Driver Manual

FS-8705-51 Open Platform Communications United Architecture (OPC UA)

APPLICABILITY & EFFECTIVITY
Effective for all systems manufactured after April 2021.

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Contents

1 Description

The OPC UA driver allows the FieldServer to transfer data to and from devices over Ethernet using the OPC UA protocol. The FieldServer can emulate either a Server or Client.

If configured as an OPC UA Client, the FieldServer will create socket connections to configured OPC UA Server endpoints. Upon successfully connecting, the driver will create client sessions and using the session, will poll for the requested data points.

If configured as an OPC UA Server, the FieldServer creates one OPC UA endpoint that other OPC UA Clients can connect to. Nodes are added to OPC Server to store data points and tasks are configured to map data stored in the FieldServer (usually from other drivers) to the Value attribute of the nodes.

In OPC UA, data is stored in nodes. Each node has a unique node-ID which is a combination of a namespace and identifier. Each node has various attributes, the actual data value and sometimes references to other nodes. For a list of supported data types and attributes, please refer to **Section 7.2** and **Section 7.3** respectively.

The information that follows describes how to expand upon the factory defaults provided in the configuration files included with the FieldServer.

2   Hardware Connections

This block diagram lists common network connections that can monitor and/or serve OPC UA data using other protocols like Modbus® RTU or Modbus TCP/IP, BACnet® and HTTP.
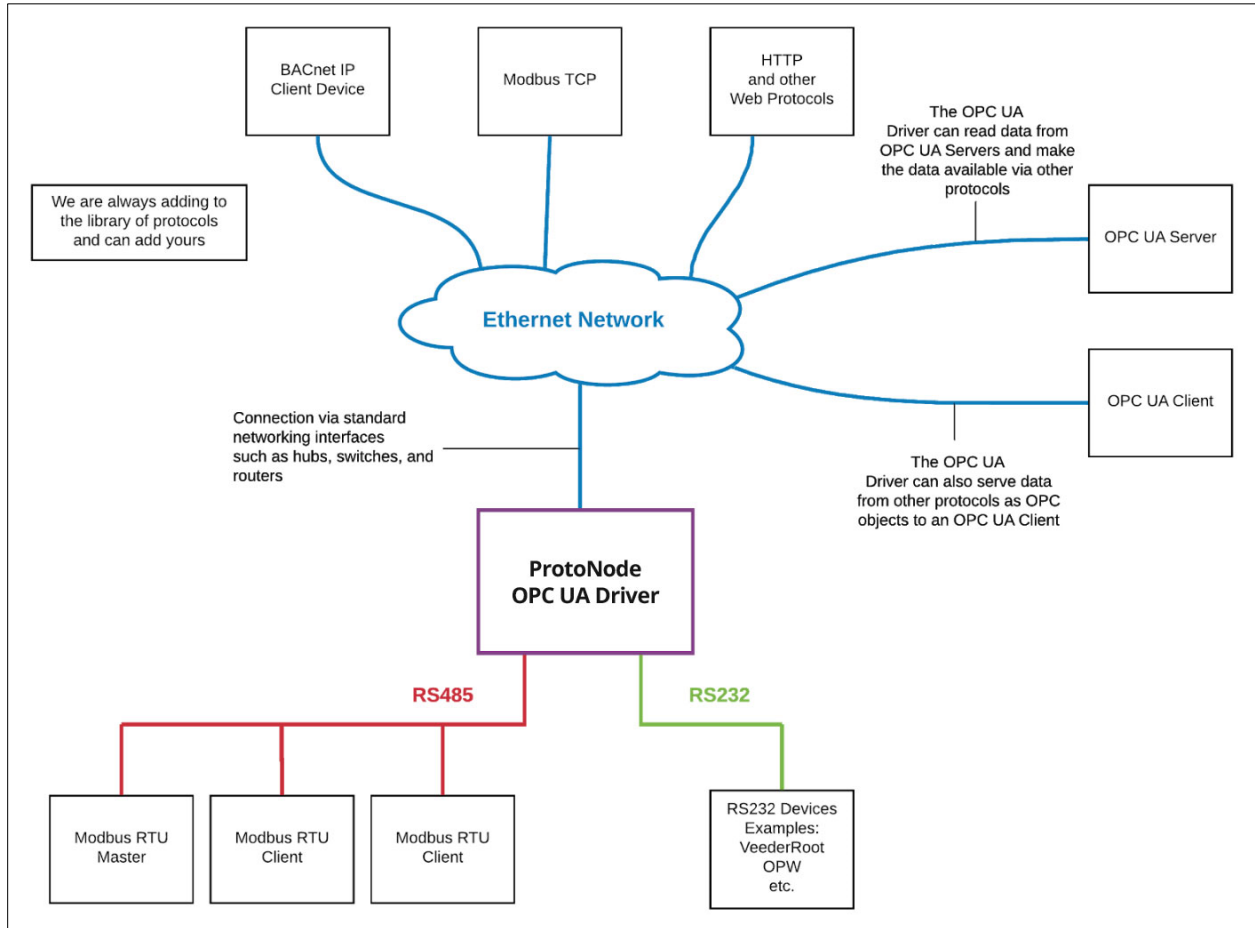
3   Generate a License Product Key

OPC UA requires a license product key. To generate this license product key a pre-key from the hardware is required.

3.1   How to Generate a Pre-key

1. Go to the license page. http://{IPADDRESS}/htm/fsgui.htm#20_OID

2. Click the Get Pre-Key button.

The License Driver allows you to do the following
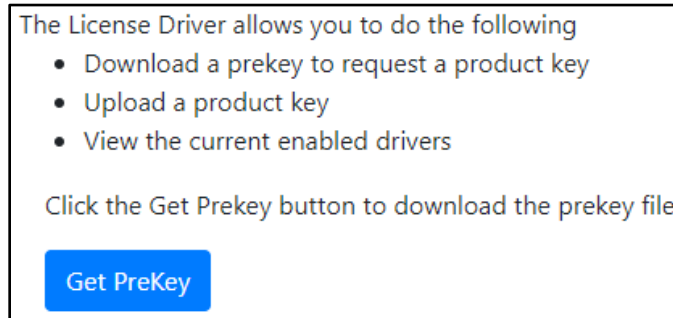- Download a prekey to request a product key
- Upload a product key
- View the current enabled drivers

Click the Get Prekey button to download the prekey file

Get PreKey

A pre-key.txt file will be created and downloaded to your system. Send this pre-key.txt and your Job number (FSE1234) to Chipkin support.

3.2   How to Activate a Product Key

Chipkin support can generate a license product key from the hardware pre-key. The product key will be sent as a text file via email.

1. Go to the license page http://{IP_ADDRESS}/chipkinLicenseDriver/ui/

2. Click "Browse" button and select the productkey-XXXXX.txt file provided to you by Chipkin Support.

3. Click the "Upload Product Key" button and wait for the product key to finish uploading.

Upload a product key. Select the product key to upload, then click the Upload Product Key button

Choose a productKey file or drop it here...   Browse

Upload Product Key
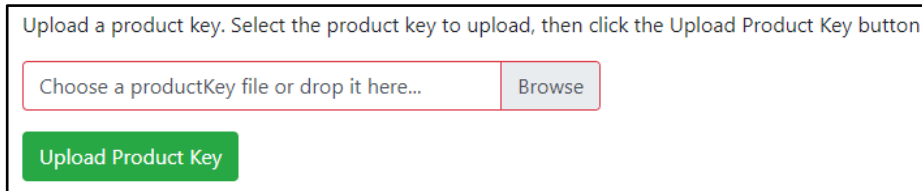
The list of enabled product codes can be viewed in the "Enabled Product Codes" list.

Enabled Product Codes

The list of product codes that have been enabled by uploaded product keys

No product keys have been uploaded.
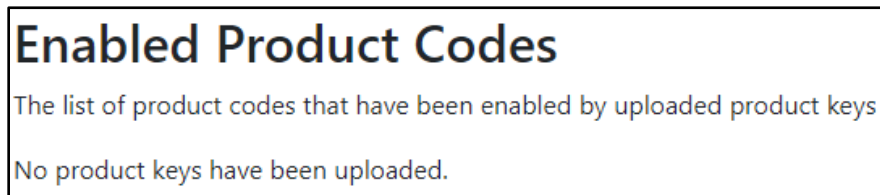
4   Data Array Parameters

Data Arrays are "protocol neutral" data buffers for storage of data to be passed between protocols. It is necessary to declare the data format of each of the Data Arrays to facilitate correct storage of the relevant data. For OPC UA configuration, the data array section is the only section needed to be defined in the CSV file. There are no Client Side or Server Side connections needed for OPC UA. To download the config.csv file refer to **Section 6.3 –** How to Import a PE Configuration.

The rest of the configuration will be completed in **Section 5**.

Section Title		
Data_Arrays		
Column Title	**Function**	**Legal Values**
Data_Array_Name	Provide name for Data Array	Up to 15 alphanumeric characters
Data_Array_Format	Provide data format. Each Data Array can only take on one format.	Float, Bit, Byte, Uint16, Uint32, Sint16, Sint32
Data_Array_Length	Number of Data Objects. Must be larger than the data storage area required by the Map Descriptors for the data being placed in this array.	1-10000

Example

```
//   Data Arrays
Data_Arrays
Data_Array_Name    , Data_Array_Format   , Data_Array_Length
DA_AI_01           , UInt16              , 200
DA_AO_01           , UInt16              , 200
DA_DI_01           , Bit                 , 200
DA_DO_01           , Bit                 , 200
```
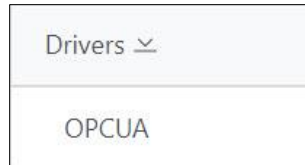
5   Configuring the FieldServer

To configure the OPC UA driver go to the home page by visiting http://{IP_ADDRESS}/opcuaDriver/ui/.

Click on the Drivers tab and then on OPCUA.

On the OPC Configuration screen, select to configure the FieldServer as an OPC UA Client or Server.
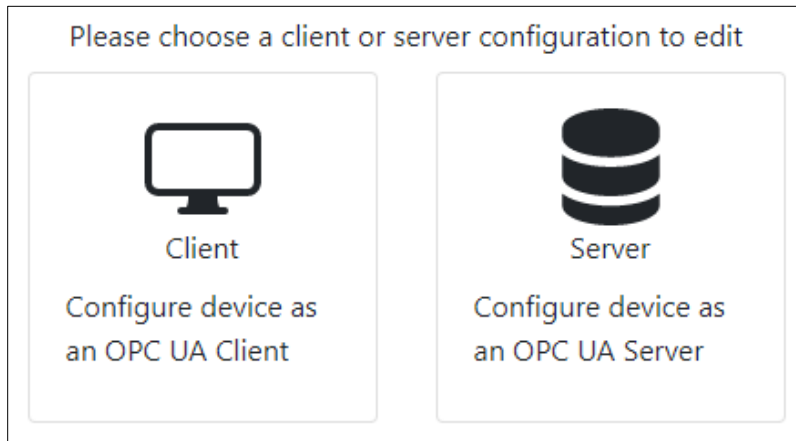
5.1   OPC UA Server Configuration

This section documents and describes the parameters necessary for configuring the FieldServer to communicate with an OPC UA Client.

The configure the FieldServer as an OPC UA Server, follow the instructions below to add a Connection (contains information about the server), Nodes (UA Objects organized by folders), and finally Tasks (UA Variables that belong to the UA Objects).

5.2   Create Connection

To set up an OPC Server, first create a connection. The connection contains information about this device acting as an OPC Server and how OPC UA Clients will connect to it.

Connections

Name	Type	Parameters	Port	Resource Path	Manufacturer Name	Product Name	Actions

Create Connection

1. Click on the "Create Connection" button to open the Create Connection form.

2. Fill out the fields in the form. The fields are as follows:

Column Title	Function	Legal Values
Name	Name of the server. Used internally as an identifier.	Text (must be unique)
Type	The type of connection.	**ethernet**
Parameters: Port	The physical port on the FieldServer to use.	**n1**
Port	The TCP listening port for the OPC UA Server.	**26543**, 4840, available TCP port
Hostname	The IP Address or domain host name of the device running the server.	**192.168.1.72**, example-pc
ResourcePath	The URI endpoint for the server. Examples: /UA or /UA/MyDevice. If blank, the uri is simply the root endpoint: opc.tcp://{IP Address}:{port}.	/UA, /UA/TestServer, any text that specifies a path format
ManufacturerName	The name of the manufacturer of the server.	Text; **Chipkin Automation Systems**
ProductName	The name of the product.	Text; **CAS FS OPC UA Server**

NOTE: In the table the bold legal values are the default.

3. Click the "Save" button to add the connection.

   If successful, the new entry will be populated in the Connections table:

Connections

Name	Type	Parameters	Port	Resource Path	Manufacturer Name	Product Name	Actions
Test Server	Ethernet		26543	/UA/TestServer	Example Company	Example Product-00XX	Edit Delete

Create Connection

NOTE: Only one server connection can exist. If multiple connections are created, only the first one will be used.

5.3   Create Node

Follow the instructions below to add objects to the OPC UA Server.

Nodes

Connection	Name	Node Id	Folder	Actions

[Create Node]

1. Click on the "Create Node" button to open the Create Node form.

2. Fill out the fields in the form. The fields are as follows:

Column Title	Function	Legal Values
Name	The name of the object.	Text (must be unique)
Connection	The name of the server to add this object.	Text (use the name of the Connection created in the previous section)
NodeId	The nodeId to assign to this object. If left blank, the driver will generate one.	"ns=1;i=1001", "ns=2;s=example_object"
Folder	The folder path where this object exists. This is primarily for organizing the objects. If left blank, the object will be placed in the root object folder of the OPC UA server.	Path Examples: "BuildingA/FloorB/RoomC" "MachineRoom1/CabinetX"

3. Click on the "Save" button to add the node.

If successful, the new entry will be populated in the Nodes table:

Nodes

Connection	Name	Node Id	Folder	Actions
Test Server	Thermostat		BuildingA/FloorB/RoomC	[Edit] [Delete]

[Create Node]

Repeat the above steps to add additional objects.

5.4   Create Task

Create tasks to add variables to configured objects.

1.   Click on the "Create Task" button to open the Create Task form.

2.   Fill out the fields in the form. The fields are as follows:

Column Title	Function	Legal Values
Name	The name of the variable to add.	Text (must be unique)
Node	The node that this variable belongs to.	Text (use the name of a node created in the previous section)
DataBroker: Name	The data array in the protocol engine to retrieve the value.	One of the Data Array names
DataBroker: Start	The starting offset in the array to retrieve the value.	0 to ("Data_Array_length" - 1)
DataType	The type of data that this data point represents.	Refer to **Section 7.2**
Type	Select whether this data point is read, read/write, or write only.	Read, Read/Write, Write
Desc	Description of the data point.	Text

3.   Click the "Save" button to add the task.

    If successful, the new entry will be populated in the Tasks table:

4.   Repeat the above steps to add additional variables.

5.5   Saving the Server Configuration

When the configuration is complete, click on the "Save Configuration" button to save all of the updates and changes. For the configuration to take effect, reboot the system.

5.6   Resetting the Server Configuration

To clear the configuration and start over, click the "Reset Configuration" button. Then follow the instructions in the sections above to create new connections, nodes, and tasks.

5.7   OPC UA Client Configuration

To configure the FieldServer as an OPC UA Client, follow the instructions below to add a Connection (how to connect to OPC UA Servers), Nodes (OPC UA Client session information), and finally Tasks (data points on the OPC UA Server to read).

5.7.1   Create Connection

Add information on how to connect to one or more OPC UA Servers.

Connections

Name	Type	Parameters	Endpoint	Initial Delay	Max Delay	Max Retry	Actions

Create Connection

1. Click on the "Create Connection" button to open the Create Connection form.

2. Fill out the fields in the form. The fields are as follows:

Column Title	Function	Legal Values
Name	The name of the server to connect to, used internally as an identifier.	Text (must be unique)
Type	The type of connection.	**ethernet**
Parameters: Port	The physical port on the FieldServer to use.	**n1**
Endpoint	The OPC UA Server endpoint to connect to.	opc.tcp://{hostname or ip address}:{port}/{referencePath} Example: opc.tcp://192.168.1.72:26543/UA/TestServer
InitialDelay	Delay in milliseconds before the first attempt to reconnect is made after initial connection failure.	0-65535, **1000**
MaxDelay	Further reconnection attempts will have an increased delay. This parameter defines the maximum delay between two reconnections.	0-65535, **20000**
MaxRetry	The maximum number of unsuccessful consecutive retries before the connection fails.	0-20, **1**

NOTE: In the table the bold legal values are the default.

3. Click the "Save" button to add the connection.

   If successful, the new entry will be populated in the Connections table:

Connections

Name	Type	Parameters	Endpoint	Initial Delay	Max Delay	Max Retry	Actions
ExampleServer	Ethernet		opc.tcp://192.168.1.72:26543/UA/TestServer	1000	20000	1	Edit Delete

Create Connection

Repeat the above steps to add other servers to poll for data.

5.7.2   Create Node

For each connection, add a node that contains information on how to create an OPC UA Client Session.

1. Click on the "Create Node" button to open the Create Node form.

2. Fill out the fields in the form. The fields are as follows:

Column Title	Function	Legal Values
Name	The name of the session, used internally as an identifier.	Text (must be unique)
Connection	The connection that this session uses.	Text (use the name of a Connection created in the previous section)
UserName	If the session requires a user login, this is the username to use when creating a session. Can be blank if the OPC UA Server endpoint supports anonymous connections.	Text
Password	If the session requires a user login, this is the password to use when creating a session. Can be blank if the OPC UA Server endpoint supports anonymous connections.	Text

3. Click the "Save" button to add the node.

    If successful, the new entry will be populated in the Nodes table:

Repeat the above steps for each connection that was created.

5.7.3 Create Task

Add tasks to poll for specific data points.

1. Click on the "Create Task" button to open the Create Task form.

2. Fill out the fields in the form. The fields are as follows:

Column Title	Function	Legal Values
Name	The name of the data point.	Text (must be unique)
Node	The node that represents the session to use to poll for this data point.	Text (use the name of a Node configured in the previous section)
DataBroker: Name	The data array in the protocol engine to store the value.	One of the Data Array names
DataBroker: Start	The starting offset in the array to store the value.	0 to ("Data_Array_length" - 1)
Type	The type of task which defines how the data point is polled.	**read**
ScanInterval	How often in seconds to poll for data.	0 - (Max UINT32), **30**
NodeId	The nodeId of the data point to poll.	"ns=1;i=1001", "ns=2;s=example_object"
Attribute	The attribute of the node to poll.	**Value** (see **Section 7.3** for list of attributes)

NOTE: In the table the bold legal values are the default.

1. Click the "Save" button to add the task.

   If successful, the new entry will be populated in the Tasks table:

Repeat the above steps to add additional data points to poll.

5.7.4   Saving the Client Configuration

When the configuration is complete, click on the "Save Configuration" button to save all of the updates and changes. For the configuration to take effect, reboot the system.

5.7.5   Resetting the Client Configuration

To clear the configuration and start over, click the "Reset Configuration" button. Then follow the instructions in the sections above to create new connections, nodes, and tasks.

6   Importing and Exporting Configurations

It is possible to export the current configuration to back it up or simply to make some edits. Users can also import either the entire configuration via a zip file or a PE (Protocol Engine) configuration.

See **Section 9** for example configurations.

6.1   How to Export the Configuration

1. Go to the system configuration page http://{IP_ADDRESS}/chipkinConfiguration/ui/.

2. Click the Export Configuration button.

Import/Export System Configuration

Export the current configuration or import a configuration. The operations apply to the entire configuration

Click the export configuration button to download current configuration as a zip file

Export Configuration
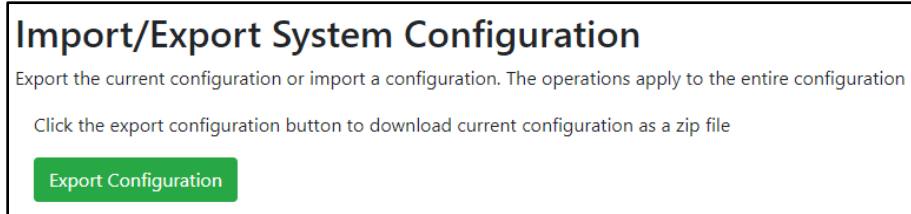
6.2   How to Import the Configuration

The file to import the configuration must be a zip file. The zip file should contain the following folders:

- ae – This folder contains any configuration files for the ae configuration. Refer to **Section 9** for an example of ae configuration.

- documents – This folder contains any driver specific documents. For example, license product keys, etc.

- pe – This folder contains one config.csv file for the pe configuration.

To make sure the folder directory is correct, do an Export first, then extract the files, edit them, then zip them up again.

To import the configuration:

1. Go to the system configuration page http://{IP_ADDRESS}/chipkinConfiguration/ui/.

2. Click the "Browse" button in the "Import/Export System Configuration" section and select the zip file containing the configuration to import.

3. Click the "Import Configuration" button and wait for the configuration to finish importing.

4. If successful, a success message will appear prompting a reboot of the FieldServer for the changes to take effect.

Import/Export System Configuration

Export the current configuration or import a configuration. The operations apply to the entire configuration

Click the export configuration button to download current configuration as a zip file

Export Configuration

Import a configuration zip file. Select the file to import, then click the Import Configuration

Choose a configuration zip file or drop it here...   Browse

Import Configuration
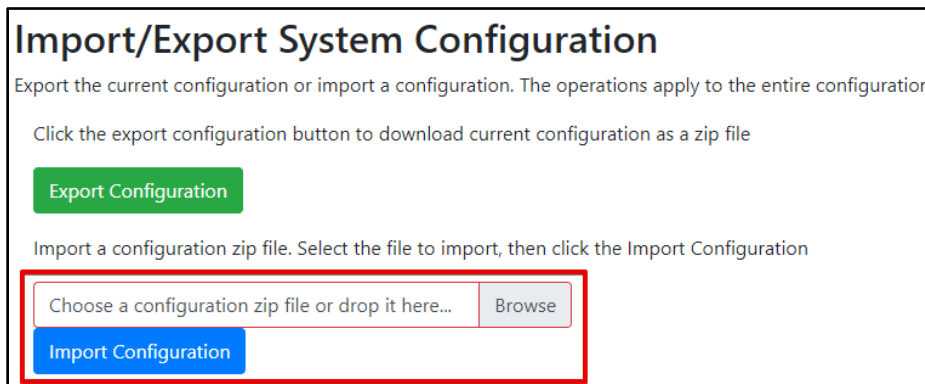
6.3   How to Import a PE Configuration

It is possible to import a PE (Protocol Engine) configuration separately. To import a PE configuration:

1. Go to the system configuration page http://{IP_ADDRESS}/chipkinConfiguration/ui/.

2. Click the "Browse" button in the "Import Specific Configuration" section and select the csv file containing the pe configuration to import.

3. Click the "Import PE Configuration" button and wait for the configuration to finish importing.

4. If successful, a success message will appear prompting a reboot of the FieldServer for the changes to take effect.

7 Communication Functionality

7.1 Supported Functionality

Client:

- Connect (using opc.tcp or https)
- CreateSession (with or without username and password)
- Read

Server:

- Read
- Write

7.2 Supported Server Datatypes

- Null
- Boolean
- SByte
- Byte
- Int16
- UInt16
- Int32
- UInt32
- Int64
- UInt64
- Float
- Double
- String
- DateTime
- Guid
- ByteString

7.3 Supported Client Attributes to Read

The following is a list of attributes that can be read from an OPC UA object. The most common one will be the 'Value' attribute, but the OPC UA driver supports reading from the other attributes as well.

- NodeId
- NodeClass
- BrowseName
- DisplayName
- Description
- WriteMask
- UserWriteMask
- IsAbstract
- Symmetric
- InverseName
- ContainsNoLoops
- EventNotifier
- Value
- DataType
- ValueRank
- ArrayDimensions
- AccessLevel
- UserAccessLevel
- MinimumSamplingInterval
- Historizing
- Executable

8   Troubleshooting

8.1   Uploading the OPC UA Firmware

The OPC UA firmware does not come in the DCC000 default firmware from MSA-Safety. A custom firmware image needs to be loaded to enable the OPC UA driver.

8.1.1   How to Update the FieldServer

1. Download the FieldServer firmware image. https://s.chipkin.com/files/uploads/2020/nov/secure-to-insecure_Chipkin-B0017-1.0.0-beta-armv7.simg

2. Use the FieldServer toolbox to discover your FieldServer.
    https://us.msasafety.com/downloads#smc

3. Browse to the FS-GUI firmware update page. http://{IPADDRESS}/htm/fsgui.htm#20_OID

4. Go to Setup => File Transfer, then click the Firmware tab on the right.

5. Click the "Choose File" button and select the secure-to-insecure FieldServer firmware image "secure-to-insecure_Chipkin-B0017-1.0.0-beta-armv7.simg" then click the "Submit" button.

6. Wait for the firmware to be uploaded. Then click the "System Reboot" button.

    NOTE: Be sure to click System Reboot, not System Restart.

8.2   OPC UA Test Tools

A list of OPC UA testing tools that you can use to test the functionality of your system.

8.2.1   UaExpert

A Full-Featured OPC UA Client:
https://www.unified-automation.com/products/development-tools/uaexpert.html

Features:

- OPC UA Data Access View

- OPC UA Alarms & Conditions View

- OPC UA Historical Trend View

- Server Diagnostics View

- Simple Data logger CSV Plugin

- OPC UA Performance Plugin

- GDS Push-Model Plugin

8.2.2   OPC Reference Client

Official reference client used by the OPC Foundation for certification.

https://github.com/OPCFoundation/UA-.NETStandard

https://github.com/OPCFoundation/UA-.NETStandard/tree/master/Applications/ReferenceClient

8.3 Debugging an OPC UA connection

- If connections are not working properly, confirm the OPC UA Server Endpoint. Depending on how it has been configured, try using both the IP Address and the HostName. For example:
  - o IP Address format: opc.tcp://192.168.1.72:26543/UA/TestServer
  - o HoseName format: opc.tcp://example-pc:26543/UA/TestServer

- Verify that the URL contains the opc.tcp://. If it is missing, the connection will fail.

- Verify the resource path part of the endpoint. These are very specific and case sensitive. Some servers do not specify a resource path. See the following examples:
  - o No resource path: opc.tcp://192.168.1.72:26543/
  - o With resource path: opc.tcp://example-pc:26543/UA/
  - o With longer path: opc.tcp://192.168.1.72:26543/UA/TestServer

- When using the FieldServer as an OPC UA Server, ensure that the FieldServer is on the same subnet as the OPC UA Client that is attempting to poll for data.

8.4 Using UaExpert for Testing an OPC UA Server

Follow the steps in this section to setup the UaExpert tool to test a connection to an OPC UA Server (either the FieldServer configured as an OPC UA Server or to test an existing server to see what data is on it).

1. Download and install the tool:
   https://www.unified-automation.com/products/development-tools/uaexpert.html

2. In the tool, right-click on the Servers folder and click the Add option.
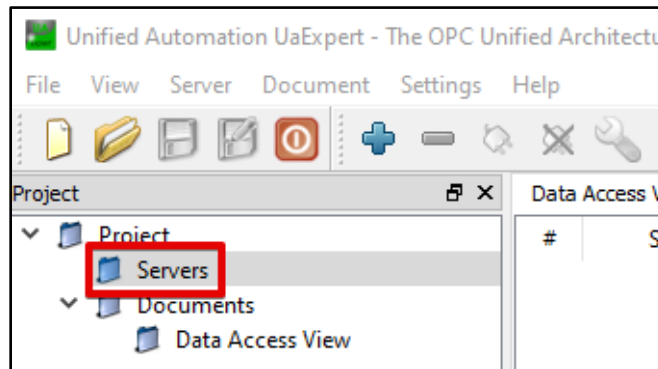
3. In the Add Server dialog box, click the "Advanced" tab
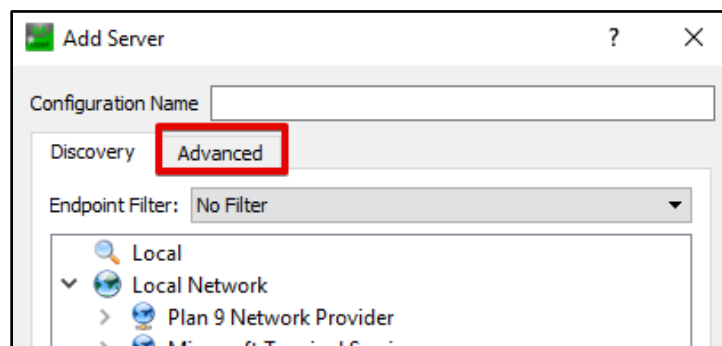
4. Fill out the following fields:

   a. Fill out the Configuration Name. This is a generic name to save this configuration

   b. Fill out the Endpoint URL. This should match the OPC UA Server endpoint.

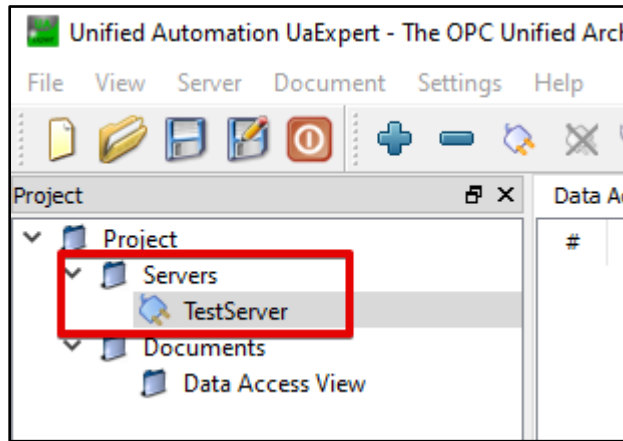   c. Fill out the Session Name. This is a generic name for the session.

5. Click the "Ok" button to add it to the Server list

6. Right-click the newly added server and click connect
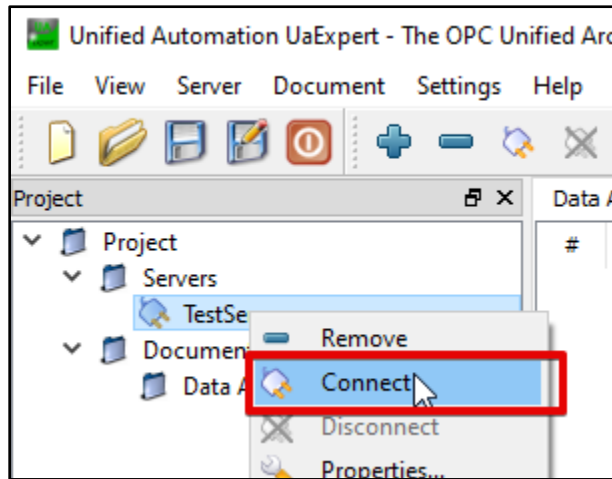
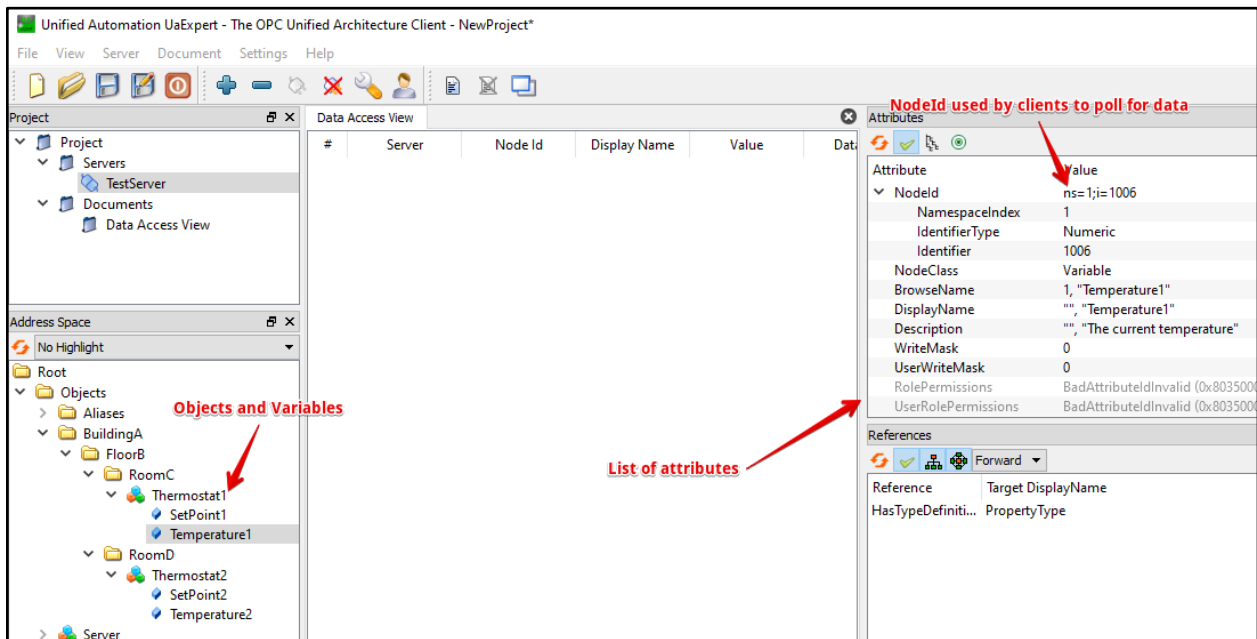7. If there is an error, it will be displayed in the Log at the bottom of the screen. Here is an example of a BadCommunicationError:

2020-11-20 8:38:52.467 AM	General		[uastack] OpcUa_SecureConnection_OnNotify: Connect event: ERROR 0x80050000!
2020-11-20 8:38:52.467 AM	General		[uastack] OpcUa_SecureConnection_OnNotify: Connect event: Notifying owner! 0x80050000
2020-11-20 8:38:52.467 AM	Server Node	TestServer	Could not connect to server: BadCommunicationError

8. If successful, the OPC UA Server object tree will be populated in the Address Space section. You may see a Certificate Validation dialog box appear. Review the information and Accept the server certificate temporarily for this session.
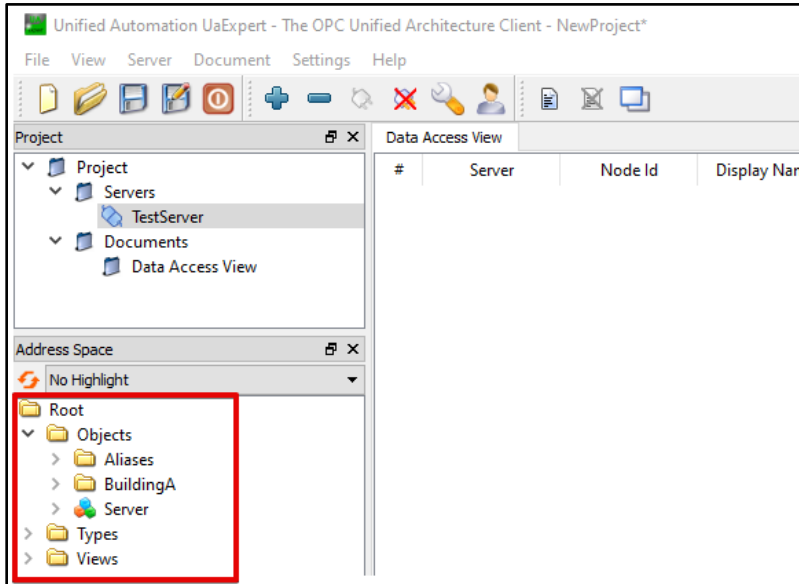
9. Open up any folders to see the objects that are available. You can see all the properties of the objects and attributes in the far right screens labelled Attributes and References.

10. Drag and drop variables to the Data Access View screen in the middle to check data values.

8.5   Testing FieldServer as an OPC UA Server

The following instructions are how to confirm that a FieldServer that has been configured as an OPC UA Server and is working correctly.

Follow the instructions in **Section 8.4** to use UaExpert to connect to a FieldServer that has been configured as an OPC UA Server.

1. Access the Data Array page by clicking on the Diagnostics tab from the Home page.

2. Change Values in the Data array and see the values updated in the UaExpert.

3. Change a value for a read/write or write only point in the UaExpert and see the value updated in the Data Array interface.

9 Example Configurations

9.1 Example Server Configuration

```json
{
  "ae": {
    "OPCUAServer": {
      "connections": [
        {
          "type": "ethernet",
          "name": "TestServer",
          "port": 26543,
          "hostname": "192.168.2.168",
          "resourcePath": "/UA/TestServer",
          "manufacturerName": "Example Company",
          "productName": "Example Product"
        }
      ],
      "nodes": [
        {
          "name": "Thermostat1",
          "connection": "TestServer",
          "folder": "BuildingA/FloorB/RoomC"
        },
        {
          "name": "Thermostat2",
          "connection": "TestServer",
          "folder": "BuildingA/FloorB/RoomD"
        }
      ],
      "tasks": [
        {
          "dataType": "Float",
          "type": ["read"],
          "name": "Temperature1",
          "node": "Thermostat1",
          "dataBroker": { "pe": { "Name": "DA_AI", "Start": "10" } },
          "desc": "The current temperature"
        },
```

```
        {
            "dataType": "Float",
            "type": ["read", "write"],
            "name": "SetPoint1",
            "node": "Thermostat1",
            "dataBroker": { "pe": { "Name": "DA_AI", "Start": "11" } },
            "desc": "Setpoint for temperature"
        },
        {
            "dataType": "Float",
            "type": ["read"],
            "name": "Temperature2",
            "node": "Thermostat2",
            "dataBroker": { "pe": { "Name": "DA_AI", "Start": "20" } },
            "desc": "The current temperature"
        },
        {
            "dataType": "Float",
            "type": ["read", "write"],
            "name": "SetPoint2",
            "node": "Thermostat2",
            "dataBroker": { "pe": { "Name": "DA_AI", "Start": "21" } },
            "desc": "Setpoint for temperature"
        }
    ]
  }
 }
}
```

9.2   Example Client Configuration

```json
{
  "ae": {
    "OPCUAClient": {
      "connections": [
        {
          "type": "ethernet",
          "name": "QuickReferenceServer",
          "endpoint": "opc.tcp://localhost:62541/Quickstarts/ReferenceServer",
          "initialDelay": 1000,
          "maxDelay": 2000,
          "maxRetry": 1
        }
      ],
      "nodes": [{ "name": "MySession", "connection": "QuickReferenceServer" }],
      "tasks": [
        {
          "type": "read",
          "scanInterval": 30,
          "attribute": "Value",
          "name": "ScalarStaticFloat",
          "node": "MySession",
          "dataBroker": { "pe": { "Name": "DA_AI", "Start": "10" } },
          "nodeId": "ns=2;s=Scalar_Static_Float"
        },
        {
          "type": "read",
          "scanInterval": 30,
          "attribute": "Value",
          "name": "ScalarStaticInt16",
          "node": "MySession",
          "dataBroker": { "pe": { "Name": "DA_AI", "Start": "11" } },
          "nodeId": "ns=2;s=Scalar_Static_Int16"
        }
      ]
    }
  }
}
```

10 Marketing

10.1 Case Studies

A series of case studies for OPC can be found here:

https://opcfoundation.org/resources/case-studies/

10.2 Keywords

OPC, OPC UA, OPC-UA Server, OPC UA Client, OPC Unified Architecture, OPC technologies, Open Platform Communications, Industry 4.0

11 Glossary

SOA – Service-oriented architecture

OPC – Open Platform Communications. The acronym OPC was borne from OLE (object linking and embedding) for Process Control.

OPC-UA – Unified Architecture

OPC-Classic – The OPC standard that was restricted to the Windows operating system.

PubSub – Publish - Subscribe. A mechanism for data and event notification

UACTT – OPC UA Compliance Test Tool: https://opcfoundation.org/developer-tools/certification-test-tools/opc-ua-compliance-test-tool-uactt/

ERP – Enterprise Resource Planning

MES – Manufacturing Execution Systems