 Automatic Standard Calibration with ArcAir

VisiFerm RS485-ECS sensors are calibrated at two points: in air and in an oxygen-free environment. During calibration, the sensor controls automatically the stability of the oxygen and temperature signals.

⬚ NOTICE: For greater measurement accuracy ensure that temperature difference between calibration medium and process medium is minimal.

7.3.2 Calibration in Air (Calibration Point Air)

1) Make sure temperature, humidity and pressure values are constant

2) Power the VisiFerm RS485-ECS and connect to ArcAir via the Arc Wireless Converter BT

3) Select the sensor in the sensor list

4) Open the Calibration tab

5) Select Calibration Point Air

6) Click Start to start the calibration wizard

7) Follow the instructions on the screen

O_2

O_2 O_2 O_2
O_2
O_2 O_2

O_2

O_2

O_2

Air: Pressure and humidity compensation required

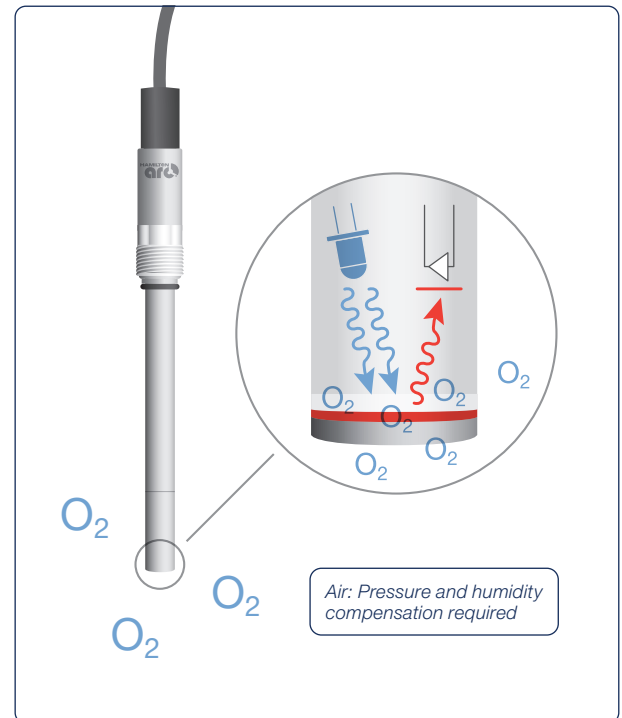*Figure 17: Calibration setup in air*

⬚ NOTICE: The value of the saturated oxygen concentration at different temperatures, different pressures and air humidity play an important role for the calibration of dissolved oxygen. For an accurate calibration Hamilton strongly recommend to to enter the atmospheric pressure and humidity values in the ArcAir calibration, product calibration and verification wizards.

7.3.3   Zero Point Calibration (Point Zero Oxygen)

1) Install the sensor into the calibration station and connected the Nitrogen calibration gas (Figure 18)

2) Power the VisiFerm RS485-ECS and connect to ArcAir via the Arc Wireless Converter BT

3) Select the sensor in the sensor list

4) Open the Calibration tab

5) Select Zero Point calibration

6) Immerse the sensor into an oxygen-free environment for e.g. nitrogen. Verify that the flow rate does not exceed 0.5 L/min and avoid overpressure

7) Click Start to start the calibration wizard
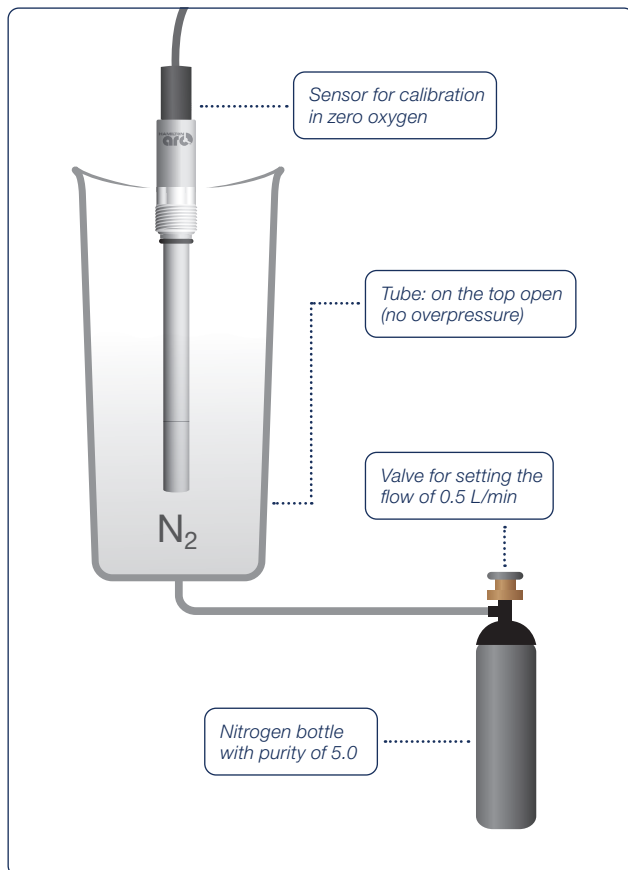
8) Follow the instructions on the screen

Figure 18: Zero point calibration setup

7.4   Product calibration

The product calibration is an in-process calibration procedure in order to adjust the measurement to specific process conditions. Product calibration is an additional calibration procedure to a standard calibration.

If product calibration is activated, the VisiFerm RS485-ECS calibration curve is calculated from the data of last calibration at point 1 and from the data of the product calibration (Figure 19). In order

to restore the original standard calibration curve, the product calibration can be at any time by selecting on the Product calibration command «cancel». A new standard calibration cancels a product calibration as well.
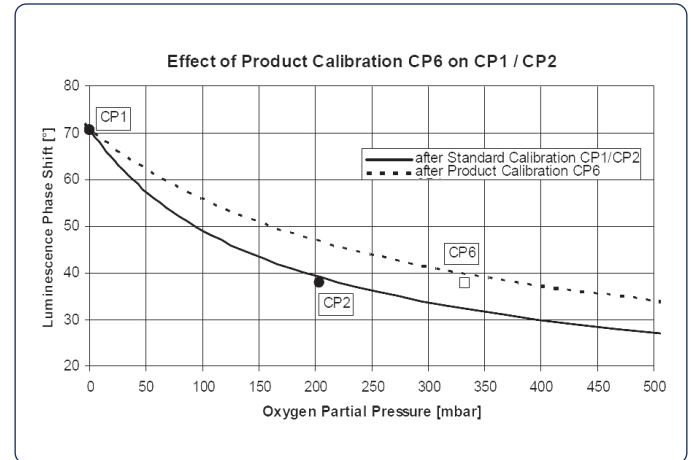

Figure 19: Effect of a product calibration (CP6) on an existing standard calibration function based on the Zero Point Calibration (CP1) and the Air Calibration (CP2).

> NOTICE: The product calibration is possible for DO values in the range of 2 to 55 %-vol (20 – 550 mbar pO_2).

A product calibration is performed as follows:

1) Connect one of the VisiFerm RS485-ECS sensor with the power supply, e.g. USB Power Cable Ref 243490 and install a Wireless Converter BT Ref 242333.

2) Select the desired sensor from the sensor list

3) Go to «Process Settings»

4) Click «Start» to start the product calibration wizard

5) Follow the instruction on the screen

> NOTICE: Alternatively, the product calibration may be performed with a field device on side the measuring point.

7.5   Cleaning

This chapter outlines a manual cleaning procedure for the care and maintenance of optical dissolved oxygen (ODO) sensors including a procedure for the cleaning the sensing membrane in particular.

Cleaning the Sensor

Carry out the cleaning procedure as follows:

1) Remove sensor from the measuring setup.

2) Check if the ODO Cap is mounted firmly on the shaft.

3) Soak a dust-free cloth or tissue paper with water and wipe the wetted parts with it. Thoroughly rinse the wetted parts and the sensing membrane with deionised water afterwards.

4) Dry the wetted parts with a clean dust-free cloth or tissue and store the sensor in dry and dark conditions (ODO Caps are light-sensitive).

5) If the sensing-membrane on the front of the cap is contaminated with oil, grease or other organic matter, soak a clean dust-free cloth with isopropyl alcohol. Rinse residua isopropyl alcohol immediately from the membrane with deionised water and gently wipe over the membrane.

6) After cleaning always perform a new calibration before carrying out measurements. (See chapter 7.3 in the corresponding Operating Instruction Manual)

⚠ **CAUTION! Cleaning, assembly and maintenance should be performed by personnel trained in such work. Do not use any abrasive tissues or cleaning materials and do not use any cleaning chemicals other then described above. Before removing the sensor from the measuring setup, always make sure that the setup is pressure-less and cold and that no process medium can be accidentally spilled. When removing and cleaning the sensor, it is recommended to wear safety glasses and protective gloves.**

8 Troubleshooting

8.1 Sensor Self-Diagnostic

VisiFerm RS485-ECS sensors provide a self-diagnostic functionality to detect and identify the most common sensor malfunctions. Digital Modbus, may provide warning and error messages. The settings of the analog 4–20 mA interface can be configured according to the NAMUR recommendations to indicate an abnormal event (see chapter 5.2.3). Use ArcAir for monitoring the sensor status and for troubleshooting. The following types of messages are provided by the self-diagnosis function.

🗐 NOTICE: Errors cannot be ignored and corrective action is immediately necessary.

🗐 NOTICE: Warnings can be ignored but the warning will be displayed continuously until the corrective action is successfully completed.

🗐 NOTICE: For additional information about the sensor status and the diagnostics features refer to the sensor operation instruction manual or the programmer`s manual.

8.1.1 Warnings

Warning	Cause / Solution
DO reading below lower limit	The oxygen reading is too low (DO < 0%-sat). Make a new zero-point calibration (chapter 7.3.3).
DO reading above upper limit	The oxygen reading is too high (DO > 300 %-sat). Make a new calibration in oxygen saturated medium (see cchapter 7.3.3). If not successful, replace the sensor cap.
T reading below lower limit	The temperature is below the user defined measurement temperature range. If the process temperature is outside this range, the sensor will not perform DO readings.
T reading above upper limit	The temperature is above the user defined measurement temperature range. If the process temperature is outside this range, the sensor will not perform DO readings.
Measurement not running	The measurement interval is set to 0 or the measurement temperature is out of the range.
DO calibration recommended	Perform a calibration in order to ensure reliable measurement (chapter 7.3)
DO replace sensor cap	Replace the ODO Cap and calibrate the cap sensor. This warning remains active as long as the sensor quality is below 40%. See chapter 7 for replacement conditions. The quality indicator takes sensor and cap into account.
ECS value above upper limit	Above allowed limit. Reconfigure and adjust installation again or contact our Technical Support.
ECS current set point not met	Not possible to control ECS. Control wiring again or contact our Technical Support.
4-20 mA value below 4 mA on the PCS	The measurement value is below the lower limit of the 4–20 mA interface output. Reconfigure the 4–20 mA interface (chapter 5.2.7)
4-20 mA value above 20 mA on the PCS	The measurement value is above the upper limit of the 4–20 mA interface output. Reconfigure the 4–20 mA interface (chapter 5.2.7)
4-20 mA current set-point not met on the PCS	The 4–20 mA interface is not able to regulate the current requested for the current measurement value according to your 4–20 mA interface configuration. Check the 4–20 mA wiring and supply voltage (chapter 5.3.2)
Sensor supply voltage too low	The sensor supply voltage is too low for the sensor to operate correctly. Ensure stable supply voltage within the sensors specifications.
Sensor supply voltage too high	The sensor supply voltage is too high for sensor to operate correctly. Ensure stable supply voltage within the sensors specifications.
Replace sensor recommmended	The Sensor quality indicator is below 40%. The quality of the sensor is sufficient for reliable measurement, but replacement of the sensor will be needed in near future.

8.1.2 Errors

Error (failures)	Cause / Solution
DO reading failure	Sensor cap is missing or the sensor is broken.
DO p(O$_2$) exceeds air pressure	Measured partial pressure of oxygen is higher than the air pressure set by the operator. Reconfigure the air pressure parameter (chapter 5.2.4).
T sensor defective	The internal temperature sensor is defect, please call our Technical Support.

Error (failures)	Cause / Solution
DO sensor cap missing	The DO sensor cap has been removed. Do not immerse the sensor in a measurement solution. Mount an ODO Cap and calibrate the sensor prior measurement (chapter 6).
DO sensor cap replace	Sensor cap has reached lower level of cap quality indicator. You have to replace the cap.
Red channel failure	Measurement channel failure. Please call our Technical Support.
Temperature reading far below min	The measured temperature is below the operation temperature
Temperature reading far above max	The measured temperature is above the operation temperature
4-20 mA value below 4 mA on the PCS	The measurement value is below the lower limit of the 4–20 mA interface output. Reconfigure the 4–20 mA interface (chapter 5.2.7)
4-20 mA value above 20 mA on the PCS	The measurement value is above the upper limit of the 4–20 mA interface output. Reconfigure the 4–20 mA interface (chapter 5.2.7)
4-20 mA current set-point not met on the PCS	The 4–20 mA interface is not able to regulate the current requested for the current measurement value according to your 4–20 mA interface configuration. Check the 4–20 mA wiring and supply voltage (chapter 5.3.2)
Sensor defective > RU	Sensor is defective or Sensor Quality indicator is below 10%. The quality of the sensor is not sufficient for reliable measurement. Sensor needs to be replaced.
EEPROM comm. (I2C) error Userend	EEPROM internal communication error. Please try to restart the sensor and try again.
Internal Communication (I2C) failure Userend	Internal I2C communication error. Please try to restart the sensor and try again
Internal Communication failure to Frontend	No communication between Frontend and Userend. Reset the sensor and try again.
Stackoverflow	Internal memory failure. Please send the sensor back to Hamilton Bonaduz or contact Technical Support.

8.2   Getting Technical Support

If a problem persists even after you have attempted to correct it, contact Hamilton`s Customer Support: Please refer to the contact information at the back of this operating instruction.

8.3   Returning VisiFerm RS485-ECS for Repair

Before returning a VisiFerm RS485-ECS sensor to Hamilton for repair, contact our Customer Service (see chapter 8.2) and request a Returned Goods Authorization (RGA) number.

Do not return a VisiFerm RS485-ECS sensor to Hamilton without an RGA number. This number assures proper tracking of your sensor. VisiFerm RS485-ECS sensors that are returned without an RGA number will be sent back to the customer without being repaired.

Decontaminate the VisiFerm RS485-ECS sensor and remove health hazards, such as radiation, hazardous chemicals, infectious agents etc. Provide complete description of any hazardous materials that have been in contact with the sensor.

9   Disposal

The design of Hamilton sensors optimally considers environmental compatibility. In accordance with the EC Directive 2012/19/EU Hamilton sensors that are worn out or no longer required must be sent to a dedicated collection point for electrical and electronic devices, alternatively, must be sent to Hamilton for disposal. Sensors must not be sent to an unsorted waste disposal point.

有害物質表，請參閱www.hamiltoncompany.com，章節過程分析，符合性聲明

10   Ordering Information

Parts below may only be replaced by original spare parts.

10.1 VisiFerm RS485-ECS

10118255	VisiFerm RS485-ECS				
	Code	Interface			
	1	RS485-ECS			
		Code	Sensor length		
		1	120		
		2	160		
		3	225*		
		4	325		
		5	425		
			Code	ODO Cap	
			1	H0	
			2	H2	
			3	H3	
			4	H4	
				Code	Wetted Parts
				1	EPDM
10118255 –					Orderingcode

*The VisiFerm RS485-ECS 225 have, in reality, a shaft length of 215 mm.
This ensures optimal rinsing in replaceable armatures, such as Retractex.*

10.2 Parts and Accessories

10.2.1 Caps for installed base
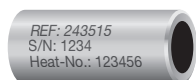
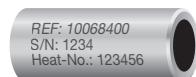| Ref	Product Name	Wetted Materials
243515	ODO Cap H0	Stainless steel 1.4435 Silicone (FDA approved and USP Class VI)

Application: For general application in biotechnology, water treatment and monitoring as well as in breweries, wineries and soft drink processing.
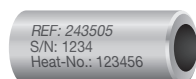
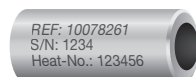| Ref	Product Name	Wetted Materials
243505	ODO Cap H2	Stainless steel 1.4435 PTFE (USP Class VI)

Application: For fermentation processes where sterilization in place (SIP) is performed in media containing higher amounts of lipophilic compounds. It comes with a hygienic design.

10.2.2 Caps for higher robustness

Ref	Product Name	Wetted Materials
10068400	ODO Cap H3	Stainless steel 1.4435 Silicone (FDA and USP Class VI)

Application: For general application in biotechnology, water treatment and monitoring as well as in breweries and wineries.

| Ref	Product Name	Wetted Materials
10078261	ODO Cap H4	Stainless steel 1.4435 PTFE (USP Class VI)

Application: For fermentation processes where sterilization in place (SIP) is performed in media containing higher amounts of lipophilic compounds. It comes with hygienic design.

10.2.3 Various accessories

Ref	Product Name	Length
355320	3 m Cable M12-8 Pole / open End	3 m
355321	5 m Cable M12-8 Pole / open End	5 m
355322	10 m Cable M12-8 Pole / open End	10 m

Description: The Sensor Cable M12 – open end is designed for connection to a data recorder, indicator, control unit or PCS (Process Control System) with analog I/O.
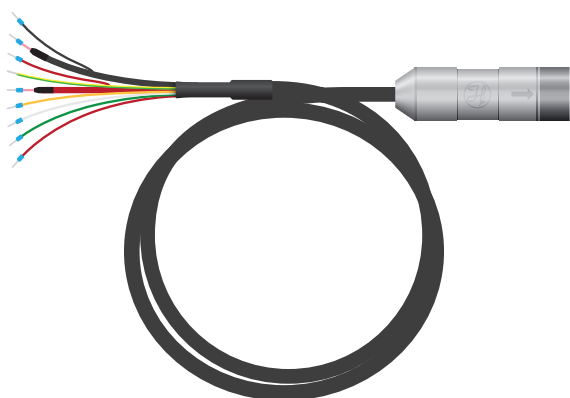
Ref	Product Name	Length	Interface
355263	Sensor Data Cable VP 8	1 m	4-20 mA/Modbus
355264	Sensor Data Cable VP 8	3 m	4-20 mA/Modbus
355265	Sensor Data Cable VP 8	5 m	4-20 mA/Modbus
355266	Sensor Data Cable VP 8	10 m	4-20 mA/Modbus
355267	Sensor Data Cable VP 8	15 m	4-20 mA/Modbus
355268	Sensor Data Cable VP 8	20 m	4-20 mA/Modbus
355217	Sensor Cable VP 8	1 m	ECS mode
355218	Sensor Cable VP 8	3 m	ECS mode
355219	Sensor Cable VP 8	5 m	ECS mode
355220	Sensor Cable VP 8	10 m	ECS mode
355221	Sensor Cable VP 8	15 m	ECS mode
355222	Sensor Cable VP 8	20 m	ECS mode

Description: The Sensor Cable VP 8 – open end is designed for connection to a data recorder, indicator, control unit or PCS (Process Control System) with analog I/O.
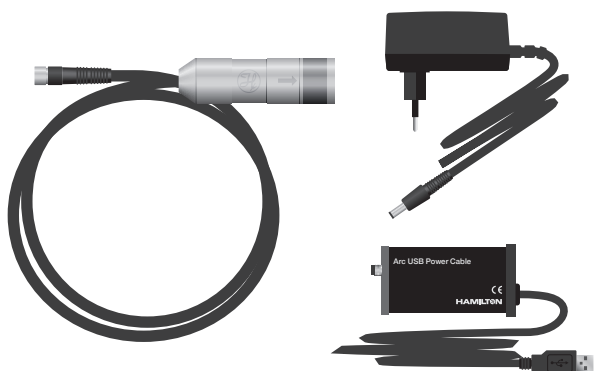
Ref	Product Name	Connection to
243490-01	Arc USB Power Cable VP 8	Arc Sensor Arc Wi 1G Adapter BT
243490-02	Arc USB Power Cable M12 - 8	Arc Wi 2G Adapter BT
242176	Arc Sensor Cable VP 8	
355339	Arc Wi 2G BT Service Cable 2m	
355289	Arc Wi 2G Service Cable 2m	

Description: The Arc USB Power Cable provides power supply via USB port for Arc sensors and digital communication to Hamilton's PC software for monitoring, configuration, calibration and firmware updates.
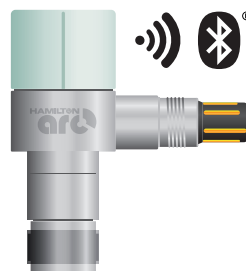

Ref	Product Name
243499	Arc Wireless Converter BT

Description: Designed for wireless communication between ArcAir and VisiFerm RS485-ECS sensor.

Ref	Product Name
242333	Arc Wireless Converter BT Advanced

Description: Designed for wireless communication between ArcAir and VisiFerm RS485-ECS sensor. Includes license to activate ArcAir Advanced features, including the GMP ones.

Ref	Product Name
243460	Arc Wi 1G Adapter BT

Description: The Arc Wi 1G Adapter BT provides the wireless communication between the Arc sensors and mobile devices via Bluetooth 4.0.

Ref	Product Name
243470	Arc Wi 2G Adapter BT

Description: The Arc Wi 2G Adapter BT not only provides wireless communication via Bluetooth 4.0, but also simplifies analog connection of Arc sensors to the process control system (PCS).

Ref	Product Name
10071111	Arc View Mobile Basic for non-Ex environments

Description: The pre-configured Arc View Mobile, Hamilton`s mobile solution for monitoring measurement values, calibrating Arc sensors and configuring various parameters with the unified user interface for pH, DO, Conductivity and ORP. The Arc View Mobile is based on the Samsung Galaxy Tab Active tablet and comes pre-configured with the ArcAir basic, app blocker application, power supply cable, instruction manual and Hamilton's quick guide.

Ref	Product Name
10071113	Arc View Mobile Advanced for non-Ex environments

Description: The pre-configured Arc View Mobile, Hamilton`s mobile solution for monitoring measurement values, calibrating Arc sensors and configuring various parameters with the unified user interface for pH, DO, Conductivity and ORP. The Arc View Mobile is based on the Samsung Galaxy Tab Active tablet and comes pre-configured with the ArcAir advanced application, including features for CFR 21 Part 11 and Eudralex Volume 4 Annex 11 compliance, app blocker application, power supply cable, instruction manual and Hamilton's quick guide.

10.3 Services

Hamilton service engineers are available in Europe and China in order to provide customers with on-site services. Hamilton offers a wide range of services from technical support to initial operation, qualification and maintenance of the sensors.

Various tailored services are offered especially for the BioPharma, ChemPharma and brewery industries. Experienced service engineers ensure an optimal and professional service.

In order to find your local service support please visit: www.hamiltoncompany.com/process-analytics/support

Overview of service offers

Online service

Technical support

Initial operation/calibration

Qualification IQ/OQ

Service contract

Maintenance

User training

Repair

Application support

HAMILT🄗N

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