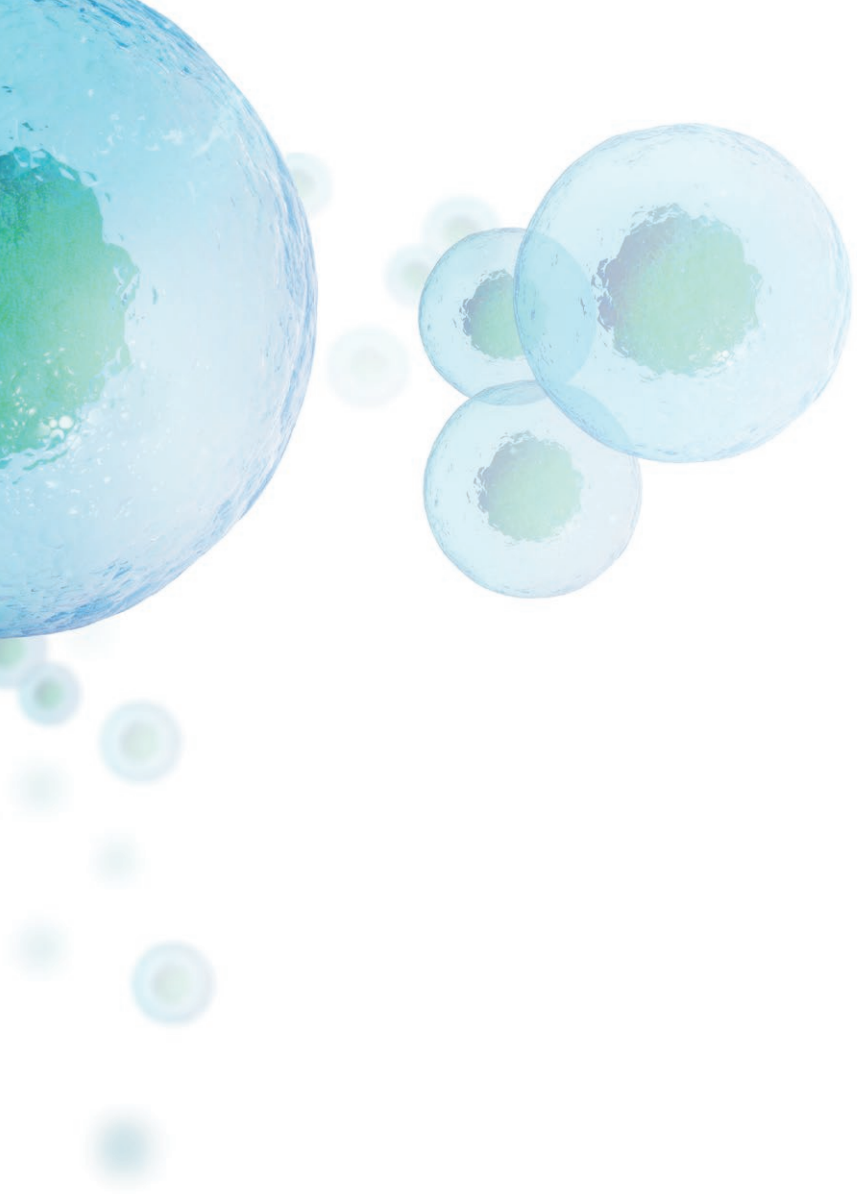
HAMILTON

ARC MODBUS OPC CONVERTER

Operating Instructions



Hamilton Warranty

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

Important Note

Contents of this document can be modified without previous announcement. Technical modifications reserved. Greatest possible care was used on the correctness of the information in this document. If errors should be discovered nevertheless, Hamilton Bonaduz AG is pleased to be informed about it. Regardless of this, Hamilton Bonaduz AG cannot assume liability for any errors in this manual or for their consequences.

Content

1 Preface

Congratulations on your purchase of the Arc Modbus OPC Converter (REF 10089359). The converter is designed to make the measurement and status information of up to four Arc sensors available via OPC UA communication.

Proper handling and maintenance of this device will increase the lifespan. To learn about proper care and maintenance, please take the time to read this manual, including the warranty information.

2 General Information

2.1 Intended Use

The Arc Modbus OPC Converter is designed to convert the Hamilton sensor's digital protocol (Arc Modbus RTU) to enable communicate via OPC UA mainly in R&D environments. For different applications please contact your local Hamilton representative.

2.2 About this Operating Instruction

The Operating Instructions will help users to operate the Arc Modbus OPC Converter correctly and safely. To achieve that goal, this document describes the different components of the device and how it functions. The manual describes both the hardware and firmware of the Converter and how it enables the user to integrate and operate the system. The manual provides an overview and description of the device as well as step-by-step instructions on how to operate the Converter.

After reading this manual, the user should be able to install and operate the Arc Modbus OPC Converter.

The following information is highlighted within this document:

⚠ **WARNING! Alerts the user to the possibility of injury, death, or other serious adverse reactions associated with the use or misuse of the device.**

NOTICE: Emphasizes information of particular importance.

3 Liability

The liability of Hamilton Bonaduz AG is detailed in the document "General Terms and Conditions of Sale and Delivery" Hamilton is expressly not liable for direct or indirect losses arising from 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 the converter upon its relevant application. The user is responsible for the care of the device. The user is responsible for taking suitable precautions in the event of a product failure. The Arc Modbus OPC Converter is not intended as a safety device.

4 Safety Precautions and Hazards

⚠ **WARNING! Read the following safety instructions carefully before installing and operating the Arc Modbus OPC Converter.**

4.1 General Precautions

For safe and correct use of the Converter, it is essential that both operating and service personnel follow generally accepted safety procedures as well as the safety instructions given in the Operating Instructions of the Arc Modbus OPC Converter. The specification given on the homepage (www.hamiltoncompany.com) with regards to temperature, pressure etc., may under no circumstances be exceeded. Inappropriate use or misuse can be dangerous. Cleaning, assembly and maintenance should be performed by personnel trained in such work.

If the device cannot be repaired by the operator, it has to be sent back to Hamilton for inspection. Necessary precautions should be taken when transporting the device. For repair or shipment the Converter should be sent back in the original reusable packaging box. Every device sent back for repair must be decontaminated. If the conditions described in these operating instructions are not adhered to or if there is any inappropriate interference with the equipment, all of our manufacturer's warranties become obsolete.

4.2 Operation of the Arc Modbus OPC Converter

The Arc Modbus OPC Converter must be used for the intended application, and in optimum safety and operational conditions. The specifications (such as temperature or humidity) defined on the homepage (www.hamiltoncompany.com) must not be exceeded under any circumstances.

Locations with significant electric noise may cause interference. In this case the Converter should be mounted in a cabinet.

5 Electrical Safety Precautions

Only use the power supply and cables provided with the Arc Modbus OPC Converter. Do not connect it to a power source of voltage beyond the range stated in the specifications. Failure to do so may lead to malfunction or damage of the system or impair user safety.

⚠ WARNING! If the power supply is switched off or disconnected, the reading on the process control system is wrong.

6 Chemical, Radioactive or Biological Hazard Precautions

Selection of the appropriate biological safety level and implementation of the required biosafety measures for working with the Arc Modbus OPC Converter is the sole responsibility of the user.

If working with hazardous liquids observe and carry out the maintenance procedures, paying attention to cleaning and decontamination. If parts or the complete device becomes contaminated with biohazardous, radioactive or chemical material, it should be cleaned. Failure to observe and carry out the maintenance procedures may impair the reliability and correct functioning of the system.

Avoid damaging the power cord. Do not bend it excessively, step on it, or place heavy objects on it. A damaged cord can easily become a shock or fire hazard. Never use a power cord after it has become damaged.

⚠ WARNING! The Arc Modbus OPC Converter is an industrial PC and it is only protected against splash water. You should not immerse the Arc Modbus OPC for cleaning. Close the Service Ethernet port if not used.

7 Product Description

The Arc Modbus OPC Converter enables the transformation of the Arc Modbus RTU protocol to a read-only OPC UA communication. The Converter continuously scans on its four channels for Arc sensors, as soon as a sensor is found, it periodically reads the sensor's data and copies it to the corresponding OPC variables. This communication is transmitted via Ethernet connection.

The Converter is delivered with a power supply with country specific connectors and 4 sensor cables (M8 connector for the Converter and VP 8 for the Arc sensor, optional integration with Arc Wi 1G Adapter BT (REF 243460) for configuration possible).

7.1 Hardware

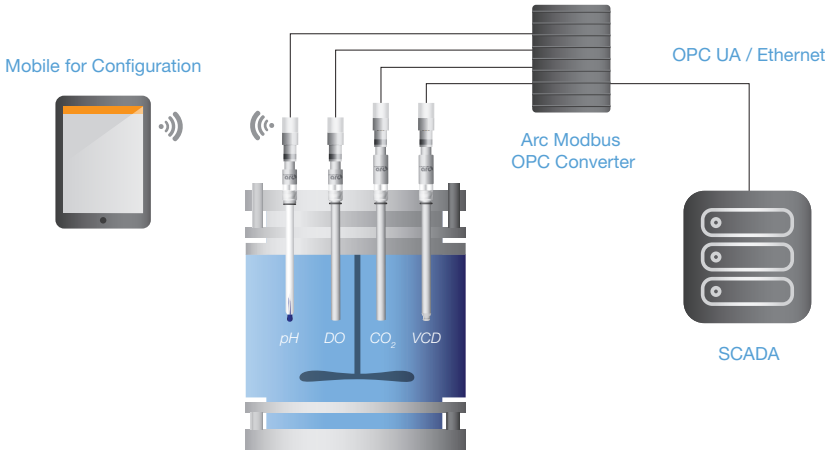
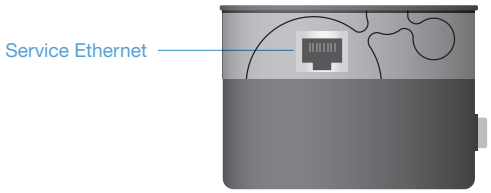
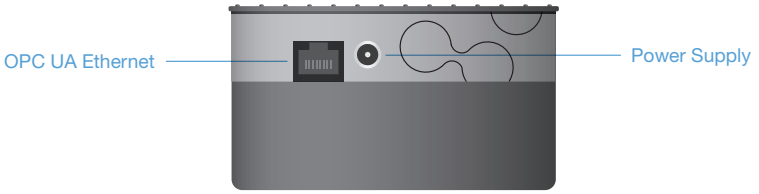


Figure 1: Installation situation of the Arc Modbus OPC Converter



Side view, left

Front view



Backside view

Figure 2: Hardware description

7.2 Configuration and Communication Interfaces

The Converter offers two Interfaces:

- A Service Center, which is used to set up the Converter (e.g. read or define the IP address). It additionally allows creating and editing specific users. This Configuration is explained in Chapter 8. This Interface is not used in routine operations.
- An OPC UA Interface, which is used while running the Converter in an OPC UA communication to the connected systems, like SCADA (explained in Chapter 8).

8 Configuration

Connecting the Modbus OPC Converter to a specific SCADA is explained below.

8.1 Introduction to OPC

OPC is a communication protocol which specifies the transmission of real-time data between control devices from different manufacturers. The Arc Modbus OPC Converter offers an OPC UA Server. The OPC Unified Architecture (UA), released in 2008, is a platform independent service-oriented architecture that integrates into one extensible framework. OPC UA has been designed for scalability and supports a wide range of application domains, ranging from field level (e.g. sensors), to enterprise management support (SCADA).

(Source: the OPC Foundation)

8.2 Unpacking of the Arc Modbus OPC Converter

1) Unpack carefully the Arc Modbus OPC Converter. Enclosed you will find the Converter, a power supply with country-specific connectors and 4 sensor cables as well as this Operating Instructions.
2) Inspect the converter for shipping damage or missing parts.

8.3 Network Setting Definition using the Service Center

The Arc Modbus OPC Converter offers a Service Center giving access to the status of the device information and settings such as network configuration. The OPC UA Interface is accessible from both Ethernet Interfaces (OPC UA and Service).

Before connecting the Arc Modbus OPC Converter to an existing network the procedure described should be followed to set up the proper network configuration.

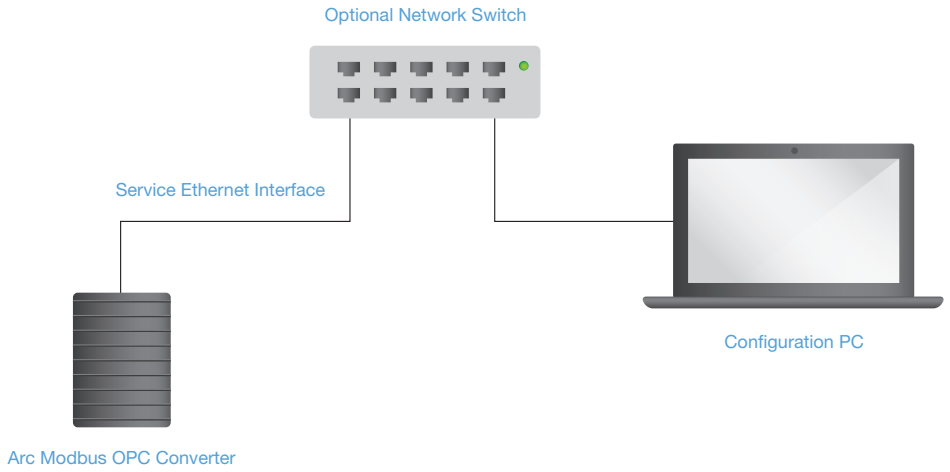


Figure 3: Installation setup for configuration of the Arc Modbus OPC Converter using the Service Configuration Interface with an optional network switch

The Arc Modbus OPC Converter is set in DHCP mode by default. To read the assigned IP address or to enter a static IP address, the configuration PC must be connected to the Arc Modbus OPC Converter as shown in Figure 3.

1) Connect the converter to the configuration PC via the service interface.
2) Connect the converter to the Company Ethernet via the OPC UA Ethernet interface.
3) Switch on the Arc Modbus OPC Converter.
4) On the configuration PC open your browser, e.g. Edge or Chrome (using Internet Explorer is not fully supported) and insert the following line: http://192.168.254.1:8000/index
5) The Service Center opens displaying the system status, the sensors connected to the channels and the version number of the OPC Converter's firmware and Hardware.

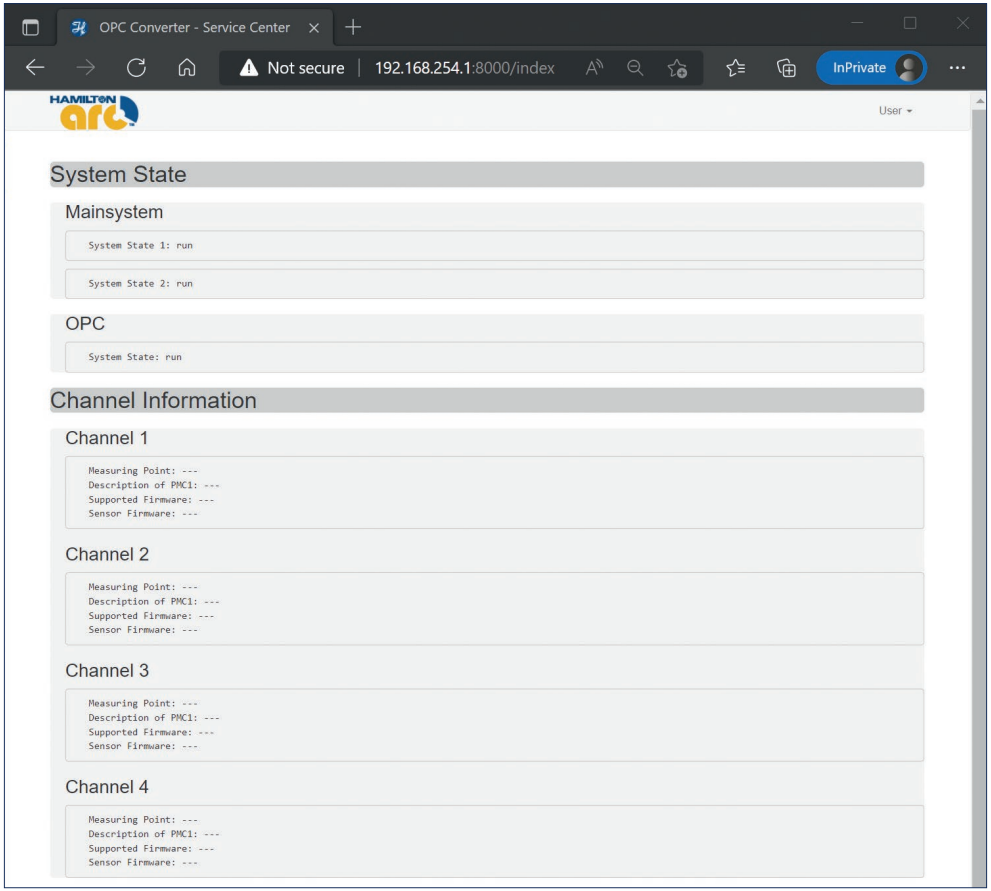


Figure 4: System state

6) In the User drop-down (upper right corner), click **Login** and insert Username (by default: administrator) and Password (by default: admin). Click **Sign In**.

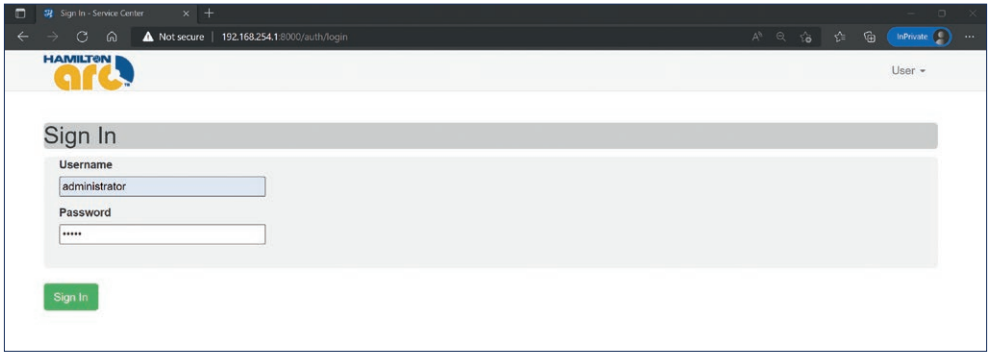


Figure 5: User sign in window

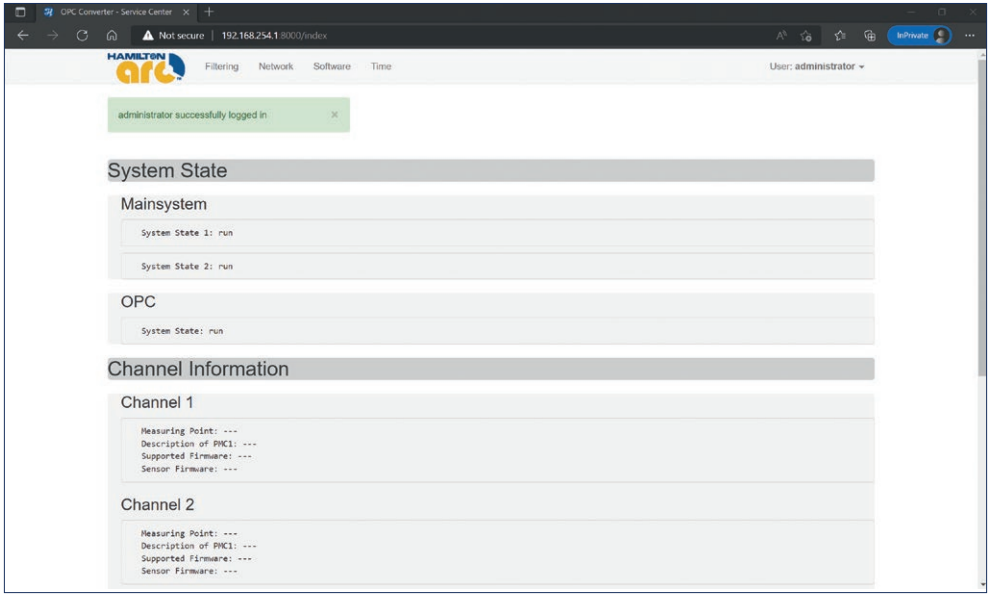


Figure 6: Administrator succesfully logged in

7) Select the **network** tab.

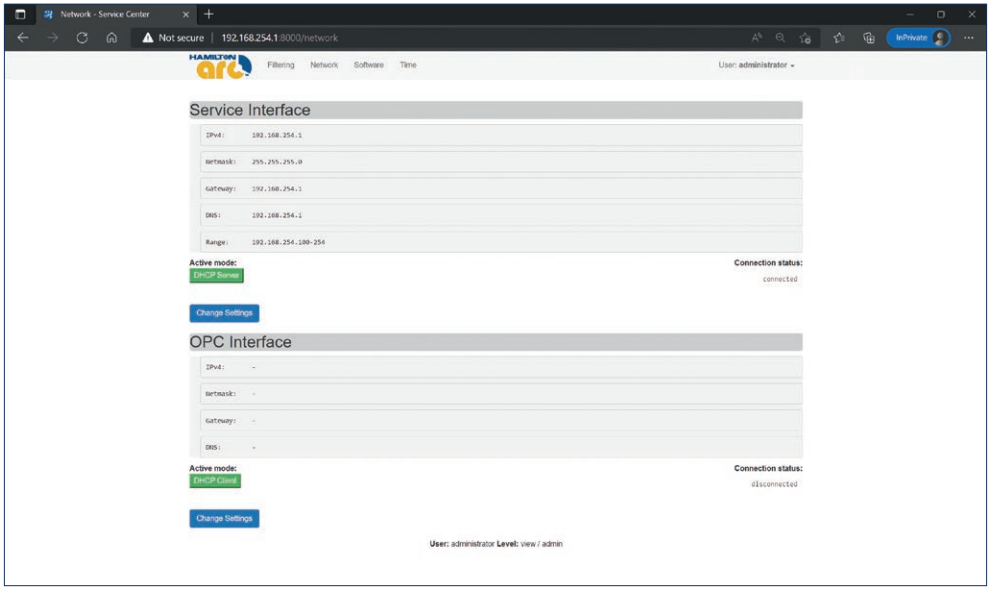


Figure 7: Interfaces

8) In the section **OPC Interface**: Select **Change Settings** in order to change the network configuration of the OPC UA Interface.

   a. For dynamic IP address assignment select **DHCP Client**.
   b. For static IP address configuration select **Static** and specify the desired network configuration.

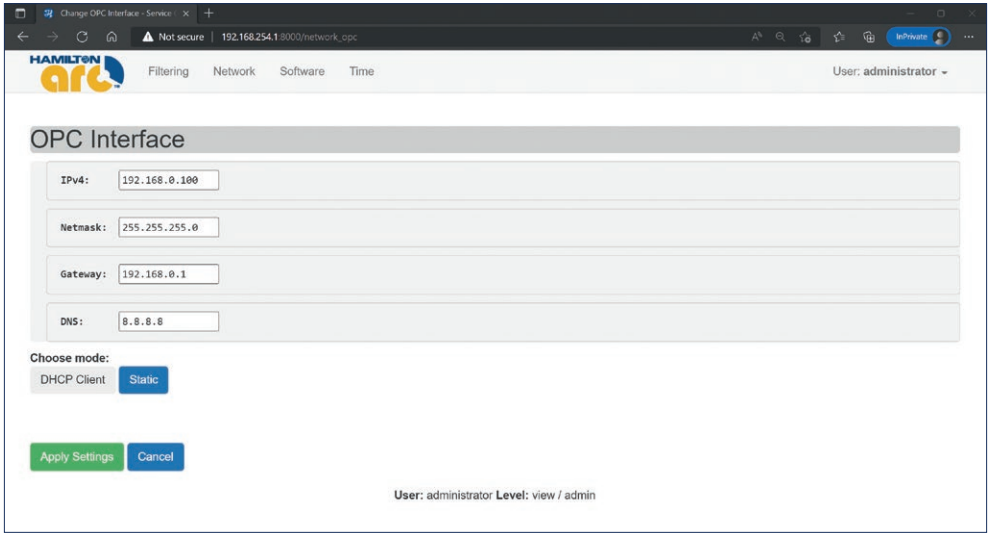


Figure 8: Configuration interface for static network configuration

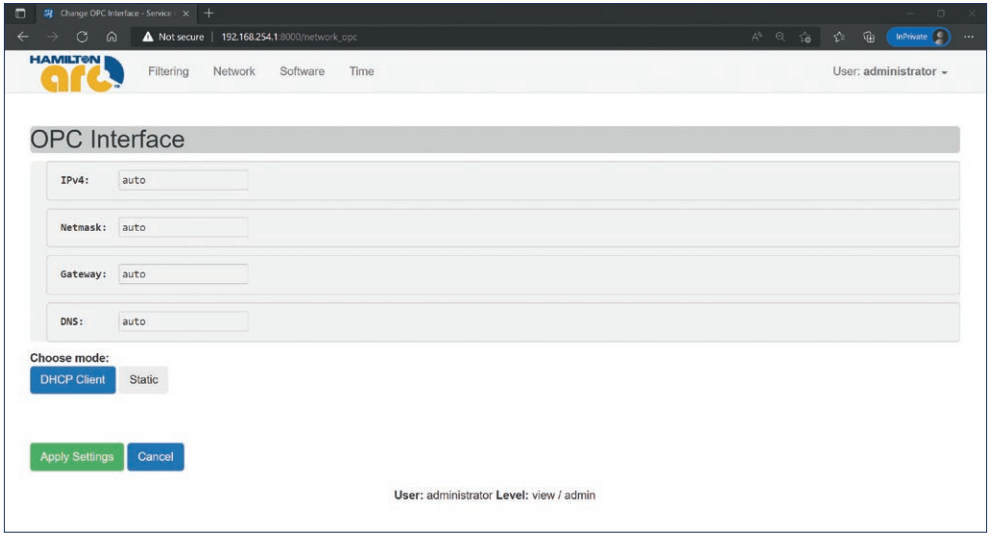


Figure 9: Configuration interface for DHCP network configuration

⚠ WARNING! Depending on your company's policy, you should not take an unassigned IP address randomly for your device since it may result in networking problems.

⚠ WARNING! Take care when changing the network configuration of the Service Configuration Interface. If the Service Configuration Interface is misconfigured and the OPC UA Interface is not accessible anymore, an external display, keyboard and mouse must be attached to the Arc Modbus OPC Converter (remove "stickers").

Log in to the system with the username "service" and the password "service". Open the built-in Firefox web browser and navigate to http://localhost:8000/index in order to access the Service Configuration Interface.

8.4 Add a new User

1) Open the Service Center (see Chapter 8.3).
2) Log in as administrator.
3) Select **Add User**.
4) Insert new Username and Password.
5) Set the check **Admin rights**, if the new user should have administrator rights.
6) Press **save**.

8.5 Edit User

1) Open the Service Center (see Chapter 8.3).
2) Log in as the user with admin rights that you want to edit.
3) Select **Edit User**.
4) Insert a new password.
5) Set the checkbox **Admin rights**, if the user to edit should have admin rights.
6) Press **save**.

8.6 Time Settings

The Arc Modbus OPC Converter's date and time settings can be configured manually by specifying the current **UTC time stamp** (Coordinated Universal Time). Alternatively, one or multiple time servers can be configured. In this case the current time stamp will be requested from the time server specified using the NTP protocol.

1) Open the Service Center (see Chapter 8.3).
2) Log in as administrator.
3) Open the **Time** tab.
4) Select **Change Settings** in order to change the date and time configuration.

   a. For manual date and time configuration select **NTP disabled** and specify the current time in UTC format.
   b. For date and time configuration using NTP select **NTP enabled** and specify the time servers.

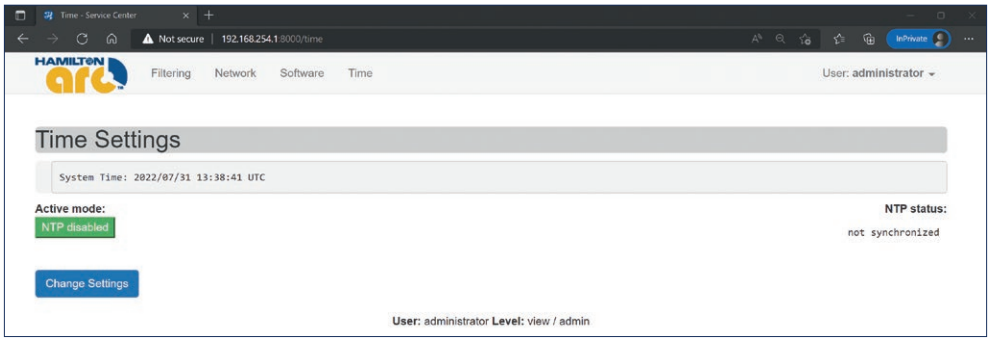


Figure 10: Time settings

8.7 Connection to the network

Once the network configuration has correctly been set up (see Chapter 8.3) the Arc Modbus OPC Converter can be connected to the company network using the OPC Interface (see Figure 11). If DHCP is configured, the IP address assigned to the Converter can be read out in the Service Center.

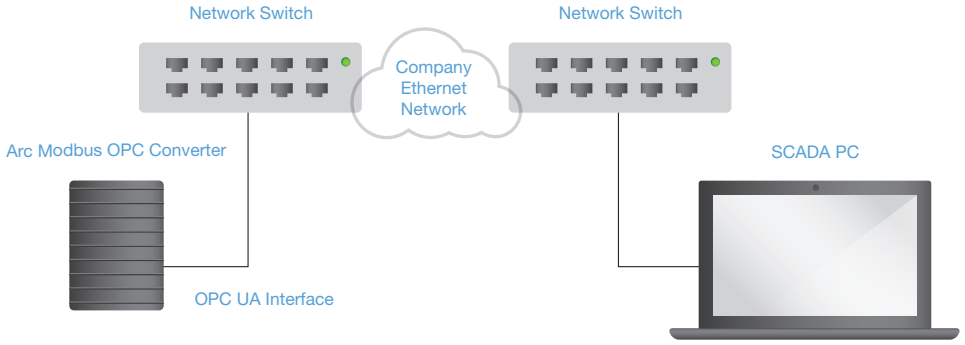


Figure 11: Installation setup for the integration of the Arc Modbus OPC Converter into the company ethernet network using the OPC UA interface

The following example describes how an OPC UA connection to the Arc Modbus OPC Converter can be established.

⚠ WARNING! The connection is described, using the free software «dataFEED OPC UA client» from Softing.

1) Use any OPC UA client to communicate with the Converter.
2) Install the client according to the instructions, provided by the supplier.
3) Switch on the Arc Modbus OPC Converter and connect it to the Ethernet.
4) Open the client and open a project.

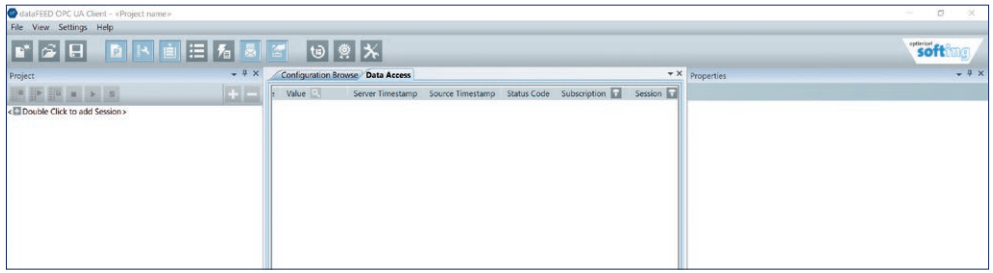


Figure 12: «dataFEED OPC UA client» user interface

5) Double-click the **+** icon in the project area to add a session.

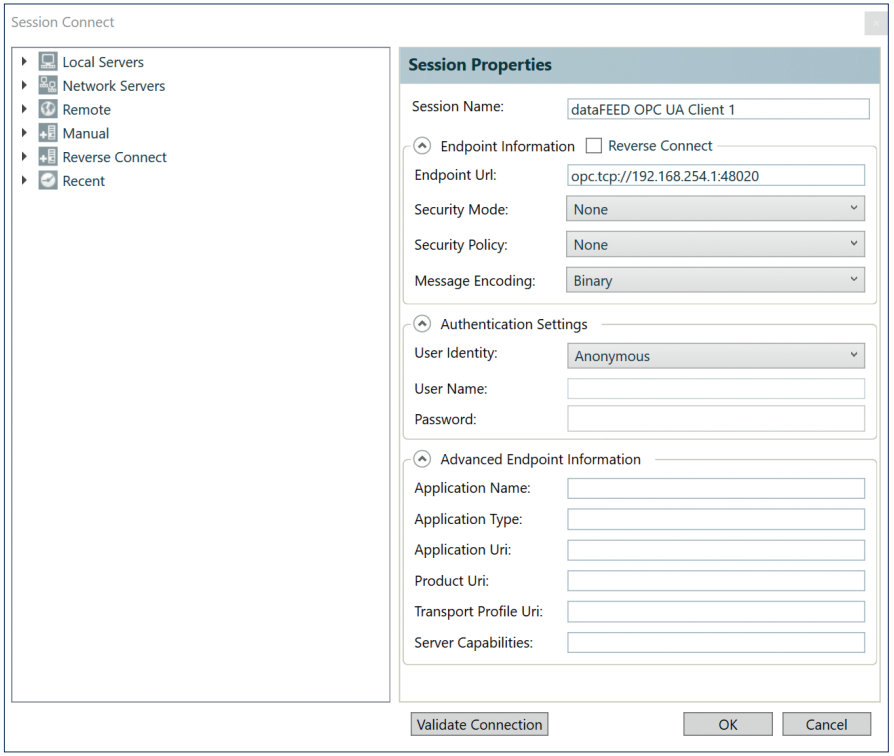


Figure 13: Definition of the IP address of the converter

6) The session content opens.

7) Add the endpoint URL: opc.tcp://<IP-Address>:48020. The value of <IP-Address> can be read by the Service Center (see Chapter 8.3). <IP-Address> refers to the IPv4 address or the Service address (depending on which port you are connected to, OPC or service port) from the OPC Interface from the Network tab.

8) Validate the connection: a green ✅ icon will be shown next to the **Validate Connection** button.

9) Click **OK**.

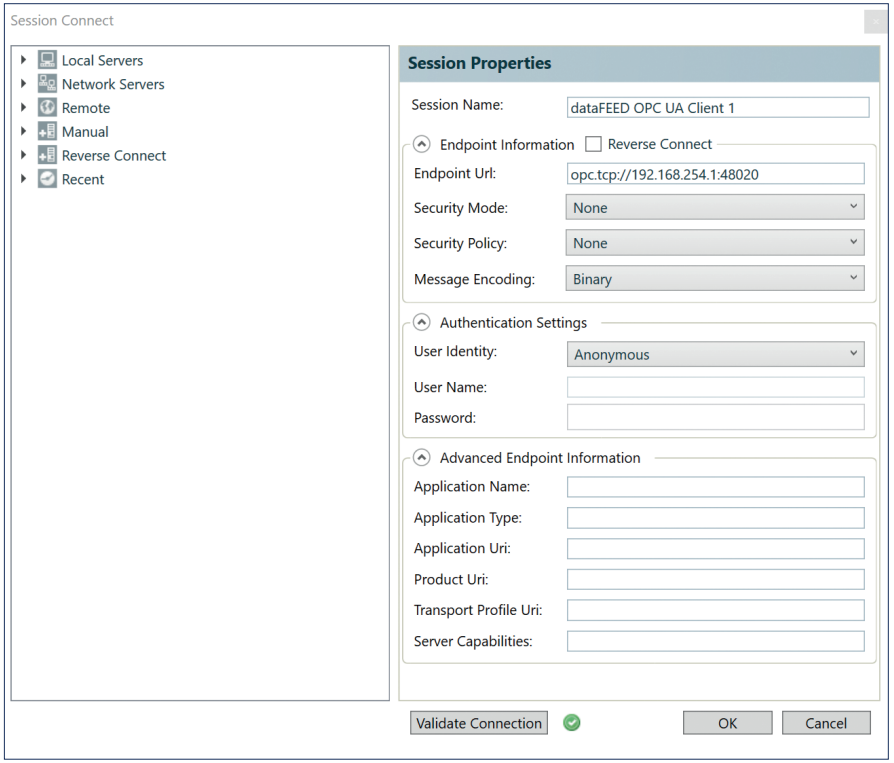


Figure 14: Communication validation

NOTICE: If an invalid IP address or syntax error is entered a red cross will appear.

8.8 Mode of operation

The Arc Modbus OPC Converter continuously scans its four channels for Arc sensors. When a sensor is found the Arc Modbus OPC Converter cyclically reads out the sensor's data and copies it to the corresponding OPC variables. Data can only be read from the sensor, no write operations via OPC are available. The communication settings of the sensor (Modbus address, baud rate, parity, and stop bit settings) may be different for every channel and are detected automatically.

It is possible to operate the sensors with an Arc Wi 1G Adapter BT (REF 243460). In this case the sensor can be configured wirelessly while the Arc Modbus OPC Converter continues to update the data on the OPC interface.

NOTICE: When the communication between the sensor and the OPC interface is interrupted, the OPC variables stop updating. The variables will not be actively reset to a zero value, instead, the last value remains. Read the time stamp of the OPC variable in order to check for the last value update.

8.9 Description of the read registers

⚠ WARNING! The Arc Modbus OPC Converter provides read-only data.

The data provided by the Arc Modbus OPC Converter is structured hierarchically within the node «ArcModbusOPCConverter» of the OPC address space. To make the data easily accessible the following hierarchy levels are used:

- Channel: the number of the physical connector used for interconnecting the Arc Modbus OPC Converter with the sensor.
- Sensor type: the type of sensor that is expected to be attached to the channel.
- Information group: thematic grouping of the information available for the sensor.

To enable browsing for information, the following OPC variables are offered in the node «ArcModbusOPCConverter»

- CH<x>_CommunicationState: a bit-mask defining the communication state of channel x (see Chapter 8.9.7.1). A value of 0 indicates that a sensor has been detected and values are read out cyclically.
- CH<x>_SensorType: the type of the sensor detected on channel x. This name is identical to the OPC sub-node that will contain all the read-out sensor data.

Example:

1) Connect an optical DO sensor to channel 3.
2) The value of the OPC variable «ArcModbusOPCConverter\CH3_CommunicationState» will change to 0 when the sensor has been detected by the OPC converter.

3) The value of the OPC variable **ArcModbusOPCConverter\CH3_SensorName** will change to **OpticalDissolvedOxygen**, indicating that the cyclically read data from the sensor will be accessible in the sub-node **ArcModbusOPCConverter\CH3\OpticalDissolvedOxygen**.

8.9.1 Information group: MeasuredValues

This information group holds the measurement values that are read from the sensor. The Arc sensors provision 6 primary measurement channels (PMC01 to PMC06) and 19 secondary measurement channels (SMC01 to SMC19). These measurement channels have assigned different measurement values depending on the sensor type. See the Operating Instructions or the Programmer's Manuals of the Arc sensor for a detailed description of the measurement channels.

Every measurement channel is represented by one OPC node within the information group «MeasuredValues» and contains the three OPC variables Name, Unit, and Value. The values will be updated cyclically with the read-out from the sensor.

OPC variable	Type	Content	Update interval
Name	String	Name of the measurement channel	Read-out upon sensor detection
Unit	UInt32	Bitmask defining the unit of the measurement value (see Chapter 8.9.7.2)	3 s
Value	Float	Measurement value	3 s

Table 1: Measured values

Example

- Connect a Conducell 4USF Arc sensor to channel 1
- The value of the OPC variable «ArcModbusOPCConverter\CH1\Conductivity4-Pole\MeasuredValues\PMC01\Name» will change to «Cond»
- The value of the OPC variable «ArcModbusOPCConverter\CH1\Conductivity4-Pole\MeasuredValues\PMC01\Unit» will be updated every 3s and indicate the current measurement unit for conductivity, e.g. 512 (0x00000200) for µS/cm
- The value of the OPC variable «ArcModbusOPCConverter\CH1\Conductivity4-Pole\MeasuredValues\PMC01\Value» will be updated every 3s and indicate the current measurement value for conductivity

NOTICE: Viable Cell Density sensors (e.g. Incyte Arc) measure frequency scan data that is written to the OPC nodes ScanFrequency and ScanPermittivity. The data are available as array as well as single values.

8.9.2 Information group: MeasurementParameters

This information group holds the measurement parameters that are read from the sensor. The Arc sensors provision 16 measurement parameters (PA01 to PA16). These measurement parameters are used to control the measurement settings of the sensor and are specific to the sensor type. See the Operating Instructions or the Programmer's Manuals of the Arc sensor for a detailed description of the measurement parameters.

Every measurement parameter is represented by one OPC node within the information group «MeasurementParameters» and contains the three OPC variables Name, Unit, and Value. The values will be updated cyclically with the read-out from the sensor.

OPC variable	Type	Content	Update interval
Name	String	Name of the measurement parameter	Read-out upon sensor detection
Unit	UInt32	Bitmask defining the unit of the measurement parameter (see Chapter 8.9.7.2)	60 s
Value	Float	Value of the measurement parameter	60 s

Table 2: Measurement parameters

Example

- Connect an OxyFerm FDA Arc sensor to channel 2
- The value of the OPC variable «ArcModbusOPCConverter\CH2\ElectrochemicalDissolved Oxygen\MeasurementParameters\PA01\Name» will change to «Salinity»
- The value of the OPC variable « ArcModbusOPCConverter\CH2\ElectrochemicalDissolved Oxygen\MeasurementParameters\PA01\Unit» will be updated every 60s and indicate the current unit of the measurement parameter Salinity, e.g. 1024 (0x00000400) for mS/cm.
- The value of the OPC variable «ArcModbusOPCConverter\CH2\ElectrochemicalDissolved Oxygen\MeasurementParameters\PA01\Value» will be updated every 60s and indicate the current value of the measurement parameter Salinity.

8.9.3 Information group: SensorInformation

This information group contains sensor information data that helps identify and characterize the sensor connected to the Arc Modbus OPC Converter.

The following data is available as OPC variable within this information group:

OPC variable	Type	Content	Update interval
Communication State	UInt32	A bit-mask defining the communication state of channel x (see Chapter 8.9.7.1) of the Arc Modbus OPC Converter. A value of 0 indicates that a sensor has been detected and values are read out cyclically	3 s
Firmware	String	The name of the sensor's firmware	Read-out upon sensor detection
MeasuringPoint	String	The measuring point string helps identify the sensor. It can be changed by the user and is displayed in the sensor list of the ArcAir software.	60 s
ModuleID	String	The ID of the Arc Module SU* (combination of REF number and serial number). For reusable Arc sensors this variable remains empty (value of 0).	Read-out upon sensor detection
ModuleName	String	The name of the Arc Module SU* (e.g. Arc Module SU pH). For reusable Arc sensors this variable remains empty (value of 0).	Read-out upon sensor detection
ModuleLot	String	The lot number of the Arc Module SU*. For reusable Arc sensors this variable remains empty.	Read-out upon sensor detection
ModuleLotDate	String	The lot date of the Arc Module SU*. For reusable Arc sensors this variable remains empty.	Read-out upon sensor detection
SensorID	String	The ID of the Arc sensor (combination of REF number and serial number)	60 s
SensorName	String	The product name of the Arc sensor (e.g. Conducell 4USF)	60 s
SensorRef	String	The REF number of the Arc sensor.	60 s

OPC variable	Type	Content	Update interval
SensorSN	String	The serial number of the Arc sensor.	
SensorLot	String	The lot number of the Arc sensor.	60 s
SensorLotDate	String	The lot date of the Arc sensor.	60 s

Table 3: Sensor information

*Single-Use

8.9.4 Information group: SensorStatus

This information group contains sensor status information that helps monitor the condition of the sensor connected to the Arc Modbus OPC Converter.
The following data is available as OPC variable within this information group:

OPC variable	Type	Content	Update interval
Autoclavings Counter	UInt32	The number of autoclavings read out from the sensor. (The user needs to increase the number of autoclavings manually in the sensor after autoclavation)	60 s
CIPcounter	UInt32	The number of cleaning in place cycles (CIP) detected by the sensor.	60 s
ErrorsCalibration	UInt32	A bit-mask defining the calibration errors in the sensor (see sensor specific programmer's manual for details).	3s
ErrorsHardware	UInt32	A bit-mask defining the hardware errors in the sensor (see sensor specific programmer's manual for details).	3 s
ErrorsInterface	UInt32	A bit-mask defining the interface errors in the sensor (see sensor specific programmer's manual for details).	3 s
Errors Measurement	UInt32	A bit-mask defining the measurement errors in the sensor (see sensor specific programmer's manual for details).	3 s
MainStatus	UInt32	A bit-mask defining the main status of the sensor (see Chapter 8.9.7.3).	3 s
OperatingHours	Float	The value of the sensor's operating hours counter.	60 s
QualityIndicator	Float	The sensor's quality indicator value. See the programmer's manual of the sensor for more information.	3 s

OPC variable	Type	Content	Update interval
SIPcounter	UInt32	The number of sterilization in place cycles (SIP) detected by the sensor.	60 s
Warnings Calibration	UInt32	A bit-mask defining the calibration warnings in the sensor (see sensor specific programmer's manual for details).	3 s
Warnings Hardware	UInt32	A bit-mask defining the hardware warnings in the sensor (see sensor specific programmer's manual for details).	3 s
Warnings Interface	UInt32	A bit-mask defining the interface warnings in the sensor (see sensor specific programmer's manual for details).	3 s
Warnings Measurement	UInt32	A bit-mask defining the measurement warnings in the sensor (see sensor specific programmer's manual for details).	3 s

Table 4: Sensor status

8.9.5 Information group: Settings

This information group is available only for Viable Cell Density sensors (e.g. Incyte Arc) and contains specific settings that cannot be mapped to measurement parameters.

The following data is available as OPC variables within this information group:

OPC variable	Type	Content	Update interval
AveragingDual	UInt32	The number of moving average filter elements used for smoothing the dual frequency measurement signal	60 s
AveragingScan	UInt32	The number of moving average filter elements used for smoothing the frequency scan measurement signal	60 s
CellTypeMode	String	Name of the currently configured Cell Type Mode	60 s
CultureTime	UInt32	Count of the seconds elapsed since inoculation has been registered in the sensor.	3 s
fmeas	UInt32	Index of the measurement frequency used with the configured Cell Type Mode (see Chapter 8.9.7.4)	60 s

OPC variable	Type	Content	Update interval
fhigh	UInt32	Index of the background frequency used with the configured Cell Type Mode (see Chapter 8.9.7.4)	60 s
InoculateActive	UInt32	Flag indicating whether inoculation has been registered in the sensor.	60 s
OffsetDual	Float	The offset value deducted from the raw dual frequency measurement.	60 s
OffsetScan	Float Array	The offset values of the frequency scan that are deducted from the raw scan measurements.	60 s
ScanMode	UInt32	Index of the scan mode used for measuring (see Chapter 8.9.7.5)	60 s
SensorRecordingActive	UInt32	Flag indicating whether a sensor recording is active on the dual frequency measurement	60 s
SensorRecordingInterval	UInt32	Sampling interval of the currently configured sensor recording (only readable when sensor is connected to ArcAir)	60 s
SensorRecordingName	String	Name of the currently configured sensor recording	60 s
CorrelationModelActive	UInt32	Indicates whether a correlation mode is active or not	60 s
CorrelationModelName	String	displays the name of the correlation model being used	60 s
CorrelationModelID	String	Displays the ID of the correlation model being used	60 s
CorrelationModelChecksum	String	Displays the checksum of the correlation model being used	60 s
CorrelationModelDate	String	Displays the date of the correlation model being used	60 s
CorrelationModelTime	String	Displays the time of the correlation model being used	60 s
Offset Cell Density	Float	Offset being used for the cell density measurement	60 s
ZeroDualActive	UInt32	Flag indicating whether mark zero is active on the dual frequency measurement	60 s
ZeroScanActive	UInt32	Flag indicating whether mark zero is active on the frequency scan measurement	60 s

Table 5: Settings

8.9.6 Information Groups Calibration TS1 and TS2

This information groups contain information about the calibration coefficients of the Arc sensor.

Depending on the sensor used, there are different Technology Standards used. They are called TS1 and TS2.

The following table will give an overview which sensor uses which Technology Standard (TS):

Technology standard for calibration	Sensor type
TS1	pH
	ORP
	Optical dissolved oxygen
	Optical dissolved oxygen (new RS485)
	Electrochemical dissolved oxygen
	Conductivity 4 pole
	Conductivity ultrapure water
TS2	Optical dissolved oxygen (new RS485)
	Viable cell density
	Total cell density
	CO_2

The following data is available as OPC variables within these information groups:

OPC variable	Type	Content TS1	Interval
CalibrationCoefficient1	Float	pH: Zero Point ORP: Offset Optical dissolved oxygen: Phase 0 Electrochemical dissolved oxygen: Zero Current Conductivity ultrapure water: Offset Resistance Conductivity 4-pole: Resistance	60 s
CalibrationCoefficient2	Float	pH: Slope ORP: Not Used Optical dissolved oxygen: Stern Volmer Coefficient Electrochemical dissolved oxygen: Slope Conductivity ultrapure water: Cell Constant Conductivity 4-pole: Cell Constant	60 s

Table 6: Calibration coefficients TS1

OPC variable	Type	Content TS1	Interval
CalibrationCoefficient1	Float	Optical dissolved oxygen: Phase 0 CO_2: Zero Point SR CDO: I0f	60 s
CalibrationCoefficient2	Float	Optical dissolved oxygen: Stern Volmer CO_2: CO_2 Point SR CDO: Rho	60 s
CalibrationCoefficient3	Float	Optical dissolved oxygen: Ref. Temp CDO: Xi	60 s
CalibrationCoefficient4	Float	CDO: I0b	60 s
CalibrationCoefficient5	Float	CDO: Ibl	60 s
Total Pressure	Float	Total Pressure for calibration	60 s
Total Humidity	Float	Total Humidity for calibration	60 s
CellConstant	Float	Cell Constant (only present for Viable Cell Density)	60 s

Table 7: Calibration coefficients TS2

8.9.7 Bit-mask Definitions

8.9.7.1 Communication State

Bit	Value (hexadecimal)	Value (decimal)	Description	Meaning / Possible measures
0	0x00000001	1	Hardware error	Contact Hamilton Technical Support
1	0x00000002	2	Sensor not detected	No sensor has been detected. OPC variables will not be updated. Make sure the sensor is properly connected to the Arc Modbus OPC Converter.
2	0x00000004	4	Sensor over-current	The over-current protection of the communication channel has been activated. Check the cabling and sensor for proper functionality.
3	0x00000008	8		
4	0x00000010	16	Sensor communication error	The connection to the sensor previously detected is interrupted. No communication is possible. Make sure the sensor is properly connected to the Arc Modbus OPC Converter.
5	0x00000020	32	Sensor scan active	The Arc Modbus OPC Converter is actively scanning for a sensor on the communication channel.
6	0x00000040	64	Internal error 06	Contact Hamilton Technical Support
7	0x00000080	128	Internal error 07	Contact Hamilton Technical Support
8	0x00000100	256	Internal error 08	Contact Hamilton Technical Support
9	0x00000200	512	Internal error 09	Contact Hamilton Technical Support
10	0x00000400	1024	Internal error 10	Contact Hamilton Technical Support
11	0x00000800	2048	Internal error 11	Contact Hamilton Technical Support
12	0x00001000	4096	Internal error 12	Contact Hamilton Technical Support

Table 8: Bit-mask Communication State

Examples:

- After power-on, when no sensor is connected to the Arc Modbus OPC Converter the communication state of all channels will be 34 (0x00000022), indicating «Sensor not detected» and «Sensor scan».
- After disconnecting a sensor that has previously been detected by the Arc Modbus OPC Converter the communication state of the channel will be 50 (0x00000032), indicating «Sensor not detected», «Sensor communication error» and «Sensor scan».

8.9.7.2 Measurement Units

Bit	Value (hexadecimal)	Value (decimal)	Conductivity4-Pole, ConductivityUltraPureWater, Electrochemical DissolvedOxygen, OpticalDissolvedOxygen, ORP, pH	Cell Density	CO_2
0	0x00000001	1	none	none	none
1	0x00000002	2	K	K	K
2	0x00000004	4	°C	°C	°C
3	0x00000008	8	°F	°F	°F
4	0x00000010	16	%-vol	PCV	%-vol
5	0x00000020	32	%-sat	AU (TCD)	%-sat
6	0x00000040	64	µg/l ppb	arb. Unit (TCD)	ug/l ppb
7	0x00000080	128	mg/l ppm	NTU (TCD)	mg/l ppm
8	0x00000100	256	g/l	g/l	g/l
9	0x00000200	512	µS/cm	µS/cm	PCV
10	0x00000400	1024	mS/cm	mS/cm	mS/cm
11	0x00000800	2048	1/cm	1/cm	1/cm
12	0x00001000	4096	pH	mS	mmHg
13	0x00002000	8192	mV/pH	pF	hPa
14	0x00004000	16384	kOhm	kOhm	kOhm
15	0x00008000	32768	MOhm	MOhm	MOhm
16	0x00010000	65536	pA	pA	pA
17	0x00020000	131072	nA	nA	nA
18	0x00040000	262144	µA	µA	uA
19	0x00080000	524288	mA	mA	mA
20	0x00100000	1048576	µV	µV	uV
21	0x00200000	2097152	mV	mV	mV
22	0x00400000	4194304	V	V	V
23	0x00800000	8388608	mbar	CFU (TCD)	mbar
24	0x01000000	16777216	Pa	-	Pa
25	0x02000000	33554432	Ohm	Ohm	Ohm
26	0x04000000	67108864	%/K	%/K	%/K
27	0x08000000	134217728	°	°	°
28	0x10000000	268435456	-	e6 cells/ml	e6 c/ml
29	0x20000000	536870912	-	pF/cm	%
30	0x40000000	1073741824	-	kHz	-
31	0x80000000	2147483648	-	OD	OD

Table 9: Bit-mask Measurement Units

8.9.7.3 Main Status

Bit	Value (hexadecimal)	Value (decimal)	Description
0	0x00000001	1	Temperature out of measurement range
1	0x00000002	2	Temperature out of operating range
2	0x00000004	4	
3	0x00000008	8	Sensor warnings not zero
4	0x00000010	16	Sensor errors not zero

Bit	Value (hexadecimal)	Value (decimal)	Description
5	0x00000020	32	
6	0x00000040	64	
7	0x00000080	128	
8	0x00000100	256	
9	0x00000200	512	
10	0x00000400	1024	
11	0x00000800	2048	
12	0x00001000	4096	
13	0x00002000	8192	
14	0x00004000	16384	
15	0x00008000	32768	
16	0x00010000	65536	
17	0x00020000	131072	
18	0x00040000	262144	
19	0x00080000	524288	
20	0x00100000	1048576	
21	0x00200000	2097152	
22	0x00400000	4194304	
23	0x00800000	8388608	VCD conditioning active (ViableCellDensity only)
24	0x01000000	16777216	
25	0x02000000	33554432	
26	0x04000000	67108864	
27	0x08000000	134217728	
28	0x10000000	268435456	
29	0x20000000	536870912	
30	0x40000000	1073741824	
31	0x80000000	2147483648	

Table 10: Bit-mask Main Status

8.9.7.4 Measurement and Background Frequency Indices

Index	Frequency [kHz]
0	300.1
1	373.8
2	465.7
3	579.8
4	720.0
5	896.4
6	999.5
7	1117.7
8	1392.3
9	1729.3
10	2002.7
11	2155.3
12	2689.3
13	3347.3
14	4158.0
15	5187.9
16	6446.8
17	8029.9
18	9994.5

Table 11: Bit-mask Frequency Indices

8.9.7.5 Scan Modes

Index	Scan Mode
0	Off
2	Dual frequency measurement
3	Frequency scan
4	Frequency scan + dual frequency measurement

Table 12: Scan Mode indices

8.10 Selection of the read registers

1) Connect the sensor (see Chapter 9.2) to the Converter.
2) Switch on the Arc Modbus OPC Converter and connect it with the Ethernet.
3) Establish a connection to the OPC Converter (see Chapter 8.7) and open the «dataFEED OPC UA client». Go to the Configuration Browse Tab.
4) Open the Objects node.

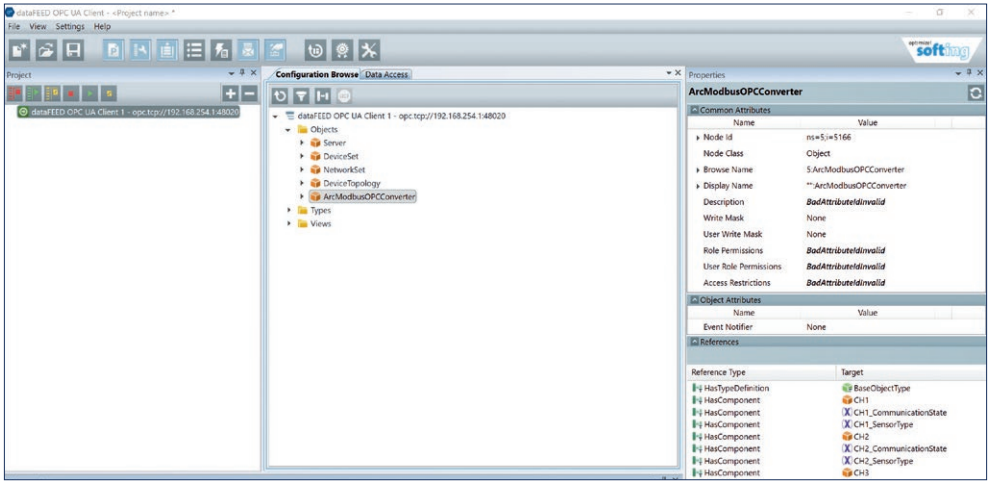


Figure 15: Objects node

5) Expand the ArcModbusOPCConverter node.
6) The OPC structure opens.

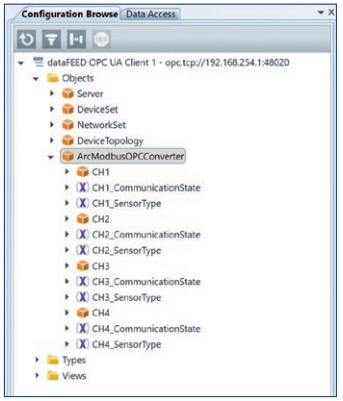


Figure 16: Arc Modbus OPC Converter node

7) On the first level, each channel (CH1 to CH 4) is shown, having the communication state (the same as described in Table 3) and sensor name.
8) Double click on the configuration state and sensor name to add it to the project.

Figure 17: Communication State node

9) Go to Data Access and ensure that the communication state is 0, which indicates that a sensor is connected and that a name is available, which identifies the connected sensor, in this case an optical dissolved oxygen sensor is connected at **Channel 1**.

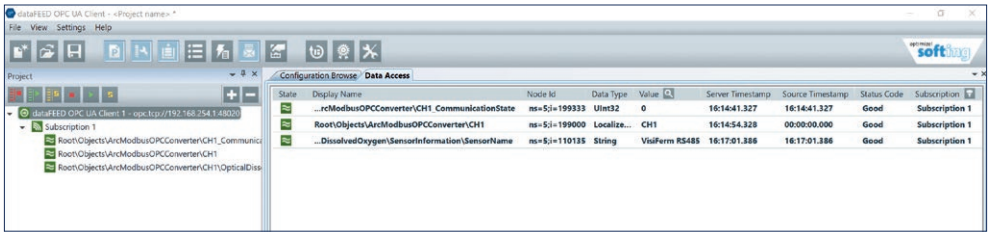


Figure 18: Data Access selection

10) Go to the Configuration Browse Tab and open **Channel 1**.

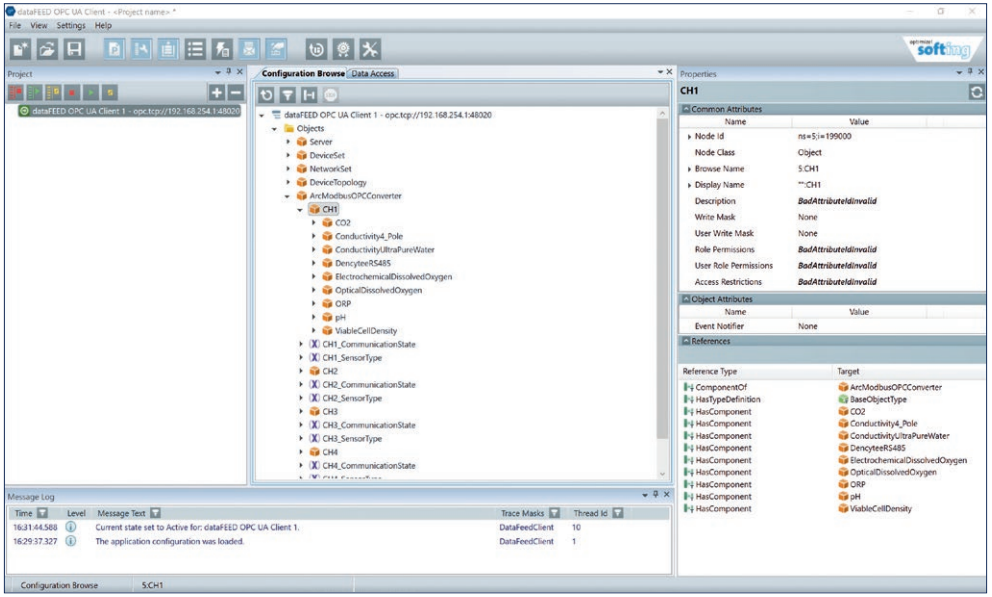


Figure 19: Configuration Browse Tab

11) Select the connected sensor from the list, for example, Optical Dissolved Oxygen.

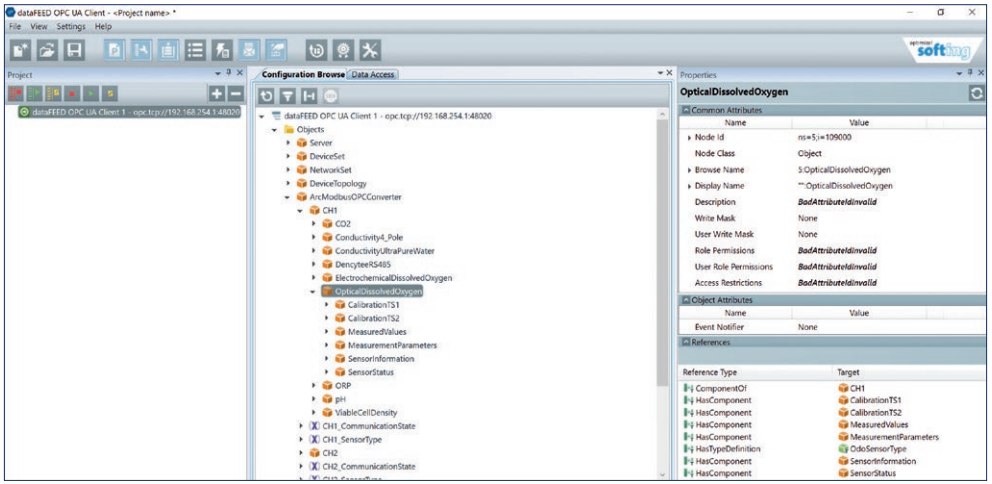


Figure 20: Sensor Name node

12) Select the Measured Values, Measurement Parameters, Sensor Information and Sensor Status to be provided to the SCADA (see Chapter 8.9.1).

13) For example for the Measured Values, select PMC 1 (the main measurement value) and double click Name, Unit, and Value individually to add it to the project.

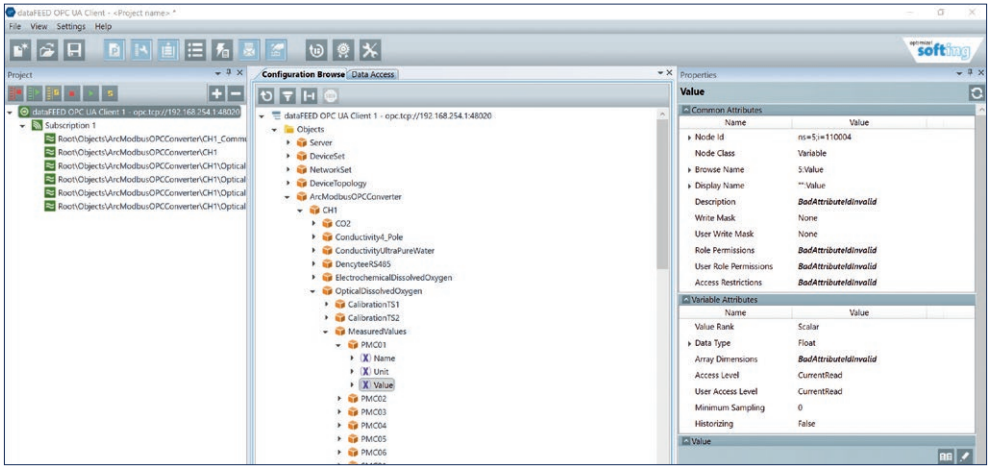


Figure 21: Measured Values node

14) Verifiy the information in the Data Acess.

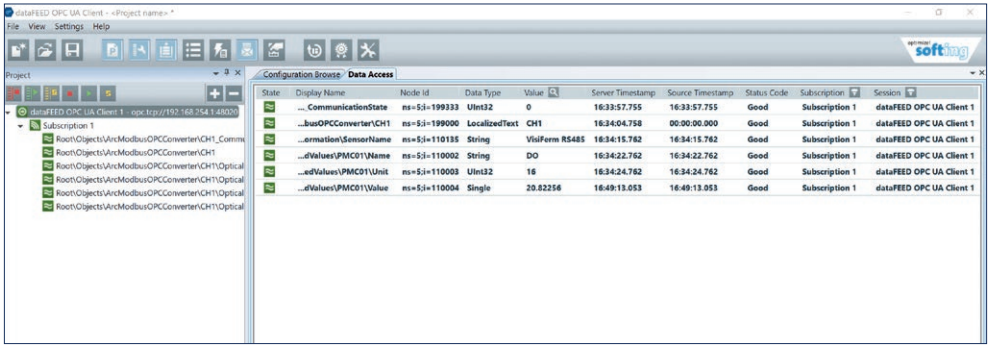


Figure 22: Data Access verification

15) Now the communication is confirmed. To integrate the measurements to the SCADA, perform the same steps there according to the operating instructions of the SCADA manufacturer.

NOTICE: Once the sensor channels are assigned, the sensor type has to be the same, e.g. a pH on Channel 1 sensor, may be replaced with a pH sensor. But a different sensor type will not be recognized (e.g. connection an oxygen sensor to Channel 1). If the sensor type is changed, different OPC variables need to be selected in the project.

8.11 Connect to SCADA

⚠ WARNING! This is a general description and may vary between different systems.

Please see Chapter 8.7 and Chapter 8.10 learn how to integrate the Arc Modbus OPC converter to the **dataFEED OPC UA client** and read-out the registers. These steps are the same as in the SCADA but have to be adapted to the operating instructions of the SCADA manufacturer.

8.12 Filter the Read Registers

To enable the integration of the Arc OPC converter, each node can filter the data which will be transmitted to the OPC client/server. The data which can be filtered for each channel are the ones displayed in Figure 23. Once a filter is set, the OPC server/ client will consequently receive just the data chosen. The user can use those data as explained in Chapter 8.10.

1) Choose the tab **Filtering**.
2) Click **Change settings**.
3) **Choose mode** should be on **Enabled**.
4) Choose the desired channel.
5) Check the nodes to be transmitted to the OPC client/server for the chosen channel.
6) Click on **Apply settings**.

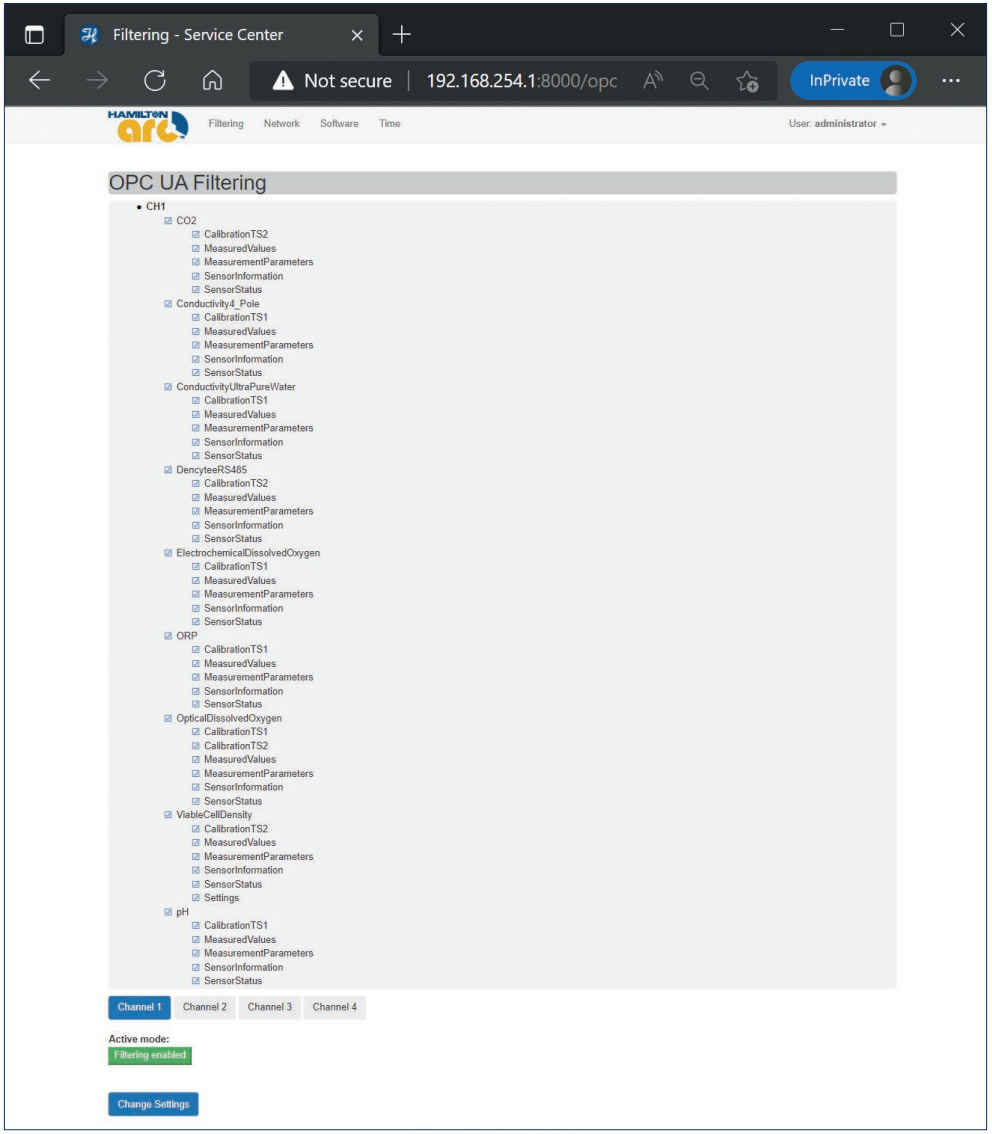


Figure 23: Arc OPC nodes filter options

9 Operation

This section explains how to connect the sensors to the Arc Modbus OPC converter.

9.1 Installation of the Converter

Place the Arc Modbus OPC Converter in a safe, clean and dry position. For example, place the Arc Modbus OPC Converter in a shelf above the bioreactor, or in a safety cabinet.

9.2 Connection of Arc Sensors to the Converter

1) Connect the cables with the Converter via M8 connector. Make sure that the notch of the connectors and socket are aligned before tightening the connection by screwing the thread.
2) Connect the sensor via VP 8. Make sure that the notch of connectors and socket are aligned, before tightening the connection by screwing the thread.
3) Switch on the Converter.
4) Select the OPC variables (see Chapter 8.10).
5) The Converter is now transmitting the translated OPC UA signal.

⚠ WARNING! Once the sensors are assigned to a channel, the sensor must be connected to the same position.

9.3 Power-on / Power-off

The Arc Modbus OPC Converter comes with a power supply with country-specific AC power connector inserts and a lockable connector to the Converter. Only use the delivered power supply.

1) Choose the AC power connector insert for your country.
2) Plug the connector end of the power supply cable the Arc Modbus OPC Converter's power supply Port (1).
3) Turn the connector clockwise after insertion to prevent the power supply connector from being pulled out.

NOTICE: To remove the connector from the Arc Modbus Converter's power supply Port (2), turn the connector counterclockwise.

4) Connect the plug end of the power supply cable to AC power source.

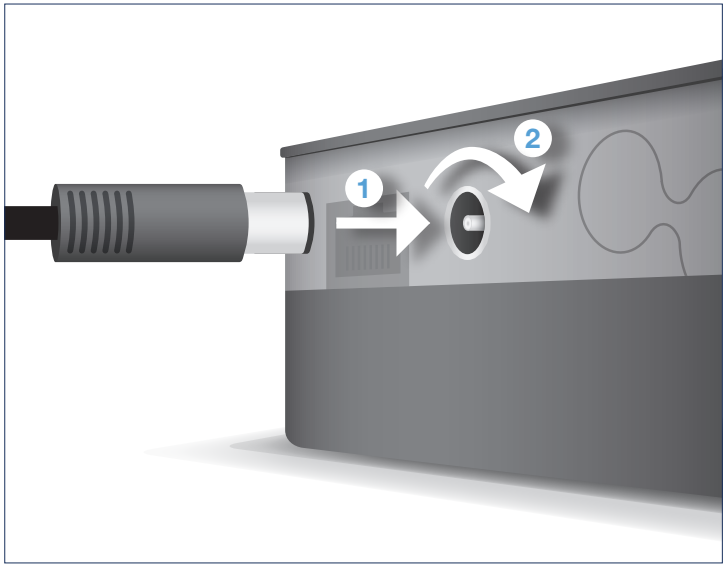


Figure 24: How to connect the power supply plug to the Arc Modbus OPC Converter

When the Arc Modbus OPC Converter is connected to the power supply the LED in the On/Off-button turns green and the converter starts up.

5) To shut down the Converter:
   a. Press the On/Off Button for 3 seconds.
   b. Login as Administrator, go to the Service Center, enter the User Menu and select the shutdown option.

NOTICE: The LED will turn orange once the Converter is turned off.

6) To restart the Converter press the power button again.

NOTICE: After an AC power failure the Converter will restart operation automatically.

9.4 Firmware Update

9.4.1 Firmware Update with Micro SD Card

NOTICE: Specification for the micro SD card (required for the firmware update):

We recommend that you use a 32 GB (max.) micro SD card with FAT32 format.

You can also connect an SD card reader to the PC if it does not have an SD card slot, then insert the micro SD card into the card reader.

1) Download the latest firmware package («OPC SD card» zip archive) for the Arc Modbus OPC Converter from www.hamiltoncompany.com.
2) Extract the zip archive and copy the files on an empty micro SD card.
3) Disconnect the power supply.
4) Insert the micro SD card into the micro SD card slot of the Arc Modbus OPC Converter. Be sure that the micro SD Card is fully inserted.
5) Connect the power supply. The firmware update procedure automatically starts.
6) The Firmware update takes approximately 10 minutes.
7) To confirm that the update is finished connect to the Service Center (see Chapter 8.3) of the Arc Modbus OPC Converter. As soon as it can be opened again the firmware update is complete.

9.4.2 Firmware Update with Web Interface

NOTICE: To perform a Firmware update with the web interface, the user has to access the OPC converter as Administrator, as described in Chapter 8.3.

1) Download the latest firmware package («OPC Web Interface» zip archive) for the Arc Modbus OPC Converter from www.hamiltoncompany.com.
2) Extract the zip archive and copy the files on the computer connected to the OPC converter (eg. «Firmware 1.9.0» or higher).
3) Choose the tab **Software**.
4) Choose the file extracted at point 2.
5) Select **Keep User Data** in order to keep the user settings configured before the firmware update.
6) Click **Upgrade**.
7) To confirm that the update is finished, connect to the Service Center (see Chapter 8.3) of the Arc Modbus OPC Converter. As soon as the Service Center can be opened again, the firmware update is complete.

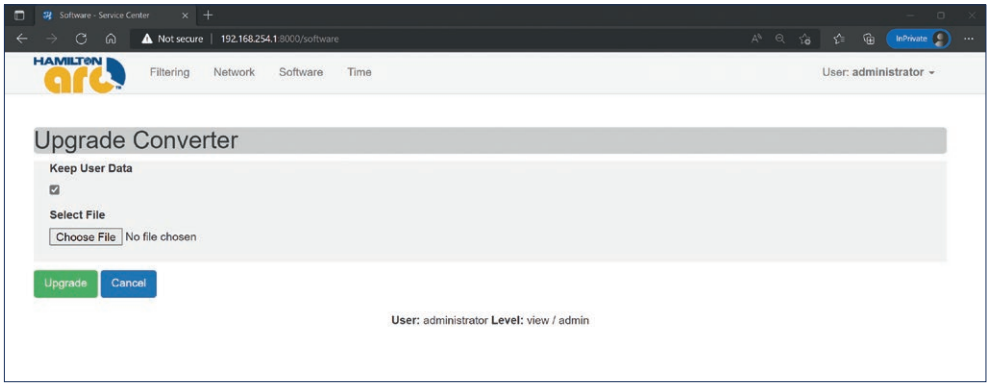


Figure 25: Firmware update web interface

10 Maintenance

⚠ WARNING! Ensure that no water or medium is spilled over the converter. In case it happens, clean the converter directly using a wipe, wetted with water, and dry afterwards. Follow the same procedure with a wipe, wetted with 70% Ethanol or Sterilization Solution.

10.1 Weekly maintenance

1) Clean the Converter: Use a wipe, wetted with 70% Ethanol or Sterilization Solution, and wipe the surfaces.
2) Use clean wipe to dry.

10.2 Yearly maintenance

1) Perform the weekly maintenance.
2) Please check our homepage for new firmware updates.
3) Run Firmware update (see Chapter 9.4).

11 Troubleshooting

Situation	Desciption	Solution
No communication to Converter	No connection to OPC Server	• Check if the Converter is powered and connected to the network using the OPC interface. Note that the LED will light up green when a communication is established between the Converter and OPC server. • Send a Ping request from a computer integrated in the network to the Arc Modbus OPC Converter. • Make sure the OPC address and format are correct. • Re-start the Converter. • Check System state in the Service Center, all states should be set to «run» if it is not the case, please contact your local representative.
No communication with sensor	Communication with OPC Converter possible, but no information from the connected sensors	Check the channel assignment (see Chapter 8.9) the sensor type, which was initially assigned, has to be connected and showing communication state «0»
OPC Converter is incorrectly configured and no change is possible	During configuration a mistake was done, leading to malfunction of the Converter	Do a Firmware update (see Chapter 9.4) in order to reset the device to factory settings

Table 13: Troubleshooting overview

12 Disposal

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

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

Notes

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