



# Intermediate

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## DOCUMENT ACCESS

Public

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## Intermediate

This tutorial builds upon the [Basic](#) configuration tutorial settings and will attempt to integrate data read from an equipment while applying some workflow logic to the retrieved value. In the basic tutorial we had an OPC-UA integration, which connected to an OPC-UA server.

The following configuration aims to support the scenario where an oven, represented by the **Resource** entity, logs a message when it reaches a given temperature, indicating the current value. Then it will grab that information and post it to a Data Collection.

 **Note**

During this tutorial, the **Automation Manager** will run in console mode in order to highlight the most important events as they take place.

### Automation Driver Definition

Let's go over the **Automation Driver Definition** Oven DD and set the properties and events that are needed to support the scenario.

 **Note**

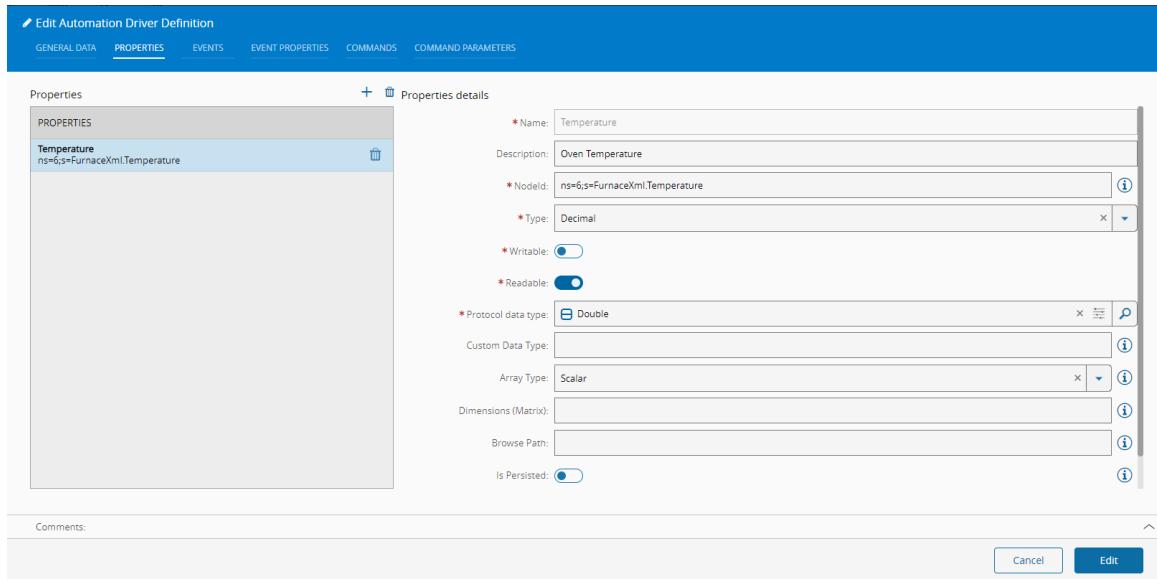
Note that to do this in a real life context, it is important to have a general knowledge about the protocol, the equipment itself and its related documentation.

### Properties

Go to [Automation Driver Definition](#), select the Oven DD and then select [Edit](#)

To add the Temperature property:

1. Skip the General Data step
2. Add a new entry to the list of Properties by selecting **+**
3. In the Property details, provide:
  - A name that represents the Property name
  - A description
  - The NodeID - identification of the Property - check the equipment documentation for the actual identification of the property on the equipment
  - The type (for classification and reporting purposes)
  - The `Writable` and `Readable` flags
  - The data type of the Property in OPC UA format - check the equipment documentation for the actual data type of the property on the equipment
4. Select [Events](#) step



Properties

Properties details

- \* Name: Temperature
- Description: Oven Temperature
- \* NodeId: ns=6;s=FurnaceXml.Temperature
- \* Type: Decimal
- \* Writable:
- \* Readable:
- \* Protocol data type: Double
- Custom Data Type: (empty)
- Array Type: Scalar
- Dimensions (Matrix): (empty)
- Browse Path: (empty)
- Is Persisted:

Comments:

Cancel Edit

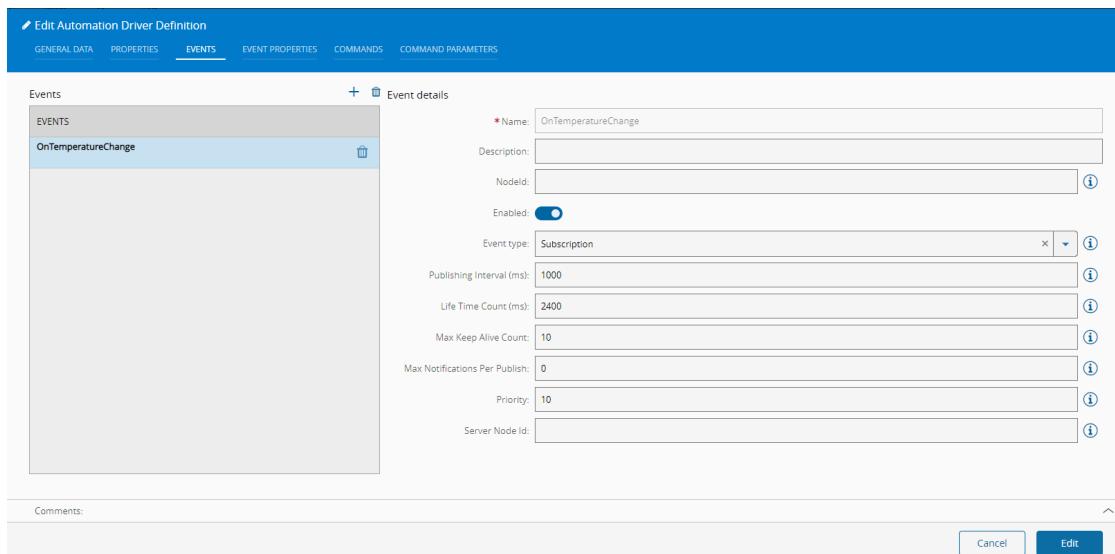
## Events and Event Properties

Now we need to add the Event On Temperature Change, that based on a technicality on the Protocol, we know that every time a Property value changes, an Event occurs.

1. Add a new entry to the list of Events by selecting +

2. In the Event details, provide:

- A name that represents the Event name
- A description
- The Enabled flag
- The Subscription Event Type
- The Publishing Interval in milliseconds
- The Life Time Count in milliseconds



Events

Event details

- \* Name: OnTemperatureChange
- Description: (empty)
- NodeId: (empty)
- Enabled:
- Event type: Subscription
- Publishing Interval (ms): 1000
- Life Time Count (ms): 2400
- Max Keep Alive Count: 10
- Max Notifications Per Publish: 0
- Priority: 10
- Server Node Id: (empty)

Comments:

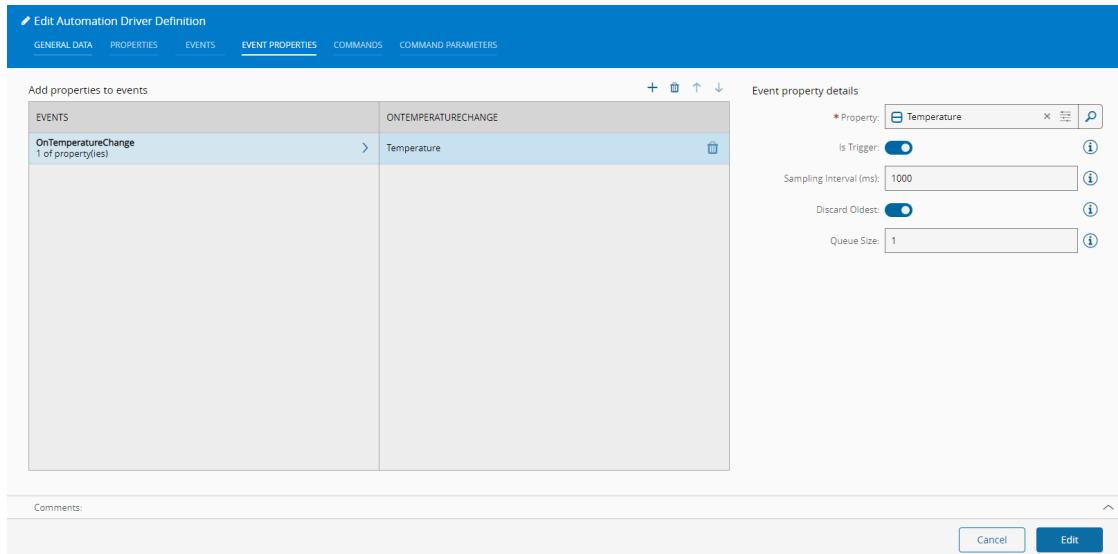
Cancel Edit

3. Select Event Properties step

4. Select the previously created Event and select + to add a Property to the Event

5. In the Property details, provide:

- The previously created Property
- The `Is Triggered` flag. In this case we only have one tag that we are monitoring, but with multiple tags it's very important to accurately decide what tag will you use as your trigger.
- The Sampling Interval in milliseconds
- The discard oldest flag
- The queue size



The screenshot shows the 'Edit Automation Driver Definition' interface with the 'EVENT PROPERTIES' tab selected. On the left, there's a table titled 'Add properties to events' with a single row for 'OnTemperatureChange'. On the right, under 'Event property details', the 'Property' is set to 'Temperature', 'Is Trigger' is turned on, 'Sampling Interval (ms)' is set to 1000, 'Discard Oldest' is turned off, and 'Queue Size' is set to 1. At the bottom right are 'Cancel' and 'Edit' buttons.

With this settings, when the `OnTemperatureChange` event is triggered, MES will receive the Temperature value, at the time it did happen. This tutorial does not focus on the equipment commands so skip the Commands panel and select `Edit` to complete your changes.

## Automation Controller

Let's go over the **Automation Controller** Oven Controller and define the logic that will support the described scenario.

1. Go to `Views > Workflow`, and in the page right panel select `+` and edit, then and rename the page to a more friendly name, for example `HandleTemperatureChange`
2. Drag and drop the following tasks:
  - `On Equipment Event`: to listen to the Event "OnTemperatureChange", and to retrieve Temperature values
  - `Expression Evaluator`: to assess if the Temperature is above 200 degrees
  - `Log Message`: to print the message into the console, in case the Temperature evaluation result is true



3. Go to the `On Equipment Event` settings and for the Equipment Event, select the Event `OnTemperaturechange`.

On Equipment Event Settings

**GENERAL**      **OUTPUT**

**General**

Name: On Equipment Event  
 Description:  
 Color:   
 Driver: OPC Server

**Event**

Auto activate:   
 All events:

\* Equipment Event:

\* Working Mode:

Comments:

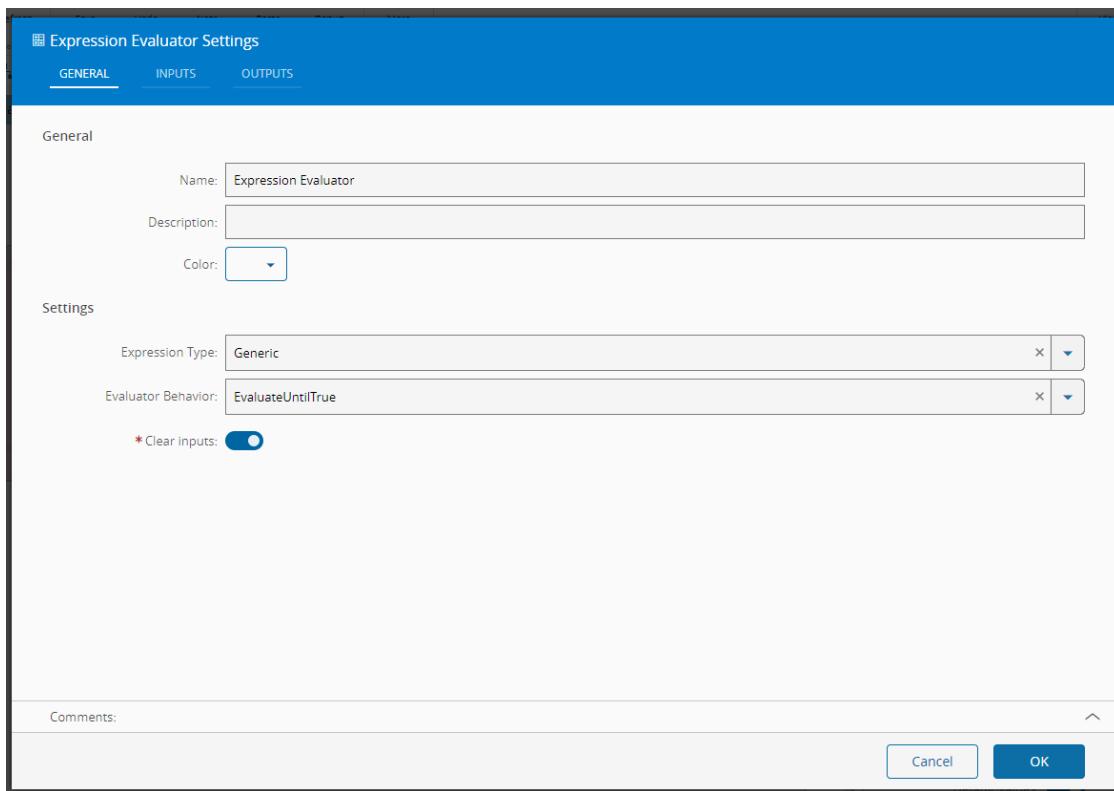
4. Confirm that in the output field the Temperature Property is prompted

HandleTemperatureChange

On Equipment Event

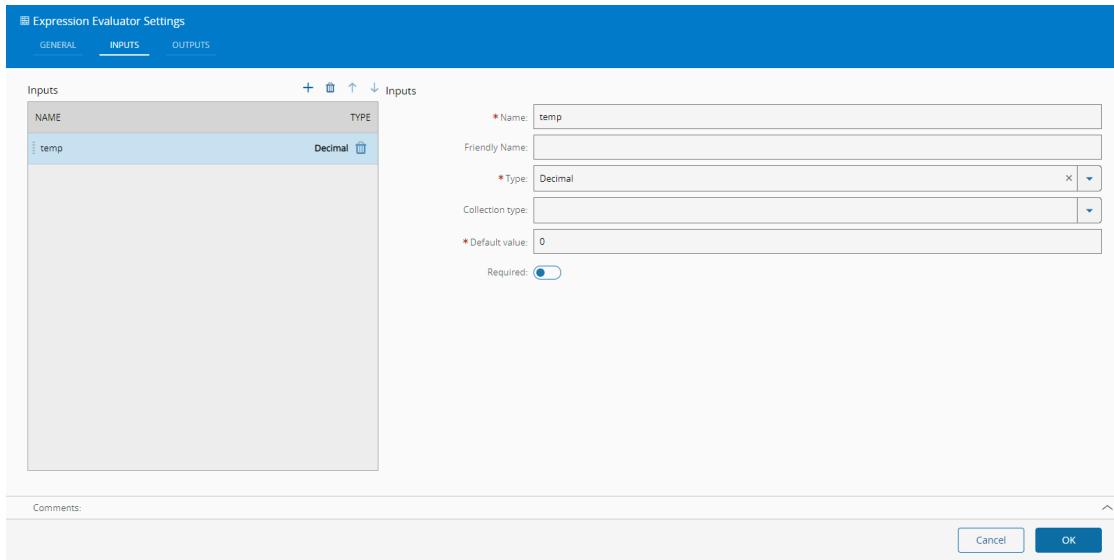
event	Not applicable
AutomationEvent	
timestamp	Not applicable
DateTime	
eventRawData	Not applicable
Object	
\$Temperature	Not applicable
Decimal	
Activate	any
Error	Object

5. Go to the **Expression Evaluator** settings



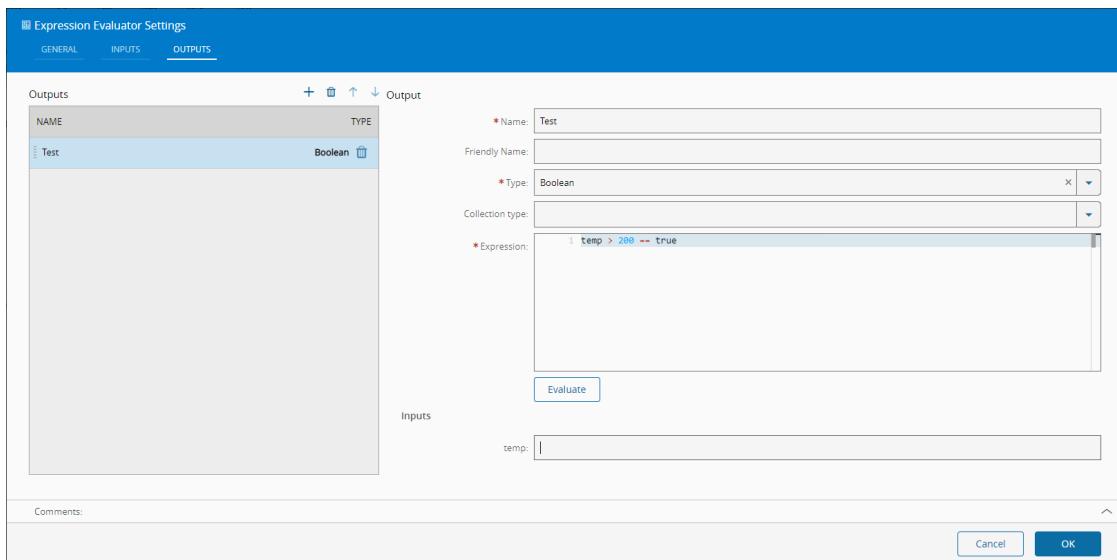
6. Go to the Inputs step, select + to add an input and provide:

- A name
- A Type
- A default value



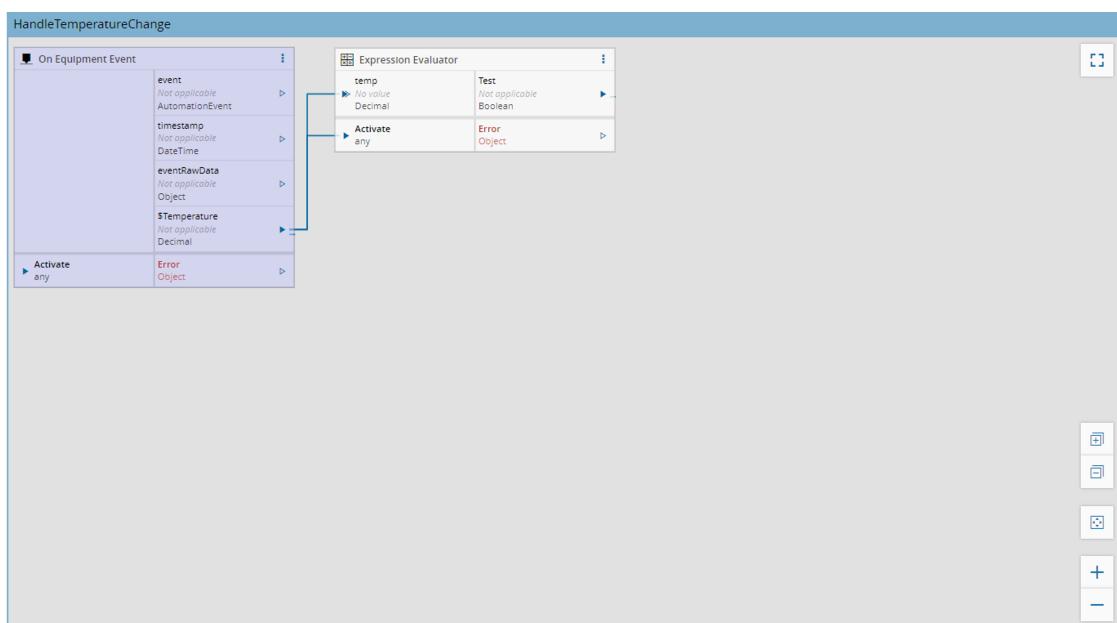
7. Go to the Outputs step, select + to add an output and provide:

- A name
- A Type
- The expression to evaluate the Temperature value: `temp > 200 == true`



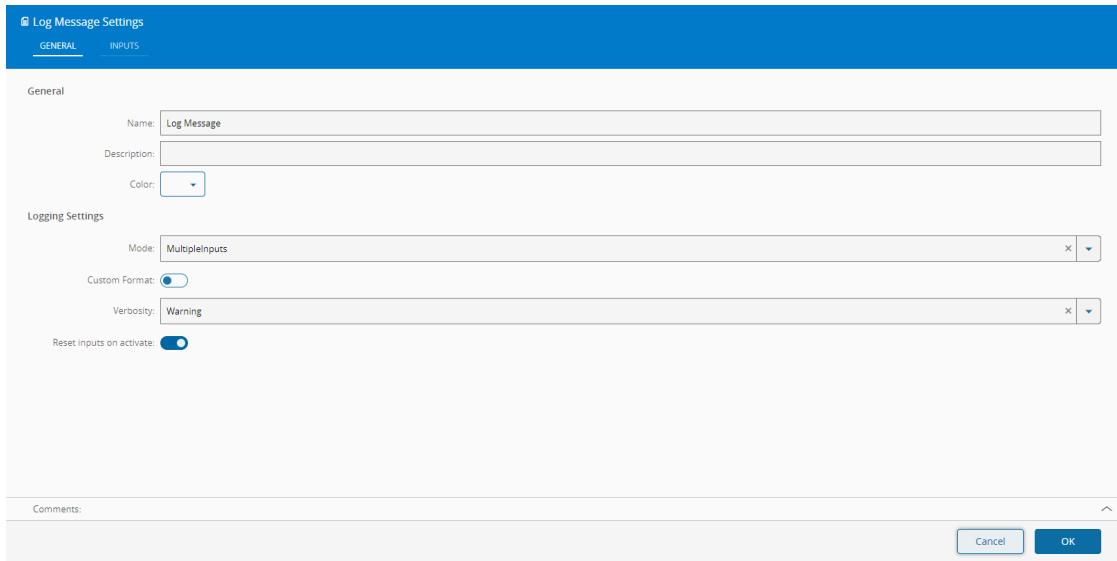
#### 8. Link:

- The Temperature output of On Equipment Event to the Expression Evaluator created input
- The Temperature output of On Equipment Event to the Expression Evaluator Activate



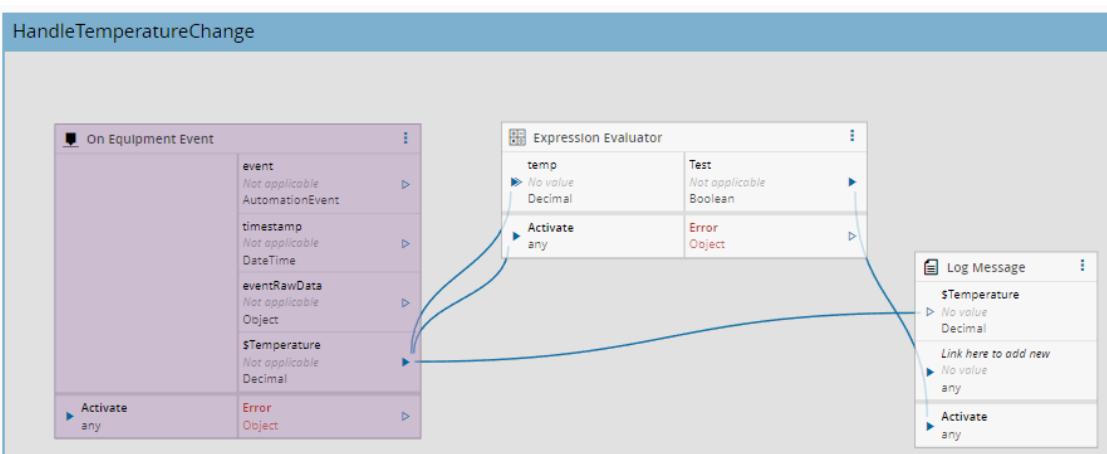
9. Link the Expression Evaluator Output to the Log Message Activate

10. Go to the Log Message settings, and set the verbosity to warning, select OK



### 11. Link:

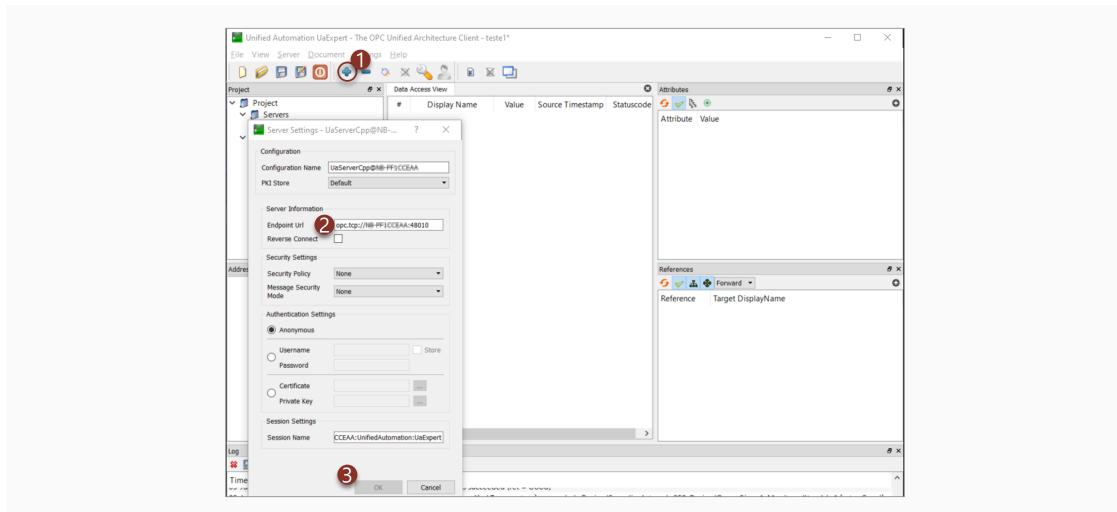
- The Expression Evaluator output Test to the Log Message Activate
- The On Equipment Event Temperature output to the Log Message output



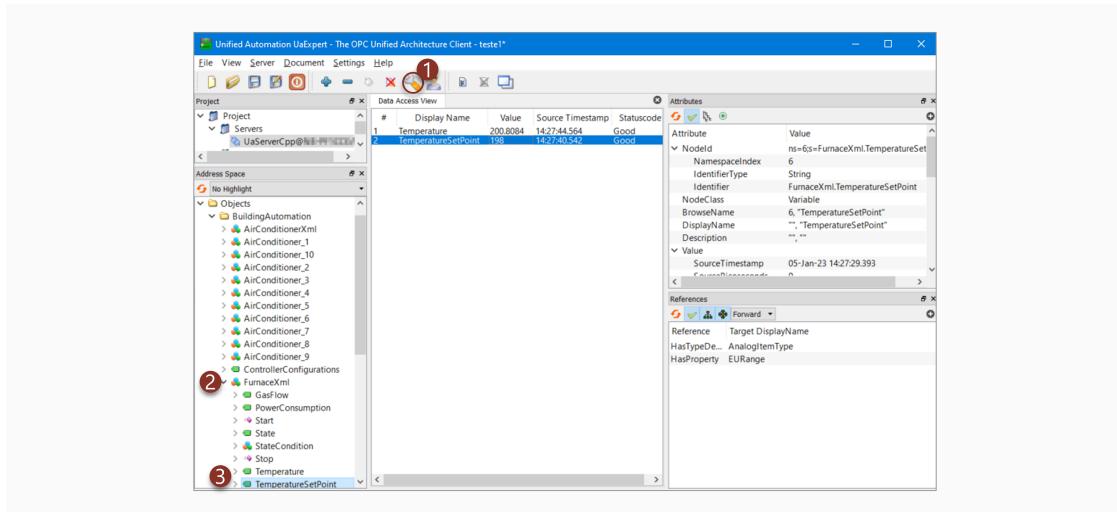
## Equipment Simulator Tests

In order to test this integration tutorial, we can use a free OPC/UA server (to mimic the behavior of an equipment) available at <https://www.unified-automation.com/products/server-sdk/c-ua-server-sdk.html> as well as an OPC/UA client (to set the values of the server accordingly), available at <https://www.unified-automation.com/products/development-tools/uaexpert.html>.

1. Go to the websites listed above to download and install the UaCPPServer server software and Unified Automation UaExpert client software.
2. Start the server.
3. Run the UaExpert client. Add a server, set the Endpoint Url to the server displayed on UaCPPServer, and select OK



4. Select Connect, and on the address space, go for `BuildingAutomation > FurnaceXml`, and drag and drop Temperature and TemperatureSetPoint to the Data Access View



#### Note

Note that the Automation Manager Console has no warnings logs with the Temperature values.

#### Note

If you are having issues dragging and dropping the properties to the Data Access View, consider running windows troubleshoot and lowering the Operating System, there have been reported issues for older versions with Windows 11.

1. Set the Temperature Set Point to a value greater than 200. By setting the set point the temperature will rise to match it.
2. The Automation Manager Console will show a warning log entry with the Temperature value.

```
2023-01-05 14:11:03.151 INFO: Sending Event Occurrence: "Thu Jan 05 2023 14:11:03 GMT+0000 (Western European Standard Time)" ["OnTemperatureChange (230105141103000000000000)"]
2023-01-05 14:11:03.152 INFO: Temperature=199.6776000000000254 || original=datatype='Double', arrayType='Scalar', dimensions=<null>, value=199.6776000000000254
2023-01-05 14:11:03.152 INFO: Received Event Occurrence: "Thu Jan 05 2023 14:11:03 GMT+0000, OnTemperatureChange"
2023-01-05 14:11:03.152 DEBUG: Temperature=199.6776000000000254 || raw=datatype='Double', arrayType='Scalar', dimensions=<null>, value=199.6776000000000254, $id='5'
2023-01-05 14:11:03.166 INFO: "OnTemperatureChange (230105141103000000000000) received from DriverProxy
2023-01-05 14:11:03.166 DEBUG: [4#fd8dfc|HandleTemperatureChange|task_25975|equipmentEvent] Event 'OnTemperatureChange' received from DriverProxy
2023-01-05 14:11:03.230 INFO: "OnTemperatureChange (230105141103000000000000) emitted
2023-01-05 14:11:03.230 DEBUG: [4#fd8dfc|HandleTemperatureChange|task_26244|switch] Switch Input 'false' changed to 'false'. Checking potential matches...
2023-01-05 14:11:03.230 DEBUG: [4#fd8dfc|HandleTemperatureChange|task_26244|switch] Triggering output False: 0
2023-01-05 14:11:04.160 INFO: Sending Event Occurrence: "Thu Jan 05 2023 14:11:04 GMT+0000 (Western European Standard Time)" ["OnTemperatureChange (230105141104000000000000)"]
2023-01-05 14:11:04.161 INFO: Temperature=199.9346000000000255 || original=datatype='Double', arrayType='Scalar', dimensions=<null>, value=199.9346000000000255
2023-01-05 14:11:04.161 INFO: Received Event Occurrence: "Thu Jan 05 2023 14:11:04 GMT+0000, OnTemperatureChange"
2023-01-05 14:11:04.161 DEBUG: Temperature=199.9346000000000255 || raw=datatype='Double', arrayType='Scalar', dimensions=<null>, value=199.9346000000000255, $id='5'
2023-01-05 14:11:04.161 DEBUG: [4#fd8dfc|HandleTemperatureChange|task_25975|equipmentEvent] Event 'OnTemperatureChange' received from DriverProxy
2023-01-05 14:11:04.161 DEBUG: [4#fd8dfc|HandleTemperatureChange|task_25975|equipmentEvent] Emitting property Value=199.9346000000000255
2023-01-05 14:11:04.222 DEBUG: [4#fd8dfc|HandleTemperatureChange|task_26244|switch] Switch Input 'false' changed to 'false'. Checking potential matches...
2023-01-05 14:11:04.222 DEBUG: [4#fd8dfc|HandleTemperatureChange|task_26244|switch] Triggering output False: 0
2023-01-05 14:11:06.170 INFO: Sending Event Occurrence: "Thu Jan 05 2023 14:11:06 GMT+0000 (Western European Standard Time)" ["OnTemperatureChange (230105141106000000000000)"]
2023-01-05 14:11:06.170 DEBUG: Temperature=-200.1916000000000255 || original=datatype='Double', arrayType='Scalar', dimensions=<null>, value=-200.1916000000000255
2023-01-05 14:11:06.171 INFO: "OnTemperatureChange (230105141106000000000000) received from DriverProxy
2023-01-05 14:11:06.171 DEBUG: [4#d4861b|HandleTemperatureChange|task_25975|equipmentEvent] Event 'OnTemperatureChange' received from DriverProxy
2023-01-05 14:11:06.171 DEBUG: [4#d4861b|HandleTemperatureChange|task_25975|equipmentEvent] Emitting property Value='Temperature' = -200.1916000000000255
2023-01-05 14:11:06.232 DEBUG: [4#d4861b|HandleTemperatureChange|task_26244|switch] Switch Input 'true' changed to 'true'. Checking potential matches...
2023-01-05 14:11:06.232 DEBUG: [4#d4861b|HandleTemperatureChange|task_26244|switch] Triggering output True: 1
2023-01-05 14:11:06.263 WARN: [2648631b|HandleTemperatureChange|task_26279|logMessage] $Temperature = -200.1916000000000255
```

You now have a built structure using Connect IoT that can connect to an equipment and retrieve values according to a specific business logic workflow. This is the end of the intermediate configuration tutorial.

## Communicating with the MES

So far we have integrated with the machine, applied conditional logic and now we want to post all the datapoints over the limit on a DataCollection. This could be the use case of the oven not even being operational for temperatures bellow a certain threshold, so we can discard them.

We will now require tasks that are MES specific.

1. In the Automation Controller in the **MES**, select **Views > Details**, then the **Edit** button and in the **Tasks** tab and check the **Critical Manufacturing Tasks** and select the button **Edit**. To go back to the workflow select **Views > Workflow**.

**Edit Automation Controller**

GENERAL DATA | DRIVERS DEFINITIONS | **TASKS**

Select Tasks Packages

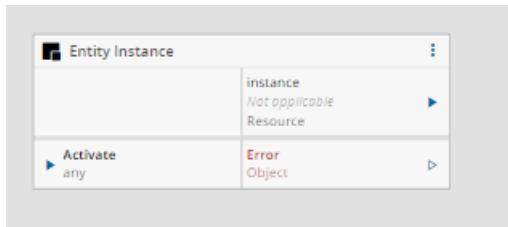
PACKAGES	CRITICAL MANUFACTURING TASKS	Selected Tasks (51)
<input checked="" type="checkbox"/> <b>CORE Tasks</b> Version 9.1.6-202302242	>  Update KPI	<input checked="" type="checkbox"/> Arithmetic Operation
<input checked="" type="checkbox"/> <b>Critical Manufacturing Tasks</b> Version 9.1.6-202302242	>  Measurement	<input checked="" type="checkbox"/> Switch
<input type="checkbox"/> <b>Factory Automation Tasks</b> Version 9.1.6-202302242	>  Data Collection	<input type="checkbox"/> Store Data
<input type="checkbox"/> <b>OPC-UA Tasks</b> Version 9.1.6-202302242	>  Recipe List Requested	<input type="checkbox"/> Retrieve Data
<input type="checkbox"/> <b>ASIM ODBC Tasks</b> Version 9.1.6-202302242	>  Recipe Body Requested	<input type="checkbox"/> Expression Evaluator
<input type="checkbox"/> <b>File Drivers Tasks</b> Version 9.1.6-202302242	>  Get Pick Map	<input type="checkbox"/> On System Event
<input type="checkbox"/> <b>SECS/GEM Tasks</b> Version 9.1.6-202302242	>  Substrate Map To String	<input type="checkbox"/> Log Message

Commands:

**Cancel** **Edit**

In the workflow tab, you will now have access to the new tasks. We will use the Entity Instance task and the Data Collection task.

2. The Entity Instance task serves to retrieve the entity that is associated to our Automation Manager, in this case it will be a Resource called Baker-01.

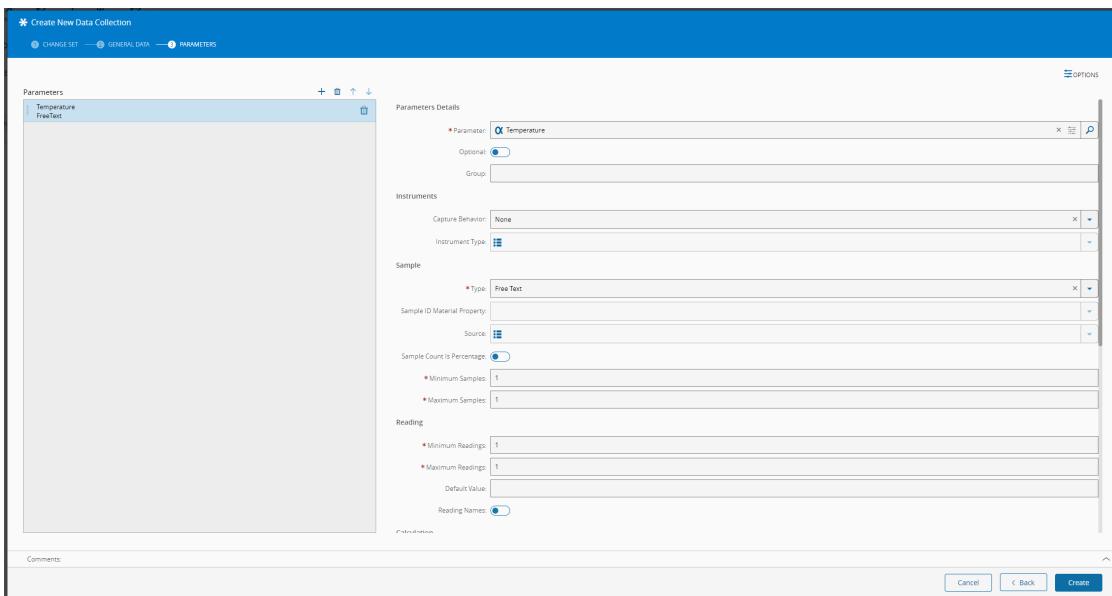


3. Before adding the Data Collection task we must create in the MES the Parameter and the Data Collection.

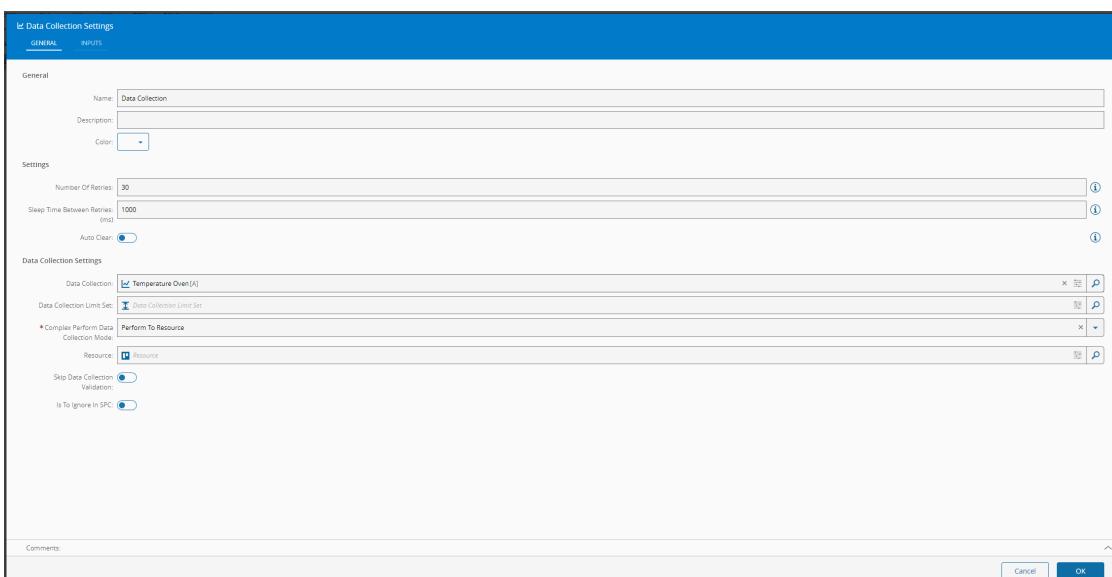
To do so, first we will need to create a unit, and in order to do that, go to Administration > Tables > LookUp Tables and open the Units table. Now, let's add a new value to the table, for example °C and save. Feel free to already add °K, we will need that later on.

4. Now select Business Data > Parameter and select New. Create a new parameter with name Temperature, data type Decimal and Units will be °C and select Create.

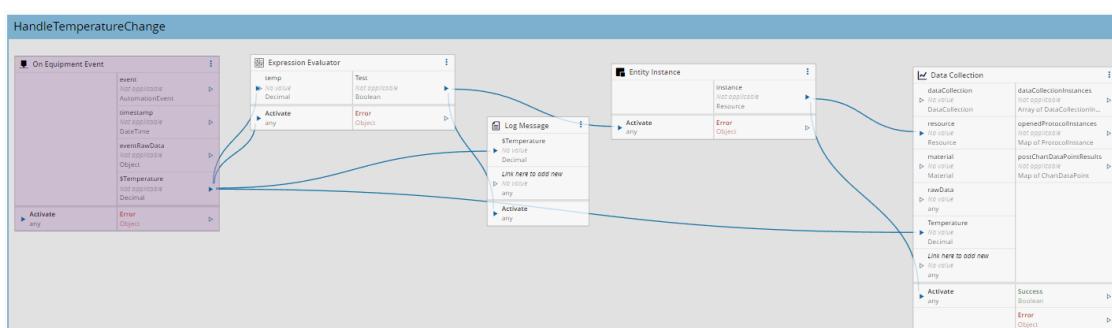
5. We can now create the Data Collection. Go To Business Data > Data Collection and select New. Leave the defaults, give the name Temperature Oven and use the parameter Temperature we have created.



6. Now add the **Data Collection** task to the Automation Controller workflow. Select the Data Collection Temperature Oven and we will use only the resource scope, so select Perform to Resource, in the Complex Perform Data Collection Mode.



7. Link the **Expression Evaluator** Output to the **Entity Instance Activate**.  
8. Link the **Entity Instance Output** to the input resource of the **Data Collection** task and to the **Data Collection** task activate.  
9. Link the **\$Temperature** from the **On Equipment Event** to the input Temperature of the **Data Collection** task.



In the console output of the Automation Manager you should now see the posts being performed. Notice that very small changes are generating posts. If you want to see the data in the MES you can go, for example to the Resource Baker-01 and see the Collected Data tab.

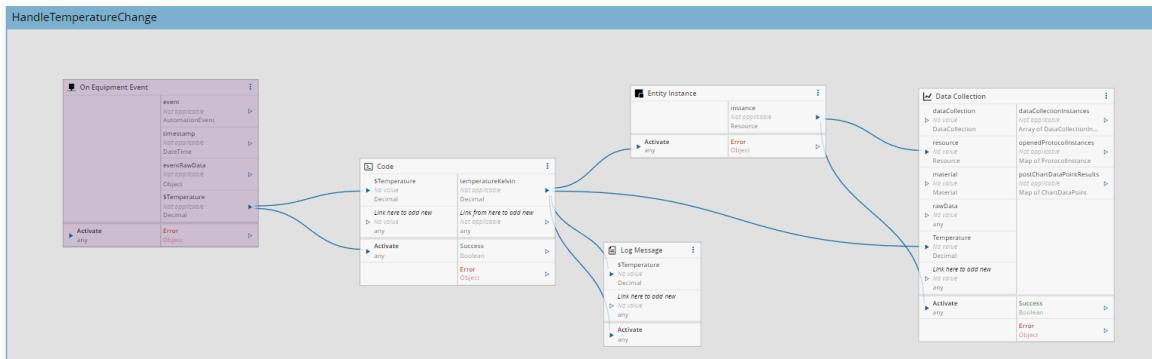
```
2023-03-17 10:47:53.725 info: Sending Event Occurrence: 'Fri Mar 17 2023 10:47:53 GMT+0000 (Western European Standard Time)', 'OnTemperatureChange (2303151030560000001)'  
temperature=200,2691999995783 || original=datatype='Double', arraytype='Scalar', dimensions=<null>, value=200,2691999995783  
2023-03-17 10:47:53.725 info: Received Event Occurrence: 'Fri Mar 17 2023 10:47:53 GMT+0000', 'OnTemperatureChange':  
temperature=200,2691999995783 || rawdatatype='Double', arraytype='Scalar', dimensions=<null>, value=200,2691999995783, $id='5'  
2023-03-17 10:47:53.726 debug: [aa595ee1]HandleTemperatureChange|task_7814[equipmentEvent] Event 'OnTemperatureChange' received from DriverProxy  
2023-03-17 10:47:53.726 debug: [aa595ee1]HandleTemperatureChange|task_7814[equipmentEvent] Emitting property value 'Temperature'=200,2691999995783  
2023-03-17 10:47:53.788 warn: [aa595ee1]HandleTemperatureChange|task_2444|logMessage] $Temperature = 200,2691999995783, Read  
ingNumber=1  
2023-03-17 10:47:53.887 info: [aa595ee1]HandleTemperatureChange|task_10931[dataCollection] Performing data {$id=<null>, $type='Cmf.Navigo.BusinessObjects.DataCollectionPoint, Cmf.Navigo.BusinessObjects', TargetEntity:$id='<null>', $type='Cmf.Navigo.BusinessObjects.Parameter, Cmf.Navigo.BusinessObjects', Name='Temperature'}, Value=200,2691999995783, Read  
ingNumber=1 into Resource Baker-01...  
2023-03-17 10:47:53.887 info: [aa595ee1]HandleTemperatureChange|task_10931[dataCollection] Successfully performed data into Resource Baker-01.
```

The next and final challenge is changing the sensitivity of our post to be just when it changes above 1°C and then we want to collect it in Kelvins and not in Celsius.

1. If you haven't done so already, add to the Units lookup the °K value.
2. In the Parameter Temperature, edit the unit to °K.
3. Delete the Expression Evaluator task, it will no longer be needed.
4. In the Automation Controller workflow, we could still use the Expression Evaluator, but let's try and use a different task that allows us to do more complex transformations, the Code task. This task allows us to write typescript code snippets. The goal for our code task is to handle the transformation to Kelvin, and to check if the temperature is above 200 and if it has 1° of difference to the previous posted value.
  - Link the output \$Temperature to the Link here to add new in the Code task and to the Activate of the Code task.
  - Add the Output temperatureKelvin as type Decimal
  - Replace the code in the main function with the following:

```
public async main(inputs: any, outputs: any): Promise<any> {  
  
  // Save Input as number  
  const temperatureInput = inputs.$Temperature as number;  
  // Retrieve last persisted temperature  
  const lastTemperature = await this.framework.dataStore.retrieve("lastTemperature", 0);  
  
  // Only check temperatures above 200°C  
  if (temperatureInput > 200){  
    // Convert to Kelvin  
    const temperatureKelvin = temperatureInput + 273.15;  
    // Delta of last posted temperature and new temperature  
    const temperatureDifferential = Math.abs(temperatureKelvin) -  
      Math.abs(lastTemperature);  
  
    // Delta must be above 1°  
    if (temperatureDifferential > 1) {  
      // Persist new temperature  
      await this.framework.dataStore.store("lastTemperature", temperatureKelvin,  
        "Temporary");  
      // Emit new temperature  
      outputs.temperatureKelvin.emit(temperatureKelvin);  
    }  
  } else {  
    this.framework.logger.debug("Temperature below 200 celsius will be discarded");  
  }  
}
```

5. Link the temperatureKelvin of the Code Task to the input Temperature of the Data Collection task, to the Activate of the Entity Instance task and to the \$Temperature and Activate of the Log Message.
6. Save the new workflow configuration



In the console output, notice you will now have two new log messages. One for temperature bellow 200°C:

```
2023-03-20 14:00:40,941 info: Sending Event Occurrence: 'Mon Mar 20 2023 14:00:40 GMT+0000 (Western European Standard Time)', 'OnTemperatureChange (2303151030560000001)'  
Temperature=199.95739999998423 || original=datatype='Double', arrayType='Scalar', dimensions='<null>', value=199.95739999998423  
2023-03-20 14:00:40,941 info: Received Event Occurrence: 'Mon Mar 20 2023 14:00:40 GMT+0000', 'OnTemperatureChange':  
Temperature=199.95739999998423 || rawdatatype='Double', arrayType='Scalar', dimensions='<null>', value=199.95739999998423, $id='5'  
2023-03-20 14:00:40,942 debug: [f43af033b]HandleTemperatureChange|task_7814[equipmentEvent] Event 'OnTemperatureChange' received from DriverProxy  
2023-03-20 14:00:40,942 debug: [f43af033b]HandleTemperatureChange|task_7814[equipmentEvent] Emitting property value 'Temperature'=199.95739999998423.  
2023-03-20 14:00:40,972 debug: Retrieving data identified with 'lastTemperature'  
2023-03-20 14:00:40,973 debug: [<>root>]HandleTemperatureChange|task_2298|codeExecution| Temperature bellow 200 celsius will be discarded
```

Another message for, when the temperature differential is above 1°C:

```
2023-03-20 13:58:29,907 info: Sending Event Occurrence: 'Mon Mar 20 2023 13:58:29 GMT+0000 (Western European Standard Time)', 'OnTemperatureChange (2303151030560000001)'  
Temperature=201.33999999998431 || original=datatype='Double', arrayType='Scalar', dimensions='<null>', value=201.33999999998431  
2023-03-20 13:58:29,908 info: Received Event Occurrence: 'Mon Mar 20 2023 13:58:29 GMT+0000', 'OnTemperatureChange':  
Temperature=201.33999999998431 || rawdatatype='Double', arrayType='Scalar', dimensions='<null>', value=201.33999999998431, $id='5'  
2023-03-20 13:58:29,908 debug: [f43af034]HandleTemperatureChange|task_7814[equipmentEvent] Event 'OnTemperatureChange' received from DriverProxy  
2023-03-20 13:58:29,908 debug: [f43af034]HandleTemperatureChange|task_7814[equipmentEvent] Emitting property value 'Temperature'=201.33999999998431  
2023-03-20 13:58:29,939 debug: Storing data identified with 'lastTemperature'  
2023-03-20 13:58:29,939 debug: Storing data identified with 'Temporary' for 'lastTemperature': 474.4099999999843  
2023-03-20 13:58:29,955 warn: [f43af034]HandleTemperatureChange|task_2444|logMessage| *** 474.4099999999843 in Kelvin ***  
2023-03-20 13:58:29,986 debug: [f43af034]HandleTemperatureChange|task_10931|dataCollection| Performing data [uid:'<null>', type:'Cmf.Navigo.BusinessObjects.DataCollectionPoint', Cmf.Navigo.BusinessObjects', TargetEntity:[ob  
jectId:110, objectName:Temperature], On:2019-07-15T10:00:00Z, Parameter: 'Cmf.Navigo.BusinessObjects', Name:'Temperature'], Value:474.4099999999843, ReadingNumber:1] into Resource Baker #1...  
2023-03-20 13:58:30,178 info: [f43af034]HandleTemperatureChange|task_10931|dataCollection| Successfully performed data into Resource Baker #1
```

You now have a built structure using Connect IoT that can connect to an equipment and retrieve values according to a specific business logic workflow. This is the end of the intermediate configuration tutorial.



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