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IO-Link SmartLight
Add-On Instruction
User Guide

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Table of Contents

1.0 Scope

1.1 This User Guide describes the installation, use and maintenance of the Add-On Instruction (AOI) software module for Balluff IO-Link SmartLight. This software module is designed for use with RSLogix5000.

2.0 Products

2.1 This guide was developed for use in conjunction with the following software modules AOI_BNI004A_40_27_040.L5X and AOI_BNI0006A_50_31_040.L5X. These software modules are available for download at the web site www.Balluff.com/AOI.

2.2 This software module was developed for use with a Balluff IO-Link SmartLight in conjunction with the Balluff EtherNet/IP Connectivity blocks BNI EIP-502-105-Z015 (hardware version 5.0, firmware version 3.1) and BNI EIP-508-105-Z015 (hardware version 4.0, firmware version 2.7).

2.3 For the development of this software module and hardware configuration, the following system components were used and validated:

2.3.1 RSLogix5000, version 18.01 (or later)

2.3.2 Rockwell 1756-L63 controller

3.0 Instructions

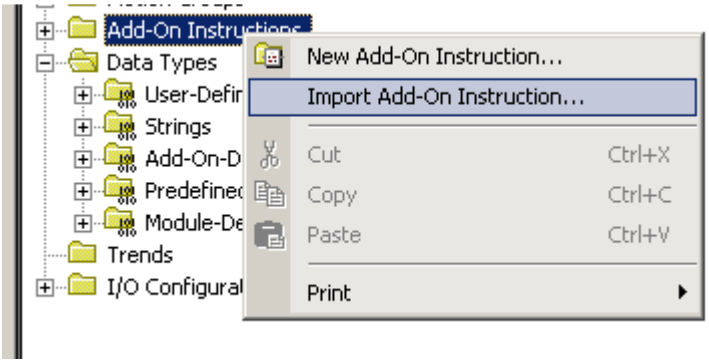
3.1 This section describes the process for installing and using the AOI module. This is a three-step process that must be followed sequentially: complete the configuration of Balluff BNI EIP-502-105-Z015 module with its associated AOI; import the SmartLight AOI module along with all associated UDTs; and create new ladder logic with AOI modules.

3.2 Configuration of Balluff BNI EIP-502-105-Z015 module and associated AOI

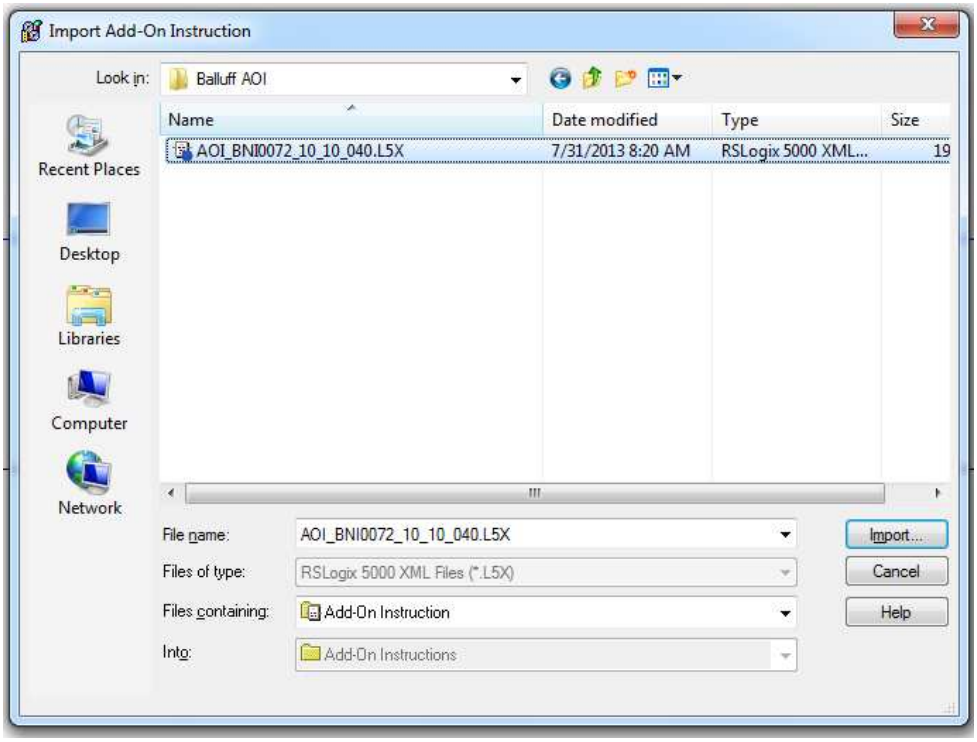
3.2.1 Follow the User Guide for the AOI_BNI004A_40_27_040, which can be found at www.Balluff.com/AOI.

3.3 Import Balluff IO-Link SmartLight AOI

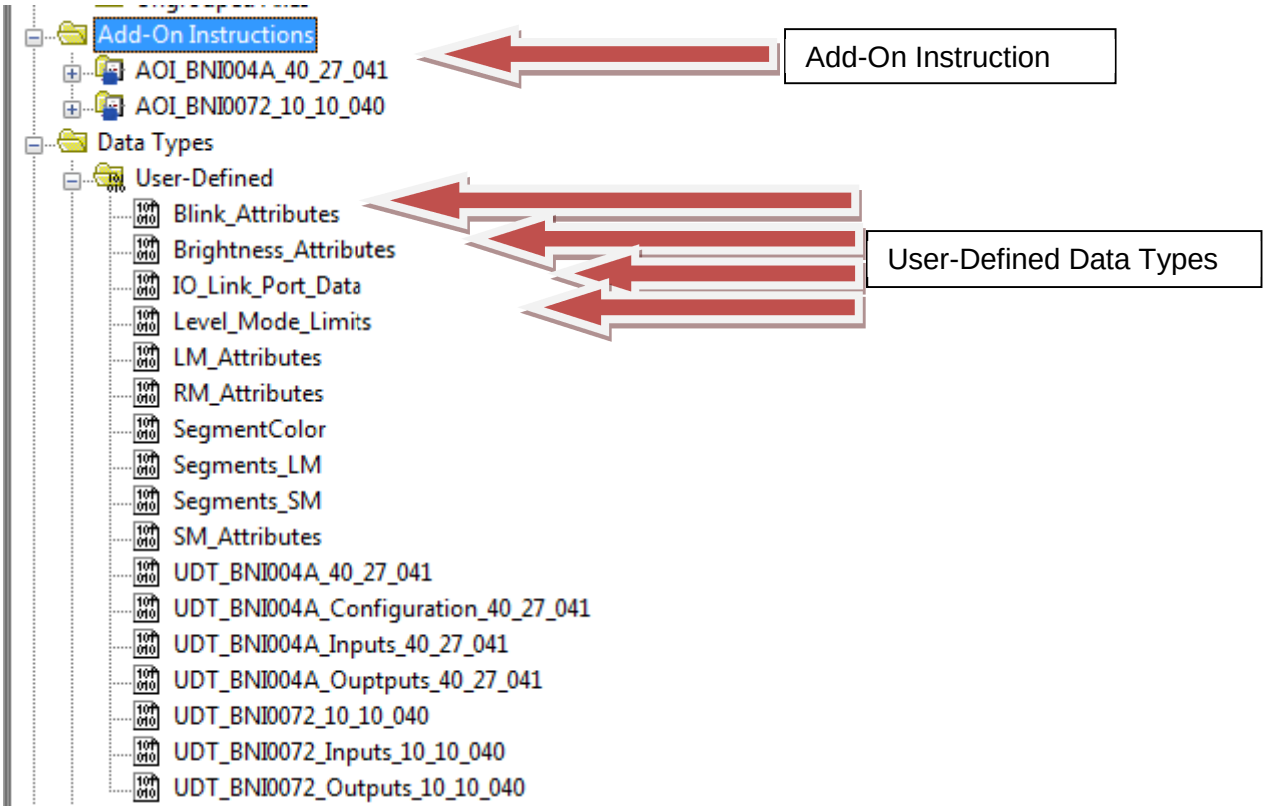
3.3.1 Right click on the Add-On Instructions element of the Controller Organizer to view a menu that includes “Import Add-On Instruction…” as shown below:



3.3.2 Locate your folder containing the downloaded Balluff AOI modules, highlight AOI_BNI0072_10_10_040.L5X file and click *Import…*

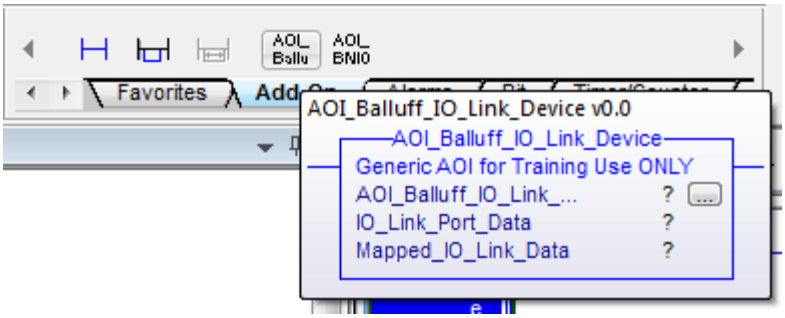


3.3.3 If the operation is successful, all UDTs associated with the AOI module will be imported into the project along with the AOI. This can be verified by checking the User-Defined element under Data Types in the Controller Organizer.

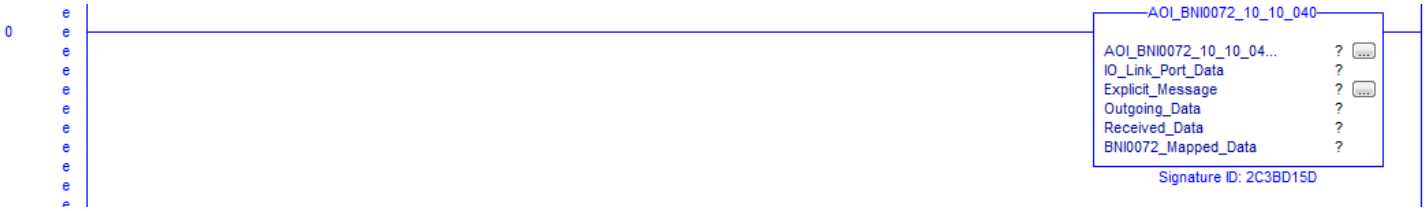


3.4 Create logic using RSLogix5000

3.4.1 Once an AOI has been imported, it can be used in the same manner as other ladder instructions. A new Element Group tab will be displayed in RSLogix5000's Language Element toolbar. This is shown here with the hover window information displayed:

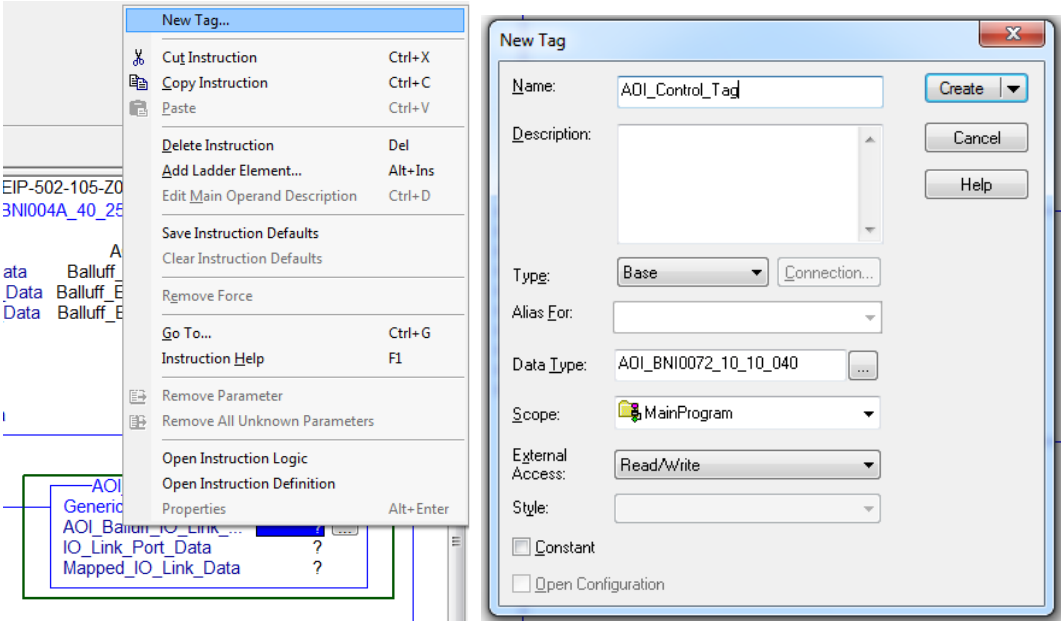


3.4.2 The AOI module can now be added to a rung of ladder:

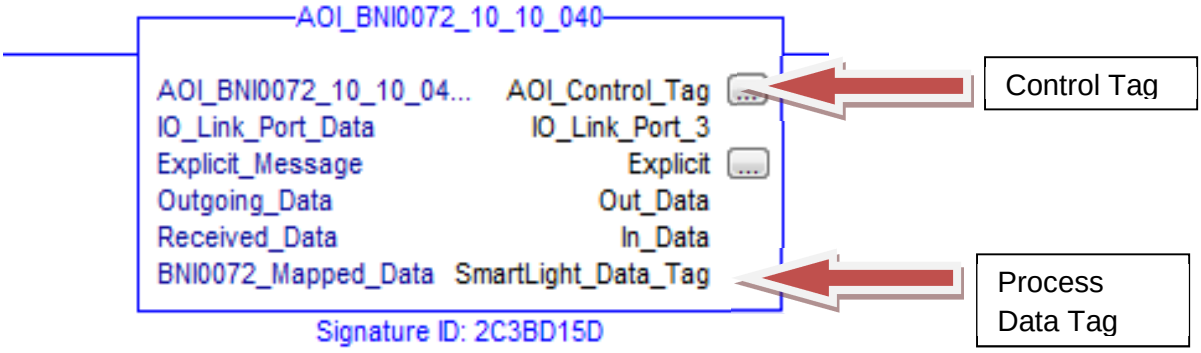


3.4.3 All parameters must be defined with tags of valid data type as defined by the AOI module. The user should create each Tag Name relevant to the user's project.

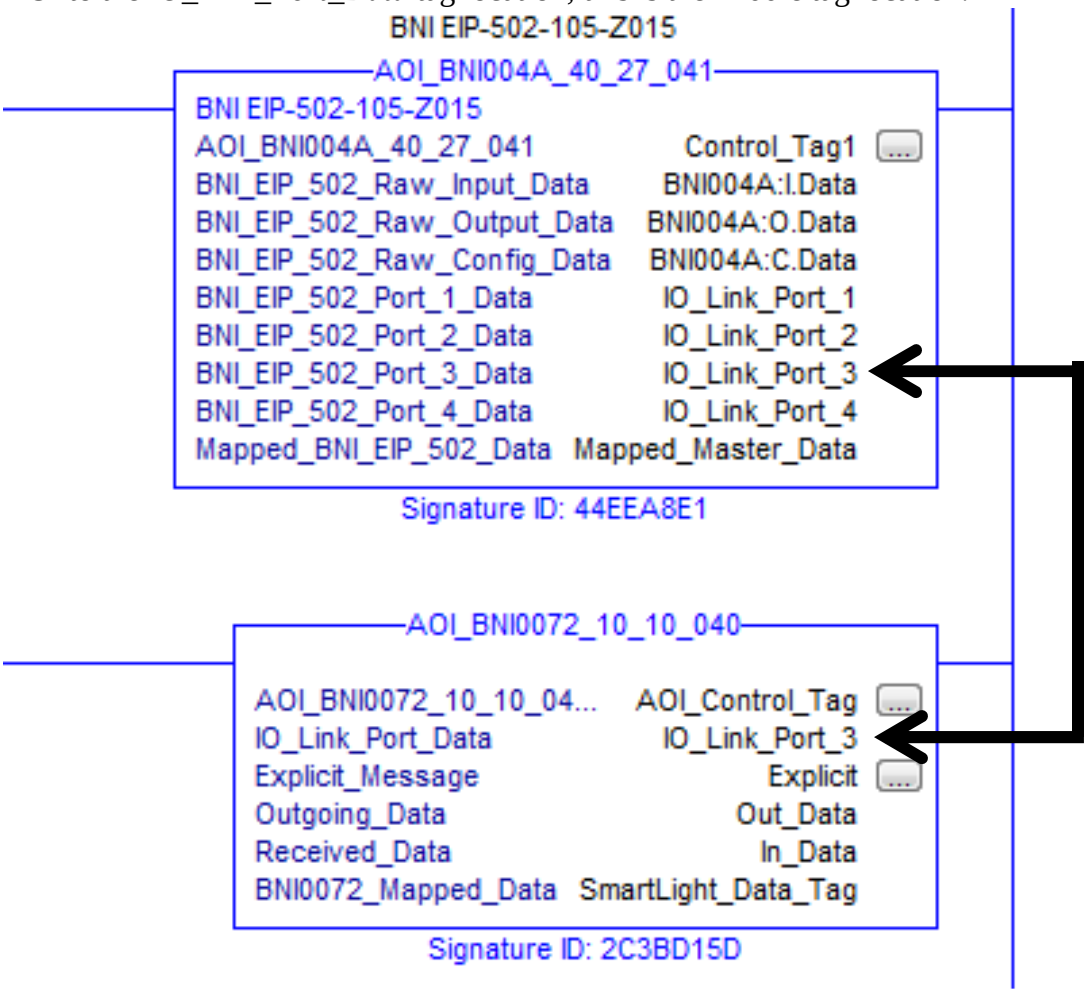
3.4.3.1 There are a total of five tags that must be created; first the AOI Control Tag this is the first tag location on the AOI. To guarantee that the new tag uses the correct data type, simply right click on the"**?**" and choose *New Tag…*, then create a tag name.



3.4.3.2 Second the IO-Link Device Data Tag, this the last tag location on the AOI. This tag contains the defined SmartLight Process and Parameter Data.

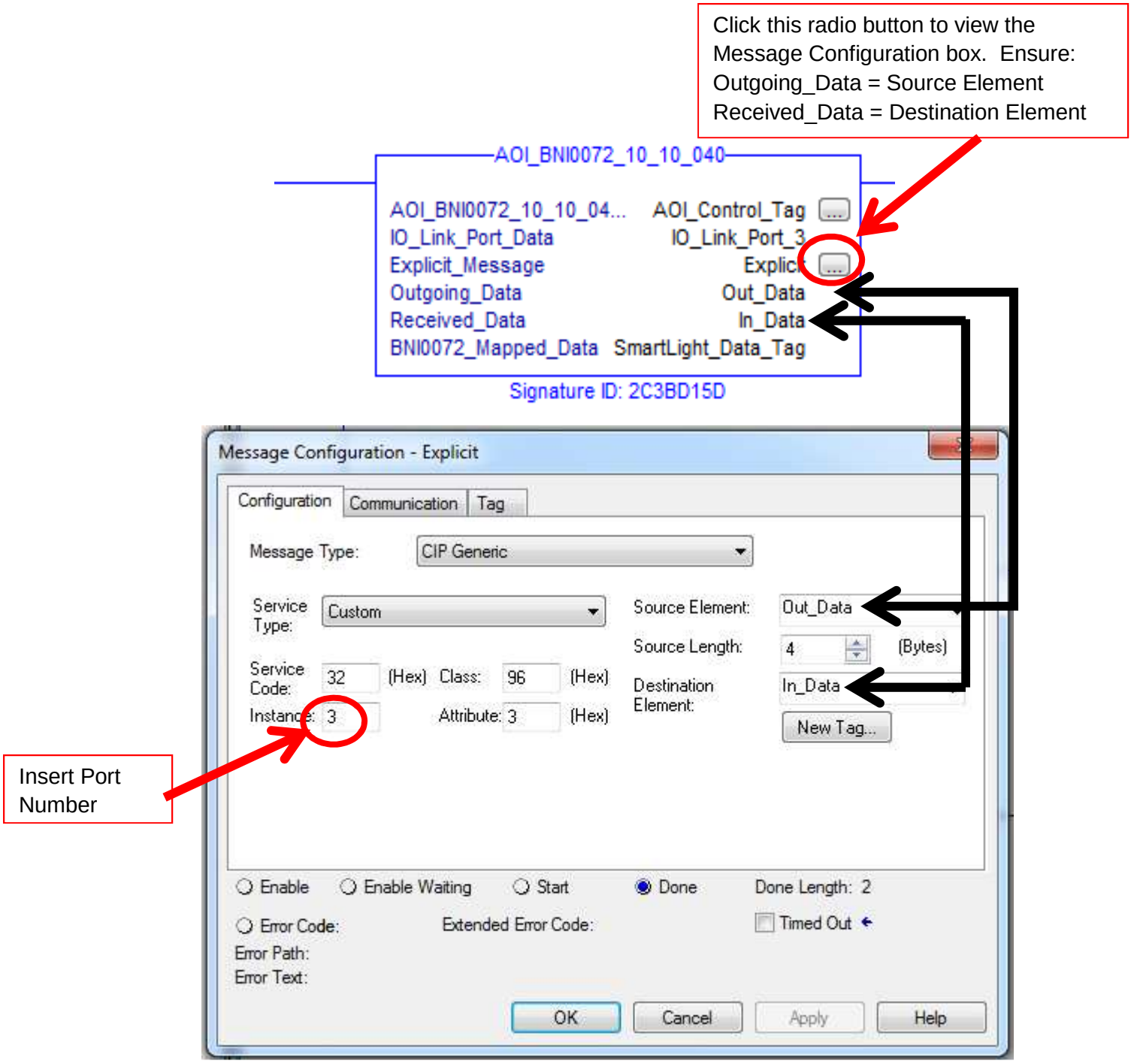


3.4.3.3 Next, drag the corresponding IO-Link Port Tag from the AOI_BNI004A_40_25_040 AOI to the *IO_Link_Port_Data* tag location; this is the middle tag location.



3.4.3.4 Finally, create thee additional new tags: Explicit_Message (Data Type = Message); Outgoing_Data (Data Type = SINT[32]); and Received_Data Outgoing_Data (Data Type = SINT[32]). These three tags are used for sending and receiving Explicit Message communication with the SmartLight. Many properties of the SmartLight must be controlled by using these Explicit Messages.

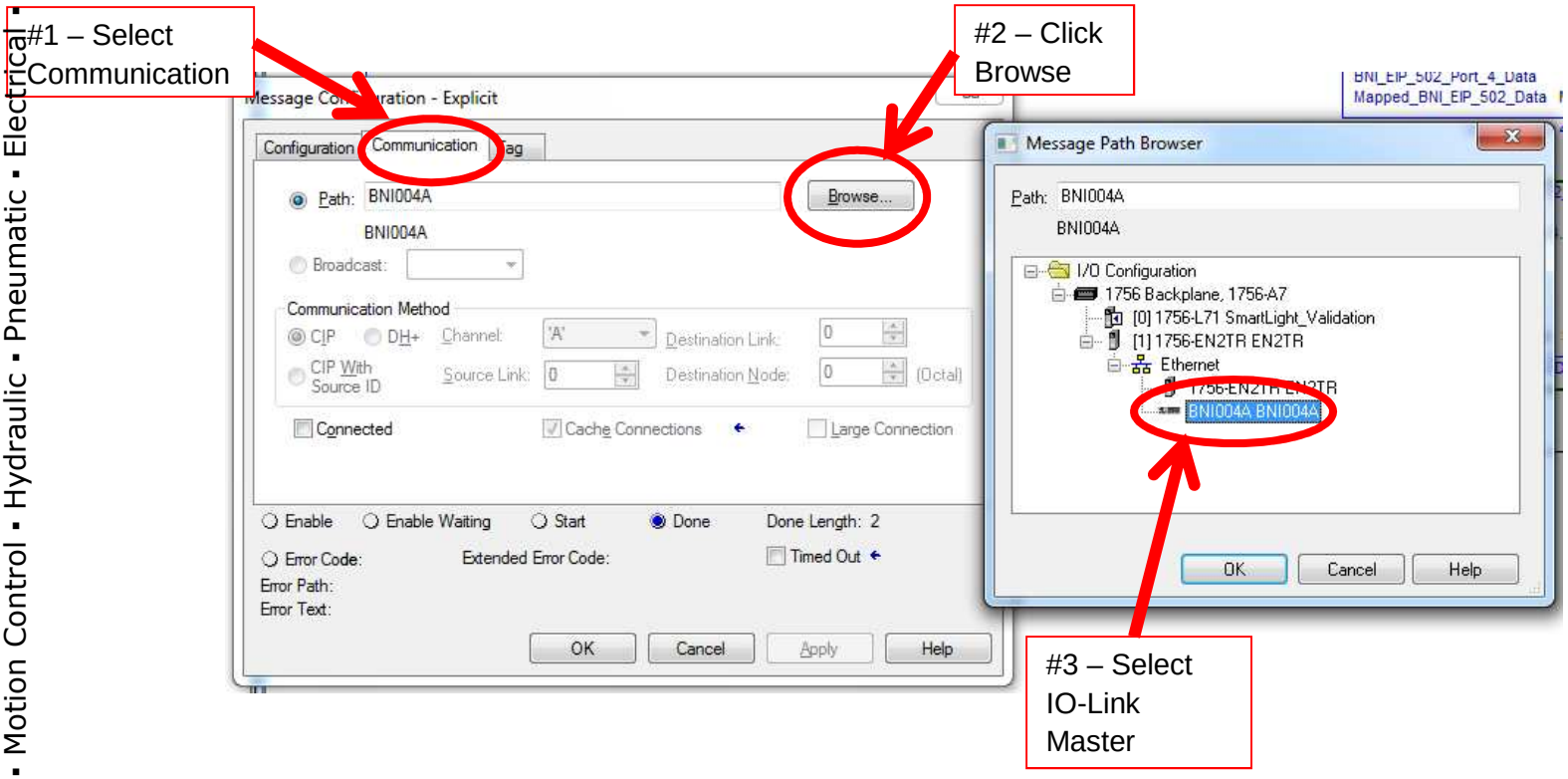
After the three tags have been created, click on the radio button to configure the Message command with these tags:



The Message Configuration box must be populated with the following values:

Message Type = CIP Generic
Service Type = Custom
Service Code = 32
Class = 96
Instance = Port Number to which SmartLight is attached
Attribute = 3
Source Element = Tag created in Outgoing_Data field
Source Length = 4
Destination Element = Tag created in Received_Data field

After all fields have been populated, click on the “Communication” tab, then the “Browse” button; and finally select the IO-Link Master device:

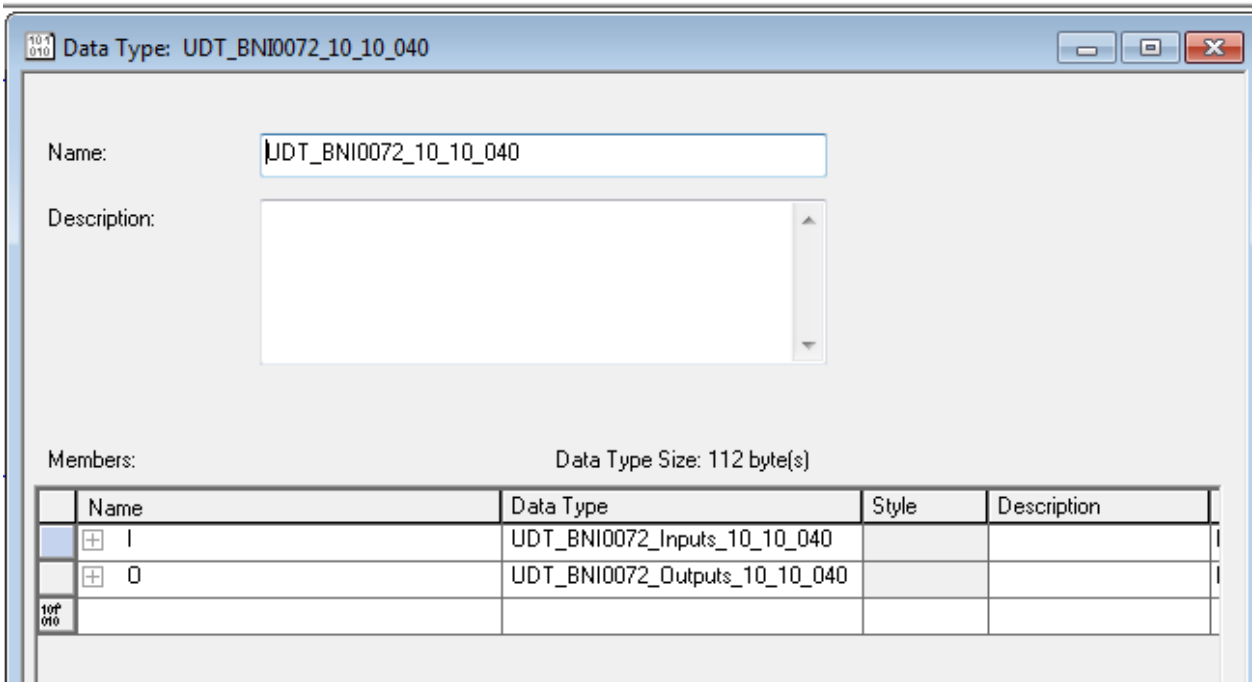


3.5 Important Note – The SmartLight AOI will execute a “boot up” sequence following every “Device_OK” bit transition to High/ON. The boot up sequence will load all current SmartLight parameter to the connected device. Thus, if a SmartLight is damaged and replaced with a new unit, the AOI will automatically load the existing parameters in the new device. This boot up sequence will last a few seconds and occur following events such as loss of system power, loss of PLC communication, etc.

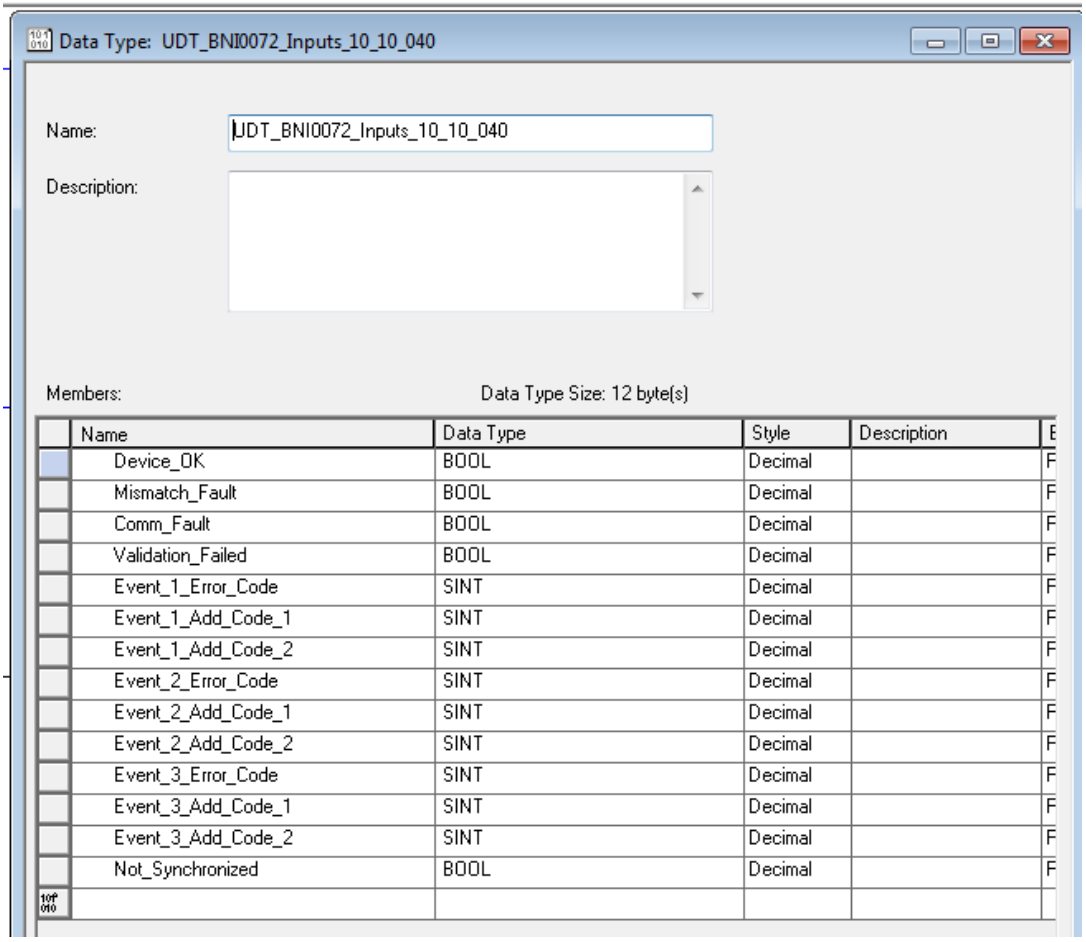
4.0 User-Defined Data Type (UDT)

4.1 The User-Defined Data Type for the Add On Instruction defines the interface for the AOI and the user's project. For most Balluff IO-Link Device AOIs, the highest level UDT. The highest level UDT is usually comprised of two sub-UDT components: Input (I) and Output (O). One additional UDT is defined, IO_Link_Port_Data, for integrating data through configured IO-Link ports.

4.2 The highest level UDT consists of the two sub-UDT.



4.3 The Input UDT consists of all inputs associated with the Balluff IO-Link Device. Each Balluff IO-Link Device Input UDT will contain the Input Data for that unique device.



Name	Data Type	Style	Description	E
Device_OK	BOOL	Decimal		F
Mismatch_Fault	BOOL	Decimal		F
Comm_Fault	BOOL	Decimal		F
Validation_Failed	BOOL	Decimal		F
Event_1_Error_Code	SINT	Decimal		F
Event_1_Add_Code_1	SINT	Decimal		F
Event_1_Add_Code_2	SINT	Decimal		F
Event_2_Error_Code	SINT	Decimal		F
Event_2_Add_Code_1	SINT	Decimal		F
Event_2_Add_Code_2	SINT	Decimal		F
Event_3_Error_Code	SINT	Decimal		F
Event_3_Add_Code_1	SINT	Decimal		F
Event_3_Add_Code_2	SINT	Decimal		F
Not_Synchronized	BOOL	Decimal		F

4.4

4.4.1 For the SmartLight, the only device-specific input tag is the Not_Synchronized diagnostic bit. This bit indicates that the hardware has experienced a power cycle event and the parameter configuration contained in the device could be different from the expected configuration in the PLC and/or network controller.

4.4.2 **Note:** There are IO-Link Diagnostic elements that are common to all Input UDTs, they are defines as follows:

Device_OK	BOOL
Mismatch_Fault	BOOL
Comm_Fault	BOOL
Validation_Failed	BOOL
Event_1_Error_Code	SINT
Event_1_Add_Code_1	SINT
Event_1_Add_Code_2	SINT
Event_2_Error_Code	SINT
Event_2_Add_Code_1	SINT
Event_2_Add_Code_2	SINT
Event_3_Error_Code	SINT
Event_3_Add_Code_1	SINT
Event_3_Add_Code_2	SINT

4.4.2.1 *Device_OK*: Diagnostic bit; when high (1), represents that the corresponding IO-Link Port on the EtherNet/IP Master Module (BNI004A) is set-up as IO-Link, there is an IO-Link device connected to the port, and that the connected device matches the correct Vendor and Device ID Number associated with the IO-Link Device AOI.

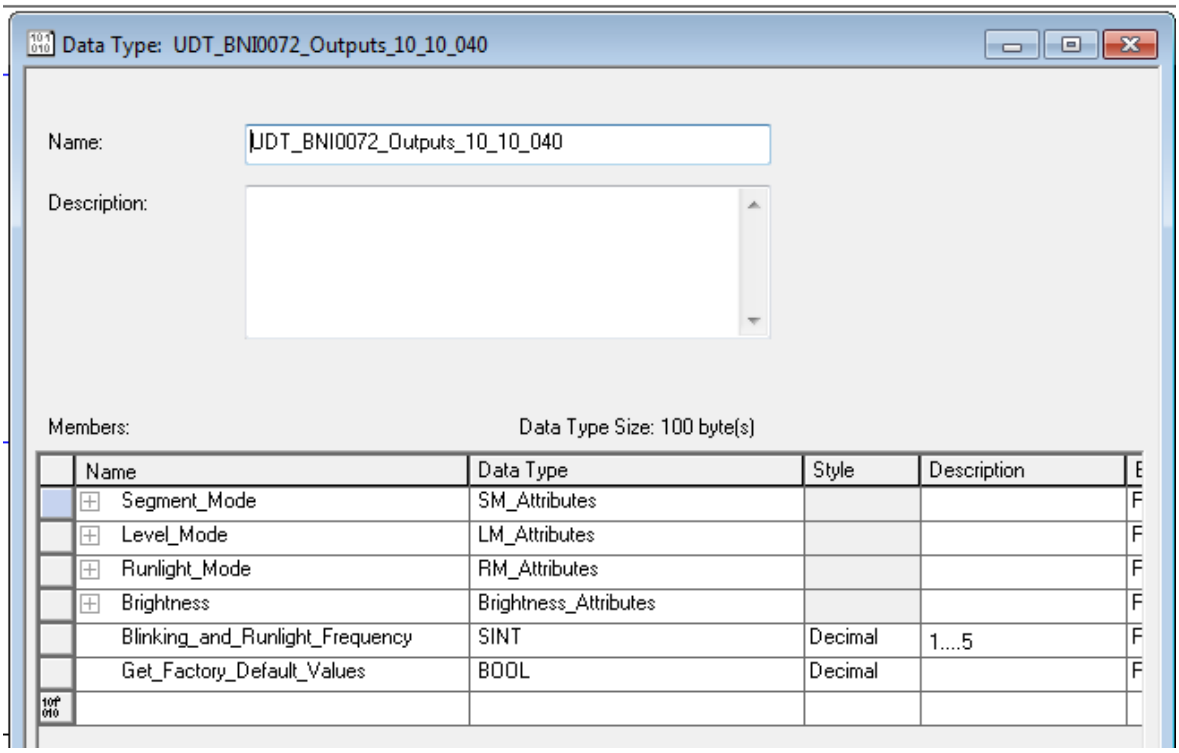
4.4.2.2 *Mismatch_Fault*: Diagnostic bit; when high (1),), represents that the corresponding IO-Link Port on the EtherNet/IP Master Module (BNI004A) is set-up as IO-Link, there is an IO-Link device connected to the port, **but** that the connected device **does not** matches the correct Vendor and Device ID Number associated with the IO-Link Device AOI.

4.4.2.3 *Comm_Fault*: Diagnostic bit; when high (1), represents that the corresponding IO-Link Port on the EtherNet/IP Master Module (BNI004A) is set-up as IO-Link, but there is not an IO-Link device connected to the port. This fault is usually associated with a short or opens on the cable between the IO-Link port and the IO-Link Device.

4.4.2.4 *Validation_Error*: when high (1), represents a validation error associated with an incorrect Vendor or Device ID number. Consult the AOI_BNI004A_40_25_040 User Guide for more information

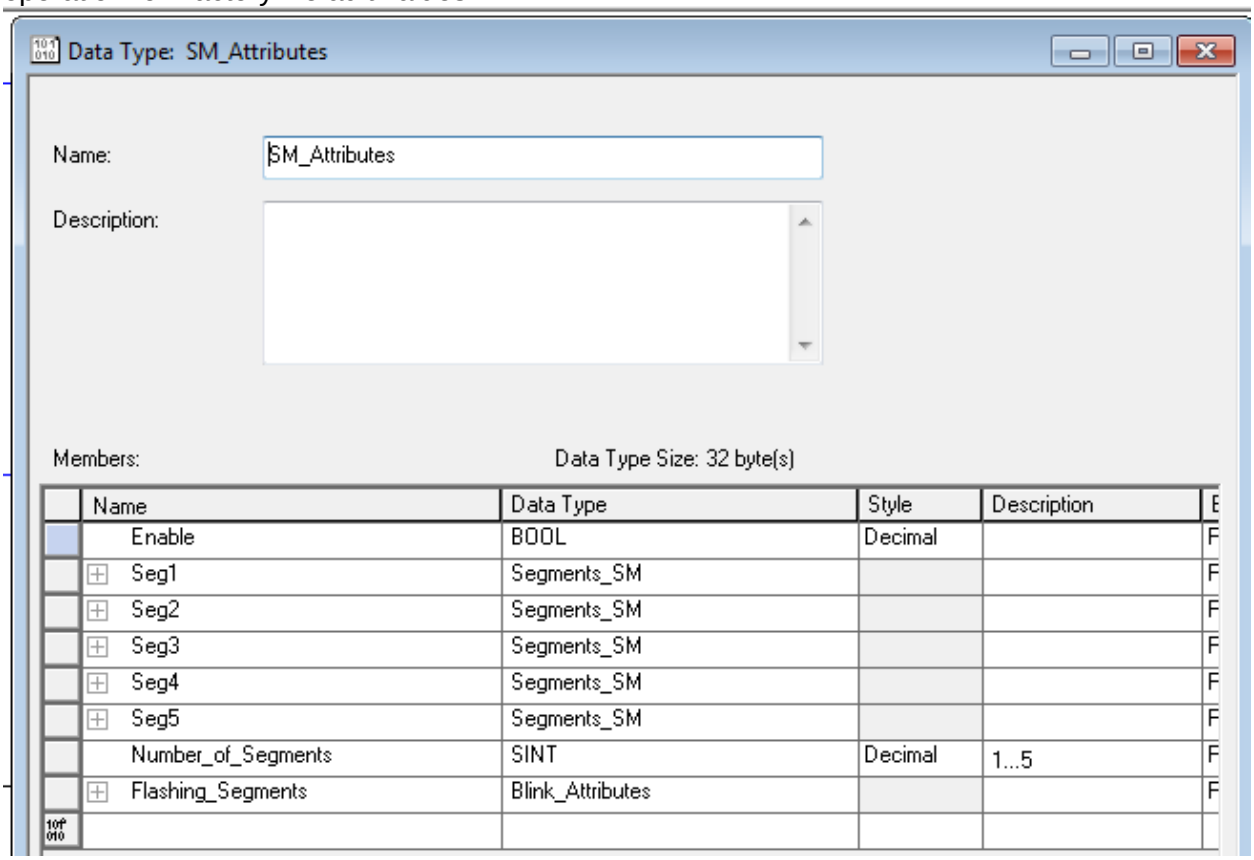
4.4.2.5 *Event_Error_Code* and *Additional_Code*; when a fault occurs, these elements will contain the error code and additional data that defines the fault. The definition of each error code and additional code can be found in the corresponding devices User Manual, which can be located at the Balluff website (www.balluff.com) or by contacting Balluff Technical Support (technical.support@balluff.com).

4.5 The Output UDT consists of all outputs associated with the Balluff SmartLight. This UDT contains four sub-UDT as well as two additional tags. The four sub-UDT include one for each of the three modes of operation (Segment, Level, and Runlight) as well as one for Brightness control.



IMPORTANT NOTE – The Output UDT contains both process and parameter values. Process values can be changed concurrently on every EtherNet/IP network scan. Parameter values, however, can only be changed through explicit messaging. Explicit messaging is built in to this AOI, so its operation is largely transparent to the user. However, only one parameter value can be changed at a time due to the limitations of explicit messaging with a delay of a few hundred milliseconds between messages.

4.5.1 SM_Attributes contains all the values used while in Segment mode, which is the default mode of operation for Factory Default values.



Name	Data Type	Style	Description
Enable	BOOL	Decimal	
Seg1	Segments_SM		
Seg2	Segments_SM		
Seg3	Segments_SM		
Seg4	Segments_SM		
Seg5	Segments_SM		
Number_of_Segments	SINT	Decimal	1...5
Flashing_Segments	Blink_Attributes		

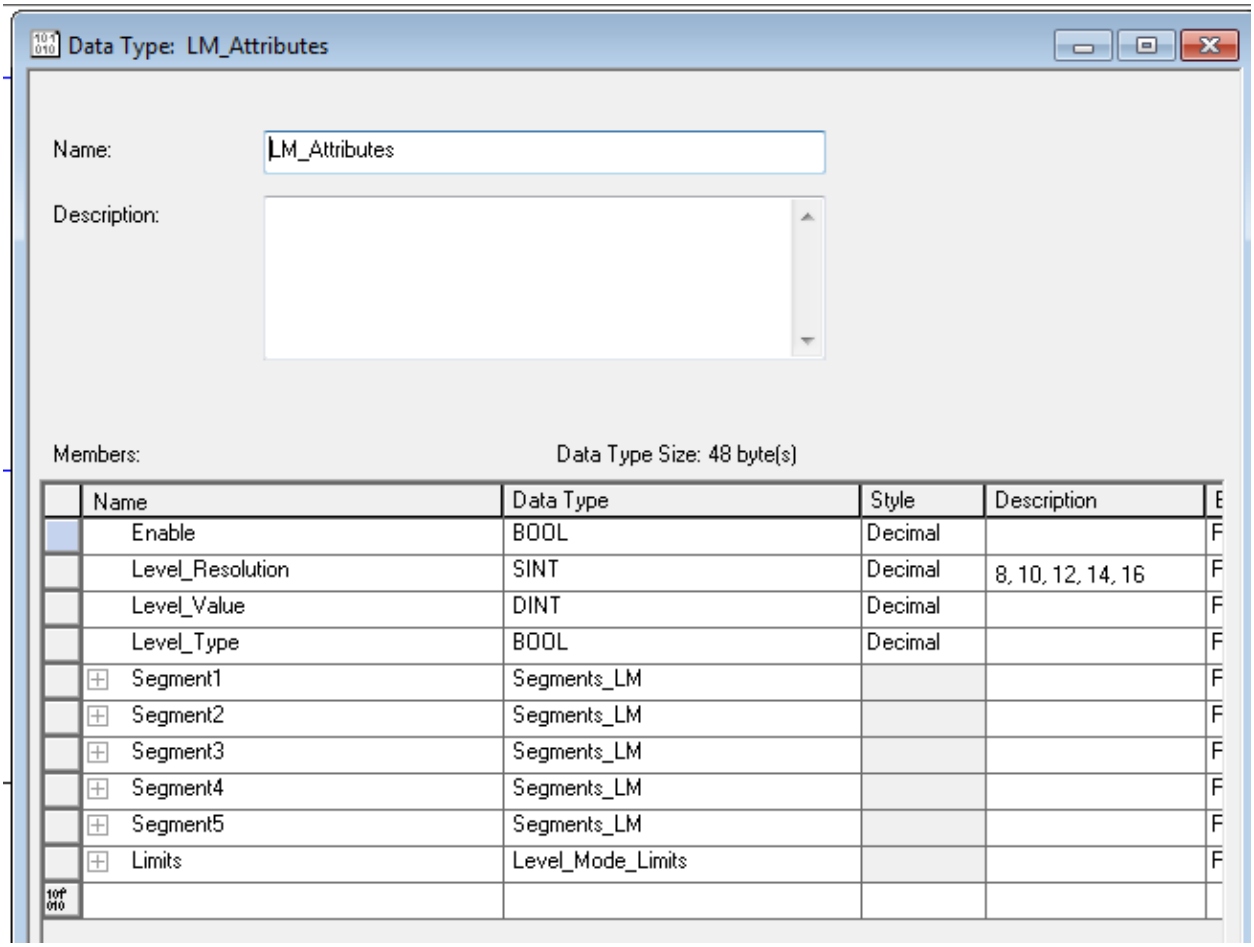
4.5.1.1 *Enable*: This bit, when high, places the SmartLight in Segment mode. The AOI also turns the enable bits for Level and Runlight modes off when the Segment Mode Enable bit turns on. All other values in the SM_Attributes UDT are ignored when the Enable bit is off.

4.5.1.2 *Seg1, Seg2, Seg3, Seg4, and Seg5*: Each sub-UDT controls its respective section of the SmartLight. This control includes the color (Green, Red, Blue, Yellow, White) as well as blinking/solid operation of the segment. Note that each color can be customized by adjusting the Brightness values as described in Section 4.5.4. Segment 1 is always furthest from the device's IO-Link connector. If less than 5 segments are selected in the Number_of_Segments value, then the additional segment values are ignored.

4.5.1.3 *Number_of_Segments*: This SINT value controls the number of segments displayed. The SmartLight automatically allocates equal size for each segment.

4.5.1.4 *Flashing_Segments*: This sub-UDT consists of five bits with one bit for each available segment. The flash feature allows for a more rapid toggling of the segment than the blink feature.

4.5.2 LM_Attributes contains all the values used while in Level mode.



Name	Data Type	Style	Description
Enable	BOOL	Decimal	
Level_Resolution	SINT	Decimal	8, 10, 12, 14, 16
Level_Value	DINT	Decimal	
Level_Type	BOOL	Decimal	
Segment1	Segments_LM		
Segment2	Segments_LM		
Segment3	Segments_LM		
Segment4	Segments_LM		
Segment5	Segments_LM		
Limits	Level_Mode_Limits		

4.5.2.1 *Enable*: This bit, when high, places the SmartLight in Level mode. The AOI also turns the enable bits for Segment and Runlight modes off when the Level Mode Enable bit turns on. All other values in the LM_Attributes UDT are ignored when the Enable bit is off.

4.5.2.2 *Level_Resolutioin*: This SINT value determines the range of values available, but must be set to one of five values: 8, 10, 12, 14 or 16. If for example, 8-bit resolution is selected, the maximum value displayed will be 255.

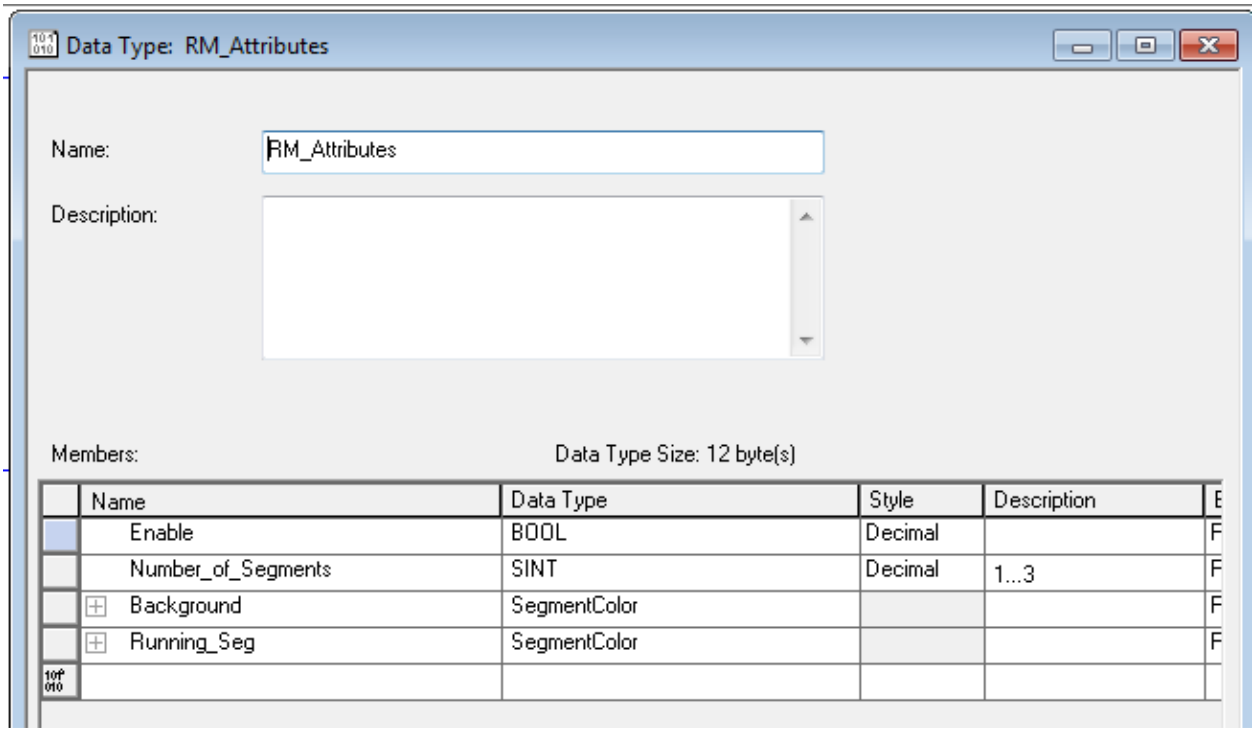
4.5.2.3 *Level_Value*: This process value indicates the level displayed by the SmartLight. If this value is 0, the SmartLight will appear to be turned off. The refresh rate of this value is limited only by the network speed.

4.5.2.4 *Level_Type*: This Boolean value determines the direction/orientation of the SmartLight level display. The default value for this bit is off, which will orient with the lowest level value (0) closest to the IO-Link connection.

4.5.2.5 *Segment1, Segment2, Segment3, Segment4, and Segment5*: Each sub-UDT controls its respective section of the SmartLight. This control includes the color (Green, Red, Blue, Yellow, White) as well as the Dominance feature operation of the segment. Note that each color can be customized by adjusting the Brightness values as described in Section 4.5.4. Segment 1 is always determined by the Level_Type value. The size of each segment is determined by the values held in the Limits sub-UDT, as well as the Level_Resolution value.

4.5.2.6 *Limits*: This sub-UDT of DINT values determines the boundaries for each segment of Level Mode. Note that the values held in the sub-UDT will likely need to be changed when the Level_Resolution value changes. For example, a value of 200 is almost full range for 8-bit resolution, but is too small to be displayed in 14- or 16-bit resolution. Note also that Level Mode will always include five segments, although each segment can be defined small enough that it cannot be displayed.

4.5.3 RM_Attributes contains all the values used while in Runlight mode.

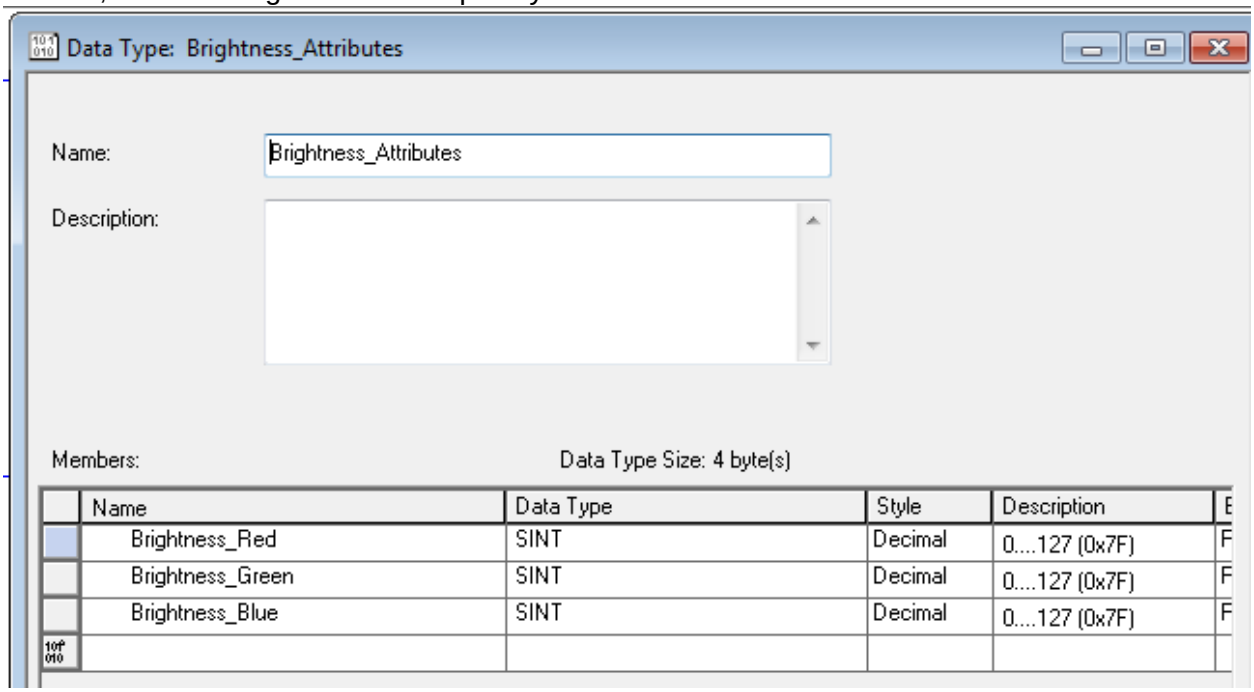


4.5.3.1 *Enable*: This bit, when high, places the SmartLight in Runlight mode. The AOI also turns the enable bits for Segment and Level modes off when the Runlight Mode Enable bit turns on. All other values in the RM_Attributes UDT are ignored when the Enable bit is off.

4.5.3.2 *Background*: This sub-UDT contains discrete bits that determine the background color. Each color can be customized using the Brightness UDT.

4.5.3.3 *Running_Seg*: This sub-UDT contains discrete bits that determine the foreground, or running, color. Each color can be customized using the Brightness UDT.

4.5.4 Brightness contains all the values controlling the brightness of the SmartLight. The brightness value is comprised of three independent sub-values which each control RGB characteristics. The default value is maximum brightness with all three value set to 127. If all three values are set to 0, the SmartLight will be completely off.

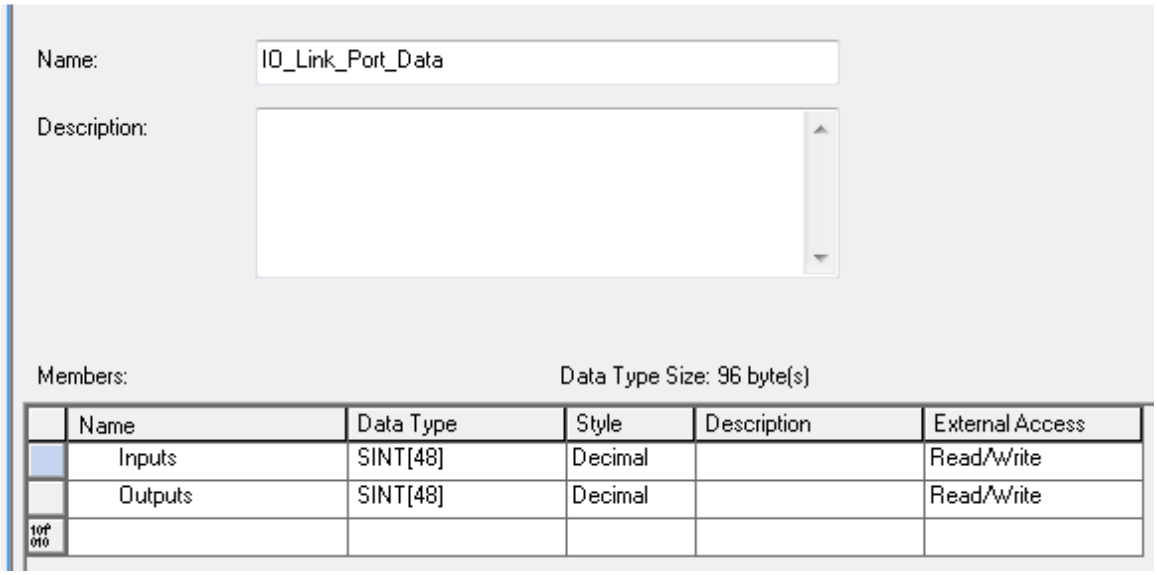


Name	Data Type	Style	Description
Brightness_Red	SINT	Decimal	0....127 (0x7F)
Brightness_Green	SINT	Decimal	0....127 (0x7F)
Brightness_Blue	SINT	Decimal	0....127 (0x7F)

4.5.5 Blinking_and_Runlight_Frequency: This SINT value must be set to a number between 1 (slowest) and 5 (fastest). Higher numbers will cause both the Blink and Runlight speed to operate faster.

4.5.6 Get_Factory_Default_Values: The bit sets all SmartLight parameter values to the factory default values and initiates a device update. This self-resetting bit should only be set high as part of an error recovery routine. IMPORTANT: this reset routine require a few seconds to execute; during this “boot up sequence”, parameter values cannot be changed until the sequence completes.

4.6 The IO_Link_Port_Data UDT consists of the 48 input bytes (SINTs) and 48 output bytes (SINTs) that the IO-Link master allocates to each port. Under normal operating conditions, the user will not be aware of any data being passed through this UDT. The AOI automates the parsing of the data for each port and allows the user to access the data directly without mapping each of the four port's data into the master's single data buffer. This UDT is used for both the IO-Link master AOI as well as each IO-Link slave AOI. The master and slave must share the same tag name for the corresponding port.



	Name	Data Type	Style	Description	External Access
	Inputs	SINT[48]	Decimal		Read/Write
	Outputs	SINT[48]	Decimal		Read/Write

4.6.1 Inputs – this 48-byte SINT array contains all raw input data values being passed from the IO-Link slave device input array to the master device input array.

4.6.2 Outputs – this 48-byte SINT array contain all raw output data values being passed from the IO-Link slave device output array to the master device output array.

5.0 Troubleshooting Tips

5.1 If the user does not obtain the correct data in the defined user tags, please ensure that the following match those described in this User Guide:

5.1.1 Hardware System layout – system must consist of the following:

5.1.1.1 Rockwell Automation Logix processor

5.1.1.2 Rockwell Logix EtherNet/IP network bridge

5.1.1.3 ODVA-compliant EtherNet/IP physical media

5.1.2 Software configurations – RSLogix5000 version 18.01 or higher must be used with this Add-On Instruction

5.1.3 Revision levels

5.2 Verify the correct LED states; on the IO-Link Port of the EtherNet/IP Master Module (BNI004A), the LED should be solid GREEN, while the IO-Link LED on the IO-Link device should flash.

5.3 As noted in the Output UDT array, many of the values used in this SmartLight AOI are parameter values that can only be changed using explicit messaging.

5.3.1 If the user tries to change multiple parameter values simultaneously, some values will be lost and the device operation will be unpredictable. Ensure that a few hundred millisecond delay is observed between making changes to parameter values.

5.3.2 When the “Device OK” bit transitions to On/High state, the SmartLight will execute a “boot up” sequence. This sequence will require a few seconds to complete, during which time no other SmartLight parameters can be changed or explicit messages sent. Any changes made during the boot up will likely result in unpredictable device operation.

5.4 If the SmartLight appears to be “turned off” in Level Mode, ensure that the proper resolution has been selected. For example, a value of 200 is almost full range for 8-bit resolution, but is too small to be displayed in 14- or 16-bit resolution. Similarly, the color associated with each segment in Level mode and the Limit values should be checked as well to ensure they correlate with the display value.

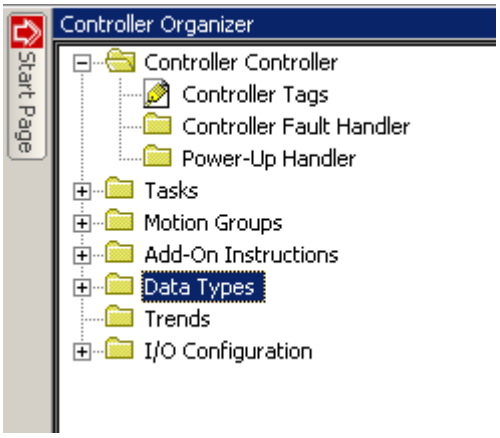
5.5 If the SmartLight appears to be “turned off”, regardless of operational mode, ensure that the Brightness values are set to a non-zero value. Another point to remember is that if a color is not selected, the default value is “off” for each segment.

5.6 If the system still does not respond properly, please contact the Balluff Technical Support Group at technicalsupport@balluff.com.

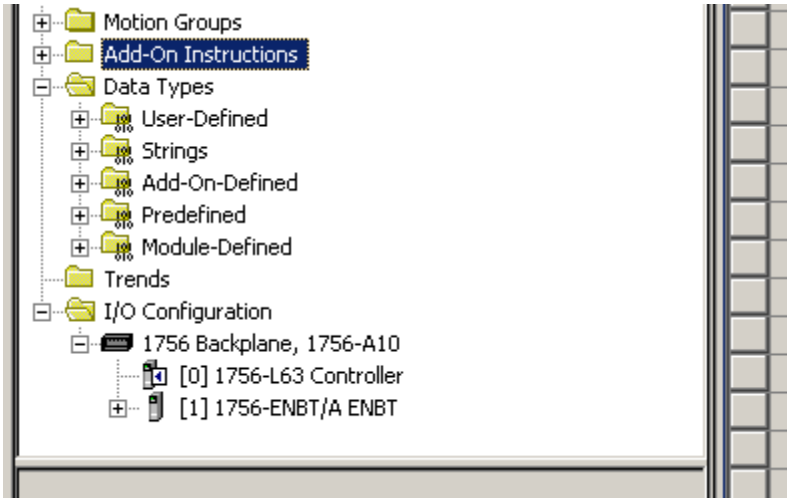
6.0 Definitions

6.1 The following terms are used in this guide with these definitions:

6.1.1 Controller Organizer – the area of RSLogix5000 where all project components can be accessed. If this toolbar is not visible, it can be opened by pressing Alt+0.



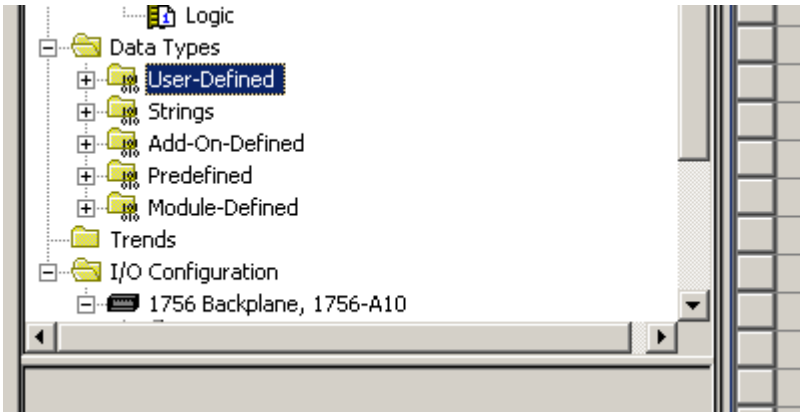
6.1.2 AOI – Add On Instruction – reusable software module created with RSLogix5000. Balluff's AOI modules are composed of UDTs and associated logic to implement control algorithms. This module is hardware specific. All AOI modules contained in a project will be located in the Controller Organizer as shown below:



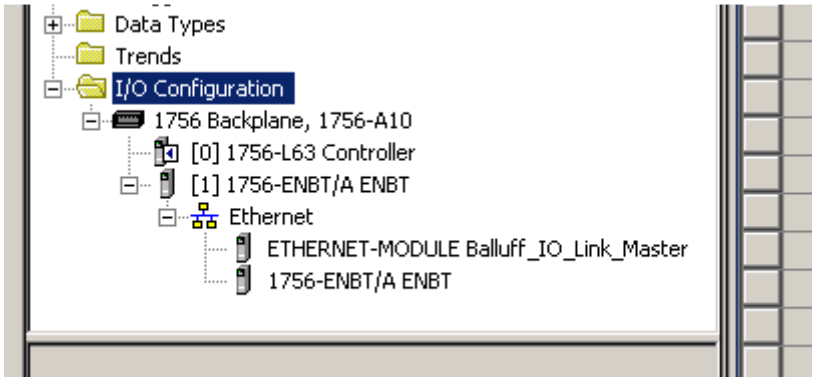
6.1.3 Controller scoped tag – a tag of any valid data type that is available to all programs within a project and must be used uniformly throughout the entire project.

6.1.4 AOI Parameter – a tag of any valid data type that is created during the definition of the AOI module and is isolated to that AOI. Its scope is limited to the each discrete use of AOI function.

6.1.5 UDT – User Defined Data Type – reusable software module created with RSLogix5000. Balluff's UDTs define the input and output tag names to be used when implementing our AOI modules. A UDT can be composed of any combination of standard Data Types defined by RSLogix5000 or other UDTs. All UDTs contained in a project will be located in the Controller Organizer as shown below:



6.1.6 I/O Configuration Tree – the area of RSLogix5000 where all physical, or "real world", Inputs and Outputs associated with the controller are defined. One example of an I/O Configuration Tree is shown below:



6.1.7 EDS – Electronic Data Sheet – software configuration file that defines how a hardware product will communicate with the network master using EtherNet/IP. The format and content of an EDS is defined by ODVA, the controlling organization for EtherNet/IP specifications.

7.0 Related Documents

7.1 The following Balluff documents support the release of this User Guide and its related software module. Each of these documents can be obtained by contacting Balluff Technical Support at technical.support@balluff.com

7.2 Other documents – Each Balluff IO-Link device that may be connected to a Balluff IO-Link Master device will have its own User Guides, both for hardware and for the AOI module software. These AOI modules and User Guides can be downloaded from Balluff's AOI website: www.Balluff.com/AOI.

8.0 References

8.1 None