

## Commissioning Guide: Data Communication – OPC-UA

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Table of Contents

- 1. Scope ..... 3
  - 1.1. Overview..... 3
- 2. Connecting your OPC client to KeitSpec..... 4
  - 2.1. Configure and Enable the OPC-UA Server ..... 4
  - 2.2. Setting a static IP address ..... 5
  - 2.3. Setting a security policy ..... 7
  - 2.4. Connect and check ..... 10
  - 2.5. Configure and test the historian ..... 10
  - 2.6. List of useful OPC tags to read ..... 10
  - 2.7. Handling Negative Concentration Values ..... 11
  - 2.8. Controlling the Spectrometer ..... 12
  - 2.9. Control systems ..... 12
- 3. Troubleshooting ..... 13
  - 3.1. General..... 13
  - 3.2. Connection Timeouts ..... 14
  - 3.3. Security token failing to validate..... 14
  - 3.4. Communicating with an OPC Classic Client..... 14

## 1. Scope

This guide explains how to set up data communications between the IRmadillo controller and your plant's Distributed Control System (DCS) using OPC-UA over ethernet. This guide requires that Keit has already set up your controller with its chemometric models and OPC server licence.

Before starting, ensure that:

- Your IRmadillo and controller are both installed and running
- Keit has provided you with your OPC-UA Address Space Mapping Document

If you have any questions, contact Keit using: [support@keit.co.uk](mailto:support@keit.co.uk). More detailed information is in the following IRmadillo user manuals, found at <https://keit.co.uk/user-manual/>:

KeitSpec 5.2.1	<b>DOC0893</b>
IRmadillo ASM0627-10-Z (internal controller)	<b>DOC0935</b>
IRmadillo ASM0627-09-Z (external controller)	<b>DOC0945</b>

### 1.1. Overview

An overview of the analyser and communications layout is shown below.

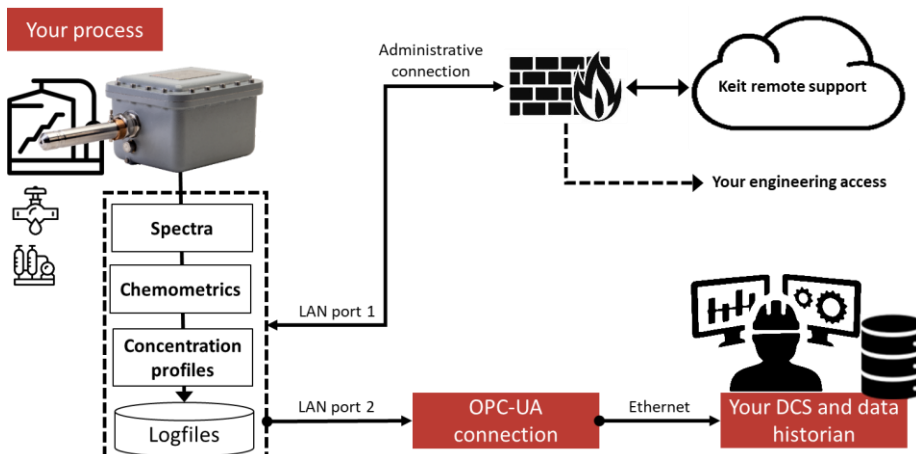


Figure 1 System schematic for ASM0627-10 (Internal controller)

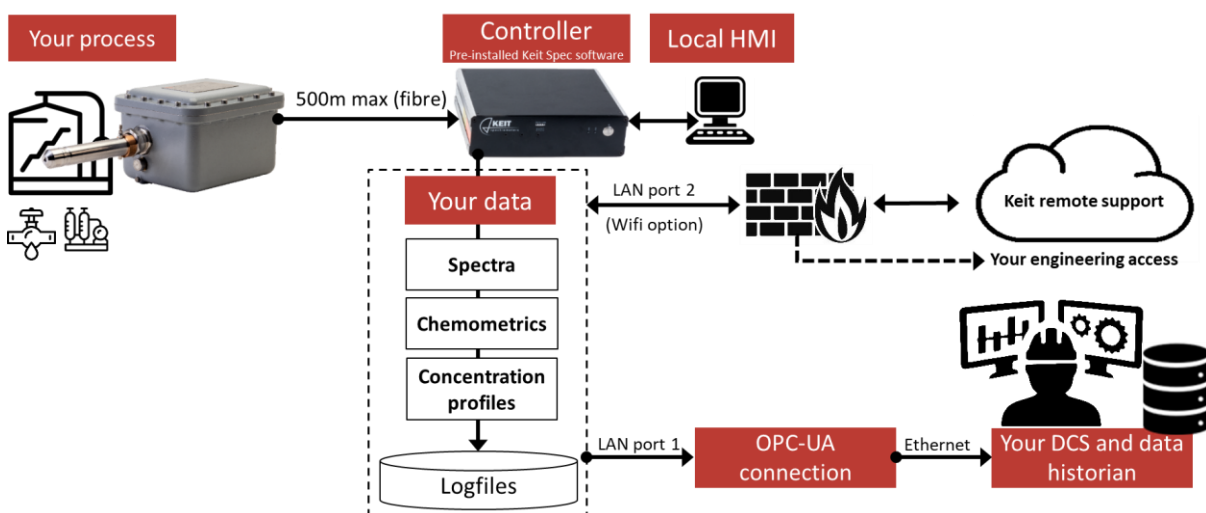


Figure 2 system schematic for ASM0627-09 (external controller)

## 2. Connecting your OPC client to KeitSpec

This section will show you how to set up the OPC-UA server for data communications.

### 2.1. Configure and Enable the OPC-UA Server

2.1.1. In KeitSpec with a continuous project open, click on the Configure Acquisition tab and then toggle 'OPC-UA Server' to On.

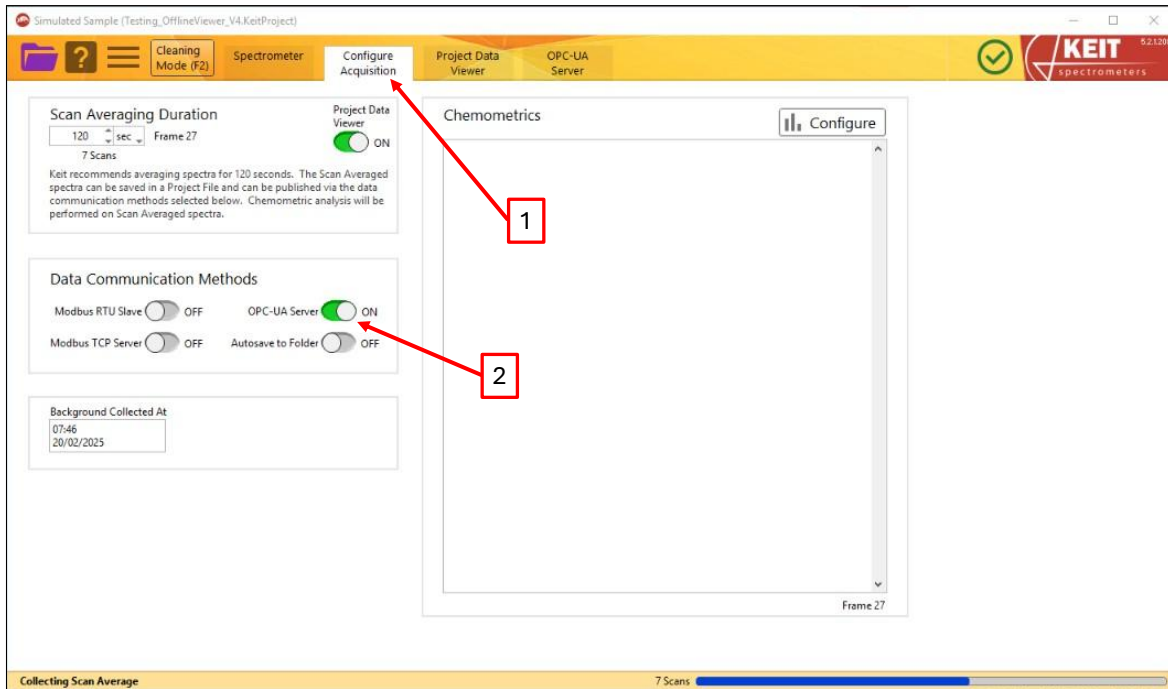


Figure 3 Enabling the OPC-UA server in KeitSpec

2.1.2. Click on the OPC-UA Server tab that appears.

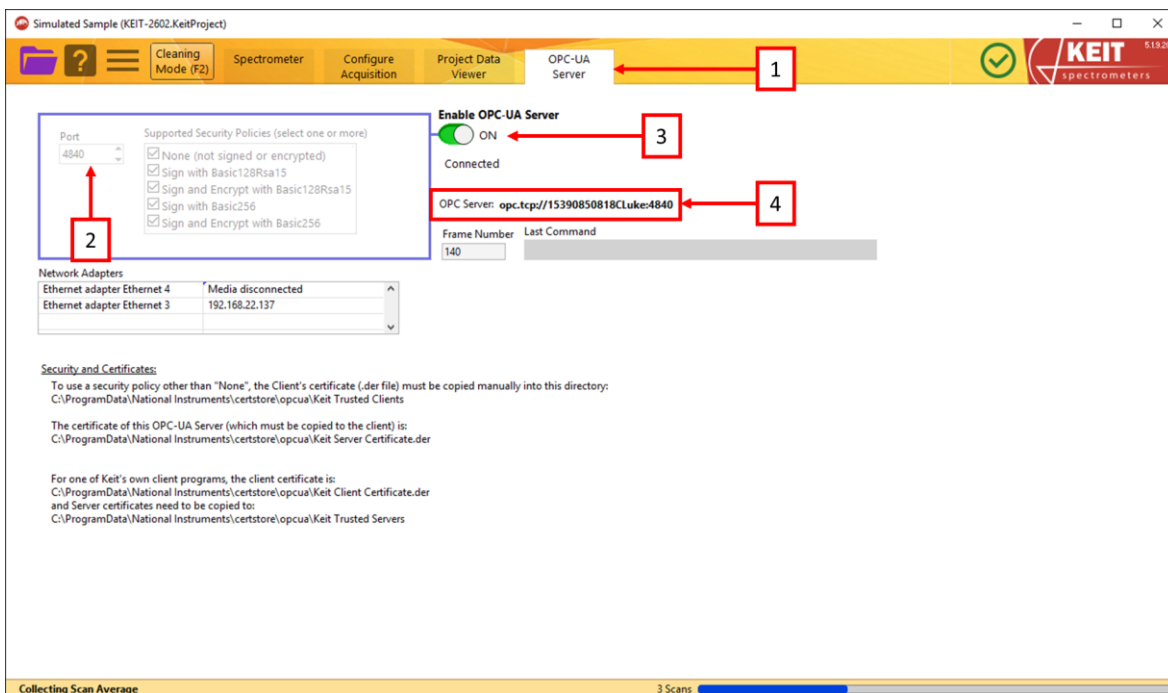


Figure 4 The OPC-UA Server tab

- 2.1.3. You may change the port number if you need to.
- 2.1.4. If you wish to set a security policy, follow the instructions in Section 2.2. Keit recommends first ensuring that the server can communicate with no security policy enabled.
- 2.1.5. Toggle 'Enable Server' to 'On'. The OPC Server name will then be displayed.

## 2.2. Setting a static IP address

You may need to assign a specific IP address to your controller. You can do this as follows:

- 2.2.1. Type 'Control Panel' into the Windows search bar and press Enter to open the control panel. In the control panel window, click 'Network and Internet' and then 'Network and Sharing Center'.
- 2.2.2. Click 'Change adapter settings'.

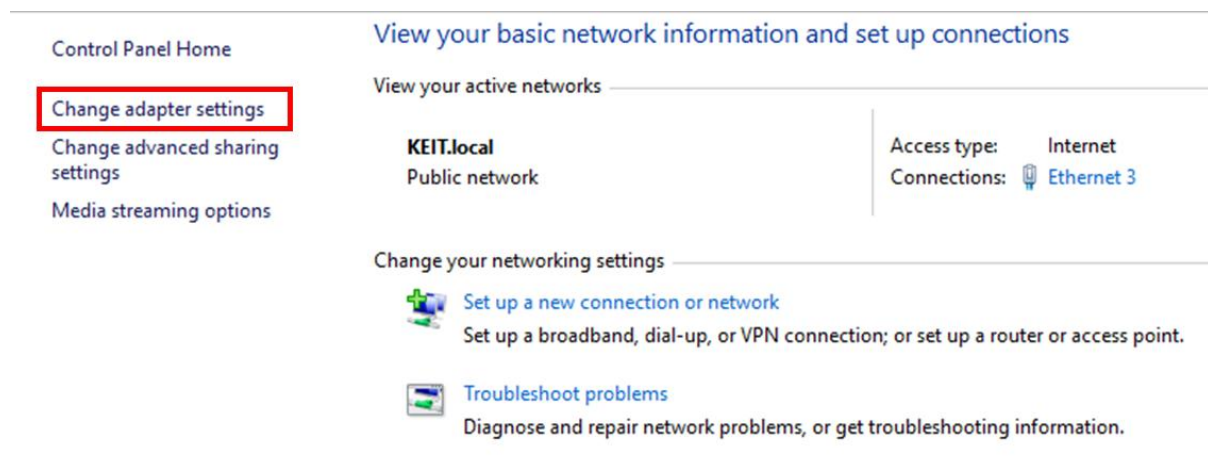


Figure 5 Network and sharing centre

- 2.2.3. Right-click on Local Area Connection and click Properties. You will need to enter the administrator password, which can be found on the sticker on the front of your controller.

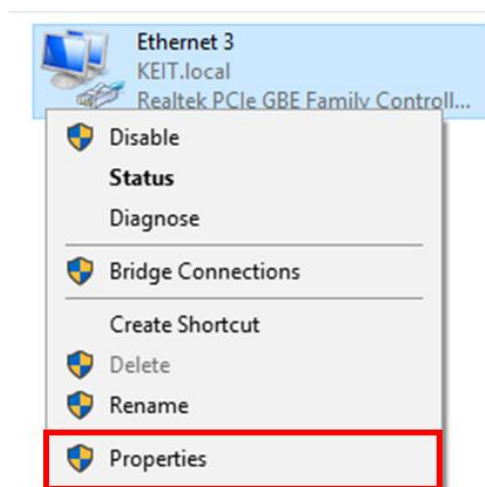


Figure 6 Change adapter settings

2.2.4. Click on 'Internet Protocol Version 4 (TCP/IPv4)' and click 'Properties'.

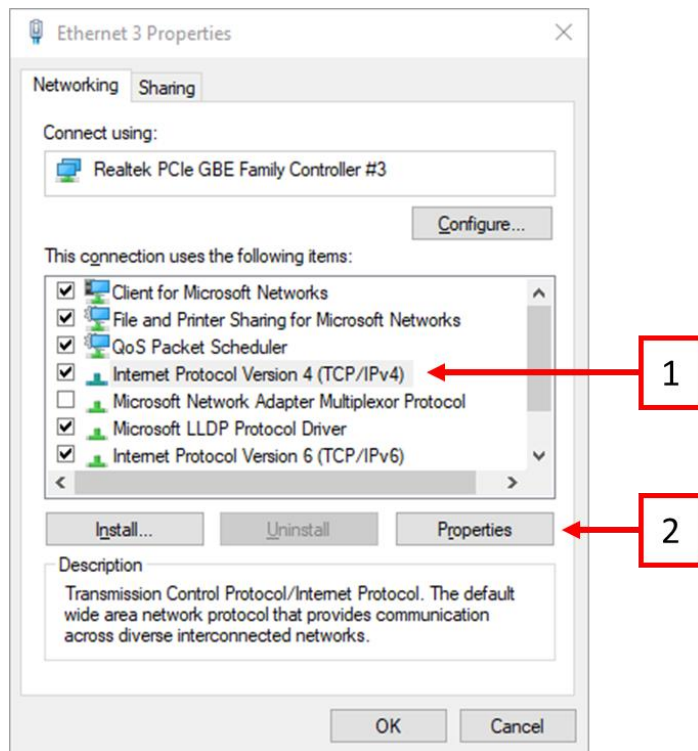


Figure 7 Ethernet properties

2.2.5. Select 'Use the following IP address'. Enter the IP address, subnet mask and default gateway that you want to use, and click 'OK'.

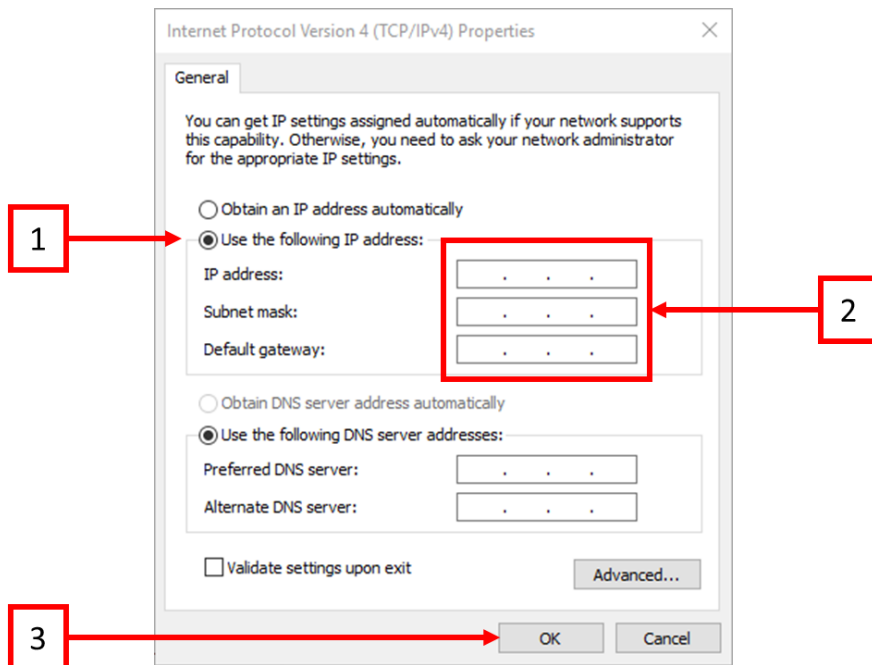


Figure 8 Setting a static IP address

2.2.6. Click 'Close'. Your controller will now use the IP address that you assigned.

If needed, you may assign two different IP addresses, one for each ethernet port on the IRmadillo.

### 2.3. Setting a security policy

KeitSpec supports four security policies:

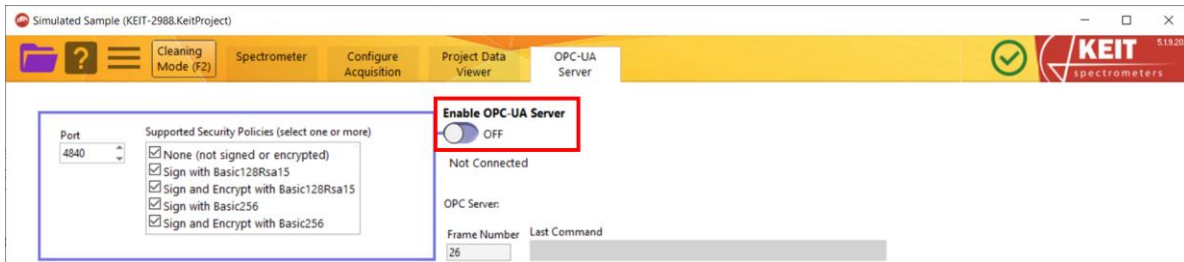
Supported Security Policies (select one or more)

<input checked="" type="checkbox"/>	None (not signed or encrypted)
<input checked="" type="checkbox"/>	Sign with Basic128Rsa15
<input checked="" type="checkbox"/>	Sign and Encrypt with Basic128Rsa15
<input checked="" type="checkbox"/>	Sign with Basic256
<input checked="" type="checkbox"/>	Sign and Encrypt with Basic256

**Figure 9 Security policies**

This section will demonstrate how to set up KeitSpec to communicate with the free OPC-UA client UAExpert using the Basic123Rsa15 security policy. This requires manually copying and installing the digital certificates from the client onto the server, and those from the server onto the client. If one of the digital certificates has expired, the connection to the OPC-UA server will be blocked.

2.3.1. On the IRmadillo controller, disable the OPC-UA server:

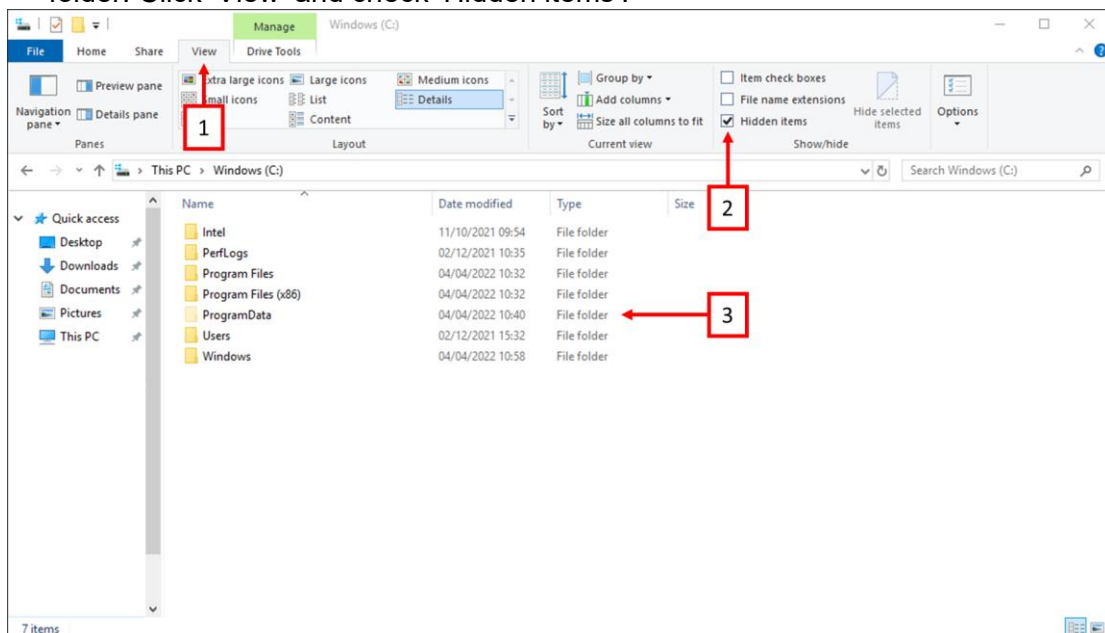


**Figure 10 Disable the server to add security.**

2.3.2. On the IRmadillo's controller PC, navigate to:

```
C:\ProgramData\National Instruments\certstore\opcua
```

You may need to show hidden folders in the C:\ drive in order to find the ProgramData folder. Click 'View' and check 'Hidden items'.



**Figure 11 Showing hidden items in Windows Explorer**

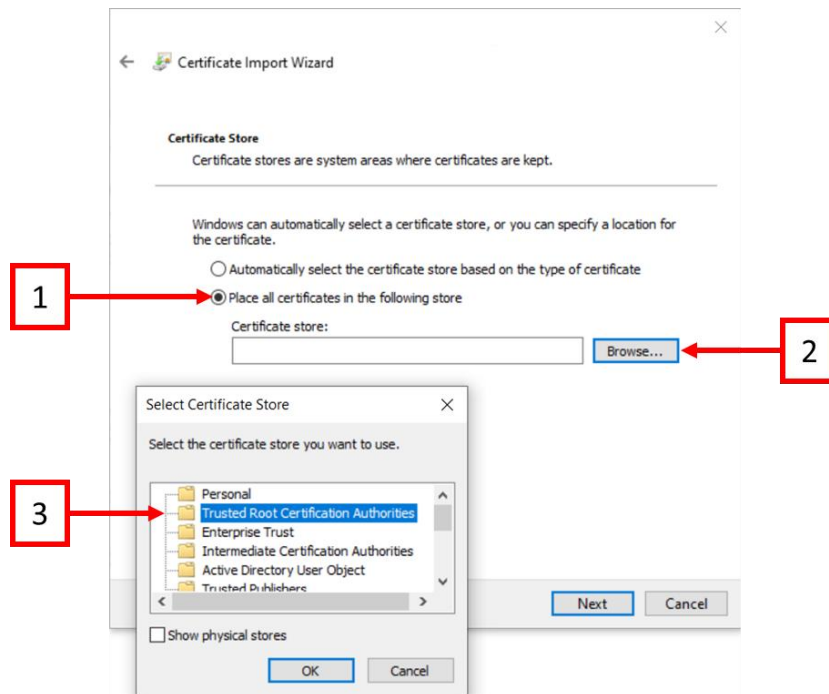
2.3.3. Copy the files '*Keit Server Certificate.der*' and '*Keit Server Certificate.pem*' to your OPC client's trusted certificates folder on the client PC. For UAExpert, this can be found in

```
C:\Users\[username]\AppData\Roaming\unifiedautomation\uaexpert\PKI\trusted\certs
```

Again, you may need to show hidden folders to navigate to the AppData folder.

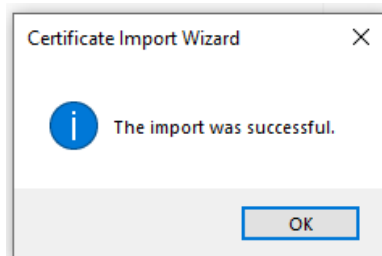
2.3.4. Open '*Keit Server Certificate.der*' to view the certificate information. Click 'Install Certificate...'. Select either 'Current User' or 'Local Machine' depending on whether you intend to run the OPC client under multiple usernames or not, and click 'Next'.

2.3.5. Select 'Place all certificates in the following store' and click 'Browse...'. Choose 'Trusted Root Certification Authorities' and click OK, then Next.



**Figure 12 Installing the certificates**

2.3.6. Click Finish. You should see a dialogue box, as shown in Figure 13. Click 'OK'.



**Figure 13 Certificates installed**

2.3.7. Locate the certificate for your OPC client on your client's PC. For UAExpert, this can be found in

```
C:\Users\[username]\AppData\Roaming\unifiedautomation\uaexpert\PKI\own\certs
```

and is called 'uaexpert.der'.

2.3.8. Copy your OPC client's certificate into the following folder on the IRmadillo's control PC:

```
C:\ProgramData\National Instruments\certstore\opcua\Keit Trusted Clients
```

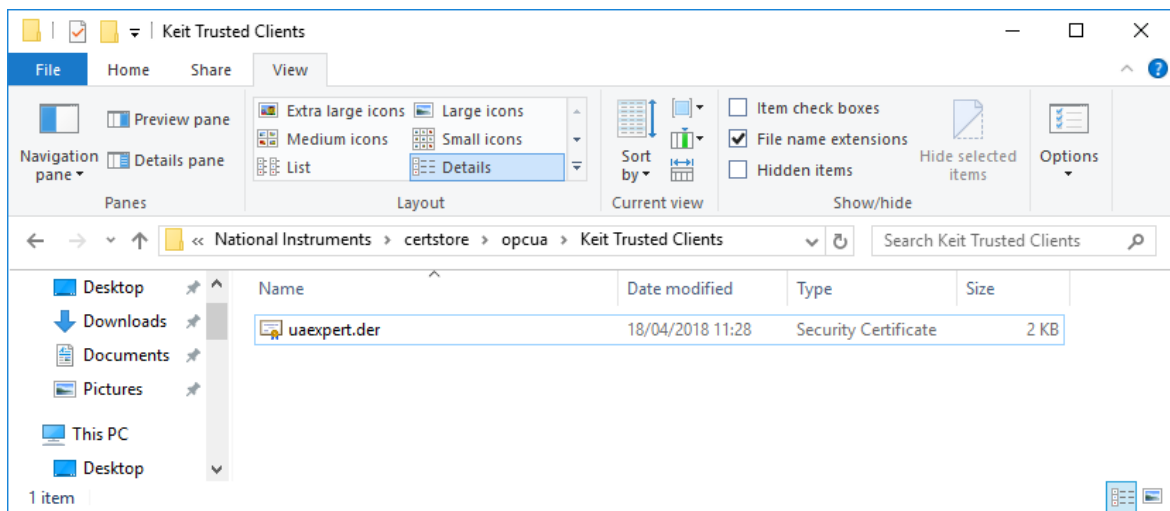


Figure 14 Location for your OPC client

2.3.9. Install the 'uaexpert.der' certificate on the IRmadillo's control PC by following steps 2.3.4 to 2.3.6.

2.3.10. Select the appropriate Supported Security policies and Re-enable the OPC-UA Server.

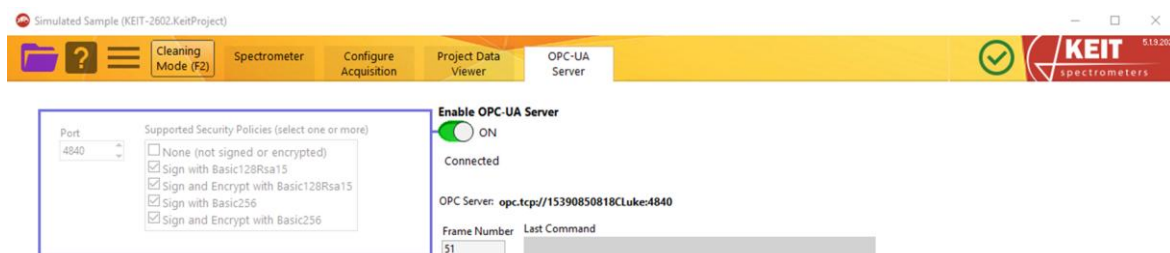
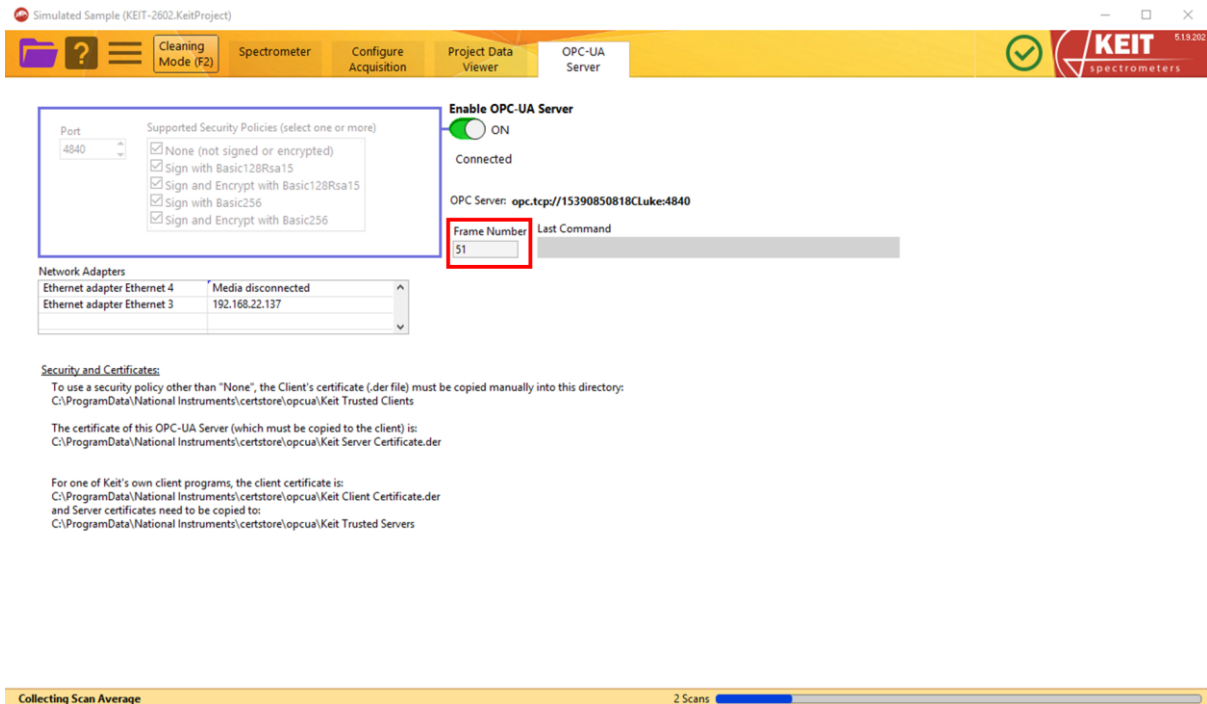


Figure 15 Server enabled with Basic128Rsa15

## 2.4. Connect and check

2.4.1. From your OPC client, read item Data.Frame Number. This will return the frame number which changes whenever there is new data.



**Figure 16** Checking the connection

2.4.2. The value you read should match the number shown in the OPC-UA server tab as shown in Figure 16. If this is the case, then you have successfully established communications.

2.4.3. If you are unable to communicate with the spectrometer then check your network configuration and firewall settings.

## 2.5. Configure and test the historian

2.5.1. All of the items in the OPC Address Space Mapping Document must be stored in the plant historian. They are not stored on the Keit controller.

2.5.2. The OPC Address Space Mapping Document includes maximum and minimum values for some of the data to help define ranges when plotting data to your end users.

2.5.3. Check that the data recorded in the historian matches that given by the spectrometer. Extensive data validation should be performed before using data for operations.

## 2.6. List of useful OPC tags to read

Below is a list of OPC tags that you will need to consider when setting up your DCS. There will also be an accompanying mapping document that will need to be considered and will provide more detail. All of the nodes detailed below are string data types.

Object Node	Description
Data.Diagnostics.Number of Self-Diagnostic Errors	This is the number of errors thrown by the spectrometer. If non-zero for more than an hour when the spectrometer has been running for more than 12 hours, contact Keit.
Data.Diagnostics.Number of Self-Diagnostic warnings	This is the number of warnings thrown by the spectrometer. If non-zero for more than an hour when the spectrometer has been running for more than 12 hours, contact Keit.
<b>Data.Diagnostics.Self-Diagnostic Errors</b>	This is the detail of the error messages from KeitSpec. Include this if you contact Keit regarding an error.
<b>Data.Diagnostics.Self-Diagnostic Warnings</b>	This is the detail of the warning messages from KeitSpec. Include this if you contact Keit regarding a warning.
Chemometrics.Metric Names	This is a list of the names of the chemicals being measured.
Chemometrics.Metric Values	This is a list of the measured concentrations of each of the chemicals. If a Confidence model is present, it will be the first item on the list.
<b>Data.Frame Number</b>	This is the frame number reported by KeitSpec. Used for monitoring.
Data.X	This is a list of the X axis wavenumber values used for plotting spectra if applicable.
Data.Y_absorption	This is a list of the Y axis absorbance values used for plotting spectra if applicable.

When shipped Metrics Names and Metric Values will contain training models and training Confidence models that can be used to help integrate the IRmadillo into your DCS earlier in the commissioning of the system. The models output fixed values to make setup easier and help with troubleshooting problems. The number of registers that need to be read will depend on what is intended to be measured by the spectrometer.

Confidence models are built to monitor the health of the measurements and whether they should be trusted. They act as Boolean status flags (0 = within specification, 1 = low confidence) and should be presented to the end user along with the measurement data to prevent users relying on bad data. The training Confidence models will only report 0.

You may notice values for Hotelling's  $T^2$  and Q-residuals which look like these: "IB-xxx\_H" and "IB-xxx\_Q" in your outputs. These are used to derive the outputs of your Confidence models and you will not need to store them as they will be factored in to the output of the Confidence models which will need to be stored.

## 2.7. Handling Negative Concentration Values

The IRmadillo may occasionally report **negative concentration values** for some chemical species. These values are not physically meaningful and occur due to model extrapolation or noise when the true concentration is near zero.

### Where this applies:

- These values are typically found in the **chemometric model outputs**, which are Nodes under Chemometrics.Metric Values (see Section 2.6 List of useful OPC tags).

If negative values are not desired, configure your DCS to replace any negative values with zero before displaying or using them in control logic.

$$\text{If } x < 0 \text{ then } x' = 0$$

This can be implemented in most DCS systems using basic conditional logic or scripting.

## 2.8. Controlling the Spectrometer

Four actions are available via OPC. These can be written to 'Control.Command'.

Instruction written to 'Command'	Description
Collect Background Scan	Collects a new background scan
Reset Spectrometer	Performs a hard reset of the spectrometer. Used in the rare event of a crash. Note that it may take several hours for the spectrometer to stabilise.
Reenable Sagnac TEC	Turns the TEC (thermal control) inside the spectrometer. Used if the TEC has been automatically shut down during an overheating event. Note that it may take several hours for the spectrometer to stabilise.
Test Dialog	Displays the 'Test Dialog' command in KeitSpec. Used to test communication between KeitSpec and the OPC client.

## 2.9. Control systems

The Frame Number is the indicator from which it is possible to tell if the device is recording spectra and upon which control systems should be based. The frame number updates with every scan average (usually 120 seconds).

To minimise the risk of integral wind-up, PID systems should not expect a continuous stream of values. Concentrations and other readings will only update when the frame number updates, not more frequently.

In the rare event that KeitSpec loses connection with the IRmadillo, your DCS values will not change.

### 3. Troubleshooting

#### 3.1. General

If you encounter issues when setting up your OPC-UA system, please check the following:

- When setting up OPC-UA in KeitSpec you must use the 'Spectrometer user' account not the 'Administrator'. You also cannot connect to the spectrometer in both accounts at the same time.
- Expired certificates will block connection to the OPC-UA server. Make sure that when setting a security policy between the client and server that the digital certificate is in date. If out of data, KeitSpec will report an error when you try to enable the OPC-UA server in the OPC-UA server tab.
- A Continuous Collection project must be loaded in KeitSpec. DCS comms are not available in the Manual Collection Project type.

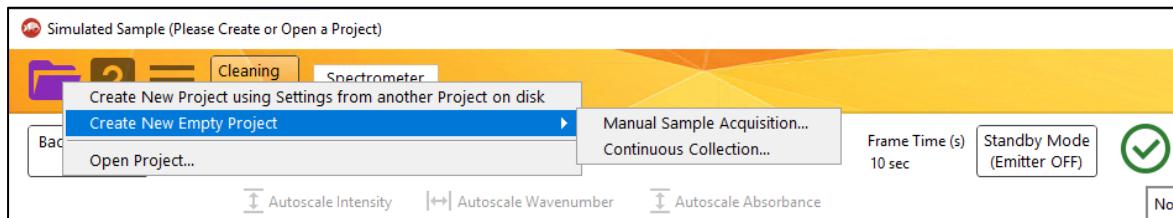


Figure 17 Opening a Continuous Collection project

- To see the Frame Number updating the project must be running and collecting spectra. If not, the OPC-UA server will not show new information that is being collected. Make sure that the spectrometer is not in Standby Mode; when in Standby Mode the Standby Mode button, highlighted below, will be red.

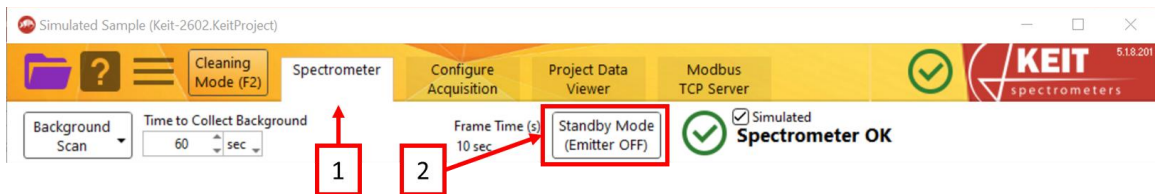


Figure 18 Check the emitter state

### 3.2. Connection Timeouts

- 3.2.1. Occasionally KeitSpec will restart if it encounters a fault. During this period the OPC-UA server will cease to report new values and will drop the connection to your client. It is important to have a suitable “Connect Timeout” on your connection configuration to avoid your OPC-UA client from automatically adjusting the length of the tags being polled.
- 3.2.2. Keit recommends setting your connect timeout to at least 6 minutes to allow for automated restarts.

### 3.3. Security token failing to validate

- 3.3.1. If using Security tokens to protect your communications you may encounter the following error “BadCertificateUriInvalid”. This can be related to certain clients being unable to read special characters like spaces in the naming of the certificate. Clients usually provide the option to select “Ignore” or change a setting to allow for this, see Figure 19.

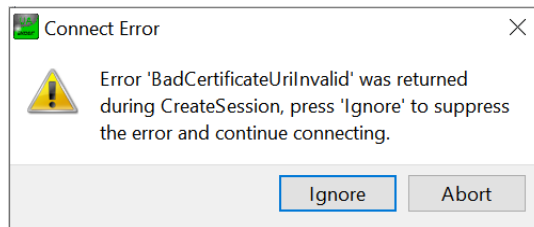


Figure 19 BadCertificateUriInvalid error message

- 3.3.2. Ignoring this error message still ensures communications are encrypted and signed as per the settings in KeitSpec, but they have not been validated by the certificate.

### 3.4. Communicating with an OPC Classic Client

If you have an OPC Classic (also known as OPC-DA) Client, then it is not compatible with OPC-UA. You will need to use a piece of software to convert between the two different OPC standards.

Some vendors, such as Matrikon, refer to this conversion software as an OPC-UA Tunneller, and it must be installed on the same computer that is running the OPC Classic client.



Figure 20 Classic client to UA server

You may also experience connection issues caused by various network security settings in the tunneller software. An example from Matrikon’s OPC-UA tunneller is given here:

```
Local Disk(C:) >Program Files(x86)> Matrikon> OPC> UA Proxy> Configuration
```

In Com2UA.xml it was required to change <UADiscoveryServiceCheck> from True to False.

