HAMILTON

VisiFerm SU RS485-ECS Sensors

Operating Instructions

Hamilton Warranty

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

Important Note

1 General Information

1.1 Intended Use

The VisiFerm SU sensors are intended for the measurement of dissolved oxygen (DO) in a single-use (SU) container together with a Hamilton ODO Cap Sx.

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 SU is not intended to be used in hazardous atmospheres.**

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

⚠ **CAUTION! The VisiFerm SU 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.**

1.2 About these Operating Instructions

These Operating Instructions are designed to support the integration, operation and qualification of the VisiFerm SU sensors together with Hamilton ODO Cap Sx built-in in the SU container. ODO Cap S0, ODO Cap S2, and ODO Cap S3 are referred in this document as "ODO Cap Sx". VisiFerm SU RS485-ECS sensors are referred as "VisiFerm SU".

To achieve this, it will describe the features of the VisiFerm SU and its integration in Process Control Systems (PCS). Both the mechanical connection to the Hamilton ODO Cap Sx and the communication between the VisiFerm SU and Process Control Systems are described detailed in this manual. After reading this manual the user should be capable of installing and operating VisiFerm SU.

⚠ **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 SU 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 SU 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 SU.

3.1   General Precautions

For safe and correct use of VisiFerm SU, it is essential that both operating and service personnel follow generally accepted safety procedures as well as the safety instructions given in this document (see 3), the VisiFerm SU Operating Instructions.

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

The lifetime of the VisiFerm SU highly depends on the specific conditions of the application. Temperature, pressure, chemicals used may accelerate the ageing of both the VisiFerm SU and its ODO Cap Sx.

The VisiFerm SU 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 VisiFerm SU. For repair or shipment the VisiFerm SU should be sent back in the original reusable packaging box. Every VisiFerm SU sent back for repair must be cleaned or decontaminated if it was accidently in contact with process media.

If the conditions described in these Operating Instructions 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 SU

When cleaning and using the VisiFerm SU 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 VisiFerm SU 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 connection for the process control. The Arc wireless interface is designed for sensor monitoring, maintenance and service purposes.

Make sure that the thread is not damaged when screwing the VisiFerm SU into the process. Even when all required safety measures have been complied with, potential risks still exist with respect to leaks or mechanical damage to the barb port. Wherever there are seals, gases or liquids may leak out undetected. Always make sure that no process medium can be accidentally spilled before removing the VisiFerm SU from its measurement setup. Make sure that no air or gas bubbles stick to the sensitive part of the ODO Cap Sx. 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.

Find details, including serial number and most important specifications, on the certificate provided with each VisiFerm SU.

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

Cross sensitivities and resistances of ODO Cap Sx (Measurement not influenced by carbon dioxide)	
Wetted parts resistant to	Ethanol (<70%)
Wetted parts not resistant to	Chlorine, Ozone and Organic Solvents such as Acetone, Tetrahydrofuran (THF)

If the VisiFerm SU together with the ODO Cap Sx 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.

3.3 Earthing

It is recommended to assign the VP8 cable shield to ground or earth especially in electromagnetically noisy environments. This significantly improves noise immunity and signal quality. The VP8 thread is connected to the metallic housing of the VisiFerm SU.

> NOTICE: Avoid earth loops (see Figure 1), and damage of the VisiFerm SU due to electrostatic discharge while mounting and dismounting of the VisiFerm SU or the cable. Do not touch contacts of the connector.
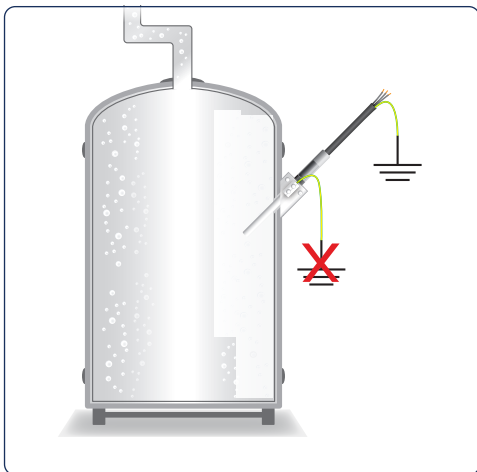
Figure 1: Single-use container with no earth connection: Connect cable shield to earth.

3.4 Electrical Safety Precautions

Do not connect the VisiFerm SU to a power source of any voltage beyond the range stated in the power rating «Specification Sheet» (www.hamiltoncompany.com).

Always use Hamilton VP8 cables for safe connection. Cables are available in a broad range of lengths (9.3). Make sure the cable is intact and properly plugged to avoid any short circuit.

Keep VisiFerm SU 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 5 to avoid electrical damage to the VisiFerm SU. The contacts must be clean and dry before the VisiFerm SU is connected to the cable.

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

⚠ **CAUTION! Particular precaution is required if the optics is unprotected.**

⚠ **CAUTION! If the power supply 230 VAC or 24 VDC 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 SU 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 SU 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 SU are intended for the measurement of dissolved oxygen together with a Hamilton ODO Cap Sx as integral part of a single-use container. With their micro-transmitter, VisiFerm SU enable direct communication to the process control system via Electrochemical Signal (ECS), 4-20 mA standard signal with Arc Wi 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.

The VisiFerm SU technology is one to one comparable to the proven performance of your existing re-useable VisiFerm RS485 sensors. It offers rapid start-up with no polarization time, and simplified maintenance. With the easy calibration of the ODO Cap Sx using the integrated calibration values on each cap, the sensor is ready to use within very short time.

With the ODO Cap Sx integrated in the SU container, the VisiFerm SU is reusable without risk of contamination, making the setup reliable and very cost effective.

Key benefits include:

- Reusable VisiFerm SU (electronic)
- Calibration fast and easy (with integrated calibration values provided with each ODO Cap Sx)
- Direct digital Modbus or analog communication to the process control system via 4-20 mA standard signal (via Arc Wi 2G Adapter)
- Full online wireless option via Bluetooth 4.0 for easy monitoring, configuration and calibration
- Robust industrial design
- No separate transmitter needed, however when using ECS mode, a connection to a transmitter for polarographic sensors is possible

4.2   Hardware Description

The VisiFerm SU sensor consists of a sensor head with integrated electronic and a sensor shaft. The sensor shaft is terminated by the ODO Cap Sx, 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 requirements.
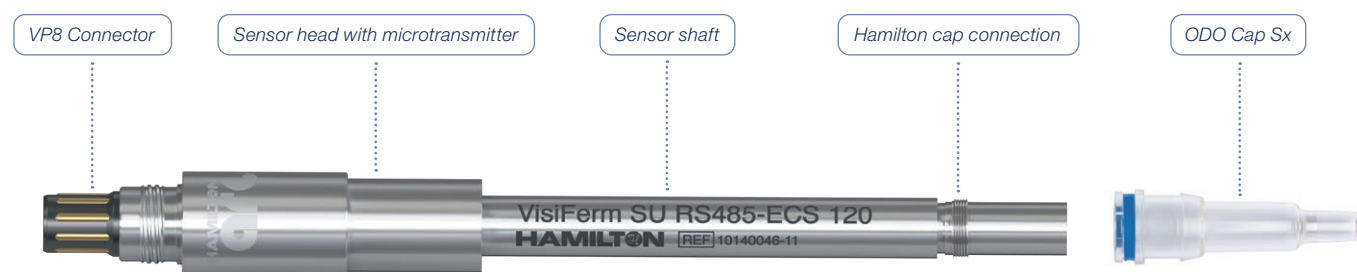
Figure 2: VisiFerm SU hardware description.

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 fluorecence and the measurable fluorescence signal decreases.
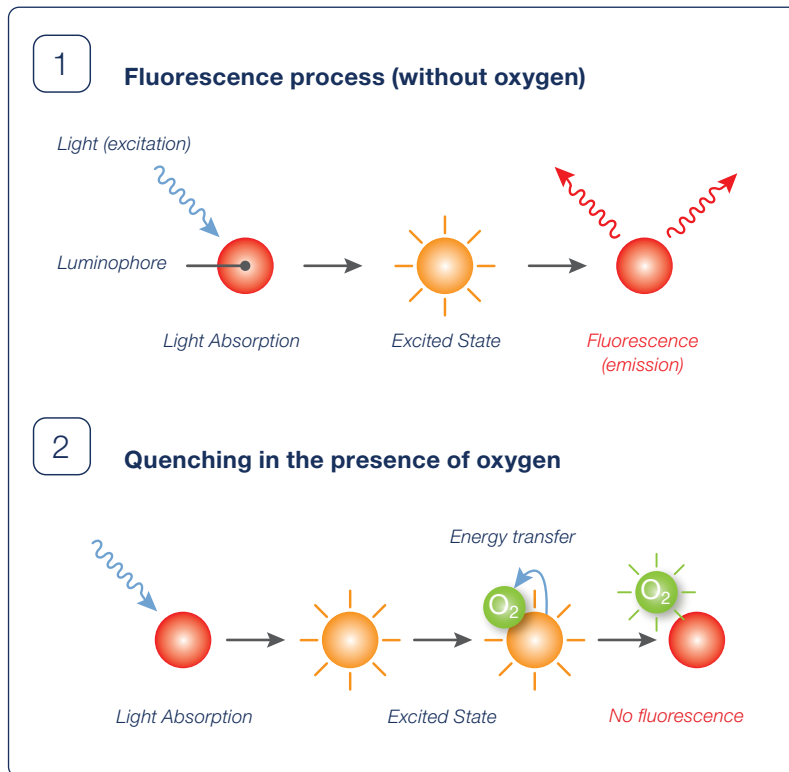
Figure 3: Fluorescence quenching by oxygen.

4.4 VisiFerm SU with Micro-Transmitter inside

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

5   Installation

5.1   Unpacking and Cleaning

1. Carefully unpack the VisiFerm SU. Enclosed you will find the VisiFerm SU, the VisiFerm SU RS485-ECS Quick Guide and Declaration of Quality.
2. Inspect the sensor for shipping damages or missing parts.
3. For cleaning purposes of the VisiFerm SU, soak a paper towel with Ethanol 70% or Isopropanol 70% and wipe down the VisiFerm SU. After cleaning the VisiFerm SU, air dry the VisiFerm SU prior to connecting with the ODO Cap Sx. Make sure that all contacts of the VisiFerm SU are completely dry to prevent electrical damage (short circuit).

> 🗍 NOTICE: VisiFerm SU is not designed for gamma or steam sterilization.

5.2   Electrical Connection

> ⚠ CAUTION! All sensors are delivered with factory-default settings for ECS mode and Modbus RS-485 connection mode respectively. Do not apply a voltage out of specified range.

> 🗍 NOTICE: If required, configure the sensor to 4-20 mA before first use. For details on how to configure the sensor, refer to Chapter 5.3.

The VisiFerm SU is fitted with a VP8 socket head. The eight golden contacts are denoted as pin A to pin H. For easy identification of each pin, the head has a notch between pin A and pin B. For the easiest and safest connection of VisiFerm SU, always use Hamilton VP8 cables, available in a range of different lengths.
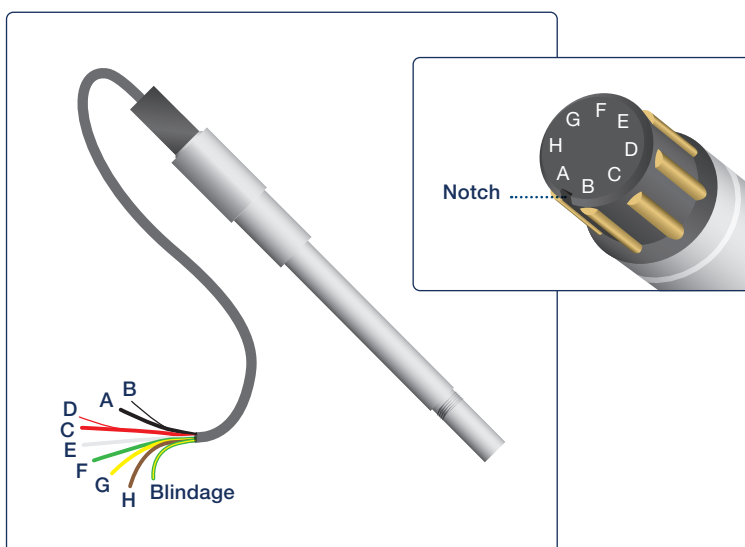
VP Pin	Function
A	ECS Cathode
B	ECS Anode (Voltage range may not exceed -2V … +2V)
C	Power supply: + 24 VDC (10 to 27 VDC) Start-up power: 1.5 W Continuous power consumption: 250 mW
D	Power supply: Ground
E	Temperature sensor NTC 22 kOhm for ECS
F	Temperature sensor NTC 22 kOhm for ECS
G	RS-485 (A)
H	RS-485 (B)
Shaft	Sensor shaft connected to earth

Figure 4: Pin Configuration VisiFerm SU

5.3 Connection to PCS or Controller

5.3.1 Layout and Overview

The VisiFerm SU can be connected to the PCS or controller by a wired connection (for reference numbers see also «Parts and Accessories»):
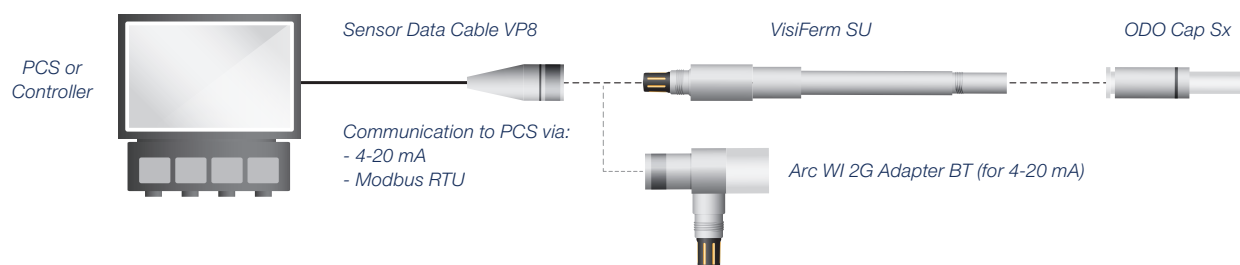
Figure 5: Layout wired connection to PCS or controller.

The digital RS-485 interface of the VisiFerm SU can be accessed by operators when integrated by the OEM system supplier. The three-tier operator levels and factory default passwords are shown in the table below.

Operator Status	Operator Level	Password	Read	Calibrate	Configure
User	U	–	✔	–	–
Administrator	A	18111978	✔	✔	–
Specialist	S	16021966	✔	✔	✔

5.3.2 Electrical connection for the digital RS-485 interface

The digital RS-485 interface enables communication with VisiFerm SU together with the ODO Cap Sx to perform measurements, calibrate the sensor and change the sensor's configuration parameters. VisiFerm SU using RS-485 interface is always connected to digital controlling devices as a Modbus slave. To function, they require a power supply (VP8 pins C and D, see below). The section entitled «Configuring the VisiFerm SU parameter» describes operation in digital mode.

By using the correct access password the system operator can adapt the VisiFerm SU to many tasks by:

- Selecting the 4–20 mA interface
- Scaling (configuring) the 4–20 mA interface
- Selecting the measured parameter:
  - DO Unit: %-vol, %-sat, ug/l ppb, mg/l ppm, mbar, ppm gas
  - Temperature: °C, K, °F

In addition, operators can read sensor information from the RS-485 interface such as:
- The VisiFerm SU serial number (SN), reference number (Ref) and manufacturing number (Lot)
- The VisiFerm SU firmware version
- The VisiFerm SU status (e.g., operation hours, warnings and errors)

Additional information

The Modbus RTU communication protocol corresponds to the Modbus-IDA standard (see www.modbus.org). VisiFerm SU uses an open register set developed by Hamilton. Additional information about the register content and structure can be found in the Programmers Manual (REF 111004303) on the Hamilton website (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 VisiFerm SU are delivered with factory-default settings, each sensor must be configured for its specific application before first use (see section entitled «Configuration of the VisiFerm SU» for more information).**

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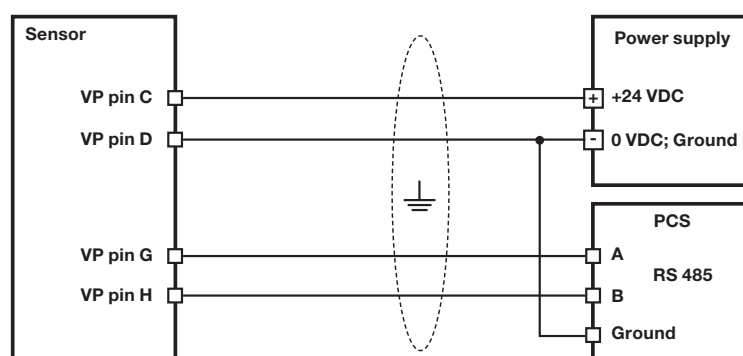
Example of circuit arrangement

Figure 6: Wiring diagram for the RS-485 interface.
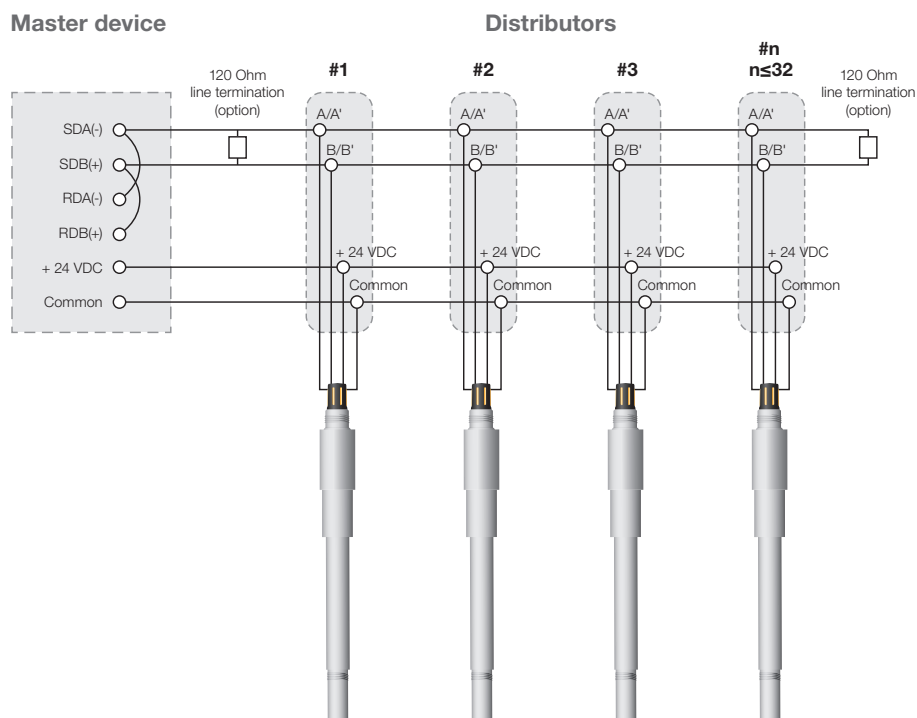
Figure 7: Multi-drop bus wiring for the Modbus two-wire mode. Each VisiFerm SU functions as a Modbus slave.

> 📄 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 VisiFerm SU must have the unique Modbus device address for proper communication.

The serial Modbus connection between the RS-485 port of the master and the corresponding interfaces of the VisiFerm SU has to be ensured according to the EIA/TIA RS-485 standard. Only one VisiFerm SU can communicate with the master at any time.

5.3.3 Electrical connection for the ECS interface

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

> ⚠️ **CAUTION! Do not use the Arc Wi 1G Adapter (Ref 243460) when the sensor is connected via ECS signal. The Arc Wi 2G Adapter (Ref 243470) converts the digital signal into 4-20 mA signal. This signal output is on pin A and B and replaces the ECS signal.**

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

The NTC 22kOhm 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 SU using ECS mode can be operated with polarization voltages usual for electrochemical sensors. The VisiFerm SU 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.

> ⎙ NOTICE: The temperature coefficient TC in %/°C must be aligned between VisiFerm SU using ECS mode (3.1%/°C) and transmitter (TC depending on transmitter). If the TC value is not aligned, the temperature compensation is not correct. We recommend to align the value within the transmitter. Even though, the temperature compensation factor within the VisiFerm SU using ECS mode can be changed by connecting it to ArcAir (see Chapter 5.4).

Example of circuit arrangement
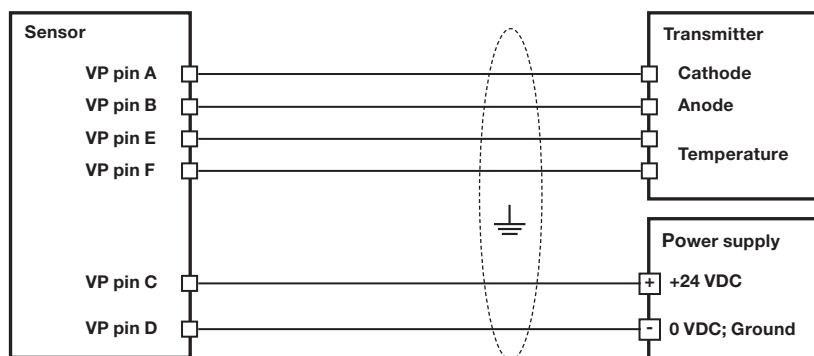
Figure 8: Wiring diagram for the ECS interface.

The VisiFerm SU in ECS mode is intended to be calibrated within the transmitter. To achieve the accuracy values stated in the specifications available on www.hamiltoncompany.com, the 100%-sat value should be calibrated within the transmitter. The calibration is very dependent on the ambient conditions like pressure, temperature and humidity.

> ⎙ NOTICE: It is recommended to execute the calibration at process conditions. The bioreactor should be filled with process media heated to process temperature (e.g. 37 °C). To allow the media to saturate with air, we recommend to purge the process media for sufficient time with air. The time needed to saturate the media is dependent on the volume and the kLa-value of the bioreactor. The pressure within the the bioreactor should also be comparable to the bioprocess to allow maximum accuracy.

The 0%-sat does not necessarily need to be calibrated due to the high manufacturing repeatability of the Hamilton ODO Cap Sx, even after gamma irradiation and storage.

The calibration within the transmitter is described in "Transmitter H100 DO User Manual" Ref TA-194.433-HAME03 20120601. You can find it on the Hamilton website (www.hamiltoncompany.com).

⚠ **CAUTION! Make sure the calibration data is correct when you use the VisiFerm SU in ECS mode. Verify that the calibration data are on factory default as shown below:**
• **Phase 0 (°) = 71.00**
• **SV Coefficient = 0.0197**

🗋 NOTICE: For details on how to configure the sensor, refer to Chapter 6.2 "Calibration".

5.3.4 Electrical connection for analog 4-20 mA interface

🗋 NOTICE: The 4-20 mA analog interface is only provided by an Arc Wi 2G adapter BT (Ref 243470).

By adding an Arc Wi 2G Adapter BT (Ref 243470) on top of the VisiFerm SU 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 (9.3).
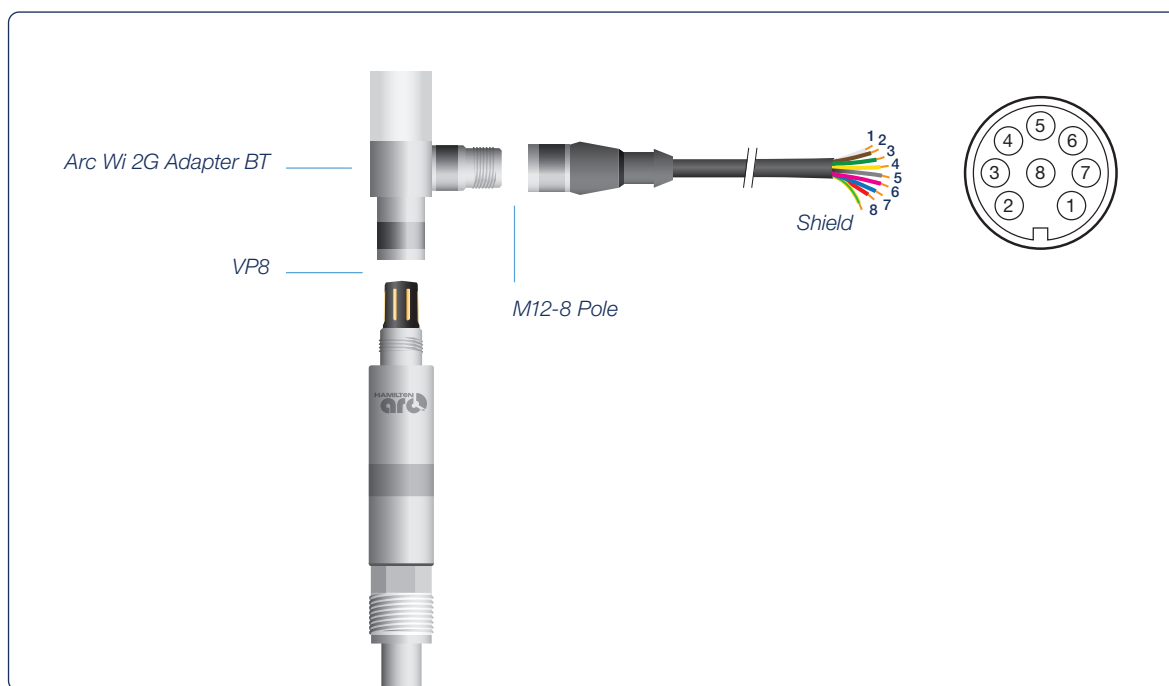

Figure 9: Arc sensor with Arc Wi 2G Adapter and M12-8 pole open-end cable.

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	Description
1	+4-20 mA # 1	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	
3	+4-20 mA # 2	
4	-4-20 mA # 2	
5	RS-485 (A)	Modbus RTU RS-485
6	RS-485 (B)	Modbus RTU RS-485
7	GND	Ground
8	+ 24 VDC	Power supply: +10 V to +27 V (Power supply can be external; not from PCS)
Housing	Shield	Connected to the housing including the VP8 female connector

The 4-20 mA interface enables direct connection of the VisiFerm SU to a data recorder, indicator, control unit or PCS with analog I/O. VisiFerm SU 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, the sensor works as a current sink and is passive. Connect the sensor according to the pin designations (5.2). The 4–20 mA interface of the Arc Wi 2G Adapter BT (Ref 243470) in combination with the VisiFerm SU 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 (5.4.6).
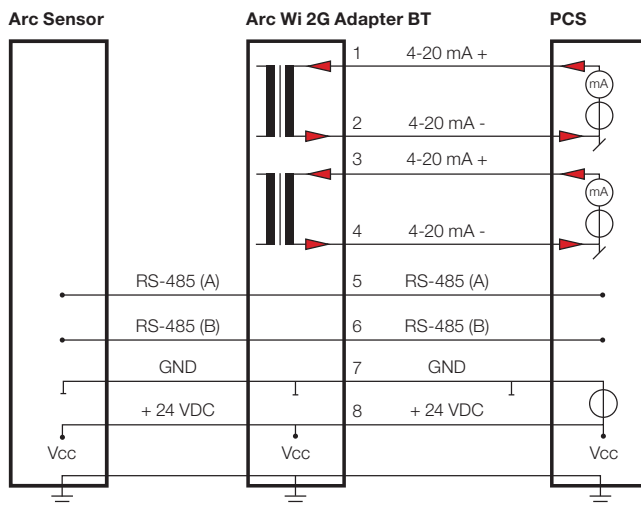

Figure 10: Typical connection to PCS using the Arc Wi 2G Adapter BT (Ref 243470). This is the safest form of wiring an Arc sensor. The Arc Wi 2G Adapter BT (Ref 243470) provides internal galvanic isolators for enhanced analog signal quality. Connection to the process control system is simplified.
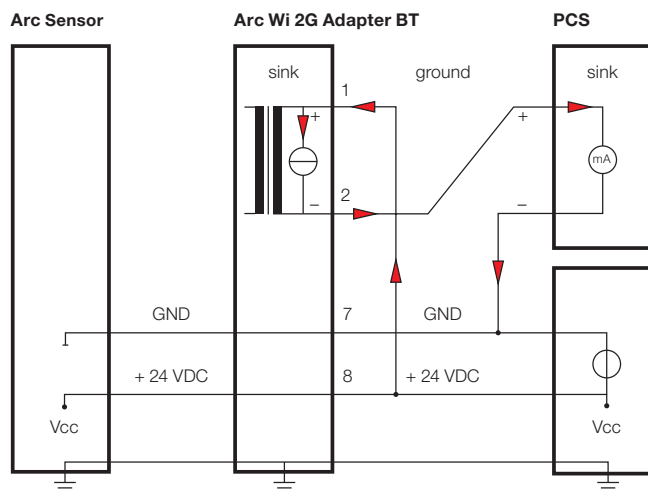
Figure 11: Typical connection to PCS using the Arc Wi 2G Adapter BT (Ref 243470)

5.4 Connection to PC or Mobile

5.4.1 Layout and Overview

The Hamilton Arc View Mobile (Ref 10071111 / Ref 10071113) represents an ideal solution for Arc sensor management. This includes an automated calibration by scanning the QR-code of the ODO Cap Sx sensing element label. The Arc View Mobile included in the package is a compact mobile wireless device with long battery lifetime and broad functionality. When using with a mobile device, each VisiFerm SU requires an Arc Wi Adapter BT and an Arc USB Power Cable for external power supply. The Arc View Mobile is based on the Samsung Galaxy Tab Active tablet and comes pre-configured with ArcAir™ App, app blocker application, power supply cable, Operating Instructions and Quick Guide.
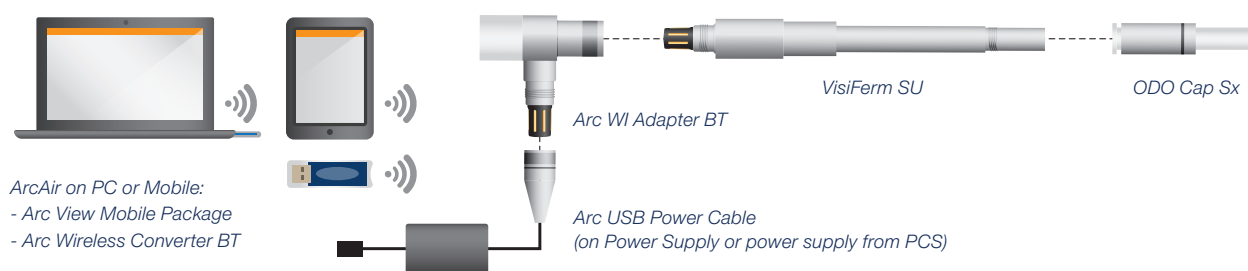
Figure 12: Layout for wireless connection

A wired connection to the PC is possible using the USB port. For connection to the PC, an Arc USB Power Cable is needed.

Figure 13: Layout wired connection to PC or notebook

5.4.2   Installing ArcAir Basic on the Computer

The ArcAir™ App can be used to display measurement values, for configuration and calibration or to generate GMP reports for calibration, verification, communication and configuration. It can be downloaded from App Store, Google Play or for PC on www.hamiltoncompany.com.
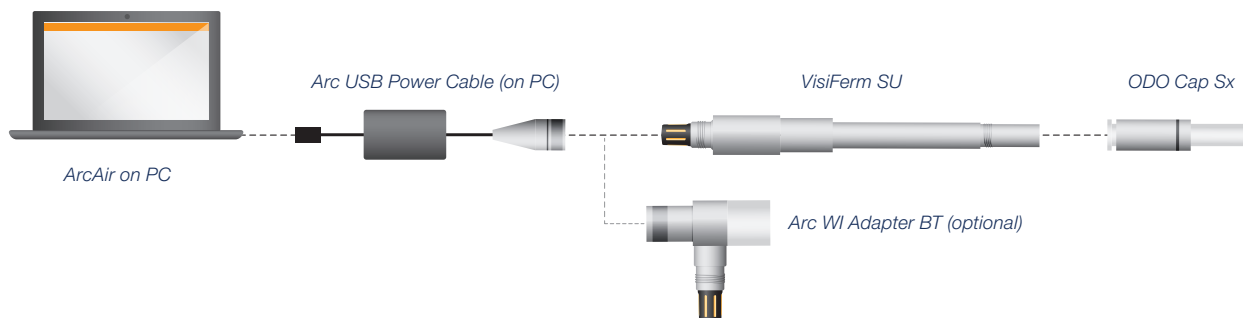
1. Download the Zip file «ArcAir» from www.hamiltoncompany.com (search for ArcAir).
2. Unpack the ZIP file.
3. Do not plug in the Wireless Converter before the installation of ArcAir is completed.
4. Install ArcAir by double clicking «ArcAir.exe» and follow the instructions on the screen.

To upgrade your PC version from Basic to Advanced version, you must connect your PC using the Arc Wireless Converter BT with your mobile device. For this purpose, the mobile device must run on the correct ArcAir version (Advanced) to activate the upgrade on your PC (for more details, see also «ArcAir™ App – Operating Instructions» on www.hamiltoncompany.com).

ArcAir Basic:

• Execute initial calibration including calibration report (see 6.2)
• Product calibration (follow the wizard of the ArcAir™ App)
• Configure the VisiFerm SU and sensor element setting including configuration report

ArcAir Advanced user can use ArcAir Basic functionality and in addition can create:

• Audit trail,
• User management
• CFR Part 11 Digital signature

VisiFerm SU require application specific configuration. To configure and set up the VisiFerm SU at least ArcAir Basic is required. In the table below you will find the different ArcAir licenses and their functionality:

ArcAir Version	Read	Calibrate	Configure	Documentation
Basic	✔	✔	✔	–
Advanced	✔	✔	✔	✔

> 🗐 NOTICE: For more detail information and configuration see Hamilton Arc System Operating Instructions.

5.4.3 Connecting VisiFerm SU to ArcAir

1. Connect a VisiFerm SU with the power supply, e.g. Arc USB Power Cable
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 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. 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.**

5.4.4 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 (see also ArcAir™ Operating Instructions) as long as no user account is created. Laboratory mode does not require a login password and enables all features in the installed license version.

5.4.5 Configuring the VisiFerm SU 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 Setting	Range	Configuration	Location
Measurement Unit	These are the measurement physical units	%sat.	%-vol %-sat ug/l ppb mg/l ppm mbar ppm gas	Required	Measurement Settings
Temperature unit	These are the temperature physical units	°C	°C, K, °F	Required	Measurement Settings
Salinity	The concentration of dissolved oxygen in saturated water is dependent on the salinity	0 mS/cm	0 to 50	Default parameter recommended	Measurement Settings
Atmospheric pressure	The partial pressure of oxygen is proportional to the atmospheric pressure or the pressure of the air supply to the process	1013 mbar	10 to 12000	Required, application dependent	Measurement Settings
Moving average	The sensor uses a moving average 1-30 over the measuring points	10	1 to 150	Recommended default parameter	Measurement Settings
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	1 to 16	Recommended default parameter	Measurement Settings
Measuring interval	The measuring interval can be set between 1-300 sec. The LED flashes once in the set measure interval	3 sec.	1 to 300	Recommended default parameter	Measurement Settings
Sensing Material	Sensing Material are different types of ODO Cap Sx which can be set by entering the REF of the ODO Cap Sx	243461	243461 10068804 10077858	Must	Calibration / Enter Calibration Data

5.4.6 Configuring the mA/ECS Interface for your process control system

Parameter Name	Description	Default Setting	Range	Configuration	Location
Mode	The output can be configured as ECS, 4-20 mA or Off	ECS	Off 4-20 mA fixed 4-20 mA linear 4-20 mA bilinear ECS fixed ECS	Recommended default parameter	Settings / mA/ECS Interface
ECS zero point current	Defined measurement value for 0 nA output	0 nA	not empty	Must (application dependent)	Settings / mA/ECS Interface

Parameter Name	Description	Default Setting	Range	Configuration	Location
ECS high point current	Defined measurement value for 60 nA output	60 nA	not empty	Must (application dependent)	Settings / mA/ECS Interface
ECS Temperature Coefficient	refer to Section 5.3.3	3.1%/°C	not empty	Recommended default parameter	Settings / ma/ECS interface
ECS Warning Mode	Current output mode in case of warnings	Off	Off Continuous Warning	Recommended default parameter	Settings / mA/ECS Interface
ECS Error Mode	Current output mode in case of errors	Off	Off Continuous Error	Recommended default parameter	Settings / mA/ECS Interface
ECS temperature out of range value	Current output in case of temperature out of range	499 nA	not empty	Recommended default parameter	Settings / mA/ECS Interface

> 🗐 NOTICE: If the "Mode" of the mA/ECS Interface is set to 4-20 mA, then refer to the configuration Section 5.4.7.

5.4.7 Configuring the mA Interface No 2 for your process control system

Parameter Name	Description	Default Setting	Range	Configuration	Location
Mode	The output of the 4-20 mA can be configured linear or with a fix value	4-20mA linear	Off 4-20 mA fixed 4-20 mA linear 4-20 mA bilinear	Recommended default parameter	Settings / mA Interface No 2
Assigned Measurement Channel	The measurement channel can be assigned as Temperature or as DO	Temperature	DO Temperature	Recommended default parameter	Settings / mA Interface No 2
Value at 4mA	Defined measurement value for 4mA output	0 °C	not empty	Must (application dependent)	Settings / mA Interface No 2
Value at 20mA	Defined measurement value for 20mA output	40 °C	not empty	Must (application dependent)	Settings / mA Interface No 2
Warning Mode	Current output mode in case of warnings	Off	Off Continuous warning	Recommended default parameter	Settings / mA Interface No 2
Error Mode	Current output mode in case of errors	Continuous errors	Off Continuous error	Recommended default parameter	Settings / mA Interface No 2

Parameter Name	Description	Default Setting	Range	Configuration	Location
Error Value	Current output in case of error	3.5 mA	not empty	Recommended default parameter	Settings / mA Interface No 2
Temperture out of range value	Current output in case of temperature out of range	3.5 mA	not empty	Recommended default parameter	Settings / mA Interface No 2

5.4.8 Defining a measuring point name for identification of the process

Parameter Name	Description	Default Setting	Range	Configuration	Location
Measuring point	User can define a sensor name for better identification of the measuring point	10140046111234	not empty	Recommended default parameter	Info / Measurement Point *or* Settings / Measurement Settings

6 Operation

> 🗊 NOTICE: This operation description refers to ArcAir™ App. For operation with PCS refer to operating instructions from the OEM system supplier.

> ⚠ **CAUTION! Only use the VisiFerm SU according to the «Specification Sheet» on www.hamiltoncompany.com. Failure to do so may lead to damages or measurement failures.**

6.1 Connecting the VisiFerm SU to the ODO Cap Sx

> ⚠ **CAUTION! Do not apply excessive force while connecting the VisiFerm SU to the ODO Cap Sx to avoid any leakage.**

> ⚠ **CAUTION! Remove the protective cap from the shaft of the VisiFerm SU before mounting into the ODO Cap Sx. Handle with care to avoid any damage to the ODO Cap Sx or the VisiFerm SU.**

The VisiFerm SU mechanical design is compatible with the Hamilton ODO Cap Sx. Before installing you should test that the parts are all in working order. Ensure that there is no damage to the VisiFerm SU or the cap.

Prepare the sensor for measurement as follows:

1. Carefully remove the protective caps from the optical sensor tip.
2. Connect the VisiFerm SU to the ODO Cap Sx (Screw in the VisiFerm SU and move up against it slightly blocks in the cap. Do not apply excessive force (torque < 0,5 Nm).
3. Carefully remove protection cap from the VP8 connector.

4. Connect the VisiFerm SU and the ODO Cap Sx according to the section «Electrical Connection» in the desired configuration (digital RS-485 interface, analog ECS interface, analog 4 - 20 mA interface). You only can use 4-20 mA interface and digital interface in parallel. Make sure that the VisiFerm SU is configured as required. If in doubt, test as described in 5.3. The signal stabilizes itself within a few minutes. The VisiFerm SU is programmed with default calibration values. To achieve best accuracy, execute calibration of the sensor (6.2).

6.2   Calibration

> 🗐 NOTICE: This is only applicable for VisiFerm SU in RS-485 mode. For the VisiFerm SU using ECS mode, refer to Section 5.3.3.

The ODO Cap Sx has been pre-calibrated at 100% and 0% saturation at 25 °C; hence calibration prior to the process is not necessary. The calibration values for Phase 0 and Stern-Volmer coefficient (SV-Coefficent) can be found on the sensing element label attached to the ODO Cap Sx.

Figure 14: Example sensing element label with calibration data

1. Read the Phase 0 (°) and SV-Coefficient (-) written on the sensing element label (see Figure 14).
2. Enter the calibration and sensor data into the VisiFerm SU:
   Calibration data (mandatory):
   - Phase 0
   - SV-Coefficient
   Data of the sensor element (enter data for traceability):
   - Ref-number
   - Name
   - Lot-number
   - Manufacturing date
   - SN-number
   - Sensor ID
   - a-length
   Push the save button to save the data.
3. We recommend that you perform a product calibration to achieve the specified accuracy.
4. Save the data to the VisiFerm SU

NOTICE: The Arc View Mobile supports automatic calibration for predefined calibration values by scanning the QR-code. Use ArcAir software on tablet or PC to perform manual input of the calibration data.

The concept behind Hamilton single-use Arc System enables calibration based on the pre-calibrated values. Additional 2-point calibration for the installation in the process setup is not required.

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 SU calibration curve is calculated from the data of last calibration at point 1 and from the data of the product calibration (Figure 15). In order to restore the original standard calibration curve, under Process > Product Calibration menu, select "Discard existing product calibration". Click "Confirm" button to apply the change. A new standard calibration discards a product calibration as well.
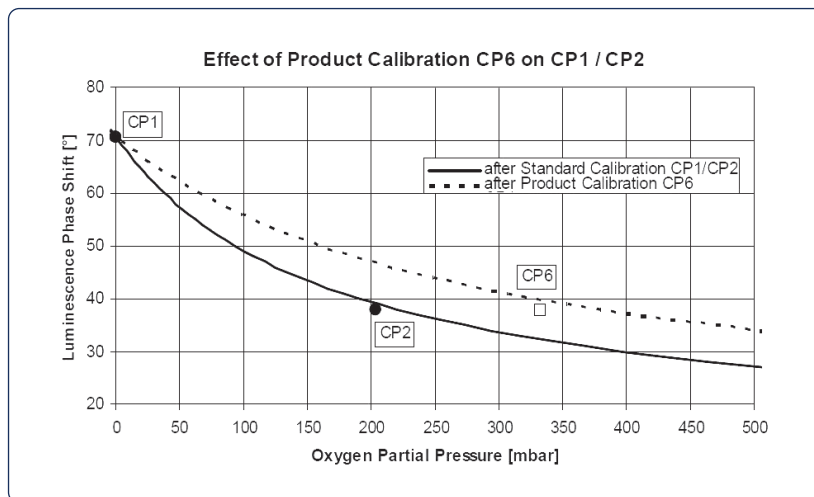

Figure 15: Effect of a product calibration (CP6) on an existing standard calibration function based on the Zero Point Calibration (CP1) and the Air Calibration (CP2).

NOTICE: The product calibration is possible for DO values in the range of 10 - 260 %-sat (2 to 55 %-vol respectively 20 – 550 mbar pO_2).

A product calibration is performed as follows:

1. Connect the VisiFerm SU to the power supply, e.g. by using the Arc USB Power Cable on a standard USB port (see Figure 1)
2. Select the desired sensor from the sensor list
3. Go to «Process Settings»
4. Click «Start» to start the product calibration wizard of the ArcAir™ App
5. Follow the instruction on the screen

NOTICE: Alternatively, the product calibration may be performed with a mobile device on site the measuring point.

6.3   Disconnecting the VisiFerm SU from the ODO Cap Sx

> ⚠ **CAUTION! Do not apply excessive force while disconnecting the VisiFerm SU from the ODO Cap Sx to avoid any leakage.**

1. Remove the connecting cable and carfully attach the protective cap to the VP8 connector
2. Hold the ODO Cap Sx (if possible)
3. Unscrew the VisiFerm SU
4. Remove the VisiFerm SU from the ODO Cap Sx and carefully attach the protective cap to the optical sensortip

The ODO Cap Sx is a single-use sensor element meant to be discarded with the container. If the process requires disconnection, the ODO Cap Sx must be decontaminated prior to disposal.

7   Troubleshooting

7.1   VisiFerm SU and ODO Cap Sx Self-Diagnostics

7.1.1   Verify Status of VisiFerm SU and ODO Cap Sx

The VisiFerm SU and ODO Cap Sx provides a self-diagnosis functionality to detect and identify the most common sensor malfunctions. The communication interfaces can be used for warning and error massages. The analog 4-20 mA interface can be configured according to the NAMUR recommendations to indicate an abnormal event. Use the ArcAir™ App for monitoring the sensor status and for troubleshooting. The following types of messages are provided by the self-diagnosis function.

Indicator status		What does it mean?
🟢	The Status symbol on the ArcAir™ App respectively LED on Arc Wi Adapter BT are green.	The connectivity to the sensor is OK. The sensor is operating correctly and no warnings or errors have been registered.
🟡	The Status symbol on the ArcAir™ App respectively LED on Arc Wi Adapter BT are yellow.	The connection to the sensor is OK. However, the sensor indicates a warning. Verify the sensor warnings in «Info > Status».
🔴	The Status symbol on the ArcAir™ App respectively LED on Arc Wi Adapter BT are red.	The connection to the sensor is OK. However, the sensor indicates an error. Verify the sensor error in «Info > Status».
◐	The Status symbol on the ArcAir™ App is grey respectively LED on Arc Wi Adapter BT for a sensor is flashing red.	The ArcAir™ App lost connection to the sensor due to one of the following reasons: • The wireless signal strength is low (ArcAir indicator grey; LED on Arc Wi Adapter BT can be green/yellow/red) • The Arc Wi Adapter BT has been removed from the sensor. • The VisiFerm SU or Arc Wi Adapter BT electronic is defective.

7.1.2   Warnings

Warning	Cause	Solution
DO reading below lower limit	The oxygen reading is too low (DO < 0%-sat)	Apply / set calibration data. Execute a new product calibration in nitrogen saturated medium (6.2)
DO reading above upper limit	The oxygen reading is too high above upper limit (DO > 300 %-sat)	Apply / set calibration data. Execute a new product calibration in air saturated medium (6.2)
DO reading unstable	Air bubbles attached to sensor cap due to process settings	Change steering speed or media composition if possible. If the problem appears repeatingly, contact Hamilton Technical Support
Verify / set calibration data	No calibration data applied	Apply / set calibration data (6.2)
Temperature out of measurement range	The measured temperature is outside the defined measurement range (4-50 °C)	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	Check measurement settings
DO calibration recommended	No calibration data applied	Apply / set calibration data (6.2)
ECS current set point not met	Not possible to control ECS	Reconfigure ECS interface
4-20 mA value below 4 mA	The measurement value is below the lower limit of the 4-20 mA interface output	Reconfigure the 4-20 mA interface (6.2)
4-20 mA value above 20 mA	The measurement value is above the upper limit of the 4-20 mA interface output	Reconfigure the 4-20 mA interface (5.3.4)
4-20 mA current set-point not met	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 (5.3.4)
Sensor supply voltage too low	The sensor supply voltage is too low for the sensor to operate correctly	Ensure stable supply voltage written in the sensor specifications
Sensor supply voltage too high	The sensor supply voltage is too high for the sensor to operate correctly	Ensure stable supply voltage written in the sensor specifications

7.1.3   Errors

Errors (failures)	Cause	Solution
DO reading failure	Sensor cap is missing or the sensor is broken	Connect to ODO Cap Sx or replace VisiFerm SU
DO(pO_2) exceeds air pressure	Measured partial pressure of oxygen is higher than the air pressure set by the operator	Reconfigure the air pressure parameter (5.4.5)
T sensor defective	The internal temperature sensor is defect	Contact Hamilton Technical Support
DO sensor cap missing	The ODO Cap Sx has been removed	Connect to ODO Cap Sx
Red channel failure	Measurement channel failure	Contact Hamilton Technical Support
Sensor supply voltage far too low	The sensor supply voltage is below 10 V	Check your power supply
Sensor supply voltage far too high	The sensor supply voltage is above 27 V	Check your power supply
Temperature out of operating range	The measurement temperature is outside the defined operating temperature range (0 to 60 °C)	Keep ODO Cap Sx below 50 °C to prevent any damage
EEPROM comm. (I2C) error Userend	EEPROM internal communication error	Restart the sensor and try again
Internal Communication (I2C) failure Userend	Internal I2C communication error	Restart the sensor and try again
Internal Communication failure to Frontend	No communication between Frontend and Userend	Restart the sensor and try again
Stackoverflow	Internal memory failure	Send the sensor back to Hamilton Bonaduz or contact Technical Support

7.2   Getting Technical Support

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

7.3   Returning VisiFerm SU for Repair

Before returning the VisiFerm SU to Hamilton for repair, contact our Customer Service and request: a Returned Material Authorization (RMA) number.

Do not return the VisiFerm SU to Hamilton without a RMA number. This number assures proper tracking of your sensor. VisiFerm SU that are returned without an RMA number will be sent back to the customer without being repaired. Decontaminate the VisiFerm SU and remove health hazards, such as radiation, hazardous chemicals, infectious agents, etc. Provide the complete description of any hazardous materials that have been in contact with the sensor.

8 Disposal

The design of Hamilton sensors optimally considers environmental compatibility. In accordance with the EC guideline 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

9 Ordering Information

9.1 VisiFerm SU

Ref	Description
10140046-11	VisiFerm SU RS485-ECS 120
10140046-12	VisiFerm SU RS485-ECS 225

9.2 ODO Cap Sx

Ref	Description	Wetted Material
243461	ODO Cap S0	PA (cycloaliphatic polyamide), Silicone, EPDM

Description: The Hamilton ODO Cap S0 kit is an optical dissolved oxygen sensor cap that can be integrated into single-use bags.

| Ref	Description	Wetted Material
10077858	ODO Cap S2	PA (cycloaliphatic polyamide), Silicone, EPDM

Description: The Hamilton ODO Cap S2 kit is an optical dissolved oxygen sensor cap that can be integrated into single-use ridgid container.

Ref	Description	Wetted Material
10113953	ODO Cap S3	PA (cycloaliphatic polyamide), Silicone, EPDM

Description: The Hamilton ODO Cap S3 kit is an optical dissolved oxygen sensor cap that can be integrated into single-use bags.

9.3   Parts and Accessories
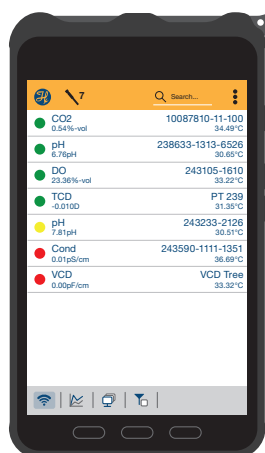
Ref	Product Name
10071111	Arc View Mobile Basic for none Ex environment

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, ORP, Incyte Arc and CO_2. 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 quick guide.

10071113	Arc View Mobile Advanced for none Ex environment

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, Incyte Arc and CO_2. 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 quick guide.
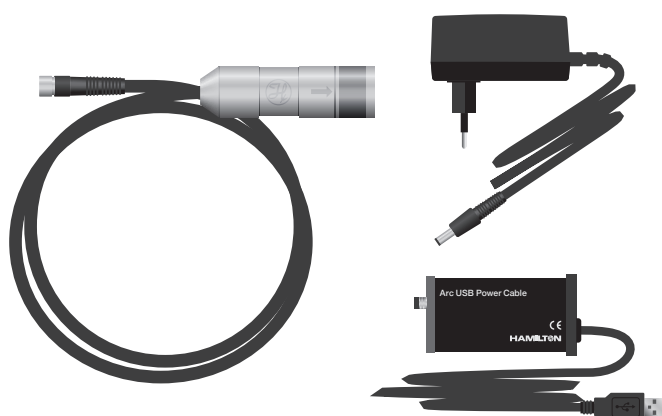
Ref	Description
243490-01	Arc USB Power Cable with VP8 connector (for the Arc Wi 1G Adapter BT)
243490-02	Arc USB Power Cable with M12 8-pole connector (for the Arc Wi 2G Adapter BT)

Description: The Arc USB Power Cable provides power supply via USB port for Arc sensors and digital communication.
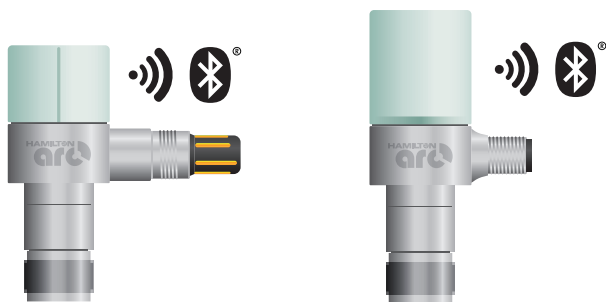
Ref	Description
243460	Arc Wi 1G Adapter BT
243470	Arc Wi 2G Adapter BT

Description: Designed to add Bluetooth communication to VisiFerm SU sensors when connecting directly to the PLC via modbus. The Arc Wi 2G Adapter BT also simplifies analog connection (4-20 mA) to the PLC.

Ref	Description
242333	Arc Wireless Converter BT

Description: Designed for wireless communication between ArcAir and VisiFerm SU sensor. ArcAir Advanced licensing included.
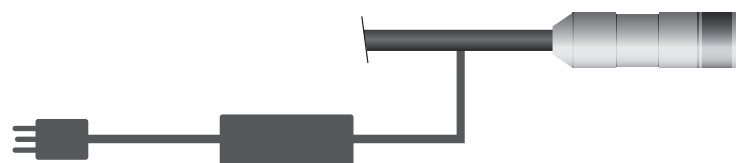

Ref	Description	Ref	Description
355263	Sensor Data Cable VP8, 1m	355266	Sensor Data Cable VP8, 10m
355264	Sensor Data Cable VP8, 3m	355267	Sensor Data Cable VP8, 15m
355265	Sensor Data Cable VP8, 5m	355268	Sensor Data Cable VP8, 20m

Description: The Sensor Data Cable VP8 is designed for the digital and 4-20 mA connection to the PCS (Process Control System) with open end connection.
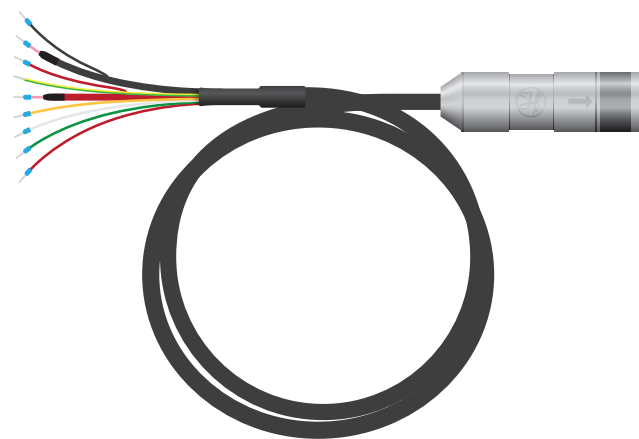
Ref	Description	Ref	Description
10070910	Data Cable VP8 / M12, 1m	10067844	Data Cable VP8 / M12, 5m
10071905	Data Cable VP8 / M12, 3m	10067846	Data Cable VP8 / M12, 10m

Description: The Sensor Data Cable VP8 is designed for the digital and 4-20 mA connection to the PCS (Process Control System) with M12 connector.

Ref	Description	Ref	Description
355298	Power Cable VP8 / AMP, 1m	355296	Power Cable VP8 / BNC, 3m
355258	Power Cable VP8 / Binder, 4m	355245	Power Cable VP8 / Lemo, 2.5m
355297	Power Cable VP8 / BNC, 1m	355194	Power Cable VP8 / Open End, 1m

Ref	Description	Ref	Description
355217	Sensor Cable VP8, 1m	355220	Sensor Cable VP8, 10 m
355218	Sensor Cable VP8, 3m	355221	Sensor Cable VP8, 15 m
355219	Sensor Cable VP8, 5m	355222	Sensor Cable VP8, 20 m

Description: The Sensor Cable VP8 – open end is designed for connection to a data recorder, indicator, control unit or PCS (Process Control System) with analog I/O (ECS mode).

Ref	Description
242413-XX	VisiFerm T82/D4-Power Adapter

9.4 Services

Hamilton service engineers 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 OEM customers. Experienced service engineers ensure an optimal and professional service.

In order to find your local service support 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

REF 10163540/00   08/2023

HAMILTON

To find a representative in your area, please visit:

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