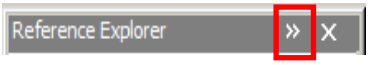
# Basic Engineering in SmartPlant Instrumentation

## Add a Loop & Instruments

In this task you will add a new open flow loop with a flow element and a flow transmitter. For the flow element you will select an existing process line.

***Hint:*** Keyboard short cuts: to open the Domain Explorer (left explorer) press **F7.**
Keyboard short cuts: to open the Reference Explorer (right explorer) press **F8.**
Or through the **Tools** menu (upper toolbar)

***Hint:*** Please click the >> icon on the Reference Explorer (right explorer) for a larger working space, clicking on the minimized explorer will restore it.




The instruments types that you select are pre-configured to comply with these instrument types.

1. In the Domain Explorer tree view, expand the **New Refinery** > **Crude Area** > **Crude Unit 1 > Loops.**
2. Select the **Loops** node, and from the right-click menu select **New** > **Loop...**
3. In the 'New Loop Number' dialog, enter the new loop name **101-F -301** (pay attention to the fixed text and the hyphens) and click **OK**.
4. On the **Loop Number Properties** dialog note the **Measured variable** property (**FLOW**).
    a. Fill in loop service
    b. Select any P&ID drawing from the list, then click **OK**.
5. Click **Yes** when prompted if you want to add new tag number.
6. On the **New Tag Number** dialog type-in the new instrument name **101-FE -301** (pay attention to the fixed text and the hyphens) and click **OK**.
7. On the **Select Instrument Type** dialog select **FE - D/P TYPE FLOW ELEMENT (Flow)** and click **OK.**
8. Explore the **Tag Number Properties** dialog. Note the ellipsis button next to each field that enables quick access to support tables and other information and various plant entities such as the P&ID drawing number and line number.
9. For the **Line** property select **4"-P-1501-11H** then click **Apply**. This line already has pre-defined process data which will be copied later to the flow element.
10. Click **New** to add the following instrument:
    a. Add new tag **101-FT -301**, select instrument type **FT - D/P TYPE FLOW TRANSMITTER**. Note that the **I/O type** is set to **AI** (Analog Input).
    b. Add new tag **101-FI -301**, select instrument type **FI – Flow Indicator (DCS).**
    c. Click OK to close the dialog.
11. On Domain Explorer, expand loop **101-F -301**. You can right click the loop or any of its components, and select Properties from the pop up menu to open its properties dialog.

Tip: Selection of instrument type is required only if there are multiple choices of the same abbreviation of that instrument type in the name.

## The Instrument List

In this task you will explore the Instrument Index browser.

1. From the menu, select **Modules** > Instrument **Index** or select the **Index** icon 

.
2. Click the **Browse** icon 

from the bottom toolbar. Explore some of the instrument index features;

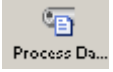
   Note: Yellow properties are "write protected"; white properties are editable.

   Columns such as manufacturer name, model name, Location and others are customizable as supporting tables and are seen and function in the index as pick-lists.

   - Values for the selection lists can be selected from support tables. These tables are accessible by selecting the **Open Supporting Table...** commands from the popup menu when you highlight a cell with pick lists and right click the mouse button.
   - You can count records by clicking the 'Count' icon.
   - Click the **Print** icon to invoke the Instrument list report. In the print preview you can revise the document and compare with previous of the document.
   - Select any tag number and click the **Documents** icon (on the module, bottom toolbar) to view its documents.
   - In the browser window, double click the **Tag Number** header to sort by the instrument name. Repeat to sort by descending order.

## Add Process Data

Engineering process data can be entered directly in SPI, it can also be entered remotely using the external process data editor and later imported into SPI. following the process data workflow, enables process engineers to control when process data can be used by instrumentation engineers. Note that SPI supports multiple process data cases for an instrument.

1. Double click the **Loop Name** header to sort.
2. Scroll down to loop **101-F -301**.
   a. *Hint*: You can use the **Find** icon to locate the loop (use the "**String**" radio button).
3. Select tag number **101-FE -301** and then click the **Process Data** icon 

(upper toolbar).
4. Press the **Instrument** button 

. In the **Enter Tag Number** dialog type-in **101-FE-301** and click **OK**.
5. When prompt to process data click **OK**.

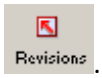
6. Experience process data units of measure conversion: change the **Upstream pressure** unit of measure to **psi;** observe the value being re-calculated.
7. In the **Additional Properties** section, in **Required range**, enter a range of 0-40 m³/h @flow.

You can proceed to the flow element calculation or try the revision and archive.

### *Revisions and archiving*

In this task, you will generate the process data report, revise the document, and experience the comparison feature.

1. Click the **Generate Reports** icon 

. When prompted to save the process data, answer **Yes**.
2. Reports can be revised and archived inside the application. Click the **Revision** icon 

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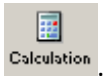
3. Select any revision method and click **New**. Enter revision data and click **OK**. Click **OK** when a save confirmation message opens.
4. Close the report tab (hint: right-click on the tab name and select **Close**).
5. Change the Normal flow rate from **30** to **28.**
6. When prompted, save the data.
7. Re-open the process data report.
8. Click the **Compare** icon. Select the **Compare the current report with an archived res. port** and click **OK.**
9. Select the revision and click **OK.**
10. In the **Changes report**, review the process data changes.
11. Switch back to the process data report. Review the marked change.

Now try to calculate a flow element...

### Calculate a Flow Element

SPI features various flow element calculations as well as other types of calculation. In this task, you will calculate an orifice plate.

1. From the main toolbar, click the **Calculation** icon 

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2. Click the **Flowmeter** icon 

on the lower toolbar. In the dialog, type the tag number **101-FE -301** according to the mask and then click **OK**.
3. The calculation opens with the process data sheet (similar to the process data module). Click the **Calculate** icon 

(bottom toolbar).
4. In the **Flowmeter calculation** dialog enter the following data:
    a. **Flowmeter type** = **Square Edge Orifice**
    b. Sub type = **Flange tapping [ISO 5167 (1998) R.W. Miller]**
    c. **Orifice Material** = **310 S.S.**
    d. Select the **Calculate discharge coefficient** checkbox.

e. In the **Select calculate field** frame, select the **Orifice Diameter** option.
f. In the **Full scale flow** option select **m³/h** and **@Flow** condition then set the value of 36 as the value.
g. In the **Differential range**, select **inH2O** as unit of measure and then type **100** as the value (make sure to leave the option button unchecked.)
h. Click **Calculate**. The orifice diameter and beta ratio are displayed.
i. Click **Close** (on the dialog window) and then click the **Save** icon 

(in the bottom toolbar).
j. Click the **Report** icon 

to see the output calculation sheet.

After entering the process data and calculating the orifice, the next step is to fill in the data sheet so an instrument package can be produced and delivered to various vendors for bids.

## Create Data Sheet

SmartPlant Instrumentation enables you to present your data sheets in the format that best meets your needs and according to your organization standards. Data sheets (or as they are called in SPI, Specification sheets) can be customized once to suit your needs.

Note that an instrument can be associated with multiple different forms. This can help during the design phase of a project when engineers send datasheets for bids to several vendors, and still didn't decide the specific nature of the instrument that is required. The module also supports separate data sheets if an instrument has multiple process cases.

To add a specification sheet, follow these steps:

1. From the main menu, select **Modules**> **Specifications** (or press the 

icon in the top toolbar).
2. From the toolbar select **Open Spec.**
3. In the **Open Specification** dialog enter item number **101-FE-301**.
    a. Hint: you can use the **Find** button to look for certain tags.
4. In the **Form number** field enter **11** or use the **Find** button to look up the form **Orifice Plate**.
5. In the **New Specification** dialog accept the document name **101-FE -301-SP**.
6. Click **OK**
7. The specification sheet open with some process data and calculation results already populated.
8. At this point you can continue to fill in additional technical data as you like.
9. When done, click **Save**
10. Click **Print** to review the report. The report and the form are identical (WYSIWYG).

At this point, basic engineering data (index, process data, calculation, & specification sheet) is ready to be used by the designers and engineers.

The next step is to add the data sheet to a Specification Binder.

## Add Data sheet to a Specification Binder

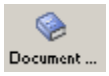
The binder module is used to gather documents in packages called binders so these binders can be printed, revised, and sent for reviews or construction easily. There are two types of binders:

A. Specification binder – Each specification binder includes several types of documents such as:
   - Instrument Specification list (Index sheet)
   - General notes sheet (per entire package)
   - Form notes (per each form)
   - Specification sheets
   - Changes report (from previous revision)

The binder package enables the user to easily group specifications for bidding, purchase, or construction purposes, track the changes, and control the revision.

B. Document Binder – This binder can include any document.

In this task you will add a specification sheet to an existing binder, review the binder features and revise the package.

1. From the main menu, select **Modules** > **Document Binder** (or press the **Document Binder** icon 

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The Document binder screen opens. The left pane displays the available binders. The right pane displays additional details, in this case the documents in the binder. You can open any of these documents by double clicking it.

2. In the hierarchy tree (left pane), expand the binder.
   - Select the **Specification Sheets** folder. The documents assigned are displayed in the tree and in the right window: Each row displays the tag number, the document name, the form number, the process case (if used), the revision and a flag if the data has changed.
   - The change flag is set automatically by the software when data changes but the user can also change it manually.
   - The change flag controls the revision of the relevant spec sheet when revising the package.
3. Select the **Specification Sheets** > **Assign Specification...**
4. In the **Find Items** window click **Find.**
5. Scroll down and select **101-FE -301**.
6. Click **OK**.

7. A prompt window asks whether to change all the specifications' notice to Yes? Click **Yes.**
8. Note that the **Changed** column has been changed to **yes** for all the specifications.

The document is added to the list of specifications.

9. To review/set specification change notification flag (in a separate window) select **Specification Sheets** > **Specification change notification**... Documents marked as **Yes** (or new ='#') will get a new revision number when the packaged is revised.
10. Click **OK**.
11. You can view a "Working issue" of the package; select the **TestDrive Demo, Technical Specification** > **Print** 

command (bottom toolbar).
12. Select Working issue then click OK.
13. After a short processing you should see a preview of the documents. Use the **Next Report** and other navigation icons to review the un-formal package.
14. Close the print preview tabs.
15. To revise the package, select the binder package **TestDrive Demo, Technical Specification** > **Revisions**... (or click the **Revisions** icon 

, bottom toolbar).
16. Type a document number (or accept the existing name).
17. Select **Revision method** from the list.
18. Click **New** and enter the revision information.
19. Click **OK.**
20. Click **OK** when prompted that data was saved successfully.
21. At this point you can print preview the formal binder. Repeat step 9, this time selecting **Formal issue** and the revision, then click **OK**.

# Detail Engineering in SmartPlant Instrumentation

Your next tasks are related to the wiring module detail engineering.

SmartPlant Instrumentation enables you to design the wiring of your plant making it easy to extract detailed wiring reports and loop drawings.

In the following exercises you will terminate the instrument's cable to a junction-box, assign the instrument to an Input/output (I/O) card, and run the automatic cross wiring. Next, you will generate some wiring reports and a loop diagram.

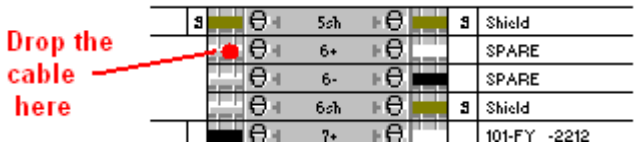
## Conventional Instrument

### *Connect an Instrument to a Junction-Box.*

When you created the flow transmitter 101-FT -301, SPI also created a device panel (a termination panel) and cable connected to it in the background based on the instrument type profile.

You will now connect that cable to a junction box. The junction box is already connected with a multi-paired cable to a marshaling panel.

1. In the Domain Explorer tree view, expand the **New Refinery** > **Panels by Category** > **Junction Boxes > 101-JB-DCS-001**. Note the two terminal strips **TS-1** & **TS-2**.
2. Select the **TS-1** node and expand it to see its terminals.
3. Select **TS-1.** From the right click menu select **Actions**> **Connection…**
   The connection screen opens displaying the terminal strip and the connected cables and wire tag numbers.
4. In the **Domain Explorer**, navigate to **New Refinery** > **Cables > 101-FT -301;** Expand the cable to see its pair and wires.
5. In **Domain Explorer,** select the cable. From the right click menu select **Actions**>**Connection…** the connection screen of the device panel opens. Close the connection screen.
6. While the connection screen of the junction box is open in front of you, select **PR#1** of the device cable (from domain explorer) and drag and drop it onto the left side of terminal **6+**




7. The **Cable Connection Definition** opens. This screen enables you to define how to connect the cable by selecting the cable-end, the termina, l and how to connect each pair. Set the following:
   a. Cable end to connect = **End 2**
   b. Start at Terminal = **6+**
   c. On the grid in the right side select Connection type = **3 in a row (**make sure the row is highlighted)

8. Click **Connect**. The screen closes and the cable is connected.
9. On the right side of terminals 6+, 6-, and 6sh you see the junction box cable connected with the wire tags already updated. This is because the tag's signal is propagated along the connections.

### *Navigate along connections*

The next task will demonstrate how it is possible to navigate along connections. With the connection screen still open, un-highlight **PR#1** (in case it is highlighted).

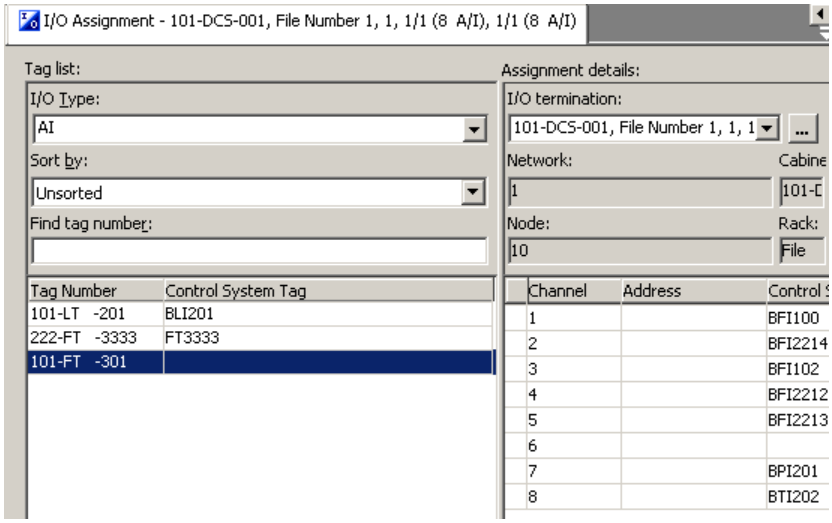
1. Select the wire that is connected to the right side of terminal **6+**
2. From the right click menu select the **Open Adjacent Connection** command
3. The connection screen of **101-MR-DCS-001, FT-1** opens.
4. Note that terminals **6+, 6-, & 6sh** are connected on the left side via the junction box multi-pair cable but there are no connections on the right side.

### *Making the I/O Assignment*

The I/O assignment is the allocation of tags and signals to the appropriate control system (DCS/ PLC) input or output. In the next step you will assign flow transmitter **101-FT -301** to a vacant analog input channel on the DCS I/O card.

1. In the **Domain Explorer** tree view, expand the **New Refinery** > **Panels by Category**> **DCS Panels > 101-DCS-001.** You see the racks (enclosures) **File Number 1 – 3.**
2. Expand **File Number 1**. You see ten slots (1-10)
3. Expand slot 1 to see I/O card **1/1 8 (AI)**
4. Expand card **1/1 8 (AI)** to its lower levels. The card has a strip **(1/1 8 (AI))** with eight **Channels 1-8** where each channels has three terminals.
5. Occupied channels, such as 1, also display the assigned control system tag.
6. To open the I/O assignment screen, right-click card **1/1 8 (AI)** and select **Actions > I/O Assignment…**
7. The I/O assignment screen opens. Channel 6 is vacant.
8. From the toolbar click the **Filter** 

icon.
9. In the **Filter for** section select the **Uncoupled instruments** option and click **OK**.
10. In the tag list window you see tag **101-FT 301**

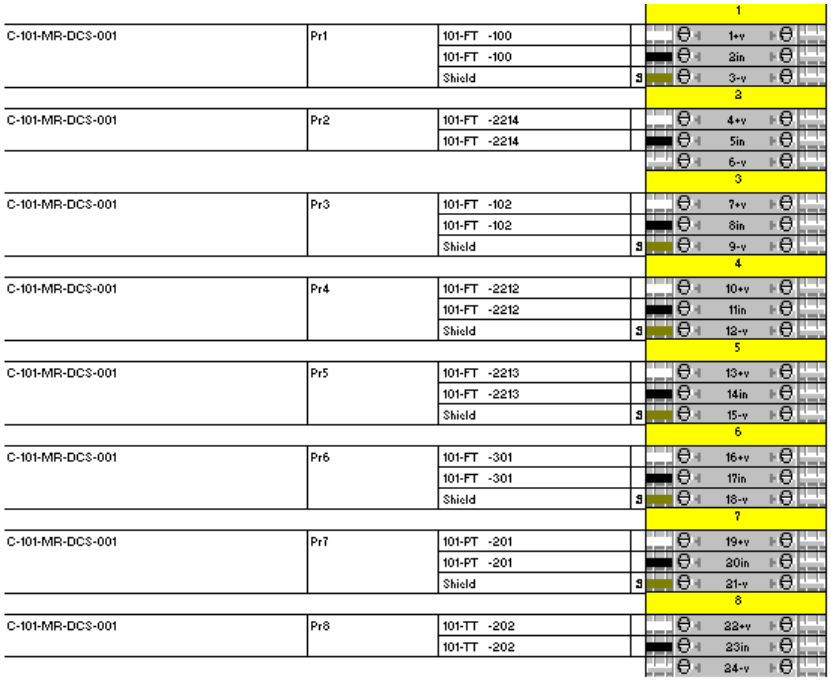



11. Drag and drop tag 101-FT -301 from the tag list pane onto **Channel #6** in the right side.
12. Click **OK** to accept the suggested Control system tag.
    You have completed the I/O assignment task. You can now generate the I/O assignment report.
13. When the I/O assignment screen opens click the **Report** icon from the toolbar. Explore the report and when done close it.

## *Complete the wiring*

So far you have connected the instrument from the field side and made the I/O assignment. The I/O card where you made the I/O assignment is connected via a cable to the marshaling.

1. Close the I/O assignment screen.
2. To open the connection screen: from the domain explorer select I/O card **1/1 8 (AI)> Actions> Connection**.



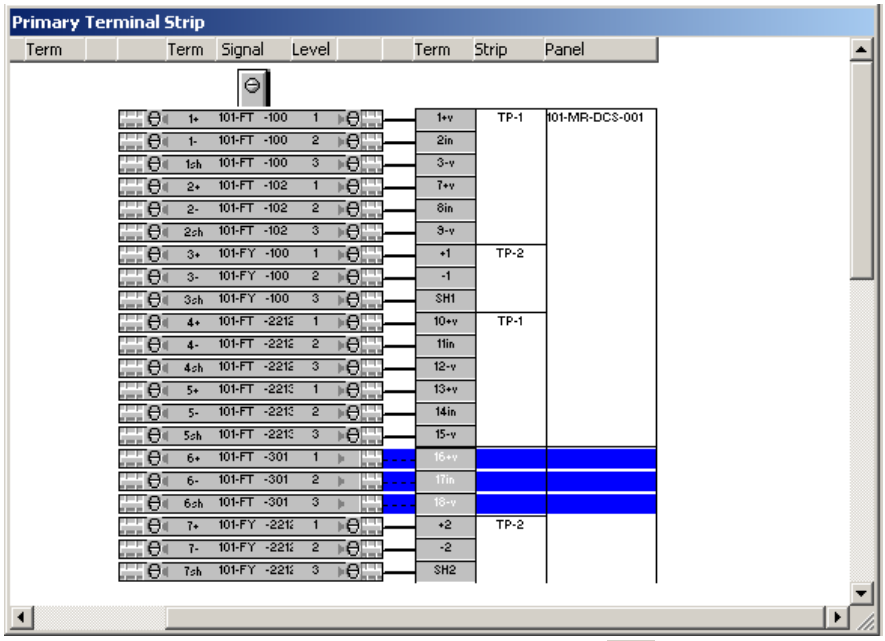

The connection screen opens. Note the grouping of terminals as per the I/O channels.

3. Select the wire that is connected to terminal **16+v**, right click > **Open Adjacent Connection**
4. The connection screen of **101-MR-DCS-001.TP-1** opens. Note the missing cross wires of the flow transmitter 101-FT -301.

The next step is to complete the cross wires of the flow transmitter. Since we have almost a complete signal, running from the field to the control system (including the I/O assignment) with some missing cross wires in the middle, designers can use the **Auto Cross wiring** feature to complete the wiring.

5. From Domain Explorer tree view, navigate to **New Refinery** > **Panels by Category**> **Marshaling Racks > 101-MR-DCS-001**
6. Select **FT-1 > Actions > Cross Wiring**.
7. From the toolbar click the **Auto** 

icon. SPI displays the proposed cross wires and their destinations (marked with blue color).




8. To accept the proposed cross wires click the **Cross**  icon.

At this point, you have completed the wiring activities of this loop.

You can now check some of the reports.

### *Generate a Loop Diagram*

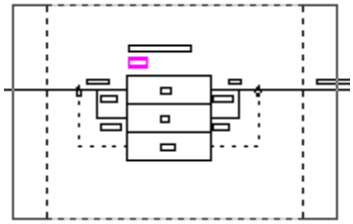
9. In Domain Explorer tree view, expand the **New Refinery** > **Crude Area** > **Crude Unit 1 > Loops**
10. Scroll down to select loop **101-F -301**
11. From the right-click menu select **Apply Generation Method > Enhanced Report > By Loop**
12. Select the loop, from the right click menu select **Reports > Generate Loop Drawings…**
13. Click **OK** in the following dialog.
14. Wait a few seconds for the loop to be generated.
15. Maximize the application window with the loop diagram
16. Click the **Fit**  icon
17. You can zoom-into area, zoom-in or zoom out using these  icons respectively

Note, continue to the next report with the loop drawing open.

### *Generate a Panel-Strip Report*

Now try the following report to see how easy it is to use SPI as a design tool.

1. Click the **Fit**  icon.
2. Zoom into the area of the first junction box.



3. Select the text **TS-1** (below 101-JB-DCS-001).
4. Click the **Generate Item Report**  icon.
5. From the list select **Panel-Strip** then click **OK**
6. Wait for the report to be processed. When done, click the **Fit** icon.
7. Explore the report.

Note, continue to the next report with the panel-strip drawing open.

### *Generate a Strip-Signal Report*

Now try the following report to see how easy it is to use SPI as a design tool.

1. Click the **Fit**  icon.
2. Zoom into the middle area where the main junction-box and strip names appear.
3. Select the **TS-1** text.
4. Click the **Generate Item Report**  icon.
5. From the list, select **Strip Signals** then click **OK.**
6. Wait for the report to be processed. When done, click the **Fit** icon.
   Note: After the report is generated it is possible to arrange it and re-position the objects and to move objects between the sheets.
7. When done, close the Enhanced Report application and all its reports.

### *Generate a Hook-Up Drawing*

*Note: when preparing the testdrive, you need to re-define the hook-up symbols as per the installation drive and directory, otherwise the hook up will not be generated.*

SmartPlant Instrumentation includes an installation detail module. Tags can be assigned to hook-up drawings as they are added to the database using the instrument type profile. This is the case with 101-FT -301.

1. In the Domain Explorer tree view, expand the **New Refinery** > **Hook-Ups** > **FLOW > FLOW INSTR. BELOW RUN-LIQUID.**
2. Explore the objects below the hook-up name. The numbers represent the items required for the installation.
3. Select an item, right click to select **Properties**.
4. Click **OK**.
5. Select the hook-up name **FLOW INSTR. BELOW RUN-LIQUID**
6. Right click and from the popup menu select **Reports>Generate Hook-Up Drawings…**

7. Click **OK**.
8. When the drawing is open, fit it and explore its content.
9. When done, close the Enhanced Report application.

## Fieldbus Instruments

SmartPlant Instrumentation supports Fieldbus instruments and wiring. Foundation Fieldbus network is basically a digital two-wire network where all instruments are connected to these wires in parallel. Foundation Fieldbus instruments can also do the control inside of them, eliminating expensive control systems. There are strict rules on the number of instruments, cable lengths, and so forth in order to have good communication between the instruments in the control system. SmartPlant Instrumentation validation report checks these rules to make sure they comply with industry standards.

In the next exercise you will add a new Fieldbus instrument, connect it to an existing Fieldbus network, activate its function block, and then create two reports: the Fieldbus wiring report and the Fieldbus validation report.

Before making any changes to the Fieldbus network, try to generate the Fieldbus Segment report.

### *Generate Fieldbus Segment Report*

1. In the Domain Explorer tree view, expand the **New Refinery** > **Fieldbus Segments**.
2. Select the **S1** fieldbus segment. Note the three instruments associated with this segment.
3. From the right click popup menu select **Reports** > **Enhanced Segment Wiring…**
4. When the report is generated, maximize the window and click the **Fit**  icon.
5. Explore the report; the instruments are connected via connectors to junction boxes, and then to the control system.
6. You can zoom-into area, zoom-in or zoom out using these  icons respectively.
7. When done, close the Enhanced Report application.

### *Add a Fieldbus Instrument*

In this task you will add a new Fieldbus flow transmitter.

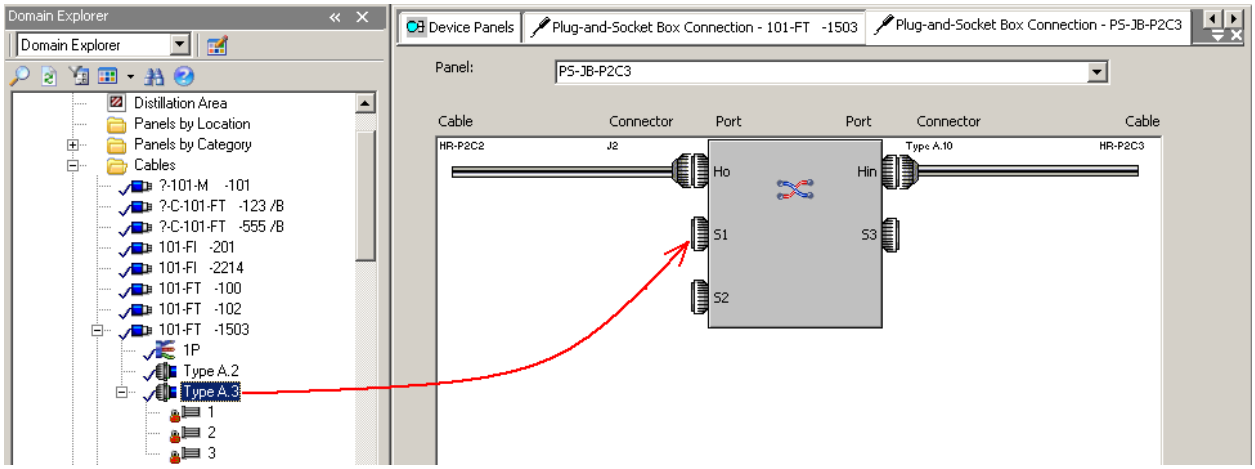
1. In the Domain Explorer tree view, expand the **New Refinery** > **Crude Area** > **Crude Unit 1 > Instruments.**
2. Select the **Instruments** node, from the right click menu select **New** > **Instrument...**
3. In the **New Tag Number** dialog select **Tag class**=**Foundation Fieldbus.**
4. In the **Tag number** field, type the new instrument name **101-FT -1503** and click **OK**.
5. On the **Select Instrument Type** dialog select **FT - Fieldbus FT** and click **OK.**
6. On the **Loop Name** dialog click **Cancel.**

7. On the **Tag Number Properties** dialog, select the **Fieldbus** tab. This dialog enables you to enter specific Fieldbus information such as the current consumption and available function blocks. Note the **AI** (Analog input) function block that appears under **Associated function blocks**.
8. Click **OK**.

### *Connect The Fieldbus Instrument cable to a Junction Box*

In this task you will connect the instrument's cable to the Fieldbus junction box. Since the junction box is configured with connectors, the cable also must have an appropriate plug in order to connect to the junction box.

1. In the Domain Explorer tree view, expand the **Panels By Category** > **Junction Boxes**.
2. Select **PS-JB-P2C3** .
3. From the right-click popup menu select **Actions > Connection…**
4. From Domain Explorer tree view, expand the **Cables** node.
5. Select and expand cable **101-FT -1503**.
6. Select connector **Type A.3** and drag and drop it onto the **S1** connector on the connections screen.

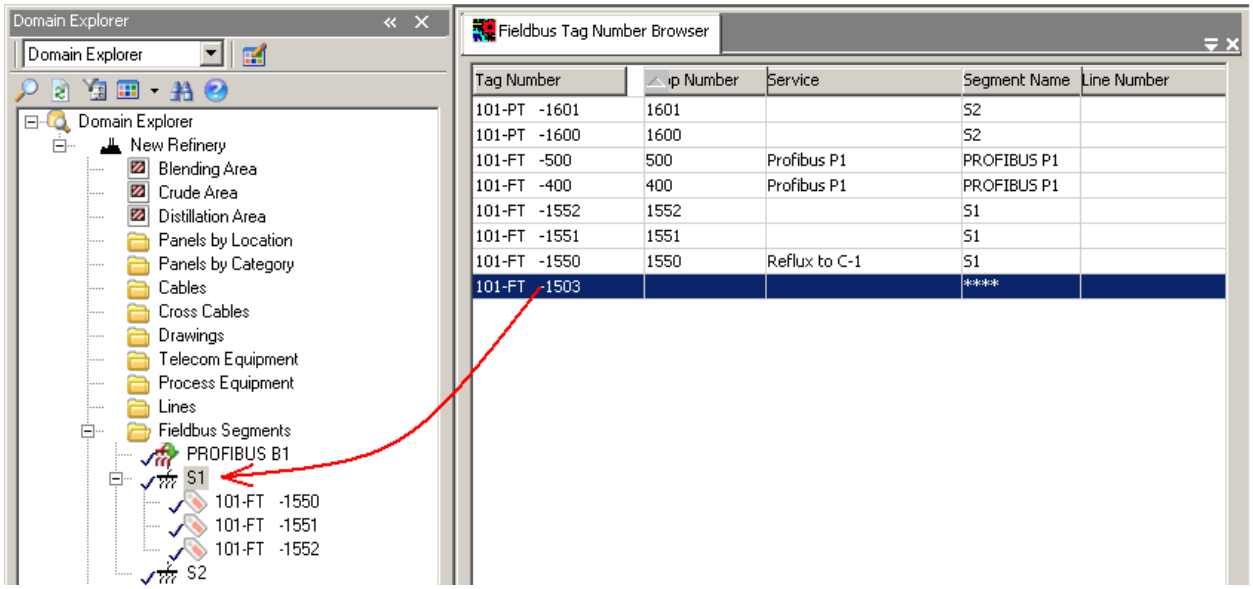



7. Close the Connection screen.

### *Associate the Fieldbus tag with the Fieldbus Segment*

In this task, you will associate the instrument with the Fieldbus segment and then activate (enable) the analog function block.

1. In the Domain Explorer tree view, expand the **New Refinery** > **Fieldbus Segments**.
2. Select **S1** segment.
3. Right click and select **Actions > Fieldbus Tag Number Browser**…
   The browser displays all the networked tags and to which network they belong. Note that tag number **101-FT -1503** is not assigned to any of the networks.
4. Drag and drop tag **101-FT -1503** onto the **S1** segment

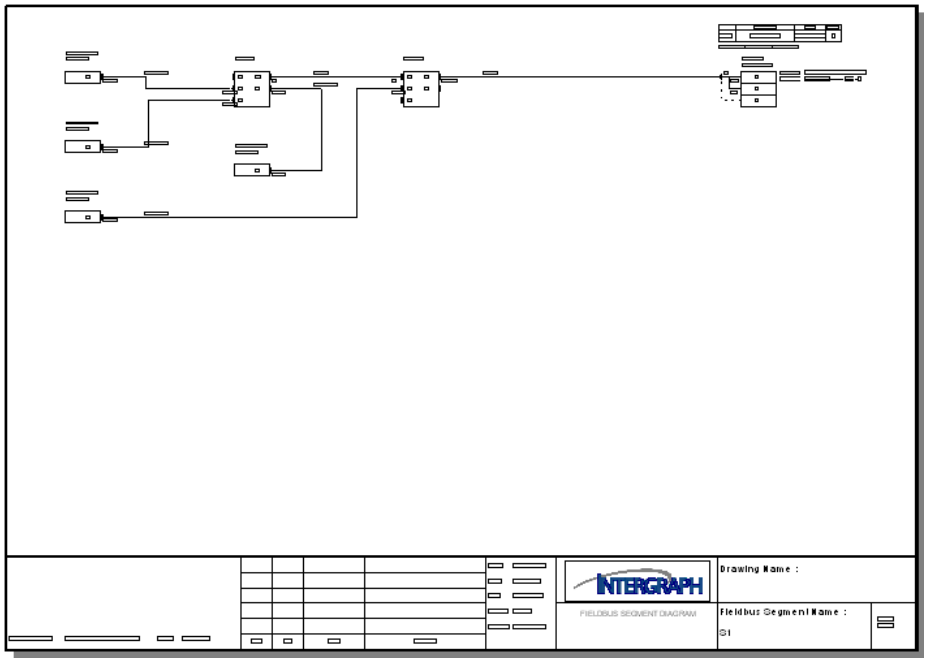



Note that tag number **101-FT -1503** is added below the **S1** segment.

5. In the tree view, under **S1**, select **101-FT -1503** to reveal the **AI** function block.
6. Select the **AI** and from the right click popup menu select **Actions>Enable.** The AI turns orange and when you click it you see the virtual device tag.

   At this point you completed adding and configuring the new tag as part of the foundation Fieldbus segment.

7. Re-run the Fieldbus segment wiring report as described in the "***Generate Fieldbus Segment Report***" section.
8. You can move the lines and objects to arrange the drawing as you wish after the drawing is processed.



### *Run the Fieldbus Validation Report*

Now try to generate the Fieldbus validation report. At the top of the report it states which tests have passed the validation followed by the details of each test.

1. In the Domain Explorer tree view, expand the **New Refinery** > **Fieldbus Segments**.
2. Select the **S1** segment.
3. Right click and select **Reports** > **Validation Report.**
4. Explore the report.