

Dencytee Arc Sensors

Operating Instructions

REF 10119689/03

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HAMILTON

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Liability

The liability of Hamilton Bonaduz AG is detailed in the *General Terms and Conditions of Sale* (GTS) document. Hamilton is expressly *not* liable for direct or indirect losses arising from the 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. Hamilton recommends regular calibration of the sensor. In the case of critical sensor applications, Hamilton recommends using backup measuring points to avoid consequential damages. The user is responsible for taking suitable precautions in the event of a sensor failure.

Hamilton Warranty

To download the latest version of the GTS, visit the Hamilton Process Analytics website: https://www.hamiltoncompany.com/general-terms-and-conditions#purchase

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Document History

Manual revision No.	Date of issue	Change summary
00	April 2022	The first release of the Dencytee Arc Sensor Operating Instructions.
01	February 2023	• Changes implemented for the ArcAir software version 3.8.1. • All chapters and sections related to ArcAir software version 3.8.1, including the screenshots have been updated. • The reference (REF) numbers for sensor ordering information have been updated.
02	November 2023	• Manual contents have been migrated to SCHEMA ST4 Component Content Management System (CCMS). • New layout design: Improved look and feel • All chapters and sections have been updated. • The content has been restructured and revised to improve comprehension and usability.
03	April 2024	• Changes implemented for the ArcAir software version 3.9.2. • All chapters and sections related to ArcAir software version 3.9.2, including the screenshots have been updated.

Preface

Dencytee Arc Sensor documentation suite

This manual is part of a documentation suite that includes the following documents:

Table 1. Dencytee Arc Sensor documentation suite

Document title	Description	Manual REF
Dencytee Arc Sensors Operating Instructions (this manual)	Provides detailed information about installing and setting up the sensor, as well as additional technical information.	10119689
Hamilton Arc Operating Instructions	This manual provides detailed information about the Arc system which consists of the Arc sensors, the ArcAir application, accessories and their applications. The Arc sensors are designed to measure pH, dissolved oxygen, conductivity, carbon dioxide, cell density, and oxidation-reduction potential (ORP) in a liquid medium.	10071115
Dencytee RS485 Sensors – Modbus RTU Programmer's Manual	This manual is intended for software programmers. It provides detailed information about the Dencytee RS485 Modbus RTU interface as well as general information about Modbus command structures and their implementation in the Hamilton Arc sensors family.	111004638

The latest version of the English manual, related documents, and translated manuals can be downloaded from the Hamilton Process Analytics website (https://www.hamiltoncompany.com/process-analytics).

Conventions used in this manual

Safety messages are displayed as follows:

⚠ WARNING

Alerts the user to the risk of injury, death, or other serious adverse reactions associated with the correct or incorrect use of the device.

⚠ CAUTION

Alerts the user to the possibility of a problem with the device associated with its use or misuse, such as device malfunction, device failure, damage to the device, or damage to other property.

NOTICE

Emphasizes information of particular importance.

In tables and some descriptive text, safety messages are indicated as follows:

⚠ WARNING!

⚠ CAUTION!

NOTICE!

Typographic conventions

Table 2. Overview of the typographic conventions used in this manual

Typographic effect	Example	Function
Bold	**Settings**	Indicate the name of an icon or a button in the software/application.
	Touch the **Settings** tab > **Measurement Settings** subtab	The notation **XX** > **XX** shows the sequence of buttons to touch to open the associated window in the software/application.
Italic	*Operating Instructions / Quick Start Guide*	Indicates the names of other documents.
	Moving Average: 50 / Measurement Interval: 3	Emphasizes information of particular importance.
`Software graphical user interface (GUI) text`	`"Initialization of the correlation point has been completed."`	Indicates text or message quoted directly from the software/application window or screen.
Procedural sequence	1. Step 1 in a sequence 2. Step 2 in a sequence	Organizes a sequence of actions into steps.
Illustration number sequence	1: Identifies part/item 1 of an illustration 2: Identifies part/item 2 of an illustration	• Used in illustrations/ graphics to identify the part/item for cross-referencing in a procedure or description. • It also relates to the specific part/item description in the legend table for the corresponding illustration/graphic.
Hyperlink text, for example, see Chapter 2 or see Figure 7-2	See Chapter 2 or see Figure 7-2	If you are viewing this file with PDF software, you can click on the hyperlinked text to instantly access the corresponding information in another part of this document.

In this manual:

- Some figures use callouts in a white circle with a blue border.

  ①: These figures may have an associated legend table or may provide a description for a single item legend in the title of the figure. Callouts may be numeric or alphabetic. Callouts are unrelated to any nearby procedures and refer only to the figures themselves and their associated legend.

- Some figures use small dark blue callouts.

  Ⓐ: These callouts show the sequence of steps. They are not directly related to the numbering of any associated procedure.

Graphics or illustrations used in this manual

- The graphics or illustrations used in this manual are for illustrative purposes only.
- The colors used in the graphics or illustrations may not be an exact representation of the actual product.

Dencytee Arc Sensor operating instructions contain the following:

- The architecture and components of the Dencytee Arc Sensor
- Information on hardware and software installation, operation, testing, troubleshooting, and maintenance procedures for the Dencytee Arc sensor
- Glossary

Table 3. Dencytee Arc Sensor operating instructions structure

Chapter/Section	Function	Your responsibility
Chapter 1 – *General Information*	This chapter provides information on the intended use of the Dencytee Arc Sensor and the operating instructions	Read the general information to understand the intended use of the Dencytee Arc Sensor and the operating instructions.
Chapter 2 – *Safety Precautions and Hazards*	This chapter provides safety and technical information about the Dencytee Arc Sensor.	Read the safety instructions carefully before installing, setting up, and operating the Dencytee Arc Sensor.

Chapter/Section	Function	Your responsibility
Chapter 3 – *Quick Start Protocol: Dencytee Arc Sensor Setup*	The quick start protocol contains a checklist for software installation, preparation of a bioreactor/fermentor, and system preparation. It contains instructions for starting an experiment and maintaining the Dencytee Arc Sensor. The protocol describes only the basic functions of the Dencytee Arc sensor.	Use the Quick Startup Protocol only as a checklist to prepare and set up the Dencytee Arc Sensor. **NOTICE!** The Quick Startup Protocol does not replace the official Dencytee Arc Sensors Operating Instructions (REF 10119689).
Chapter 4 – *Product Description*	This chapter provides an overview of the Dencytee Arc Sensor, measuring principle, and setup.	Read this chapter to familiarize yourself with the Dencytee Arc Sensor.
Chapter 5 – *Hardware and Software Installation*	This chapter provides information, and instructions on how to install and set up the Dencytee Arc Sensor and its hardware as well as the ArcAir software.	Read this chapter before you install and set up the Dencytee Arc Sensor and its hardware as well as the ArcAir software.
Chapter 6 – *Operation: Integrating the Dencytee Arc Sensor into an Experiment*	This chapter provides a detailed description of the recommended settings for integrating the Dencytee Arc Sensor into an experiment.	Read this chapter before you set up the Dencytee Arc Sensor and integrate the sensor into an experiment.
Chapter 7 – *Maintenance*	This chapter provides information on the sensor's maintenance procedures, including verification, calibration, cleaning, and firmware update instructions.	Read this chapter to familiarize yourself with the maintenance procedures and firmware updates for the Dencytee Arc Sensor.
Chapter 8 – *Troubleshooting*	This chapter provides information on troubleshooting procedures.	Read this chapter to familiarize yourself with the troubleshooting procedures for the Dencytee Arc Sensor.

Chapter/Section	Function	Your responsibility
Chapter 9 – *Disposal*	This chapter provides information on how to dispose of the Dencytee Arc Sensor.	• You must dispose of the Dencytee Arc Sensor according to the EU Directive 2012/19/EU or WEEE (Waste Electrical and Electronic Equipment). • Dispose of all parts removed from the sensor according to your institution's protocol. Follow all local, state, and federal/regulations concerning environmental protection, especially when disposing of the electronic device or parts of it.
Chapter 10 – *Services*	This chapter provides an overview of the services offered by Hamilton Process Analytics.	Read this chapter to familiarize yourself with the services offered by Hamilton Process Analytics.
Chapter 11 – *Ordering information*	This chapter provides an overview of the different types of Dencytee Arc Sensors available to order.	Read this chapter to familiarize yourself with the different types of sensors offered by Hamilton Process Analytics.
Glossary	This chapter contains an alphabetical list of terms, words, or acronyms used in Dencytee Arc Sensors Operating Instructions, with explanations.	Refer to the glossary for the definition of terms, words, or acronyms used in the Dencytee Arc Sensors Operating Instructions.

1 Introduction

This chapter provides information about the intended use of the Dencytee Arc Sensor and the operating instructions.

1.1 Intended use

⚠ CAUTION

The Dencytee Arc Sensor does not have an Ex (explosion-proof) approval. This means that the Dencytee Arc Sensor is not certified for use in potentially explosive atmospheres or hazardous locations where the presence of flammable gases, vapors, or dust could pose a risk.

The Hamilton Dencytee Arc Sensor (Product type name: Dencytee RS485) is designed to measure total cell densities (TCD) in bioprocesses. This can be used for monitoring or process control, as per the specifications provided on the Hamilton Process Analytics website (https://www.hamiltoncompany.com/process-analytics).

The sensor can measure the density of organisms and/or particles in a media. The sensor is suitable for use in upstream applications.

The sensor is designed for installation in benchtop and stainless steel fermenters for a PG13.5 port. Application in the single-use area is possible via a suitable adapter. Contact Hamilton Technical Support for a suitable solution.

NOTICE

- The Dencytee Arc Sensors are designed for use in an industrial electromagnetic environment according to IEC/EN 61326-1.
- Hamilton Process Analytics offers different housings for connection to pipes or bypasses. For additional information, contact Hamilton Technical Support.

1.2 About these operating instructions

The Dencytee Arc Operating Instructions are intended to guide users to operate the Dencytee Arc Sensor in combination with the ArcAir application (version 3.7 or higher) correctly and safely. The document also describes the different components and functions of the Dencytee Arc Sensor and the ArcAir application.

These operating instructions provide an in-depth description of both the hardware and software of the Dencytee Arc Sensor and how to operate the sensor in a bioprocess system.

Each section introduces various parts of the system, followed by step-by-step instructions on how to operate the Dencytee Arc Sensor with the ArcAir application. After reading this manual, the user should be able to install and operate the Dencytee Arc Sensor with the ArcAir application.

To quickly resolve some of the most common problems, see Section 8.1.

1.3 General precautions

For safe and correct use of the Dencytee Arc Sensor, both operating and service personnel must follow the generally accepted safety procedures and the safety instructions given in the Operating Instructions of the Dencytee Arc Sensor. The specifications provided for temperature and pressure must not be exceeded. Inappropriate use or misuse can be dangerous.

Operating conditions, cleaning, assembly, and maintenance shall be performed by trained personnel. Before removing the sensor from the measuring setup, always make sure that no process medium can be accidentally spilled. The vessel shall have no over-pressure and be cooled down.

When removing and cleaning the sensor, it is recommended to wear safety goggles and protective gloves. If the sensor cannot be repaired by the operator, it must be sent back to Hamilton for inspection.

You must take necessary precautions when transporting the sensors. The sensor must be sent back in the original reusable packaging box for repair or shipment. Every sensor sent back for repair must be decontaminated. Failure to comply with Operating Instructions or inappropriate sensor usage voids all manufacturer's warranties.

2 Safety Precautions and Hazards

⚠ CAUTION

- *Carefully read and observe the following safety precautions and hazards before installing, setting up, and operating the sensor.*
- *Failure to observe and follow through with the maintenance procedures can impair the reliability and correct function of the system.*
- *Failure to observe the safety precautions and hazards described in this manual, improper use of the sensor, and unauthorized interference with the sensor by external devices will void all warranties provided by the manufacturer.*
- *Do not expose the sensor to corrosive media or substances. This will help to protect the sensor from deterioration.*

This chapter provides safety information and technical-related information about the Dencytee Arc Sensor.

If you have questions about any of the information in this manual, contact your Hamilton Process Analytics representative or technical service personnel.

NTC temperature sensor

⚠ CAUTION

- *The Dencytee Arc Sensor has a built-in temperature sensor, that is, Negative Temperature Coefficients (NTC) of 22 kΩ. This temperature sensor only monitors the sensor conditions and does not control the process temperature.*
- *The measurement values transmitted over wireless communication are not intended to be used for process control.*

Temperature compensation

NOTICE

Although the sensor signal has temperature compensation, a change in the optical behavior of the media due to temperature changes is not compensated.

Sensor handling

⚠ CAUTION

Do not drop the sensor during handling. Dropping the sensor can cause damage to the optical path.

Sensor's material compliance

NOTICE

- The shaft of the Dencytee Arc Sensor is made of stainless steel, which complies with biopharma requirements, thus, **stainless steel 1.4435**. Different stainless steel heat numbers may be used due to minor variations in the manufacturing processes.
- For wetted steel surfaces > 1%, the corresponding Material Certification and Identification EN 10204–3.1.B is delivered with the sensor in paper form or it can be downloaded from the Hamilton Process Analytics website (https://www.hamiltoncompany.com/process-analytics).

2.1 Operating precautions for Dencytee Arc Sensors

⚠ CAUTION

- *The Dencytee Arc Sensor must be used for the intended applications and in optimum safety and operational conditions. The customer has to validate the sensor to determine if it qualifies for the intended application.*
- *Make sure that the process connections and the O-rings are not damaged when screwing a sensor into the process. The O-rings are consumable parts that must be exchanged regularly (at least once a year).*
- *Even when all required safety measures have been complied with, potential risks still exist concerning leaks or mechanical damage. Wherever there are seals or screws, gases or liquids can leak out undetected. Do not put stress such as vibration, bending, or torsion on the system.*
- *The sensor can remain connected to a Process Control System (PCS), Supervisory Control and Data Acquisition (SCADA), or computer during Cleaning in Place (CIP) and Sterilization in Place (SIP). Stand clear of the sensor during the CIP and SIP procedures as the sensor can become very hot.*

2.2 Electrical safety precautions

⚠ WARNING

- Before you remove/disconnect the sensor from the process tank, benchtop, or bioreactor, you must always turn off the power supply and disconnect the cable connector from the sensor.
- Only use the cables provided by Hamilton Process Analytics.
- Do not bend, step on, or place heavy objects on the cable/cord. A damaged cable/cord can pose a shock or fire hazard.
- Do not use a damaged power cord.
- Do not connect the sensor to a power source with an output voltage below or above the range stated in the specifications. For additional information, see the Hamilton Process Analytics website (https://www.hamiltoncompany.com/process-analytics). Failure to do so can lead to malfunction or damage to the system or impair the safety of the user.
- The sensor must be installed at a location that is electrically conductive (< 1 MΩ).
- We recommend that you inspect the entire grounding (sensor or sensor with reactor) before use and after altering the setup.

NOTICE

The PCS will show incorrect readings when the power supply (24 VDC) is tuned off or disconnected.

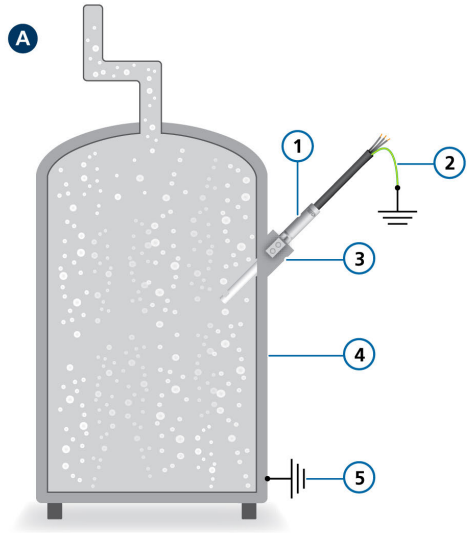
We recommend that you assign the sensor shaft and/or VP8 cable shield to ground or earth (potential equalization), especially in electromagnetically noisy environments. This significantly improves noise immunity and signal quality. The VP8 thread is connected to the metallic housing of the Dencytee Arc Sensor.

There are two options available for connecting the sensor to the process environment (see Figures 2-1 and 2-2).

NOTICE

- Option A: Metal tank/bioreactor with own earth/ground system (see Figure 2-1)
- Option B: Glass, plastic tank, or benchtop reactor not connected to earth/ground (see Figure 2-2).
- Option B setup has to be applied if the tank is not connected to the earth/ground.

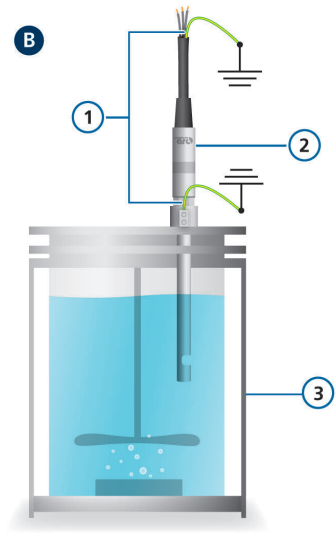
Figure 2-1. Metal tank with earth connection (Option A)



1	Dencytee Arc Sensor	4	Bioreactor (for example, metal tank)
2	Earth/ground cable (green/yellow)	5	Bioreactor earth/ground
3	Stainless steel PG 13.5 with thread to connect the sensor shaft to the metallic tank		

The glass or plastic tank is not connected to the earth. Therefore, it is necessary to connect the sensor shaft via a screw clamp or VP8 cable to the ground/earth. We recommend that you connect the sensor shaft and/or VP8 cable shield to the ground/earth.

Figure 2-2. Glass, plastic tank, or benchtop reactor setup without earth/ground connection (Option B)

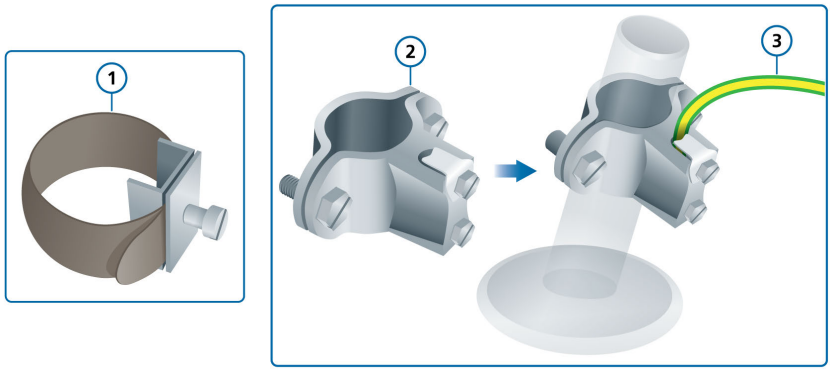


1	Earth/ground cable (green/yellow)	3	Glass, plastic tank, or benchtop reactor
2	Dencytee Arc Sensor		

Connecting clamps

Figure 2-3 show several examples of clamps required for a setup with an earth/ground connection (Clamp 1) or a setup without an earth/ground connection (Clamp 2).

Figure 2-3. Examples of clamps required for installing the sensor to a glass/metal tank reactor, plastic tank, or benchtop reactor



1	Earth/ground strap for pipes	3	Clamp with earth/ground cable connection to a metal tank reactor
2	Earth/ground clamp for pipes		

2.3 Chemical, radioactive, and biological hazard precautions

⚠ WARNING

You must observe and follow the maintenance procedures. Pay attention to the cleaning and decontamination procedures if you work with hazardous liquids. Avoid any contact of the equipment with corrosive media.

⚠ CAUTION

- *You must clean the Dencytee Arc Sensor if it becomes contaminated with biohazardous, radioactive, or chemical material.*
- *Failure to observe and follow the maintenance procedures can decrease the reliability and the correct functionality of the system.*

The selection of the appropriate biological safety level and implementation of the required biosafety measures for working with Dencytee Arc Sensor is the sole responsibility of the user.

3 Quick Start Protocol: Dencytee Arc Sensor Setup

NOTICE

- The *Quick Startup Protocol* does not replace the official Operating Instructions for the Dencytee Arc Sensor. The protocol provides only a checklist for the software installation, bioreactor/fermented preparation, system setup, starting an experiment in the ArcAir application, and maintenance of the sensor. The protocol describes only the basic functions of the Dencytee Arc Sensor.
- For the sensor specification details, refer to the Hamilton Process Analytics website (https://www.hamiltoncompany.com/process-analytics).

Install the ArcAir application	
Task	**Status**
Download and install the latest software version of the Hamilton ArcAir from the Hamilton website.	☐

Prepare the bioreactor/fermenter	
Task	**Status**
Install the sensor into the bioreactor and autoclave the reactor with the sensor.	☐
or	
Install the sensor into the stainless steel fermenter, then clean (CIP) and/or sterilize (SIP) the equipment according to your working protocol/procedure.	☐

Setup the system	
Task	**Status**
NOTICE! You can rotate the sensor within the thread nut for the correct orientation.	☐
• Connect the sensor with the Arc USB Power Cable (REF 243490) to a PC. • Connect the USB Power Cable to an external power supply to make sure that there is sufficient power supply to the sensor.	

Setup the system	
Task	Status
• Start the ArcAir application and wait until the sensor is displayed under the Sensor list. • Check if the **Filter** for the **Sensor type** is correct. You must select an active Total Cell Density (TCD) under the **Sensors** list.	☐
Check if the status indicator color is green. **NOTICE!** The status indicator color will be red if there are no cells or media present.	☐
• To connect to the sensor, click on the sensor **Dashboard** in the ArcAir application. • Navigate to **Settings** tab > **Measurement Settings** subtab, then set the **Moving Average** and **Measurement Interval** to the desired value. • Measurement settings recommendation: Moving Average: 50 | Measurement Interval: 3 s	☐

Default offline Correlation Models

NOTICE! Activate one of the four default correlation models.

Name	Unit	Description	Status
Transmission	AU	The sensor measures only transmitted light.	☐
Reflection	Arb. unit	The sensor is measuring only reflected light	
CDW Yeast	g/L	Measurement of Transmission and Correlation to cell dry weight of yeast is based on the transmission signal.	
Turbidity Std	NTU	Measurement of Transmission and Correlation to a turbidity standard is based on the transmission signal.	

Maintenance of the sensor	
Task	Status
After cultivation, rinse the sensor with water and clean the bioreactor using one of the standard cleaning procedures (CIP, SIP and/or Autoclaving).	☐
Depending on the user/company requirements, you can do a post-run to check the verification check and performance of the sensor. For additional details, see Section 5.5.3 and Chapter 10 in the *Dencytee Arc Sensors Operating Instructions* (REF 10119689).	☐

Remarks

4 Product Description

The Dencytee Arc Sensor is designed to determine the total cell density in bioprocesses. The cells in the medium are determined by a combination of two different measuring methods. The Dencytee Arc Sensor combines both transmission and reflection measurement principles in one sensor. This combination enables the probe to measure precisely and reliably in low- and high-concentration ranges.

The signal of the Dencytee Arc Sensor is transferred into the desired unit via offline correlation and effectively represents the bioprocess using the desired measurement. The sensor has a built-in daylight filter, but it is not recommended to expose the sensor to direct light.

Sensor specification range:

Yeast	0 - 200 g/l CDW
Turbidity Standard	0 - 30,000 NTU

NOTICE

The sensor specification range can vary if the media has very high turbidity.

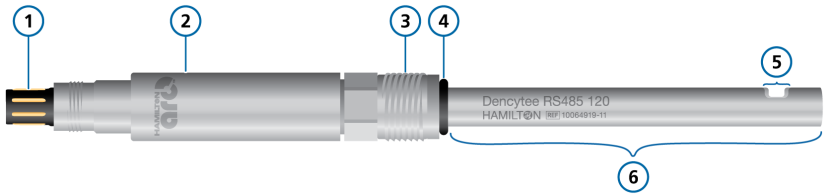
4.1 Hardware description

A schematic illustration of the Dencytee Arc Sensor is shown in Figure 4-1. The sensor has a VP8 connector head for external connection to a PCS. The sensor receives its power via the VP8 connector cable. The sensor head has an integrated microtransmitter.

The PG 13.5 thread is the standard connector for installing the sensor into the ports of different bioreactors. The **Reference Number**, **Serial Number**, and **Heat Number** of the sensor can be found on the shaft of the sensor.

The measuring component of the sensor is located at the front, comprising the measuring path with two windows.

Figure 4-1. Overview of the Dencytee Arc Sensor



1	VP8 connector	4	O-ring
2	Sensor head with integrated transmitter	5	Sensing part (optical path)
3	Process connection with PG 13.5 thread, stainless steel	6	Sensor shaft with heat number, REF number, and serial number (SN)

4.2 Measuring principle

The configuration of the emitter and receptors allows the sensor to use both transmission and reflection measurement principles. The signal is processed within the sensor and displayed in the unit of the selected offline correlation.

4.3 Dencytee Arc Sensor with an integrated microtransmitter

The Dencytee Arc Sensor provides a fully compensated signal directly to the PCS through its integrated microtransmitter. Communication protocols include digital Modbus and an optional 4-20 mA, using the Arc Wi 2G BT Adapter (REF 243470).

The microtransmitter located in the sensor head stores all relevant sensor data. This includes factory calibration and diagnostic information which simplifies verification and maintenance.

4.4 Connecting Arc sensors to the ArcAir application

Hamilton's Arc Sensor family of intelligent sensors enables operators to monitor and adjust process parameters in a bioprocess to their requirements. The Dencytee Arc Sensor has an integrated microtransmitter that enables direct communication to the Process Control System (PCS) using Modbus digital communication protocol or via a 4-20 mA interface (optional) using the Arc Wi 2G Bluetooth® (BT) Adapter (REF 243470).

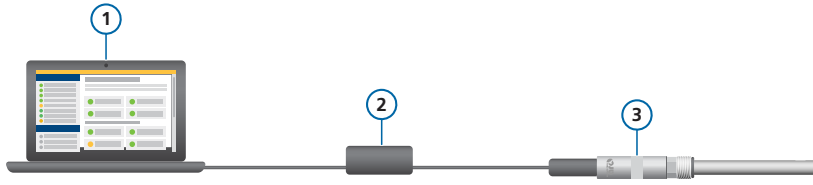
A wired connection can be established using an Arc USB Power Cable (REF 243490-XX) and a computer (see Figure 4-2). With the integrated microtransmitter, the Dencytee Arc Sensor provides more reliable measurements directly to the PCS or ArcAir application.

Bluetooth® wireless communication can be used with the Arc Wireless Adapter for configuring and troubleshooting the Arc sensors. This saves time without compromising the quality of the wired connection (see Figure 4-2). Wireless communication is available via a smart phone, tablet, or computer.

Key benefits of connecting the Dencytee Arc Sensor with the ArcAir application:

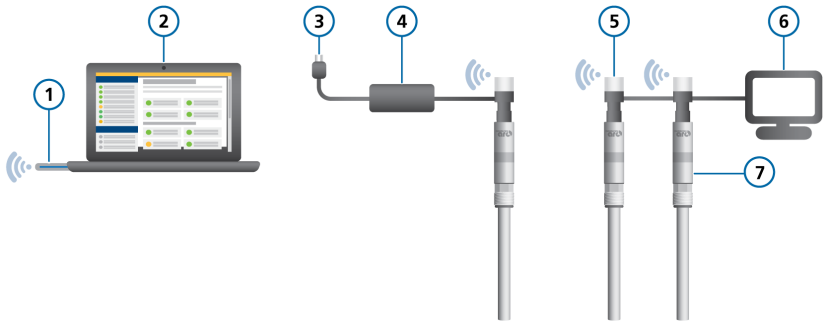
- A separate transmitter is not required
- Maintenance is simple
- Easy to install
- There is an option for a digital Modbus or analog communication via Arc Wi 2G BT Adapter (REF 243470)
- It offers a full online wireless option via Bluetooth® 4.0 for easy configuration
- It has a recording functionality (in ArcAir) with data export from the ArcAir experiment
- Reporting and central data management of user accounts, validation reports for verification, configuration, and communication within the GMP guidelines, including FDA CFR21 Part 11 and Eudralex Volume 4 Annex 11

Figure 4-2. Arc system setup: Wired connection to ArcAir application on a PC



1	ArcAir application installed on PC/ Notebook	3	Dencytee Arc Sensor
2	Arc USB power cable (REF 243490-XX)		

Figure 4-3. Arc sensor system setup: Wireless connection to ArcAir application



1	Arc wireless BT converter	5	Arc wireless BT adapter
2	ArcAir application installed on a PC/ Notebook	6	Process control system (PCS)
3	Power supply plug	7	Dencytee Arc Sensor
4	Arc USB power cable		

NOTICE

Wireless communication is not intended to be used for process control applications.

4.4.1 ArcAir application

The ArcAir application provides a secure and efficient communication platform for monitoring, validating, and managing Arc sensors and user accounts. It seamlessly integrates Arc sensors into the bioprocess setup, making the system cost-effective and reliable. You can easily configure Arc sensors using a mobile device or computer with the ArcAir application installed.

Users can benefit from making in-lab configurations and in-process adjustments by combining the reliability of Dencytee Arc Sensors with external power and mobile devices. The offset compensation functions, thus, **Mark Zero** and **Clear Zero** can be used in the process environment and during sensor `Verification`.

Users can benefit from the automated standard calibrations and configurations in the laboratory, as well as product calibrations and validations in process environments. The reporting feature allows users to manage validation, verification, configuration, and communication reports. User profiles for all Arc sensors can be managed in compliance with GMP regulatory requirements.

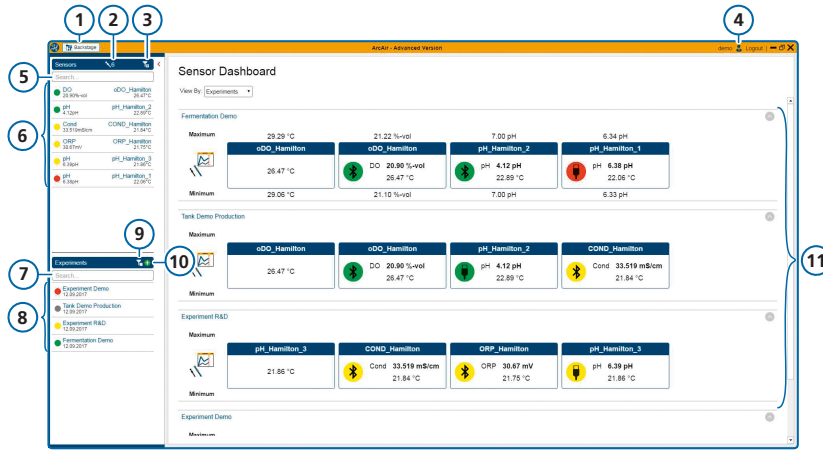
The ArcAir application can be installed on various devices, including computers, tablets, and mobile phones to provide users with an overview of all the Arc sensors in the operational environment. The ArcAir mobile version only supports the most important workflow. Note that data recording and display of the experiment are not available in the ArcAir mobile version.

NOTICE

- For additional information about the ArcAir application and the general workflow of the ArcAir application, refer to the *Hamilton Arc Operating Instructions* (REF 10071115).
- We highly recommend that you use a screen/display with a minimum resolution of 1280 x 768 pixels.
- ArcAir v3.7 or higher is required to use the Dencytee Arc Sensor.

Overview of the ArcAir application (PC version) main screen

Figure 4-4. ArcAir application (PC version): Overview of the ArcAir main screen

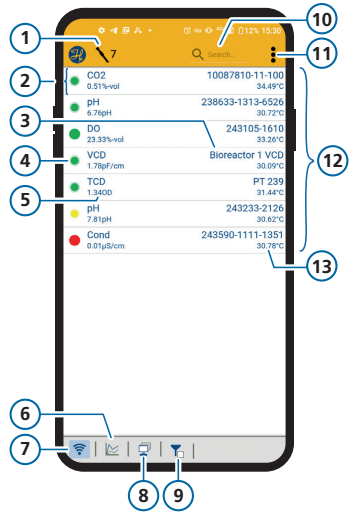


1	Backstage tab: You can access the user profile, manage passwords, sensor groups, mobile connection, Firmware update, audit trail, and electronic signatures	7	Experiment search field: Use the field to search for sensors used in an experiment
2	Number of sensors online	8	Overview of the list of sensors used in an experiment

3	Filter icon: Use the filter to specify or refine your search for the sensor list	9	Filter icon: Use the filter to specify or refine your search for the sensor list under experiment
4	User profile name/account	10	Create a new experiment
5	Search field: Use the search field to search for sensors connected to the ArcAir application	11	Sensor dashboard: Provides an overview of the sensors connected to the ArcAir application, including the sensor status, type of connection and status, measurement parameters, and measured value with the corresponding units.
6	Sensor list: Provides an overview of the sensors connected to the ArcAir application, including the sensor status, measurement parameters, and measured value with the corresponding units.		

Overview of the ArcAir application (mobile version) main screen

Figure 4-5. ArcAir application (mobile version): Overview of the ArcAir main screen



1	Number of sensors online	8	Computer connection
2	Primary sensor: Provides an overview of the sensor status, measurement parameter, and measured value with the corresponding units	9	Filter icon: Use the filter to specify and refine your search for the sensors connected to the ArcAir application
3	Measuring point: The default measuring information is set to show the reference number (REF) and serial number (SN) of the sensor. **NOTICE!** The user can change the default measuring point information to differentiate between the sensors. For example, Bioreactor 1 VCD.	10	Search field: Use the search field to search for sensors connected to the ArcAir application

4	Sensor status indicator: • **Green:** Indicates that there are not warnings or errors • **Yellow:** Indicates that at least one warning has been registered • **Red:** Indicates that at least one error has been registered • **Gray:** Indicates that the sensor is offline For additional information about the Sensor Status Indicator, see Chapter 8.	11	ArcAir licenses and other information related to the sensor
5	Current measurement point	12	Sensor dashboard: Provides an overview of the sensors connected to the ArcAir application, including the sensor status, measurement parameters, and measured value with the corresponding units.
6	Experiment view: Touch to view the list of sensors used in an experiment	13	Current temperature reading
7	Wi-Fi icon: Touch to view the list of sensors connected via Wi-Fi to the ArcAir application		

4.4.2 Accessories

The Dencytee Arc Sensor can be combined with different hardware accessories from the Arc portfolio for specific applications.

All listed accessories for the Dencytee Arc Sensor must be ordered directly from Hamilton. Contact the Hamilton Application Specialists team if you need support with finding and selecting the right accessories required to complete your application setup with the Dencytee Arc Sensor.

Accessories overview

- **Wireless**
  - Arc Wi 2G BT Adapter (REF 243470): 4-20 mA, Modbus, and Bluetooth® connection
  - Arc Wi 1G BT Adapter (REF 243460)

NOTICE

We recommend you use the Arc Wi 1G BT Adapter (REF 243460) in combination with the Arc Modbus OPC Converter (REF 10089359). This will enable bi-directional communication.

- **Wired/external power**

  External Power supply with Arc USB Power Cable (REF 243490-01/-02)

- **Modbus connection**

  To get a better overview of what is required to connect your sensor to the existing control system, see Section 5.3.

4.5 Dencytee Arc Sensor in a GMP environment

For additional information about using the Dencytee Arc Sensor in a Good Manufacturing Processes (GMP) environment, see the *Hamilton Arc Operating Instructions* (REF 10071115).

5 Hardware and Software Installation

This chapter provides information and instructions on how to install and set up the Dencytee Arc Sensor and its hardware as well as the ArcAir application.

5.1 Unpacking the sensor

⚠ CAUTION

- *Always handle the sensor with care.*
- *Verify the functionality of the sensor before use if the sensor is accidentally dropped when outside of the Hamilton original packaging. For details about troubleshooting, see Chapter 8.*
- *Contact Hamilton Technical Support if you experience warning and error messages with the sensor.*

1. Carefully unpack the Dencytee Arc Sensor. Inside the packaging, you will find the Dencytee Arc Sensor, Declaration of Quality (DoQ), Material Certificates, and Operating Instructions (see Figure 5-1).
2. Inspect the sensor for damage or missing parts.

Figure 5-1. Overview of the Dencytee Arc Sensor package contents: Dencytee Arc Sensor, DoQ, Material Certificates, and Operating Instructions



5.2 Installing the Dencytee Arc Sensors in a bioreactor

There are different ways of installing the Dencytee Arc Sensor into the reactor depending on the type of bioreactor. There are various housings available to custom-fit the sensor in every installation.

1. Remove the yellow protective caps from the VP8 sensor head.
2. Inspect the Dencytee Arc Sensor:
   - Check the O-ring on the sensor shaft.
   - Check if the sensing part (optical path) is free of damage and dirt particles.

⚠ CAUTION

- *The gas bubbles from the media can interfere with the measurement while installing the Dencytee Arc. We recommend that you revalidate the positioning regularly and make adjustments if necessary.*
- *Make sure the sensing part of the sensor is always submerged fully in the medium.*
- *Make sure the sensor does not rotate out of the defined position when you attach the power cable.*
- *Do not use mechanical or power tools to tighten the Dencytee Arc Sensor during the installation.*
- *Do not use the Arc Wi BT Adapter to unscrew the sensor from the reactor.*
- *Tighten the sensor by hand when it is installed via the side wall port (stainless steel PG 13.5 thread) on the bioreactor. The torque must not exceed 2 Nm.*

3. Carefully install the sensor in the port on the bioreactor and make adjustments if necessary (see Figure 5-2).
4. Tighten the sensor by hand. The torque must not exceed 2 Nm.

Dencytee Arc Sensor installation configurations

- **Installation configuration A**

  The Dencytee Arc Sensor is installed via the side wall of the bioreactor (stainless steel or single-use bioreactors). See Figure 5-2 – Configuration A.

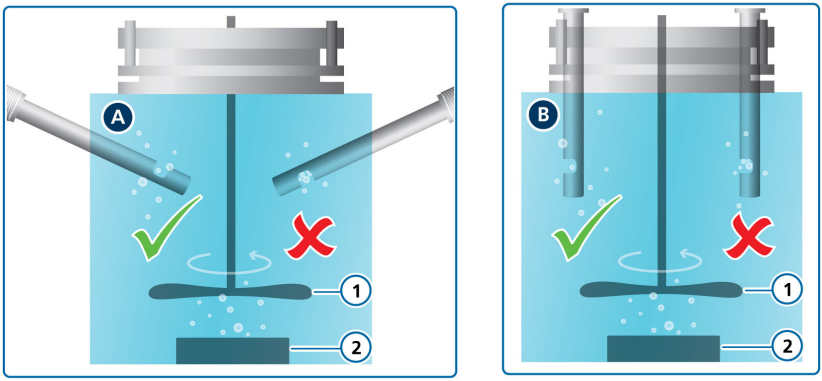
- **Installation configuration B**

  The Dencytee Arc Sensor is installed via the top ports relative to the stirring and gas systems of the benchtop bioreactor. See Figure 5-2 – Configuration B.

NOTICE

The notch on the VP8 head serves as an alignment guide for the sensor and the measuring gap (see Figure 5-3).

Figure 5-2. Dencytee Arc Sensor installation configurations



1	Stirrer	2	Sparger

Dencytee Arc Sensor configuration with the Arc Wi adapter

⚠ CAUTION

- *Do not use a manual or mechanical tool to install or remove the Dencytee Arc Sensor. Using a manual or mechanical tool to install or remove the sensor can cause damage to the sensor.*
- *Do not use the Arc Wi BT Adapter to unscrew the sensor from the reactor.*

The notch on the sensor head will determine the connection orientation of the two components if the Dencytee Arc Sensor is combined with the Arc Wi Adapter (see Figure 5-3). This orientation should be individually adapted to the process conditions. For example, signal quality and the distance between other reactor components.

5.3 Connecting Dencytee Arc Sensors to a process control system

Hamilton offers a wide range of options for integrating the sensors into a variety of process setups. For additional information about the Dencytee Arc Sensor integration options, see Sections 5.3.1, 5.3.2, and 5.3.3.

The mechanical design of the Dencytee Arc Sensor makes it compatible with all Hamilton process housings. For additional information about the process housings offered by Hamilton Process Analytics, see Table 11-4.

Sensor installation tips

- Before you install the housing, you must test the seal for tightness and the functionality of the sensor parts.
- Make sure that there is no damage to the sensor or the housing.
- Make sure that each O-ring is in the appropriate groove and not damaged.
- To prevent mechanical damage to O-rings, apply a small amount of grease to the O-rings before you install the sensor in a reactor.

NOTICE

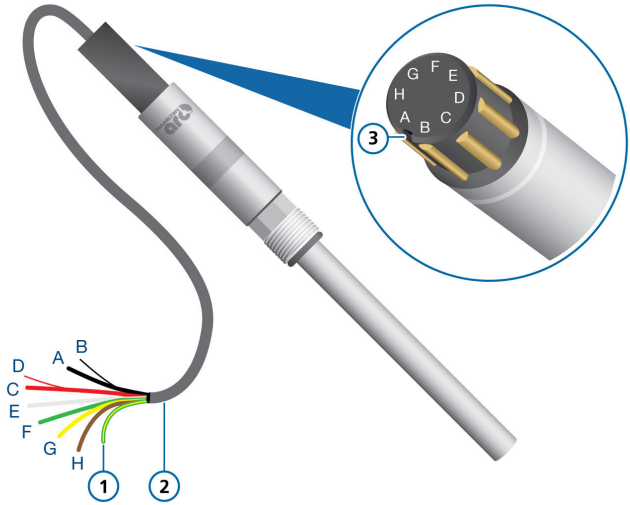
The O-rings are wetted parts, and lubricant compounds must comply with FDA application requirements.

5.3.1 VP8 or M12 Pin assignment

Always use Hamilton VP8 sensor cables for safe connection. The VP8 sensor cables are available in different lengths (see Chapter 11). The Dencytee Arc Sensor is fitted with a VP8 male connector by default.

The VP8 head has a notch to denote the Pin position and prevent incorrect pairing with the cable connectors (see Figure 5-3).

Figure 5-3. Dencytee Arc Sensor electrical connection: VP8 connector Pin assignment



1 VP8 earth/ground cable (yellow/green)

⚠ **CAUTION!** *Do not ground/earth the sensor via the VP8 earth/ground cable, as the sensor is grounded via the metallic bioreactor.*

2 Cable shield (double coaxial open-end cable and data cable conductor)

3 A notch on the VP8 head for the sensor alignment

Table 5-1 provides an overview of the VP8 connector Pin assignment for the Dencytee Arc Sensor electrical connection.

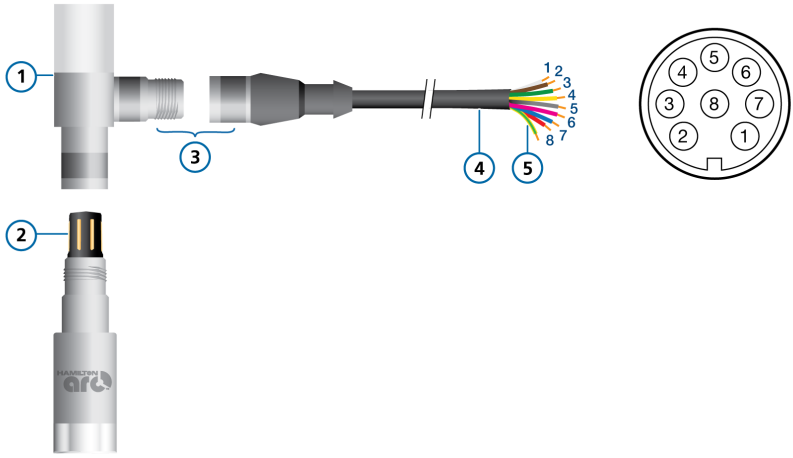
Table 5-1. Dencytee Arc Sensor connector: VP8 connector Pin assignment

VP Pin	Function	Double coaxial cable description	Data cable description
A	Not used	Coaxial core, black transparent	Yellow
B	Not used	Coaxial shield, black	Green
C	Power supply: +10 V to 27 V	Coaxial core, red transparent	Red
D	Power supply ground/ earth: 0 VDC	Coaxial shield, red	Blue
E	Not used	White	Brown
F	Not used	Green	White
G	RS-485 A	Yellow	Gray
H	RS-485 B	Brown	Pink

5.3.2 Connecting Dencytee Arc Sensors via 4-20 mA analog interface

Connecting an Arc Wi 2G BT Adapter (REF 243470) to the Dencytee Arc Sensor head makes it possible to output an analog signal of 4-20 mA from the Modbus digital communication protocol. Always use the Hamilton M12 sensor cable for a safe connection. The Hamilton M12 sensor cables are available in different lengths (see Chapter 11).

Figure 5-4. Arc sensor setup with Arc Wi 2G BT adapter and M12-8 pole open-end cable



1	Arc Wi 2G BT adapter	4	Cable shield
2	VP8 male connector	5	Green/Yellow cable: Connected to the housing including the VP8 female connector
3	M12-8 pole connection		

Table 5-2 provides an overview of the M12 (A coded) Pin assignment for the Hamilton M12-8 pole sensor cable connector.

Table 5-2. M12 (A coded) Pin assignment for the Hamilton M12-8 pole sensor cable connector

M12 Pin	Function	Cable description	Description
1	+4 to +20 mA, #1	White	• The 4-20 mA two-wire interface functions as a current sink and needs to be powered. It regulates the input current according to the measurements of the sensor. • The 4-20 mA two-wire is galvanically isolated from the power supply.
2	-4 to +20 mA, #1	Brown	
3	+4 to +20 mA, #2	Green	
4	-4 to +20 mA, #2	Yellow	
5	RS-485 (A)	Gray	Modbus RTU RS-485
6	RS-485 (B)	Pink	Modbus RTU RS-485
7	GND	Blue	Ground/earth: 0 VDC
8	+24 VDC	Red	Power supply: +10 V to +27 V **NOTICE!** The power supply can be external but not from the PCS.

5.3.3 Electrical connection: Setup for 4-20 mA analog interface

The 4–20 mA interface enables direct connection of the Dencytee Arc Sensor to a data recorder, indicator, control unit, or PCS with an analog Input/Output (I/O). In this configuration, the Wi 2G BT Adapter works as a current sink in a passive state.

Connect the sensor according to the Pin assignments (see Sections 5.3.1 and 5.3.2).

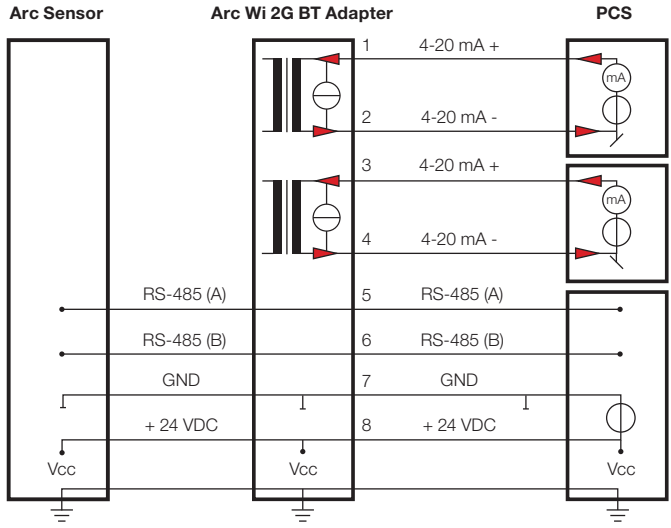
The 4–20 mA interface setup consists of the Arc Wi Adapter and Dencytee Arc Sensor. The interface has to be configured according to the requirements of the user. The Dencytee Arc Sensor is pre-configured with default values for the 4-20 mA and measurement unit. For more details about the correct measurement in the ArcAir application, see Section 5.5.5.5.

⚠ CAUTION

- *The PCS connection with an active 4-20 mA input card setup is the safest form of wiring an Arc sensor.*
- *The Arc Wi 2G BT Adapter (REF 243470) provides internal galvanic isolators for enhanced analog signal quality as well as simplified connection to the PCS.*
- *The PCS requires an active 4-20 mA input card.*

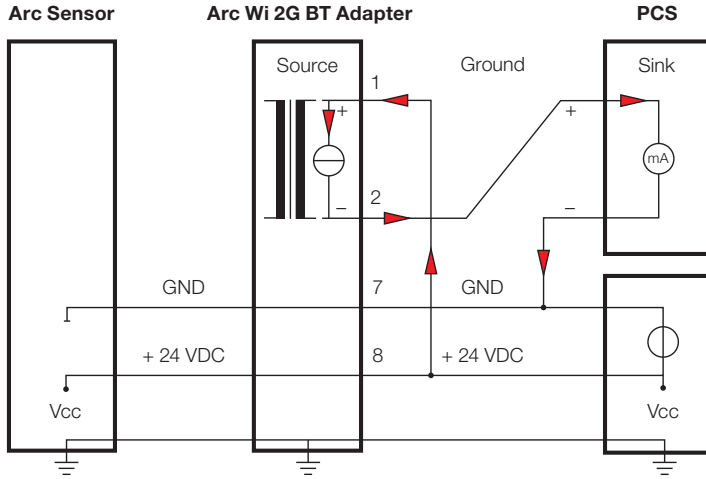
PCS configuration with an active 4-20 mA input card

Figure 5-5. Typical PCS configuration with an active 4-20 mA input card: Setup with an Arc Wi 2G BT Adapter (REF 243470)



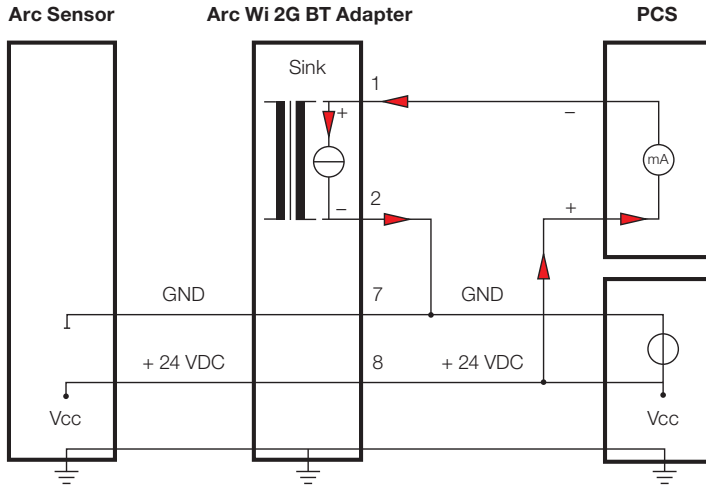
PCS configuration with a passive 4-20 mA input card: Sensor configured as the current sink

Figure 5-6. Typical PCS configuration with a passive 4-20 mA input card: Setup with an Arc Wi 2G BT Adapter (REF 243470) if there is no active 4-20 mA connection available



PCS configuration with a passive 4-20 mA input card: Sensor configured as the current sink

Figure 5-7. Typical PCS configuration with a passive 4-20 mA input card: Setup with an Arc Wi 2G BT Adapter (REF 243470)



5.3.4 Connecting Dencytee Arc Sensors via Modbus

The digital RS-485 interface enables communication with the Arc sensor for performing measurements, monitoring the status of the sensor, and changing the configuration parameters of the sensor.

The Arc sensors are always connected to digital controlling devices such as a Modbus slave. The Arc sensors require a power supply via the VP8 Pins **C** and **D** to function correctly (see Figure 5-3).

Additional information: Modbus RTU communication protocol

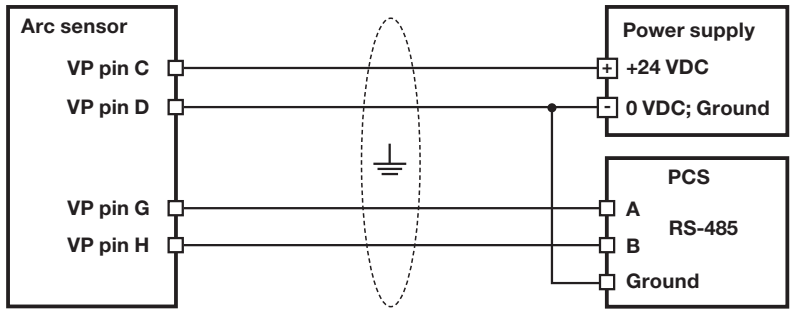
- The Modbus RTU communication protocol corresponds to the Modbus-IDA standard. For more information, refer to the Modbus organization website (https://modbus.org/). The Modbus physical layer is described in detail with requirements on cabling and line termination in the *Modbus Serial line Protocol and Implementation Guide*. For more information on the Modbus physical layer, refer to the *Modbus Serial Line Protocol and Implementation Guide* > *Technical Resources* > *Modbus Specifications.*
- The Dencytee Arc Sensor connection via Modbus can be found in the Dencytee Arc *Programmer's Manual* (REF 111004638).

⚠ CAUTION

- *All the sensors are delivered with the factory-default setting. Each sensor must be configured for its specific application before first use (see Chapter 5).*
- *In an electromagnetically noisy environment, we recommend that you connect the VP cable shield to the earth (see Section 2.2). This significantly reduces noise interference and improves the signal quality.*

Example of the circuit arrangement

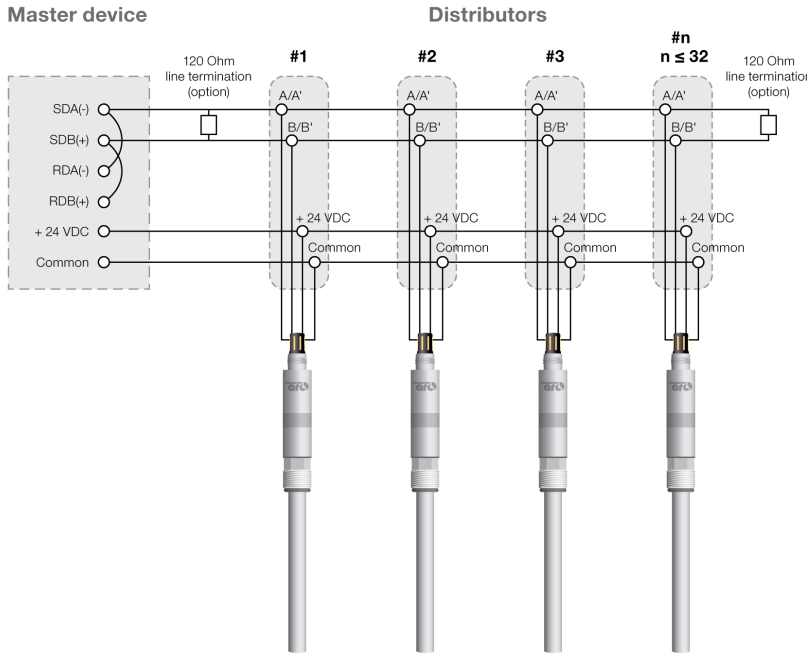
Figure 5-8. Wiring diagram for the RS-485 interface



⚠ CAUTION

You must assign a unique Modbus device address to each sensor for the correct communication in the wiring configuration shown in Figure 5-9.

Figure 5-9. Multi-drop bus wiring: Two-wire mode for the Modbus connection



NOTICE

- Each sensor functions as a Modbus slave.
- Only one sensor can communicate with the master at a time.
- To prevent signal reflection on the lines, we recommend that you use a line termination resistor of 120 Ω on each line.
- The effect of signal reflections becomes noticeable with long cable and/or high baud rates.
- The serial Modbus connection between the RS-485 port of the master and the corresponding interfaces of the sensors must comply with the EIA/TIA RS-485 standard.

5.4 ArcAir application

The ArcAir application provides a secure and efficient communication platform for monitoring, validating, and managing Arc sensors and user accounts. It seamlessly integrates Arc sensors into the bioprocess setup, making the system cost-effective and reliable. You can easily configure Arc sensors using a mobile device or computer with the ArcAir application installed.

Users can benefit from making in-lab configurations and in-process adjustments by combining the reliability of Dencytee Arc Sensors with external power and mobile devices. The offset compensation functions, thus, **Mark Zero** and **Clear Zero** can be used in the process environment and during sensor `Verification`.

Users can benefit from the automated standard calibrations and configurations in the laboratory, as well as product calibrations and validations in process environments. The reporting feature allows users to manage validation, verification, configuration, and communication reports. User profiles for all Arc sensors can be managed in compliance with GMP regulatory requirements.

The ArcAir application can be installed on various devices, including computers, tablets, and mobile phones to provide users with an overview of all the Arc sensors in the operational environment. The ArcAir mobile version only supports the most important workflow. Note that data recording and display of the experiment are not available in the ArcAir mobile version.

NOTICE

- For additional information about the ArcAir application and the general workflow of the ArcAir application, refer to the *Hamilton Arc Operating Instructions* (REF 10071115).
- We highly recommend that you use a screen/display with a minimum resolution of 1280 x 768 pixels.
- ArcAir v3.7 or higher is required to use the Dencytee Arc Sensor.

5.4.1 Installing ArcAir on a computer

Download the latest software version of ArcAir from the Hamilton website: www.hamiltoncompany.com.

For details about the ArcAir application installation and configuration, refer to the *Hamilton Arc Operating Instructions* (REF 10071115).

5.4.2 Installing ArcAir on a mobile or tablet

Download the latest software version of ArcAir from the App Store or Google Play.

For details about the ArcAir application installation and configuration, refer to the *Hamilton Arc Operating Instructions* (REF 10071115).

5.4.3 Software update

⚠ CAUTION

Make sure that all configurations and experimental data are exported and saved before a new software version is installed.

1. Download the latest software version of ArcAir from the Hamilton website (www.hamiltoncompany.com).
2. Save the software file on a USB drive or the computer on which the software is to be installed.
3. Install the software.

5.5 Connecting Arc sensors to the ArcAir application

The Arc USB Power Cable (REF 243490-XX) is required to connect the Dencytee Arc Sensor. Alternatively, a wireless connection is also possible with an Arc Wi BT Adapter (REF 243470), see Section 4.4.

To connect the Arc sensor to the ArcAir application, follow these steps:

⚠ CAUTION

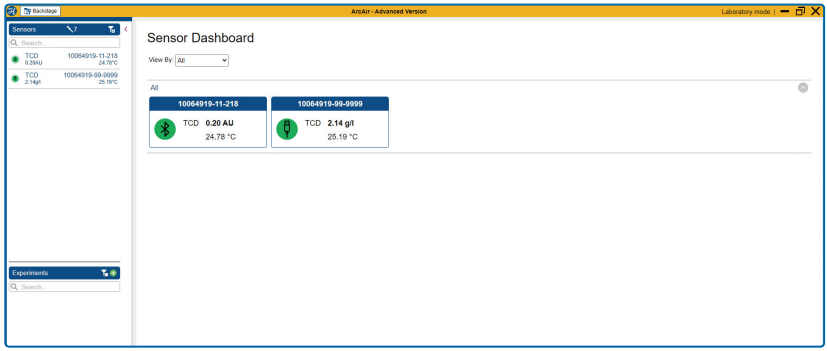
You must generate a Communication Validation Report from the ArcAir application if the Dencytee Arc Sensor is connected to the PCS via 4-20 mA: Navigate to the Communication Validation tab in ArcAir and follow the on-screen instructions.

1. Connect one Dencytee Arc Sensor with the power supply and the computer, by using the Arc USB Power Cable (REF 243490-XX) on a standard USB port.
2. The ArcAir application recognizes and displays the connected sensor automatically on the Sensor Dashboard. The available connection type used to connect the sensor is indicated next to the sensor in the dashboard. For example, the sensor can be connected via Bluetooth® or the USB power cable (see Figure 5-10).
3. To connect to the Dencytee Arc Sensor: Click the **TCD** sensor on either the **Sensor Dashboard** or select the applicable sensor from the list in the upper left corner of the display (see Figure 5-10). When the sensor is connected, the **Info** tab of the sensor will be shown on the display.
4. Verify the sensor functionality and status on the computer, mobile device, or process control system with the **Sensor Quick View/Info**.

NOTICE

For details on how to resolve connection issues, refer to Chapter 8.

Figure 5-10. Overview of the ArcAir application: Sensor dashboard showing the different connection types for the Arc sensor



5.5.1 Info tab

The **Info** tab is divided into the following categories:

- Sensor quick view
- Status
- Measurement value
- Measurement point
- Information
- Userspace

Sensor Quick View

The following information is under the **Sensor Quick View** page: `Current Measurement` and `Sensor Health`.

- **Current Measurement**

  Shows the currently measured Total Cell Density (TCD) and Temperature.

- **Sensor Health**

  Displays information about the life cycle and the quality of the sensor. In addition to the operating hours and the number of sterilization (SIP) and cleaning cycles (CIP), the Quality Indicator is also displayed under `Sensor Health`.

NOTICE

The Quality Indicator increases in value after the sensor conditioning process (see Sections Manual e-conditioning and Automated e-conditioning).

- **Warnings and Errors**

  This part shows a detailed list of existing warnings and errors.

Status

Shows the current status of the sensor and information about the life cycle and the quality of the sensor. In addition to the operating hours, the number of sterilization (SIP) and cleaning cycles (CIP), the Quality Indicator is also displayed here. Note that the status is not automatically updated.

Measurement Value

Provides detailed information about the current measurement. Note that the measurement value is not automatically updated. To update the values, click the drop-down arrow to refresh and view the updated values.

Measuring Point

You can assign a name to the sensor to help you identify the specific sensor when multiple sensors are connected.

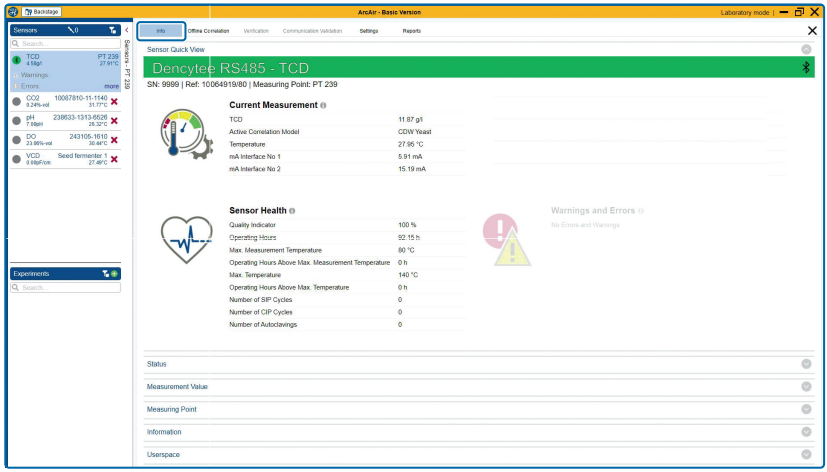
Information

Shows information about the sensor. For example, the sensor `Name`, `Ref No.`, `Serial Number (SN)`, `Sensor ID`, `Sensor Length`, `Lot`, `Lot Date`, `Firmware Version`, `Firmware Date`, and `Sensing Material`.

Userspace

Offers users the choice to include extra comments or descriptions. For example, bioreactor ID.

Figure 5-11. Sensor quick view screen: Information about the connected Dencytee Arc Sensor



5.5.2 Offline correlation

It is a common procedure to convert the measured values of an optical measurement into the bio-moisture. For example, Cell Wet Weight (CWW), Wet Cell Weight (WCW), bio-dry mass Cell Dry Weight (CDW), or Dry Cell Weight (DCW). This process is commonly referred to as conversion or correlation. The procedure is defined as follows:

1. Take a sample.
2. Measure the sample.
3. Plot the values on a graph.
4. Calculate the function and use it for the following correlation.

This procedure can now be automated with ArcAir which supports the workflow and stores the intermediate results and correlation formula directly on the sensor head of the Dencytee Arc.

The sensor is delivered with four default Offline Correlations. These are **Transmission**, **Reflection**, **CDW Yeast**, and **Turbidity Standard** (see Table 5-3).

NOTICE

- The default Offline Correlations for `Transmission`, `CDW Yeast`, and `Turbidity Standard` use the measuring mode of transmission.
- The Offline Correlation model for `Reflection` uses the reflection measuring principle.
- The correlation set also defines the unit of measure of the sensor. Changing the unit of the signal is only possible by changing the Offline Correlation.

To create a custom Offline Correlation, you must combine the measuring modes of transmission and reflection. You can create six additional Offline Correlations to suit your application.

Table 5-3. Overview of the default offline correlation models

Default offline correlation model	Unit	Remark
Transmission	AU	• Only the Transmission signal is used. • The Reflection signal is suppressed.
Reflection	Arb. unit	• Only the Reflection signal is used. • The Transmission signal is suppressed.
CDW Yeast	g/L	Baker's yeast in a stirred tank
Turbidity Std	NTU	Formazine equivalent standard

Figure 5-12. Offline correlation screen: Overview of the offline correlation



Three options are accessible on the **Offline Correlation** screen (see Figure 5-12). The Offline Correlation options include:

- New: Create a new correlation
- Continue unfinished correlation models
- Edit existing correlation models

NOTICE

- When you start a new correlation, the information about the correlation model will be stored on the sensor until the entire model is created.
- After the correlation model has been created, you can close the ArcAir application during the recording of the correlation points and continue the correlation at a later stage.

A wide variety of units can be used for the correlation. An overview of the units is shown in Table 5-4.

Table 5-4. Overview of the offline correlation units

Unit description	Unit	Remark
Arbitrary unit	Arb. unit	Relative unit. We recommend you select `Arb. Unit` if the desired unit is not available.
Absorption unit	AU	A typical unit used to describe turbidity
Colony forming units	CFU	–
Million cells per milliliter	e^6 cells/ml	–
Gram per liter	g/L	To differentiate between *wet* and *dry* weight, use the name of the correlation model.
Nephelometric turbidity unit	NTU	Corresponds to Formazine Turbidity Unit (FTU), which is used as a turbidity standard

Unit description	Unit	Remark
Optical density	OD	The value could be generated by a photometer device measuring at a different wavelength, for example, at 600 nm (OD 600).
Packed cell volume	PCV	–

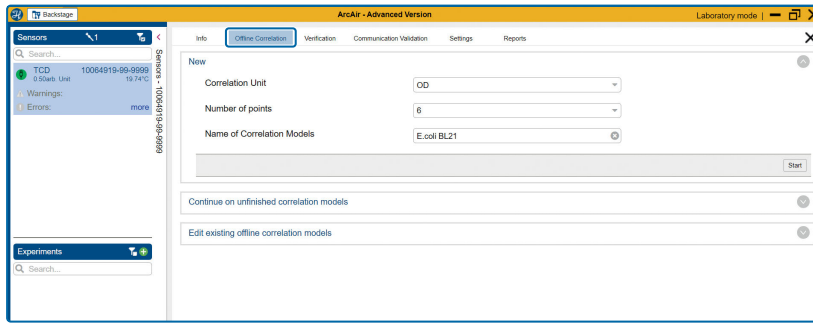
⚠ CAUTION

You can select a maximum of six (6) arbitrary points within the process for the Offline Correlation.

For offline correlation modeling, consider the following:

- *The correlation points must have a monotonic behavior. The sensor signal value of transmission decreases while the offline and reflection values increase.*
- *The first correlation point should represent the lowest turbidity and the last correlation point should represent the highest turbidity. An additional correlation point at turbidity with 20% transmission is recommended. This corresponds to* `0.7 AU` *with the default Offline Correlation Model:* `Transmission`*.*
- *Significant changes in process parameters, like feeding and control, can affect the robustness of an Offline Correlation Model and should be reflected by an Offline Correlation point. It is important for all process parameters to remain constant within an Offline Correlation Model.*
- *Parameter changes like stirring rate or the addition of antifoam can impact the accuracy of the Offline Correlation. If a parameter change is required, we recommend you generate an additional correlation model and use the two Offline Correlation Models during the cultivation.*

Figure 5-13. Offline correlation screen: Example of creating a new offline correlation



5.5.2.1 Creating a new offline correlation model

You must define the following three parameters before you create a **new Offline Correlation** (see Figure 5-13).

1. **Correlation Unit:** Select the applicable correlation unit.
2. **Number of Points:** Select the number of correlation points.
3. **Name of Correlation Models:** Assign a name to the offline correlation.

NOTICE

A minimum of two points and a unique name are required for the correlation model.

The ArcAir application automatically guides the user through the following steps, which are repeated for each correlation point:

- Initialization
- Assign
- Next Correlation Point or Correlation Information to save the offline correlation model

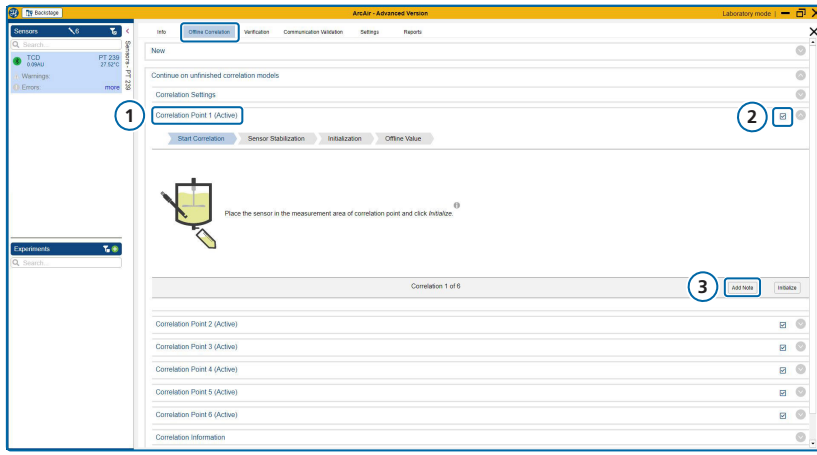
NOTICE

A correlation model is only saved and stored on the sensor when you click the **Create Correlation Model** button on the Correlation Information page (see Figure 5-19).

Initialization

The `Initialization` process ensures that the sensor values are reliable and do not include any outliers during the sampling process (see Figure 5-14). As a result, the system takes several measurements for transmission and absorption over a maximum time of 180 seconds by default. From these measurements, the algorithm calculates the *mean* value. Note that you can shorten the `Initialization` process time from 180 seconds to 100 seconds via the **Next** button.

Figure 5-14. Offline correlation screen: Example of Correlation Point initialization



1 `Correlation Point 1 (Active)`: Status of the correlation point (Active/ Initialized/Assigned/Inactive)

2 Correlation Points can be activated and deactivated in the offline correlation.

Use the checkbox ☐ to activate/deactivate the Correlation Points

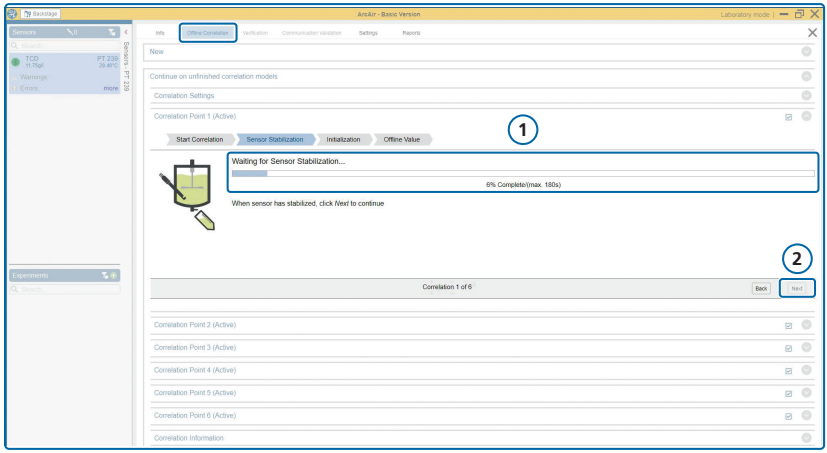
3 `Add Note`: For example, you can enter the sample ID

NOTICE! The information entered under Add Note will be stored in the Audit Trail.

As soon as the `Initialization` starts, the timer will start to record the measured values to verify that the process conditions are stable. By default, the `Initialization` takes 180 seconds to complete. To shorten the `Initialization` process time, click the **Next** button (see Figure 5-15). The time for `Initialization` can be used to take the sample from the reactor for the offline measurement.

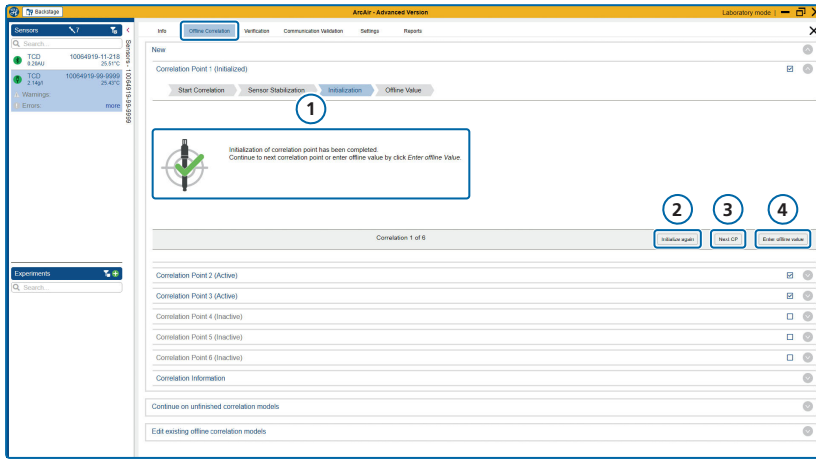
After the `Initialization` of the correlation point process has been completed, the status message `Initialization of correlation point has been completed` is automatically shown on the display (see Figure 5-16). When the value set is stable, positive feedback is displayed and the status is set to `Initialized`.

Figure 5-15. Offline correlation screen: Sensor stabilization (Completion time: Max. 180 s)



1	Sensor stabilization status	2	Next button: Navigate to the next correlation point

Figure 5-16. Offline correlation screen: Status of correlation point after initialization



1 Initialization status and on-screen instructions

2 **Initialize Again:** Use the Initialize Again button to repeat the initialization in case of a failure or an unexpected event.

3 **Next CP:** Use the Next CP button to activate the next correlation point

4 **Enter Offline Value:** Use the Enter Offline Value button when you want to enter an offline value. If the offline value is not available to add, then you add the value at a later stage when it becomes available.

The offline correlation is completed after all the selected points have been initialized and assigned. A summary of all the correlation points is shown in the `Correlation Information` overview (see Figure 5-18).

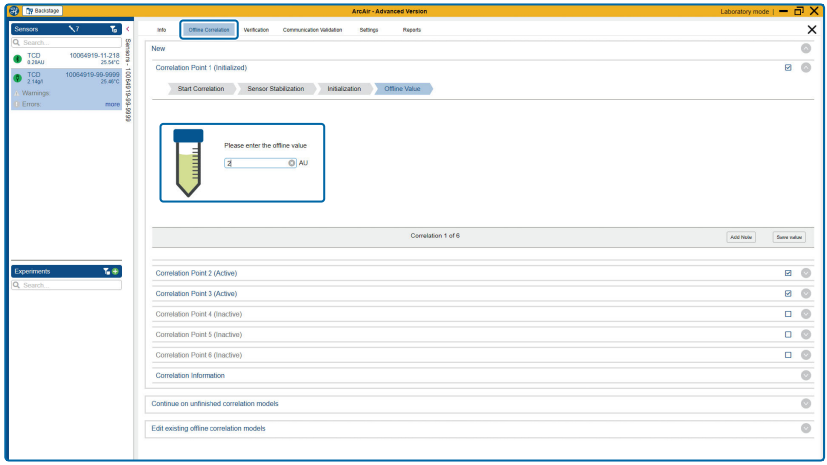
The `Offline Correlation` points can be saved with the **Save Report** button at the bottom right corner of the screen. Correlation report for the `Offline Correlation` points can be created with the **Create Correlation Model** button (see Figure 5-19). The correlation report will be created automatically.

NOTICE

The values of the offline measurement and reflection increase monotonously, while the values of the transmission decrease monotonously.

For further explanation about the offline correlation troubleshooting, see Section 5.5.2.4.

Figure 5-17. Offline correlation screen: Enter the offline value after the initialization of the correlation point



5.5.2.2 Continue with an unfinished offline correlation model

New correlation models will be shown as **New**. It is not necessary to finish the correlation initialization if it can be stopped, as the process can be completed later.

Once the correlation process has stopped, for example, closing the ArcAir application, checking in an existing experiment, or turning off the computer, you can return to the unfinished offline correlation model in this section. The steps required for completing the correlation are the same as described in Section 5.5.2.1.

Figure 5-18. Offline correlation screen: Overview of all completed offline correlation points with the corresponding parameter

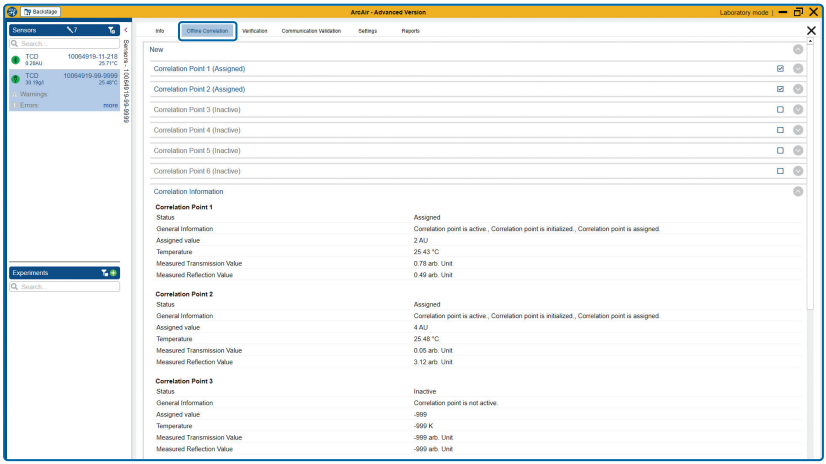
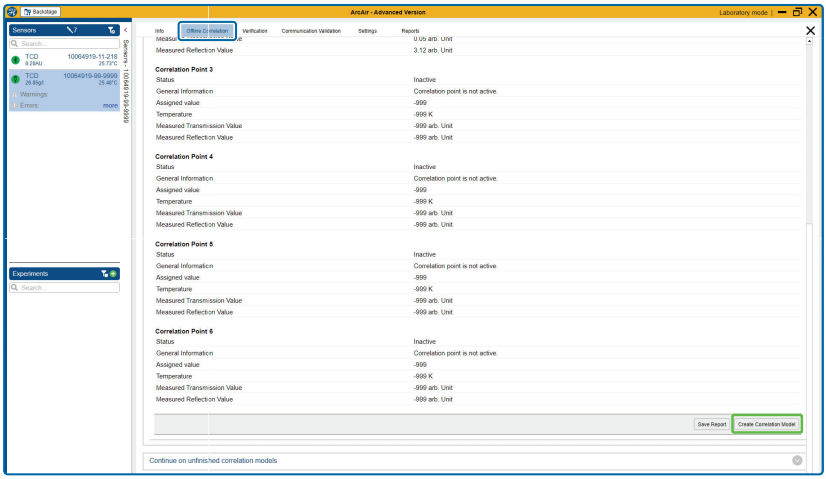


Figure 5-19. Offline correlation screen: Save the correlation information with the “Create Correlation Model“ button



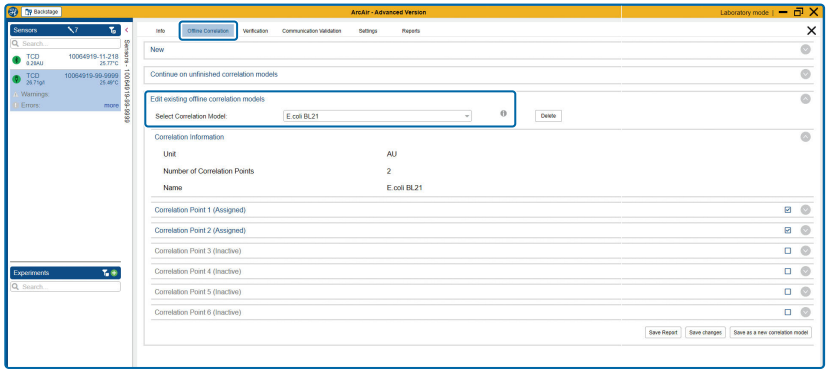
5.5.2.3 Edit an existing offline correlation model

You can edit saved correlation models from this menu. Each correlation point can be individually accessed and modified. You can update the model with new sensor values, input or correct offline data, deactivate entire correlation points, or add new ones using the **Edit Existing Offline Correlation Model** option.

NOTICE

You can replace the correlation model of the sensor with new values, enter or correct offline values, or deactivate entire correlation points from the model and add new ones via the **Edit existing offline correlation model**.

Figure 5-20. Offline correlation screen: Edit existing offline correlation models

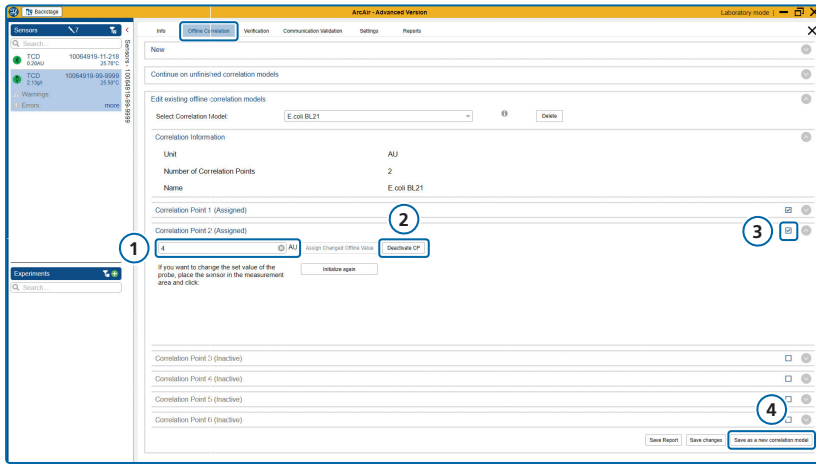


In an existing correlation model, additional points can be activated via the checkboxes, and the points can be initialized and assigned.

To add a new pair of correlation points, follow the instructions below:

1. Activate a **Correlation Point**.
2. Place the sensor in the correlation-derived measuring environment.
3. Click the **Initialize** button.
4. Assign the measured offline value.

Figure 5-21. Offline correlation screen: Overview of changes for correlation point (CP) 2 in an existing offline correlation models



1	Correlation Point X (assigned): Change the offline value to enable the changes to be saved	3	Checkbox ☐: Check to activate a CP required for the correlation model *or* uncheck to deactivate the CP
2	Deactivate CP: Deactivate a correlation point (CP) so it is not used in the correlation model	4	Save a new correlation model: Save the changes in a new correlation model with a new name

5.5.2.4 Troubleshooting offline correlation model

The points are checked for monotonic behavior before the correlation model is created. If one of the recorded values does not meet the requirements, there are two ways to deal with the problem:

1. **Analyze the points:** Initialize the faulty point(s) again or assign the offline measured values.
2. **Points deactivation and activation:** Deactivate faulty point(s) and activate new point(s). Place the sensor in the correct measuring environment and initialize and assign the offline measurement value.

NOTICE

An extension of the correlation points is only possible at the end of the correlation model. The correlation points cannot be swapped at the extension points.

5.5.3 Verification tab

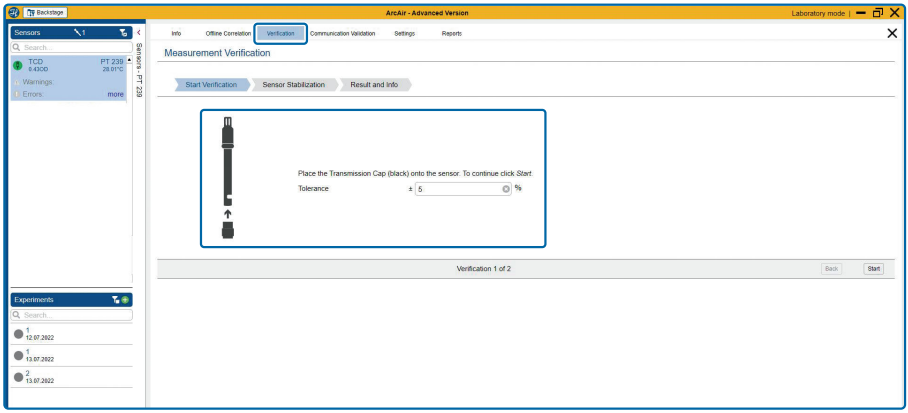
Verification is performed with the Dencytee Arc Maintenance Tool Kit (REF 10146924).

Follow the on-screen instructions in the ArcAir application to complete the verification process The user can set the required tolerance value that applies to the application.

Figure 5-22. Tolerance values for the Dencytee Arc Sensor

Default Tolerance	5%
Minimum Tolerance	3%

Figure 5-23. ArcAir verification screen: Dencytee Arc Maintenance Tool Kit for the sensor verification process



NOTICE

- We recommend calibrating the Dencytee Arc Sensor if the measured signal is outside the specified tolerance. Contact your local representative or Hamilton Technical Support.
- Only trained Hamilton service personnel can calibrate the Dencytee Arc Sensor.

NOTICE

To install the Transmission Cap onto the Dencytee Arc Sensor, gently turn the cap while sliding it along the sensor shaft to cover the sensing part. Make sure the Transmission Cap covers the sensing part completely.

Figure 5-24. Dencytee Arc Sensor calibration with the Transmission Cap from the Dencytee Arc Maintenance Tool Kit



Figure 5-25. Dencytee Arc Sensor calibration with the Absorber Clip from the Dencytee Arc Maintenance Tool Kit

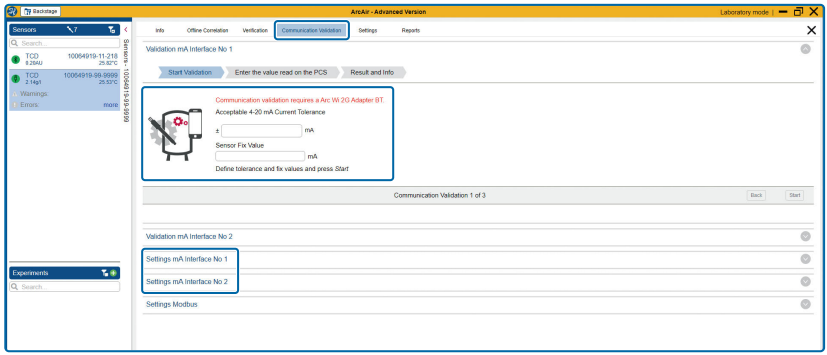


5.5.4 Communication validation tab

Under the **Communication Validation** tab, it is possible to validate the 4-20 mA communication and custom tolerances (see Figure 5-26). In addition, it is possible to set up the 4-20 mA or the Modbus communication.

The **Settings mA Interface No. 1 and 2**, and **Settings Modbus** options can also be found under the **Settings** tab. For additional information, see Sections 5.5.5.1 and 5.5.5.

Figure 5-26. Communication validation screen: Example of communication validation in ArcAir application



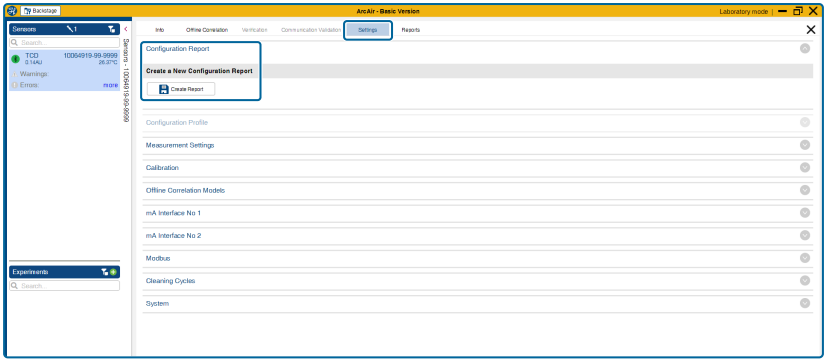
5.5.5 Settings tab

This **Settings** tab contains settings related to the sensor and signal processing. The submenu of the **Settings** tab is described below.

5.5.5.1 Create a new configuration report

The **Configuration Report** compiles the properties, for example, the temperature range of the sensor and adjustments/settings made by the user, such as `Offline Correlation Models` and `Offset` in a tabular format. The reports can be viewed under the **Report** tab and exported as a PDF.

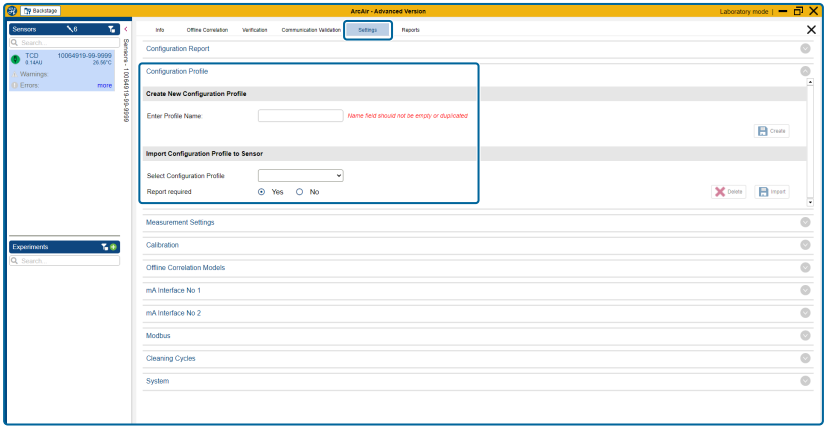
Figure 5-27. Settings screen: Create a new configuration report



5.5.5.2 Configuration report/profile

The **Configuration Report/Profile** can be exported, as described in the *Hamilton Arc Operating Instructions* (REF 10071115).

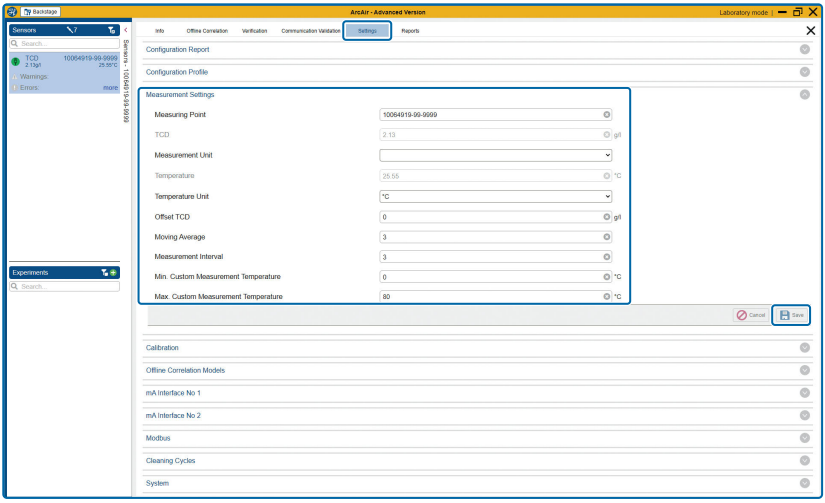
Figure 5-28. Settings screen: Create a new configuration profile for the sensor



5.5.5.3 Measurement settings

You can access and adjust all essential settings related to the measurements of the Dencytee Arc Sensor in this section. To apply the changes, click the **Save** button. Figure 5-29 provides an example of the `Measurement Settings` parameters for the Dencytee Arc Sensor.

Figure 5-29. Settings screen: Measurement settings for the Dencytee Arc Sensor



Measuring Point

You can assign a name or description to the sensor in the **Measuring Point** field. By default, the measuring point reference is based on the `Serial Number` of the connected sensor.

The **Sensor List**, **Dashboard**, or **Experiment** provides a better overview of the connected sensors. The name or description of the sensor can also be changed in the **Sensor Quick View** (see Section 5.5.1).

Measurement Unit

The unit of the **Total Cell Density** (TCD) signal is determined by the active correlation model unit.

NOTICE

You can only change the signal unit via the offline correlation.

Temperature Unit

You can select the applicable `Temperature Unit` from the dropdown menu. The measured value and unit are displayed with the correlation model. Table 5-5 shows the available units for the temperature measurement.

Table 5-5. Temperature units available in the ArcAir application

Temperature units	
Measurement parameter	Unit
Degree Celsius	°C
Kelvin	K
Degree Fahrenheit	°F

Offset TCD

You can enter a manual offset in the **Offset TCD** field. In addition, the **Mark Zero** button can be used in the **Experiment**. For example, click the **Mark Zero** button to start an **Experiment** with an **Offset TCD** of `0 g/L`. To reset the offset, set the value in this menu point to zero or click the **Clear Zero** button in the experiment.

Moving Average

To smooth the signal, enter a value in the **Moving Average** field. The value you enter in the **Moving Average** field will determine the number of measurements that will be collected and averaged.

Measurement Interval

You can enter a value in the **Measurement Interval** field to specify the measurement interval for the sensor. Note that the unit of measurement for the **Measurement Interval** is in `seconds (s)`.

NOTICE

- The measurement interval for the Dencytee Arc Sensor can be set between 3 s (min.) and 300 s (max.).
- If you enter 1 s or 2 s in the Moving Interval field, the value will be set to `3 s` automatically.
- The Measurement Interval and the Recording Time in an experiment cannot be the same.

Min. / Max. Custom Measurement Temperature

Use the **Min. / Max. Custom Measurement Temperature** settings to customize the `Min.` and `Max.` of the measurement temperature settings for the sensor. By default, the `Min.` temperature is set to 0 °C and the `Max.` temperature is set to 80 °C.

5.5.5.4 Offline correlation model

There are four (4) offline correlation models delivered with the sensor (see Figure 5-30). You can also add additional correlation models after an experiment. For details about adding additional correlation models, see Section 5.5.2

1. Select the applicable **Active Correlation Model** from the dropdown menu (see Figure 5-30).
2. Click the **Save** button to finalize the changes.

Figure 5-30. Settings screen: Overview of the offline correlation models

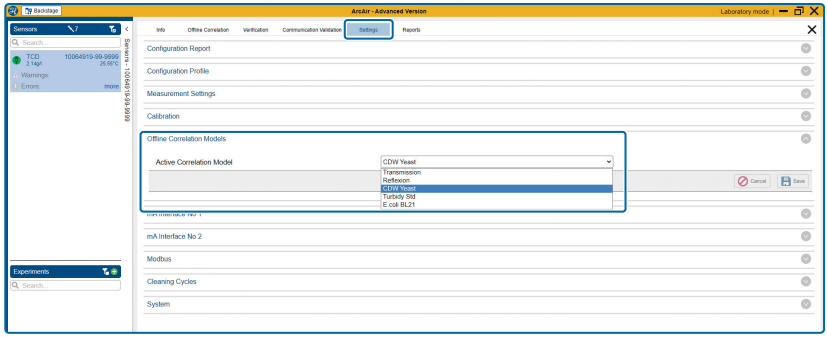


Table 5-6. Overview of the default offline correlation models

Default offline correlation model	Unit	Remark
Transmission	AU	• Only the Transmission signal is used. • The Reflection signal is suppressed.
Reflection	Arb. unit	• Only the Reflection signal is used. • The Transmission signal is suppressed.
CDW Yeast	g/L	Baker's yeast in a stirred tank
Turbidity Std	NTU	Formazine equivalent standard

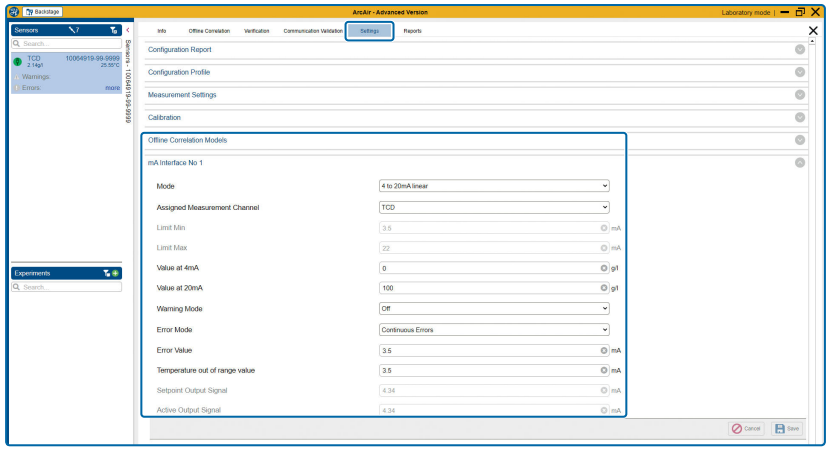
5.5.5.5 mA Interface No. 1 / No. 2

NOTICE

The Arc Wi 2G BT Adapter (REF 243470) is required to receive a 4–20 mA signal.

The **mA Interface No. 1** feature provides users with the option to configure the 4–20 mA communication interface. To apply these modifications, click the **Save** button located at the bottom right of the screen.

Figure 5-31. Settings screen: Overview of the mA interface No. 1 or mA interface No. 2 parameters



Mode

The 4-20 mA interface can be operated with one of the following **Modes**:

- `4-20 mA linear`
- `4-20 mA fixed`
- `off`

Table 5-7 provides an overview of the different Modes for the 4-20 mA interface.

Table 5-7. Overview of the different modes for the 4-20 mA interface

4-20 mA interface mode	Description
4 to 20 mA linear	Linear correlation of 4-20 mA and permittivity, or cell density and conductivity
4 to 20 mA fixed	Can be used for testing the 4-20 mA signal transmission
Off	Disables the current on the 4-20 mA lines

Assigned measurement channel

Each interface can only be assigned one of the two available variables: **TCD** or `Temperature`. The value transmitted through TCD relies on the configurations specified in the **Measurement Settings**.

Limit Min.

The `Limit Min.` describes the minimum possible analog current. The unit of measurement is milliampere (mA).

Limit Max.

The `Limit Max.` describes the maximum possible analog current. The unit of measurement is milliampere (mA).

Value at 4 mA / Value at 20 mA

Define the `Limit Min.` and `Limit Max.` range for the **Assigned Measurement Channel** and assign the limits to a `Value at 4 mA` or `Value at 20 mA`. For example, for the **Assigned Measurement Channel**, select **TCD**, then enter the mA value range:

- `Value at 4 mA := 0 g/L`
- `Value at 20 mA := 100 g/L`

Warning mode

Table 5-8 provides an overview of the different Warning Modes.

Table 5-8. Warning modes description

Warning Mode	Description
Off	No warnings output
Continuous warnings	All warnings will be transferred on the 4-20 mA signal

Error mode

Table 5-9 provides an overview of the different Error Modes.

Table 5-9. Error modes description

Error Mode	Description
Off	No errors output
Continuous Errors	All errors will be transferred on the 4-20 mA signal

Error Value

Define a current value to be output when an error occurs.

Warning Value

Define a current value to be output when a warning occurs.

Temperature out-of-range value

Define a current value to be output when the temperature is out of a specified range.

NOTICE

The parameter settings for mA Interface No. 1 are also valid for mA Interface No. 2.

5.5.5.6 Modbus

Table 5-10 provides an overview of the Modbus parameters settings. Configure the Modbus parameters as required and click the **Save** button at the bottom right of the screen to apply the changes (see Figure 5-32).

⚠ CAUTION

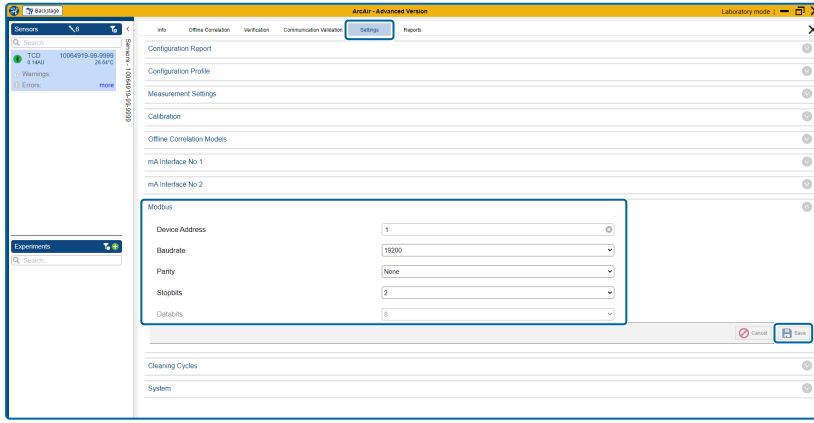
Apply the following standard settings to the Modbus:

- *Device Address: 1*
- *Baud rate: 19200*
- *Parity: None*
- *Stop bit: 2*

Table 5-10. Overview of the Modbus setting options

Setting	Value range	Description
Device Address	1–32	The device address is a unique address that allows communication with up to 31 sensors on one bus.
Baud rate	Available baud rate options: • 4800 • 9600 • 19200 • 38400 • 57600 • 115200	The baud rate is used to specify the transmission speed. It is defined in baud/second.
Parity	Parity options: • None • Even • Odd	Parity is used to control the transmission of individual data bytes. This check refers to the sum of all bits in a data byte.
Stop bits	1, 2	The sum of the data byte must be 11 bits. If no parity is set, then you must set 2 stop bits.

Figure 5-32. Settings screen: Overview of the Modbus standard parameters

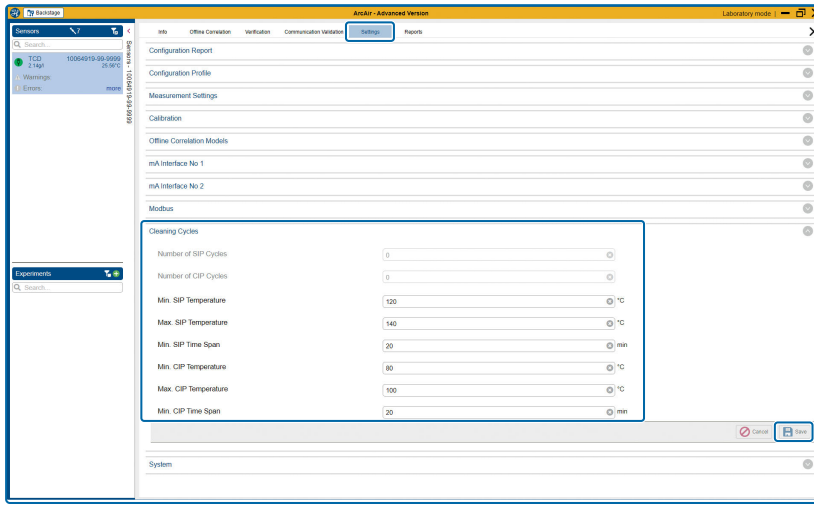


5.5.5.7 Cleaning cycles

Under the **Cleaning Cycles** menu, you can enter the `Number of SIP Cycles` or the `Number of CIP Cycles` in their respective field (see Figure 5-33).

You can also increase the counters for autoclaving under the **Cleaning Cycles** menu, as the software cannot track the counters automatically.

Figure 5-33. Settings screen: Overview of the cleaning cycle parameters



Define the sterilization cycle conditions

Define the conditions to count the **SIP** and **CIP** cycles automatically. The SIP and CIP definitions are set as standard but can be customized (see Figure 5-33). The cycles can be changed manually using the pointers on the left and right sides of the text box.

The default temperature setting for SIP is between 120 °C and 140 °C for approximately 20 minutes, while for CIP, the default temperature setting is between 80 °C and 100 °C for more than 20 minutes. To activate the changes, click the **Save** button at the bottom of the screen.

Increase the number of autoclave cycles

Note that it is not possible to increase the autoclave cycles automatically. The autoclave cycles can be changed manually by using the pointers on the left and right side of the text box (see Figure 5-33). This can also be changed in the **Measurement Settings** menu.

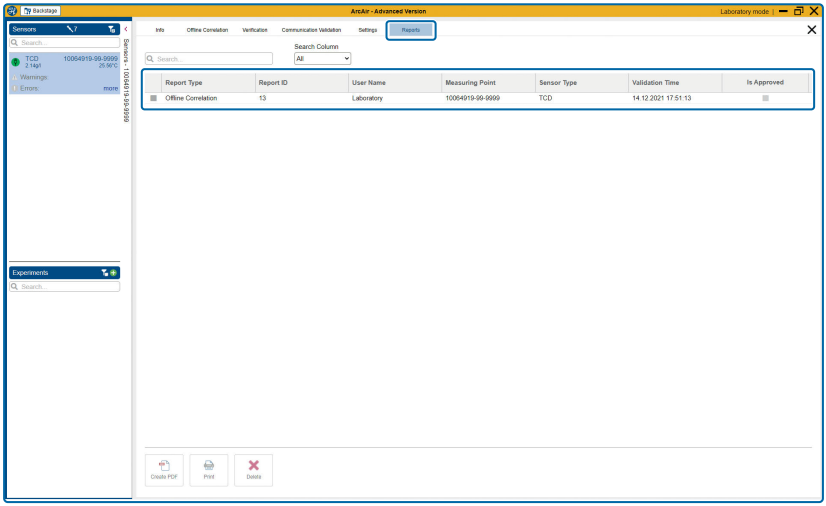
5.5.5.8 System

To delete all user settings and configuration: select **System** > check ☑ the **Restore Factory Settings** checkbox > click the **Save** button.

5.5.6 Reports tab

All reports created via the ArcAir application are saved under the **Reports** tab (see Figure 5-34). You can manage the saved reports here and export the reports as a PDF for analysis.

Figure 5-34. Reports screen: Overview of the available reports to download



6 Operation: Integrating the Dencytee Arc Sensor into an Experiment

This chapter provides a detailed description of the recommended settings for integrating the Dencytee Arc Sensor into an experiment. This chapter is brief because it contains cross-references to previous chapters/sections where the detailed settings and procedures are described.

6.1 Experiment functionality

For a detailed overview of the Experiment functionality, refer to the *Hamilton Arc Operating Instructions* (REF 10071115).

6.2 Starting an experiment

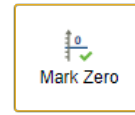
Before starting an experiment, the appropriate **Offline Correlation Model** should be selected to suit the cultivation.

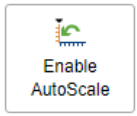
⚠ CAUTION

*Do not change the **Offline Correlation Model** during an experiment, as different units are set for each experiment.*

For details on setting the **Offline Correlation Model**, see Section 5.5.5.4.

Follow the recommended workflow below after you have initiated an experiment:

Task	Description	ArcAir GUI: Button/Icon to click	Dencytee Arc Sensor manual reference	Status
Select an `Offline Correlation Model`	Select preset or custom `Offline Correlation Model` to convert the sensor signal into: • g/L • AU • e^6 cells/mL	–	For additional information about the Offline Correlation Model, see Section 5.5.2	☐
Set an `Offset`	**NOTICE!** Starting an Experiment at point (0 | 0) is a standard procedure. • To start the readings at **0 g/L**, use the **Mark Zero** button. • To deactivate the offset, use the **Clear Zero** button. These actions will be visibly shown on the graph.	 *Or* 	For additional information about the Mark Zero or Clear Scan function, see Section 6.2.1	☐

Task	Description	ArcAir GUI: Button/Icon to click	Dencytee Arc Sensor manual reference	Status
Inoculate	**NOTICE!** The Inoculation action can be done only once in an experiment. Click the **Inoculate** button after you have injected/ pumped the cells into the bioreactor. This action will be visibly shown on the graph.		For additional information about the Inoculation function, see Section 6.2.2	☐
Add a comment	Click on a measurement point to add a comment if required.	–	–	–
Enable autoscale	Click **Enable AutoScale** so the graph adjusts automatically to the current value range of the signal.		–	–

6.2.1 Mark Zero and Clear Zero functions

To achieve the best measurement *accuracy* and *linearity*, we recommend that you perform an offline correlation for a defined cultivation process. However, for small medium changes, it is usual to do an in-process adjustment, thus, a zero adjustment before Inoculation. To make in-process adjustments, click the **Mark Zero** button to initiate the change.

You have the option to apply the signal offset during an Experiment using one of the following functions:

- Measurement settings
- Mark Zero / Clear Zero

For additional information about how to apply the signal offset during an Experiment, see Section 5.5.5.3.

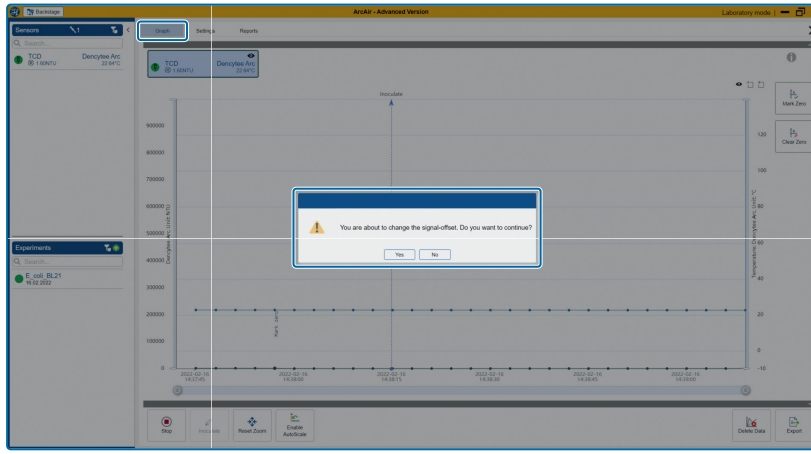
Once the Experiment is initiated, a popup window with the message `You are about to change the signal-offset. Do you want to continue?` will be shown on the display. Select **Yes** to confirm the adjustment or select **No** to cancel the adjustment (see Figure 6-1).

Note that if you select **Yes** to proceed, the status message `Mark zero was successful` will be shown in a pop-up window before the experiment starts. Click the **OK** button to confirm and exit the window.

NOTICE

After the Inoculation event, the ArcAir application will always prompt you to confirm whether a Mark Zero or Clear Zero action is required.

Figure 6-1. Example of Mark Zero function activated after inoculation



6.2.2 Inoculation function

The **Inoculate** button enables you to mark a time point in the experiments when the cells enter the cultivation system. Inoculation is available in the `Experiment` function in the ArcAir application. This event is unique and occurs once in a process cycle. Figure 6-2 shows an example of an inoculation graph with a marked time point in an experiment.

The status message "Inoculation was successful!" will be displayed in a popup window after clicking the **Inoculate** button. Click **OK** to acknowledge the Inoculation status and exit the window (see Figure 6-3).

Figure 6-2. Inoculation function overview: Example of inoculation graph with a marked time point in an experiment

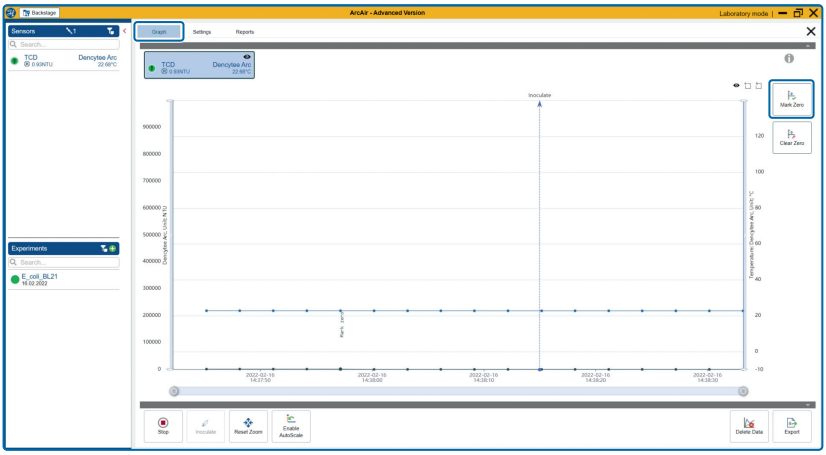
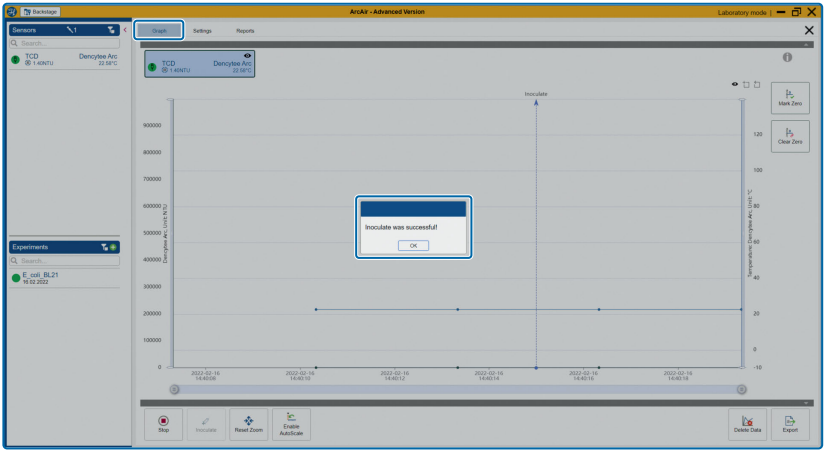


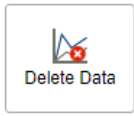
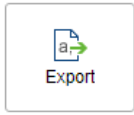
Figure 6-3. Inoculation function overview: Example of successful inoculation in an experiment



6.2.3 Stopping an experiment

Table 6-1 provides an overview of the `Experiment` screen buttons (**Stop**, **Delete**, and **Export**) in the ArcAir graphical user interface (GUI).

Table 6-1. ArcAir GUI: Experiment screen buttons (Stop, Delete, and Export)

ArcAir GUI: Experiment screen buttons	Functional description
Stop 	Once the `Experiment` is over, click the **Stop** button to end the recording. To restart the recording, click the **Start** button. **NOTICE!** In the Excel file, you will notice a gap (an interval) between the recordings to indicate the stop and restart of the experiment recording.
Delete Data 	**NOTICE!** All the experiment data stored in the ArcAir application will be deleted, including the current data. The data cannot be retrieved once deleted. To delete the `Experiment` data and the graph, click the **Delete Data** button.
Export 	Export the `Experiment` data and save it as an Excel file. **NOTICE!** The experiment data is not saved automatically.

7 Maintenance

⚠ CAUTION

You must read the Safety Precautions and Hazards in Chapter 2 before you start with the maintenance.

This chapter provides information about the sensor maintenance procedures, including verification, calibration, cleaning, and firmware update instructions.

All of the procedures in this chapter must be performed by the operator. Contact Hamilton Technical Support for additional maintenance requirements (see Section 8.4).

7.1 Verification

The purpose of verification is to identify measurement drifts, and mechanical issues and to assess whether corrective action is necessary. Verification is an important procedure used to determine the Quality Indicator (QI) and, thus, the performance and accuracy of the sensor.

To perform verification, you will need the Dencytee Arc Maintenance Tool Kit (REF 10146924) of the Dencytee Arc Sensor. For a detailed description of the verification procedure, see Section 5.5.3.

7.2 Calibration

Contact Hamilton Technical Support to assist you with the calibration procedures, Further information can be found in Chapter 10.

7.3 Cleaning

⚠ CAUTION

- *Only authorized/trained service personnel can install, operate, clean, calibrate, or maintain the sensor or do other service-related tasks.*
- *Always make sure that the system is depressurized, cold, and free from any potential accidental spillage of the process medium before you remove the sensor from the measuring system.*
- *Always wear protective eyewear and gloves before you remove the sensor from the system (bioreactor) for cleaning.*
- *Do not use acetone and strong acid solutions to clean the sensor.*
- *Do not use abrasive tissues or cleaning agents/solutions other than the recommended standard cleaning agents/solutions to clean the Sensor.*
- *We recommend using ethanol and isopropanol to clean the sensor.*
- *You must decontaminate every sensor or product before shipping it back to Hamilton Process Analytics for repair.*

The sensor can be cleaned of cells and sterilized using the usual CIP and SIP procedures. Also, you must make sure that the optical window is clean and free from interfering particles or scratches.

7.4 Firmware update

The firmware updates can be found on the Hamilton Process Analytics website (https://www.hamiltoncompany.com/process-analytics). You can update the firmware on the sensors via the ArcAir application.

The backstage area of the ArcAir application contains the location for the firmware update. Both the Arc sensors and the Accessories can be updated via this menu.

NOTICE

For more information about the ArcAir application, see the *Hamilton Arc Operating Instructions* (REF 10071115).

8 Troubleshooting

You must do periodic maintenance routines to ensure a safe and reliable operation and measurement with the Arc sensor and its accessories. Make sure that there is no mechanical damage to the sensor tip.

The status/condition of the sensor is indicated by the traffic light identification (ID) system (see Table 8-1).

Table 8-1. Sensor status indicator in ArcAir application: Overview of the traffic light ID system

Sensor status indicator: Traffic light ID system	Description
Green 	• The sensor is functioning correctly. • No errors or warnings have been registered.
Yellow 	• At least a warning has been registered. • Verify the warnings of the sensor under `Sensor Status`.
Red 	• At least an error has been registered. • Verify the error of the sensor under `Sensor Status`.
Gray 	The sensor is offline.

NOTICE

The quality of the sensor is affected by the following factors:

- Warnings
- Errors
- Verification procedure running in ArcAir application

To resolve a warning or an error, follow these steps:

1. Connect the Dencytee Arc Sensor by using the Arc USB Power Cable (REF 243490) on a standard USB port.
2. Investigate and resolve the warning or error under the **Sensor Quick View** or **Sensor** list in the ArcAir application.

8.1 Quick tips

Table 8-2. Overview of corrective actions for resolving sensor problems

Problem	Possible cause	Corrective action
Sensor is not displayed in the ArcAir application	Incorrect baud rate configured for sensor	• Make sure the connected Sensor ID is shown in the **Sensor** list filter in the ArcAir application. **NOTICE!** The Dencytee Arc Sensor is configured to a baud rate of 19,200. If you change the baud rate from the default configuration, the ArcAir application may not recognize the sensor. • To resolve the baud rate issue: click the **Backstage** button > **Setting** button > **Wired connection**, then select **Baud rate** > **Parity and Stop bit** according to the settings in the ArcAir application, and click the **Save** button.
	Global Operator Level S password has not been set for all Arc sensor	• Make sure a unique and global Operator Level S password is set for all Arc sensors to enable automatic sensor login. Configure this password in the ArcAir application under **Backstage** > **Settings Operator Level S Password**. • Verify the **Sensors** list on the dashboard to confirm whether the filter function includes `Sensor Type TCD` and if the checkbox is selected.

Problem	Possible cause	Corrective action
Wrong reading on the process control system	Disconnected power supply or sensor	A disconnected power supply (24 V ±10%) or disconnected sensor can cause the wrong reading on the process control system.
Sensor connection not possible	Sensor connection error	Verify if the sensor ID is displayed under the **Sensor** and **Offline** list of sensors. If the sensor ID is displayed in both **Sensor** and **Offline** list of sensors, then we recommend that you delete the sensor from the **Offline** list and try to reconnect it again.

8.2 Sensor self-diagnostic

⚠ CAUTION

- *You must acknowledge* `Warnings` *by following through with the recommended corrective actions. The required corrective action will vary for each warning depending on the root cause. The warning will be displayed continuously until the corrective action is completed.*
- *You must address sensor* `Errors` *by following through with the recommended corrective actions.*

Arc sensors have an integrated self-diagnostic function that can detect and identify the most common sensor malfunctions. These malfunctions can trigger warning and error messages through various interfaces, including the analog 4–20 mA, digital Modbus, or PC/Notebook connection.

The analog 4–20 mA interface can be configured based on NAMUR recommendations to indicate abnormal events (see Sections 5.3.2 and 5.5.5.5). Use the ArcAir application to monitor the status of the sensor and troubleshoot.

8.3 Sensor status

An overview of the condition of the sensor is indicated by the `Sensor Status` described in Sections 8.3.1 and 8.3.2.

NOTICE

For additional information about the sensor status and the diagnostics features refer to the Troubleshooting chapter of the *Dencytee RS-485 Sensors Programmer`s Manual* (REF 111004638).

8.3.1 Warnings

The status indicator of the sensor lights up **Yellow** when a warning is registered.

Warnings associated with the measurement

Table 8-3. Overview of the warnings associated with the measurement

Measurement troubleshooting		
Warning description	Possible cause	Corrective action
TCD reading below the lower limit	The TCD reading is too low.	Create a new correlation.
TCD reading above the upper limit	The TCD reading is too high.	Create a new correlation.
Temperature (T) reading below the lower limit	The temperature is below the user-defined measurement temperature range. **NOTICE!** The sensor cannot perform TCD readings if the measurement temperature is outside the defined range.	Make sure the defined measurement temperature is within the defined range.
Temperature (T) reading above upper limit	The temperature is above the user-defined measurement temperature range. **NOTICE!** The sensor cannot perform TCD readings if the measurement temperature is outside the defined range.	Make sure the defined measurement temperature is within the defined range.

Measurement troubleshooting		
Warning description	Possible cause	Corrective action
Measurement not running	• The operating voltage range of the sensor is not between 10-27 VDC. • The temperature measurement is outside the user-defined temperature range. • The measurement is turned off via the parameter measurement interval.	• Make sure the sensor's operating voltage range is between 10-27 VDC. • Make sure the defined measurement temperature is within the defined range. • Make sure the measurement is turned on via the parameter measurement interval.

Warning associated with the calibration

Table 8-4. Overview of the warnings associated with the calibration

Calibration troubleshooting		
Warning description	Possible cause	Corrective action
TCD calibration recommended	TCD measurement out of range	Send the sensor to Hamilton Technical Support (TS) for standard calibration.

Warnings associated with the hardware

Table 8-5. Overview of the warnings associated with the hardware

Hardware troubleshooting		
Warning description	Possible cause	Corrective action
Sensor supply voltage too low	The sensor supply voltage is below 10 V.	Check and verify the output voltage of the sensor.
Sensor supply voltage too high	The sensor supply voltage is above 27 V. Please check your power supply.	Check and verify the input voltage of the sensor.

Hardware troubleshooting		
Warning description	Possible cause	Corrective action
Replace sensor recommended	The Quality Indicator (QI) of the sensor is below 40%. The quality of the sensor is sufficient for reliable measurement, but a replacement of the sensor must be considered.	Replace the sensor.

8.3.2 Errors

The status indicator of the sensor lights up **Red** when a warning is registered.

Errors associated with the measurement

Table 8-6. Overview of the errors associated with the measurement

Measurement troubleshooting		
Error description	Possible cause	Corrective action
TCD reading failure	TCD algorithm error	Contact Hamilton Technical Support for assistance (see Section 8.4).
Temperature (T) sensor defective	The internal temperature sensor is defective	Contact Hamilton Technical Support for assistance (see Section 8.4).

Errors associated with the hardware

Table 8-7. Overview of the errors associated with the hardware

Hardware troubleshooting		
Error description	Possible cause	Corrective action
Temperature reading below the minimum (min.)	The measured temperature is below the operating temperature	Increase the minimum temperature setting.
Temperature reading above maximum (max.)	The measured temperature is above the operating temperature	Increase the maximum temperature setting.
Sensor defective	The sensor is defective or the sensor Quality Indicator (QI) is below 10%. The quality of the sensor is not sufficient for reliable measurement.	Replace the sensor.
Dark current too low	The dark current is too low	Contact Hamilton Technical Support for assistance (see Section 8.4).
EEPROM comm. (I2C) error (user-end)	EEPROM communication error	Reset the sensor and try again.

Hardware troubleshooting		
Error description	Possible cause	Corrective action
Internal communication (I2C) failure (use-rend)	Internal I2C communication error	Reset the sensor and try again.
Internal communication failure (Frontend)	No communication between front-end and user-end	Reset the sensor and try again.
Stack overflow	Internal memory failure	Reset the sensor and try again.

8.4 Request for technical support

If a problem persists after you have attempted to correct it, contact Hamilton Technical Support via email (contact.pa.ch@hamilton.ch) or phone (+41-58-610-10-10).

8.5 Returning the sensor for repairs

⚠ WARNING

- Make sure you decontaminate the Dencytee Arc Sensors and remove health hazards such as radiation, hazardous chemicals, or infectious agents before returning the sensor to Hamilton.
- Provide a complete description of any hazardous materials that have been in contact with the sensor.

⚠ CAUTION

- *Do not return an the sensor to Hamilton without an RMA number. The RMA number ensures that your sensor can be tracked, so your request can be handled by the correct department.*
- *Dencytee Arc Sensors that are returned without an RMA number will be sent back to the customer without being repaired.*

Before returning an Arc sensor to Hamilton for repair, contact our Technical Support and request a Return Material Authorization (RMA) number (see Section 8.4).

9 Disposal

⚠ CAUTION

- *Do not dispose of the sensor(s) at an unsorted waste disposal point.*
- *Hamilton sensors that are worn out or no longer required must be sent to a dedicated collection point for electrical and electronic devices.*

NOTICE

You can also send the sensor to Hamilton for disposal.

The design of the Hamilton sensors optimally considers environmental compatibility and regulations compliance (see Table 9-1).

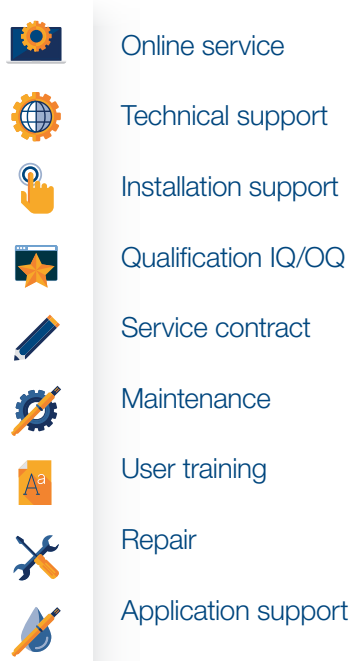
Table 9-1. Symbols used on the sensor labels and packaging

Symbol	Definition
	Dispose of in accordance with the EU Directive 2012/19/EU or WEEE (Waste Electrical and Electronic Equipment)
	有害物質表，請參閱, 章節過程分析， 符合性聲明 (For additional information, see the Hamilton website: www.hamiltoncompany.com)

10 Services

This chapter provides an overview of the services provided by Hamilton Process Analytics (see Figure 10-1).

Figure 10-1. Overview of the services provided by Hamilton Process Analytics

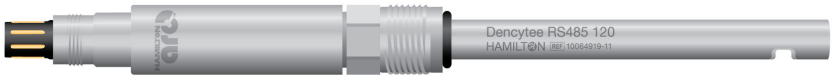


11 Ordering Information

This chapter provides an overview of the different types of Dencytee Arc Sensors and accessories that are available to order.

11.1 Dencytee Arc Sensors

Figure 11-1. Overview of the Dencytee Arc Sensor



Ordering information

Table 11-1. Different types of the Dencytee Arc Sensors

REF	Product description
10064919-11	Dencytee RS485 120
10064919-12	Dencytee RS485 225
10064919-13	Dencytee RS485 325
10064919-14	Dencytee RS485 425

11.2 Parts, accessories, and software

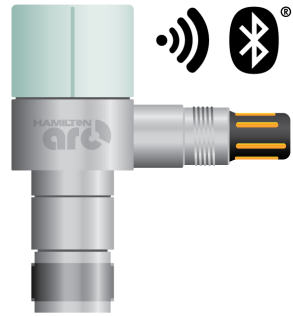
⚠ CAUTION

Use only original spare parts or accessories when replacement is necessary.

Arc Wi 1G BT adapter

The Arc Wi 1G BT Adapter enables wireless communication between the Arc sensors and mobile devices via Bluetooth®.

Figure 11-2. Arc Wi 1G BT adapter



REF	Product description
243460	Arc Wi 1G BT adapter

Arc Wi 2G BT adapter

The Arc Wi 2G BT Adapter converts Modbus digital communication protocol to 4-20 mA signals and enables Bluetooth® communication for sensor configuration and monitoring.

Figure 11-3. Arc Wi 2G BT adapter

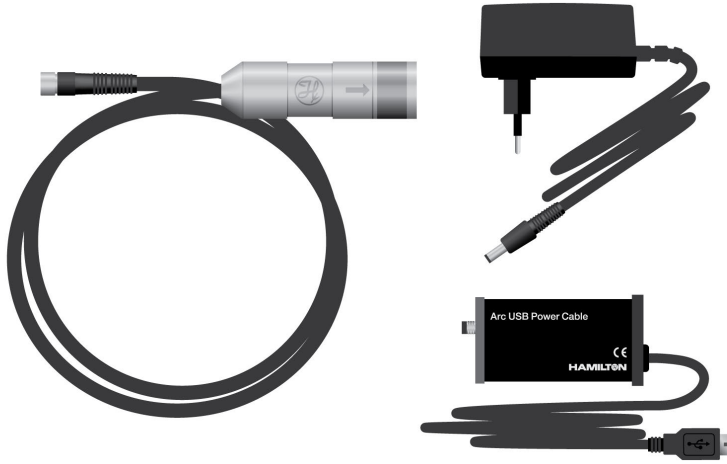


REF	Product description
243470	Arc Wi 2G BT adapter

Arc USB power cable: USB/VP8 and USB/M12-8 Pole

The Arc USB Power Cable provides power via a USB port for the Arc sensors and digital communication with the ArcAir application for monitoring, configuration, calibration, and firmware updates.

Figure 11-4. Arc USB power cable: USB/VP8 and USB/M12-8 pole connector



REF	Product description
243490-01	Arc USB power cable: USB/VP8 for direct connection to the sensor
243490-02	Arc USB power Cable: USB/M12–8 pole for connection to the sensor with Arc Wi 2G BT Adapter

NOTICE

An additional power supply is supplied with the Arc USB Power Cable in case the PC/Notebook does not provide enough power to power the sensor. A PC/Notebook with a USB 2.0 port or higher can provide sufficient power to the sensor.

Sensor data cable: VP8 double coaxial / open-end data cable

The VP8 Sensor Data Cable with open-end wires is designed to enable interface connection between the sensor and a data recorder, indicator, control unit, or PCS with an analog I/O (input/output).

Figure 11-5. Arc sensor data cable: VP8 double coaxial / open-end wiring

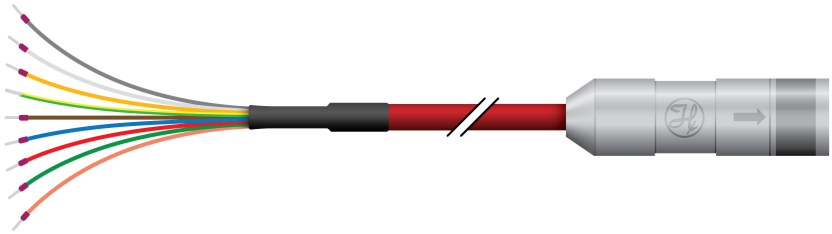


Table 11-2. VP8 double coaxial / open-end data cable

REF	Product description	Length	Interface
355263	VP8 double coaxial / open-end data cable	1 m	4-20 mA/Modbus
355264	VP8 double coaxial / open-end data cable	3 m	4-20 mA/Modbus
355265	VP8 double coaxial / open-end data cable	5 m	4-20 mA/Modbus
355266	VP8 double coaxial / open-end data cable	10 m	4-20 mA/Modbus
355267	VP8 double coaxial / open-end data cable	15 m	4-20 mA/Modbus
355268	VP8 double coaxial / open-end data cable	20 m	4-20 mA/Modbus

Sensor data cable: VP8 open-end / 4-wire data cable

Table 11-3. VP8 open-end / 4-wire data cable

REF	Product description	Length
10109026	VP8 open-end / 4-wire data cable	1 m
10109251	VP8 open-end / 4-wire data cable	3 m
10109250	VP8 open-end / 4-wire data cable	5 m

M12-8 pole-open-end cable

The M12-8 Pole Sensor Cable with open-end wires is designed to enable interface connection between the sensor and a data recorder, indicator, control unit, or PCS with analog I/O.

Figure 11-6. M12-8 pole with open-end cable

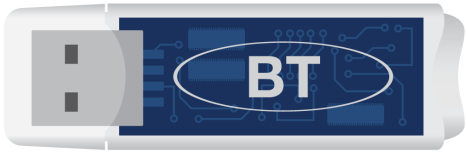


REF	Product description	Length (in meters)
355320	M12-8 pole/open-end cable	3 m
355321	M12-8 pole/open-end cable	5 m
355322	M12-8 pole/open-end cable	10 m

Arc wireless BT converter

The Arc Wireless BT Converter is designed to enable wireless communication between the Arc sensor and the ArcAir application.

Figure 11-7. Arc wireless BT converter



NOTICE

The internal Bluetooth® of the PC can be used instead of the Arc wireless BT converter.

Arc wireless BT converter advanced

The Arc Wireless BT Converter Advanced enables wireless communication between the Arc sensor and the ArcAir application. It includes the license to activate ArcAir Advanced functions for GMP (Good Manufacturing Practice) compliant production.

REF	Product description
243499	Arc wireless BT converter
242333	Arc wireless BT converter advanced

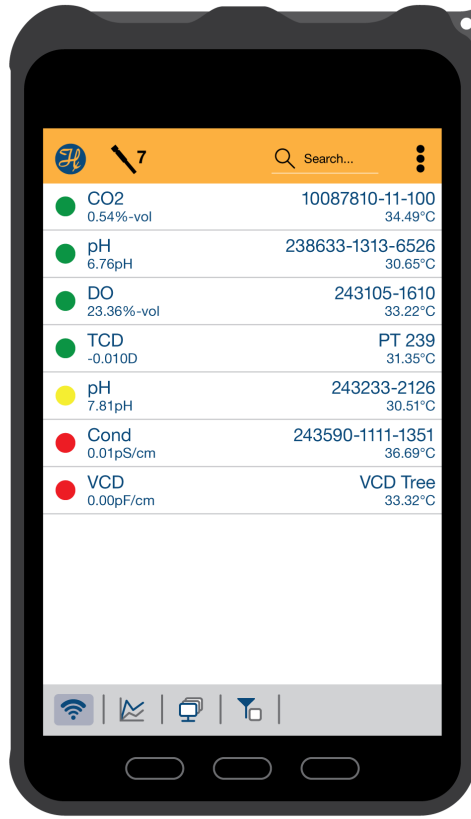
Basic Arc view tablet for non-Ex environments

The pre-configured Basic Arc view tablet is Hamilton`s solution for monitoring measurement values, calibrating Arc sensors, and configuring various parameters with the unified user interface for pH, DO, Conductivity, VCD, TCD, and ORP (see Figure 11-8).

The Basic Arc view operates on the Samsung Galaxy Tab Active tablet and is pre-configured with the Basic ArcAir software and an App Blocker application.

The Basic Arc view tablet comes with a Power Supply Cable, a Manual, and Hamilton's Quick Start Guide.

Figure 11-8. Basic Arc view tablet for non-Ex environments



REF	Product description
10071111	Basic Arc view tablet for non-Ex environments

Advanced Arc view tablet for non-Ex environments

The pre-configured Advanced Arc view tablet is Hamilton`s solution for monitoring measurement values, calibrating Arc sensors, and configuring various parameters with the unified user interface for pH, DO, Conductivity, VCD, TCD, and ORP.

The Advanced Arc view operates on the Samsung Galaxy Tab Active tablet and is pre-configured with the Advanced ArcAir application. This includes features for CFR 21 Part 11 and Eudralex Volume 4, Annex 11 Compliance, along with an App Blocker application.

The Advanced Arc view tablet comes with a Power Supply Cable, a Manual, and Hamilton's Quick Start Guide.

REF	Product description
10071113	Advanced Arc view tablet for non-Ex environments

ArcAir application download

Download the ArcAir application from the App Store or Google Play.

Figure 11-9. ArcAir application download from the App Store or Google Play



Process housings

Table 11-4. Overview of the process housings offered by Hamilton Process Analytics

FlexiFit REF	Retractex REF	RetractoFit REF	Hygienic Sockets REF
237331-OP	243200-XXXXXX	237240	242535
237341	243255-XXXXXX	237490	242545
237344		237440	242548
237345		237480	242550
237380-OP			

⚠ CAUTION

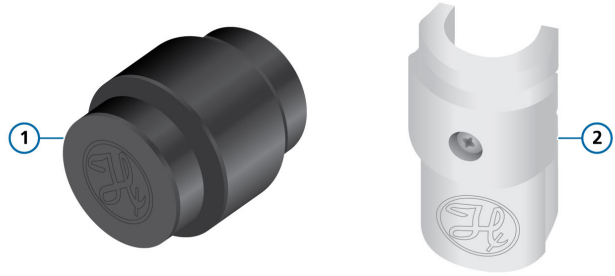
Housings with cable protections such as RetractoFit are not compatible with the Arc Wi 2G Adapter and the power cable. If the adapter is required, the cable protection can be removed.

11.3 Accessories for maintenance

Dencytee Arc Sensor maintenance tool kit

The maintenance tool kit for the Dencytee Arc Sensor contains a Transmission Cap (1) and an Absorber Clip (2) (see Figure 11-10). Follow the instructions in the ArcAir application to perform verification and quality checks on the Dencytee Arc Sensor. For details, see Section 5.5.3).

Figure 11-10. Dencytee Arc Maintenance Tool Kit



1	Transmission cap	2	Absorber clip

BT

Bluetooth® is a technology standard that enables short-range wireless communication between electronic devices.

CDW Yeast

Measurement of transmission and correlation to cell dry weight of yeast based on the transmission signal. The unit of measurement is g/L.

CIP

Cleaning in Place (CIP) is a cleaning procedure used for cleaning the interior or contact surfaces of process pipes, vessels, and processing equipment without disassembly. The CIP helps remove debris and microorganisms from the pipework and processing equipment.

Correlation

Correlation of the offline measurements with inline measurements.

FTU

Formazine Turbidity Unit (FTU) is used as a turbidity standard.

Inoculation

Inoculation is the process of marking the time point after the cells have entered the cultivation system. This event is unique, and it occurs once in a process cycle.

Measurement Interval

The Measurement Interval is the time the sensor takes to measure and deliver the signal over a 4-20 mA, Modbus, or an ArcAir experiment between two measuring processes. The measuring process takes approximately 3 seconds, so the smallest value that can be set is 3 seconds.

NTU

Nephelometric Turbidity Unit (NTU) corresponds to Formazine Turbidity Unit (FTU) and is used as a turbidity standard.

PCS

A Process Control System (PCS) is a computerized system that provides autonomous control of the process at a process plant on the customer's site.

SCADA

Stands for Supervisory Control and Data Acquisition (SCADA). It is a control system architecture with layered control options for managing and operating project-driven processes. The PCS is on level one of five of the control operations.

Sensor ID

The Sensor ID contains unique attributes for the identification of the sensor. The Sensor ID consists of the REF Number and Serial Number.

SIP

Sterilization in place of a bioreactor (SIP) is mainly used for bigger bioreactors that do not fit into an autoclave. This process of sterilization requires an external steam line.

TCD

The total cell density (TCD) measurement by the Dencytee Arc Sensor is based on the optical density and the turbidity of suspension at near-infrared (NIR) wavelengths. All particles and molecules that scatter the NIR light will be detected and can be correlated to the TCD measured offline.

Wi-Fi

Wi-Fi is a networking technology that uses radio waves to allow high-speed data transfer over short distances. Wi-Fi networks allow devices such as computers, mobile devices, and other equipment to interface with the Internet, and exchange information with each other.

More information and free software simulation:
www.hamiltoncompany.com/process-analytics

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