ZMX Series 3D Time of Flight Sensor

Instruction Manual

Original Instructions
230551 Rev. C
9 February 2023

230551

Contents

1 Product Description

Simple, reliable, volume and height monitoring with ZMX Series. Patent pending.

- 3D Time of Flight technology detects peak fill height and volume within a large field of view
- Fits many applications with adjustable sensing height and field of view
- Sensor monitors entire sensing region of interest, not a single point like an ultrasonic or laser sensor
- Completely self-contained, no controller or PC required
- Deploy in minutes with only a few settings to define
- Configurable sensing range up to 2.5 m for height monitoring
- Define sensor field of view to monitor specific area of interest
- Available in discrete and Pulse Pro outputs for simplified deployment; industrial Ethernet communications available to integrate with the Smart Factory
- Compact, rugged IP65 housing designed for industrial environments

WARNING:
- **Do not use this device for personnel protection**
- Using this device for personnel protection could result in serious injury or death.
- This device does not include the self-checking redundant circuitry necessary to allow its use in personnel safety applications. A device failure or malfunction can cause either an energized (on) or de-energized (off) output condition.

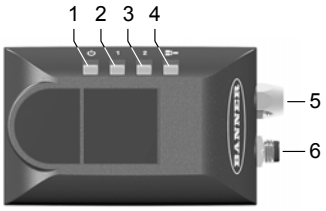
1.1 Models

Models	Resolution	Field of View	Range
ZMX-3DE2500HF-Q7	272 × 208 pixels	60 × 45 degrees	200 mm to 2500 mm (7.9 in to 8.2 ft)

1.2 Features and Indicators

LED indicators provide ongoing indication of sensing status.

Figure 1. Features



1. Power and Fault LED (off, green, red, or flashing red)
2. Ready LED
3. Image Transmitted LED
4. Ethernet Activity LED
5. Ethernet connection
6. Power connection

1.3 Sample Application: Bin Fill

Use the ZMX Series in a variety of applications.

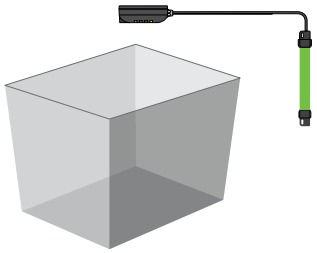
- Gaylord volume fill level monitoring at a material handling facility
- Continually monitoring the height of packages in a shipping container
- Level monitoring of consumer or grocery items in a tote
- Determine if an item is protruding over the top of a bin
- Detect overfill of items within a defined region of interest

When boxes or other solid objects are collected in a bin, the true amount of space consumed is not accurately measured by measuring the height at any one point. Inconsistent shapes and uneven stacking are common, leaving an uneven top surface. Many other types of distance measurement sensors can give inconsistent readings. Sometimes their measurements vary based on whether they hit a top surface object or a hole between objects. The ZMX sensor measures distance over a

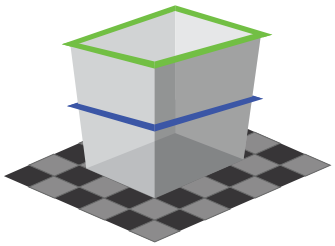
large rectangular area and calculates a fill level as well as peak height of the whole area, allowing better control of how the bin space is used and preventing overfill.

Figure 2. ZMX Sensor and Tower Light At the Bottom of a Chute

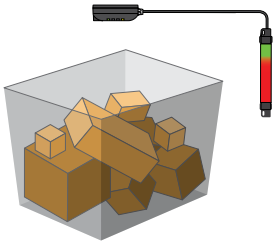
Container monitoring in three simple steps, up and running within minutes.



Step 1—Mount and connect to sensor – mounting is ultra-simple with built-in mounting holes or a variety of mounting brackets to choose from. Once mounted, connect the cables and begin communicating with Banner Banner 3D Configuration software.



Step 2—Define Sensing Conditions – only a few inputs need to be defined for the sensor to accurately monitor container height. Start by defining the anchor point for measurements at the bottom of the container, then define the size of the sensing region of interest. Finally, choose the sensing criteria for the application such as peak height or volume.



Step 3—Monitor fill level – Once mounted and configured, the sensor is completely self-contained and does not require any external controllers or PC. Begin sensing and integrate with chosen PLC, controller, or indication light.

1.4 Laser Description and Safety Information

CAUTION:

- **Return defective units to the manufacturer.**
- Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.
- Do not attempt to disassemble this sensor for repair. A defective unit must be returned to the manufacturer.

Class 1 lasers are lasers that are safe under reasonably foreseeable conditions of operation, including the use of optical instruments for intrabeam viewing.

Complies with 21 CFR 1040.10 and 1040.11, except for deviations pursuant to Laser Notice No. 56, dated May 8, 2019.

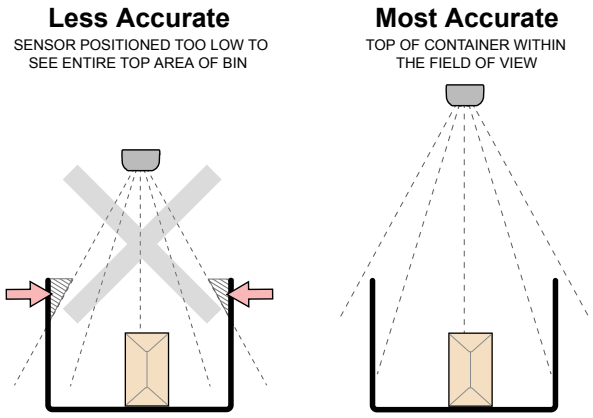
Complies with IEC 60825-1:2014 and EN 60825-1:2014+A11:2021.

2 Installation Instructions

2.1 Installation Best Practices

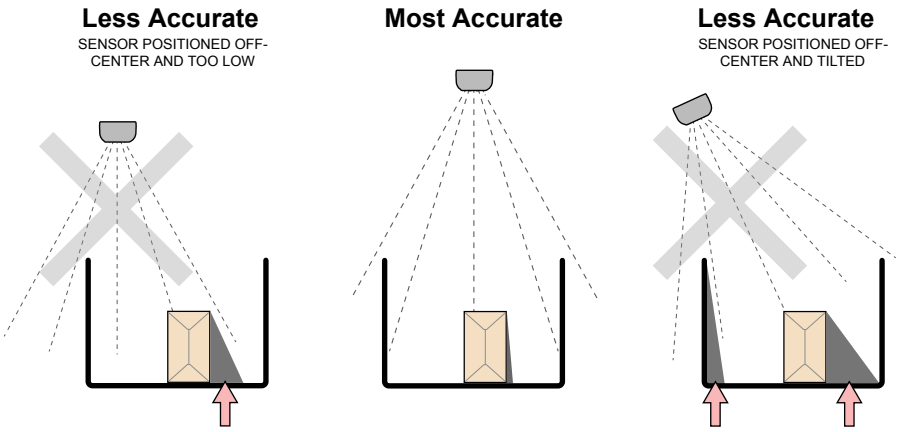
The following diagrams show best practices for installing the ZMX sensor.

Figure 3. Sensor Height



For accurate fill levels, position sensor higher up and centered over container.

Figure 4. Minimize Blind Spots



Minimize the potential for blind spots by positioning sensor higher up and centered over container.

2.2 Mount the Device

1. If a bracket is needed, mount the device onto the bracket.
2. Mount the device (or the device and the bracket) to the machine or equipment at the desired location. Do not tighten the mounting screws at this time.

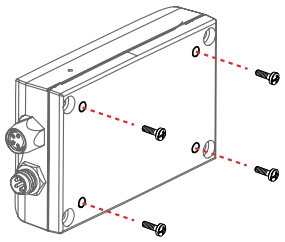
CAUTION: This device accepts M4 screws. Engaging the screws more than 4 mm will damage the device.

CAUTION: 8 in·lbf (0.904 Nm) maximum torque

3. Check the device alignment.

4. Tighten the mounting screws to secure the device (or the device and the bracket) in the aligned position.

Figure 5. Mounting Holes



Note: Do not remove the housing screws.

Note: Provide adequate dissipation of heat. A good heat conductor, such as aluminum, may be required.

Mounting Surface Thickness	Length of Mounting Screws
≤ 2 mm	4 mm
2 mm to 4 mm	6 mm
4 mm to 6 mm	8 mm

2.3 Wiring

To maintain the ratings listed in the Specifications, use cables with shields.

Tighten the cables finger tight only.

Figure 6. Channel 1 as PNP Output, Channel 2 as Trigger Input

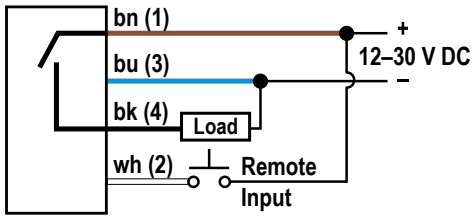


Figure 7. Channel 1 as NPN Output, Channel 2 as Trigger Input

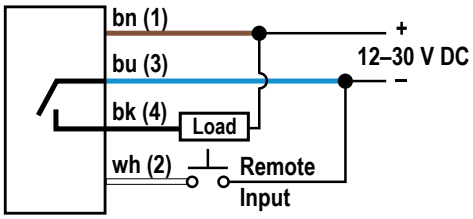


Figure 8. M8 Male Connector

Table 1: Power and I/O Pinouts

Pin	Wire Color	Description
1	Brown	12 V DC to 30 V DC
2	White	Trigger Input or Output (selectable PNP, NPN, or push-pull)
3	Blue	Common
4	Black	Output (selectable PNP, NPN, or push-pull)

2.4 Install the Software

Use the following instructions to install the Banner 3D Configuration software on your computer.

Important: Administrative rights may be required to install the Banner 3D Configuration software.

1. Download the latest version of the software from www.bannerengineering.com.
2. Navigate to and open the downloaded file.
3. Run the downloaded installer.
4. Check the agreement for license terms and conditions.

5. Click **Install** to install the software.

   A Windows security message displays. This indicates that the installer is signed and is from Banner.
6. Click **Yes**.
7. Click **Close** to exit the installer when the installation is complete.
8. Locate the program icon on the desktop or in the **Start** menu and open the Banner 3D Configuration software.

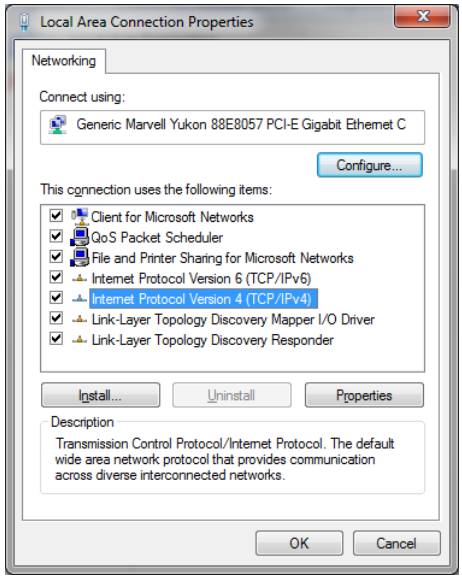
3 Getting Started

3.1 Connect to the Sensor

These instructions use Windows® operating system version 8, 10, or 11. [3]

1. Confirm the network connections.
   a) Click the **Start** button, then on the **Start** menu, click **Control Panel**.
   b) In **Control Panel**, click **Network and Internet**, then click **Network and Sharing Center**, and then click **Change adapter settings**.
   c) Right-click on the connection that you want to change, then click **Properties**.
   If you are prompted for an administrator password or confirmation, enter the password or provide confirmation.
   d) In the connection properties, click **Internet Protocol Version 4 (TCP/IPv4)**, and then click **Properties**.

Figure 9. Local Area Connection Properties



   e) In the **Internet Protocol (TCP/IPv4) Properties**, select **Use the following IP address**.
   f) Make sure that the IP address is 192.168.0.2 (or an unused IP address within the 192.168.0.x subnet), and the subnet mask is 255.255.255.0.
2. Open the Banner 3D Configuration software from the desktop or the **Start** menu.
3. Connect to the ZMX sensor using one of the following options:
   - From the **Connection** pane, enter the IP address of the desired ZMX sensor into the **Sensor IP Address** field, then click **Connect**.
   - From the **Connection** pane, locate the IP address of the desired sensor in the list of discovered sensors, then click  next to **IP Address**.

   The default IP address for the sensor is 192.168.0.10.

3.2 Set Up the ZMX Sensor

Use the following basic steps to set up an application in the Banner 3D Configuration software.

1. Make sure the container is in place and is empty.
2. Adjust the pitch/roll/yaw if an angle correction is needed.
   See Sensor Controls Pane on page 13.
3. From the **Amplitude** view, click in the center of the container.
   A green cursor displays in the center of the container and the coordinates of the cursor are shown in the lower right.
4. Copy the X, Y, and Z coordinates from the lower right of the **Image** pane into the **Anchor Point** X, Y, and Z fields in the **Fill Level** pane.

[3] Windows is a registered trademark of Microsoft Corporation in the United States and/or other countries.

5. Enter the dimensions of the container (in mm) in the **Size** field.
   It is best practice to use slightly smaller X and Y measurements than the inner dimensions of the container.
   The white box in the view updates in size.

   Note: If the box is not visible, click  .

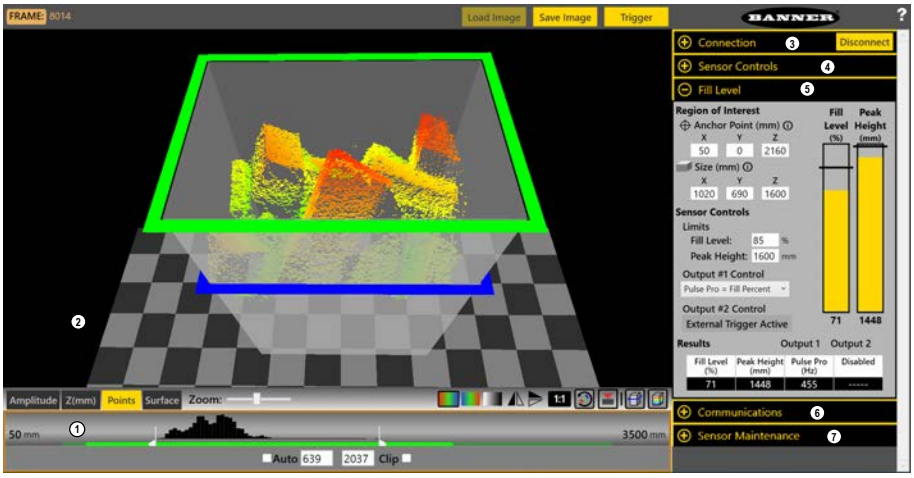
6. Enter the desired **Fill Level** and **Peak Height** limits.
   The lines on the **Fill** and **Peak** bar graphs update.

   Note: Allow the sensor to warm up for 15 minutes to ensure optimal sensor performance.

4 Banner 3D Configuration Workspace

The Banner 3D Configuration software displays the information needed to modify sensor parameters.

Figure 10. Banner 3D Configuration Software



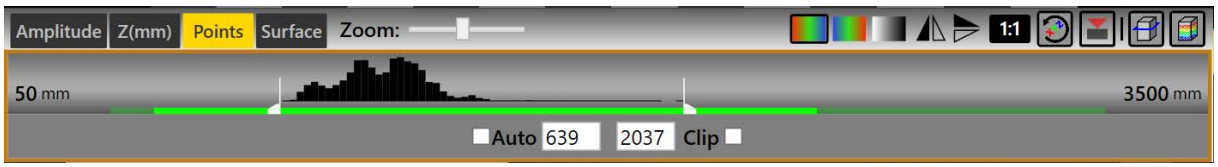
The workspace is divided into several panes.

1. Image Pane Parameters—Includes zoom; x, y, z coordinates; image color; view selection (Amplitude, Z(mm), Points, Surface). The options vary depending on the selected view. See Image Pane Parameters on page 11.
2. Image pane—Displays the current image captured by the sensor and includes the buttons:
   - **Load Image**—Loads a previously saved file for viewing while disconnected from the sensor
   - **Save Image**—Save file as a .t3f
   - **Trigger**—Manually triggers the sensor when Trigger mode is set to **External** or **Software**
3. **Connection** pane—Enables connection to a sensor and includes settings and information related to the sensor's IP address. See Connection Pane on page 13.
4. **Sensor Controls** pane—Controls the trigger mode and illumination output. See Sensor Controls Pane on page 13.
5. **Fill Level** pane— Includes options for the region of interest and sensor controls, as well as live fill and peak height data. See Fill Level Pane on page 15.
6. **Communications** pane—Sets the communication protocol and DHCP option for the sensor. See Communications Pane on page 17.
7. **Sensor Maintenance** pane—Includes sensor information and options to update the firmware, restore the sensor to the default settings, to backup the current sensor settings, or restore the sensor to previously saved settings. See Sensor Maintenance Pane on page 18.

4.1 Image Pane Parameters

Use the **Image Pane Parameters** to change how the Image pane displays.

Figure 11. Image Pane Parameters



Click a view selection button to change the view and the available options:

Amplitude

Shows a top down 2D pseudo-grayscale image of the container.

Z(mm)

Shows a top down 2D color-coded Cartesian Z image of the container.

Points

Shows the individual measurement points in 3D.

Surface

Shows a smoothed out view of the measurement points in 3D.

When using either the **Points** view or the **Surface** view, left-click, hold, and drag inside the image pane to rotate the image three-dimensionally. Right-click, hold, and drag to move the image horizontally and vertically.

The histogram graph in the center of the Image Pane Parameters graphically displays the distribution of pixels in the current image on a scale of amplitude or Z distance, depending on the current view. The white bars can be adjusted left or right to adjust the shading of the pixels. The histogram is available in all views. The specified operating distance of the sensor is colored green. A portion of the green bar is a lighter shade of green. The sensor may still return data from this region, but it may not adhere to the stated accuracy specifications of the device. The green bar is available in **Z(mm)**, **Points**, and **Surface** views.

Use the **Auto** checkbox to automatically scale the pixels to view the entire field of view. When checked, the white shading control bars are adjusted for each image to start the shading range just before the left-most pixels, and end the shading range after the right-most pixels in the histogram.

Use the **Clip** checkbox to change what is outside of the histogram graph markers to purple (**Amplitude** and **Z(mm)** views) or to disappear (**Points** and **Surface** views) to indicate that these areas are not of interest.

The two numbers between the **Auto** and **Clip** checkboxes show the locations of the two white markers in the histogram graph. These markers can be dragged to the desired location.

 Red is Near, Blue is Far—Displays objects closest to the sensor as red, while objects further from the sensor display as blue. Objects between these points display in various colors, depending on their distance from the sensor. Available in **Z(mm)**, **Points**, and **Surface** views.

 Blue is Near, Red is Far—Displays objects closest to the sensor as blue, while objects further from the sensor display as red. Objects between these points display in various colors, depending on their distance from the sensor. Available in **Z(mm)**, **Points**, and **Surface** views.

 Grayscale Overlays Distance—Changes the image color scheme to grayscale. Available in **Z(mm)**, **Points**, and **Surface** views.

 Horizontal Flip Mode—Changes the view to a horizontal mirror image of the true view—the objects that were on one side of the view are now shown on the other side. Available in all views.

 Vertical Flip Mode—Changes the view to a horizontal mirror image of the true view - the objects that were on one side of the view are now shown on the other side—what was showing on the top of the screen is now showing on the bottom of the screen. Available in all views.

 Bubble Level On/Off—Shows or hides a level on screen at the cursor location that updates as the sensor is tilted. Available in **Amplitude** and **Z(mm)** views. Default is off.

 Image Center Crosshairs On/Off—Shows or hides crosshairs that indicate the center of the field of view of the sensor. Available in **Amplitude** and **Z(mm)** views. Default is off.

 Toggle 3D point cloud display decimation levels—Changes the size of the points shown. Available in **Points** and **Surface** views. Does not change image acquisition parameters. Default is 2:1.

 Show or hide the 3D camera—Shows or hides the position of the sensor over the container as well as the field of view. Available in **Points** and **Surface** views. Default is hidden.

 and  Hide or show the application working volume sidewalls—Shows or hides the user-defined boundaries of the container. This view also shows two colored boxes. The first is the Z-height setting shown as a green box. This box turns to red when the peak height is reached. The second is the fill level shown as a blue box that moves as the container is filled or emptied. Available in **Points** and **Surface** views. Default is show.

 and  Hide or show all points outside of the application 3D Space—Show or hide objects that are within the field of view of the sensor but are located outside of the defined boundaries of the container. Available in **Points** and **Surface** views. Default is show.

 and  Reset 3D camera view—Resets the 3D view to the default X, Y, and Z positions.

Coordinates in the Amplitude and Z(mm) Views—The following display in the lower right in the Amplitude view.

Amp

Brightness level of the selected pixel. The Amplitude range is 10 to 3000.

X(mm)
Horizontal distance from the surface visible in the selected pixel to the center of the image, along the X axis.

Y(mm)
Horizontal distance from the surface visible in the selected pixel to the center of the image, along the Y axis.

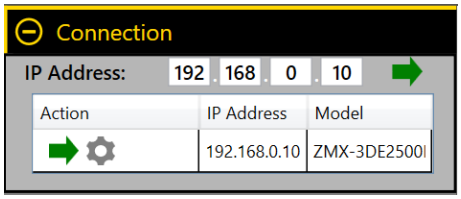
Z(mm)
Depth from the surface visible in the selected pixel to the face of the sensor.

Cursor(x,y)
Pixel coordinates of the selected pixel on the image sensor chip.

4.2 Connection Pane

Use the **Connection** pane parameters to change the sensor IP address and to connect to the sensor.

*Figure 12. **Sensor** Pane*



The default IP address for the ZMX sensor is 192.168.0.10.

The Banner 3D Configuration software remembers the IP address of the last connected sensor. The software also searches the local Ethernet subnetwork to find any available sensors. These sensors are listed in the **Connection** pane.

Hover over ⚙ to view sensor name, serial number, MAC address, Gateway, firmware version, etc. To change a sensor's IP address, click ⚙.

To connect to a sensor, enter the IP address of the desired ZMX sensor into the **Sensor IP Address** field, then click ➡ next to the IP address. Alternately, locate the IP address of the desired sensor in the list of discovered sensors, then click ➡ in the **Action** column.

The model number of the sensor also displays.

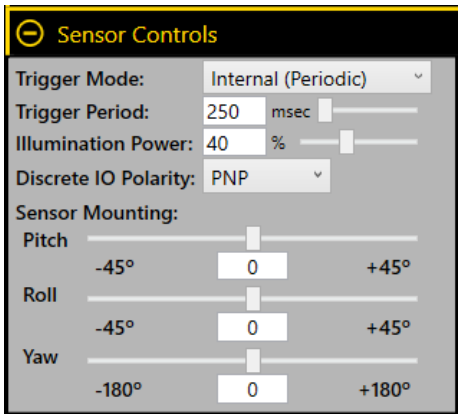
To disconnect from a sensor, click ⏹.

Click ↻ to reboot a connected sensor.

4.3 Sensor Controls Pane

Use the **Sensor Controls** pane parameters to set the trigger mode and illumination output.

*Figure 13. **Sensor Controls** Pane*



Trigger Mode

The **Trigger Mode** drop-down menu displays both the name for a given trigger mode and additional information in parentheses. There are four trigger modes for the sensor:

- **External (White Wire)**—In External trigger mode the sensor waits for a discrete input signal to arrive via the dedicated trigger input wire. The trigger is defined as the rising edge of a PNP signal. The software **Trigger** button also provides a sensor trigger while in this mode.
- **Internal (Periodic)**—In Internal trigger mode the sensor triggers at a user-defined Trigger Interval (from 200 milliseconds to 10,000 milliseconds). The software **Trigger** button also provides a sensor trigger while in this mode. In this mode, it is possible to provide triggers at a rate faster than the sensor can act on them. See the missed trigger count value available via an industrial protocol connection.
- **Free Run**—In Free Run trigger mode the sensor triggers as fast as possible. When a software connection is present, after one image is taken and transmitted to the software, the sensor moves immediately to take the next. When no connection is present, the sensor uses a 125 millisecond delay between triggers to simulate the image transfer time delays and avoid overheating.
- **Software (Protocols)**—In Software trigger mode the sensor is triggered by via an industrial protocols connection. The Banner 3D Configuration software **Trigger** button also provides a sensor trigger while in this mode.

Trigger Period

The time between each trigger. Use the slider or enter the desired trigger period in milliseconds. Available for **Internal (Periodic)** trigger modes.

Illumination Power

Control the illumination power of the sensor. Targets that are dark or farther away require higher illumination power. Use the slider or enter the desired power as a percentage. The default is 40%.

Discrete IO Polarity

Select

- **PNP**
- **NPN**
- **Push-Pull**

Sensor Mounting

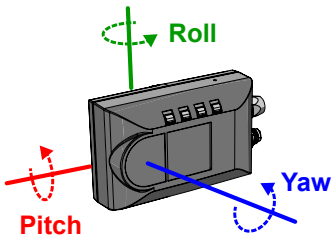
Adjust the view of the sensor using the following controls.

Pitch—Adjust the up-and-down view of the sensor. The view (angle) setting is in degrees.

Roll—Adjust the view of the sensor along the longitudinal axis. The view (angle) setting is in degrees.

Yaw—Adjust the side-to-side view of the sensor. The view (angle) setting is in degrees.

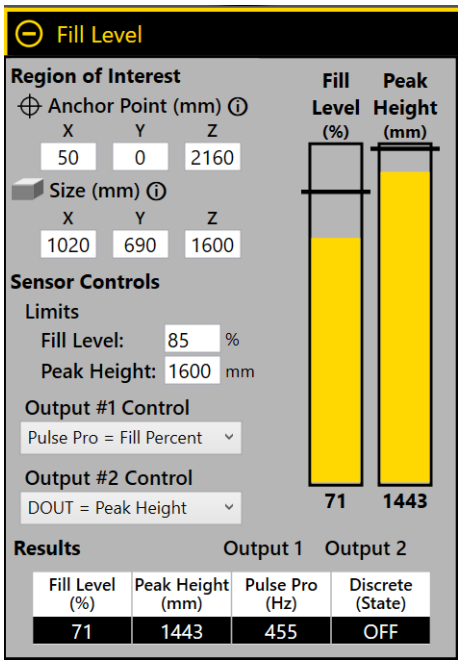
Figure 14. Pitch, Roll, Yaw Diagram



4.4 Fill Level Pane

Use the **Fill Level** pane to set the parameters for the region of interest (ROI) and to view live estimated fill and peak information.

*Figure 15. **Fill Level** Pane*



Fill Level (%)

This bar displays live information regarding the estimated volume percent of the objects in the container. The line corresponds to the set Fill Level Limit. The number below the bar is the estimated percent full.

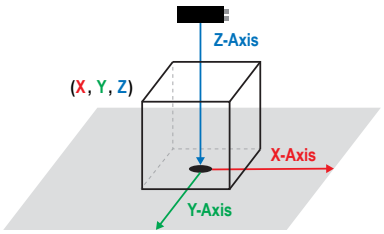
Peak Height (mm)

This bar displays live information regarding the estimated height of the tallest point in the container. The line corresponds to the set Peak Height Limit. The number below the bar is the measured height in millimeters.

Region of Interest

Anchor Point (mm)—Define the X, Y and Z points of the sensor region of interest. From the **Z(mm)** view (Image Pane parameters), click the center of the container region of interest. Record the X(mm), Y(mm), and Z(mm) values from the software. These represent the bottom of the container. Pay attention to positive and negative values.

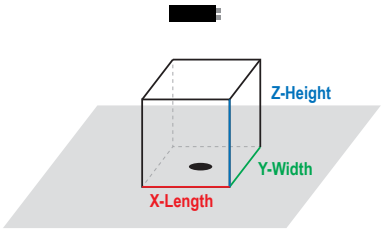
Figure 16. Anchor Point Diagram



X = Center X point of container
Y = Center Y point of container
Z = The Z measurement from the bottom, or furthest point, of the container

Size (mm)—Define the length, width, and height of the container region of interest. The entire region of interest should be contained within the walls of the container.

Figure 17. Dimensions Diagram



X = X-Length size dimension
Y = Y-Width size dimension
Z = Z-Height of container or desired detection limit

Sensor Controls

Limits—Fill Level: The threshold percentage that activates the Fill Level Limit Output.
Limits—Peak Height: The threshold height, in millimeters, that activates the Peak Height Limit Output.

Output #1 Control and **Output #2 Control**—The desired sensor outputs being exported; for more information, see Discrete Output on page 17.

Disabled
DOUT = Fill Percent
DOUT = Peak Height
DOUT = Fill or Peak
Pulse Pro = Fill Percent
Pulse Pro = Peak Height

Output 2 is disabled when the external trigger is enabled."External Trigger Active" shows in **Output #2 Control** when this occurs.

Results

Fill Level (%): The percentage of volume filled within the ROI.

Peak Height (mm): The peak height within the ROI.

Output 1: Varies depending on what is selected from the **Output #1 Control** list.

Discrete Out
Pulse Pro (Hz): The Pulse Pro frequency from 100 Hz to 600 Hz.
Not Used

Output 2: Varies depending on what is selected from the **Output #2 Control** list. Output 2 is disabled (not used) when the external trigger is enabled.

Discrete Out
Pulse Pro (Hz): The Pulse Pro frequency from 100 Hz to 600 Hz.
Not Used

4.4.1 Discrete Output

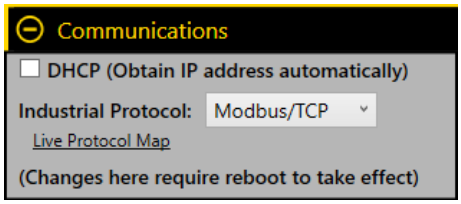
The sensor can generate pulses whose frequency are proportional to the sensor's measured Fill Level or Peak Height, thereby providing a method for representing an analog signal with only a discrete counter.

When Output Control is set to **Pulse Pro = Fill Level**, the pulse frequency is scaled from 100 Hz at 0% full and 600 Hz at 100% full. When Output Control is set to **Pulse Pro = Peak Height**, the pulse frequency is scaled from 100 Hz at 0 mm peak height and 600 Hz at peak height equal to the height of the region of interest.

4.5 Communications Pane

Use the **Communications** pane parameters to select the industrial protocol.

*Figure 18. **Communications** Pane*



DHCP (Obtain IP address automatically)

Select this checkbox to enable Dynamic Host Control Protocol (DHCP). For additional information, see DHCP on page 17.

Industrial Protocol

Select the desired industrial protocol from the list.

- Off
- EtherNet/IP
- Modbus/TCP

Note that any changes to the parameters in this pane require a sensor reboot to take effect.

To view live industrial protocol data, click **Live Protocol Map**.

4.5.1 DHCP

This option allows a Dynamic Host Control Protocl (DHCP) client (for example, the ZMX sensor) to obtain its IP address, subnet, and gateway from a DHCP Server.

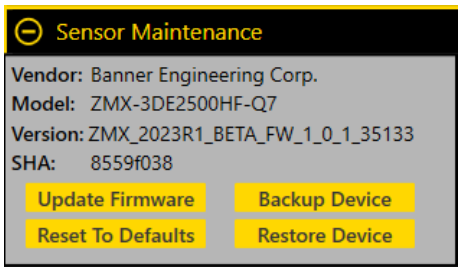
For this feature to work, the following criteria must be met:

1. The DHCP server is running, configured properly, and connected to the same network as the ZMX sensor.
    a. Often the DHCP server is embedded into a router, smart switch or other industrial IT network equipment.
    b. Banner does not provide this hardware or server software.
2. The ZMX sensor is connected by Ethernet cable to a location that has a running DHCP server.
3. The ZMX sensor is powered on.
    a. The sensor continues to request its DHCP network settings up to approximately two minutes.
    b. During the request period, the ZMX is not reachable and will not show up on the Banner 3D Configuration software discovered sensors list.
    c. If the DHCP server provides network settings within the timeout period:
        a. The sensor is reachable as a network device.
        b. The DHCP network settings are not saved.
    d. If the DHCP server fails to provide the network settings within the timeout period:
        a. The sensor goes to the “Auto-IP” address, which will be in the range of 169.254.*.*
        b. The sensor is available at this new, temporary IP address.
        c. Reboot the ZMX sensor to repeat the DHCP IP address assignment process.

4.6 Sensor Maintenance Pane

Use the **Sensor Maintenance** pane to update the firmware, restore to factory default settings, and backup or restore the sensor.

*Figure 19. **Sensor Maintenance** Pane*



Click the desired option and follow the prompts to complete the action.

5 Specifications and Requirements

5.1 Specifications

Sensing Range
200 mm to 2500 mm (7.9 in to 8.2 ft) on a 90% reflectance white target
200 mm to 2500 mm (7.9 in to 8.2 ft) on a 20% reflectance gray target
200 mm to 1700 mm (7.9 in to 5.6 ft) on a 6% reflectance black target

Supply Voltage
12 V DC to 30 V DC
Current: 200 mA average, 2.5 A peak (exclusive of load and lights)
Use only with a suitable Class 2 power supply, or current-limiting power supply rated 12 V DC to 30V DC, 2.5 A

Discrete I/O Configuration
Channel 1: Push-pull, PNP or NPN discrete output, or Pulse Pro/Pulse Frequency Modulation (PFM) output
Channel 2: PNP or NPN discrete output, or Pulse Pro/Pulse Frequency Modulation (PFM) output, or remote trigger

Flatness (Pixel-to-Pixel Accuracy)
±20 mm for > 10x excess gain
±60 mm for 2x to 10x excess gain

Response Time
150 ms in Free Run mode

Accuracy
±30 mm for > 10x excess gain [4]

Repeatability (1-sigma)
Peak excess gain: 2 mm
>10x excess gain, 10 mm
>2x excess gain, 40 mm

Communication Interface
Ethernet; 100 Mbps

Communication Protocol [5]
Modbus® TCP/IP
EtherNet/IP™

Boresighting
±20 mm at 1 m range

Delay at Power Up
< 10 s

Recommended Warm Up Time
15 minutes

Light Source
Infrared, 850 nm

Temperature Effect
< 0.5 mm/°C

Resolution
272 horizontal × 208 vertical pixels

Field of View
60 horizontal × 45 vertical degrees

Reading Rate, Full Resolution
Up to 6 frames per second in Free Run mode

Ambient Light Immunity
10,000 lux

Torque—Tapped Holes for Mounting Screws
8 in·lbf (0.904 Nm) maximum torque

Torque—Cables
Finger tighten only

Construction
Housing: Aluminum
Lens Cover: Acrylic with optical coating
Light Pipe: Polycarbonate

Connections
4-pin M8 male for power and discrete I/O
4-pin M8 female for Ethernet

Storage Conditions
–30 °C to +65 °C (–22 °F to +149 °F)

Operating Conditions
–10 °C to +40 °C (+14 °F to +104 °F), assuming adequate mounting and ventilation

Environmental Rating
IP65 per IEC60529

Vibration
MIL-STD-202G, Method 201A (Vibration: 10 Hz to 55 Hz, 0.06 inch (1.52 mm) double amplitude, 2 hours each along X, Y and Z axes), with device operating

Shock
MIL-STD-202G, Method 213B, Condition I (100G 6x along X, Y, and Z axes, 18 shocks), with device operating

Weight
205 g

Output Rating
Current rating: 50 mA maximum

White wire specifications per configuration		
PNP	Output High	≥ Vsupply − 2.5 V
	Output Low	≤ 2.5 V (loads ≤ 70 kΩ)
NPN	Output High	≥ Vsupply − 2.5 V
	Output Low	≤ 2.5 V

[4]
- For 6% to 90% diffuse targets in the center 25% of the field of view.
- ±60 mm accuracy for 2x to 10x excess gain.

[5] Modbus® is a registered trademark of Schneider Electric USA, Inc. EtherNet/IP™ is a trademark of ODVA, Inc.

Required Overcurrent Protection

WARNING: Electrical connections must be made by qualified personnel in accordance with local and national electrical codes and regulations.

Overcurrent protection is required to be provided by end product application per the supplied table.
Overcurrent protection may be provided with external fusing or via Current Limiting, Class 2 Power Supply.
Supply wiring leads < 24 AWG shall not be spliced.
For additional product support, go to www.bannerengineering.com.

Supply Wiring (AWG)	Required Overcurrent Protection (Amps)
20	5.0
22	3.0
24	2.0
26	1.0
28	0.8
30	0.5

Certifications

E526767

Banner Engineering BV Park Lane, Culliganlaan 2F bus 3, 1831 Diegem, BELGIUM

Turck Banner LTD Blenheim House, Blenheim Court, Wickford, Essex SS11 8YT, Great Britain

Advanced Capabilities

5.2 FCC Part 15 Class A

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

5.3 Industry Canada

This device complies with CAN ICES-3 (A)/NMB-3(A). Operation is subject to the following two conditions: 1) This device may not cause harmful interference; and 2) This device must accept any interference received, including interference that may cause undesired operation.

Cet appareil est conforme à la norme NMB-3(A). Le fonctionnement est soumis aux deux conditions suivantes : (1) ce dispositif ne peut pas occasionner d'interférences, et (2) il doit tolérer toute interférence, y compris celles susceptibles de provoquer un fonctionnement non souhaité du dispositif.

5.4 Performance Curves

Figure 20. Excess Gain

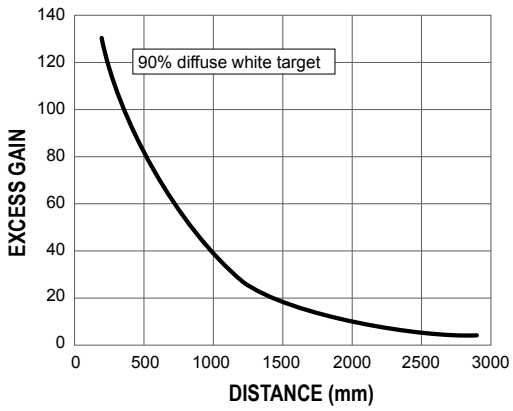
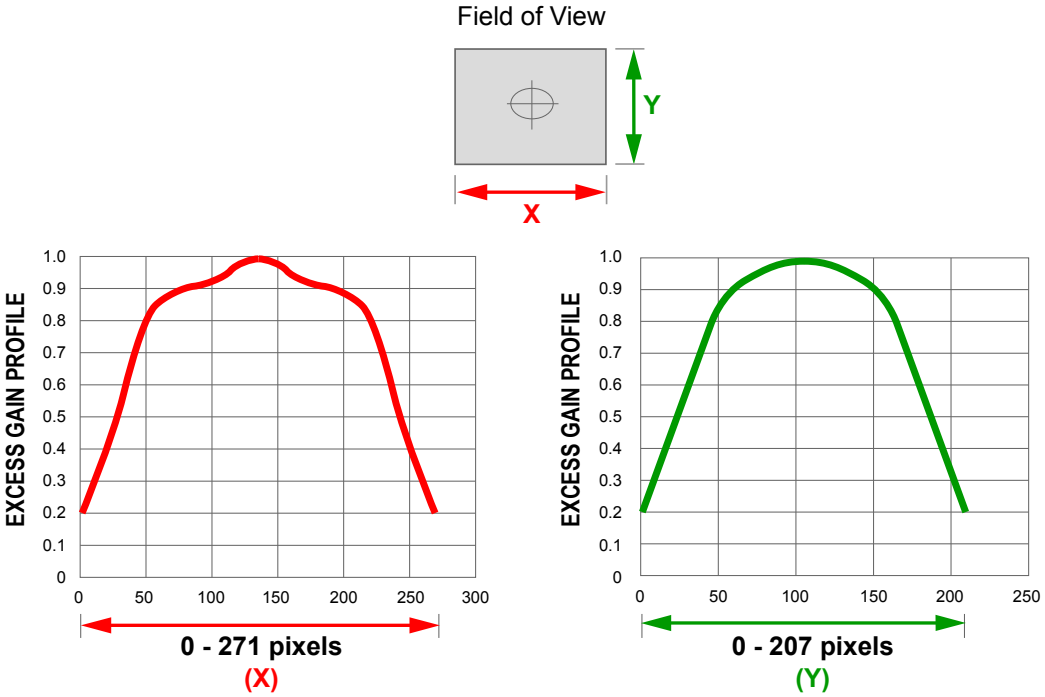


Figure 21. Excess Gain Profile



5.5 PC Requirements

Operating System
Microsoft® Windows® operating system version 8, 10, or 11 [6]

Hard Drive Space
100 MB

Screen Resolution
1024 × 768 pixels

Memory (RAM)
500 MB

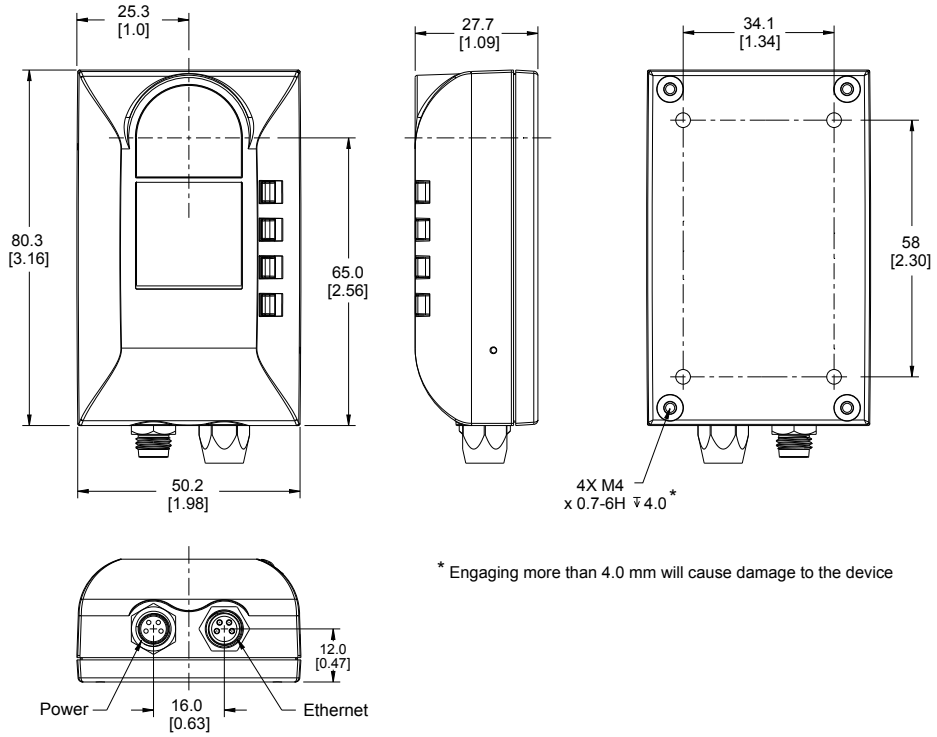
Ports Needed
TCP/IP port 32000
TCP/IP port 32200
UP/IP Port 19995

Important: Administrative rights may be required to install the Banner 3D Configuration software.

[6] Microsoft and Windows are registered trademarks of Microsoft Corporation in the United States and/or other countries.

5.6 Dimensions

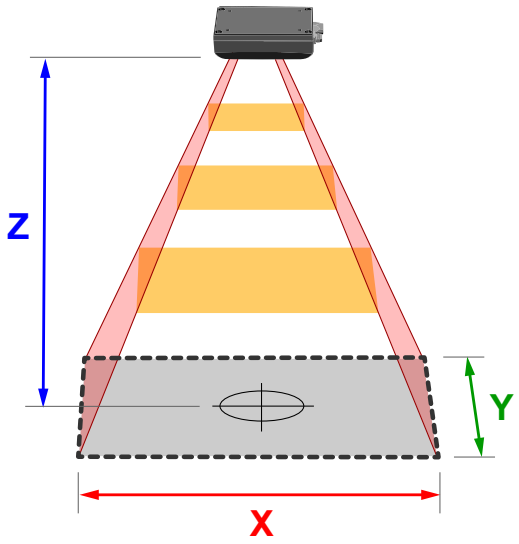
All measurements are listed in millimeters [inches], unless noted otherwise.



* Engaging more than 4.0 mm will cause damage to the device

5.7 Field of View Charts

Figure 22. FOV Chart



Z (mm)	X (mm)	Y (mm)
250	290	221
500	602	461
750	915	700
1000	1228	939
1500	1853	1417
2000	2478	1895
2500	3104	2374
3000	3729	2852

5.8 Factory Defaults

The following table lists some of the factory default settings for both the device and the software.

Setting	Factory Default
IP Address	192.168.0.10
Subnet Mask	255.255.255.0
Gateway	0.0.0.0
Trigger Mode	Internal at 250 ms or 4 frames per second
Illumination Power	40%
Pitch	0°
Roll	0°
Yaw	0°
Discrete Output Polarity	PNP
DHCP	Disabled
Industrial Protocols	Off

To restore the sensor to the factory default settings, go to the **Sensor Maintenance** pane and click **Reset To Factory Defaults**.

6 Industrial Ethernet Overview

6.1 EtherNet/IP™

In this context, references to EtherNet/IP™ [9] refer specifically to EtherNet/IP transport class 1. Sometimes referred to as cyclic EtherNet/IP IO data transfer or implicit messaging, this connection is meant to approximate a real-time data transfer to and from the PLC and the target device.

Allen-Bradley's CompactLogix® and ControlLogix® [10] family of PLCs uses this communication protocol. The programming software used by these PLCs is RSLogix5000® or Studio 5000 Logix Designer™ [11].

The ZMX is controlled via EtherNet/IP using assembly objects.

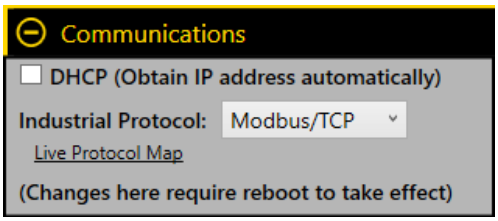
The Originator of the EtherNet/IP connection is the PLC. The Target of the EtherNet/IP connection is the ZMX. The direction of communication can be described as T > O or O > T (sometimes also shown as T2O or O2T).

6.1.1 Configuring the Sensor to use an Industrial Protocol

Use the following instructions to enable the Modbus TCP protocol or the EtherNet/IP protocol on the ZMX sensor.

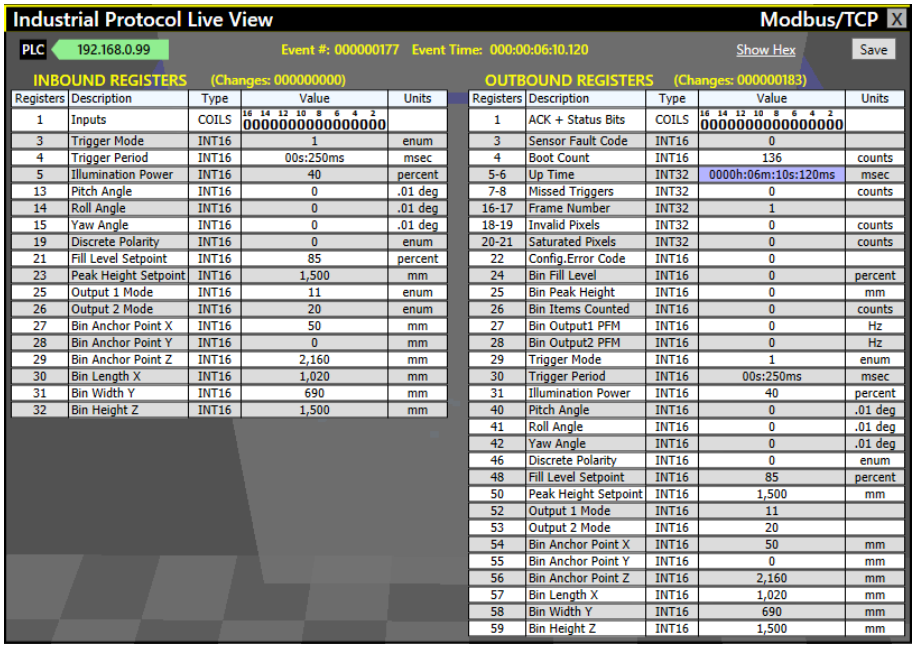
1. Go to the **Communications** pane in the Banner 3D Configuration software.

*Figure 23. **Communications** Pane*



2. From the **Industrial Protocol** menu, select the desired protocol.
   A sensor reboot may be required.
3. Click **Live Protocol Map** to open a view of the data.

Figure 24. Industrial Protocol Live View—Modbus TCP Shown



Registers	Description	Type	Value	Units
1	Inputs	COILS	0000000000000000	
3	Trigger Mode	INT16	1	enum
4	Trigger Period	INT16	00s:250ms	msec
5	Illumination Power	INT16	40	percent
13	Pitch Angle	INT16	0	.01 deg
14	Roll Angle	INT16	0	.01 deg
15	Yaw Angle	INT16	0	.01 deg
19	Discrete Polarity	INT16	0	enum
21	Fill Level Setpoint	INT16	85	percent
23	Peak Height Setpoint	INT16	1,500	mm
25	Output 1 Mode	INT16	11	enum
26	Output 2 Mode	INT16	20	enum
27	Bin Anchor Point X	INT16	50	mm
28	Bin Anchor Point Y	INT16	0	mm
29	Bin Anchor Point Z	INT16	2,160	mm
30	Bin Length X	INT16	1,020	mm
31	Bin Width Y	INT16	690	mm
32	Bin Height Z	INT16	1,500	mm

Registers	Description	Type	Value	Units
1	ACK + Status Bits	COILS	0000000000000000	
3	Sensor Fault Code	INT16	0	
4	Boot Count	INT16	136	counts
5-6	Up Time	INT32	0000h:06m:10s:120ms	msec
7-8	Missed Triggers	INT32	0	counts
16-17	Frame Number	INT32	1	
18-19	Invalid Pixels	INT32	0	counts
20-21	Saturated Pixels	INT32	0	counts
22	Config.Error Code	INT16	0	
24	Bin Fill Level	INT16	0	percent
25	Bin Peak Height	INT16	0	mm
26	Bin Items Counted	INT16	0	counts
27	Bin Output1 PFM	INT16	0	Hz
28	Bin Output2 PFM	INT16	0	Hz
29	Trigger Mode	INT16	1	enum
30	Trigger Period	INT16	00s:250ms	msec
31	Illumination Power	INT16	40	percent
40	Pitch Angle	INT16	0	.01 deg
41	Roll Angle	INT16	0	.01 deg
42	Yaw Angle	INT16	0	.01 deg
46	Discrete Polarity	INT16	0	enum
48	Fill Level Setpoint	INT16	85	percent
50	Peak Height Setpoint	INT16	1,500	mm
52	Output 1 Mode	INT16	11	
53	Output 2 Mode	INT16	20	
54	Bin Anchor Point X	INT16	50	mm
55	Bin Anchor Point Y	INT16	0	mm
56	Bin Anchor Point Z	INT16	2,160	mm
57	Bin Length X	INT16	1,020	mm
58	Bin Width Y	INT16	690	mm
59	Bin Height Z	INT16	1,500	mm

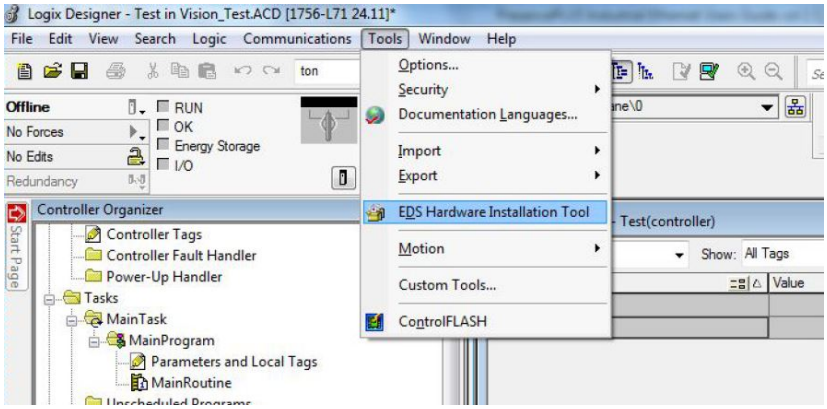
[9] EtherNet/IP™ is a trademark of ODVA, Inc.
[10] CompactLogix® and ControlLogix® are registered trademarks of Rockwell Automation.
[11] RSLogix5000® and Studio 5000 Logix Designer™ are registered trademarks of Rockwell Automation.

6.1.2 ZMX Series EDS File Installation in ControlLogix Software

Use the **EDS Hardware Installation Tool** to register the Electronic Data Sheet (EDS) file.

1. On the **Tools** menu, click **EDS Hardware Installation Tool**.
   The **Rockwell Automation's EDS Wizard** dialog displays.

Figure 25. Tools—EDS Hardware Installation Tool

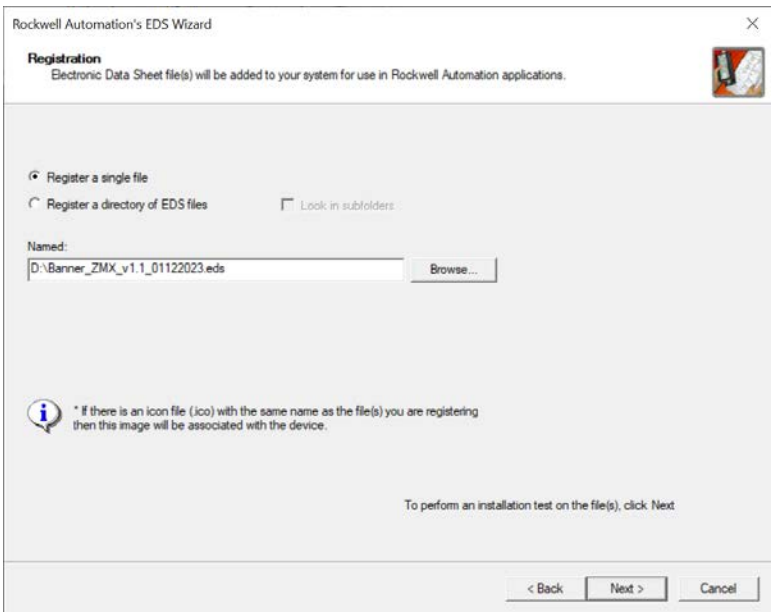


2. Click **Next**.
3. Select the **Register an EDS file(s)** option.

Figure 26. Rockwell Automation's EDS Wizard—Options

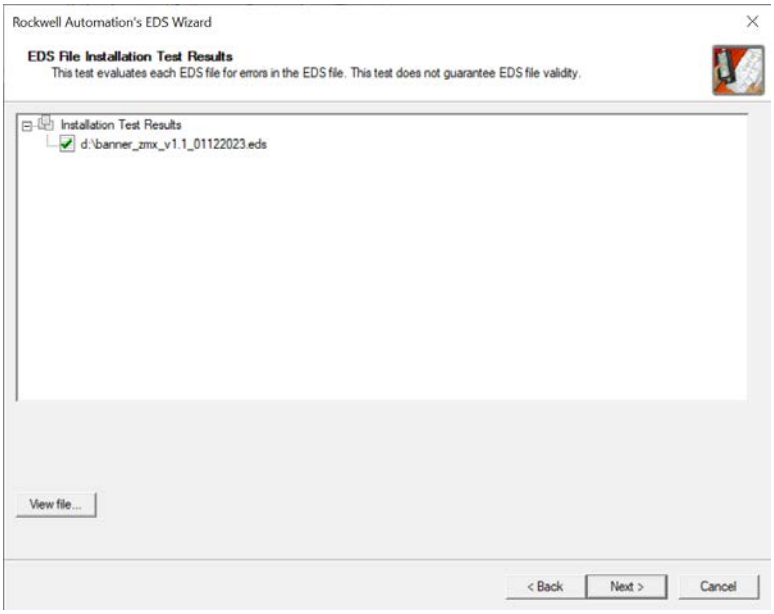
4. Browse to locate the EDS file and click **Next**.

Figure 27. Select File to Register



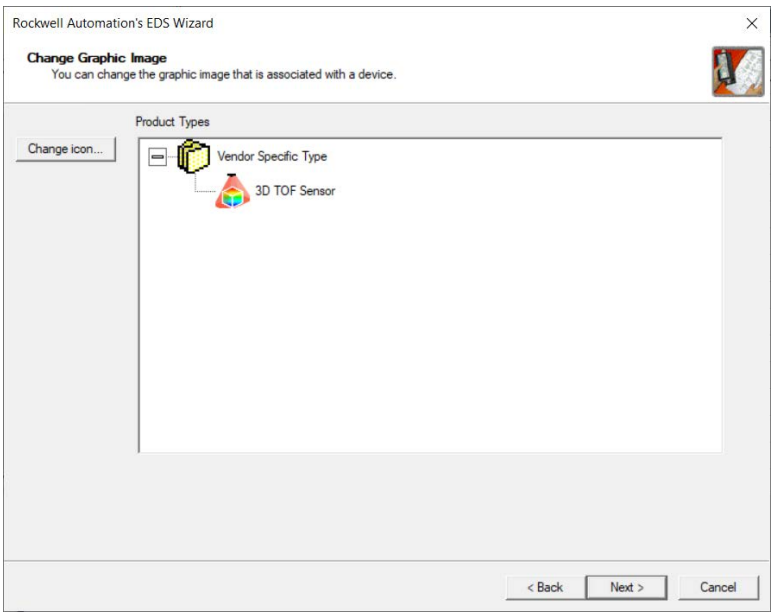
5. Click **Next** to register the tested file.

Figure 28. Register the Tested File



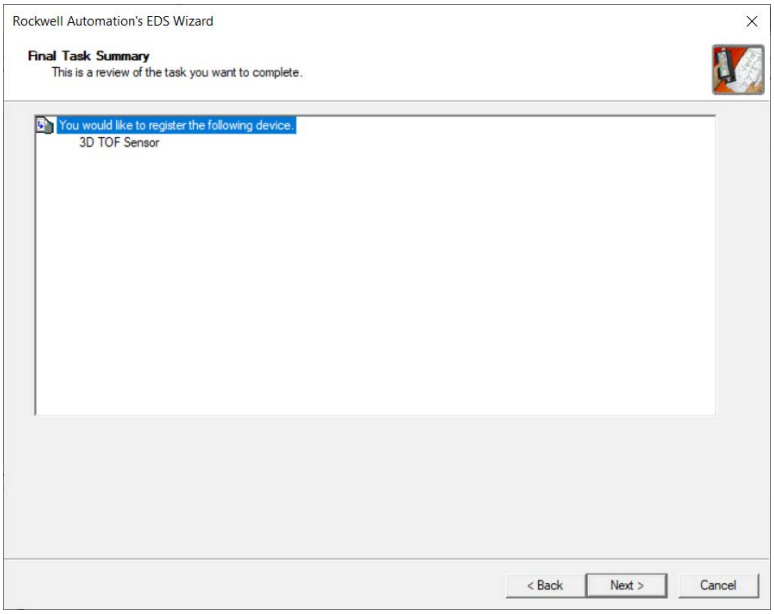
6. Click **Next** when you see the icon associated with the EDS file.

Figure 29. Rockwell Automation's EDS Wizard



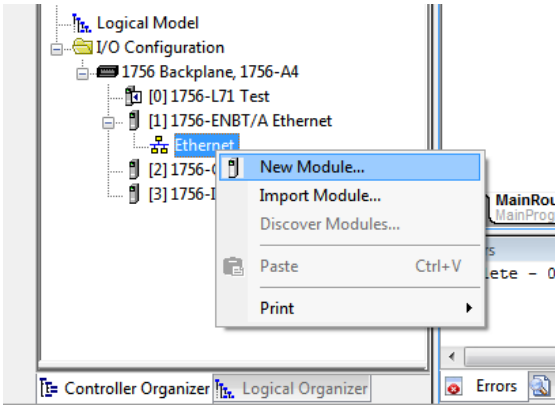
7. Click **Next** to register the EDS file.

Figure 30. Register the EDS File



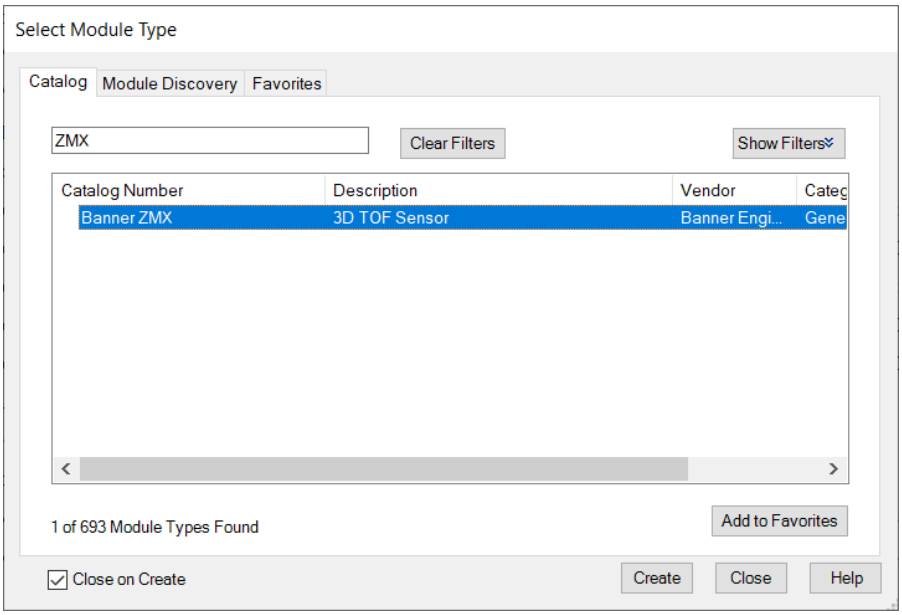
8. Click **Finish** to close the **EDS Wizard** .
9. Right-click on the PLC's Ethernet adapter and select **New Module...**

Figure 31. New Module



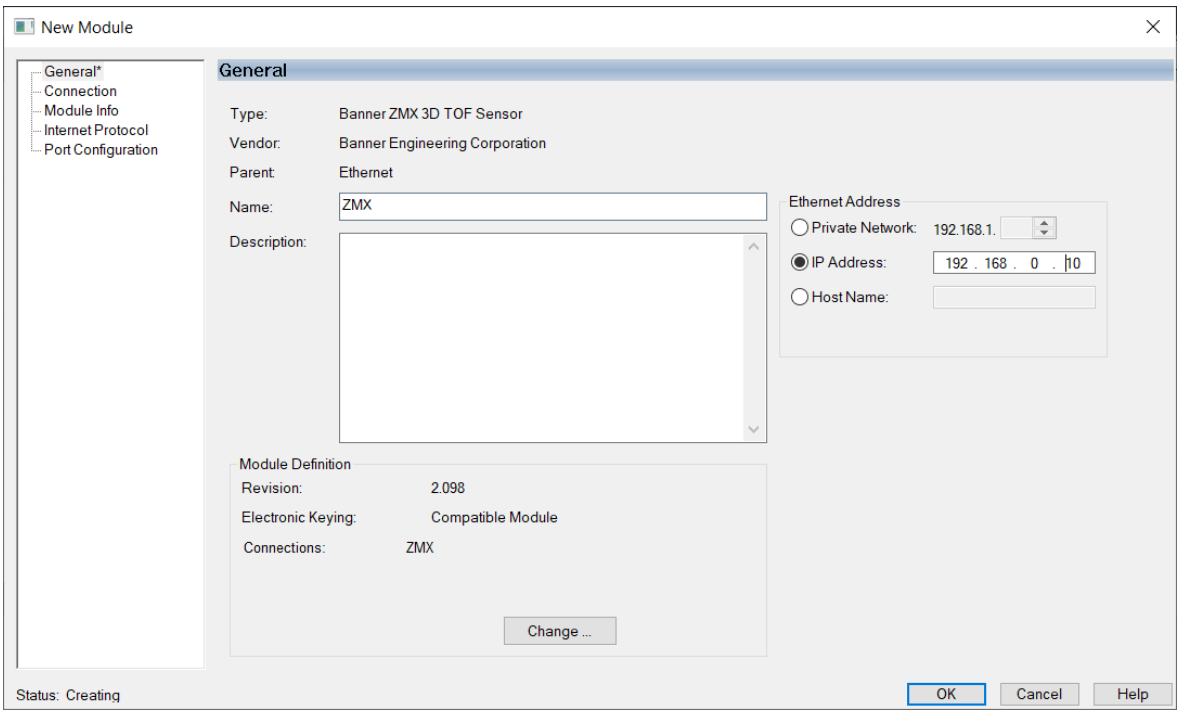
10. Locate the device in the catalog and click **Create**.

Figure 32. Select Module Type



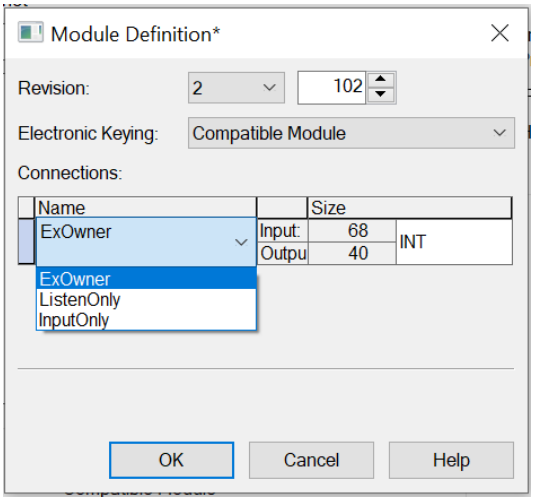
11. Enter a name, description (optional), and IP address for the device.

Figure 33. New Module



12. Click **Change** in the **Module Definition** field.

Figure 34. Module Definition



Note: The ZMX supports three types of EtherNet/IP connections: Exclusive Owner (ExOwner), Listen Only, and Input Only. Most users select Exclusive Owner because it provides full control of both the input and output data. An Input Only connection provides the T > O (ZMX output data) to the PLC. A Listen Only connection provides the T > O (ZMX output data) to a device wishing to listen to an existing multicast connection.

13. Select the desired connection in the **Module Definition** window. Each of the items in the **Name** list represents a fixed grouping of input and output assembly instances:

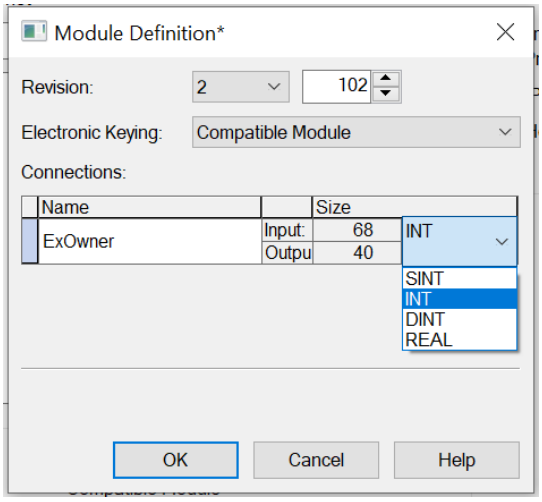
ExOwner
- T > O PLC Input/ZMX Output Assembly 100 (0×64), size 68 16-bit registers
- O > T PLC Output/ZMX Input Assembly 112 (0×70), size 40 16-bit registers

Listen Only T > O PLC Input/ZMX Output Assembly 100 (0×64)

Input Only T > O PLC Input/ZMX Output Assembly 100 (0×64)

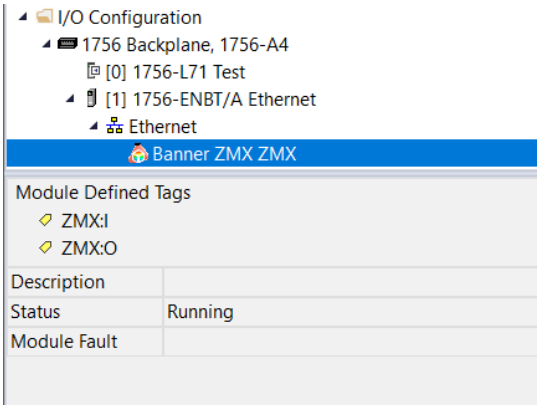
14. Select **INT** as the data type.

Figure 35. Module Definition—Data Type



15. Click **OK** twice and download the program to the PLC.

Figure 36. Download to the PLC



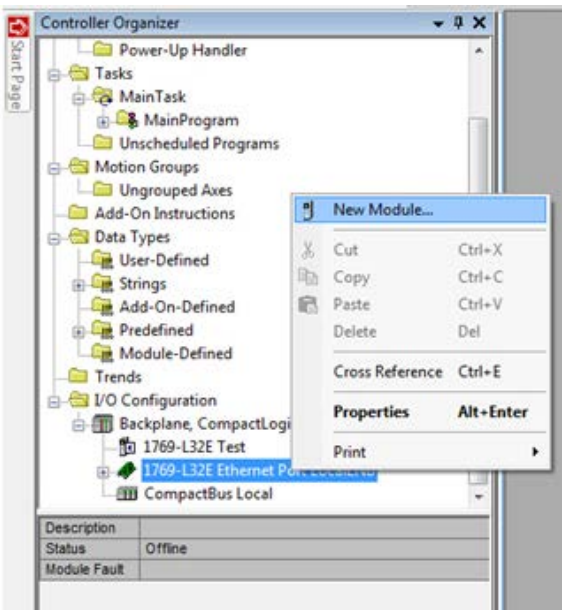
The connection looks like the one in Figure 36 on page 31.

6.1.3 EtherNet/IP Configuration Using Generic Ethernet Module

To create an implicit Class 1 configuration to the ZMX using EtherNet/IP when using a ControlLogix family PLC, configure the ZMX as a “Generic Ethernet Module”. The following is a sample setup of a Banner device using RSLogix5000® or Studio 5000 Logix Designer software:

1. Add a generic Ethernet module to the PLC's Ethernet card.
   a) Right-click and select **New Module**.

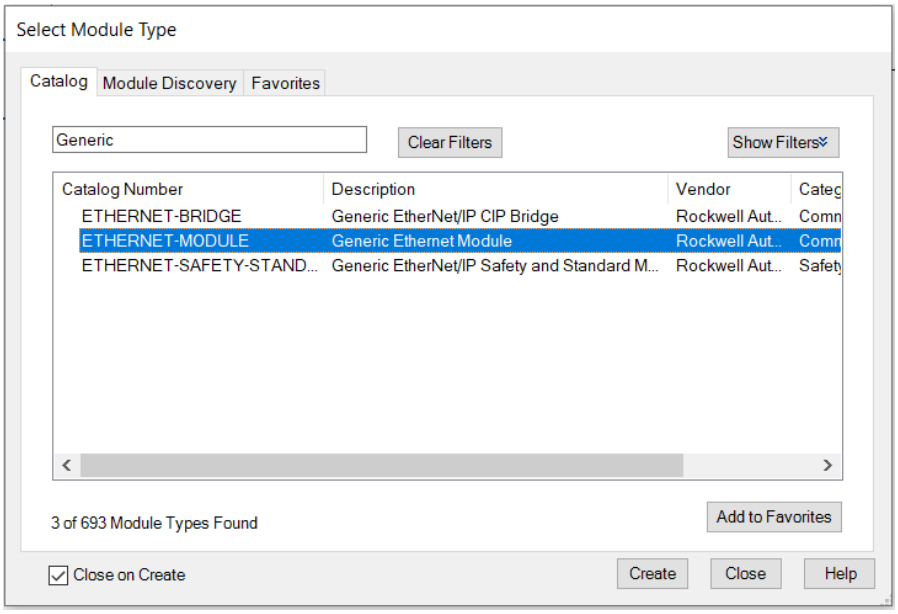
Figure 37. Add Ethernet Module



The **Select Module Type** window opens.

b) Select **Generic Ethernet Module**.

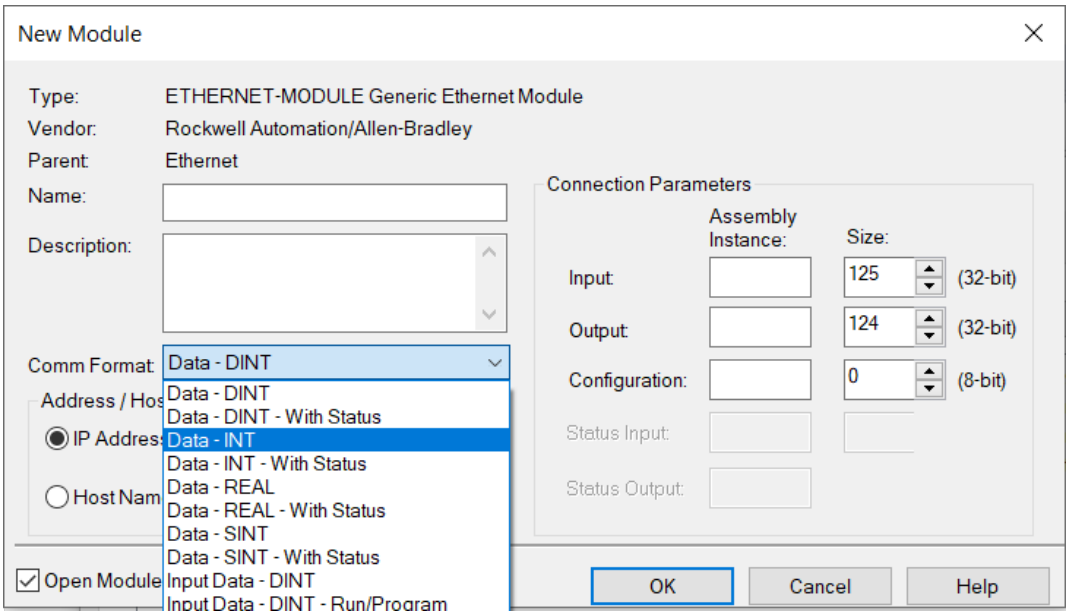
Figure 38. Select Module Type



The **New Module** window opens.

2. Configure the Module Properties.
   a) Change the **Comm Format** to **Data - INT**.

Figure 39. Comm Format



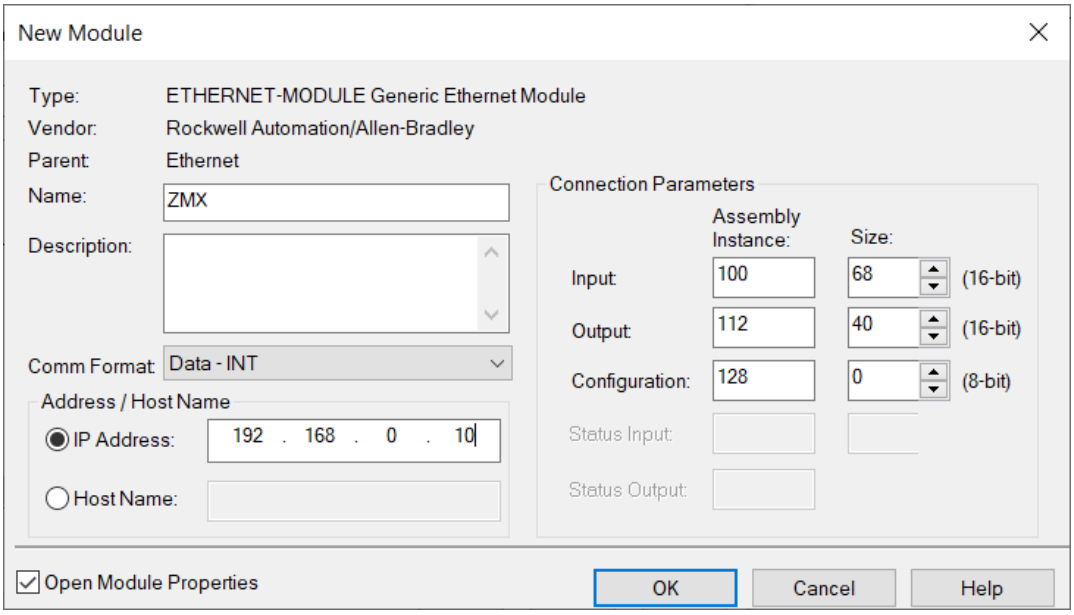
b) Enter a module **Name** and **IP address**.

The default IP address is 192.168.0.10 with a subnet mask of 255.255.255.0.

c) Under Connection Parameters, enter the **Assembly Instance** parameters and **Size** parameters.

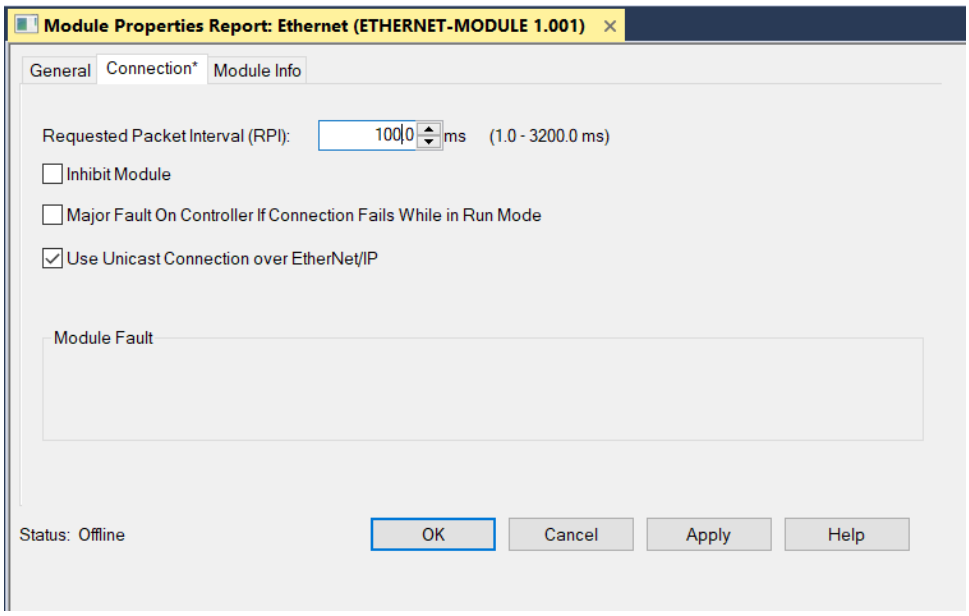
PLC Input Assembly 100 (0×64), size 68 words
PLC Output Assembly 112 (0×64), size 40 words
PLC Configuration Assembly 128 (0×64), size 0 words

Figure 40. New Module Window



d) On the **Connection** tab, set the **Requested Packet Interval (RPI)** and select the **Use Unicast Connect over EtherNet/IP** checkbox.

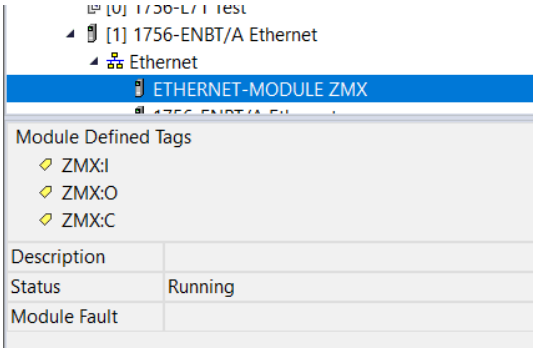
*Figure 41. **Connection** Tab*



Note: The recommended minimum RPI is 100 msec.

3. If the module configuration was successful, the following information displays:

Figure 42. Successful Configuration



Module Defined Tags

C = Configuration (not used)
I = Inputs to PLC (outputs from the device)
O = Outputs from PLC (inputs to the device)

6.1.4 Assembly Objects

Inputs to the Sensor (Outputs from the PLC)

PLC Assembly Instance 112 (0×70) - 40 Registers (ZMX Inputs/PLC Outputs) O > T

This Assembly Instance includes parameters to control the ZMX sensor.

Table 2: PLC Assembly Instance 112 (0×70)

WORD #	WORD NAME	DATA TYPE	RELEVANT INPUT BITS	RANGE & INFO
0	Input bits (see Flags on page 37)	16 bits		
1	*reserved*	16-bit INT		

WORD #	WORD NAME	DATA TYPE	RELEVANT INPUT BITS	RANGE & INFO
2	Trigger Mode [17]	16-bit INT	14, 1	**Trigger Mode:** 1 = External 5 = Internal (uses Trigger Period in ms) 6 = Free Run 10 = Software (EIP)
3	Trigger Period (ms) [17]	16-bit INT	14, 1	100 … 60,000
4	Illumination Power (%) [17]	16-bit INT	14, 1	1 … 100
5–11	*reserved*	16-bit INT		
12	Pitch Angle (degrees × 100) [17]	16-bit INT	14, 1	-4,500 … 4,500
13	Roll Angle (degrees × 100) [17]	16-bit INT	14, 1	-4,500 … 4,500
14	Yaw Angle (degrees × 100) [17]	16-bit INT	14, 1	-18,000 … 18,000
15–17	*reserved*	16-bit INT		
18	Discrete I/O Polarity [17]	16-bit INT	14, 1	**Polarity Mode:** 0 = PNP 1 = NPN 2 = Push-Pull
19	*reserved*	16-bit INT		
20	Fill Level Limit Setpoint (%) [18]	16-bit INT	0, 1	0 … 200
21	*reserved*	16-bit INT		
22	Peak Height Limit Setpoint (mm) [18]	16-bit INT	0, 1	0 … 2,950 [19]
23	*reserved*	16-bit INT		
24	Discrete Output 1 Control Mode [18]	16-bit INT	0, 1	**Discrete Output 1 & 2 Mode:** 0 = Disabled 1 = Fill percent above setpoint 2 = Peak height above setpoint 9 = Fill percent above setpoint **OR** peak height above setpoint 10 = Pulse Pro 100Hz to 600Hz scaled to fill percent 0 to 100 11 = Pulse Pro 100Hz to 600Hz scaled to peak height above bottom of container 20 = No output, channel used as input
25	Discrete Output 2 Control Mode [18]	16-bit INT	0, 1	
26	ROI Anchor Point X (mm) [18]	16-bit INT	0, 1	-2,500 … 2,500
27	ROI Anchor Point Y (mm) [18]	16-bit INT	0, 1	-2,500 … 2,500
28	ROI Anchor Point Z (mm) [18]	16-bit INT	0, 1	200 … 3,000
29	ROI Length (X) (mm) [18]	16-bit INT	0, 1	50 … 5,000
30	ROI Width (Y) (mm) [18]	16-bit INT	0, 1	50 … 5,000
31	ROI Height (Z) (mm) [18]	16-bit INT	0, 1	50 … 5,000
32–39	*reserved*	16-bit INT		

[17] These parameters use the Enable Inputs bit (bit 14 in word 0 of the PLC Output Assembly). See Using Input Bits on page 38.
[18] These parameters use the Update ROI Parameters bit (bit 0 in word 0 of the PLC Output Assembly). See Using Input Bits on page 38.
[19] Maximum value is reduced to not extend past the minimum sensing distance.

Outputs from the Sensor (Inputs to the PLC)

PLC Assembly Instance 100 (0×64) - 68 Registers (ZMX Outputs/PLC Inputs) T > O

This Assembly Instance includes the readbacks from the ZMX sensor.

Table 3: PLC Assembly Instance 100 (0×64)

WORD #	WORD NAME	DATA TYPE	RELEVANT INPUT BITS	RANGE & INFORMATION
0	Input ACK & Status bits (see Flags on page 37)	16 bits		
1	*reserved*	16-bit INT		
2	Sensor Fault Code (see Sensor Fault Codes on page 44)	16-bit INT		
3	Boot Count	16-bit INT		1 … 65,535
4–5	Up Time (ms)	32-bit DINT		1 … 4,294,967,295
6–7	Missed Trigger Count	32-bit DINT		1 … 4,294,967,295
8–14	*reserved*	16-bit INT		
15–16	Frame Number	32-bit DINT		1 … 4,294,967,295
17–18	Invalid Pixel Count	32-bit DINT		0 … 56,576
19–20	Saturated Pixel Count	32-bit DINT		0 … 56,576
21	Configuration Error Code (see Configuration Error Codes on page 45)	16-bit INT		
22	*reserved*	16-bit INT		
23	Fill Level %	16-bit INT	3	0 … 200
24	Peak Height (mm)	16-bit INT	3	0 … 3,500
25	Estimated Item Count	16-bit INT	3	
26	Output 1 PFM Frequency (Hz)	16-bit INT		0 | 100 ... 600
27	Output 2 PFM Frequency (Hz)	16-bit INT		0 | 100 ... 600
28	Trigger Mode [20]	16-bit INT		**Trigger Mode:** 1 = External 5 = Internal (uses Trigger Period in ms) 6 = Free Run 10 = Software (EIP)
29	Trigger Period (ms) [20]	16-bit INT		100 … 60,000
30	Illumination Power (%) [20]	16-bit INT		1 … 100
31–38	*reserved*	16-bit INT		
39	Pitch Angle (degrees × 100) [20]	16-bit INT		-4,500 … 4,500
40	Roll Angle (degrees × 100) [20]	16-bit INT		-4,500 … 4,500
41	Yaw Angle (degrees × 100) [20]	16-bit INT		-18,000 … 18,000
42–44	*reserved*	16-bit INT		
45	Discrete I/O Polarity [20]	16-bit INT		**Polarity Mode:** 0 = PNP 1 = NPN 2 = Push-Pull

[20] Readbacks of the current application settings.

WORD #	WORD NAME	DATA TYPE	RELEVANT INPUT BITS	RANGE & INFORMATION
46	*reserved*	16-bit INT		
47	Fill Level Limit Setpoint (%) [20]	16-bit INT		0 … 200
48	*reserved*	16-bit INT		
49	Peak Height Limit Setpoint (mm) [20]	16-bit INT		0 … 2,950 [21]
50	*reserved*	16-bit INT		
51	Discrete Output 1 Control Mode [20]	16-bit INT		**Discrete Output 1 & 2 Mode:** 0 = Disabled 1 = Fill percent above setpoint 2 = Peak height above setpoint 9 = Fill percent above setpoint **OR** peak height above setpoint 10 = Pulse Pro 100Hz to 600Hz scaled to fill percent 0 to 100 11 = Pulse Pro 100Hz to 600Hz scaled to peak height above bottom of container 20 = No output, channel used as input
52	Discrete Output 2 Control Mode [20]	16-bit INT		
53	ROI Anchor Point X (mm) [20]	16-bit INT		-2,500 … 2,500
54	ROI Anchor Point Y (mm) [20]	16-bit INT		-2,500 … 2,500
55	ROI Anchor Point Z (mm) [20]	16-bit INT		200 … 3,000
56	ROI Length (X) (mm) [20]	16-bit INT		50 … 5,000
57	ROI Length (Y) (mm) [20]	16-bit INT		50 … 5,000
58	ROI Length (Z) (mm) [20]	16-bit INT		50 … 3,000
59–67	*reserved*	16-bit INT		

Configuration Assembly Object

The ZMX sensor does not use a Configuration Assembly Object.

Because some EtherNet/IP clients require one, use Instance 128 (0×80) with a size of zero registers (16-bit).

Flags

Word 0 in both Assembly Instances is a collection of individual bit values, as shown in the following table.

Table 4: Input Bits and Input ACK & Status Bits

Input bits (PLC Outputs, word 0)			Input ACK & Status bits (PLC Inputs, word 0)	
Bit #	**Name**		**Bit #**	**Name**
0	Update ROI Parameters		0	Update ROI Parameters ACK
1	Save Parameters Permanent		1	Save Parameters Permanent ACK
2	Reset Application Results		2	Reset Application Results ACK
3	Trigger		3	Trigger ACK
4	*reserved*		4	*reserved*
5	*reserved*		5	*reserved*
6	*reserved*		6	Fill Level Limit
7	*reserved*		7	*reserved*
8	*reserved*		8	Peak Height Limit

[21] Maximum value is reduced to not extend past the minimum sensing distance.

Input bits (PLC Outputs, word 0)			Input ACK & Status bits (PLC Inputs, word 0)	
Bit #	**Name**		**Bit #**	**Name**
9	*reserved*		9	*reserved*
10	*reserved*		10	Discrete Output State (1)
11	*reserved*		11	Discrete Output State (2)
12	*reserved*		12	*reserved*
13	*reserved*		13	*reserved*
14	Enable Inputs bit		14	*reserved*
15	*reserved*		15	Configuration Error

6.1.5 Controlling the ZMX Sensor

Using Input Bits

Writeable Input Bits are inputs to the sensor (outputs from the PLC or HMI). They are used for basic control of the sensor. Toggle them from 0 to 1, one at a time, to request the associated action. Most bits have a corresponding ACK Output bit that changes to 1 in response, to indicate that the action has been completed. The ACK bits reset to 0 when the command bit is reset to 0.

`Update ROI Parameters`—This action tells the sensor to take all of the new bin fill parameters, as a group, and apply them to the sensor.

1. Enter the desired PLC Output values for all bin fill parameters:
   - Fill Level Setpoint (word 20)
   - Peak Height Limit Setpoint (word 22)
   - Discrete Output 1 Control Mode (word 24)
   - Discrete Output 2 Control Mode (word 25)
   - ROI Anchor Point X (word 26)
   - ROI Anchor Point Y (word 27)
   - ROI Anchor Point Z (word 28)
   - ROI Length (X) (word 29)
   - ROI Width (Y) (word 30)
   - ROI Height (Z) (word 31)
2. Toggle the Update ROI Parameters bit (word 0, bit 0, PLC Outputs) from 0 to 1.
3. Look for the corresponding Update ROI Parameters ACK bit (word 0, bit 0, PLC Inputs) to go from 0 to 1.
4. Confirm that the Configuration Error bit (word 0, bit 15, PLC Inputs) is still 0.

   If it is a 1, read the Configuration Error Code (word 21, PLC Inputs) and correct the error. See Configuration Error Codes on page 45.

`Save Parameters Permanent`— This action tells the sensor to take all editable parameters modifiable over EtherNet/IP and save them in the sensor's permanent memory. This includes the size and position of the Region of Interest, as well as settings such as Trigger Mode and Output Control Mode.

`Reset Application Results`—This action resets all measurement output values to 0 in the EtherNet/IP registers.

`Trigger`—This action triggers an immediate image acquisition and measurement.

`Enable Inputs`—This bit controls whether changes to basic sensor parameters like Trigger Mode, Trigger Period, Illumination Power, Pitch, Roll, and Yaw Angle, and Discrete I/O Polarity should take effect in the sensor. To adjust these parameters on the fly:

1. Toggle the Enable Inputs bit from 0 to 1 (word 0, bit 14, PLC Outputs).
2. Adjust any of the above parameters as needed.

   The new values will take effect only if the Enable Inputs bit is a 1 and the new value written represents a change from the previous value.

6.2 Modbus® TCP

The Modbus® [23] TCP protocol provides device information using register and coil banks defined by the slave device. Modbus TCP can also be used to modify parameters of the sensor.

Important: Parameter changes over Modbus TCP are only stored in temporary memory and are not retained through a reboot unless the Save Parameters Permanent Input Bit is used.

This section defines the register and coil banks. By specification, Modbus TCP uses TCP port 502.

The Modbus Client must use a UNIT ID of 1 or higher to connect to the ZMX sensor. The Modbus TCP remote unit identifier is used with Modbus TCP devices that are composites of several Modbus devices. For example, on Modbus TCP to Modbus RTU gateways. In this case, the unit identifier tells the Slave Address of the device behind the gateway. Most Modbus TCP Clients use a Unit ID of 1 or higher.

The Input Bits can be set as Coils using Modbus function code 05 (Force Single Coil). The state of the Input ACK Bits and Status Bits can be read as Inputs (10000) using Modbus function code 02 (Read Input Status).

Modbus Function Codes Supported

01: Read Coil Status
02: Read Input Status
03: Read Holding Registers
04: Read Input Registers
05: Force Single Coil
06: Preset Single Register
07: Read Exception Status
16: Preset Multiple Registers

Table 5: Modbus TCP Input and Output Bits

Input Bits			**Output Bits**	
Function Code 05: Force Single Coil			**Function Code 02: Read Input Status**	
Coil	**NAME**		**Input**	**NAME**
00001	Update ROI Parameters		10001	Update ROI Parameters ACK
00002	Save Parameters Permanent		10002	Save Parameters Permanent ACK
00003	Reset Application Results		10003	Reset Application Results ACK
00004	Trigger		10004	Trigger ACK
00005	*reserved*		10005	*reserved*
00006	*reserved*		10006	*reserved*
00007	*reserved*		10007	Fill Level Limit
00008	*reserved*		10008	*reserved*
00009	*reserved*		10009	Peak Height Limit
00010	*reserved*		10010	*reserved*
00011	*reserved*		10011	Discrete Output State (1)
00012	*reserved*		10012	Discrete Output State (2)
00013	*reserved*		10013	*reserved*
00014	*reserved*		10014	*reserved*
00015	*reserved*		10015	*reserved*
00016	*reserved*		10016	Configuration Error

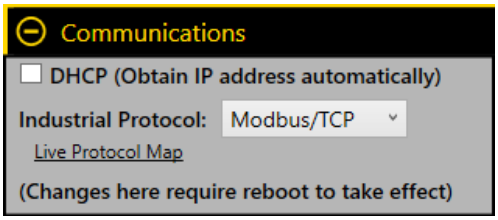
[23] Modbus® is a registered trademark of Schneider Electric USA, Inc.

6.2.1 Configuring the Sensor to use an Industrial Protocol

Use the following instructions to enable the Modbus TCP protocol or the EtherNet/IP protocol on the ZMX sensor.

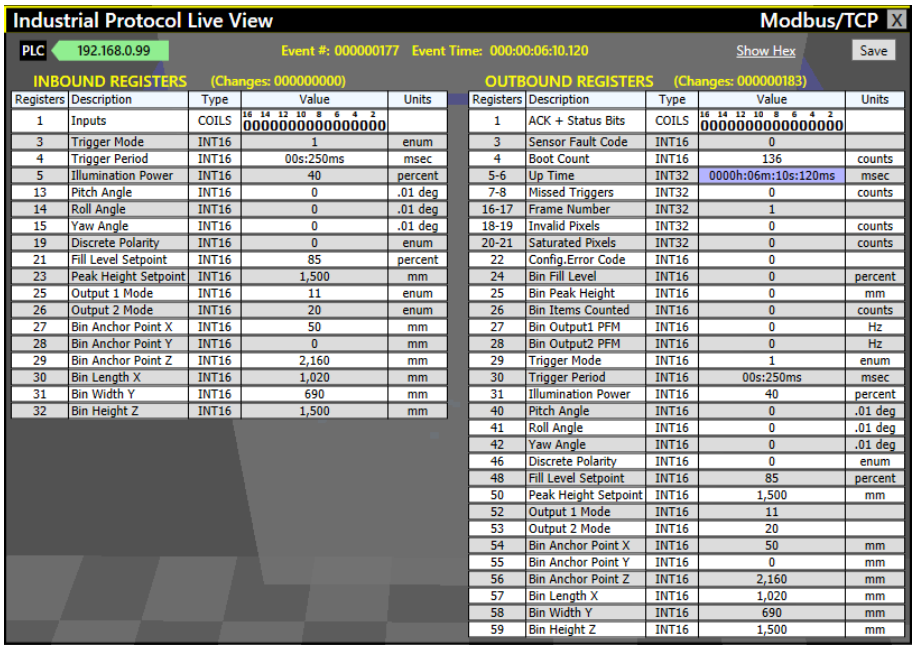
1. Go to the **Communications** pane in the Banner 3D Configuration software.

*Figure 43. **Communications** Pane*



2. From the **Industrial Protocol** menu, select the desired protocol.
   A sensor reboot may be required.
3. Click **Live Protocol Map** to open a view of the data.

Figure 44. Industrial Protocol Live View—Modbus TCP Shown



Registers	Description	Type	Value	Units
1	Inputs	COILS	16 14 12 10 8 6 4 2 1 0000000000000000	
3	Trigger Mode	INT16	1	enum
4	Trigger Period	INT16	00s:250ms	msec
5	Illumination Power	INT16	40	percent
13	Pitch Angle	INT16	0	.01 deg
14	Roll Angle	INT16	0	.01 deg
15	Yaw Angle	INT16	0	.01 deg
19	Discrete Polarity	INT16	0	enum
21	Fill Level Setpoint	INT16	85	percent
23	Peak Height Setpoint	INT16	1,500	mm
25	Output 1 Mode	INT16	11	enum
26	Output 2 Mode	INT16	20	enum
27	Bin Anchor Point X	INT16	50	mm
28	Bin Anchor Point Y	INT16	0	mm
29	Bin Anchor Point Z	INT16	2,160	mm
30	Bin Length X	INT16	1,020	mm
31	Bin Width Y	INT16	690	mm
32	Bin Height Z	INT16	1,500	mm

Registers	Description	Type	Value	Units
1	ACK + Status Bits	COILS	16 14 12 10 8 6 4 2 1 0000000000000000	
3	Sensor Fault Code	INT16	0	
4	Boot Count	INT16	136	counts
5-6	Up Time	INT32	0000h:06m:10s:120ms	msec
7-8	Missed Triggers	INT32	0	counts
16-17	Frame Number	INT32	1	
18-19	Invalid Pixels	INT32	0	counts
20-21	Saturated Pixels	INT32	0	counts
22	Config.Error Code	INT16	0	
24	Bin Fill Level	INT16	0	percent
25	Bin Peak Height	INT16	0	mm
26	Bin Items Counted	INT16	0	counts
27	Bin Output1 PFM	INT16	0	Hz
28	Bin Output2 PFM	INT16	0	Hz
29	Trigger Mode	INT16	1	enum
30	Trigger Period	INT16	00s:250ms	msec
31	Illumination Power	INT16	40	percent
40	Pitch Angle	INT16	0	.01 deg
41	Roll Angle	INT16	0	.01 deg
42	Yaw Angle	INT16	0	.01 deg
46	Discrete Polarity	INT16	0	enum
48	Fill Level Setpoint	INT16	85	percent
50	Peak Height Setpoint	INT16	1,500	mm
52	Output 1 Mode	INT16	11	
53	Output 2 Mode	INT16	20	
54	Bin Anchor Point X	INT16	50	mm
55	Bin Anchor Point Y	INT16	0	mm
56	Bin Anchor Point Z	INT16	2,160	mm
57	Bin Length X	INT16	1,020	mm
58	Bin Width Y	INT16	690	mm
59	Bin Height Z	INT16	1,500	mm

6.2.2 Using Input Bits

Writeable Coil Bits are inputs to the sensor (outputs from the PLC or HMI). They are used for basic control of the sensor. Toggle them from 0 to 1, one at a time, to request the associated action. Each bit has a corresponding ACK Output bit that changes to 1 in response, to indicate that the action has been completed. The ACK bits reset to 0 when the command bit is reset to 0.

The Input bits can be found in Holding Register 1 or as Coils 00001–00016.

The ACK bits can be found in Input Register 1, Holding Register 1001, or as Inputs 10001–10016.

`Update ROI Parameters`—This action tells the sensor to take all of the new bin fill parameters, as a group, and apply them to the sensor.

1. Enter the desired PLC Output values for all bin fill parameters:
   - Fill Level Setpoint (Holding Register 21)
   - Peak Height Limit Setpoint (Holding Register 23)
   - Discrete Output 1 Control Mode (Holding Register 25)
   - Discrete Output 2 Control Mode (Holding Register 26)
   - ROI Anchor Point X (Holding Register 27)
   - ROI Anchor Point Y (Holding Register 28)
   - ROI Anchor Point Z (Holding Register 29)

- ROI Length (X) (Holding Register 30)
- ROI Width (Y) (Holding Register 31)
- ROI Height (Z) (Holding Register 32)

2. Toggle the Update ROI Parameters bit (Holding Register 1, bit 0 **or** Coil 00001) from 0 to 1.
3. Look for the corresponding Update ROI Parameters ACK bit (Input Register 0, bit 0 **or** Holding Register 1001, bit 0 **or** Input 10001) to go from 0 to 1.
4. Confirm that the Configuration Error bit (Input Register 1, bit 15 **or** Holding Register 1001, bit 15 **or** Input 10016) is still 0.

   If it is a 1, read the Configuration Error Code (Holding Register 1022 **or** Input Register 22) and correct the error. See Configuration Error Codes on page 45.

`Save Parameters Permanent`—This action tells the sensor to take all editable parameters modifiable over Modbus TCP and save them in the sensor's permanent memory. This includes the size and position of the Region of Interest, as well as settings such as Trigger Mode and Output Control Mode.

`Reset Application Results`—This action resets all measurement output values to 0 in the Modbus TCP registers.

`Trigger`—This action triggers an immediate image acquisition and measurement.

6.2.3 ZMX Sensor Output Values

The ZMX sensor sends output data to the PLC or HMI via a bank of Input Registers (30000).

Some devices, such as the Modicon family of PLCs, cannot access data using the 30000 range of register addresses. For these devices, the ZMX sensor output data is also made available as Holding Registers (40000). To access this data, use either function code 04 (Read Input Registers) or function code 03 (Read Holding Registers).

Input REG #	Holding REG #	WORD NAME	DATA TYPE	RANGE
1	1001	Input ACK & Status bits (Inputs 10001–10016)	16 bits	
2	1002	*reserved*	16-bit UINT	
3	1003	Sensor Fault Code (see Sensor Fault Codes on page 44)	16 bit UINT	
4	1004	Boot Count	16-bit UINT	1 …. 65535
5–6	1005–1006	Up Time (ms)	32-bit UINT	1 … 4,294,967,295
7–8	1007–1008	Missed Trigger Count	32-bit UINT	0 … 4,294,967,295
9–15	1009–1015	*reserved*	7 16-bit UINTs	
16–17	1016–1017	Frame Number	32-bit UINT	1 … 4,294,967,295
18–19	1018–1019	Invalid Pixel Count (pixels with too little light received to be able to measure)	32-bit UINT	0 … 56,576
20–21	1020–1021	Saturated Pixel Count (pixels with too much light received to be able to measure)	32-bit UINT	0 … 56,576
22	1022	Configuration Error Code (see Configuration Error Codes on page 45)	16-bit UINT	
23	1023	*reserved*	16-bit UINT	
24	1024	Fill Level %	16-bit UINT	0 … 200
25	1025	Peak Height (mm)	16-bit UINT	0 … 3,500
26	1026	Estimated Item Count	16-bit UINT	0 … 4,294,967,295
27	1027	Output 1 PFM Frequency (Hz)	16-bit UINT	0 | 100 … 600
28	1028	Output 2 PFM Frequency (Hz)	16-bit UINT	0 | 100 … 600

Input REG #	Holding REG #	WORD NAME	DATA TYPE	RANGE
29	1029	Trigger Mode [27]	16-bit UINT	**Trigger Mode:** 1 = External 5 = Internal (uses trigger period) 6 = Free run 10 = Software (Modbus TCP)
30	1030	Trigger Period (ms) [27]	16-bit UINT	200 … 60000
31	1031	Illumination Power (%) [27]	16-bit UINT	1 … 100
32–39	1032–1039	*reserved*	8 16-bit UINTs	
40	1040	Pitch angle (degrees × 100) [27]	16-bit INT	-4500 … 4500
41	1041	Roll angle (degrees × 100) [27]	16-bit INT	-4500 … 4500
42	1042	Yaw angle (degrees × 100) [27]	16-bit INT	-18000 … 18000
43–45	1043–1045	*reserved*	3 16-bit UINTs	
46	1046	Discrete I/O Polarity [27]	16-bit UINT	**Polarity Mode:** 0 = PNP 1 = NPN 2 = Push-Pull
47	1047	*reserved*	16-bit UINT	
48	1048	Fill Level Limit Setpoint (%) [27]	16-bit UINT	0 … 200
49	1049	*reserved*	16-bit UINT	
50	1050	Peak Height Limit Setpoint (mm) [27]	16-bit UINT	0 … 2,950**
51	1051	*reserved*	16-bit UINT	
52	1052	Discrete Output 1 Control Mode [27]	16-bit UINT	**Discrete Output 1 & 2 Mode:** 0 = Disabled 1 = Fill percent above setpoint 2 = Peak height above setpoint 9 = Fill percent above setpoint **OR** peak height above setpoint 10 = Pulse Pro 100 Hz to 600 Hz scaled from fill percent between 0% to 100% 11 = Pulse Pro 100 Hz to 600 Hz scaled to peak height above bottom of container 20 = No output, channel used as input
53	1053	Discrete Output 2 Control Mode [27]	16-bit UINT	
54	1054	ROI Anchor Point X (mm) [27]	16-bit INT	-2,500 … 2,500
55	1055	ROI Anchor Point Y (mm) [27]	16-bit INT	-2,500 … 2,500
56	1056	ROI Anchor Point Z (mm) [27]	16-bit INT	200 … 3,000
57	1057	ROI Length (X) (mm) [27]	16-bit UINT	50 … 5,000
58	1058	ROI Width (Y) (mm) [27]	16-bit UINT	50 … 5,000

[27] Readbacks of the current application settings.

Input REG #	Holding REG #	WORD NAME	DATA TYPE	RANGE
59	1059	ROI Height (Z) (mm) [27]	16-bit UINT	50 … 3,000
60–67	1060–1067	*reserved*	8 16-bit UINTs	

6.2.4 ZMX Sensor Input Values

Holding Registers (40000) are used by the PLC or HMI to write values to the ZMX sensor. To write, use function codes 06 (Preset Single Register) or 16 (Preset Multiple Registers).

Holding REG #	WORD NAME	DATA TYPE	RANGE & INFO
1	Input bits (Coils 00001–00016)	16 bits	
2	*reserved*	16-bit UINT	
3	Trigger Mode	16-bit UINT	**Trigger Mode:** 1 = External 5 = Internal (uses trigger period) 6 = Free run 10 = Software (Modbus TCP)
4	Trigger Period (ms)	16-bit UINT	100 … 60,000
5	Illumination Power (%)	16-bit UINT	0…100
6–12	*reserved*	7 16-bit UINTs	
13	Pitch angle (degrees × 100)	16-bit INT	-4500 … 4500
14	Roll angle (degrees × 100)	16-bit INT	-4500 … 4500
15	Yaw angle (degrees × 100)	16-bit INT	-18000 … 18000
16–18	*reserved*	3 16-bit UINTs	
19	Discrete I/O Polarity	16-bit UINT	**Polarity Mode:** 0 = PNP 1 = NPN 2 = Push-Pull
20	*reserved*	16-bit UINT	
21	Fill Level Limit Setpoint (%)	16-bit UINT	0 … 200
22	*reserved*	16-bit UINT	
23	Peak Height Limit Setpoint (mm)	16-bit UINT	0 … 2,950 [29]
24	*reserved*	16-bit UINT	
25	Discrete Output 1 Control Mode	16-bit UINT	**Discrete Output 1 & 2 Mode:** 0 = Disabled 1 = Fill percent above setpoint 2 = Peak height above setpoint 9 = Fill percent above setpoint **OR** peak height above setpoint 10 = Pulse Pro 100 Hz to 600 Hz scaled from fill percent between 0% to 100% 11 = Pulse Pro 100 Hz to 600 Hz scaled to peak height above bottom of container 20 = No output, channel used as input
26	Discrete Output 2 Control Mode	16-bit UINT	
27	ROI Anchor Point X (mm)	16-bit INT	-2,500 … 2,500
28	ROI Anchor Point Y (mm)	16-bit INT	-2,500 … 2,500

[29] Maximum value is reduced to not extend past the minimum sensing distance.

Holding REG #	WORD NAME	DATA TYPE	RANGE & INFO
29	ROI Anchor Point Z (mm)	16-bit INT	200 … 3,000
30	ROI Length (X) (mm)	16-bit UINT	50 … 5,000
31	ROI Width (Y) (mm)	16-bit UINT	50 … 5,000
32	ROI Height (Z) (mm)	16-bit UINT	50 … 3,000
33–40	*reserved*	8 16-bit UINTs	

6.3 Troubleshooting

6.3.1 Sensor Fault Codes

The following is a list of the possible error codes from Word 2 in the PLC Input (ZMX Output) Assembly Instance.

Sensor Fault Code	Description	Recommended Solution
0	Online, No Fault	
1	EEPROM Timeout	• Reboot the sensor • If the fault persists, call Banner Customer Support
2	EEPROM Failure	• Reboot the sensor • If the fault persists, call Banner Customer Support
4	Acquisition Error	• Reboot the sensor • If the fault persists, call Banner Customer Support
5	Internal Temperature Error	• Turn off the power and allow the sensor to cool • Use a lower frame rate • Use a better heat sink or better airflow
6	Illumination Temperature Error	• Turn off the power and allow the sensor to cool • Use a lower frame rate • Use a better heat sink or better airflow
7	Main Sensor Temperature Error	• Turn off the power and allow the sensor to cool • Use a lower frame rate • Use a better heat sink or better airflow
8	Acquisition Error 2	• Reboot the sensor • If the fault persists, call Banner Customer Support
11	Laser Operation Error	• Reboot the sensor • If the fault persists, call Banner Customer Support
20	Internal Test Error	• Reboot the sensor • If the fault persists, call Banner Customer Support • Reboot the sensor • If the fault persists, call Banner Customer Support
21	Internal Read Error	• Reboot the sensor • If the fault persists, call Banner Customer Support
22	Internal Write Error	• Reboot the sensor • If the fault persists, call Banner Customer Support
30	Laser Power Test Error	• Reboot the sensor • If the fault persists, call Banner Customer Support
31	Laser Power Read Error	• Reboot the sensor • If the fault persists, call Banner Customer Support

Sensor Fault Code	Description	Recommended Solution
32	Laser Power Write Error	• Reboot the sensor • If the fault persists, call Banner Customer Support
1000	Acquisition Error 3	• Reboot the sensor • If the fault persists, call Banner Customer Support
1011–1017	Internal Flash Error 1–7	• Call Banner Customer Support
30000-32000	Boot Loader Error	• Call Banner Customer Support

6.3.2 Configuration Error Codes

The following is a list of possible error codes.

Modbus TCP: The codes are from input register 22 (holding register 1022).

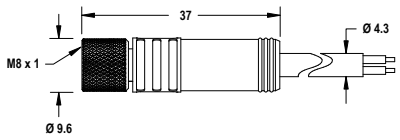
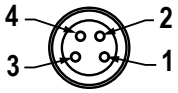
EtherNet/IP: The codes are from word 21 in the PLC Input (ZMX Output) Assembly Instance

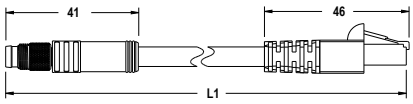
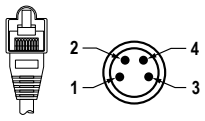
Error Code	Description
110	Illumination Power < 1
111	Illumination Power > 100
120	Invalid Trigger Mode
130	Trigger Period < 200 ms
131	Trigger Period > 60000 ms
140	Pitch Angle < -4500
141	Pitch Angle > 4500
150	Roll Angle < -4500
151	Roll Angle > 4500
160	Yaw Angle < -18000
161	Yaw Angle > 18000
300	Invalid Discrete Polarity
2000	Anchor Point X < -2500 mm
2001	Anchor Point X > 2500 mm
2010	Anchor Point Y < -2500 mm
2011	Anchor Point Y > 2500 mm
2020	Anchor Point Z < -2500 mm
2021	Anchor Point Z > 2500 mm
2030	Bin Length X < 50 mm
2031	Bin Length X > 5000 mm
2040	Bin Width Y < 50 mm
2041	Bin Width Y > 5000 mm
2050	Bin Height Z < 50 mm
2051	Bin Height Z > 5000 mm
2052	Invalid Bin Height
2060	Fill Level Setpoint < 0%
2061	Fill Level Setpoint > 200%
2080	Peak Height Setpoint < 0

Error Code	Description
2081	Peak Height Setpoint > Bin Height Z (mm)
2100	*Discrete Output 1 Selection Invalid*
2110	*Discrete Output 2 Selection Invalid*

7 Accessories

7.1 Cordsets

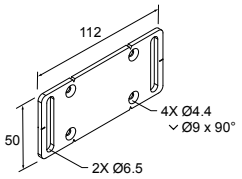
4-Pin Threaded M8 Cordsets with Shield for Power and I/O				
Model	**Length**	**Style**	**Dimensions**	**Pinout (Female)**
PKG4MS-2-22	2.0 m (6.6 ft)	Straight		 1 = Brown 2 = White 3 = Blue 4 = Black
PKG4MS-4.6-22	4.6 m (15.1 ft)			
PKG4MS-9.1-22	9.1 m (29.9 ft)			

Double-Ended 4-Pin M8 male to RJ45 male Ethernet and PC communication				
Model	**Length**	**Style**	**Dimensions**	**Pinout**
STP-M8MRJ45-406	1.83 m (6 ft)	Straight		 1 = Blue 2 = White/Blue 3 = White/Orange 4 = Orange
STP-M8MRJ45-415	4.57 m (15 ft)			
STP-M8MRJ45-430	9.14 m (30 ft)			

7.2 Brackets

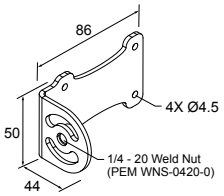
SMBZMXMP

- Plate for flush mounting sensor
- 11-gauge stainless steel
- M4 × 0.7 mounting hardware included
- ¼ - 20 thread included for mounting with bogen arm



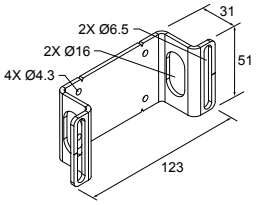
SMBZMXRA

- Right angle mounting bracket, with rotation available
- 12-gauge stainless steel
- M4 × 0.7 mounting hardware included



SMBZMXRM

- Recessed mounting bracket
- 12-gauge stainless steel
- M4 × 0.7 mounting hardware included



8 Product Support

8.1 Cleaning Instructions

Handle the sensor with care during installation and operation. Sensor windows soiled by fingerprints, dust, water, oil, etc. may create stray light that may degrade the peak performance of the sensor.

Clean as necessary using:

- Optical lens cleaner designed for coated optics
- Optical wipes designed for coated optics

Alternatively, use a soft, clean cloth and isopropyl alcohol or a soft, clean cloth and a mild soap or detergent with lukewarm water. Do not use any other chemicals for cleaning (for example, avoid vinegar or ammonia-based products because they will damage the surface).

Canned air may also be used to blow dust from the sensor.

8.2 Back Up the Sensor

Use the following procedure to create a backup of the ZMX sensor.

1. Connect to the desired sensor.

   Note: The sensor can be running, however, consider the status of the connected equipment (for example, the PLC) prior to creating a backup.
2. On the **Sensor Maintenance** pane, click **Backup Device**.
3. Navigate to the desired location.
4. Click **Start**.
   All settings, including sensor name, IP address, subnet mask, and gateway are saved. The backup is saved as a .bak file.

8.3 Restore the Sensor

Use the following procedure to restore the ZMX sensor from a saved file.

1. Connect to the desired sensor.

   Note: The sensor can be running, however, consider the status of the connected equipment (for example, the PLC) prior to restoring the sensor.
2. On the **Sensor Maintenance** pane, click **Restore Device**.
3. Navigate to the desired .bak file.
4. Select options.
   a) Select the **Overwrite IP Address, Subnet Mask and Gateway** checkbox (default) if you do not want to keep the current information from the connected sensor.
   b) Select the **Overwrite Sensor Name** checkbox (default) if you do not want to keep the current sensor name of the connected sensor.
5. Click **Start**.
   The sensor settings are restored to those from the .bak file.
6. Reboot the sensor.

8.4 Repairs

Contact Banner Engineering for troubleshooting of this device. **Do not attempt any repairs to this Banner device; it contains no field-replaceable parts or components.** If the device, device part, or device component is determined to be defective by a Banner Applications Engineer, they will advise you of Banner's RMA (Return Merchandise Authorization) procedure.

Important: If instructed to return the device, pack it with care. Damage that occurs in return shipping is not covered by warranty.

8.5 Contact Us

Banner Engineering Corp. headquarters is located at:

9714 Tenth Avenue North
Minneapolis, MN 55441, USA
Phone: + 1 888 373 6767

For worldwide locations and local representatives, visit www.bannerengineering.com.

8.6 Banner Engineering Corp. Limited Warranty

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