



## **S15S-TH-KQ Process Data AOI Guide, v4**

### **December 9<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 S15S-TH-KQ sensor via an IO-Link Master to an Allen-Bradley PLC. The AOI covers parsing and display of the S15S TH sensor Process Data In and Process Data Out. The AOI has one User Defined Tag data type.

#### **Components**

Banner\_S15S\_TH\_PD\_v4\_AOI.L5X

#### **Additional AOI Packaged with AOI**

Banner\_S15S\_TH\_Float\_In\_v4

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

Banner\_S15S\_TH\_Floating\_Point

Banner\_S15S\_TH\_PDI\_v4

Banner\_S15S\_TH\_Smart\_Sensor\_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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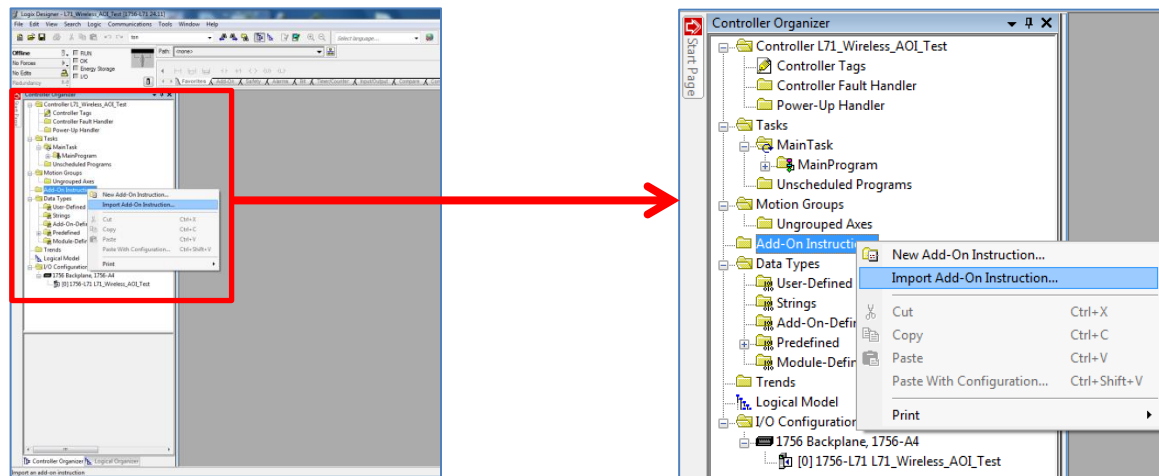
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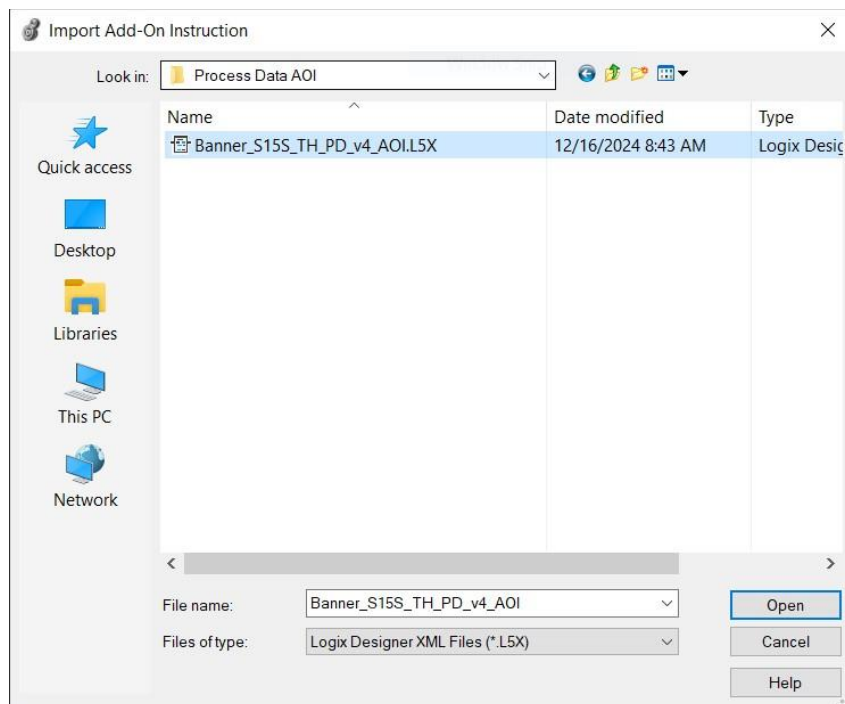
## 1. Installation Process

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

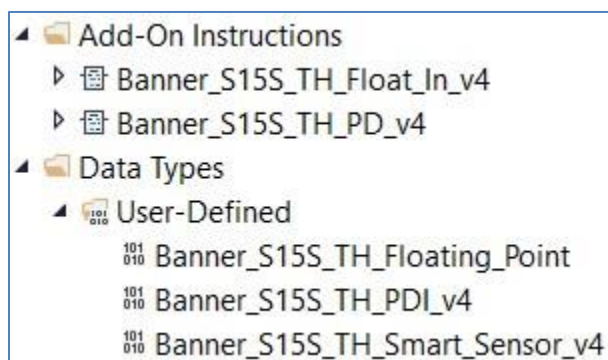
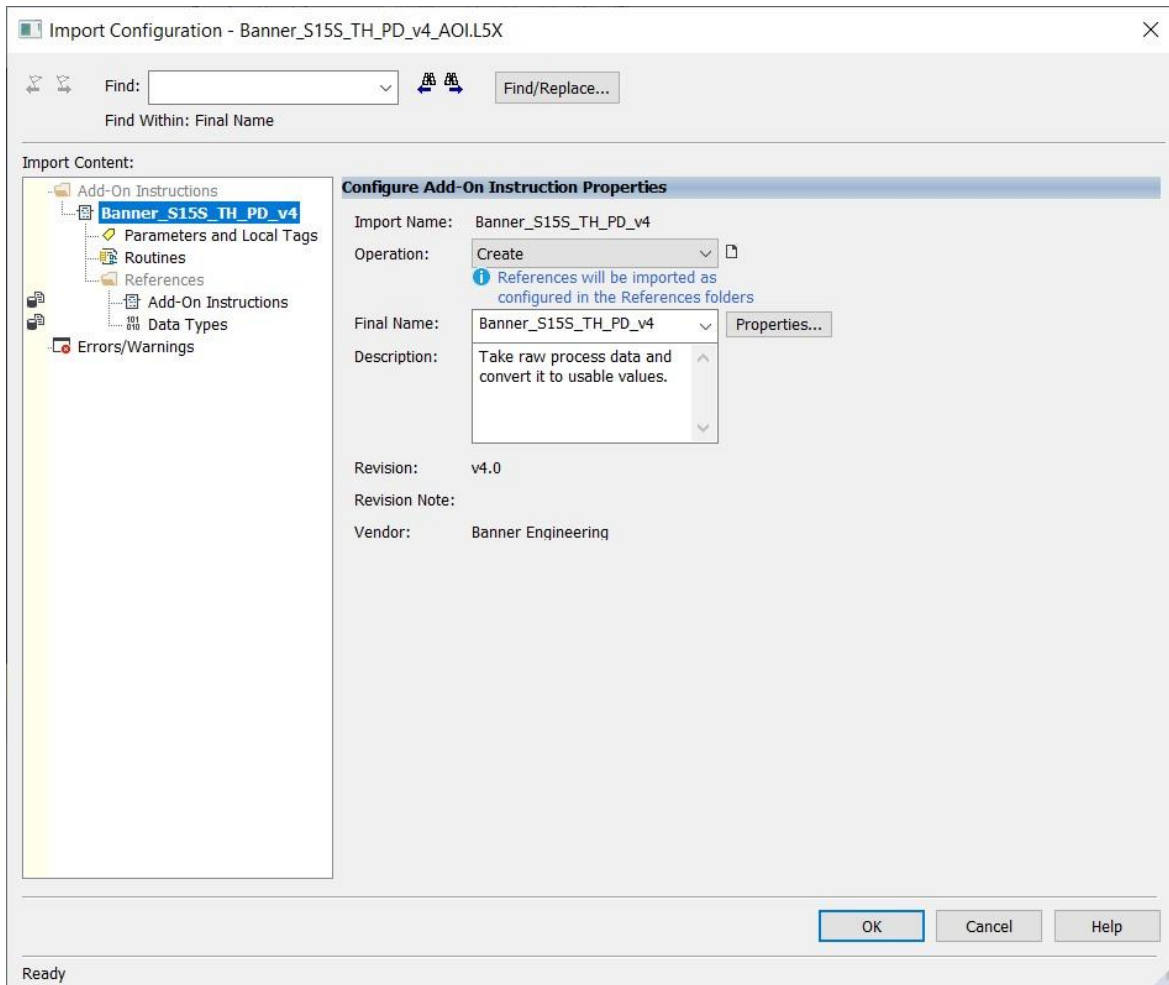
1. Open a project in Logix Designer software.
2. In the Controller Organizer window, right-click on the Add-On Instruction folder. Select the Import Add-On Instruction option.



3. Navigate to the correct file location and select the AOI to be installed. In this example the “Banner\_S15S TH\_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.

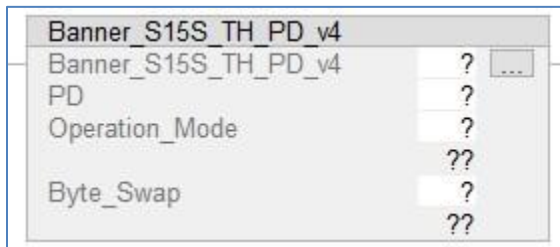
## 2. Configuring the IO-Link Master

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. This example uses the name IOLM1 for the connection.

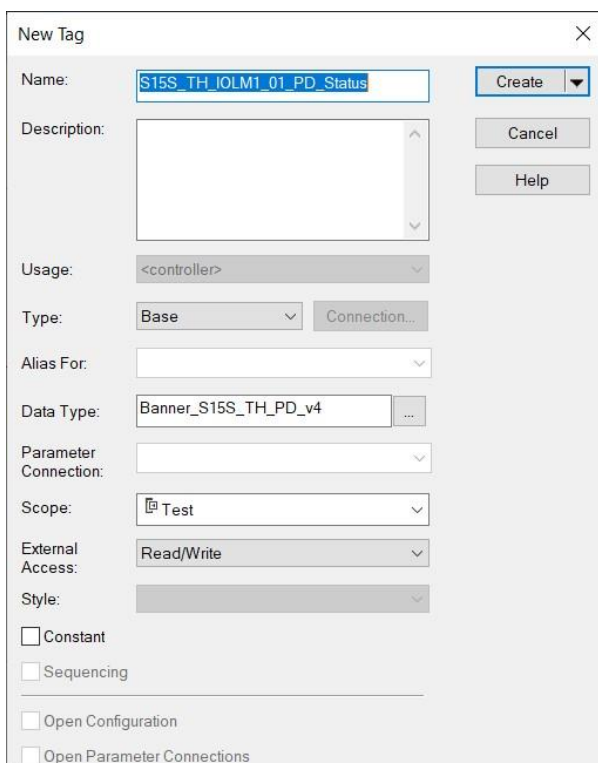
### 3. Configuring the AOI

1. Add the “Banner\_S15S\_TH\_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\_S15S\_TH\_PD\_v4”. Click New Tag. Name the new tag. This example uses the name “S15S\_TH\_IOLM1\_01\_PD\_Status”. The example naming convention accounts for this being a S15S TH 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\_S15S\_TH\_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: S15S\_TH\_IOLM1\_01\_PD\_Status Create

Description:

Usage: <controller>

Type: Base Connection...

Alias For:

Data Type: Banner\_S15S\_TH\_PD\_v4

Parameter Connection:

Scope: Test

External Access: Read/Write

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 "S15S\_TH\_IOLM1\_01\_PD". Notice that the Data Type is "Banner\_S15S\_TH\_PDI\_v4". Click Create.

**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 line labeled “Operation Mode” allows the AOI to know which of four possible Process Data definitions is currently in use. The choices for this setting are “1” (Smart Sensor Fahrenheit), “2” (Smart Sensor Celsius), “3” (Floating Point Fahrenheit), or “4” (Floating Point Celsius). This AOI needs to know which selection mode has been set in the device. The default value is 1.

There are two ways to achieve this goal. We can simply type in the correct number as a constant, or we can link this S15S TH Process Data AOI to the S15S TH Parameter Data AOI. See Appendix A for more information about S15S TH Process Data. It is easier to just type in the number being used. Adding Parameter Data AOI involves numerous steps. Contact Banner Engineering if there are questions on which process to use for your application.

|                      |                                |
|----------------------|--------------------------------|
| Banner_S15S_TH_PD_v4 |                                |
| Banner_S15S_TH_PD_v4 | S15S_TH_IOLM1_01_PD_Status ... |
| PD                   | S15S_TH_IOLM1_01_PD            |
| Operation_Mode       | 1                              |
| Byte_Swap            | 0                              |

|                      |  |
|----------------------|--|
| Banner_S15S_TH_PD_v4 |  |
| Banner_S15S_TH_PD_v4 | S15S_TH_IOLM1_01_PD_Status ...           |
| PD                   | S15S_TH_IOLM1_01_PD                      |
| Operation_Mode       | S15S_TH_IOLM1_01.Write.Process_Data_Mode |
|                      | 0  |
| Byte_Swap            | 0  |

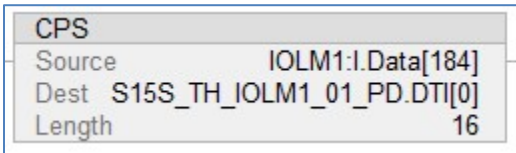
NOTE: if you type in the incorrect number (i.e., it does not match the device’s current configuration) you will get incorrectly displayed Process Data Out information.

- 5. The last line in the AOI is a setting to account for byte swapping. In the case of the S15S TH, the Process Data Out is 15 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.



- 6. The final step required before we download and run the S15S TH Process Data AOI involves a Synchronous Copy File (CPS) instruction. This instruction allows the AOI to read from 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 (example), 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.DTI[0]” location, as seen below. Finally, the length will be 16 bytes, as that is the size of the S15S TH (the extra byte is to handle byte swapping).



Here is what the entire rung looks like when completed.



The “S15S\_TH\_PD\_v4” AOI is now ready for use.

## 4. Using the AOI

The “Banner\_S15S\_TH\_PD\_v4” Add-On Instruction has created a group of tags representing the S15S TH 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 “S15S\_TH\_IOLM1\_01\_PD”. The tag array, seen below, has multiple individual pieces of information.

Each operating mode for Process Data has its own tag array. If the S15S TH device is in operating mode “1” (Smart Sensor Fahrenheit), use the tags found under the “Smart\_Fahrenheit” array. If the operating mode is “3” (Floating Point Fahrenheit), use the corresponding tags in the “Floating\_Fahrenheit” array instead.

|   |
|---|
| ▲ S15S_TH_IOLM1_01_PD                     |
| ▶ S15S_TH_IOLM1_01_PD.Smart_Fahrenheit    |
| ▶ S15S_TH_IOLM1_01_PD.Smart_Celsius       |
| ▶ S15S_TH_IOLM1_01_PD.Floating_Fahrenheit |
| ▶ S15S_TH_IOLM1_01_PD.Floating_Celsius    |

|  |       |         |
|--|-------|---------|
| ▲ S15S_TH_IOLM1_01_PD.Smart_Fahrenheit                                   | {...} |         |
| ▶ S15S_TH_IOLM1_01_PD.Smart_Fahrenheit.Temp_Value                        | 7185  | Decimal |
| ▶ S15S_TH_IOLM1_01_PD.Smart_Fahrenheit.Temp_Scale                        | 254   | Decimal |
| ▶ S15S_TH_IOLM1_01_PD.Smart_Fahrenheit.Temp_Over_Threshold               | 0     | Decimal |
| ▶ S15S_TH_IOLM1_01_PD.Smart_Fahrenheit.Temp_Under_Threshold              | 0     | Decimal |
| ▶ S15S_TH_IOLM1_01_PD.Smart_Fahrenheit.Dew_Point_Value                   | 3456  | Decimal |
| ▶ S15S_TH_IOLM1_01_PD.Smart_Fahrenheit.Dew_Point_Scale                   | 254   | Decimal |
| ▶ S15S_TH_IOLM1_01_PD.Smart_Fahrenheit.Dew_Point_Over_Threshold          | 0     | Decimal |
| ▶ S15S_TH_IOLM1_01_PD.Smart_Fahrenheit.Dew_Point_Under_Threshold         | 0     | Decimal |
| ▶ S15S_TH_IOLM1_01_PD.Smart_Fahrenheit.Relative_Humidity_Value           | 2543  | Decimal |
| ▶ S15S_TH_IOLM1_01_PD.Smart_Fahrenheit.Relative_Humidity_Scale           | 254   | Decimal |
| ▶ S15S_TH_IOLM1_01_PD.Smart_Fahrenheit.Relative_Humidity_Over_Threshold  | 0     | Decimal |
| ▶ S15S_TH_IOLM1_01_PD.Smart_Fahrenheit.Relative_Humidity_Under_Threshold | 0     | Decimal |

The Smart Sensor profile lists out scaling values based on a number. Here 254 represents a (.01). So 7185 times .01 gives 71.85 F. See the Smart Sensor profile for scaling value conversions.

## Appendix A S15S TH Process Data

The S15S TH has 15 bytes of Process Data In as shown below. 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 1, “Smart Sensor Fahrenheit”.

### ProcessDataIn "Process Data In" id=V\_PDIn\_SmartSensorFahrenheit\_DataRef

bit length: 120

data type: 120-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        | 80         | 16-bit Integer |                |               |             |                 |               | Temperature Value                 |             |
| 2        | 72         | 8-bit Integer  |                |               |             |                 |               | Temperature Scale                 |             |
| 3        | 65         | Boolean        |                |               |             |                 |               | Temperature Over Threshold        |             |
| 4        | 64         | Boolean        |                |               |             |                 |               | Temperature Under Threshold       |             |
| 5        | 48         | 16-bit Integer |                |               |             |                 |               | Dew Point Value                   |             |
| 6        | 40         | 8-bit Integer  |                |               |             |                 |               | Dew Point Scale                   |             |
| 7        | 33         | Boolean        |                |               |             |                 |               | Dew Point Over Threshold          |             |
| 8        | 32         | Boolean        |                |               |             |                 |               | Dew Point Under Threshold         |             |
| 9        | 16         | 16-bit Integer |                |               |             |                 |               | Relative Humidity Value           |             |
| 10       | 8          | 8-bit Integer  |                |               |             |                 |               | Relative Humidity Scale           |             |
| 11       | 1          | Boolean        |                |               |             |                 |               | Relative Humidity Over Threshold  |             |
| 12       | 0          | Boolean        |                |               |             |                 |               | Relative Humidity Under Threshold |             |

The next mode, “2”, is “Smart Sensor Celsius”.

### ProcessDataIn "Process Data In" id=V\_PDIn\_SmartSensorCelsius\_DataRef

bit length: 120

data type: 120-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        | 80         | 16-bit Integer |                |               |             |                 |               | Temperature Value                 |             |
| 2        | 72         | 8-bit Integer  |                |               |             |                 |               | Temperature Scale                 |             |
| 3        | 65         | Boolean        |                |               |             |                 |               | Temperature Over Threshold        |             |
| 4        | 64         | Boolean        |                |               |             |                 |               | Temperature Under Threshold       |             |
| 5        | 48         | 16-bit Integer |                |               |             |                 |               | Dew Point Value                   |             |
| 6        | 40         | 8-bit Integer  |                |               |             |                 |               | Dew Point Scale                   |             |
| 7        | 33         | Boolean        |                |               |             |                 |               | Dew Point Over Threshold          |             |
| 8        | 32         | Boolean        |                |               |             |                 |               | Dew Point Under Threshold         |             |
| 9        | 16         | 16-bit Integer |                |               |             |                 |               | Relative Humidity Value           |             |
| 10       | 8          | 8-bit Integer  |                |               |             |                 |               | Relative Humidity Scale           |             |
| 11       | 1          | Boolean        |                |               |             |                 |               | Relative Humidity Over Threshold  |             |
| 12       | 0          | Boolean        |                |               |             |                 |               | Relative Humidity Under Threshold |             |

The next mode, “3”, is “Floating Point Fahrenheit”.

#### ProcessData id=PDin\_FloatingPointFahrenheit (condition V\_ProcessDataMode = 3)

##### ProcessDataIn "Process Data In" id=V\_PDin\_FloatingPointFahrenheit\_DataRef

bit length: 120

data type: 120-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        | 88         | Float32   |                |               |             |                 |               | Temperature Value                 |             |
| 2        | 81         | Boolean   |                |               |             |                 |               | Temperature Over Threshold        |             |
| 3        | 80         | Boolean   |                |               |             |                 |               | Temperature Under Threshold       |             |
| 4        | 48         | Float32   |                |               |             |                 |               | Dew Point Value                   |             |
| 5        | 41         | Boolean   |                |               |             |                 |               | Dew Point Over Threshold          |             |
| 6        | 40         | Boolean   |                |               |             |                 |               | Dew Point Under Threshold         |             |
| 7        | 8          | Float32   |                |               |             |                 |               | Relative Humidity Value           |             |
| 8        | 1          | Boolean   |                |               |             |                 |               | Relative Humidity Over Threshold  |             |
| 9        | 0          | Boolean   |                |               |             |                 |               | Relative Humidity Under Threshold |             |

The next mode, “4”, is “Floating Point Celsius”.

#### ProcessData id=PDin\_FloatingPointCelsius (condition V\_ProcessDataMode = 4)

##### ProcessDataIn "Process Data In" id=V\_PDin\_FloatingPointCelsius\_DataRef

bit length: 120

data type: 120-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        | 88         | Float32   |                |               |             |                 |               | Temperature Value                 |             |
| 2        | 81         | Boolean   |                |               |             |                 |               | Temperature Over Threshold        |             |
| 3        | 80         | Boolean   |                |               |             |                 |               | Temperature Under Threshold       |             |
| 4        | 48         | Float32   |                |               |             |                 |               | Dew Point Value                   |             |
| 5        | 41         | Boolean   |                |               |             |                 |               | Dew Point Over Threshold          |             |
| 6        | 40         | Boolean   |                |               |             |                 |               | Dew Point Under Threshold         |             |
| 7        | 8          | Float32   |                |               |             |                 |               | Relative Humidity Value           |             |
| 8        | 1          | Boolean   |                |               |             |                 |               | Relative Humidity Over Threshold  |             |
| 9        | 0          | Boolean   |                |               |             |                 |               | Relative Humidity Under Threshold |             |

## 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 in the IO-Link Master. 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 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<br>Port | Upper Bits<br>15 - 8 | Lower Bits<br>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