



Q5X Process Data AOI Guide, v4

September 25th, 2023

This document covers the installation and use of Add-On Instruction (AOI) for the Logix Designer software package from Rockwell Automation. This AOI handles cyclic IO-Link Process Data In and Process Data Out to and from a Banner Q5X sensor via an IO-Link Master to an Allen-Bradley PLC. The AOI covers parsing and display of the Q5X sensor Process Data In and Process Data Out. The AOI has four User Defined Tag data types.

Components

Banner_Q5X_PD_v4.L5X

UDT Packaged with the AOI

Banner_Q5X_PD0_v4

Banner_Q5X_PD1_v4

Banner_Q5X_PD2_v4

Banner_Q5X_PDIO_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 Process Data.

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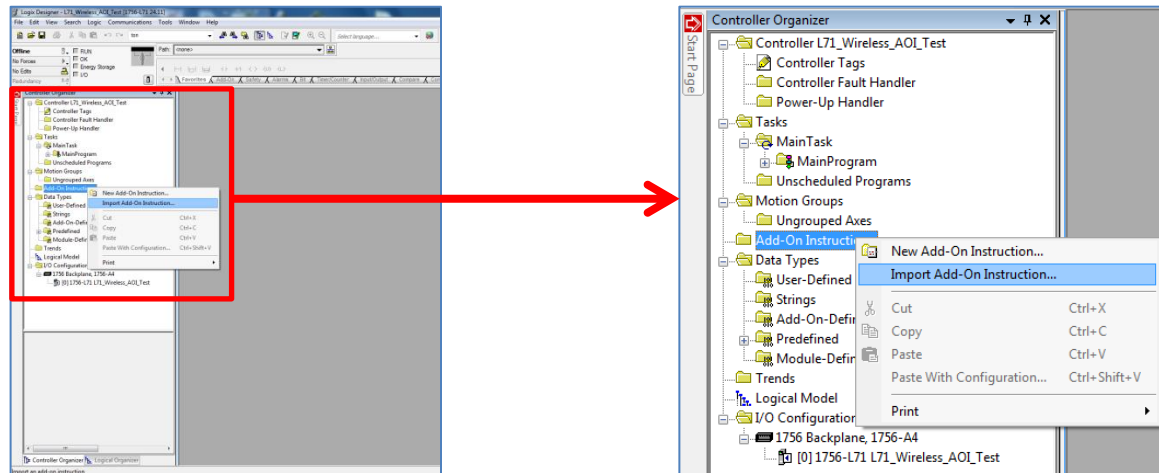
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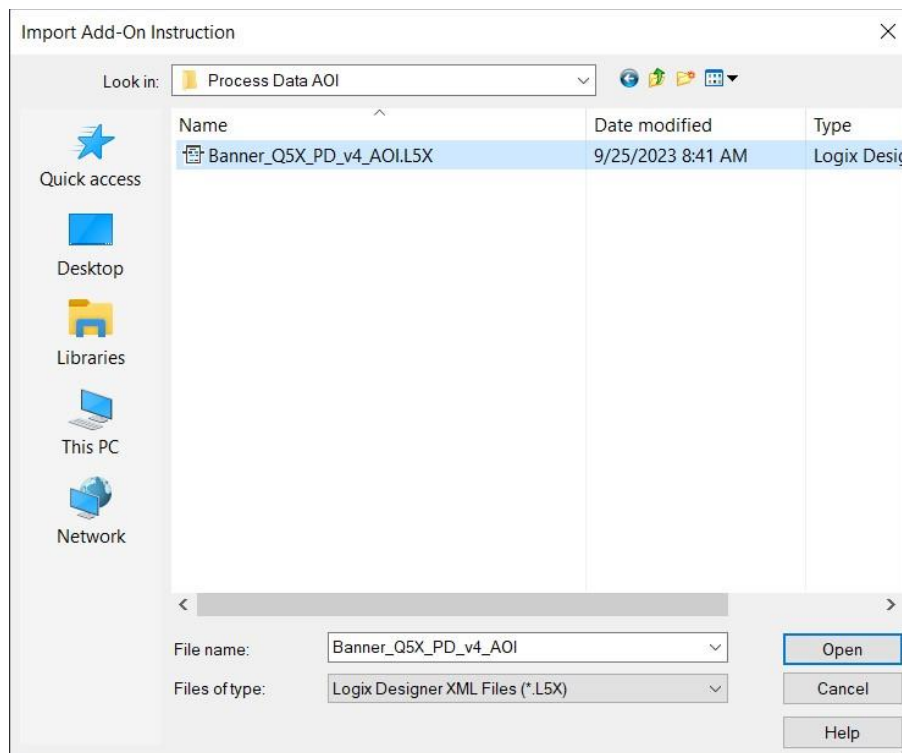
1. Installation Process

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

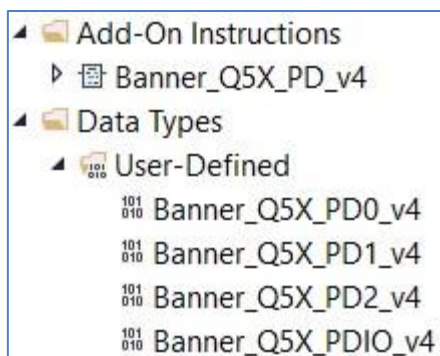
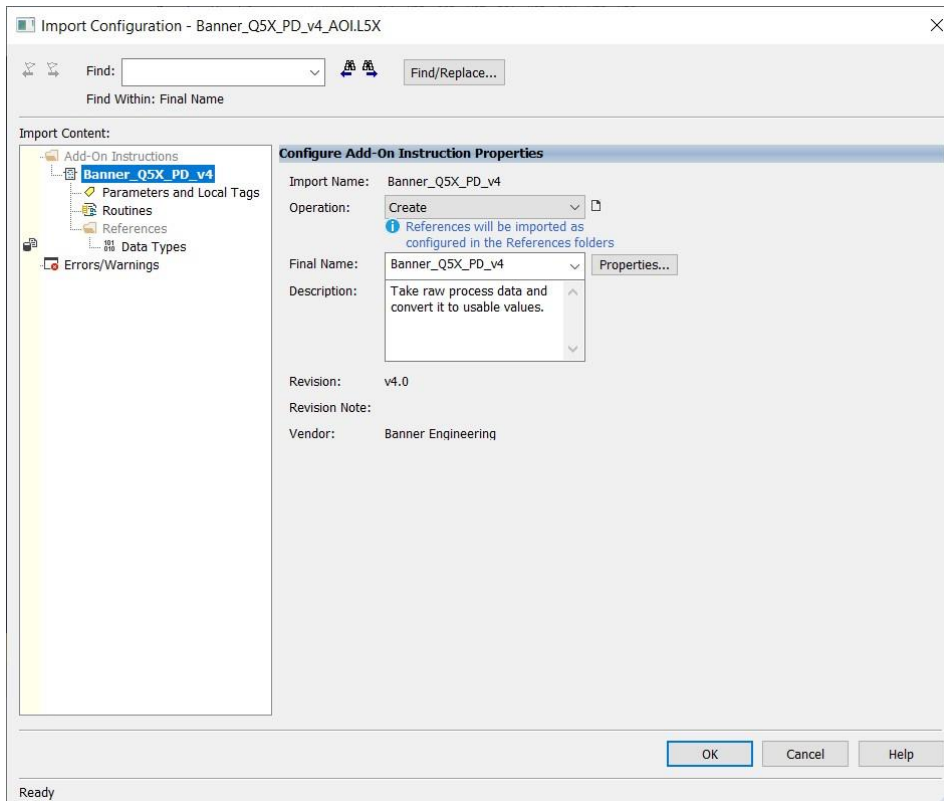
1. Open a project.
2. In the Controller Organizer window, right-click on the Add-On Instruction folder. Select the Import Add-On Instruction option.



3. Navigate to the correct file location and select the AOI to be installed. In this example the "Banner_Q5X_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.

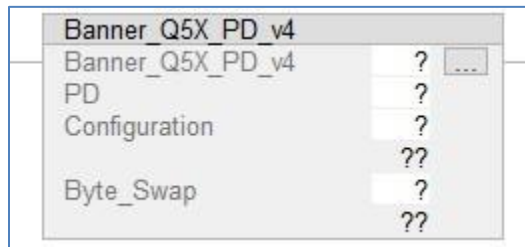
2. Configuring the IO-Link Master

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_Q5X_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_Q5X_PD_v4”. Click New Tag. Name the new tag. This example uses the name “Q5X_IOLM1_01_PD_Status”. The example naming convention accounts for this being a Q5X sensor 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_Q5X_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 “Q5X_IOLM2_01_PD”. Notice that the Data Type is “Banner_Q5X_PDIO_v4”. Click Create.

This array will handle the displaying of the parsed Process Data In and Process Data Out for the Q5X.

New Tag

Name:

Description:

Usage:

Type:

Alias For:

Data Type:

Parameter Connection:

Scope:

External Access:

Style:

☐ Constant

☐ Sequencing

☐ Open Configuration

☐ Open Parameter Connections

4. The next line in the AOI is a setting to account for byte swapping. In the case of the Q5X, the Process Data In is four bytes long. 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 last line, “Configuration”, allows the AOI to correctly interpret the Process Data In. In the case of the Q5X, there are two user-defined measurements in the Process Data In, and there can be some extra bits included to tell the state of discrete channels 1 and 2 as well as the stability indicator. This AOI needs to know what choices have been made in the sensor for these three options.

There are two ways to achieve this goal. We can simply type in the correct number for this selection, or we can link this Q5X Process Data AOI to the Q5X Parameter Data AOI. See Appendix A for more information about Q5X Process Data In.

Banner_Q5X_PD_v4	
Banner_Q5X_PD_v4	Q5X_IOLM1_01_PD_Staus ...
PD	Q5X_IOLM1_01_PD
Configuration	0
Byte_Swap	0

Banner_Q5X_PD_v4	
Banner_Q5X_PD_v4	Q5X_IOLM1_01_PD_Staus ...
PD	Q5X_IOLM1_01_PD
Configuration	Q5X_IOLM1_01.Write.Include_Binary_Data
	0 ←
Byte_Swap	0

NOTE: if you type in the incorrect number (i.e., it does not match the sensor’s current configuration) you will get incorrectly displayed Process Data In information.

Configuration: the options here are 0, 1, or 2, depending on the sensor’s configuration (setting found in Index 64, Subindex 11). Q5X 2000 and Jam units only have 0 or 1 as an option.

- 6. The final two steps required before we download and run the Q5X Process Data AOI involve a pair of File Synchronous Copy (CPS) instructions. These instructions allow the AOI to read from and write to the raw Process Data values found in the register tags of the IO-Link Master.

Add a CPS instruction before the AOI on the ladder rung that looks like the one seen below. Refer to Appendix B for which byte to start with in the “Source” area. In this case, the IO-Link Master in question has the raw Process Data In values for a device connected to port 1 starting at byte 184. For the “Destination”, we will enter the “PDI_DT[0]” location, as seen below. Finally, the length will be 4 bytes, as that is the size of the Q5X Process Data In.

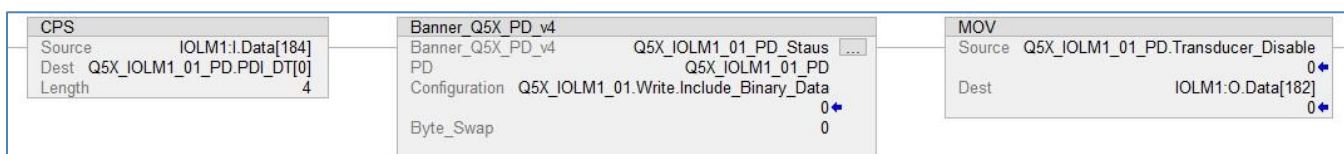
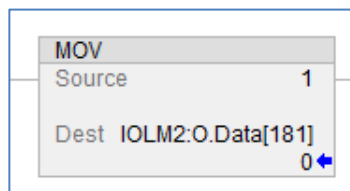
CPS	
Source	IOLM1:I.Data[184]
Dest	Q5X_IOLM1_01_PD.PDI_DT[0]
Length	4

A MOV instruction is added to the AOI rung, this time after the AOI. This MOV instruction is used to move Process Data Out from the AOI into the raw Process Data Out registers used by the IO-Link Master. See Appendix B for more information. In this example, we will connect the AOI’s “Q5X_IOLM2_04_PD.Transducer_Disable]” to the starting byte location for port 1 in the Process Data Out. In this example, that is byte 182.

MOV	
Source	Q5X_IOLM1_01_PD.Transducer_Disable
	0 ➡
Dest	IOLM1:O.Data[182]
	0 ➡

Here is what the entire rung looks like when completed.

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



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.

The "Banner_Q5X_PD_v4" AOI is now ready for use.

4. Using the AOI

The “Banner_Q5X_PD_v4” Add-On Instruction has created a group of tags representing the Q5X Process Data In and Process Data Out, broken out into its component parts.

Look in the Controller Tags to find the name you used in Step 4 above. This example used the name “Q5X_IOLM1_01_PD”. The tag array, seen below, has individual pieces of information instead of a group of unlabeled bits. The first five items are the Process Data In and include the on/off status of both discrete output channels and the stability indicator and the Q5X Measurement_1_Value and Measurement_2_Values. The last item is the Process Data Out control of the laser transducer.

▲ Q5X_IOLM1_01_PD	{...}
▲ Q5X_IOLM1_01_PD.PDI_0	{...}
▸ Q5X_IOLM1_01_PD.PDI_0.C1_Output_State	0
▸ Q5X_IOLM1_01_PD.PDI_0.C2_Output_State	1
▸ Q5X_IOLM1_01_PD.PDI_0.Stability	1
▸ Q5X_IOLM1_01_PD.PDI_0.Measurement_1	2782
▸ Q5X_IOLM1_01_PD.PDI_0.Measurement_2	442
▸ Q5X_IOLM1_01_PD.PDI_1	{...}
▸ Q5X_IOLM1_01_PD.PDI_2	{...}
▸ Q5X_IOLM1_01_PD.Transducer_Disable	0

▲ Q5X_IOLM1_01_PD	{...}
▸ Q5X_IOLM1_01_PD.PDI_0	{...}
▲ Q5X_IOLM1_01_PD.PDI_1	{...}
▸ Q5X_IOLM1_01_PD.PDI_1.Measurement_1	22430
▸ Q5X_IOLM1_01_PD.PDI_1.Measurement_2	442
▸ Q5X_IOLM1_01_PD.PDI_2	{...}
▸ Q5X_IOLM1_01_PD.Transducer_Disable	0

Appendix A Q5X Process Data

The Q5X has 4 bytes of Process Data In and 1 byte of Process Data Out, as shown below. There are three (two for Q5X 2000) modes for this Process Data called Include, Don't Include, and Measurement Device. The default mode, Include, is shown first. In this mode, the Process Data In includes the binary states of channel 1, channel 2, and the stability indicator alongside the Measurement 1 and Measurement 2 values. The Process Data Out includes control of the Q5X laser transducer.

ProcessDataIn "Process Data In" 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	Boolean	false = Inactive, true = Active					Channel 1 Output State	Channel 1 Output State
2	1	Boolean	false = Inactive, true = Active					Channel 2 Output State	Channel 2 Output State
3	2	Boolean	false = No target or Marginal, true = Stable					Stability	Stability state
4	3	13-bit UInteger						Measurement 1 Value	The selected measurement 1 value
5	16	16-bit Integer						Measurement 2 Value	The selected measurement 2 value

ProcessDataOut "Process Data Out" id=PD_ProcessDataOut									
bit length: 8 data type: 8-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	Boolean	false = Active, true = Inactive					Transducer Disable	

This Process Data In is mapped to a specific group of EtherNet/IP registers. The 32-bits of Process Data In encode five separate pieces of information. Bit 0 is the state of BDC1 (Binary Data Channel 1, also known simply as Output Channel 1). Bit 1 is BDC2 (Channel 2). Bit 2 is the stability indicator. The remaining 29 bits are used to communicate the Q5X measurement values, Measurement 1, and Measurement 2.

Process Data Out is the same for all 3 operations is identical. There is one byte (8-bits) controls the state of the Laser Transducer. When the byte has a value of 0 the laser is ON, while a value of 1 turns the laser OFF.

This AOI intelligently parses this Process Data into its component pieces.

The “Don’t Include” mode for the Q5X Process Data In is shown below (the Process Data Out remains unchanged from that shown above). In this mode, the binary components of the Process Data In are removed, simply leaving Measurement 1 and Measurement 2.

ProcessDataIn "Process Data In" id=PD_ProcessDataInWithoutBinary									
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	16-bit UInteger						Measurement 1 Value	The selected measurement 1 value
2	16	16-bit Integer						Measurement 2 Value	The selected measurement 2 value

Finally, the “Measurement Device” (not available for a Q5X 2000 model) mode for the Q5X Process Data In is shown below.

ProcessDataIn "Process Data In" id=PD_ProcessDataInMeasurement									
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
3	2	Boolean	false = No target or Marginal, true = Stable					Stability	Stability state
4	1	Boolean	false = Inactive, true = Active					Channel 2 Output State	Channel 2 Output State
5	0	Boolean	false = Inactive, true = Active					Channel 1 Output State	Channel 1 Output State

Appendix B 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"

Port	Allen-Bradley*		Comtrol		Balluff		Turck		ifm		Banner	
	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