S15C and R45C Analog Process Data AOI Guide, v4
October 30th, 2023

This document covers the installation and use of an Add-On Instruction (AOI) for the Logix Designer software package from Rockwell Automation. This AOI handles cyclic IO-Link Process Data from a Banner S15C-I-KQ, S15C-U-KQ, R45C-K-IQ, R45C-K-UQ, R45C-K-IIQ, R45C-K-UUQ, R45C-KII-IIQ, or R45C-KUU-UUQ device via an IO-Link Master to an Allen-Bradley PLC. For the rest of the document S15C and R45C will be used to represent all the models listed previously. The AOI has ten User Defined Tag data types that are packed with it.

Components

Banner_Analog_Converter_PD_v4_AOI.L5X

UDT Packaged with the AOI

Banner_Analog_Converter_PDIO_v4
Banner_R45C_Set_0_v4
Banner_R45C_Set_1_v4
Banner_R45C_UI_PD_v4
Banner_R45C_UUII_Set_0_v4
Banner_R45C_UUII_Set_1_v4
Banner_R45C_UU_II_PD_v4
Banner_S15C_UI_PDI_v4
Banner_S15C_UI_Set_0_v4
Banner_S15C_UI_Set_1_v4

Other AOIs Available Separately

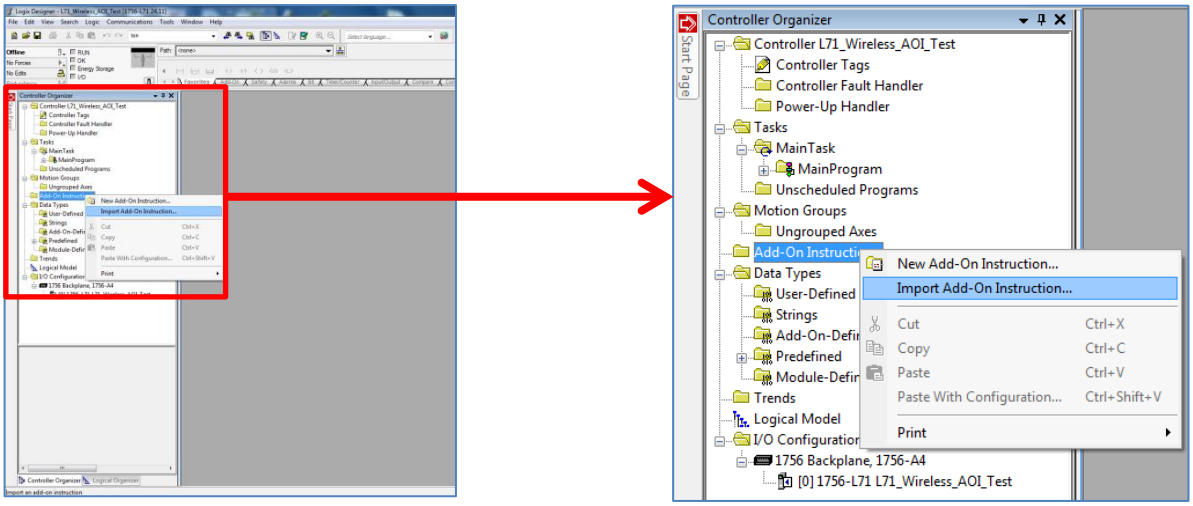
Banner has AOI files for controlling other Banner IO-Link devices and for a variety of IO-Link Masters. Banner also has AOI files for easily handling Banner device Parameter Data.

Contents

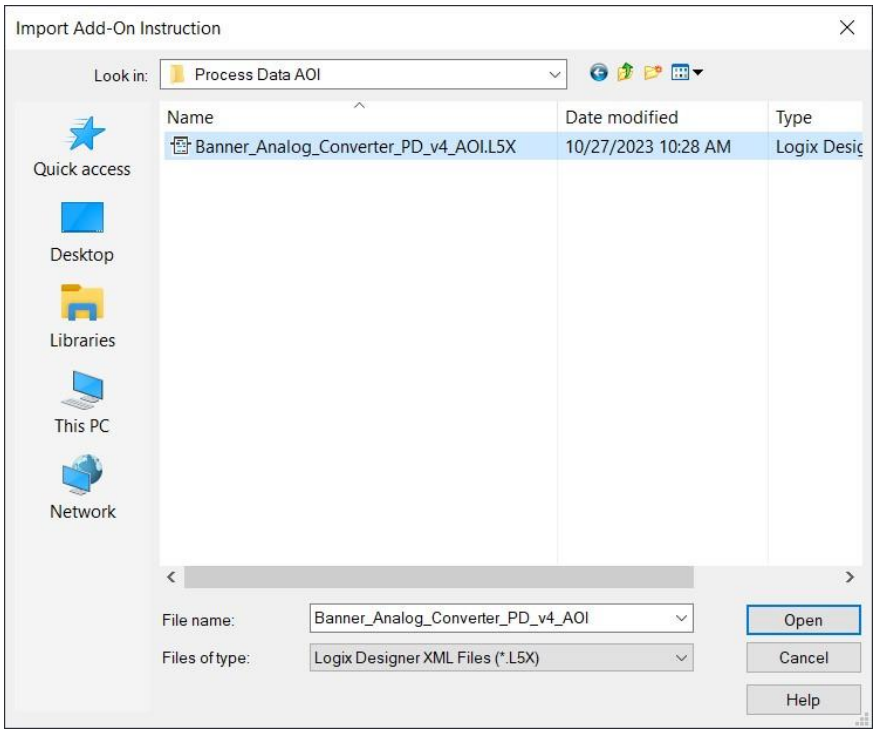
1. Installation Process

This section describes how to install the AOI in Logix Designer software.

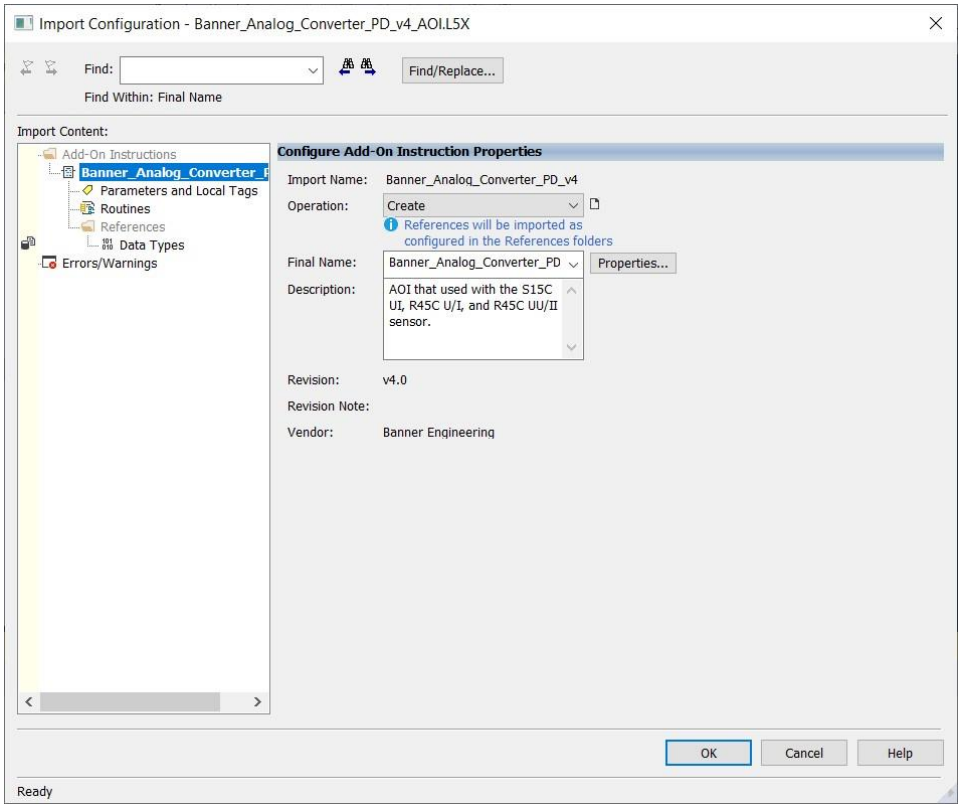
1. Open a project.
2. In the Controller Organizer window, right-click on the Add-On Instruction folder. Select the Import Add-On Instruction option.

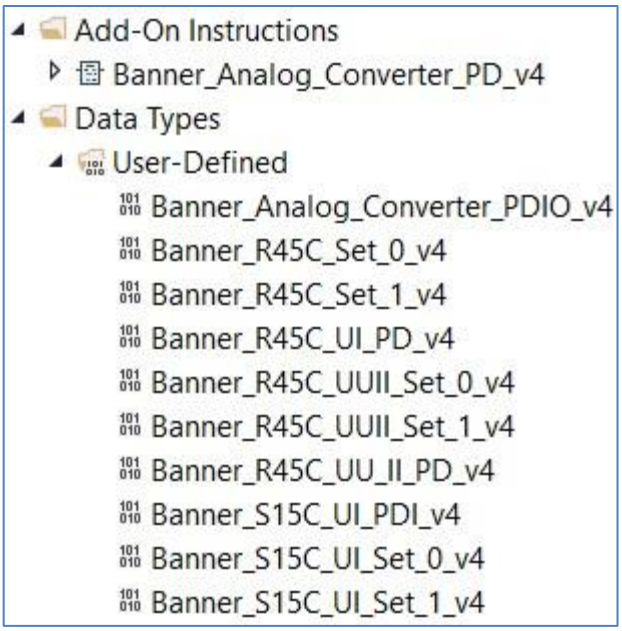


3. Navigate to the correct file location and select the AOI to be installed. In this example the "Banner_Analog_Converter_PD_v4_AOI.L5X" file will be selected. Click the Open button.



4. The Import Configuration window will pop up. The default selection will create all the necessary items for the AOI. Click the OK button to complete the import process.





5. The AOI is added to the Controller Organizer window and should look like the picture at left.
6. AOI installation into the Logix Designer software complete.

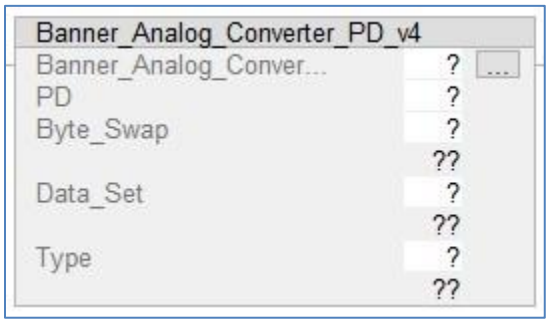
2. Configuring the IO-Link Master

Make an EtherNet/IP connection to the IO-Link Master.

Create an Ethernet communications module for the IO-Link Master device. The controller tags generated include Input (I) and Output (O) Assembly Instances. Each Assembly has a corresponding tag array. Creating this Class 1 EtherNet/IP implicit IO connection will provide PLC access to the IO-Link device Process Data. Each port on the IO-Link Master is given a dedicated group of I and O registers. See the relevant IO-Link Master User's Guide for more information.

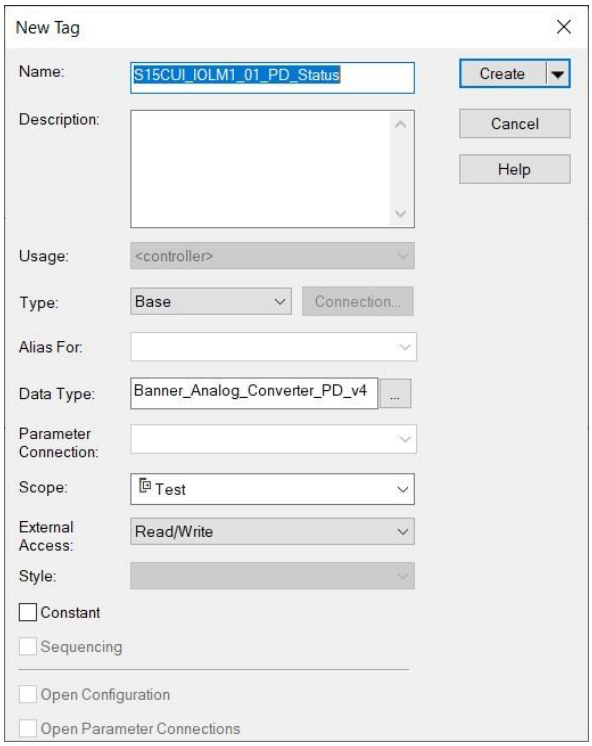
3. Configuring the AOI

1. Add the "Banner_Analog_Converter_PD_v4" AOI to your ladder logic program. For each of the question marks shown in the instruction we need to create and link a new tag array. The AOI includes a new type of User Defined Tags (UDT): a custom array of tags meant specifically for this AOI.



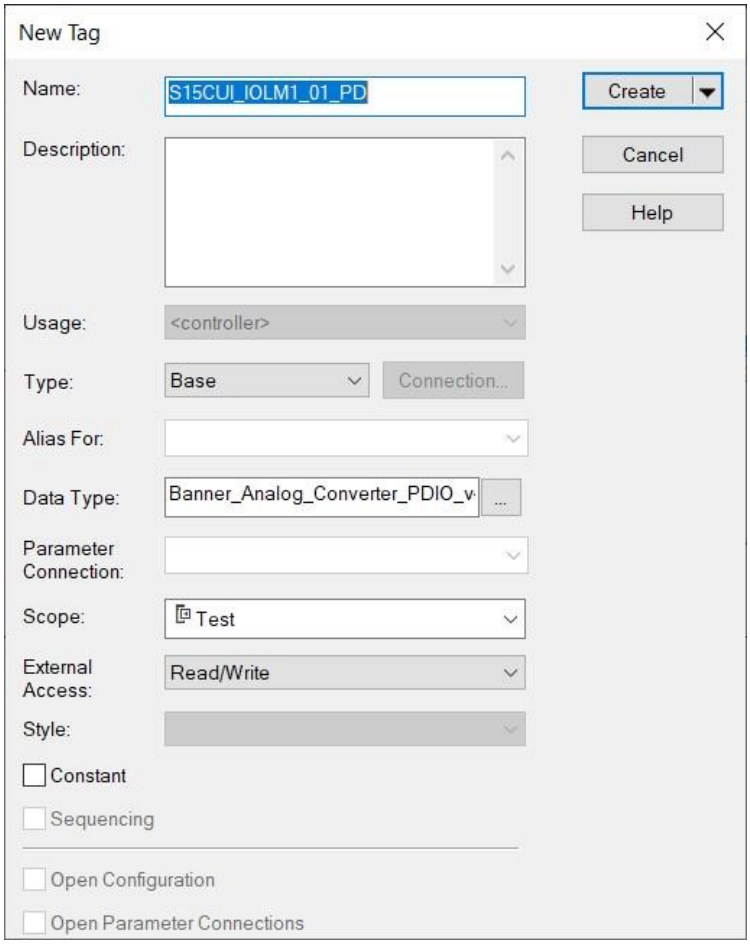
2. In the AOI, right-click on the question mark on the line labeled "Banner_Analog_Converter_PD_v4". Click New Tag. Name the new tag. This example uses the name "S15CUI_IOLM1_01_PD_Status". The example naming convention accounts for this being a R45C device connected to IO-Link Master #1, port #1, in our program. More masters could be named IOLM2, IOLM3, and different sensors could be connected at other port numbers, etc.

   Note that the Data Type is the User-Defined Data Type (UDT) entitled "Banner_Analog_Converter_PD_v4". This custom-made array of registers is specially built to handle the memory needs of this AOI. Click Create to make the tag array.



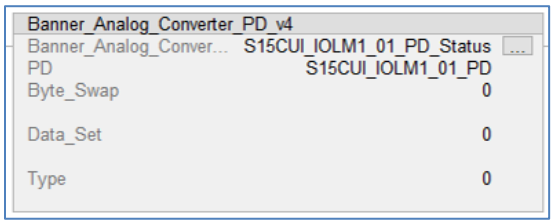
3. Now we will right-click on the question mark on the line labeled “PD” in the AOI. Click on “New Tag”. Give the tag a name. This example uses the name “S15CUI_IOLM1_01_PD”. Notice that the Data Type is “Banner_Analog_Converter_PDIO_v4”. Click Create.

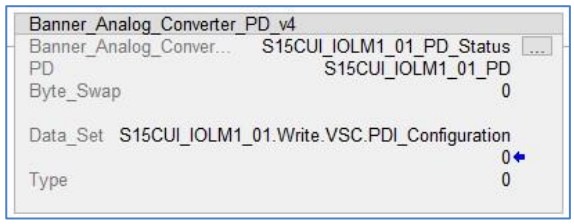
   This array will handle the displaying of the parsed Process Data In for the S15C or R45C.



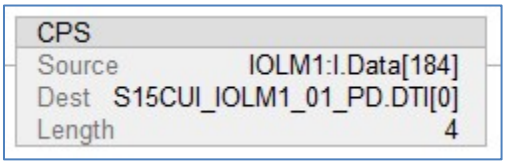
4. The next line in the AOI is a setting to account for byte swapping. In the case of the S15C-U or I, the Process Data is 4 bytes long for both input and output. IO-Link Masters may read each pair of bytes in either order, so this AOI must be ready to perform a byte swap. Enter a “0” or a “1” to toggle this setting. See Appendix B for more information.
5. The line labeled “Data Set” allows the AOI to know which of two possible Process Data definitions is currently in use. The choices for this setting are “0” and “1”. The default setting is “0”. This AOI needs to know which mode selection has been made in the device.

   There are two ways to achieve this goal. We can simply type in the correct number as a constant, or we can link this S15C or R45C Process Data AOI to the S15C or R45C Parameter Data AOI.

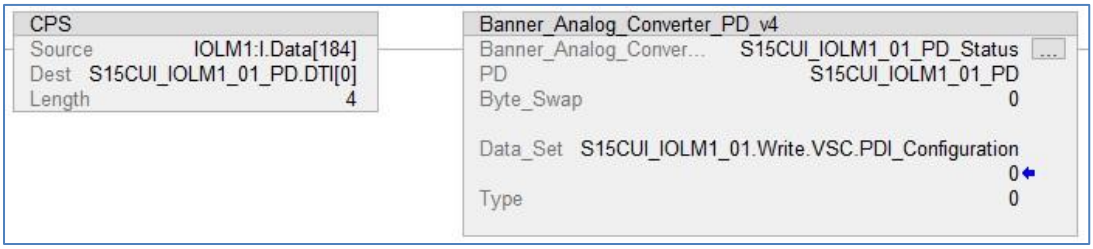




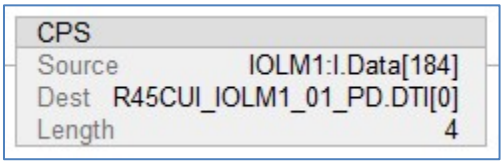
   NOTE: if you type in the incorrect number (i.e., it does not match the device’s current configuration) you will get incorrectly displayed Process Data Out information.
6. The last item that needs to be set is the “Type” parameter. This tells the Process Data AOI what type of S15C or R45C is being used.
   a. Type 0: S15C-I-KQ or S15C-U-KQ.
   b. Type 1: R45C-K-IQ, R45C-K-UQ, R45C-K-IIQ, or R45C-K-UUQ.
   c. Type 2: R45C-KII-IIQ, or R45C-KUU-UUQ.
7. The final step required is to add File Synchronous Copy (CPS) instructions. The three different types require different setups.
   a. Type 0 (S15C-I-KQ or S15C-U-KQ) CPS setup.
      i. Add one CPS instruction. Link the Source to the data for the Port (Example is for Port 1). Link the Dest to the Process Data element DTI[0]. Four bytes of data are transferred.



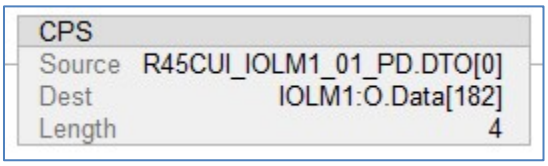
      ii. An example of what a complete S15C setup would look like.



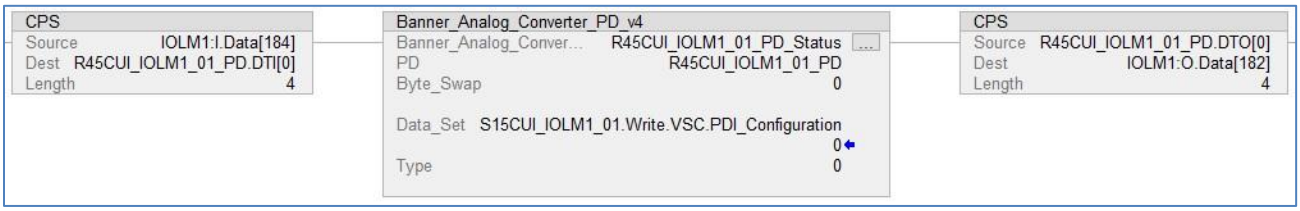
b. Type 1 (R45C-K-IQ, R45C-K-UQ, R45C-K-IIQ, or R45C-K-UUQ) CPS setup.
   i. Add Two CPS instructions.
   ii. The first CPS transfers the input data. Link the Source to the data for the Port (example is for Port 2). Link the Dest to the Process Data element DTI[0]. Four bytes of data are transferred.



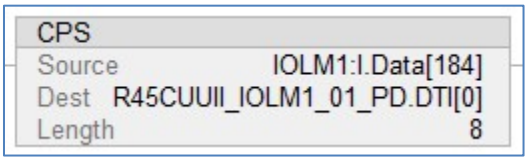
   iii. The second CPS transfers the output data. Link the Source to the Process Data element DTO[0]. The Dest is linked to the data for the Port (example is for Port 2). Four bytes of data are transferred.



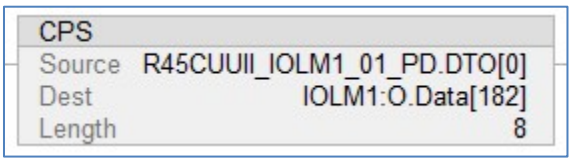
   iv. An example of what a complete R45C single analog setup would look like.



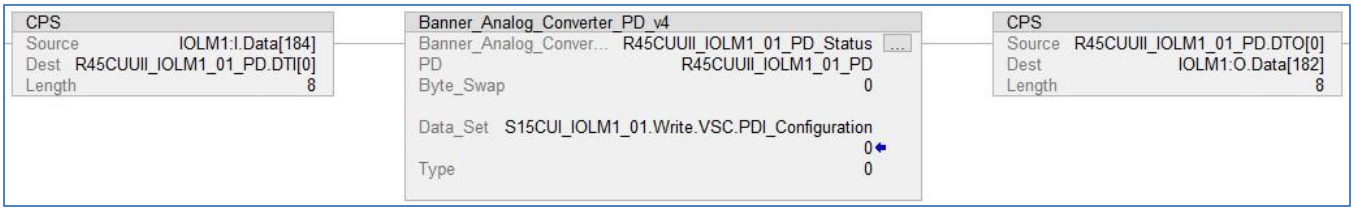
c. Type 2 (R45C-KII-IIQ, or R45C-KUU-UUQ) CPS setup.
   i. Add Two CPS instructions.
   ii. The first CPS transfers the input data. Link the Source to the data for the Port (example is for Port 2). Link the Dest to the Process Data element DTI[0]. Four bytes of data are transferred.



   iii. The second CPS transfers the output data. Link the Source to the Process Data element DTO[0]. The Dest is linked to the data for the Port (example is for Port 2). Four bytes of data are transferred.

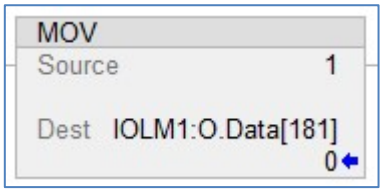


iv. An example of what a complete R45C single analog setup would look like.



8. If a Banner IO-Link Master is being used, setup a Move block. Send a 1 to the Activate Outputs array value (see table for each port's value). As an example, if port 1 needs the process data outputs active then send a 1 to 181.

IO-Link Master Port	Activate Outputs
1	181
2	215
3	249
4	283
5	317
6	351
7	385
8	419

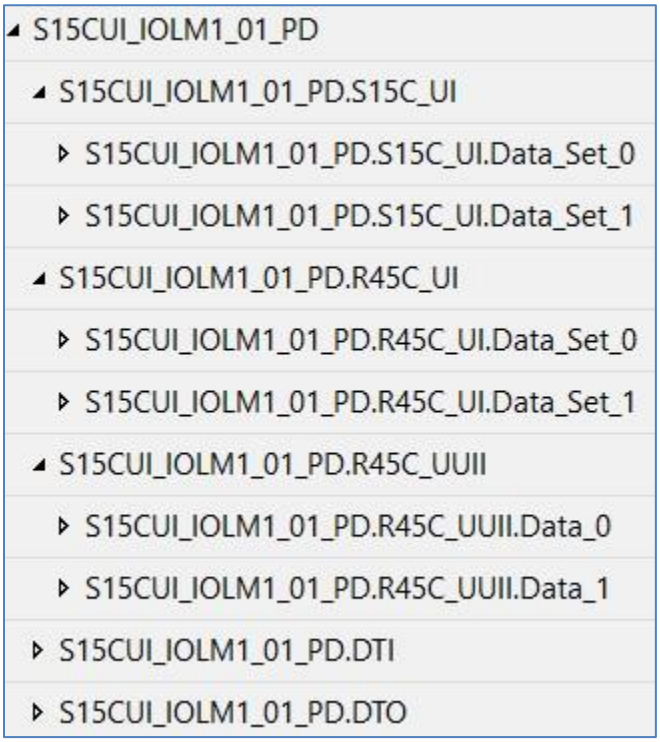


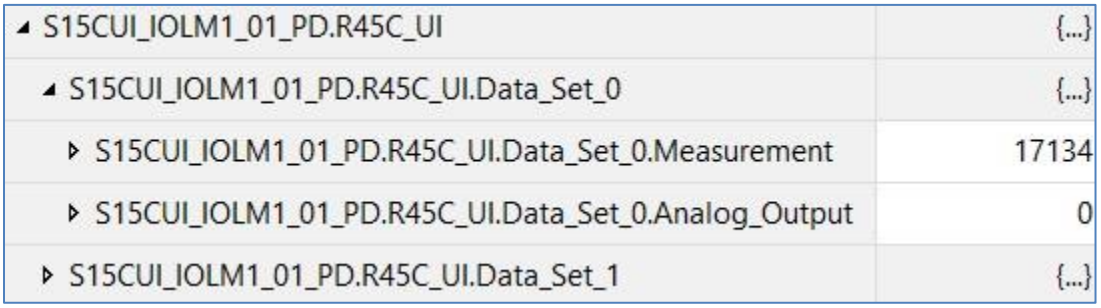
The AOI is now ready for use.

4. Using the AOI

The “Banner_Converter_Analog_PD_v4” Add-On Instruction has created a group of tags representing the S15C or R45C Process Data , broken out into its component parts.

Look in the Controller Tags to find the name you used for the PD above. This example used the name “R45C_IOLM1_02_PD”. The tag array, seen below, has individual pieces of information instead of a group of unlabeled bits. The tag has data sets for S15C_UI, R45C_UI, and R45C_UUII models. In our example the R45C_UI is used.





Data Set 0 will be used by default. If that is expanded the data for the unit can be seen. The Measurement will give the analog value for the device. Here a value of 17134 is returned. A current model (I version) is being used so the current reading is 17.134 mA. The “Analog Output” parameter is what the analog output will be set to.

Appendix A S15C-UI Process Data

The S15C-MUI has 4 bytes of Process Data In.

ProcessData id=PD_ProcessDataWithSignal (condition V_Vendor_Specific_Configuration.1 == 0)

ProcessDataIn "Process Data Input" id=PD_ProcessDataIn

bit length: 32
data type: 32-bit Record (subindex access not supported)

subindex	bit offset	data type	allowed values	default value	acc. restr.	mod. other var.	excl. from DS	name	description
1	0	32-bit Integer						Measurement Value	The measurement device value

octet	0	1	2	3
bit offset	31 - 24	23 - 16	15 - 8	7 - 0
subindex	1	1	1	1
element bit	31 - 24	23 - 16	15 - 8	7 - 0

ProcessData id=PD_ProcessDataWithDMS (condition V_Vendor_Specific_Configuration.1 == 1)

ProcessDataIn "Process Data Input" id=PD_ProcessDataInDMS

bit length: 32
data type: 32-bit Record (subindex access not supported)

subindex	bit offset	data type	allowed values	default value	acc. restr.	mod. other var.	excl. from DS	name	description
1	16	16-bit Integer						Measurement Value	The measurement device value
2	8	8-bit Integer						Measurement Scale	The measurement device scale

octet	0	1	2	3
bit offset	31 - 24	23 - 16	15 - 8	7 - 0
subindex	1	1	2	//////
element bit	15 - 8	7 - 0	7 - 0	

Appendix B R45C-UI Process Data

The R45C-UI has 4 bytes of Process Data In and Out.

ProcessData id=PD_ProcessDataWithSignal (condition V_Vendor_Specific_Configuration.1 == 0)

ProcessDataIn "Process Data Input" id=PD_ProcessDataIn

bit length: 32
data type: 32-bit Record (subindex access not supported)

subindex	bit offset	data type	allowed values	default value	acc. restr.	mod. other var.	excl. from DS	name	description
1	0	32-bit Integer						Measurement Value	The measurement device value

octet	0	1	2	3
bit offset	31 - 24	23 - 16	15 - 8	7 - 0
subindex	1	1	1	1
element bit	31 - 24	23 - 16	15 - 8	7 - 0

ProcessDataOut "Process Data Output" id=PD_ProcessDataOut

bit length: 32
data type: 32-bit Record (subindex access not supported)

subindex	bit offset	data type	allowed values	default value	acc. restr.	mod. other var.	excl. from DS	name	description
1	0	32-bit Integer						Analog Output Value	The value to output to the analog output

octet	0	1	2	3
bit offset	31 - 24	23 - 16	15 - 8	7 - 0
subindex	1	1	1	1
element bit	31 - 24	23 - 16	15 - 8	7 - 0

ProcessData id=PD_ProcessDataWithDMS (condition V_Vendor_Specific_Configuration.1 == 1)

ProcessDataIn "Process Data Input" id=PD_ProcessDataInDMS

bit length: 32
data type: 32-bit Record (subindex access not supported)

subindex	bit offset	data type	allowed values	default value	acc. restr.	mod. other var.	excl. from DS	name	description
1	16	16-bit Integer						Measurement Value	The measurement device value
2	8	8-bit Integer						Measurement Scale	The measurement device scale

octet	0	1	2	3
bit offset	31 - 24	23 - 16	15 - 8	7 - 0
subindex	1	1	2	/ / / / / /
element bit	15 - 8	7 - 0	7 - 0	

ProcessDataOut "Process Data Output" id=PD_ProcessDataOutDMS

bit length: 32
data type: 32-bit Record (subindex access not supported)

subindex	bit offset	data type	allowed values	default value	acc. restr.	mod. other var.	excl. from DS	name	description
1	0	32-bit Integer						Analog Output Value	The value to output to the analog output

octet	0	1	2	3
bit offset	31 - 24	23 - 16	15 - 8	7 - 0
subindex	1	1	1	1
element bit	31 - 24	23 - 16	15 - 8	7 - 0

Appendix C R455C-UUII Process Data

The R45C-UUII has 8 bytes of Process Data In and Out.

ProcessData id=PD_ProcessDataWithSignal (condition V_Vendor_Specific_Configuration.1 == 0)

ProcessDataIn "Process Data Input" id=PD_ProcessDataIn

bit length: 64
data type: 64-bit Record (subindex access not supported)

subindex	bit offset	data type	allowed values	default value	acc. restr.	mod. other var.	excl. from DS	name	description
1	32	32-bit Integer						Measurement Value 1	The measurement device value
5	0	32-bit Integer						Measurement Value 2	The channel 2 measurement device value

octet	0	1	2	3	4	5	6	7
bit offset	63 - 56	55 - 48	47 - 40	39 - 32	31 - 24	23 - 16	15 - 8	7 - 0
subindex	1	1	1	1	5	5	5	5
element bit	31 - 24	23 - 16	15 - 8	7 - 0	31 - 24	23 - 16	15 - 8	7 - 0

ProcessDataOut "Process Data Output" id=PD_ProcessDataOut

bit length: 64
data type: 64-bit Record (subindex access not supported)

subindex	bit offset	data type	allowed values	default value	acc. restr.	mod. other var.	excl. from DS	name	description
1	32	32-bit Integer						Analog Output Value 1	The value to output to the channel 1 analog output
2	0	32-bit Integer						Analog Output Value 2	The value to output to the channel 2 analog output

octet	0	1	2	3	4	5	6	7
bit offset	63 - 56	55 - 48	47 - 40	39 - 32	31 - 24	23 - 16	15 - 8	7 - 0
subindex	1	1	1	1	2	2	2	2
element bit	31 - 24	23 - 16	15 - 8	7 - 0	31 - 24	23 - 16	15 - 8	7 - 0

ProcessData id=PD_ProcessDataWithDMS (condition V_Vendor_Specific_Configuration.1 == 1)

ProcessDataIn "Process Data Input" id=PD_ProcessDataInDMS

bit length: 64
data type: 64-bit Record (subindex access not supported)

subindex	bit offset	data type	allowed values	default value	acc. restr.	mod. other var.	excl. from DS	name	description
1	48	16-bit Integer						Measurement Value 1	The measurement device value
2	40	8-bit Integer						Measurement Scale 1	The channel 1 measurement device scale
4	32	Boolean						SSC1.1 - Switching Signal	Indicates the detection status of an object or measurement value within a window.
5	16	16-bit Integer						Measurement Value 2	The channel 2 measurement device value
6	8	8-bit Integer						Measurement Scale 2	The channel 2 measurement device scale
8	0	Boolean						SSC2.1 - Switching Signal	Indicates the detection status of an object or measurement value within a window.

ProcessDataOut "Process Data Output" id=PD_ProcessDataOutDMS

bit length: 64
data type: 64-bit Record (subindex access not supported)

subindex	bit offset	data type	allowed values	default value	acc. restr.	mod. other var.	excl. from DS	name	description
1	32	32-bit Integer						Analog Output Value 1	The value to output to the channel 1 analog output
2	0	32-bit Integer						Analog Output Value 2	The value to output to the channel 2 analog output

octet	0	1	2	3	4	5	6	7
bit offset	63 - 56	55 - 48	47 - 40	39 - 32	31 - 24	23 - 16	15 - 8	7 - 0
subindex	1	1	1	1	2	2	2	2
element bit	31 - 24	23 - 16	15 - 8	7 - 0	31 - 24	23 - 16	15 - 8	7 - 0

Appendix D IO-Link Master Cheat Sheet

Different IO-Link Masters behave differently in several ways. For one, the register locations where Process Data is stored varies. For another, some IO-Link Masters require byte-swapping and/or word-swapping. The tables below aim to define some of these differences. Note that these numbers are when using all default settings. IO-Link Masters can change the register locations to which Process Data is mapped in response to non-default, optional settings. See relevant IO-Link Master documentation for more information.

PDI (Process Data In) is found in the IO-Link Master's T->O (PLC "Input") Assembly Instance.

PDO (Process Data Out) is found in the IO-Link Master's O->T (PLC "Output") Assembly Instance.

Table 1. First Register of Process Data "SINT0"

	Allen-Bradley*		Comtrol		Balluff		Turck		ifm		Banner	
Port	PDI	PDO	PDI	PDO	PDI	PDO	PDI	PDO	PDI	PDO	PDI	PDO
1	I.Ch0Data[0]	O.Ch0Data[0]	4	0	8	6	6	4	190	46	184	182
2	I.Ch1Data[0]	O.Ch1Data[0]	40	32	56	38	38	36	222	78	218	216
3	I.Ch2Data[0]	O.Ch2Data[0]	76	64	104	70	70	68	254	110	252	250
4	I.Ch3Data[0]	O.Ch3Data[0]	112	96	152	102	102	100	286	142	286	284
5	I.Ch4Data[0]	O.Ch4Data[0]	148	128	200	134	134	132	318	174	320	318
6	I.Ch5Data[0]	O.Ch5Data[0]	184	160	248	166	166	164	350	206	354	352
7	I.Ch6Data[0]	O.Ch6Data[0]	220	192	296	198	198	196	382	238	388	386
8	I.Ch7Data[0]	O.Ch7Data[0]	256	224	344	230	230	228	414	270	422	420

*see relevant Banner Allen-Bradley IO-Link Master AOI Guide and Allen-Bradley User Guides for more information on using device IODD files to aid in integration.

Note: Murr IO-Link Masters have configurable process data. Refer to the Murr IO-Link Master Instruction Manual for Process Data mappings.

Table 2. Byte-Swap

IO-Link Master	Byte Swap
Allen-Bradley	0
Comtrol	1
Balluff	0
Turck	1
ifm	1
Murr	0
Banner	0

Specific hardware used in both tables (all default settings):

- Allen-Bradley Armor Block I/O IO-Link Master (1732E-8IOLM12R)
- Comtrol 8-EIP IO-Link Master (99608-8)
- Balluff BNI006A (BNI EIP-508-105-Z015)
- Turck TBEN-L5-8IOL
- ifm AL1122
- Murr Impact67 E DIO 12 DIO4/IOL4 4P (Art.-No. 55144)

Banner IO-Link Masters (DXMR90-4K) have a port status register. The register gives the status of the port. It gives information on if the port has an IO-Link device connected and if Process Data is valid. This is optional information but is useful for troubleshooting. The data comes into the PLC as bytes while the literature shows the value as a word. The table below gives the upper- and lower-byte data location in the PLC. The upper byte includes bits 15 through 8, while the lower byte has bits 7 through 0.

IO-Link Master Port	Upper Bits 15 - 8	Lower Bits 7 - 0
1	182	183
2	216	217
3	250	251
4	284	285
5	318	319
6	352	353
7	386	387
8	420	421

Port Status:

Bit0 = Connected?
Bit1 = Process Data Valid?
Bit2 = Event Pending?
Bit3 = Ready for ISDU?
Bit4 = Pin4 SIO State
Bit5 = Pin2 SIO State

Bit6-7 = Pin4 Mode:
SDCI Mode = 0
SIO Input Mode = 1
SIO Output Mode = 2

Bit8-10 = Pin2 Mode:
Disabled = 0
Input Normal = 1
Output = 2
Diagnostic Input = 3
Inverted Input = 4