



## **LCA Process Data AOI Guide, v4**

### **May 14<sup>th</sup>, 2024**

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 LCA device via an IO-Link Master connected to an Allen-Bradley PLC. The AOI covers parsing and display of the LCA Process Data In and Process Data Out. The AOI has five User Defined Tag data types.

#### **Components**

Banner\_LCA\_PD\_v4\_AOI.L5X

#### **UDT Packaged with the AOI**

Banner\_LCA\_Advanced\_v4

Banner\_LCA\_Adv\_v4

Banner\_LCA\_PDIO\_v4

Banner\_LCA\_State\_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.

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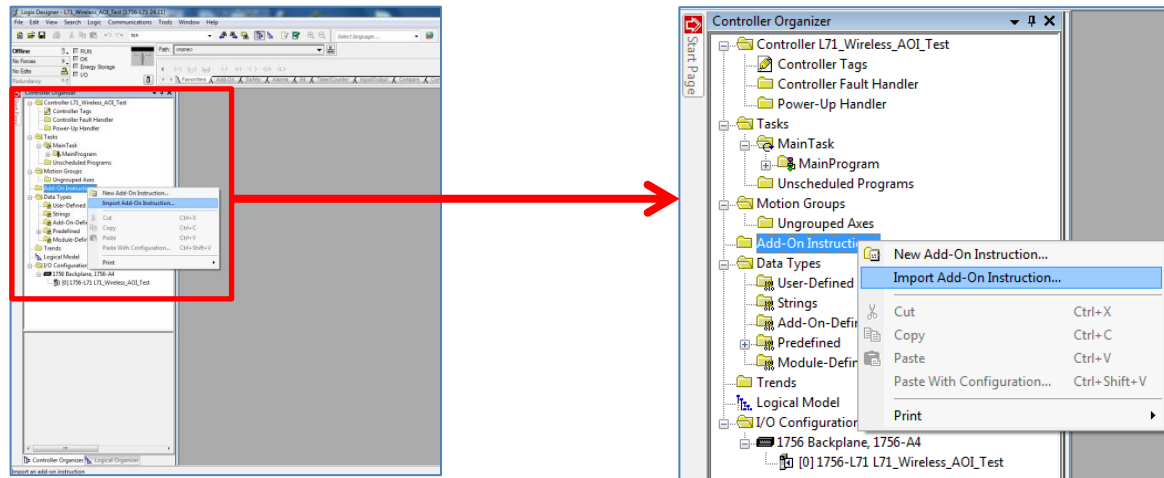
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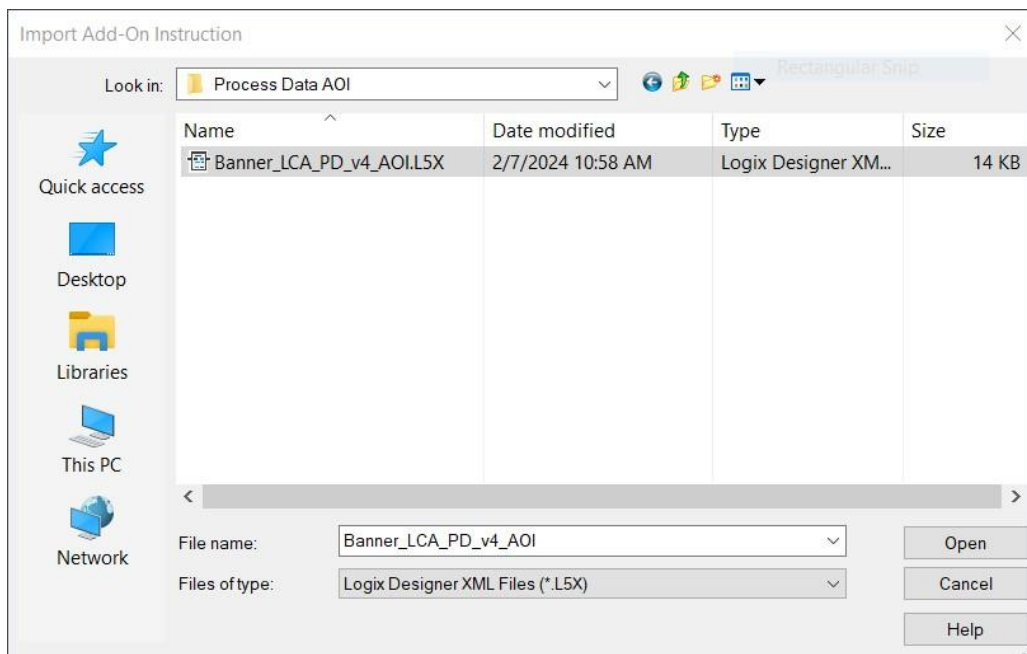
## 1. Installation Process

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

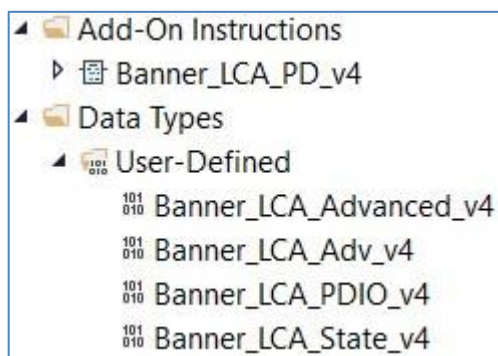
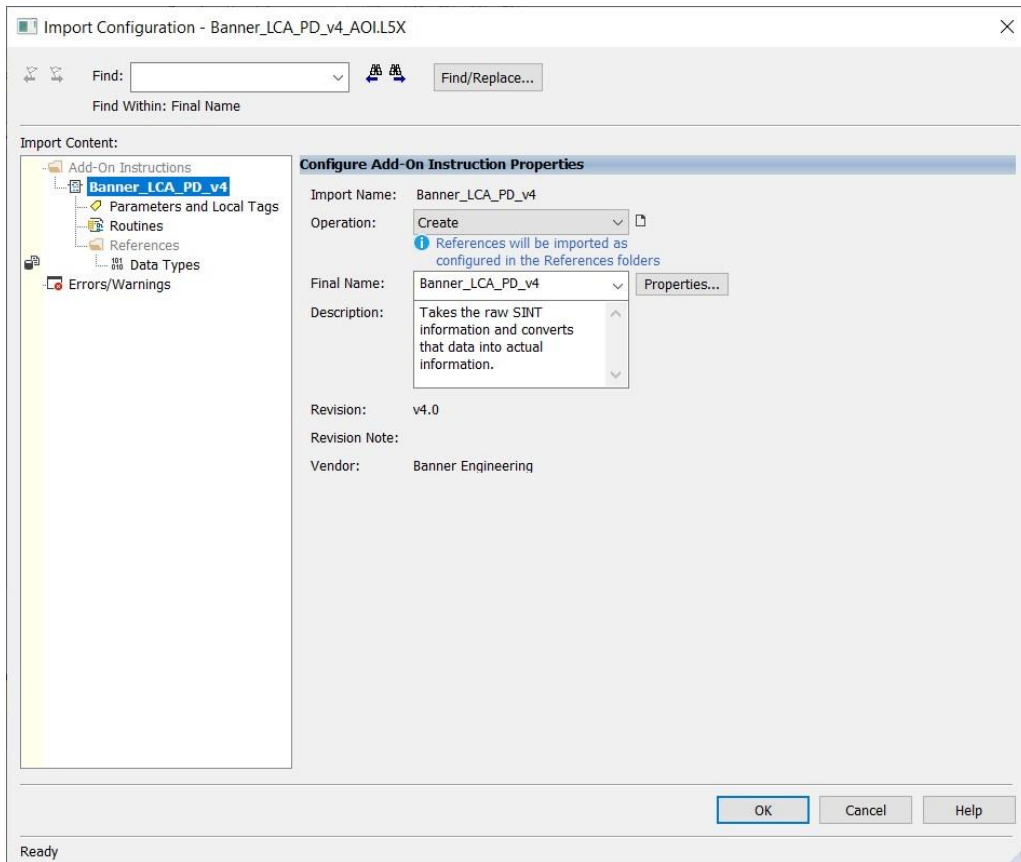
1. Open a project.
2. In the Controller Organizer window, right-click on the Add-On Instruction folder. Select the Import Add-On Instruction option.



3. Navigate to the correct file location and select the AOI to be installed. In this example the "Banner\_LCA\_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 is complete.

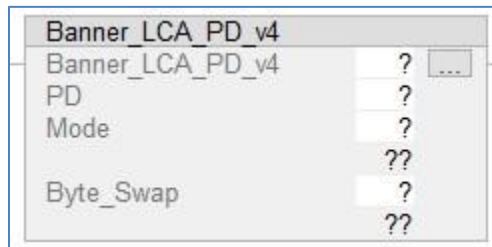
## **2. Configuring the IO-Link Master**

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.

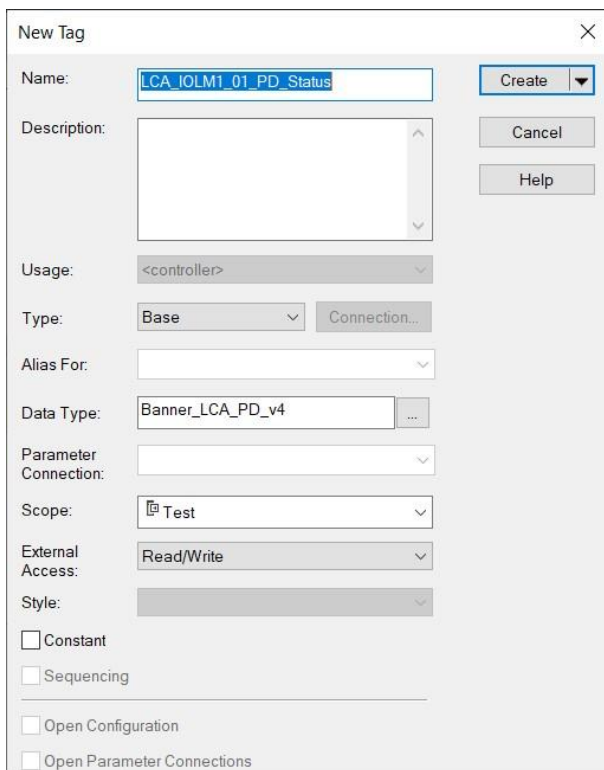
### 3. Configuring the AOI

1. Add the “Banner\_LCA\_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\_LCA\_PD\_v4”. Click New Tag. Name the new tag. This example uses the name “LCA\_IOLM1\_01\_PD\_Status”. The example naming convention accounts for this being an LCA 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\_LCA\_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.



New Tag

Name:  Create

Description:

Usage:

Type:  Connection...

Alias For:

Data Type:  ...

Parameter Connection:

Scope:

External Access:

Style:

☐ Constant

☐ Sequencing

☐ Open Configuration

☐ Open Parameter Connections

Cancel Help

- 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 "LCA\_IOLM1\_01\_PD". Notice that the Data Type is "Banner\_LCA\_PDIO\_v4". Click Create.

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

New Tag

Name: LCA\_IOLM1\_01\_PD

Description:

Usage: <controller>

Type: Base

Alias For:

Data Type: Banner\_LCA\_PDIO\_v4

Parameter Connection:

Scope: Test

External Access: Read/Write

Style:

☐ Constant

☐ Sequencing

☐ Open Configuration

☐ Open Parameter Connections

Create

Cancel

Help

- 4. The line labeled “Operation Mode” allows the AOI to know which of five possible Process Data Out definitions is currently in use. The choices for this setting are “0” (State mode) or “1” (Advanced mode). 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 LCA Process Data AOI to the LCA Parameter Data AOI. See Appendix A for more information about LCA Process Data.

Banner_LCA_PD_v4	
Banner_LCA_PD_v4	LCA_IOLM1_01_PD_Status
PD	LCA_IOLM1_01_PD
Mode	0
Byte_Swap	0

Banner_LCA_PD_v4	
Banner_LCA_PD_v4	LCA_IOLM1_01_PD_Status
PD	LCA_IOLM1_01_PD
Mode	LCA_IOLM1_01.Write.Operation_Mode
	0
Byte_Swap	0

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.

- 5. The last line in the AOI is a setting to account for byte swapping. In the case of the LCA, the Process Data Out 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. A value of 0 is used for a Banner IO-Link unit.



6. The final two steps required before we download and run the LCA 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 2 bytes, as that is the size of the LCA Process Data In.

CPS	
Source	IOLM1:I.Data[184]
Dest	LCA_IOLM1_01_PD.DTI[0]
Length	2

Another CPS instruction is added to the AOI rung, this time after the AOI. This CPS instruction is used to copy 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 “PDO\_DT[0]” to the starting byte location for port 1 in the Process Data Outside. In this example, that is byte 182. The size to be copied is 20 bytes.

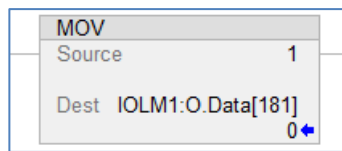
CPS	
Source	LCA_IOLM1_01_PD.DTO[0]
Dest	IOLM1:O.Data[182]
Length	20

Here is what the entire rung looks like when completed.

<table border="1"> <thead> <tr> <th colspan="2">CPS</th> </tr> </thead> <tbody> <tr> <td>Source</td> <td>IOLM1:I.Data[184]</td> </tr> <tr> <td>Dest</td> <td>LCA_IOLM1_01_PD.DTI[0]</td> </tr> <tr> <td>Length</td> <td>2</td> </tr> </tbody> </table>	CPS		Source	IOLM1:I.Data[184]	Dest	LCA_IOLM1_01_PD.DTI[0]	Length	2	<table border="1"> <thead> <tr> <th colspan="2">Banner_LCA_PD_v4</th> </tr> </thead> <tbody> <tr> <td>Banner_LCA_PD_v4</td> <td>LCA_IOLM1_01_PD_Status</td> </tr> <tr> <td>PD</td> <td>LCA_IOLM1_01_PD</td> </tr> <tr> <td>Mode</td> <td>LCA_IOLM1_01.Write.Operation_Mode</td> </tr> <tr> <td>Byte_Swap</td> <td>0</td> </tr> </tbody> </table>	Banner_LCA_PD_v4		Banner_LCA_PD_v4	LCA_IOLM1_01_PD_Status	PD	LCA_IOLM1_01_PD	Mode	LCA_IOLM1_01.Write.Operation_Mode	Byte_Swap	0	<table border="1"> <thead> <tr> <th colspan="2">CPS</th> </tr> </thead> <tbody> <tr> <td>Source</td> <td>LCA_IOLM1_01_PD.DTO[0]</td> </tr> <tr> <td>Dest</td> <td>IOLM1:O.Data[182]</td> </tr> <tr> <td>Length</td> <td>20</td> </tr> </tbody> </table>	CPS		Source	LCA_IOLM1_01_PD.DTO[0]	Dest	IOLM1:O.Data[182]	Length	20
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Mode	LCA_IOLM1_01.Write.Operation_Mode																											
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CPS																												
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Dest	IOLM1:O.Data[182]																											
Length	20																											

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\_LCA\_PD\_v4" AOI is now ready for use.



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

## 4. Using the AOI

The “Banner\_LCA\_PD\_v4” Add-On Instruction has created a group of tags representing the LCA Process Data, broken out into its component parts.

Look in the Controller Tags to find the name you used above. This example used the name “LCA\_IOLM1\_01\_PD”. The tag array, seen below, has individual pieces of information instead of unlabeled bits.

Each operating mode for the Process Data (except for Demo mode) has its own tag array. If the LCA device is in operating mode “0” (State mode), use the tags found under the “State” array. If the operating mode is “1” (Advanced mode), use the corresponding tags in the “Advanced” array instead. Default mode is “0” or State mode.

▲ LCA_IOLM1_01_PD
▶ LCA_IOLM1_01_PD.State
▲ LCA_IOLM1_01_PD.Advanced

State mode has two sections. The first is Output Status. This tells us the current state of the output.

▲ LCA_IOLM1_01_PD.State.Output_Status	{...}
▶ LCA_IOLM1_01_PD.State.Output_Status[0]	0
▶ LCA_IOLM1_01_PD.State.Output_Status[1]	2
▶ LCA_IOLM1_01_PD.State.Output_Status[2]	2
▶ LCA_IOLM1_01_PD.State.Output_Status[3]	1
▶ LCA_IOLM1_01_PD.State.Output_Status[4]	1
▶ LCA_IOLM1_01_PD.State.Output_Status[5]	1

The second section is Output State. This section allows control of the output state. In the below example a value of 2 or ON is sent to Segment 2 of the LCA.

▲ LCA_IOLM1_01_PD.State.Output_State	{...}
▶ LCA_IOLM1_01_PD.State.Output_State[0]	0
▶ LCA_IOLM1_01_PD.State.Output_State[1]	0
▶ LCA_IOLM1_01_PD.State.Output_State[2]	2
▶ LCA_IOLM1_01_PD.State.Output_State[3]	0
▶ LCA_IOLM1_01_PD.State.Output_State[4]	0
▶ LCA_IOLM1_01_PD.State.Output_State[5]	0

## Appendix A LCA Process Data

The LCA has 2 bytes of Process Data In and 9 bytes of Process Data Out. There are four modes for displaying this data, as shown below. This AOI intelligently parses this Process Data into its component pieces. The first is mode 0, "State".

### ProcessDataIn "Process Data In" id=V\_Pd\_InState

bit length: 16

data type: 16-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	8	2-bit UInteger	0 = Reserved, 1 = Off, 2 = On, 3 = Hold					Output 1 State	Output State. Related parameters defined in output and touch settings parameter data.
2	10	2-bit UInteger	0 = Reserved, 1 = Off, 2 = On, 3 = Hold					Output 2 State	Output State. Related parameters defined in output and touch settings parameter data.
3	12	2-bit UInteger	0 = Reserved, 1 = Off, 2 = On, 3 = Hold					Output 3 State	Output State. Related parameters defined in output and touch settings parameter data.
4	14	2-bit UInteger	0 = Reserved, 1 = Off, 2 = On, 3 = Hold					Output 4 State	Output State. Related parameters defined in output and touch settings parameter data.
5	0	2-bit UInteger	0 = Reserved, 1 = Off, 2 = On, 3 = Hold					Output 5 State	Output State. Related parameters defined in output and touch settings parameter data.

### ProcessDataOut "Process Data Out" id=V\_Pd\_OutState

bit length: 160

data type: 160-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	152	2-bit UInteger	0 = No Override, 1 = Off, 2 = On, 3 = Hold					Output 1 State	Output State. Related parameters defined in output and touch settings parameter data.
2	144	2-bit UInteger	0 = No Override, 1 = Off, 2 = On, 3 = Hold					Output 2 State	Output State. Related parameters defined in output and touch settings parameter data.
3	136	2-bit UInteger	0 = No Override, 1 = Off, 2 = On, 3 = Hold					Output 3 State	Output State. Related parameters defined in output and touch settings parameter data.
4	128	2-bit UInteger	0 = No Override, 1 = Off, 2 = On, 3 = Hold					Output 4 State	Output State. Related parameters defined in output and touch settings parameter data.
5	120	2-bit UInteger	0 = No Override, 1 = Off, 2 = On, 3 = Hold					Output 5 State	Output State. Related parameters defined in output and touch settings parameter data.

The next mode, "1", is "Advanced".

### ProcessDataIn "Process Data In" id=V\_Pd\_InAdvanced

bit length: 16

data type: 16-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	8	Boolean	false = Off, true = On					Output 1 State	Output State. Related parameters defined in output and touch settings parameter data.
2	9	Boolean	false = Off, true = On					Output 2 State	Output State. Related parameters defined in output and touch settings parameter data.
3	10	Boolean	false = Off, true = On					Output 3 State	Output State. Related parameters defined in output and touch settings parameter data.
4	11	Boolean	false = Off, true = On					Output 4 State	Output State. Related parameters defined in output and touch settings parameter data.
5	12	Boolean	false = Off, true = On					Output 5 State	Output State. Related parameters defined in output and touch settings parameter data.

Only Button 1 Output Data shown.

### ProcessDataOut "Process Data Out" id=V\_Pd\_OutAdvanced

bit length: 160

data type: 160-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	152	4-bit UInteger	0 = Off, 1 = Steady, 2 = Flash, 3 = Two Color Flash, 4 = Intensity Sweep, 5 = Color Sweep					Button 1 Animation Type	The Animation type
2	156	2-bit UInteger	0 = Off, 1 = On, 2 = Pattern					Button 1 Output	The Output state
3	144	3-bit UInteger	0 = Flash, 1 = Strobe, 2 = Three Pulse, 3 = SOS, 4 = Random					Button 1 Animation Pattern	The pattern of Animation/Haptic Feedback
4	147	2-bit UInteger	0 = Slow, 1 = Medium, 2 = Fast, 3 = Custom					Button 1 Animation Speed	The speed of the Animation/Haptic Feedback
5	136	5-bit UInteger	0 = Green, 1 = Red, 2 = Orange, 3 = Amber, 4 = Yellow, 5 = Lime Green, 6 = Spring Green, 7 = Cyan, 8 = Sky Blue, 9 = Blue, 10 = Violet, 11 = Magenta, 12 = Rose, 13 = White, 14 = Custom1, 15 = Custom2					Button 1 Color 1	The main color of the Animation, Custom Colors are defined in Parameter data
6	141	3-bit UInteger	0 = High, 1 = Medium, 2 = Low, 3 = Off, 4 = Custom					Button 1 Color 1 Intensity	The Intensity of Color 1, Custom Intensity defined in Parameter Data
7	128	5-bit UInteger	0 = Green, 1 = Red, 2 = Orange, 3 = Amber, 4 = Yellow, 5 = Lime Green, 6 = Spring Green, 7 = Cyan, 8 = Sky Blue, 9 = Blue, 10 = Violet, 11 = Magenta, 12 = Rose, 13 = White, 14 = Custom1, 15 = Custom2					Button 1 Color 2	The secondary color of the Animation, Custom Colors are defined in Parameter data
8	133	3-bit UInteger	0 = High, 1 = Medium, 2 = Low, 3 = Off, 4 = Custom					Button 1 Color 2 Intensity	The Intensity of Color 2, Custom Intensity defined in Parameter Data

## 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) has 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