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Connecting BioPAT® MFCS to Kaiser Raman via OPC UA

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Abstract

This application note describes the connection between BioPAT® MFCS and a Kaiser Raman RXN analyzer. It outlines in detail the steps required to configure a BioPAT® MFCS (4.8 and above) system to connect to a Kaiser Raman RXN4 analyzer via OPC UA and acquire process data from the device.

Introduction

This application note is intended to be used by customers who want to connect a Kaiser Raman RXN4 analyzer for data acquisition of univariate data that can be used by BioPAT® MFCS for automated process control, process monitoring and defining alarm limits. The connection of the Kaiser Raman analyzer is performed via OPC UA, a platform independent standard, that enables secure exchange of information between industrial systems.

How to apply a SIMCA® model to the Kaiser Raman RXN4 analyzer, how to manage the device is, or the model related to the OPC UA namespace structure is not within the scope of this application note.

Materials

Sartorius Software
BioPAT® MFCS Core Software

Third Party Instruments
Kaiser Raman Rxn Series Analyzer

Methods

BioPAT® MFCS Requirements | Prerequisites

To connect a Kaiser Raman RXN 4 analyzer to the BioPAT® MFCS system, several prerequisites have to be met. These prerequisites consist of software, hardware, and license components.

Software Prerequisites
To communicate with a Kaiser Raman RXN4 device, it is recommended to use BioPAT® MFCS v4.8 or above. Due to continuous improvements, it is always recommended to use the latest version of BioPAT® MFCS.

Hardware Prerequisites
Connectivity between BioPAT® MFCS and the Kaiser Raman RXN4 system utilizes an ethernet based connection. The MFCS host system as well as the Kaiser Raman RXN4 analyzer should be connected to the same network.

BioPAT® MFCS License Prerequisites
BioPAT® MFCS consist of a core application and functional modules. To connect the BioPAT® MFCS system to a Kaiser Raman RXN4 analyzer, the BioPAT® MFCS OPC Client Module must be licensed. This will allow the collection, visualization and reporting of the collected parameters.

BioPAT® MFCS has many more options to maximize the use of the connected Raman analyzer which may require the following modules:

- The Recipe Control Module is required to utilize the measured parameters supplied by the Kaiser Raman analyzer in controlling a running batch.
- A Calculation Module license is needed to use the collected data for calculations e.g., if the Raman system is measuring glucose values which are in turn used to calculate the volume of a feed bolus.
- The 21 CFR part 11 module is mandatory, if the BioPAT® MFCS system is being used in a GMP environment, supporting an audit trail of all automated and manual actions.

BioPAT® MFCS Configuration Connectivity

BioPAT® MFCS can connect to multiple PAT analyzers supporting different connection protocols. For the purpose of this application note the Kaiser Raman RXN4 will be treated as an OPC UA device in BioPAT® MFCS.

The general approach of configuring a device in BioPAT® MFCS to any OPC UA device is described in the OPC Client Manual.

Specific connectivity parameters for connecting the Kaiser Raman RXN4 to the BioPAT® MFCS system are described below.

Kaiser Raman RXN4 specific parameters

Parameter	Device Type
Value	OPC UA
The device type defines the communication protocol to be used for the communication.	

Parameter	OPC UA server address
Value	A network address of the Kaiser Raman RXN4 device
Format (IP)	opc.tcp://IP-Address:4840
Format (Host)	opc.tcp://Hostname:4840
The OPC UA server address can be either an IP address or a valid hostname. The correct parameters can be found under **Options → System → Network** in the Kaiser Raman RXN4 software application.	
The Kaiser Raman RXN4 system contains 2 configurable IP addresses. Depending on the configuration of the network adapters, the IP address is either static or assigned by a DHCP server. In both cases, the IP address is shown on the screen. To be able to connect the BioPAT® MFCS system to the Kaiser Raman RXN4 device, the BioPAT® MFCS system as well as the Kaiser Raman RXN4 system have to be part of the same subnet. Furthermore, in windows-based networks the computer name can be used as hostname. The computer name can be shown and edited in the Network options screen of the Kaiser Raman RXN4 software application.	

Parameter	Authentication Mode
Value	Username
The Kaiser Raman RXN4 device does not support anonymous access.	

Parameter	Username
Value	The Kaiser Raman RXN4 OPC UA username
Format (IP)	opc.tcp://IP-Address:4840
Format (Host)	opc.tcp://Hostname:4840
The username for OPC UA communication is shown under **Options → System → Automation** in the Kaiser Raman RXN4 HMI. By default, it is set to **kaiser-opc**	

Parameter	Password
Value	The Kaiser Raman RXN4 OPC UA password
The password for OPC UA communication can be set under **Options → System → Automation** in the Kaiser Raman RXN4 HMI. By default, it is set to **opc**	

BioPAT® MFCS Configuration Unit

Depending on the process needs, the user can associate the Process Variables and Controllers for a connected PAT device. For the Kaiser Raman RXN4 analyzer the user must select the OPC UA NodeIDs that are required to be used. For further information on how to configure see BioPAT® MFCS OPC Client Module manual.

OPC UA Namespace

The OPC UA server on a Kaiser Raman RXN4 contains a set of static NodeIDs and a set of NodeIDs, which are dynamically created based on the applied SIMCA® model. This chapter only lists the static NodeIDs. The NodeIDs supported are dependent on the version of analyzer.

The following table lists the key NodeIDs supported by BioPAT® MFCS.

System Information & Status

Tag Name	Data Type	Description
SystemVersion	String	Version identifier for instrument software.
SystemName	String	User-assigned instrument identifier.
SystemTime	DateTime	Current time on the instrument (instrument time zone).
SystemStartTimeUTC	DateTime	Time of most recent start-up (UTC time zone).
SystemExportID	String	Timestamp identifying current system export [yyyyMMdd-HHmm]
Info.InstrumentType	String	Brief description of instrument type.
Info.ChannelCount	Int32	Number of instrument channels.
Info.RangeMin	Double	Default Raman shift of first point in sample spectra.
Info.RangeMax	Double	Default Raman shift of last point in sample spectra.
Info.RangeIncrement	Double	Default step in Raman shift between consecutive points in sample spectra.
Info.LaserWavelength	Double	Nominal excitation wavelength. [nm]
Info.LaserPowerMin	Int32	Minimum laser output power. [mW]
Info.LaserPowerMax	Int32	Maximum laser output power. [mW]
Info.VerificationStandards	String	Newline-delimited list of supported verification standard names.
AcquisitionInProgress	Boolean	True if any acquisition is currently in progress.
AcquisitionTimeRemaining	Double	Amount of time remaining in the active acquisition, expressed in seconds.
AcquisitionDescription	String	Brief description of acquisition.
AcquisitionChannels.<X>	Boolean	True if channel X is addressed by the acquisition currently in progress.
Model.Count	Int32	Number of models loaded on the instrument.
Model.<number>.Name	String	Name of model.
Model.<number>.EnabledChannels.<X>	Boolean	True if model is currently enabled on channel <X>.

Diagnostic Information

Tag Name	Data Type	Description
Diagnostics.SystemStatus	Int32	Global diagnostic code for instrument status. { 0=Normal, 1=Warning, 2=Error }
Diagnostics.SystemStatusCommon	Int32	Diagnostic code for instrument status, excluding channel-specific state. { 0=Normal, 1=Warning, 2=Error }
Diagnostics.SystemErrors	String	Newline-delimited list of error descriptions, excluding channel-specific diagnostics.
Diagnostics.SystemWarnings	String	Newline-delimited list of warning descriptions, excluding channel-specific diagnostics.
Diagnostics.Laser.ServiceAlert	Boolean	True if laser is at or near maximum current. Power output may gradually decline.
Diagnostics.Calibration.Alignment.Failed	Boolean	True if most recent calibration attempt failed.
Diagnostics.Calibration.Alignment.FailTime	DateTime	Time of most recent failed calibration attempt (when Failed = True).
Diagnostics.Calibration.Wavelength.Failed	Boolean	True if most recent calibration attempt failed.
Diagnostics.Calibration.Wavelength.FailTime	DateTime	Time of most recent failed calibration attempt (when Failed = True).
Diagnostics.Calibration.Laser.Failed	Boolean	True if most recent calibration attempt failed.
Diagnostics.Calibration.Laser.FailTime	DateTime	Time of most recent failed calibration attempt (when Failed = True).
Diagnostics.Channel<X>.Status	Int32	Diagnostic code for channel status. { 0=Normal, 1=Warning, 2=Error }
Diagnostics.Channel<X>.Errors	String	Newline-delimited list of error descriptions.
Diagnostics.Channel<X>.Warnings	String	Newline-delimited list of warning descriptions.
Diagnostics.Channel<X>.CanAcquire	Boolean	True if channel state is compatible with sample acquisition.
Diagnostics.Channel<X>.Calibration.Probe.Failed	Boolean	True if most recent calibration attempt failed.
Diagnostics.Channel<X>.Calibration.Probe.FailTime	DateTime	Time of most recent failed calibration attempt (when Failed = True).
Diagnostics.Channel<X>.Calibration.Verification.Failed	Boolean	True if most recent verification failed.
Diagnostics.Channel<X>.Calibration.Verification.FailTime	DateTime	Time of most recent failed verification attempt (when Failed = True).

Calibration Information

Tag Name	Data Type	Description
Calibration.Report.PDF	Byte[]	Detailed calibration report formatted as PDF.
Calibration.Report.Time	DateTime	Modification time of calibration report.
Calibration.Alignment.Time	DateTime	Time at which current calibration was performed.
Calibration.Wavelength.Time	DateTime	Time at which current calibration was performed.
Calibration.Laser.Time	DateTime	Time at which current calibration was performed.
Calibration.Channel<X>.Probe.Time	DateTime	Time at which current calibration was performed.
Calibration.Channel<X>.Verification.Time	DateTime	Time at which verification was most recently passed.
Calibration.Channel<X>.Verification.Signal	Double	Signal-per-second metric calculated during most recent passing verification.

Channel Data

Tag Name	Data Type	Description
Channel<X>.SubjectName	String	User-assigned identifier for channel (e.g. descriptive name of bioreactor).
Channel<X>.Spectrum.Time	DateTime	Time at which acquisition of the most recent spectrum completed.
Channel<X>.Spectrum.StartTime	DateTime	Time at which acquisition of the most recent spectrum began.
Channel<X>.Spectrum.AcquisitionLength	Double	Total amount of sample acquisition time in the most recent spectrum, expressed in seconds.
Channel<X>.Spectrum.StartX	Double	Raman shift of the first point in the most recent spectrum.
Channel<X>.Spectrum.IncrementX	Double	Difference in Raman shift between consecutive points in the most recent spectrum.
Channel<X>.Spectrum.Intensity	Double[]	Array of intensity values for each point in the most recent spectrum.
Channel<X>.Spectrum.SaturationLevel	Double	Saturation level of the detector during acquisition of the most recent spectrum.
Channel<X>.Spectrum.Name	String	Custom name associated with spectrum.
Channel<X>.Data.<component>.Model	String	Name of model from which component originates.
Channel<X>.Data.<component>.ProcessValue	Double	Principal analysis value for component.
Channel<X>.Data.<component>.<property>	Double	Model output.
Channel<X>.Batch.Name	String	User-assigned name of batch.
Channel<X>.Batch.State	Int32	State code for the channel's current batch. { 0=Unknown, 1=Not Started, 2=Active, 3=Paused, 4=Completed }
Channel<X>.Batch.StartTime	DateTime	Time at which the channel's current batch was initiated.
Channel<X>.Batch.AcquisitionCount	Int32	Number of spectra acquired to date in the channel's current batch.
Channel<X>.Batch.CollectionMode	Int32	Current collection mode. { 1=Continuous, 2=Periodic, 3=Manual }

External Data

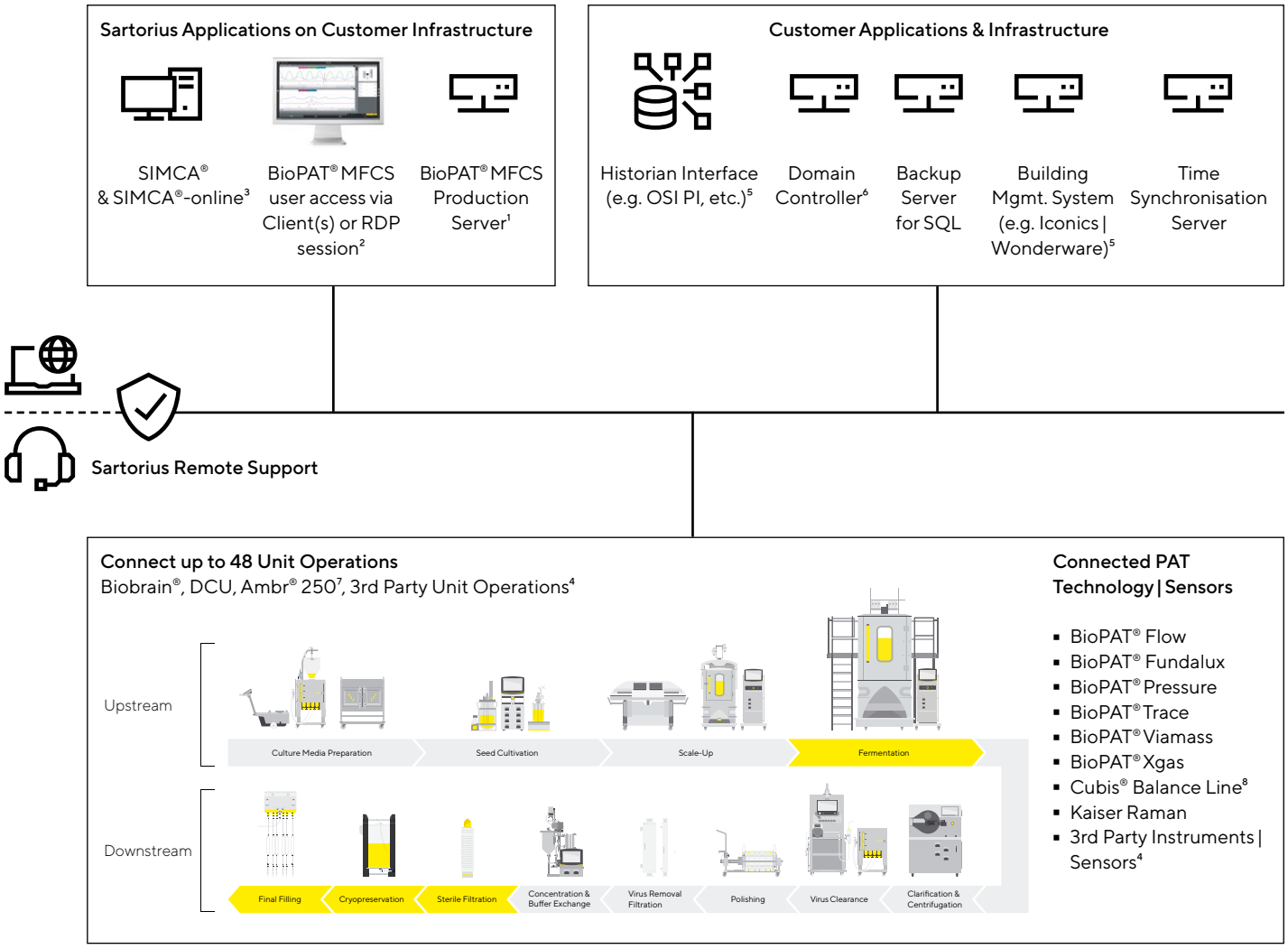
Tag Name	Data Type	Description
External.Channel<X>.Sample.Temperature	Double	Client-injected sample temperature. [C]
External.Channel<X>.Sample.Pressure	Double	Client-injected sample pressure. [kPa]
External.Channel<X>.Sample.Unmeasured	Double	Client-injected concentration of unmeasured components. [%]

Control Commands & Parameters

Tag Name	Data Type	Description
Control.Abort.Trigger	Boolean	Write true to abort current acquisition.
Control.CalibrateInternal.Trigger	Boolean	Write true to initiate automatic calibration of the instrument.
Control.CalibrateInteral.LaserPower	Int32	Power at which to operate laser following calibration. Value of 0 (or outside supported range) maintains current power setpoint. [mW]
Control.CalibrateInteral.Mode	Int32	{ 0=Automatic, 1=Recalibrate X Axis, 2=Recalibrate All }
Control.CalibratePeriodic.Trigger	Boolean	Configures periodic internal calibration using the 'Automatic' mode.
Control.CalibratePeriodic.Enable	Boolean	Enables or disables periodic calibration.
Control.CalibratePeriodic.Period	Int32	Period in hours.
Control.CalibrateWavelength.Trigger	Boolean	Write true to initiate wavelength calibration of the instrument.

Tag Name	Data Type	Description
Control.CalibrateLaser.Trigger	Boolean	Write true to initiate laser calibration of the instrument.
Control.CalibrateLaser.Power	Int32	Power at which to operate laser following calibration. Value of 0 (or outside supported range) maintains current power setpoint. [mW]
Control.CalibrateProbe.Trigger	Boolean	Write true to initiate intensity calibration of the probe/channel.
Control.CalibrateProbe.Channel	Int32	Channel on which to calibrate.
Control.CalibrateProbe.ReferenceTemperature	Double	Temperature of the intensity reference. [C]
Control.VerifyChannel.Trigger	Boolean	Write true to initiate verification of channel calibration.
Control.VerifyChannel.Channel	Int32	Channel on which to verify.
Control.VerifyChannel.StandardName	String	Name of verification standard that is presented to probe. When null or empty, default standard will be used.
Control.Acquire.Trigger	Boolean	Write true to initiate acquisition.
Control.Acquire.Channel	Int32	Channel on which to acquire.
Control.Acquire.ExposureLength	Double	Length of each exposure in acquisition, expressed in seconds.
Control.Acquire.ExposureCount	Int32	Number of exposures to capture in acquisition.
Control.Acquire.DarkExposureCount	Int32	Number of dark exposures to capture in acquisition.
Control.Acquire.ForceNewDark	Boolean	Setting to True results in new dark being taken at beginning of acquisition.
Control.Acquire.Name	String	Custom name to be associated with acquired spectrum.
Control.Acquire.ExcludeFromBatch	Boolean	Setting to True excludes the resulting acquisition from any ongoing batch, and suppresses on-board storage.
Control.Channel<X>.Batch.Start.Trigger	Boolean	Write true to initiate an acquisition batch for the channel using batch parameters currently configured on the instrument.
Control.Channel<X>.Batch.Start.Name	String	Name of batch.
Control.Channel<X>.Batch.Pause.Trigger	Boolean	Write true to pause channel's current batch (if one is currently active).
Control.Channel<X>.Batch.Resume.Trigger	Boolean	Write true to resume channel's current batch (if one is currently paused).
Control.Channel<X>.Batch.Stop.Trigger	Boolean	Write true to terminate channel's current batch (if one is currently active).
Control.Channel<X>.Batch.Configure.Trigger	Boolean	Write true to apply configuration parameters to channel's batch settings.
Control.Channel<X>.Batch.Configure.Period	Double	Sets the period between automatic acquisitions, expressed in seconds.
Control.Channel<X>.Batch.Configure.ExposureLength	Double	Sets the length of each exposure in batch acquisitions, expressed in seconds.
Control.Channel<X>.Batch.Configure.ExposureCount	Int32	Sets the number of exposures in batch acquisitions.
Control.Channel<X>.Batch.Configure.DarkExposureCount	Int32	Sets the number of dark exposures in batch acquisitions.
Control.Channel<X>.Batch.Configure.ForceNewDark	Boolean	Setting to True results in new dark being taken at beginning of batch acquisitions.
Control.Channel<X>.Batch.Configure.BufferLength	Int32	Sets the number of consecutive acquisitions to sum. Minimum value is 1. Only effective in Continuous collection mode.
Control.Channel<X>.Batch.Configure.CollectionMode	Int32	Sets the batch collection mode. { 0=Unspecified, 1=Continuous, 2=Periodic, 3=Manual }
Control.Model.Enable.Trigger	Boolean	Write true to change enabled state of model.
Control.Model.Enable.Name	String	Name of model to enable/disable.
Control.Model.Enable.Channel	Int32	Channel on which to enable/disable model.
Control.Model.Enable.Enable	Boolean	True = enable, False = disable
Control.System.Export.Trigger	Boolean	Initiates a system export at the 'Basic' level.
Control.System.ShutDown.Trigger	Boolean	Initiates system shutdown.
Control.System.Restart.Trigger	Boolean	Initiates system restart.

Simplifying Your Process – The Sartorius EcoSystem



[1] BioPAT® MFCS server application deployed on a customer hosted virtual server
[2] BioPAT® MFCS client deployed on customer PC´s or accessing server by Remote Desktop
[3] SIMCA® | SIMCA®-online connected using SimApi (part of MFCS core)
[4] BioPAT® MFCS needs OPC® UA client module
[5] BioPAT® MFCS needs OPC® UA server module
[6] BioPAT® MFCS needs user managent module
[7] Ambr® 250 needs Kepware OPC® UA server
[8] Cubis® balance line via OPC® DA server (part number VF4844)

Conclusion

This application note outlines how to connect Kaiser Raman Rxn analyzers with BioPAT® MFCS via OPC UA.

The OPC UA client functionality of BioPAT® MFCS offers a flexible and standardized way of integrating any PAT analyzers without using proprietary communication protocols.

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