

Communicating to B&R PLCs with In-Sight Vision Systems over POWERLINK

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POWERLINK and In-Sight Vision Systems

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Notes:

- POWERLINK is only supported by In-Sight 7000 series vision systems running In-Sight firmware version 4.7.2 or later, and In-Sight Explorer software version 4.7.2 or later.
- In-Sight vision systems are only supported in B&R Automation Studio, version 3.090 or later, and on Automation Runtime version 3.08 or later.

Overview

POWERLINK is a real-time Ethernet protocol for use in time-critical systems and high-performance applications, which uses a mixture of timeslot and polling procedures to achieve isochronous data transfer. In order to ensure coordination, a PLC or an Industrial PC is designated as the Managing Node (MN). This MN enforces the cycle timing (200 μ s to 10000 μ s) that serves to synchronize all devices, and controls cyclical data communication.

The other devices operating on the network, such as an In-Sight vision system, are operated as Controlled Nodes (CN). In the course of one clock cycle, the MN sends a "Poll Request" (PReq) to each CN, in a fixed sequence. Each CN replies immediately to this request with a "Poll Response" (PRes), which all other nodes can listen in on.

NOTE	When connecting POWERLINK nodes together, because the devices never compete for network bandwidth, it is recommended that standard Ethernet hubs are used instead of switches, due to their reduced latency.
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Every device on a POWERLINK network is identified by a node ID number (1-250). The MN is always node ID 240, and the CNs may have any of the other node IDs from 1 to 240. The node ID number is combined with the fixed IP subnet of 192.168.100.<NodeID>, which assigns each device on the network a fixed IP address within the POWERLINK network. This IP address can also be used to communicate with other devices outside of the POWERLINK network.

POWERLINK Cycle

The POWERLINK network is divided into fixed time slices, which are called "cycles" (200 μ s to 10000 μ s). A POWERLINK cycle consists of three periods, the Start Period, Cyclic Period and Asynchronous Period.

Start Period

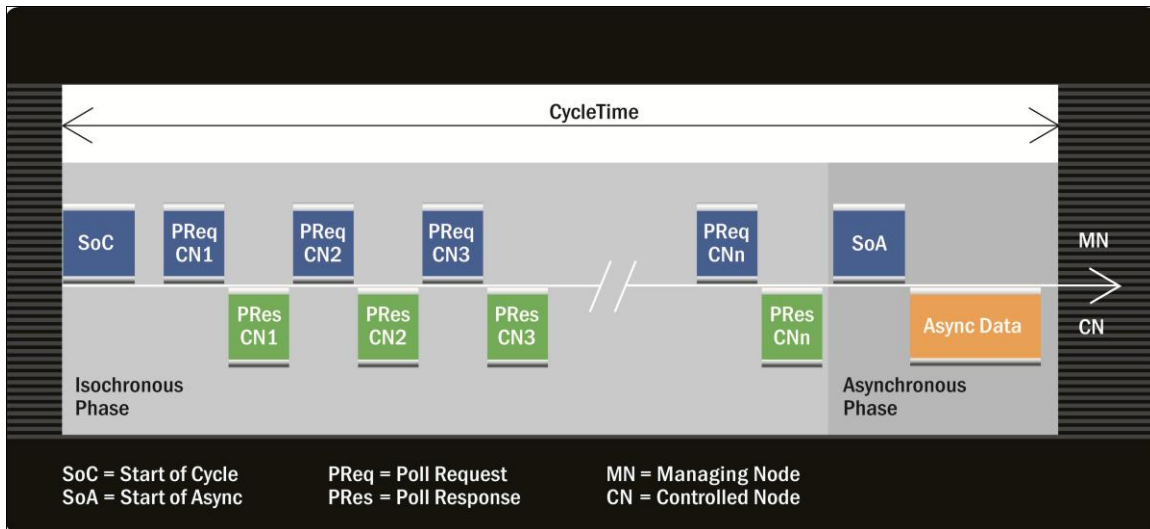
During the first period, the MN sends a Start of Cycle (SoC) frame to all CNs to synchronize the devices (jitter amounts to about 20 nanoseconds).

Cyclic Period

Cyclic isochronous data exchange takes place during the second period. After sending the SoC message, the MN proceeds to send a Poll Request (PReq) to each configured CN on that cycle. Each CN responds with a Poll Response (PRes) message. Multiplexing allows for optimized bandwidth use in this phase.

Asynchronous Period

After every CNs' data has been transferred, the MN sends a Start of Asynchronous (SoA) message to the network, indicating that the Asynchronous phase of the cycle is beginning. The third period enables the transfer of large, non-time-critical data packets. If this type of data, e.g. user data or TCP/IP frames more data to transmit than the cycle's period has capacity for, the transmission will be spread out over the asynchronous period of several cycles.



POWERLINK distinguishes between real-time and non-real-time domains. Since data transfer in the asynchronous period supports standard IP frames, routers separate data safely and transparently from the real-time domains. POWERLINK is very well suited to all sorts of automation applications, including I/O, Motion Control, robotics tasks, PLC-to-PLC communication, and visualization.

Asynchronous Data Transfer

The Asynchronous data transfer capabilities of the POWERLINK network are critically important to the In-Sight vision system. The Asynchronous phase is used to perform the following tasks:

- Configuring and monitoring a vision system using In-Sight Explorer
- Transferring images and data to In-Sight Explorer or a Cognex VisionView while Online
- Transferring images to an FTP server via the WriteImageFTP function

The two configuration settings for the POWERLINK network that have the greatest affect on Asynchronous data throughput are the Maximum Transmission Unit (MTU) setting and the Cycle Time.

MTU

The MTU for Asynchronous Packets on a POWERLINK network ranges from 300 bytes to 1500 bytes. By default, B&R PLCs set the MTU to 300 bytes. Increasing the default MTU requires that additional time be reserved in each cycle for Asynchronous data transfers. For example, the default MTU requires that 27 μ s be reserved for Asynchronous data transfer, while the maximum size (1500 bytes) would require that 123 μ s be reserved.

Cycle Time

The Cycle Time also limits Asynchronous data transfers. The POWERLINK network is configured such that only one Asynchronous packet can be transferred per cycle, so decreasing the Cycle Time allows more Asynchronous packets to be transferred on the network. One of the most common POWERLINK network configurations has a 400 μ s Cycle Time, which translates into 2500 cycles per second, or 2500 possible Asynchronous frames transferred per second.

Ideal MTU and Cycle Time Settings for In-Sight Vision Systems

Due to the fact that POWERLINK relies upon Ethernet to transmit data, especially the asynchronous portion, understanding how to calculate the total bandwidth available on the POWERLINK network is an important determinant in establishing optimal performance. The total bandwidth is shared between all CNs communicating via asynchronous transfers on the POWERLINK network.

A general formula for calculating the total bandwidth available on the POWERLINK network is:

- $\text{Bandwidth (Mbps)} = \text{MTU} * 8 / \text{Cycle Time } \mu\text{s}$

Cognex has determined that optimal settings for an In-Sight vision system on the POWERLINK network require an **MTU of 1500 bytes**, and a **Cycle Time of 400 μs** . Any significant decrease in the MTU size or an increase in the Cycle Time will result in substantially reduced performance which In-Sight Explorer interaction with the In-Sight unit, Image transfer to In-Sight Explorer or VisionView while Online and FTP images from In-Sight to a server. Please consult the B&R Microsoft Excel spreadsheet (powerlink_cycletime_calculations.xls) for calculating Cycle Time, included with the B&R Automation Studio application.

Notes:

The following In-Sight application parameters may impact the performance of the connection:

- Acquired image and image update settings, such as acquiring full images or sending and recording full resolution images. Within a limited bandwidth environment, the goal is to reduce the rate at which images are acquired. This can be accomplished by any or all of the following settings: Setting the AcquireImage function's *Start Row* and *Number of Rows* parameters to create partial acquisitions, and, in the **Record** tab of the *Record/Playback Options* dialog, setting the *Image Resolution* parameter to *Half* or *Quarter*. Also, minimize the image resolution while online by selecting *Sensor*, then *Options* from the In-Sight Explorer Main menu bar, then set the *Online Resolution* to *Half* or *Quarter*. Configuring the settings in this manner will create more bandwidth for background services, if necessary.
- Sending images with the WriteImageFTP or WriteImageSFTP functions, regardless of the image resolution settings, will reduce bandwidth available for In-Sight Explorer.

POWERLINK Network Gateway and In-Sight Vision Systems

B&R PLCs have the ability to act as a gateway for TCP/IP traffic between devices on the POWERLINK network and devices connected through the standard Ethernet port. In-Sight Explorer has the ability to add the POWERLINK network into the In-Sight Network pane. The Explorer Remote Subnet List dialog (accessible from the System menu) can be used to add the POWERLINK network and configure the subnet information. After establishing this configuration, the In-Sight Network pane will display the In-Sight vision systems on the POWERLINK subnet.

Configuring In-Sight vision systems for POWERLINK Communications

This section describes how to connect a B&R PLC to an In-Sight vision system using POWERLINK communications.

- [Enabling POWERLINK Communications on an In-Sight Vision System](#)
- [Adding a POWERLINK Network \(Subnet\) to the In-Sight Network](#)
- [Establishing a Cyclic Connection to an In-Sight Vision System](#)
- [Configuring the AcquireImage Trigger Parameter](#)
- [Getting Data from an In-Sight Vision System](#)
- [Sending Data to an In-Sight Vision System](#)
- [Loading/Changing Jobs via a B&R PLC](#)
- [Disabling POWERLINK Communications on an In-Sight Vision System](#)

Notes:

- These steps assume that the In-Sight vision system has a job loaded that contains data ready to be transmitted via the POWERLINK network.
- For application development, Cognex recommends connecting directly to the In-Sight vision system installed on the factory line. This will allow for faster image updates, which makes it easier to adjust focus, align the image and set up the application. Once the application has been developed, save the job and then enable POWERLINK and add a remote subnet. The remote subnet will allow the vision system to be monitored from In-Sight Explorer for potential troubleshooting and additional application development.
- In-Sight Explorer provides two different development environments: EasyBuilder View and Spreadsheet View. This document describes the setup and configuration of the two development environments, with the Spreadsheet View steps preceding the EasyBuilder View steps.

Application Note

Enabling POWERLINK Communications on an In-Sight Vision System

Before the In-Sight vision system can be placed on the POWERLINK network, the vision system must be configured to enable POWERLINK, using the Network Settings dialog of the In-Sight vision system. There is another alternate method to enable POWERLINK directly from the EasyBuilder interface which is described in the EasyBuilder section below:

NOTE	These steps assume that the POWERLINK network is already functioning, with other devices on the network, and that the MN is a B&R PLC.
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Spreadsheet View

1. Connect the In-Sight vision system to be placed on the POWERLINK network directly to the PC running In-Sight Explorer.
2. Open In-Sight Explorer and connect to the desired In-Sight vision system.
3. From the Sensor menu, open the Network Settings dialog.
4. In the *Real-time Ethernet Protocols* section of the dialog, select *POWERLINK* and press the **Settings** button to launch the POWERLINK Settings dialog.
5. The POWERLINK Settings dialog is used to define the Node ID of the In-Sight vision system.
6. At the message prompt, restart the In-Sight vision system, and afterward the POWERLINK protocol will be enabled upon the completion of the power cycle.
7. Disconnect the vision system from the PC and connect the vision system to the POWERLINK network.

EasyBuilder View

1. Go to the **Communication** Application Step. In the *Communications* group box, press the **Add Device** button.
2. From the *Device Setup* group box, select *PLC* from the *Device* drop-down list.
3. Select *B&R* from the *Manufacturer* drop-down list.
4. Select *POWERLINK* from the *Protocol* drop-down list.
5. Press the **OK** button. Once these settings are enabled, the *Settings* and *Format Input/Output* tabs can be configured. Input/Output configuration is described in Getting Data from and Sending Data to an In-Sight vision system.
6. On the POWERLINK Settings Tab, Check the POWERLINK box to enable POWERLINK on the In-Sight vision system (default = unchecked).
7. Set the Node ID for the In-Sight vision system on the POWERLINK network.
8. At the message prompt, restart the In-Sight vision system, and afterward the POWERLINK protocol will be enabled upon the completion of the power cycle.
9. Disconnect the vision system from the PC and connect the vision system to the POWERLINK network.

Adding a POWERLINK Network to the In-Sight Network

Follow these steps to add a POWERLINK network to the In-Sight Network pane.

Spreadsheet View and EasyBuilder View

1. On the System menu, click **Remote Subnets**.
2. In the Explorer Remote Subnet List dialog, press the **Add** button to launch the Add Subnet dialog.
3. In the *Name* field, enter a descriptive name for the subnet that will be added.
4. In the *IP Address* field, the IP address should match the "POWERLINK NAT subnet" IP address programmed in the PLC for the POWERLINK network.
5. In the *Mask* field, enter "255.255.255.0".
6. If the network infrastructure is incapable of routing to the POWERLINK network, check the *Use Custom Gateway* option, and set the *Gateway* field to the IP address of the PLC on the standard Ethernet network. This will establish a route to the remote subnet in the PC's routing table.
7. Press the **OK** button to accept the changes and close the Add Subnet dialog.
8. The newly configured remote subnet will appear in the Explorer Remote Subnet List dialog. Press the **OK** button to close the dialog.
9. The POWERLINK network will now be displayed in the In-Sight Network pane in the Spreadsheet View, and in the *Select an In-Sight Sensor or Emulator* group box of the **Get Connected** Application Step in the EasyBuilder View.

Establishing a Cyclic Connection to an In-Sight Vision System

To help integrate In-Sight vision systems onto the POWERLINK network, Cognex has created the In-Sight-7000.xdd file (0000031D_In-Sight-7000.xdd), to import into Automation Studio. The In-Sight-7000.xdd file describes the network interface of the In-Sight vision system to a POWERLINK Master Node, to facilitate the transfer of data over a POWERLINK network.

1. From within Automation Studio, go to the Tools menu and select the Import Fieldbus Device option.
2. Navigate to the .xdd file, included with In-Sight Explorer 4.7.1 (e.g. C:\Program Files\Cognex\In-Sight\In-Sight Explorer 4.7.1\XDD), and import the file (0000031D_In-Sight-7000.xdd).
3. After the In-Sight-7000.xdd file has been imported, the In-Sight vision system will need to be added to the POWERLINK network and assigned a Node ID.

Note: Please consult the B&R Automation Studio Help Explorer POWERLINK Help Contents for specific information about adding 3rd-party devices to Automation Studio.

4. Once the In-Sight vision system has been successfully added, enable the Channels that will be transmitted cyclically on the POWERLINK network. Set the Cyclic transmission Value to Write (for output to the vision system) or Read (for input from the vision system) to transfer the data in the Channel once communications with the In-Sight vision system are established.
5. The enabled Channels can be mapped to system variables, as well.

Note: Bit-level data, such as the Control and Status blocks, must be accessed by appending the bit position designator to the double-integer variable name. Direct mapping of the bit variables is not possible in this release.

6. With the project properly configured, it is downloaded to the B&R PLC, and the PLC initiates the cyclic transfer of data with the In-Sight vision system.
7. Verify that the In-Sight vision system is performing correctly by going into Monitor mode in Automation Studio, opening the I/O mapping of the vision system and validate that the ModuleOK channel is TRUE.

Configuring the AcquireImage Trigger Parameter

With the In-Sight vision system integrated into the POWERLINK network, it is possible to trigger the vision system to acquire images over the POWERLINK network. Setting the *Trigger* parameter to *Real-time Ethernet* enables a hardware assisted trigger mode when POWERLINK is enabled.

Spreadsheet View

1. Open the AcquireImage function's property sheet.
2. Set the Trigger parameter to *Real-time Ethernet*.
3. Place the In-Sight vision system Online.
4. An In-Sight vision system can be triggered by directly manipulating the *Trigger Enable* and *Trigger* bits in the **Control** field of the [Inspection Control Object](#), or by monitoring the *Trigger Ready*, *Trigger Ack*, *Acquiring* and *Missed Acq* bits in the **Status** structure of the [Inspection Status Object](#).
5. While in Automation Studio, from the Inspection Control Channel, set the *Trigger Enable* bit to True and toggle the *Trigger* bit from False to True, while the *Trigger Ready* bit is set to True.

EasyBuilder View

1. In the **Set Up Image** Application step, set the Trigger parameter to *Real-time Ethernet*.
2. Place the In-Sight vision system Online.
3. An In-Sight vision system can be triggered by directly manipulating the *Trigger Enable* and *Trigger* bits in the **Control** field of the [Inspection Control Object](#), or by monitoring the *Trigger Ready*, *Trigger Ack*, *Acquiring* and *Missed Acq* bits in the **Status** structure of the [Inspection Status Object](#).
4. While in Automation Studio, from the Inspection Control Channel, set the *Trigger Enable* bit to True and toggle the *Trigger* bit from False to True, while the *Trigger Ready* bit is set to True.

Application Note

Getting Data from an In-Sight Vision System

Spreadsheet View

In order to get data from the In-Sight Explorer spreadsheet to a B&R PLC, the data must be written to the POWERLINK network by using the WriteResultsBuffer function. This function takes a buffer of data created by the FormatOutputBuffer function and writes the data to the configured data table of the B&R PLC. This data is then transferred during the next update cycle, which is synchronized, at most, every 4ms, regardless of the Cycle Time.

The following steps explain how to format the data that will be sent from an In-Sight vision system to a B&R PLC.

1. To begin, using In-Sight Explorer, create a new job.
2. From the Palette's Snippets tab, add these two Snippets to the spreadsheet: *Acquisition > AcqCounter* and *Math & Logic > Random*.
3. Open the AcquireImage cell and set the Trigger parameter to *Continuous*.
4. Right-click an empty cell and select Insert Function to open the Insert Function dialog. From the left pane, click on the *Input/Output* category, then double-click the FormatOutputBuffer function, from the right pane, to insert it into the spreadsheet.
5. From the FormatOutputBuffer dialog, click on the *Add* button. This will initiate the cell selection mode; select the "Scaled random number" cell of the *Random* snippet.
6. From the FormatOutputBuffer dialog, click on the *Add* button again. This will initiate the cell selection mode; select the count cell of the *AcqCounter* snippet.

The screenshot shows the In-Sight Explorer spreadsheet on the left and the FormatOutputBuffer dialog on the right.

Spreadsheet View:

	A	B	C
0	Image		
1			
2	Computes a random number		
3	0.128	100	12.830
4			
5	Counts acquisitions		
6	Reset	0.000	
7			
8			
9	Buffer		
10			
11			
12			
13			
14			
15			
16			

FormatOutputBuffer Dialog:

Cell(s)	Data Type	Total Size (bytes)
\$C\$3	32 bit float	4
\$B\$6	32 bit integer	4

Buttons: Add, Delete, Move Up, Move Down

Cell(s): \$C\$3
Data Type: 32 bit floating point
Element Size (bytes): 4

Hexadecimal view: 0000 00 46 4d 41 00 00 00 00 .FMA....

Buttons: OK, Cancel

7. Close the FormatOutputBuffer dialog by clicking the **OK** button.

8. Right-click an empty cell and select Insert Function to open the Insert Function dialog. From the left pane, click on the *Input/Output* category, then double-click the WriteResultsBuffer function, from the right pane, to insert it into the spreadsheet.
9. Set the WriteResultsBuffer function's *Buffer* parameter as a cell reference to the recently created FormatOutputBuffer function's *Bufferdata* structure.
10. Place the In-Sight vision system Online.
11. Verify that the In-Sight vision system is performing correctly by going into Monitor mode in Automation Studio, opening the I/O mapping of the vision system and validate that the ModuleOK channel is TRUE.

EasyBuilder View

Getting data from EasyBuilder View jobs, such as individual tool results or overall job results, can be setup via the Format Output Data tab in the **Communication** section of the Application Steps.

Formatted output data will be sent after the vision system completes its job execution.

To format your data:

1. Click the *Format Output Data* tab.
2. Press the **Add** button to launch the *Select Output Data* dialog.
3. The *Select Output Data* dialog contains the data from any Location or Inspection Tools that were added to your job and the overall job results. From the dialog, select the appropriate data that you want to be sent from the In-Sight vision system, and press the **OK** button.
4. After you have added your data, you can modify the default data type of the selected data by choosing a different data type in the *Data Type* drop-down list.

NOTE	If you select <i>String</i> from the <i>Data Type</i> drop-down list, the <i>Element Size (bytes)</i> control will be enabled and you can specify the string length by choosing the correct number of bytes. The maximum length for input and output data is 256 bytes.
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3. Rearrange the order of the data that will be sent or received by selecting the data from the list and clicking either the **Up** or **Down** buttons to set your desired order.
5. Place the In-Sight vision system Online.

Application Note

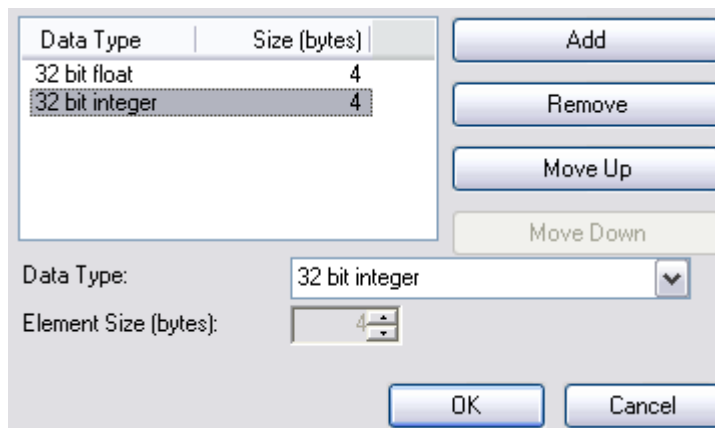
Sending Data to an In-Sight Vision System

Spreadsheet View

In order to send data from the B&R PLC to the In-Sight Explorer spreadsheet, the data must be pulled from the POWERLINK protocol stack by using the ReadUserDataBuffer function. This function takes the data format created within the FormatInputBuffer function, reads the data received from the B&R PLC, and formats this data into the In-Sight Explorer spreadsheet. In order to trigger the In-Sight vision system to read the user data from the B&R PLC, the *Set User Data* bit in the [Control](#) block must be triggered from the PLC.

For this example, create a new job within In-Sight Explorer and then perform the following steps to configure the data that will be received by the B&R PLC.

1. Open the AcquireImage cell and set the Trigger parameter to *Continuous*.
2. Right-click an empty cell and select Insert Function to open the Insert Function dialog. From the left pane, click on the *Input/Output* category, then double-click the FormatInputBuffer function, from the right pane, to insert it into the spreadsheet.
3. From the FormatInputBuffer dialog, click on the *Add* button and add a 32-bit float and a 32-bit integer to the list.



4. Close the FormatInputBuffer dialog by clicking the *OK* button.
5. Right-click an empty cell and select Insert Function to open the Insert Function dialog. From the left pane, click on the *Input/Output* category, then double-click the ReadUserDataBuffer function, from the right pane, to insert it into the Spreadsheet .
6. Set the ReadUserDataBuffer function's *Buffer* parameter as a cell reference to the recently created FormatInputBuffer function's *Bufferdata* structure.
7. The Vision Data Access functions will automatically be added to the spreadsheet based on the fields added to the FormatInputBuffer function.
8. Place the In-Sight vision system Online.

EasyBuilder View

Sending data to EasyBuilder View jobs, such as individual tool data, can be setup via the Format Input Data tab in the **Communication** step of the Application Steps.

Formatted input data will be read after the In-Sight vision system acquires an image.

To format your data:

1. Click the Format Input Data tab.
2. Press the **Add** button to launch the *Select Input Data* dialog.
3. The *Select Input Data* dialog contains the data from any Location or Inspection Tools that were added to your job. From the dialog, select the appropriate data that you want to be sent to the In-Sight vision system, and press the **OK** button.
4. After you have added your data, you can modify the default data type of the selected data by choosing a different data type in the *DataType* drop-down list.

NOTE	If you select <i>String</i> from the <i>Data Type</i> drop-down list, the <i>Element Size (bytes)</i> control will be enabled and you can specify the string length by choosing the correct number of bytes. The maximum length for input and output data is 256 bytes.
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4. Rearrange the order of the data that will be sent or received by selecting the data from the list and clicking either the **Up** or **Down** buttons to set your desired order.
5. Place the In-Sight vision system Online.

Loading/Changing Jobs via a B&R PLC

1. In order to change jobs on an In-Sight vision system from the PLC, the job's name must start with a numerical character (0-999; e.g. 23Inspection.job).
2. Set the JobID parameter in the Inspection Control channel in the PLC to the numerical character starting the job name (e.g. 23).
3. In order to load a job, the vision system must be taken Offline. Set the vision system Offline by setting bit 7 in the Inspection Control Object to 1.
4. To initiate the Job Load, set bit 4 in the Inspection Control Object to 1.
5. The status of the job load can be monitored in the Inspection Status Object, bits 12-14 of the Status structure.
6. Finally, set the vision system back Online by setting the Offline bit, bit 7 of the Inspection Control Object, to 0. This should return the vision system to its Online state.
7. Verify that the system is Online by monitoring bit 7 in the Inspection Status Object.

Disabling POWERLINK Communications on an In-Sight Vision System

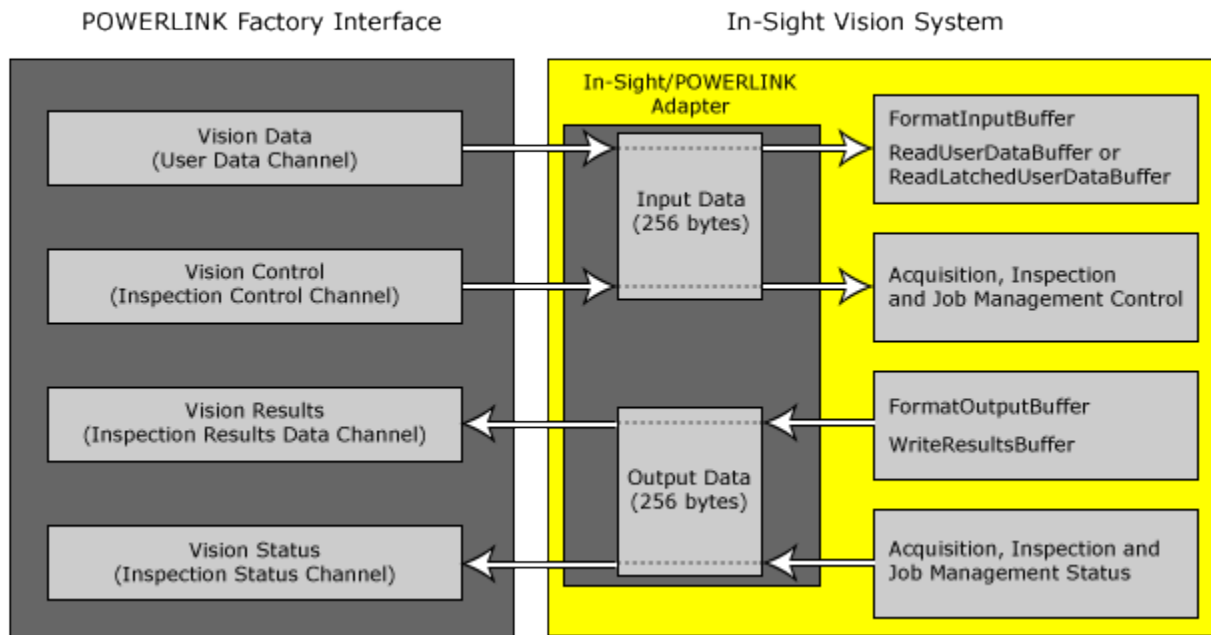
Follow these steps to disable an In-Sight vision system that was configured to operate on a POWERLINK network.

1. From a PC running In-Sight Explorer, connect the In-Sight vision system to an available Ethernet port, set to DHCP, on the PC.
2. On the System menu, click **Add Sensor/Device to Network**.
3. In the Add Sensor/Device to Network dialog, select the In-Sight vision system, select the *Obtain IP Address Automatically (DHCP)* option and then press the **Apply** button.
4. After a message prompt altering the successful change of the settings, the vision system should appear in the In-Sight Network pane.
5. Open a connection to the vision system in either the Spreadsheet or EasyBuilder development environments.
6. On the Sensor menu, click **Network Settings** to launch the Network Settings dialog.
7. For the *Real-time Ethernet Protocols*, select *None* and then press the **OK** button.
8. Restart the vision system to apply the changes.

POWERLINK Factory Interface

The data transferred between the POWERLINK Master Node and an In-Sight vision system during the isochronous phase is organized into five data channels. The Channels described below are mappable to the Process Data Object (PDO) for cyclic transfer over a POWERLINK network during the isochronous phase. The Channels from the POWERLINK Factory Interface provide a communication path to specific In-Sight vision system data buffers, for the exchange of data and vision system job management, acquisition and inspection control and status data.

- [Inspection Control Object \(0x2000\)](#)
- [Inspection Status Object \(0x2001\)](#)
- [Inspection Results \(0x2010\)](#)
- [Inspection Results Data \(0x2011\)](#)
- [User Data \(0x2021\)](#)



Inspection Control Object (0x2000)

The Inspection Control Object is a pre-defined double-integer that enables the PLC to issue certain common In-Sight vision system commands, such as triggering the vision system, changing the vision system's job file and initiating [Soft Events](#).

Index	Name	Type	Access	Notes
1	Control	32-bit integer	RW	The 32-bit Control field is mapped into the Control structure, which is described in the Control Structure Table, below.
2	JobLoadID	16-bit integer	RW	The ID number (1-999) of the job to load when the Initiate Job Load bit is set by the PLC.

Control Structure

When the Control field of the Inspection Control Object is configured for cyclic transfer, the individual bits of the Control Structure will be accessible in the PLC.

NOTE In the current release, the Control field is exposed as a DWORD only (without bitwise labels).

Bit	Name	Description
0	Trigger Enable	This field is set to enable triggering via the <i>Trigger</i> bit. Clear this bit to disable the network triggering mechanism.
1	Trigger	Setting this bit triggers an acquisition when the following conditions are met: - The In-Sight vision system is Online. - The <i>Trigger Enable</i> bit is set. - The <i>AcquireImage</i> function's <i>Trigger</i> parameter is set to <i>Real-time Ethernet</i>. Note: The <i>Trigger</i> parameter settings of <i>Network</i> or <i>External</i> may also be used, but they will add additional latency.
2	Buffer Results Enable	When this bit is set, the <i>Inspection Count</i> , <i>Inspection Result Code</i> and <i>Inspection Results</i> fields are held constant until they are acknowledged by setting the <i>Inspection Results Ack</i> bit. Up to eight inspections are held in the In-Sight vision system's buffer. The vision system will respond to the acknowledgment by clearing the <i>Results Valid</i> bit. Once the <i>Inspection Results Ack</i> bit is cleared and there is a new set of results sent to the PLC, the <i>Results Valid</i> bit will no longer be cleared. If the <i>Inspection Results Ack</i> bit is cleared and there are no more results in the vision system's buffer that are to be sent to the PLC, the <i>Results Valid</i> bit remains cleared.
3	Inspection Results Ack	When the <i>Buffer Results Enable</i> bit is set, the <i>Inspection Results Ack</i> bit is set by the PLC to acknowledge that it has received the <i>Inspection Count</i> , <i>Inspection Result Code</i> and <i>Inspection Results</i> data. The next set of inspection results is then sent to the PLC. Clearing the <i>Inspection Results Ack</i> bit causes the vision system to set the <i>Results Valid</i> bit if the buffer is not empty.
4	Initiate Job Load	When set, the vision system loads the job ID specified in the Job Load ID field. NOTE Do not set the Initiate Job Load bit while the In-Sight vision system is Online. Take the vision system Offline before setting the Initiate Job Load bit; otherwise the Job Load Failed bit will not be set.
5 -	Reserved	Reserved for future implementations.

Application Note

Bit	Name	Description
6		
7	Set Offline	When this bit is set, the In-Sight vision system is taken Offline until the bit is cleared again.
8 - 15	Reserved	Reserved for future implementations.
16	Set User Data	This command is used by the PLC to indicate to the In-Sight vision system that it should transfer the <i>User Data</i> field into a holding buffer for consumption by the vision system.
17 - 18	Reserved	Reserved for future implementations.
19	Clear Exposure Complete	While this signal is High, the <i>Exposure Complete</i> status will remain reset. Once this signal is set to Low, the <i>Exposure Complete</i> status will be set to High on the next exposure completion.
20 - 23	Reserved	Reserved for future implementations.
24 - 31	Soft Event 0 - 7	Allows Spreadsheet soft events to be triggered. Setting any of these bits causes the associated soft event in the Spreadsheet to be triggered.

Inspection Status Object (0x2001)

The Inspection Status Object is also a pre-defined double integer block, which informs the PLC about the status of the In-Sight vision system, such as Trigger Ready, Inspecting, and Inspection Complete, for example, and provides additional diagnostic information, such as error statuses, Online/Offline status or missed acquisitions.

Index	Name	Type	Access	Notes
1	Status	32-bit integer	R	The 32-bit Control field is mapped into the Status structure, which is described in the Status Structure Table, below.
2	CurrentJobID	16-bit integer	R	The ID number of the currently running job on the vision system, or 65535 if the current job does not have an ID number. This field is updated when the job is changed on the vision system, regardless of method of job change.
3	AcquisitionID	16-bit integer	R	The identifier is associated with the current acquisition. This identifier is set to the Acquisition ID when the Trigger Ack signal is asserted for an acquisition triggered using the Network Trigger bit.

Status Structure

When the Status field of the Inspection Status Object is configured for cyclic transfer, the individual bits of the Status Structure will be accessible in the PLC.

NOTE In the current release, the Control field is exposed as a DWORD only (without bitwise labels).

Bit	Name	Description															
0	Trigger Ready	Indicates when an In-Sight vision system can accept a new trigger via the <i>Trigger</i> bit. This field is true when the vision system is Online, the <i>Network Trigger Enable</i> bit is set, the <i>AcquireImage</i> function's <i>Trigger</i> parameter is set to <i>Real-time Ethernet</i> and the vision system is not currently acquiring an image. NOTE The <i>Trigger</i> parameter settings of <i>Network</i> or <i>External</i> may also be used, but they will add additional latency.															
1	Trigger Ack	Indicates when an In-Sight vision system has been triggered by the <i>Trigger</i> bit being set; this bit will stay set until the <i>Trigger</i> bit is cleared.															
2	Acquiring	Set when an In-Sight vision system is currently acquiring an image, regardless how the acquisition was triggered.															
3	Missed Acq	Set when an In-Sight vision system misses an acquisition trigger, regardless how the acquisition was triggered; cleared when an acquisition is successfully triggered.															
4 - 6	Offline Reason	This field is a 3-bit field used to identify the cause of why an In-Sight vision system is Offline: <table> <tr> <th>Offline Reason</th><th>Name</th><th>Description</th></tr> <tr> <td>0</td><td>Online</td><td>The vision system is Online.</td></tr> <tr> <td>1</td><td>Programming</td><td>The vision system's job is being modified.</td></tr> <tr> <td>2</td><td>Discrete Offline</td><td>A discrete signal is holding the vision system Offline.</td></tr> <tr> <td>3</td><td>Comm. Offline</td><td>A communications protocol is holding the vision system Offline.</td></tr> </table> NOTE It is possible to have multiple devices holding the In-Sight vision system Offline.	Offline Reason	Name	Description	0	Online	The vision system is Online.	1	Programming	The vision system's job is being modified.	2	Discrete Offline	A discrete signal is holding the vision system Offline.	3	Comm. Offline	A communications protocol is holding the vision system Offline.
Offline Reason	Name	Description															
0	Online	The vision system is Online.															
1	Programming	The vision system's job is being modified.															
2	Discrete Offline	A discrete signal is holding the vision system Offline.															
3	Comm. Offline	A communications protocol is holding the vision system Offline.															

Application Note

Bit	Name	Description
		In this scenario, this field will return the channel with the lowest reason code.
7	Online	This bit is set when the In-Sight vision system is Online, and cleared when the vision system is Offline. When the vision system is Offline, examine the <i>Offline Reason</i> field to determine the reason.
8	Inspecting	This bit is set when an In-Sight vision system is running a job.
9	Inspection Complete	This bit is toggled upon the completion of an inspection.
10	Results Buffer Overrun	This field is set when the <i>Buffer Results Enable</i> bit is set and the In-Sight vision system has discarded a set of inspection results because the PLC has not acknowledged the results by setting the <i>Inspection Results Ack</i> bit. Up to eight inspections are held in the vision system's buffer; therefore, this bit is set when the ninth inspection is added to the buffer, and will overwrite the eighth inspection in the buffer. The bit is not cleared until a valid inspection occurs and a previous inspection is not overwritten.
11	Results Valid	Set when the <i>Inspection Count</i> , <i>Inspection Result</i> and <i>Inspection Results</i> fields are valid.
12	Job Loading	This bit is set when a job load was initiated through this protocol.
13	Job Load Complete	This bit is toggled on the completion of a job load operation initiated by this protocol.
14	Job Load Failed	This bit is set when the last job load attempt failed. It is cleared after a successful job load, initiated by the MN.
15	Reserved	Reserved for future implementations.
16	Set User Data Ack	This command is used by the PLC to indicate to the In-Sight vision system that it should transfer the <i>User Data</i> field into a holding buffer for consumption by the vision system.
17 - 18	Reserved	Reserved for future implementations.
19	Exposure Complete	This bit is set upon the completion of the In-Sight vision system's exposure period, and is cleared when an acquisition is triggered. This bit will be held in a reset state if the Clear Exposure Complete signal is set to High.
20 - 23	Reserved	Reserved for future implementations.
24 - 31	Soft Event Ack 0 - 7	These bits are used to indicate the completion of a soft event.

Inspection Results (0x2010)

The Inspection Results provide the acquisition ID and the length of the data in the Inspection Results Data block.

Index	Name	Type	Access	Notes
1	InspectionID	32-bit integer	R	The acquisition ID associated with this set of results.
2	InspectionResultCode	16-bit integer	R	Currently unused; always 0.
3	InspectionResultLength	16-bit integer	R	The length of the inspection results data.

Inspection Results Data (0x2011)

The Inspection Results Data Channel is a configurable series of registers that are used for communicating data from the vision inspection to the PLC. For example, the PLC may want to know what the overall "Pass/Fail" result, the result of a measurement, the X, Y and angle position of a part or the result of a bar code. This data is sent via the Inspection Results Data Channel.

Index	Name	Type	Access	Notes
1 - 64	InspectionResultsNN	32-bit integer	R	Inspection result data written from In-Sight Explorer, using the WriteResultsBuffer function.

User Data (0x2021)

The User Data Channel is a configurable series of registers used for sending values from the PLC to the In-Sight vision system. For example, a tolerance setting can be sent from the PLC to the vision system, so that it applies the applicable tolerance when inspecting a certain part.

The User Data Channel can also be used to write individual 32-bit integer values to the User Data Block, or assign them to the Process Data Object (PDO) for cyclical transfer.

Index	Name	Type	Access	Notes
1 - 64	UserDataNN	32-bit integer	RW	Data buffer which can be read into In-Sight Explorer using the ReadUserDataBuffer or ReadLatchedUserDataBuffer function.

POWERLINK/In-Sight Vision System Mapping

The following modules allow access to the various subsystems in the In-Sight vision system:

- [Typical Acquisition Sequence](#)
- [Inspection/Result Sequence](#)
- [Results Buffering](#)
- [Soft Events](#)

Typical Acquisition Sequence

An In-Sight vision system can be triggered by directly manipulating the *Trigger Enable* and *Trigger* bits in the **Control** field of the [Inspection Control Object](#), or by monitoring the *Trigger Ready*, *Trigger Ack*, *Acquiring* and *Missed Acq* bits in the **Status** structure of the [Inspection Status Object](#).

While in Automation Studio, from the Inspection Control Channel, set the *Trigger Enable* bit to True and toggle the *Trigger* bit from False to True, while the *Trigger Ready* bit is set to True.

Sample In-Sight Vision System Acquisition Sequence

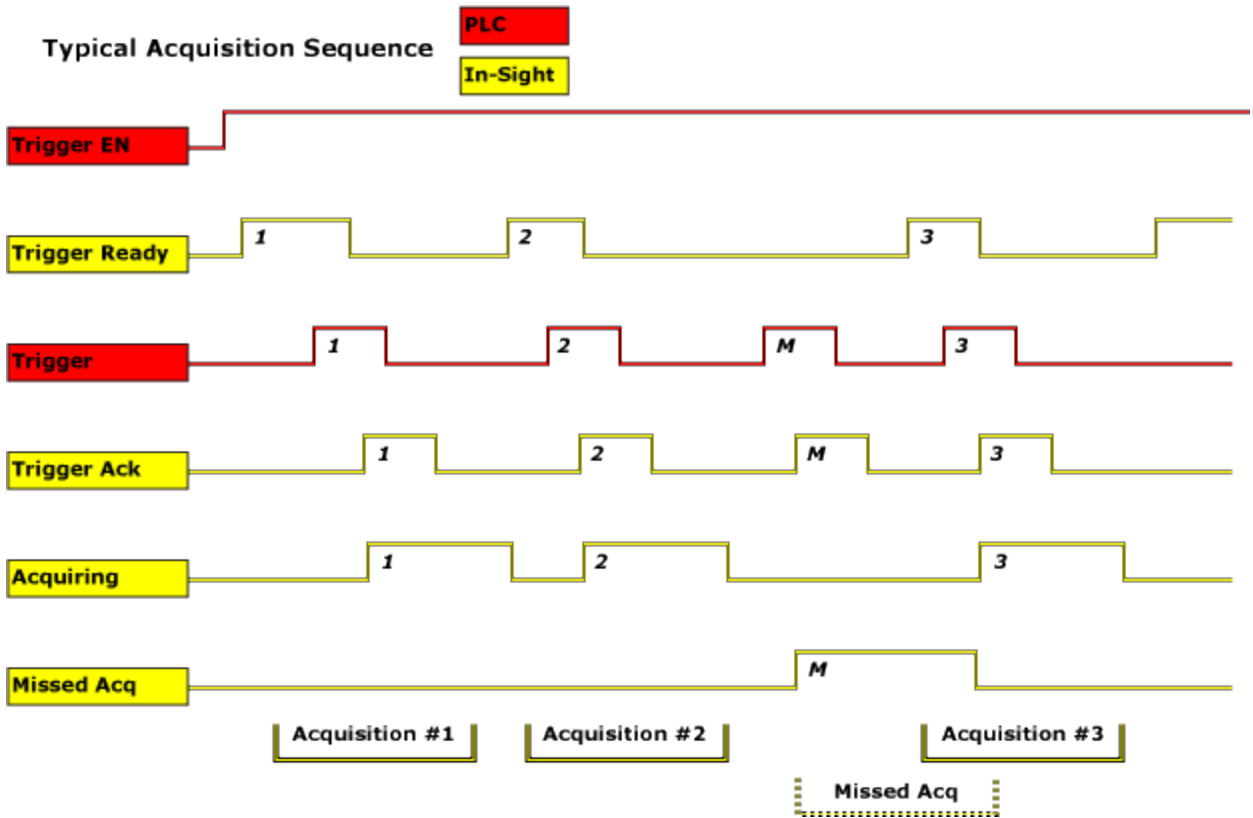
On initial start-up, the *Trigger Enable* bit will be False, and must be set to True to enable triggering. When the vision system is ready to accept triggers, the *Trigger Ready* bit in the **Control** field of the Inspection Control Object will be set to True.

While the *Trigger Enable* and *Trigger Ready* bits are True, each time the vision system sees the *Trigger* bit change from False to True, an image acquisition will be initiated. The *Trigger* bit should be held on until the *Trigger Ack* bit of the **Status** structure of the Inspection Status Object changes to False (this is a necessary handshake to guarantee that the change has been seen by the vision system).

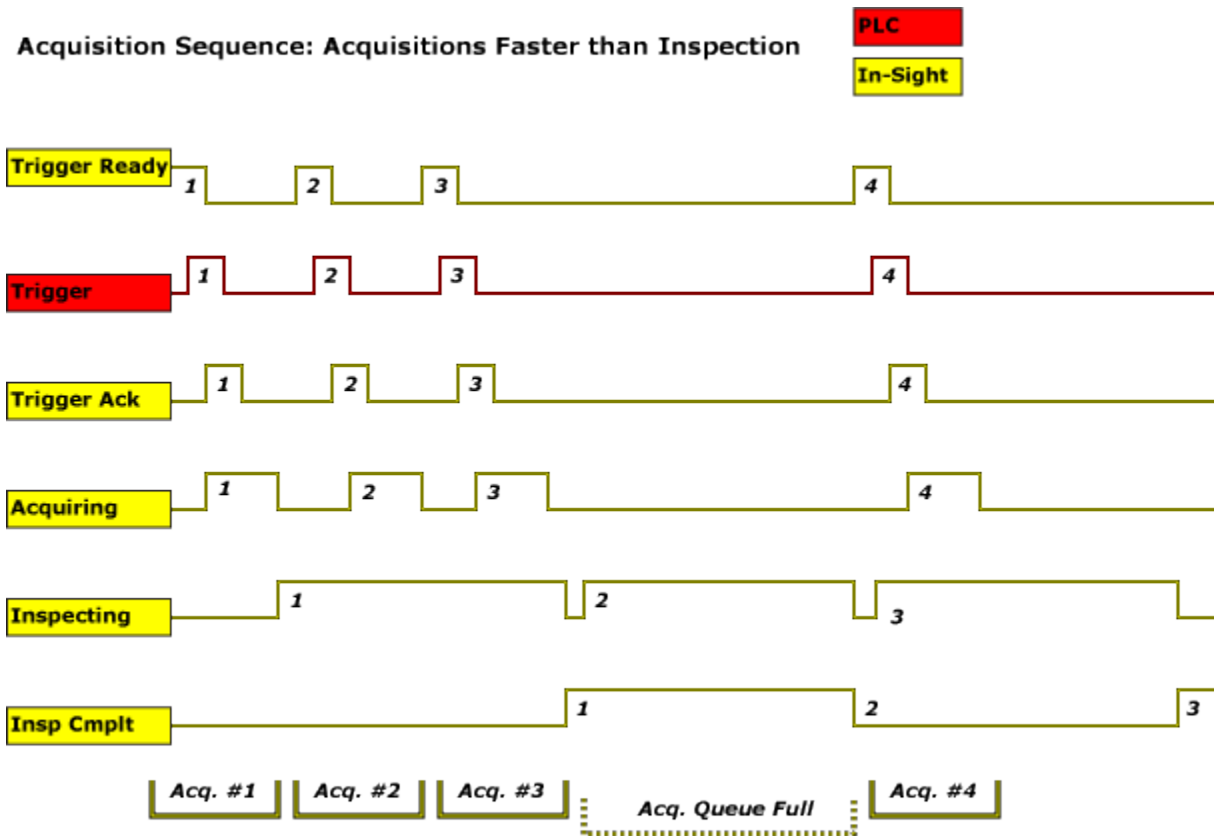
During an image acquisition, the *Trigger Ready* bit in the **Control** field of the Inspection Control Object will be cleared and the *Acquiring* bit will be set to True. When the acquisition is completed, the *Acquiring* bit will be cleared and the *Trigger Ready* bit will again be set to True, indicating that the vision system is ready to begin a new image acquisition.

To force a reset of the trigger mechanism, set the *Trigger Enable* bit to False until the **Acquisition Status** register is True. Then the *Trigger Enable* bit can be set to True and acquisitions re-enabled.

Typical Acquisition Sequence



Acquisition Sequence: Acquisitions Faster than Inspection



Inspection/Result Sequence

When an image is acquired by an In-Sight vision system, the image is placed in a queue for processing. While the vision system is processing the image, the *Inspecting* bit of the **Status** structure is set. When the vision system has finished processing the image, the *Inspecting* bit is cleared and the *Inspection Completed* bit is toggled.

The *Buffer Results Enable* bit of the **Control Structure** determines how inspection results are handled by the vision system. If the *Buffer Results Enable* bit is set to False, then the inspection results are immediately placed into the **Control Structure** and the *Results Valid* bit is set to True. If the *Buffer Results Enable* bit is set to True, the new results are queued. The earlier inspection results remain in the **Control Structure** until the PLC sets the *Inspection Results Ack* bit to True, acknowledging receipt of the results. After the *Results Valid* bit is cleared, the PLC should set the *Inspection Results Ack* bit back to False to allow the queued results to be placed into the **Status Structure** (this is a necessary handshake to ensure that the results are received by the PLC).

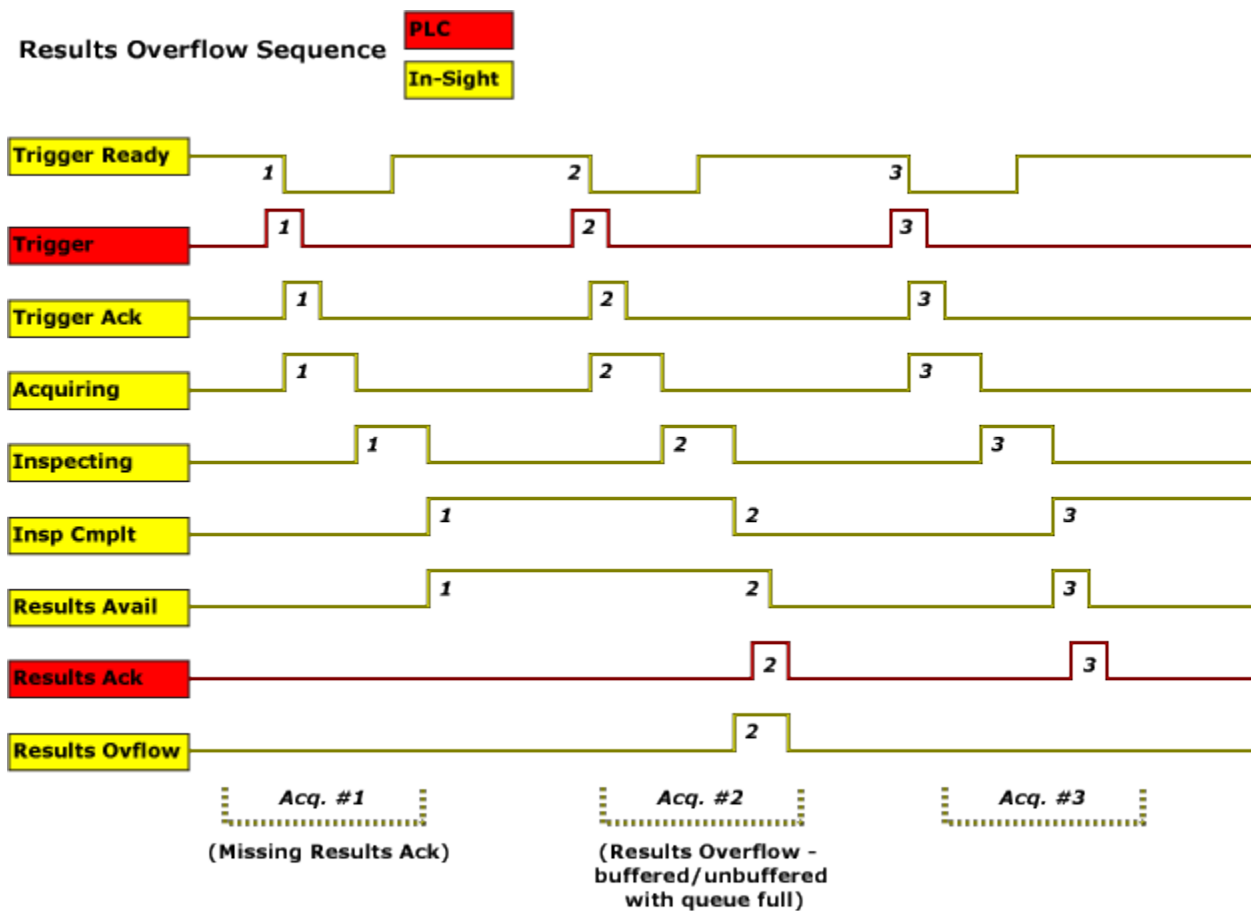
Inspection Status Signal Behavior

Bit Name	Results If Buffering Is Disabled	Results If Buffering Is Enabled
Inspecting	Set when processing an image.	Set when processing an image.
Inspection Complete	Toggled on completion of image processing.	Toggled on completion of image processing.
Results Buffer Overflow	Remains set to 0.	Set when the inspection results could not be queued because the PLC failed to acknowledge the previous results, causing the results buffer to overflow. Cleared when an inspection result is successfully queued.
Results Valid	Set when new results are placed in the Inspection Results and Inspection Results Data channels. Stays set until the results are acknowledged by setting the <i>Inspection Results Ack</i> bit to True.	Set when new results are placed in the Inspection Results and Inspection Results Data channels. Stays set until the results are acknowledged by setting the <i>Inspection Results Ack</i> bit to True.

Results Buffering

A queue for inspection results may be enabled. If enabled, this allows a finite number of inspection data results to be queued until the PLC has time to read them. This is a useful feature for smoothing out data flows if different parts of the system (including the external PLC) slow down for short periods of time.

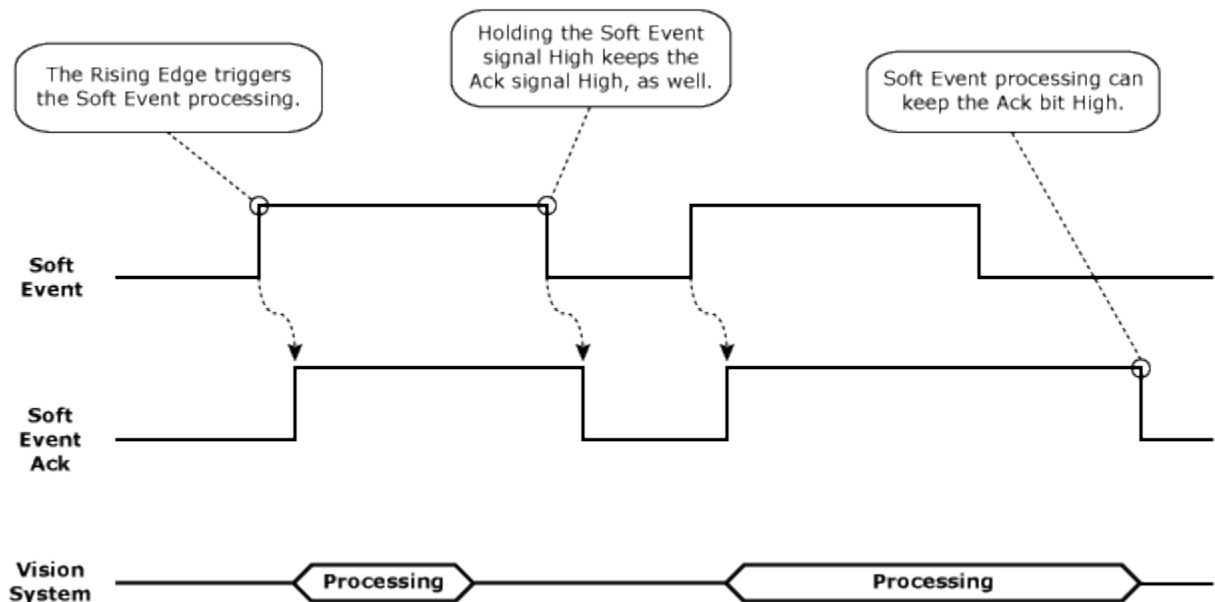
In general, if inspections are occurring faster than the results can be sent out, the primary difference between buffering and not buffering is determining which results get discarded. If buffering is not enabled, the most recent results are kept, and the earlier result that the PLC was unable to read is lost. Essentially, the most recent result will simply overwrite the earlier result. If buffering is enabled (and the queue becomes full), the most recent results are discarded until room becomes available in the results queue.



Application Note

Soft Events

In addition to sending data to an In-Sight vision system from a PLC, soft events can be sent to control job specific behavior. Each soft event has a trigger (bits 24-31 in the [Inspection Control Object](#)) and acknowledgment bit (bits 24-31 in the [Inspection Status Object](#)) associated with it. The rising edge of the trigger bit causes the In-Sight vision system to process the action associated with the soft event. Upon initiation of the soft event, the vision system will set the Soft Event Ack bit to High. This bit will be held High until the PLC resets the trigger bit, and the processing of the action associated with the soft event has been completed. If the soft event could not be triggered, the general fault bit will be set to High; this bit will remain High until an event is successfully triggered.



POWERLINK/In-Sight Vision System LED Behavior

When utilizing a POWERLINK-enabled In-Sight vision system, the vision system's LEDs are used to convey POWERLINK-specific behavior status updates. User 1 LED is the POWERLINK error LED, and User 2 LED is the POWERLINK status LED; these states cannot be modified in the Discrete Output Settings dialog.

NOTE User 2 LED will turn on when the vision system, as a Node on the POWERLINK network, detects an error condition on the POWERLINK network, and will turn off once normal operation resumes.

LED State	LED Behavior	Description
LED OFF	Constantly OFF	POWERLINK is initializing.
LED Flickering	Blinking at 10Hz	POWERLINK is in basic Ethernet mode (i.e. a POWERLINK Master Node has not been detected on the network).
LED Single Flash	One short flash (200ms), followed by a long OFF phase (1000ms)	The vision system has detected a Master Node on the POWERLINK network, however, isochronous communications have not been detected.
LED Double Flash	Two short flashes, followed by a long OFF phase	The POWERLINK network has begun isochronous communications, but the vision system has not been configured to participate.
LED Triple Flash	Three short flashes, followed by a long OFF phase	The Node device has completed configuration, and is awaiting a signal from the Master Node to begin isochronous communications.
LED ON	Constantly ON	The Node device is communicating on the POWERLINK network.
LED Blinking	Blinking at 2.5Hz	The POWERLINK Node has stopped due to an error.