Application Note

April 5, 2023

Keywords or phrases:
BioPAT® MFCS, Software, SCADA, OPC UA,
Bioreactors powered by Biobrain®

Connecting BioPAT® MFCS to Bioreactors Powered by Biobrain® via OPC Unified Architecture (UA)

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Abstract

Since version 4.9, BioPAT® MFCS has provided a simple way to connect Biobrain® powered devices via the built-in OPC UA client, which enables different instruments or systems that provide OPC Unified Architecture (UA) servers to be connected securely.

This application note provides step-by-step guidance for establishing a secure connection between BioPAT® MFCS and bioreactors powered by Biobrain® using OPC UA to allow supervisory control and data acquisition.

Find out more: www.sartorius.com/en/products/process-analytical-technology/process-control-automation/biopat-mfcs

Introduction

BioPAT® MFCS is a Supervisory Control and Data Acquisition (SCADA) system. An OPC Unified Architecture (UA) client was introduced in BioPAT® MFCS 4.9, allowing the software to easily connect to the OPC UA server of a bioreactor.

Bioreactors powered by the Biobrain® automation platform are engineered to allow rapid adaption of a biomanufacturing facility to address ever-changing requirements. Among its several practical features, it provides an OPC UA server to enable connections to other SCADA, Distributed Control System (DCS), or historian systems.

OPC Unified Architecture (OPC UA) is an open standard communication protocol for industrial automation developed by the OPC Foundation. It is manufacturer-independent and can be used for different kinds of data exchange (machine to machine, machine to PC, PC to PC).

The following instructions are exemplary for Biostat® STR Generation 3 and they are applicable for all bioreactors powered by Biobrain®.

Prerequisites

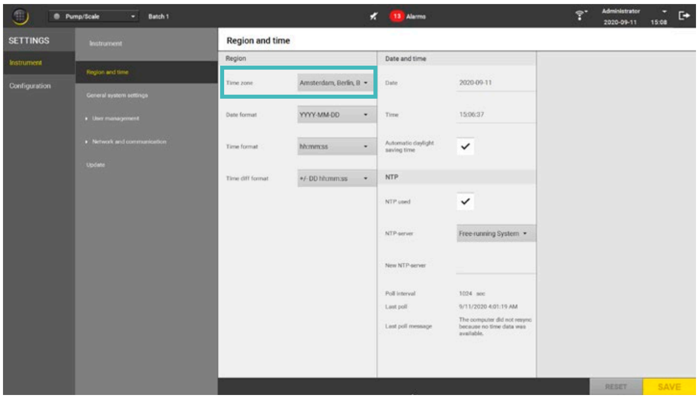
Ensure that the BioPAT® MFCS system running version 4.9 or newer with a licensed OPC UA client module and the bioreactor is connected to the same network. In the context of this application note, it is required that the bioreactor is configured for local user management and use a static IP address. It is assumed that both systems use self-signed OPC UA application certificates default configuration for both systems. Traffic via TCP port 4840, as used by the OPC UA server, must be permitted by the respective firewalls.

Bioreactor Configuration

Step 1: Verify the Time Zone is Correct
Log in to the bioreactor using an account with administrative privileges. Open the "Region and time" section located in the Instrument settings of the device administration interface.

Verify that the currently selected "Time zone" (Figure 1) matches the actual time zone of the instrument's installation location. If the time zone is not set correctly, change it to the appropriate setting and click SAVE.

After changing the instrument's time zone, create a new self-signed X.509 application certificate for the OPC UA server using the built-in function of the bioreactor. Open the "OPC settings" located under "Network and communication" in the Instrument settings. Click the "UPDATE CERTIFICATE" button to create an updated certificate (Figure 3).



Region and time

Region
Time zone: Amsterdam, Berlin, B
Date format: YYYY-MM-DD
Time format: hh:mm:ss
Time diff format: +/- DD hh:mm:ss

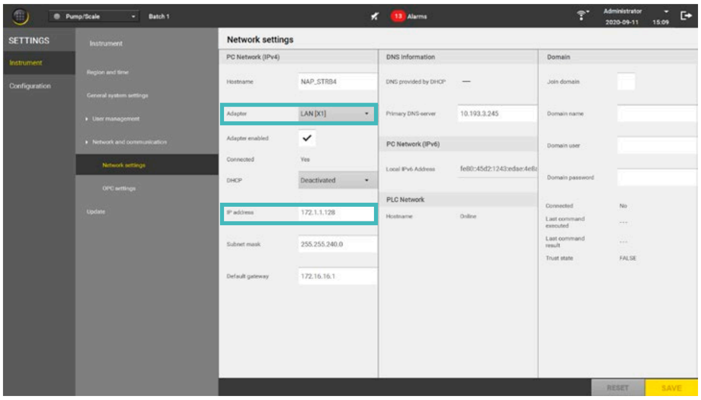
Date and time
Date: 2020-09-11
Time: 15:06:37
Automatic daylight saving time: ✓

NTP
NTP used: ✓
NTP-server: Free-running System
New NTP-server:
Poll interval: 1024 sec
Last poll: 9/11/2020 4:01:19 AM
Last poll message: The computer did not resync because no time data was available.

Figure 1: *Time Zone Configuration in the "Region and Time" Settings of the Biostat STR® Generation 3.*

Step 2: Determine the OPC UA Server Endpoint URL

To determine the bioreactors OPC UA server’s endpoint URL, open the “Network settings” in the “Network and communication” section of the Instrument settings (Figure 2).



Network settings

PC Network (IPv4)
Hostname: NAP_STRB4
Adapter: LAN [X1]
Adapter enabled: ✓
Connected: Yes
DHCP: Deactivated
IP address: 172.1.1.128
Subnet mask: 255.255.240.0
Default gateway: 172.16.16.1

DNS Information
DNS provided by DHCP: —
Primary DNS-server: 10.193.3.245

PC Network (IPv6)
Local IPv6 Address: fe80::45d2:1243:edae:4e8

PLC Network
Hostname: Online

Domain
Join domain: □
Domain name:
Domain user:
Domain password:
Connected: No
Last command executed: ---
Last command result: ---
Trust state: FALSE

Figure 2: *Determination of the Biostat STR® Generation 3 IP Address.*

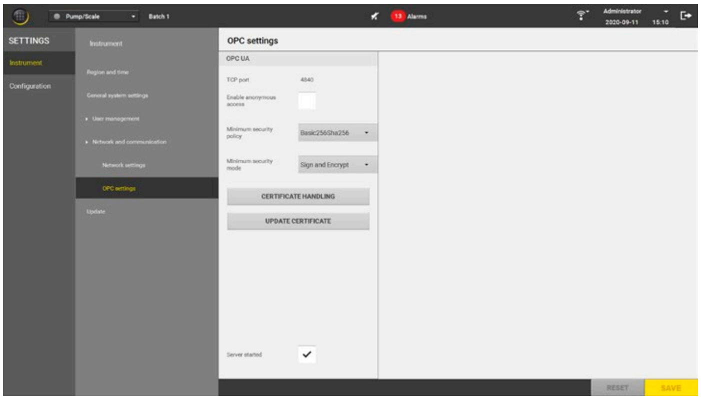
Identify and take note of the IP address of the adapter “LAN [X1]” See Table 1 for the server address.

OPC UA server address	<IP address>:4840 e.g., 172.1.1.128:4840

Table 1: *Biostat STR® Generation 3 OPC UA Server Address.*

Step 3: Configure the OPC UA Server

The configuration of the bioreactors OPC UA server can be modified in the “OPC settings” located in the “Network and communication” section of the Iinstrument settings (Figure 3).



OPC settings

OPC UA
TCP port: 4840
Enable anonymous access: □
Minimum security policy: Basic256Sha256
Minimum security mode: Sign and Encrypt
Server started: ✓

Figure 3: *Default Configuration of the Biostat STR® Generation 3 OPC UA Server.*

It is recommended to only allow secure client connections to the OPC UA server by applying the most secure profile. “Anonymous access” should be disabled to prevent unauthorized access to the OPC UA server.

The “Minimum security mode” should be set to “Sign and Encrypt,” enforcing authentication at the application level. Digital signatures ensure the integrity and authenticity of communication messages exchanged and encryption prevents eavesdropping. The security policy defines the algorithm and key length used to sign and/or encrypt messages exchanged. We suggest that you set the “Minimum security policy” to “Basic256Sha256.”

Ensure that the server is started by activating the checkbox next to “Server started.”

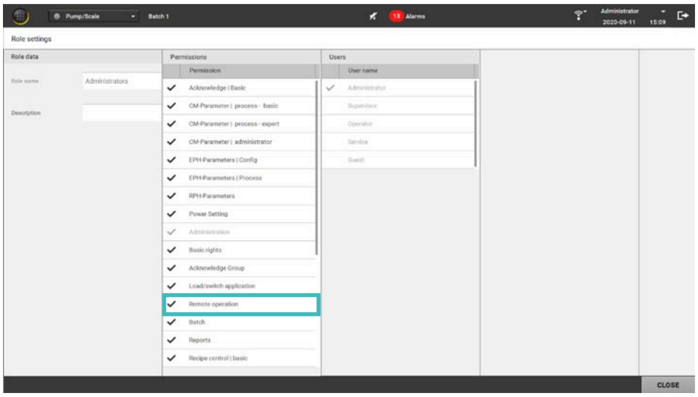
Save any changes made by clicking the SAVE button. Table 2 summarizes the default settings of the OPC UA server that coincide with the recommendations made above.

Function	Setting
Enable anonymous access	Deactivated
Minimum security policy	Basic256Sha256
Minimum security mode	Sign and Encrypt
Server started	Activated

Table 2: *Default Configuration Settings of the Biostat STR® Generation 3 OPC UA Server.*

Step 4: Grant Access Permissions for the OPC UA Server

The bioreactors OPC UA server supports user authentication with built-in user management. Any user assigned to a security role for which "Remote operation" permission is granted can establish a client session to the OPC UA server. Permissions for security roles can be granted or revoked under "Roles" located in the "User management" section of the Instrument settings (Figure 4).



Role settings

Role data

Role name: Administrators

Description:

Permissions

	Permission
✓	Acknowledge | Basic
✓	CM-Parameter | process - basic
✓	CM-Parameter | process - expert
✓	CM-Parameter | administrator
✓	EPH-Parameters | Config
✓	EPH-Parameters | Process
✓	RPH-Parameters
✓	Power Setting
✓	Administration
✓	Basic rights
✓	Acknowledge Group
✓	Load/switch application
✓	Remote operation
✓	Batch
✓	Reports
✓	Recipe control | basic

Users

	User name
✓	Administrator
	Supervisor
	Operator
	Service
	Guest

Figure 4: *"Remote Operation" Permission Granted for the "Administrators" Security Role.*

By default, this permission is granted to the security roles and users listed in Table 3.

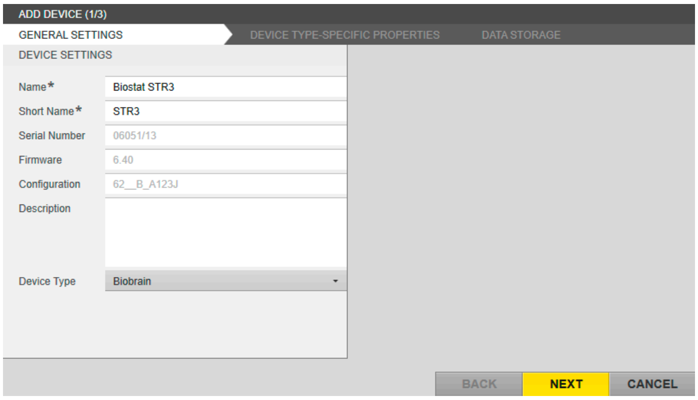
Security Role	User
Administrators	Administrator
Supervisors	Supervisor

Table 3: *Security Roles and Users With the "Remote operation" Permission Set as Default.*

BioPAT® MFCS Configuration

Step 1: Configure a Device to Connect to Bioreactors Powered by Biobrain®

Open BioPAT® MFCS and create a new device by activating the "Add device" functionality located under "Devices" in the administration interface. In the GENERAL SETTINGS tab of the opened ADD DEVICE dialog, enter a "Name" (e.g., "Biostat STR3") and a "Short Name" (e.g., "STR3") for the new device. For the "Device Type," select "Biobrain" (Figure 5). Continue by clicking NEXT.



DEVICE SETTINGS

Name*: Biostat STR3

Short Name*: STR3

Serial Number: 06051/13

Firmware: 6.40

Configuration: 62__B_A123J

Description:

Device Type: Biobrain

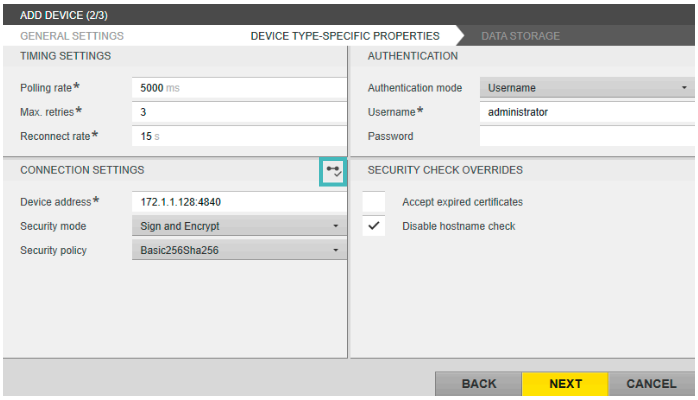
Figure 5: *General Configuration Settings of an Opc UA Device in BioPAT® MFCS.*

In the DEVICE TYPE-SPECIFIC PROPERTIES tab (Figure 6), configure the appropriate TIMING SETTINGS (e.g., "Polling rate: "5000 ms,; "Max. retries:" 3,; "Reconnect rate" 15 s).

Under CONNECTION SETTINGS enter the IP address and port of the bioreactor OPC UA server determined earlier (e.g., 172.1.1.128:4840). Select "Sign and Encrypt" as the "Security mode" and "Basic256Sha256" as the "Security policy."

Select "Username" as the "Authentication mode" and enter the username and password for the bioreactor user who has "Remote operation" permissions such as an administrator by default, the administrator account has no password).

Under SECURITY CHECK OVERRIDES leave "Accept expired certificates" deactivated and ensure that the "Disable hostname check" checkbox is activated.



TIMING SETTINGS

Polling rate* 5000 ms
Max. retries* 3
Reconnect rate* 15 s

CONNECTION SETTINGS

Device address* 172.1.1.128:4840
Security mode Sign and Encrypt
Security policy Basic256Sha256

AUTHENTICATION

Authentication mode Username
Username* administrator
Password

SECURITY CHECK OVERRIDES

☐ Accept expired certificates
☑ Disable hostname check

Figure 6: *DEVICE TYPE-SPECIFIC PROPERTIES During the Configuration of an OPC UA Device in BioPAT® MFCS With "Test Connection" Highlighted.*

Table 4 lists all necessary settings to connect BioPAT® MFCS to the default configuration of a Biostat STR® Generation 3 OPC UA server.

Remain on this configuration tab to initiate the exchange of OPC UA certificates as described in the following sections of this technical note.

Parameter	Setting
CONNECTION SETTINGS	
Device address (OPC UA server)	<IP address of Biostat STR® Generation 3 OPC UA server>:4840
Security mode	Sign and Encrypt
Security policy	Basic256Sha256
AUTHENTICATION	
Authentication mode	Username
Username	administrator
Password	<no password>
SECURITY CHECK OVERRIDES	
Accept expired certificates	Deactivated
Disable hostname check	Activated

Table 4: *Connection and Authentication Settings for a BioPAT® MFCS Device to Connect to a Biostat STR® Generation 3 Using the Default Configuration.*

Step 2: Exchange Certificates and Establish the OPC UA Connection

When a connection between BioPAT® MFCS and the bioreactor is first established, an application certificate will be sent from the bioreactors OPC UA server to the BioPAT® MFCS OPC UA client, and vice versa. Both certificates need to be trusted on either side to allow a secure connection.

Step 2.1: Trust the Server Certificate

To initiate the certificate exchange, activate the "Test connection" button in the CONNECTION SETTINGS configuration dialog (Figure 6) of BioPAT® MFCS. The bioreactor OPC UA server will send its application certificate to BioPAT® MFCS. The connection test will fail as BioPAT® MFCS does not yet trust the application certificate of the OPC UA server. Acknowledge the connection test result.

Open the Windows Explorer of the BioPAT® MFCS system and navigate to the folder location shown in Table 5. Cut and paste the certificate file of the bioreactor OPC UA server from the "rejected" folder into the "trusted" folder (Table 5).

Rejected certificates
%ProgramData%\Sartorius\BioPAT_MFCS\Services\OpcUa\Client\pki\rejected\certs
Trusted certificates
%ProgramData%\Sartorius\BioPAT_MFCS\Services\OpcUa\Client\pki\trusted\certs
Certificate file of the Biostat STR® Generation 3 OPC UA server
Sartorius BIOBRAIN OPC Server [<Thumbprint>].der

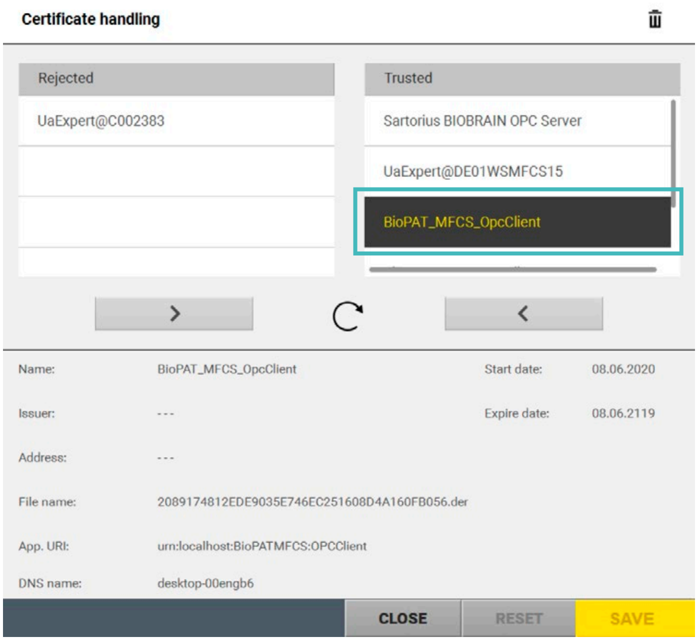
Table 5: *Folder Locations for Rejected and Trusted BioPAT® MFCS Certificates and File Name Structure of Biostat STR® Generation 3 OPC UA Server Application Certificates.*

Step 2.2: Trust the BioPAT® MFCS Client Certificate

Return to BioPAT® MFCS and execute "Test connection" again (Figure 6). The connection test will fail again as the bioreactor OPC UA server does not yet trust the application certificate of the MFCS client. Acknowledge the connection test result.

In the bioreactor Human Machine Interface (HMI), go to the "OPC settings" located in the "Network and communication" section of the Instrument settings (Figure 3). Open "Certificate handling" (Figure 7).

Trust the BioPAT® MFCS client certificate "BioPAT_MFCS_OpcClient" by moving it from the "Rejected" column to the "Trusted" column and click SAVE.



Certificate handling

Rejected	Trusted
UaExpert@C002383	Sartorius BIOBRAIN OPC Server
	UaExpert@DE01WSMFCS15
	BioPAT_MFCS_OpcClient

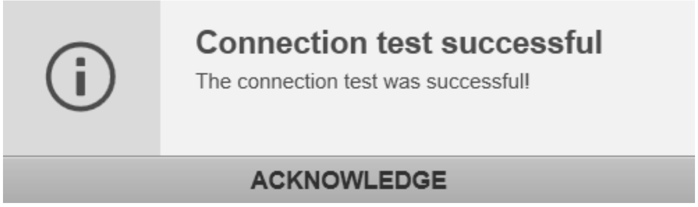
Name: BioPAT_MFCS_OpcClient
Start date: 08.06.2020
Issuer: ---
Expire date: 08.06.2119
Address: ---
File name: 2089174812EDE9035E746EC251608D4A160FB056.der
App. URI: urn:localhost:BioPATMFCS:OPCClient
DNS name: desktop-00engb6

Figure 7: *Certificate Handling for the Biostat STR® Generation 3 OPC UA Server.*

Step 2.3: Verify the Correct Connection Settings

Return to BioPAT® MFCS and execute "Test connection" once more (Figure 6).

The connection test will now pass as all necessary application certificates are trusted on both the client and server sides (Figure 8). Acknowledge the connection test result and continue configuring the device. Finally, add the newly created device by clicking SAVE.



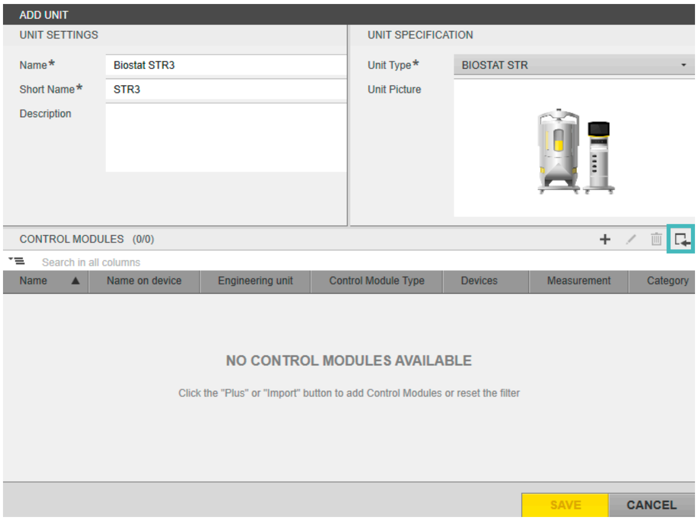
Connection test successful

The connection test was successful!

Figure 8: *Successful Connection Test in BioPAT® MFCS After Trusting All Necessary Application Certificates.*

Step 3: Configure a Bioreactor Unit in BioPAT® MFCS

Create a new unit by activating the "Add unit" functionality located under "Units" in the administration section. In the ADD UNIT dialog, enter a "Name" (e.g., "Biostat STR3") and a "Short Name" (e.g., "STR3") for the new unit. Click on the "Import Control Modules" button (Figure 9).



ADD UNIT

UNIT SETTINGS

Name* Biostat STR3
Short Name* STR3
Description

UNIT SPECIFICATION

Unit Type* BIOSTAT STR
Unit Picture

CONTROL MODULES (0/0)

Search in all columns

Name ▲	Name on device	Engineering unit	Control Module Type	Devices	Measurement	Category

NO CONTROL MODULES AVAILABLE

Click the "Plus" or "Import" button to add Control Modules or reset the filter

Figure 9: *ADD UNIT Dialog in BioPAT® MFCS With "Import Control Modules" Functionality Highlighted.*

In the following "Import Control Modules" dialog, select the newly created device for the bioreactor (e.g., "Biostat STR3") and click NEXT.

Load the XML configuration file provided with the bioreactor instrument and click NEXT to continue.

Select the appropriate instrument configuration specified in the configuration file (e.g., "STR3_010008_B1_BI010000") and click NEXT to continue.

In the control module selection, select all control modules and finish the import by clicking OK. Save the new unit by clicking SAVE in the "Add unit" dialog.

Results

By completion of this step-by-step guide, a secure connection between BioPAT® MFCS and the bioreactor system was successfully configured and established. BioPAT® MFCS is ready to be used for supervisory control and data acquisition of the connected bioreactor.

Conclusion

This application note outlines how to successfully connect bioreactors powered by Biobrain® with BioPAT® MFCS software via OPC UA so it can be conveniently used for upervisory control and data acquisition.

The OPC client functionality of BioPAT® MFCS, leveraging the UA protocol and advanced setting options, offers a flexible and secure way of integrating bioreactors powered by Biobrain® into BioPAT® MFCS systems using a standardized communication protocol.

Consequently, users can extend the capabilities of a bioreactor instrument with the complete set of functionalities offered by BioPAT® MFCS.

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Status: 05 | 2023