QS18E Process Data AOI Guide, v4
November 1st, 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 In and Process Data Out to and from a Banner QS18E sensor via an IO-Link Master to an Allen-Bradley PLC. The AOI covers parsing and display of the QS18E sensor Process Data In and Process Data Out. The AOI has one User Defined Tag data type.

Components

Banner_QS18E_PD_v4.L5X

UDT Packaged with the AOI

Banner_QS18E_PDIO_v4

Other AOIs Available Separately

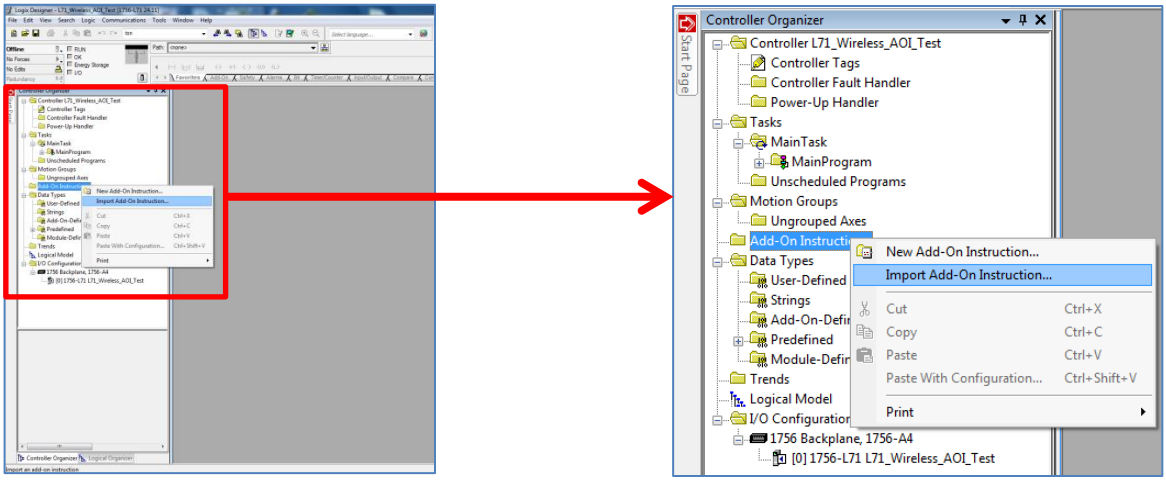
Banner has AOI files for controlling other Banner IO-Link devices and for a variety of IO-Link Masters. Banner also has AOI files for easily handling Banner device Process Data.

Contents

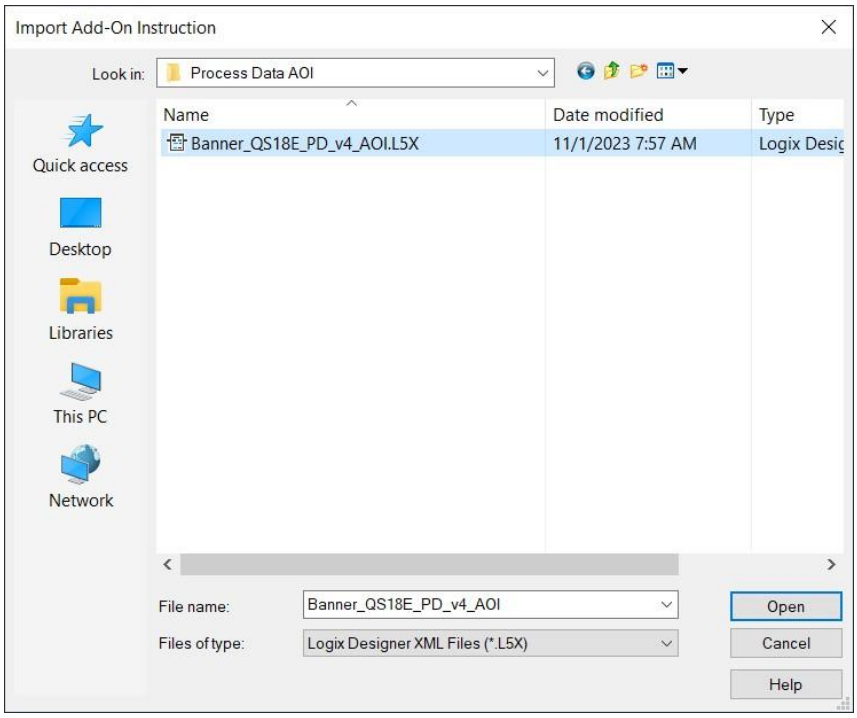
1. Installation Process

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

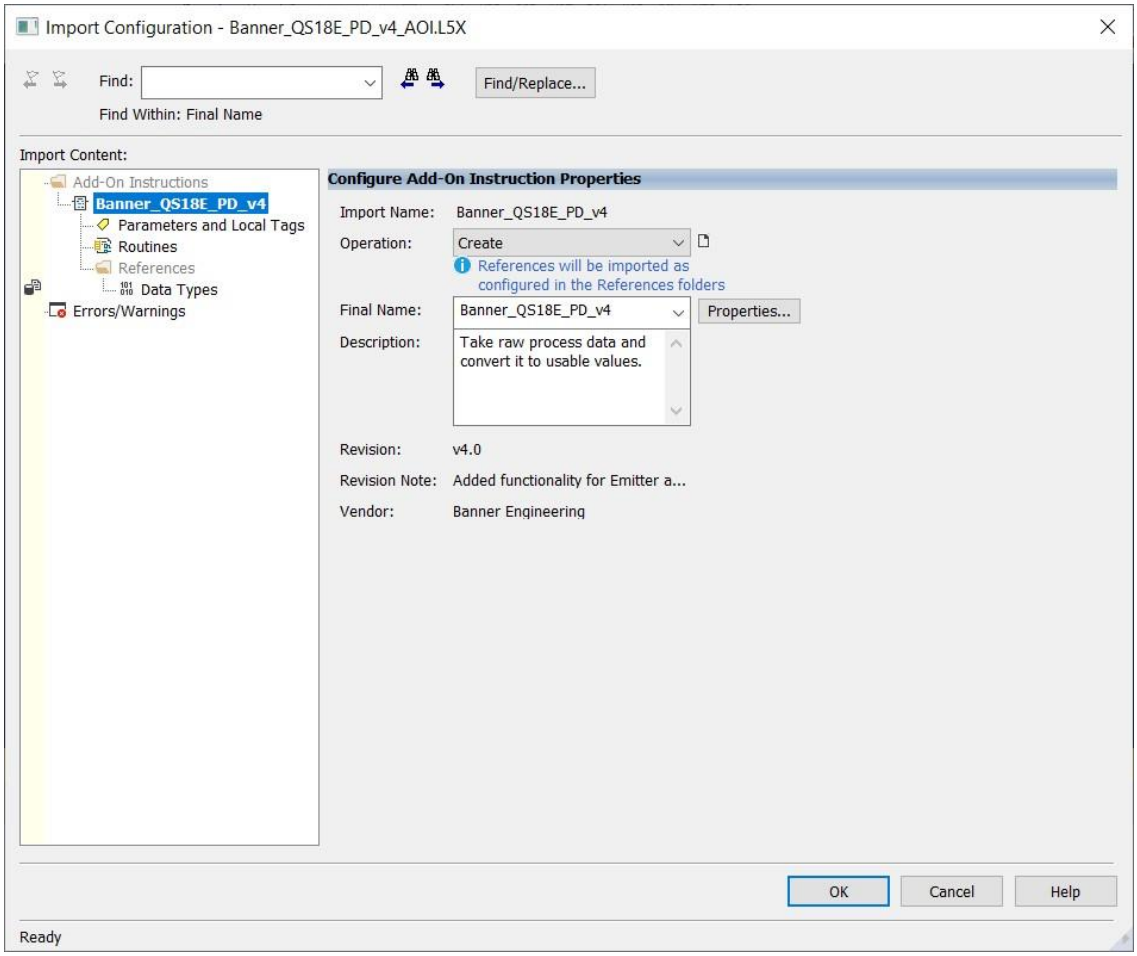
1. Open a project.
2. In the Controller Organizer window, right-click on the Add-On Instruction folder. Select the Import Add-On Instruction option.

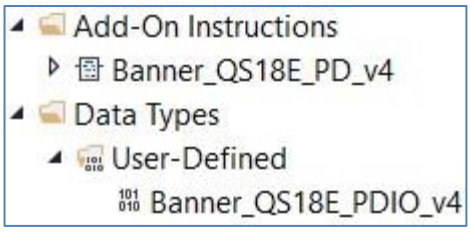


3. Navigate to the correct file location and select the AOI to be installed. In this example the "Banner_QS18E_PDI_v4_AOI.L5X" file will be selected. Click the Open button.



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.

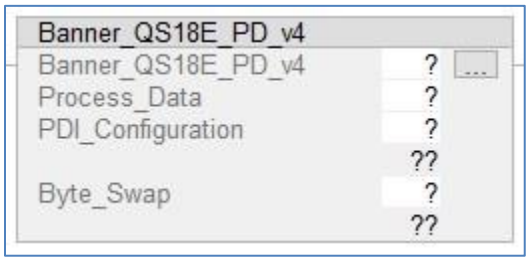
2. Configuring the IO-Link Master

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.

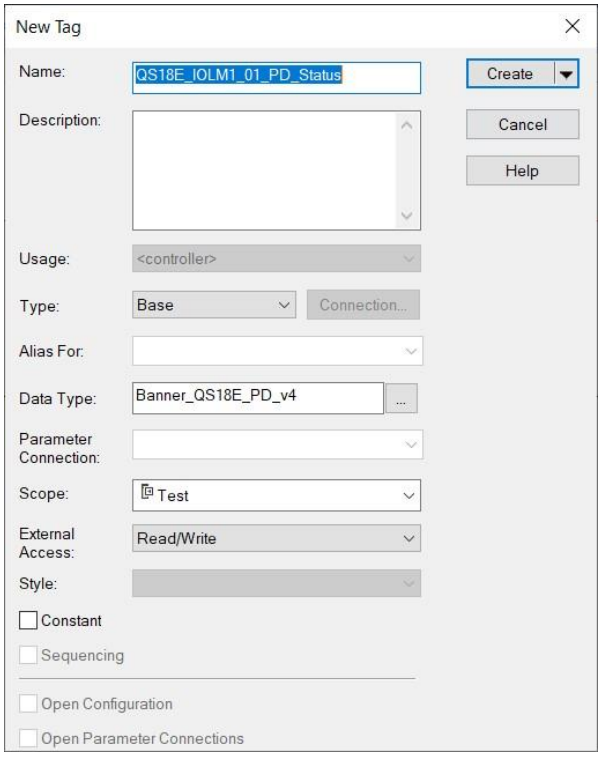
3. Configuring the AOI

1. Add the "Banner_QS18E_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.

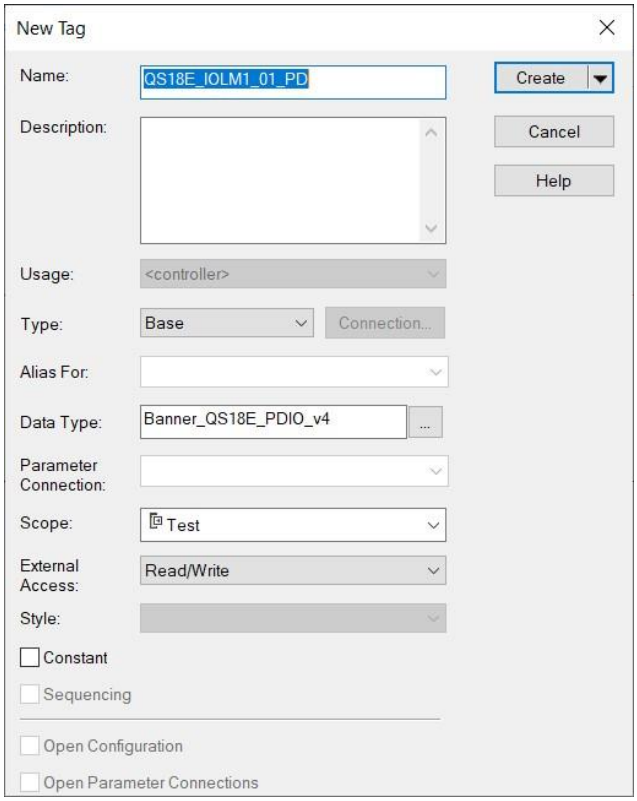


2. In the AOI, right-click on the question mark on the line labeled "Banner_QS18E_PD_v4". Click New Tag. Name the new tag. This example uses the name "QS18E_ IOLM1_01_PD_Status". The example naming convention accounts for this being a QS18E sensor connected to IO-Link Master #1, port #1, in our program. 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_QS18E_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.

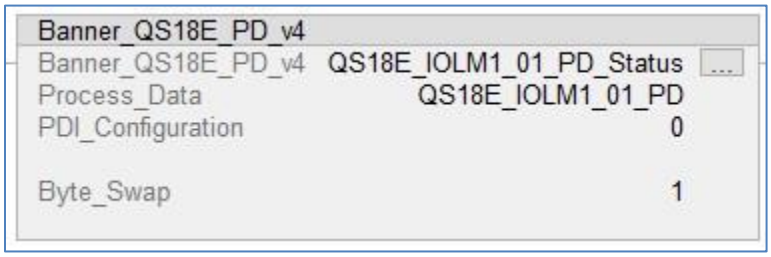


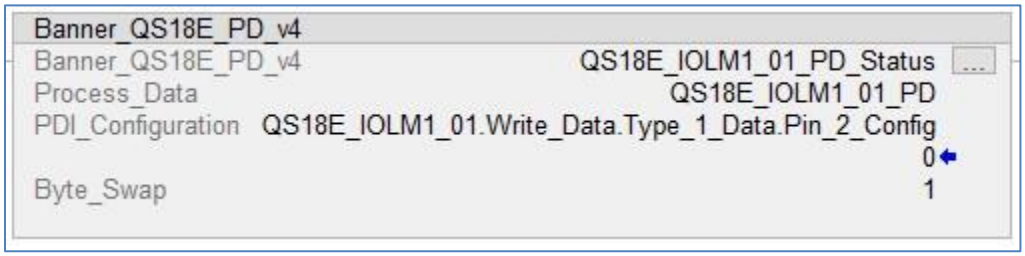
3. Now we will right-click on the question mark on the line labeled “Process_Data” in the AOI. Click on “New Tag”. Give the tag a name. This example uses the name “QS18E_IOLM1_01_PD”. Notice that the Data Type is “Banner_QS18E_PDIO_v4”. Click Create.



4. The line labeled “PDI_Configuration” allows the AOI to know which of four possible Process Data In definitions is currently in use. The choices for this setting are “0” (Process Data with Signal), “1” (Process Data with Count), “2” (Process Data with Duration), and “3” (Process Data with Events per Minute). 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 QS18E Process Data AOI to the QS18E Parameter Data AOI. See Appendix A for more information about QS18E Process Data.

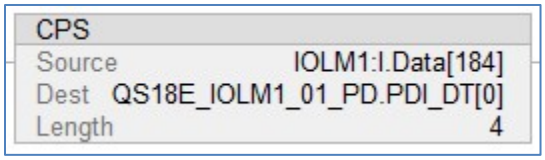




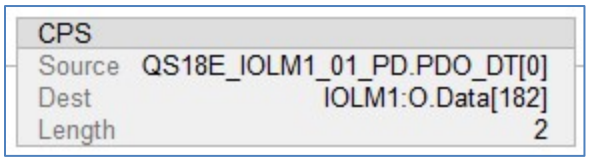
   NOTE: if you type in the incorrect number (i.e. it does not match the device’s current configuration) you will get incorrectly displayed Process Data In information.

5. The last line in the AOI is a setting to account for byte swapping. In the case of the QS18E, the Process Data is four bytes long. IO-Link Masters may read each pair of those two 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.

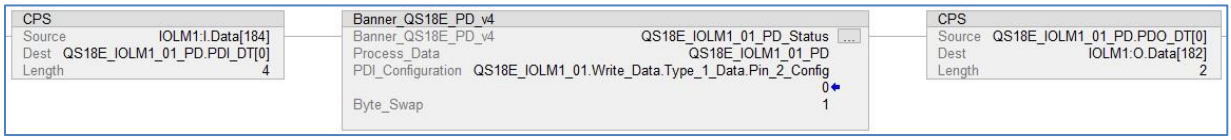
6. The final step required before we download and run the QS18E Process Data AOI involves a pair of File Synchronous Copy (CPS) instructions. A CPS instruction is added to the AOI rung, before the AOI. This CPS instruction is used to copy Process Data In into the AOI from the raw Process Data registers used by the IO-Link Master. See Appendix B for more information. In this example, we will connect the starting byte location for port 1 in the Process Data In to the AOI's "PDI_DT[0]" array. The size to be copied is 4 bytes.



Another CPS instruction is added to the same rung, after the AOI. This one is set to copy 2 bytes from the QS18E AOI's "PDO_DT[0]" array into the IO-Link Master's Output Assembly Instance. This handles the Process Data Out for the QS18E. The length to be copied is 2 bytes.



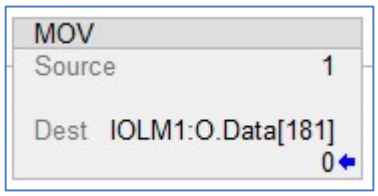
Here is what the entire rung looks like when completed.



NOTE: In the case where a pair of opposed mode QS18E sensors are being used, the Process Data In CPS command (before the AOI) will be linked to the QS18E Receiver and the Process Data Out CPS command (after the AOI) will be linked to the QS18E Emitter.

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 "Banner_QS18E_PD_v4" AOI is now ready for use.

4. Using the AOI

The “Banner_QS18E_PD_v4” Add-On Instruction has created a group of tags representing the QS18E Process Data, 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 “QS18E_IOLM1_01_PD”. The tag array, seen below, has multiple individual pieces of information instead of 32 unlabeled bits. Some items are common to all Process Data modes, including the Output State, the Health Signal, the Marginal Light State, the Marginal Dark State, and the Normalized Signal Strength. The final piece of the Process Data In varies according to the mode setting. In mode = 0 the sixth piece of information is the raw ADC “Signal” value, for instance. See Appendix A for more information.

The “Emitter_LED” variable is tied to the Process Data Out for the QS18E. This is used to turn the sensor’s LED on or off. A value of “0” means ON, a value of “1” means OFF.

QS18E_IOLM1_01_PD	{...}
QS18E_IOLM1_01_PD.Output_State	1
QS18E_IOLM1_01_PD.Health_Signal	1
QS18E_IOLM1_01_PD.Marginal_Light_State	0
QS18E_IOLM1_01_PD.Marginal_Dark_State	0
QS18E_IOLM1_01_PD.Normalized_Signal_Strength	990
QS18E_IOLM1_01_PD.Signal	2439
QS18E_IOLM1_01_PD.Count	0
QS18E_IOLM1_01_PD.Duration	0
QS18E_IOLM1_01_PD.Events_per_Minute	55
QS18E_IOLM1_01_PD.Emitter_LED	0
QS18E_IOLM1_01_PD.Emitter_Status	0
QS18E_IOLM1_01_PD.PDI_DT	{...}
QS18E_IOLM1_01_PD.PDO_DT	{...}

Figure 1: QS18E Process Data, mode 0 "with Signal"

QS18E_IOLM1_01_PD	{...}
QS18E_IOLM1_01_PD.Output_State	1
QS18E_IOLM1_01_PD.Health_Signal	1
QS18E_IOLM1_01_PD.Marginal_Light_State	0
QS18E_IOLM1_01_PD.Marginal_Dark_State	0
QS18E_IOLM1_01_PD.Normalized_Signal_Strength	990
QS18E_IOLM1_01_PD.Signal	0
QS18E_IOLM1_01_PD.Count	8
QS18E_IOLM1_01_PD.Duration	0
QS18E_IOLM1_01_PD.Events_per_Minute	0
QS18E_IOLM1_01_PD.Emitter_LED	0
QS18E_IOLM1_01_PD.Emitter_Status	0
QS18E_IOLM1_01_PD.PDI_DT	{...}
QS18E_IOLM1_01_PD.PDO_DT	{...}

Figure 2: QS18E Process Data, mode 1 "with Count"

QS18E_IOLM1_01_PD	{...}
QS18E_IOLM1_01_PD.Output_State	1
QS18E_IOLM1_01_PD.Health_Signal	1
QS18E_IOLM1_01_PD.Marginal_Light_State	0
QS18E_IOLM1_01_PD.Marginal_Dark_State	0
QS18E_IOLM1_01_PD.Normalized_Signal_Strength	990
QS18E_IOLM1_01_PD.Signal	0
QS18E_IOLM1_01_PD.Count	0
QS18E_IOLM1_01_PD.Duration	1826
QS18E_IOLM1_01_PD.Events_per_Minute	0
QS18E_IOLM1_01_PD.Emitter_LED	0
QS18E_IOLM1_01_PD.Emitter_Status	0
QS18E_IOLM1_01_PD.PDI_DT	{...}
QS18E_IOLM1_01_PD.PDO_DT	{...}

Figure 3: QS18E Process Data, mode 2 "with Duration"

QS18E_IOLM1_01_PD	{...}
QS18E_IOLM1_01_PD.Output_State	1
QS18E_IOLM1_01_PD.Health_Signal	1
QS18E_IOLM1_01_PD.Marginal_Light_State	0
QS18E_IOLM1_01_PD.Marginal_Dark_State	0
QS18E_IOLM1_01_PD.Normalized_Signal_Strength	990
QS18E_IOLM1_01_PD.Signal	0
QS18E_IOLM1_01_PD.Count	0
QS18E_IOLM1_01_PD.Duration	0
QS18E_IOLM1_01_PD.Events_per_Minute	55
QS18E_IOLM1_01_PD.Emitter_LED	0
QS18E_IOLM1_01_PD.Emitter_Status	0
QS18E_IOLM1_01_PD.PDI_DT	{...}
QS18E_IOLM1_01_PD.PDO_DT	{...}

Figure 4: QS18E Process Data, mode 3 “with Events per Minute”

Appendix A QS18E Process Data

The QS18E has 4 bytes of Process Data In, and 1 byte of Process Data Out, as shown below. The specific information included in the Process Data In varies by mode.

First is Mode = 0, also called Process Data with Signal.

ProcessDataIn "Process Data Input" id=PD_ProcessDataInWithSignal

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 = False, true = True					Output State	true (1) = C/Q Output Active
2	1	Boolean	false = False, true = True					Health State	true (1) = Sensor is Healthy
3	2	Boolean	false = False, true = True					Marginal Light State	true (1) = Sensor is Marginal Light
4	3	Boolean	false = False, true = True					Marginal Dark State	true (1) = Sensor is Marginal Dark
5	4	10-bit UInteger						Normalized Signal Strength Value	Normalized Signal Strength value.
6	16	16-bit UInteger						Signal	The raw ADC signal.

Octet 0

bit offset	31	30	29	28	27	26	25	24
subindex	6							
element bit	15	14	13	12	11	10	9	8

Octet 1

bit offset	23	22	21	20	19	18	17	16
subindex	6							
element bit	7	6	5	4	3	2	1	0

Octet 2

bit offset	15	14	13	12	11	10	9	8
subindex	///////	///////	5					
element bit			9	8	7	6	5	4

Octet 3

bit offset	7	6	5	4	3	2	1	0
subindex	5				4	3	2	1
element bit	3	2	1	0				

ProcessDataOut "Process Data Output" id=PD_ProcessDataOutWithSignal

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 = On, true = Off					Emitter LED	

Octet 0

bit offset	7	6	5	4	3	2	1	0
subindex	///////	///////	///////	///////	///////	///////	///////	1

Mode = 1 is called Process Data with Count.

ProcessDataIn "Process Data Input" id=PD_ProcessDataInWithCount

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 = False, true = True					Output State	true (1) = C/Q Output Active
2	1	Boolean	false = False, true = True					Health State	true (1) = Sensor is Healthy
3	2	Boolean	false = False, true = True					Marginal Light State	true (1) = Sensor is Marginal Light
4	3	Boolean	false = False, true = True					Marginal Dark State	true (1) = Sensor is Marginal Dark
5	4	10-bit UInteger						Normalized Signal Strength Value	Normalized Signal Strength value.
6	16	16-bit UInteger						Count	The output event count.

Octet 0

bit offset	31	30	29	28	27	26	25	24
subindex	6							
element bit	15	14	13	12	11	10	9	8

Octet 1

bit offset	23	22	21	20	19	18	17	16
subindex	6							
element bit	7	6	5	4	3	2	1	0

Octet 2

bit offset	15	14	13	12	11	10	9	8
subindex	///////	///////	5					
element bit			9	8	7	6	5	4

Octet 3

bit offset	7	6	5	4	3	2	1	0
subindex	5				4	3	2	1
element bit	3	2	1	0				

ProcessDataOut "Process Data Output" id=PD_ProcessDataOutWithCount

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 = On, true = Off					Emitter LED	

Octet 0

bit offset	7	6	5	4	3	2	1	0
subindex	///////	///////	///////	///////	///////	///////	///////	1

Mode = 2 is called Process Data with Duration.

ProcessDataIn "Process Data Input" id=PD_ProcessDataInWithDuration

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 = False, true = True					Output State	true (1) = C/Q Output Active
2	1	Boolean	false = False, true = True					Health State	true (1) = Sensor is Healthy
3	2	Boolean	false = False, true = True					Marginal Light State	true (1) = Sensor is Marginal Light
4	3	Boolean	false = False, true = True					Marginal Dark State	true (1) = Sensor is Marginal Dark
5	4	10-bit UInteger						Normalized Signal Strength Value	Normalized Signal Strength value.
6	16	16-bit UInteger						Duration	The output event duration.

Octet 0

bit offset	31	30	29	28	27	26	25	24
subindex	6							
element bit	15	14	13	12	11	10	9	8

Octet 1

bit offset	23	22	21	20	19	18	17	16
subindex	6							
element bit	7	6	5	4	3	2	1	0

Octet 2

bit offset	15	14	13	12	11	10	9	8
subindex	///////	///////	5					
element bit			9	8	7	6	5	4

Octet 3

bit offset	7	6	5	4	3	2	1	0
subindex	5				4	3	2	1
element bit	3	2	1	0				

ProcessDataOut "Process Data Output" id=PD_ProcessDataOutWithDuration

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 = On, true = Off					Emitter LED	

Octet 0

bit offset	7	6	5	4	3	2	1	0
subindex	///////	///////	///////	///////	///////	///////	///////	1

Mode = 3 is called Process Data with Events per Minute.

ProcessDataIn "Process Data Input" id=PD_ProcessDataInWithEventsPerMinute

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 = False, true = True					Output State	true (1) = C/Q Output Active
2	1	Boolean	false = False, true = True					Health State	true (1) = Sensor is Healthy
3	2	Boolean	false = False, true = True					Marginal Light State	true (1) = Sensor is Marginal Light
4	3	Boolean	false = False, true = True					Marginal Dark State	true (1) = Sensor is Marginal Dark
5	4	10-bit UInteger						Normalized Signal Strength Value	Normalized Signal Strength value.
6	16	16-bit UInteger						Events Per Minute	The events per minute.

Octet 0

bit offset	31	30	29	28	27	26	25	24
subindex	6							
element bit	15	14	13	12	11	10	9	8

Octet 1

bit offset	23	22	21	20	19	18	17	16
subindex	6							
element bit	7	6	5	4	3	2	1	0

Octet 2

bit offset	15	14	13	12	11	10	9	8
subindex	//////	//////	5					
element bit			9	8	7	6	5	4

Octet 3

bit offset	7	6	5	4	3	2	1	0
subindex	5				4	3	2	1
element bit	3	2	1	0				

ProcessDataOut "Process Data Output" id=PD_ProcessDataOutWithEventPerMinute

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 = On, true = Off					Emitter LED	

Octet 0

bit offset	7	6	5	4	3	2	1	0
subindex	//////	//////	//////	//////	//////	//////	//////	1

This Process Data is mapped to a specific group of EtherNet/IP registers. The 32-bits of Process Data In actually encode six separate pieces of information. The 8-bits of Process Data Out are used to enable or disable the sensor's LED.

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

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"

	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