ZEBEX
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User's Manual

Intelligent Vision Camera



Revision History

Changes to the original manual are listed below:

Version	Date	Description of Version
1.0	06/20/2026	Initial release
1.1	11/13/2026	Features revised to reflect design update

Important Notice

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Printing Instructions

This manual is **A5 size**. Please verify your printer settings before printing.

Adjustments

Do not attempt to make any adjustments or modifications to this product. **Do not remove the scanner housing**; there are no user-serviceable parts inside.

Optical Safety

The use of optical instruments with this product will increase the risk of eye injury. Optical instruments include binoculars, magnifying glasses, and microscopes, but do not include standard prescription eyeglasses.

Caution

Use of controls, adjustments, or performance of procedures other than those specified herein may result in hazardous **radiation exposure**.

For CE Countries

This scanner complies with **CE standards**. To maintain CE compliance, please ensure you use a certified power supply marked with the **CE log**

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Product Introduction

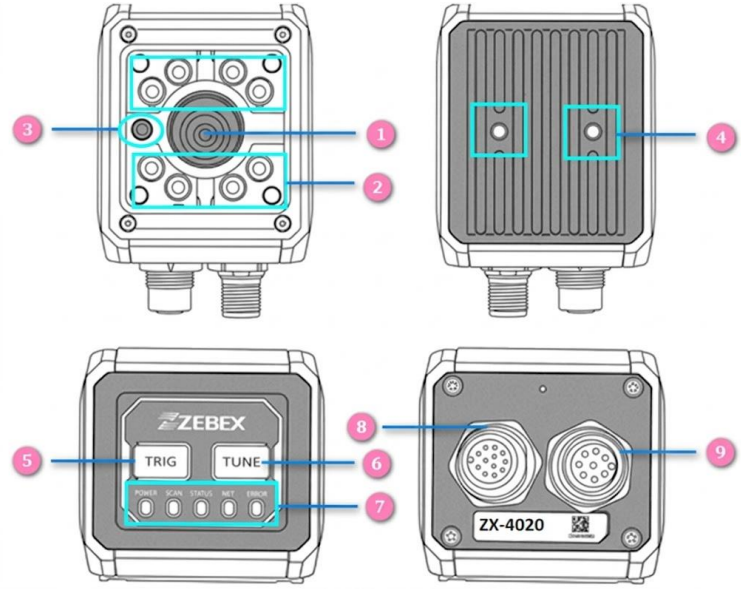
Product Description

The ZX-4020 Intelligent Vision Camera is specifically designed for industrial automation and is widely applied in sectors such as automotive components, 3C electronics, food and pharmaceutical packaging, and semiconductors. By combining a high-resolution image camera with built-in AI algorithms, the device efficiently performs inspection tasks including presence detection, orientation judgment, counting, code reading, and object classification. It supports a variety of I/O and network communication protocols, allowing for seamless integration with external control systems.

Key Features

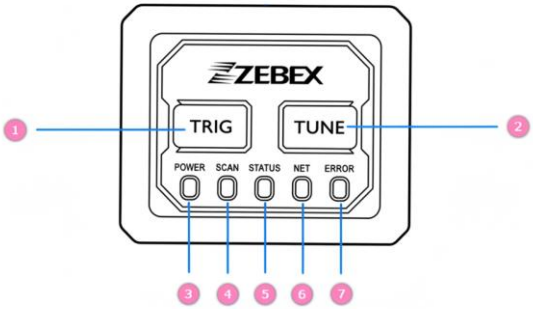
- **Smart Tuning**: One-click **auto-focus**, exposure, and gain for rapid setup.
- **AI Engine**: Deep learning algorithms perform complex tasks with minimal samples.
- **Flexible Optics**: Multiple lens options supporting distances from **100mm to 1000mm**.
- **Integrated Lighting**: Independent White LEDs with **polarization** for reflective surfaces.
- **Industrial Grade**: Multiple **I/O** channels with **IP67** durability.

Product Overview



#	Component	Function
1	**Lens**	Captures images
2	**Standard Light Source**	Provides fill light for image acquisition; optional Red/White LEDs
3	**Targeting Light**	Indicates the center of the image for easy target aiming
4	**Mounting Holes**	Used for camera installation
5	**TRIG Button**	Manual trigger key
6	**TUNE Button**	Smart parameter auto-tuning key
7	**Indicator Lights**	Indicator display panel
8	**M12-12PIN Interface**	Provides power, Serial (RS-232), and I/O functions
9	**M12-8PIN Interface**	Provides network transmission functions

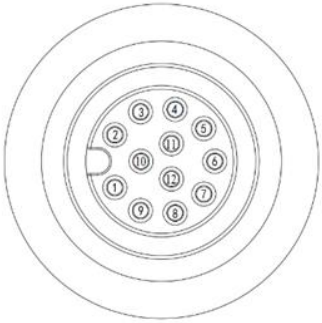
Control Panel Description



#	Component	Function
1	**TRIG Button**	Manual trigger key
2	**TUNE Button**	Smart parameter auto-tuning key
3	**POWER LED**	Solid green when the device is operating normally
4	**SCAN LED**	Solid green upon successful trigger or button press
5	**STATUS LED**	Green for "Pass" (OK), Red for "Fail" (NG)
6	**NET LED**	Solid green for normal communication; flashes during data transmission
7	**ERROR LED**	Off by default; solid red if a device fault occurs

Interface Definition

M12-12 Pin Male Interface



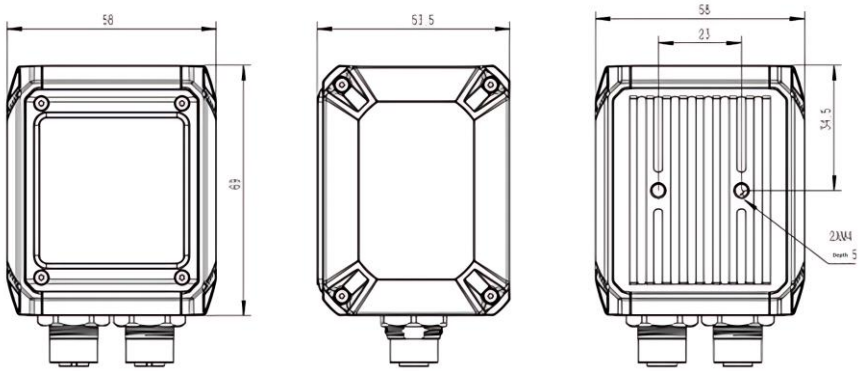
Pin	Signal Name	Cable Color
1	**RS232_TXD**	Green/White
2	**LINE_OUT2**	Yellow
3	**OUT_COM**	Green
4	**DGND**	Black
5	**VIN 24V**	Red
6	**IN_COM**	White
7	**LINE_IN1**	Purple
8	**RS232_GND**	Brown
9	**RS232_RXD**	Blue/White
10	**LINE_IN0**	Orange
11	**LINE_OUT1**	Gray/White
12	**LINE_OUT0**	Blue
13	**Shield (GND)**	Transparent

Accessories

Please prepare the following items before installation:

- **Dedicated Cable (M12-12PIN)**: Provides power, RS-232, and I/O functions. Length options: 3m.
- **Dedicated Ethernet Cable (M12-8PIN)**: Provides network transmission. Length options: 3m.
- **Power Supply**: 24V DC power adapter (optional).
- **L-shaped Mounting Bracket**: Includes fixing screws.

Product Dimensions



Vision Camera Setup Workflow

1. **Device Installation & Wiring**: Complete the physical mounting of the camera and all electrical connections.
2. **Configure Camera Parameters**: Adjust **Exposure**, **Gain**, and **Focus** to ensure clear images with distinct contrast between "Pass" and "Fail" items.
3. **Register Master Sample**: Capture an image of a confirmed **OK** product to serve as the **Master Image** (inspection baseline).
4. **Set Up Inspection Tools**: Configure algorithm tools on the image (e.g., **Area**, **Count**, etc.) and define the judgment threshold values.
5. **Output Settings**: Configure result output via **I/O** signals or communication protocols.
6. **Testing & Deployment**: Perform live testing before officially starting production line operation.

Device Installation and Connection

Mounting Distance and Field of View (FOV)

Please select the appropriate model and mounting distance based on your inspection requirements. The following table provides the Field of View (FOV) specifications for various focal length lenses (Unit: mm):

Focal Length Field of View Specifications

Focal length (mm)	Working distance (mm)	Horizontal (mm)	Vertical (mm)
8	100	72	45
8	200	144	90
8	300	216	135
8	400	288	180
8	500	360	225
8	600	432	270
8	700	504	315
8	800	576	360
8	900	648	405
8	1000	720	450

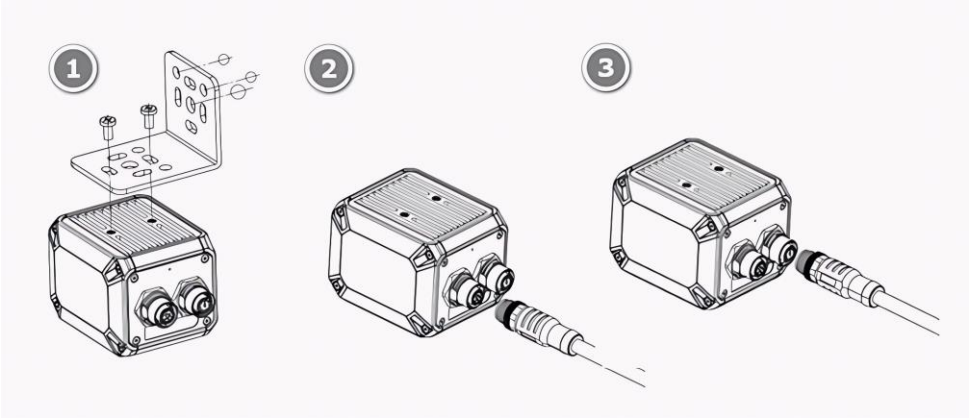
Device Installation

Hardware Installation Instructions

1. **Bracket Mounting**: Secure the **ZX-4020** main body to the **L-shaped bracket** using **M4 screws**, then firmly lock the other end of the bracket onto the automation mechanism.

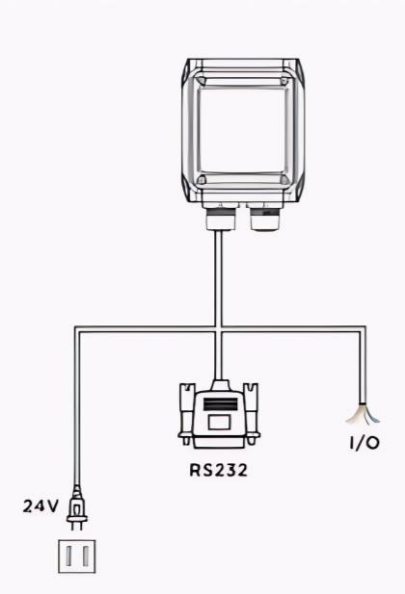
2. **Power Wiring**: Referring to the **Pin Definition** in the previous chapter, connect the **M12-12PIN cable set** to a suitable switching power supply (24V DC / 3A recommended).

3. **Network Connection**: Use the dedicated **M12 to RJ45 Ethernet cable** to connect the camera to a **Switch** or a computer's network interface card (NIC).

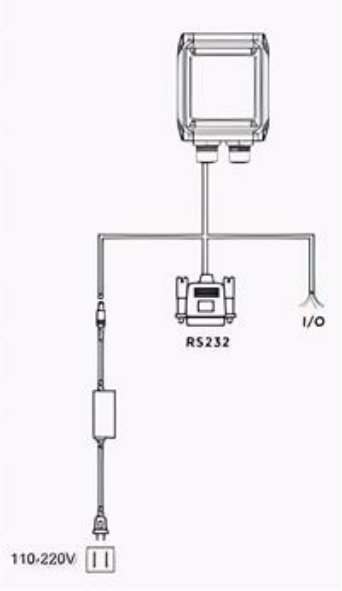


Power Connection Specifications

- **Rated Input**: 24V DC (3A Max).
- **Power Options**: 24V DC direct wiring or 100V~220V AC via dedicated power adapter.



Direct External DC Power: 24V DC



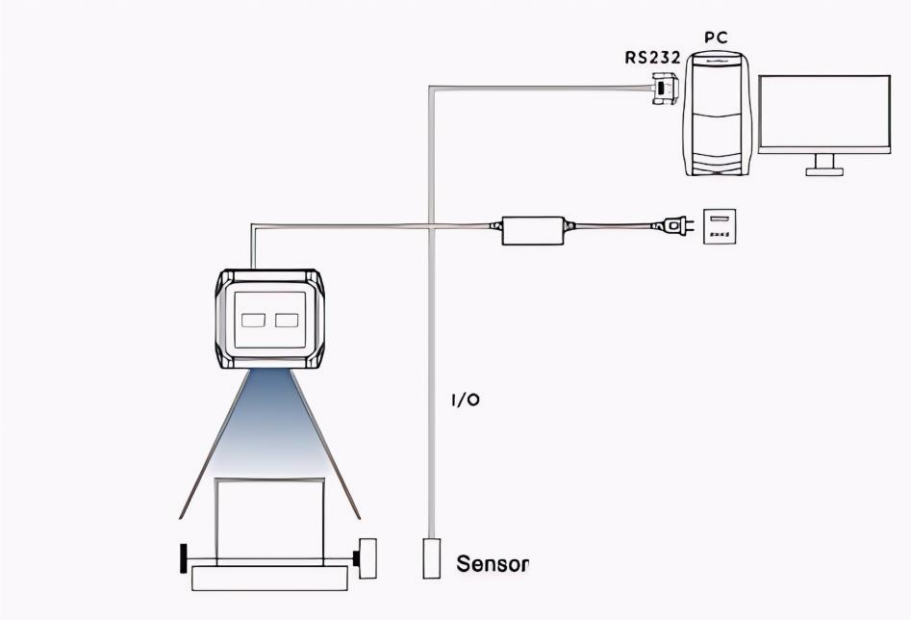
Direct External AC Power: 100–220V AC (Converted to 24V DC via power adapter)

Communication Settings

RS-232 Connection

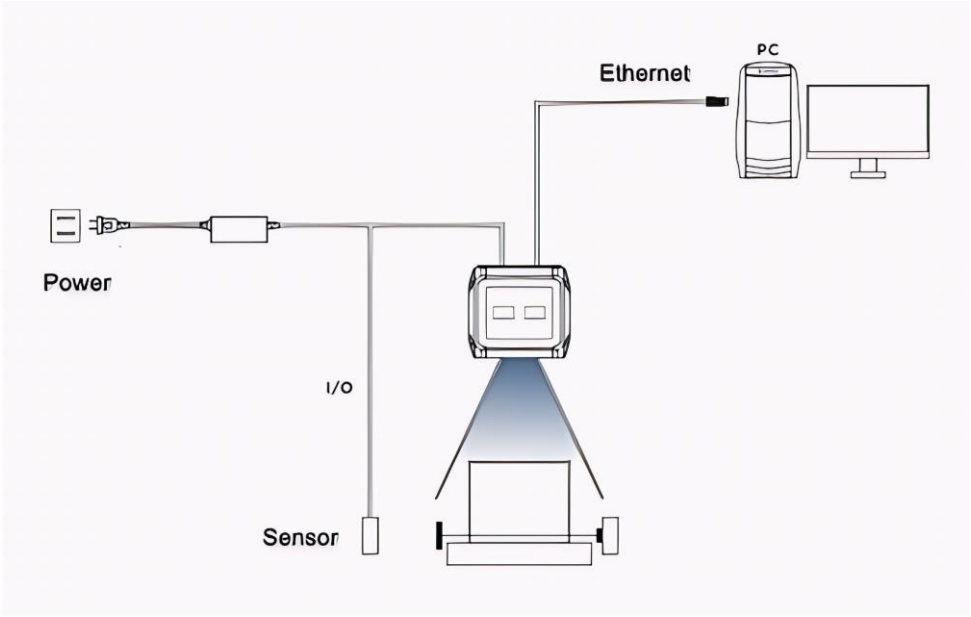
Default Parameters：

- **Baud rate**: 9600
- **Data bits**: 8
- **Stop bits**: 1
- **Parity**: NONE
- **Modification**: All parameters above can be modified via the client software.



Ethernet Connection

- **Default IP Address**: 169.254.153.0
- **Default Port**: 15000
- **Suggestion**: If the device is not found, ensure the computer and camera are on the same network segment.



I/O Electrical Characteristics & Wiring

I/O Electrical Characteristics

Among the device I/O signals, LINE_IN 0/1 are optocoupler isolated inputs, and LINE_OUT 0/1/2 are optocoupler isolated outputs.

Input Specifications

Parameter	Symbol	Specification
Input Low Level Limit	V_{OL}	6V
Input High Level Limit	V_{OH}	12V
Fall Time Delay	T_{DF}	1.3 μs
Rise Time Delay	T_{DR}	35 μs

Output Specifications

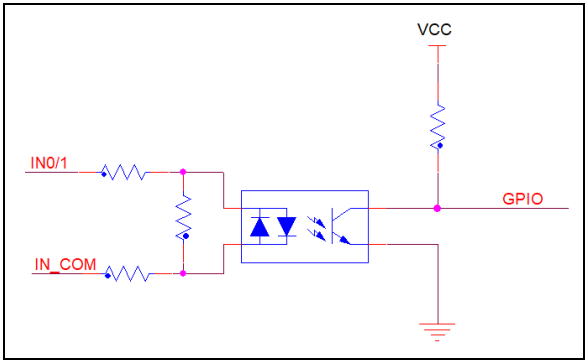
Parameter	Symbol	Specification
Output Logic Low Level	V_{OL}	0.7V (Max)
Output Logic High Level	V_{OH}	Dependent on Pull-up Resistor
Output Fall Time Delay	T_{DF}	7.5 μs
Output Rise Time Delay	T_{DR}	141 μs
Output Fall Time	T_F	12.6 μs
Output Rise Time	T_R	157.8 μs

Note: Logic High/Low represent input voltage thresholds; Rise/Fall delay represent response performance.

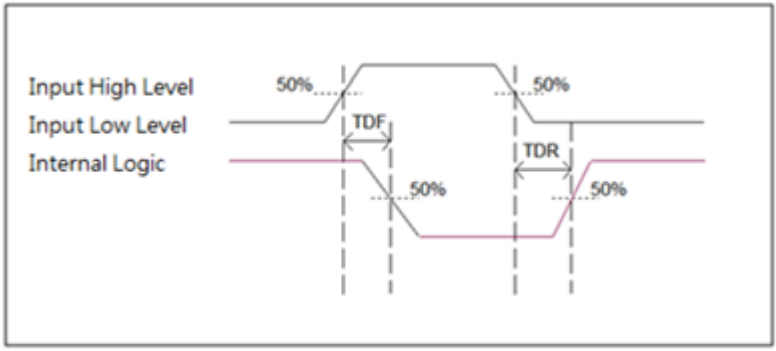
Input Internal Wiring Diagram

Input Signals

- **LINE_IN 0/1** are optocoupler isolated inputs.
- **Input Voltage Range**: 0–24V DC.
-



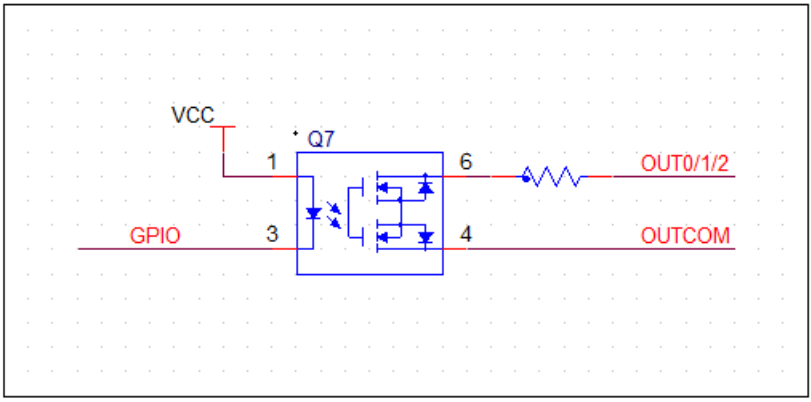
Input Circuit Diagram



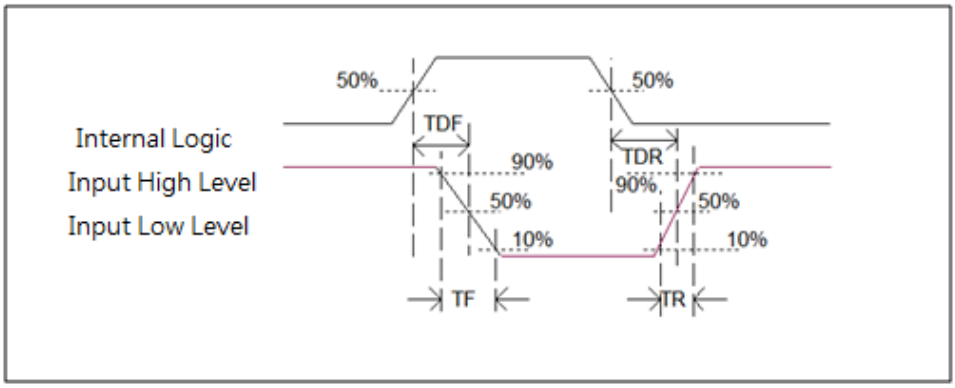
Input Logic Level Diagram

Output Signals

- LINE_OUT 0/1/2 are optocoupler isolated outputs. Maximum VCC driving voltage: 28V. Output current: Must not exceed 30mA.
- Note: Inductive loads are not supported.



Device Output Circuit Diagram

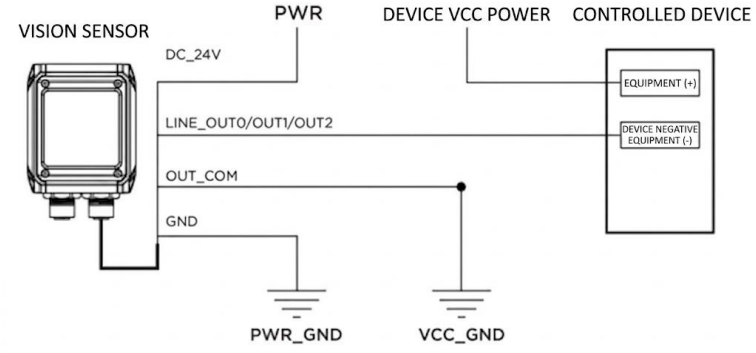


Output Logic Level Diagram

Output External Wiring Diagram

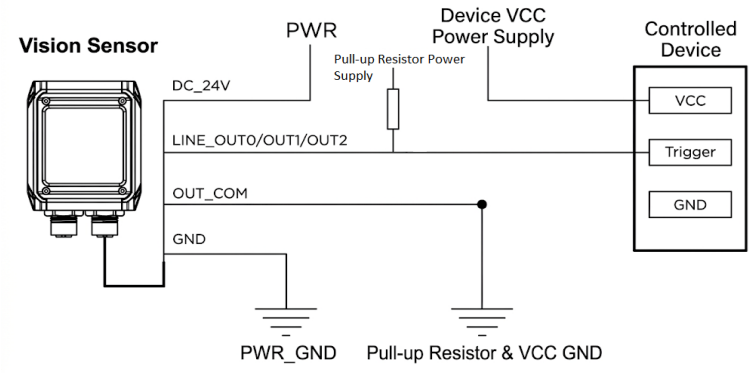
Wiring methods vary depending on the type of external device connected.

- External devices requiring direct circuit control: Such as optocouplers, alarms, or indicator lights.



Note: Driving inductive loads (e.g., relays, motors) is strictly prohibited. The output load current must meet product specifications (use series current-limiting resistors if necessary).

- External devices responding to logic high/low levels.



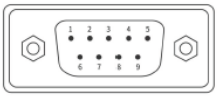
Notes:

1. **TRIGGER Pin Voltage**: Measure the device TRIGGER Pin. If voltage is present, an internal pull-up resistor exists; no external resistor is needed. Ensure this voltage is ≤ 28V.
2. **External Pull-up**: If no voltage is present, confirm the target device's input range. The pull-up supply must be ≤ the target's max input and strictly < 28V to avoid hardware damage.
3. **Resistor Calculation**: Select resistance based on P=U2/R. Ensure actual power is below the resistor's rated power to prevent burnout.

RS-232 Port

The device supports RS-232 serial output. The pin definitions for a standard 9-pin Male RS-232 connector are shown below.

9-pin Male Connector Pinout



Pin	Function	Description
2	**RX**	Data Receive
3	**TX**	Data Transmit
5	**GND**	Signal Ground

Note: The above definitions are for the male connector. Ensure orientation is correct during wiring.

Client Installation & Operation

Client Software

Minimum PC OS & Hardware Requirements

Please run the client software on a PC meeting or exceeding the following specifications:

Item	Requirement
OS Version	Windows 7 or later
System Architecture	64-bit OS
Memory (RAM)	4GB minimum
Disk Space	64GB minimum

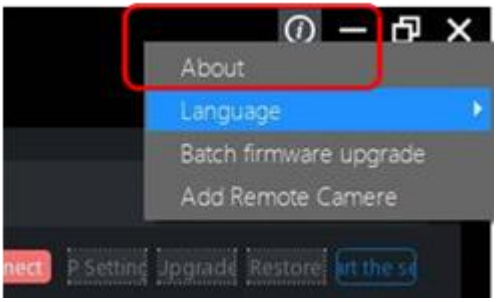
Software Installation Procedure

- Decompress the software package, locate the corresponding executable (.exe), and run to start.

Note: If a missing .dll error occurs on first launch, locate and install vc_redist.x64.exe in the software installation path, then restart the application.

Check Software Version

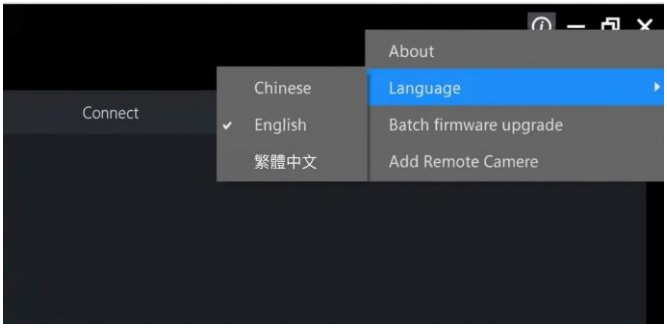
- Click the "**Info**" icon in the top-right corner to display software details in a pop-up window.



Supported Languages

The client software supports Chinese, English, and Traditional Chinese.

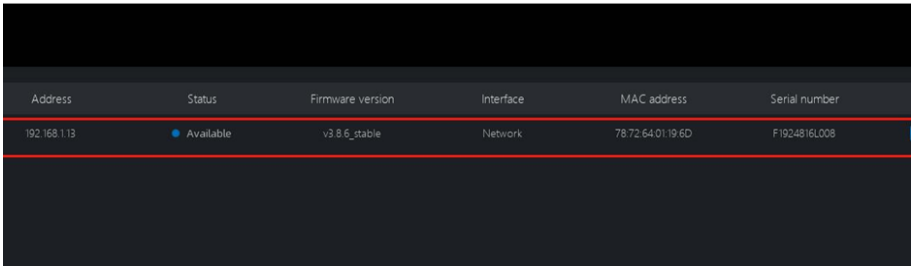
- Click the "**Info**" icon in the top-right corner to select and switch the language.



Connecting the Vision Camera

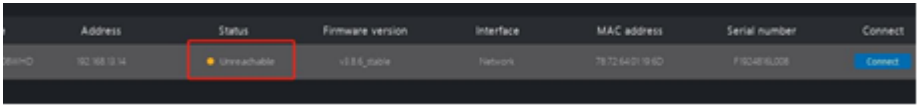
Search and Connect

1. **Launch Software**: Open the host application.
2. **Device Management**: Upon startup, the Device Management page appears. If the vision camera is correctly wired, connected to the PC, and the network is stable, the device will appear in the list.
3. **Connected Status**: If the camera and PC are on the same subnet, the status will show as "Idle." Click "**Connect**" to establish communication.
4. **Unreachable Status**: If the camera and PC are on different subnets, the status will show as "Unreachable." Modify the camera's IP settings or the PC's IP address to ensure they are on the same subnet.



Vision Camera IP Settings

1. **Select IP Settings**: Locate the corresponding vision camera in the device list and select "IP Settings."



2. **Configuration Modes**: The camera supports DHCP (Auto-obtain IP) and Static IP (including "One-Click Match" functionality).





Change PC IP Address

Steps (Windows 10 example):

1. **Navigate**: Go to Start > Settings > Network & Internet > Ethernet > Change adapter options.
2. **Select Adapter**: Right-click the relevant network adapter (e.g., "Ethernet 3") and select Properties > Networking > Internet Protocol Version 4 (TCP/IPv4).
3. **Configure**: Modify the IP address settings to ensure the PC is on the same subnet as the vision camera.

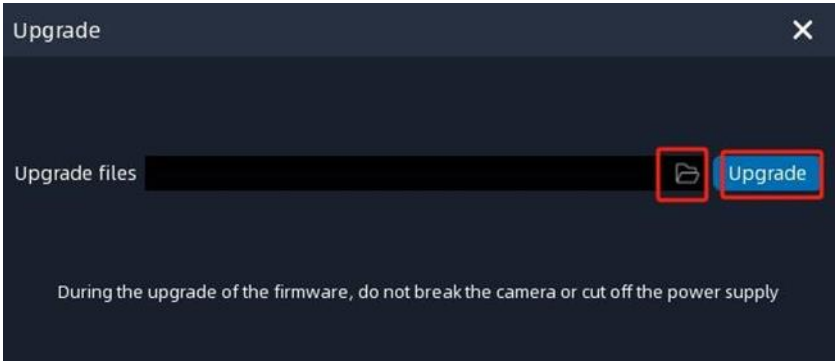
Firmware Update

Update Single Device

1. Select Firmware Update: Locate the target device in the device list and select "**Firmware Update**."

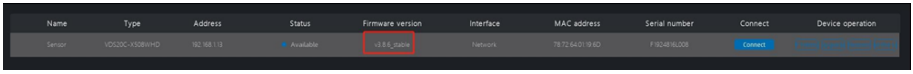


2. Select & Update: Click the folder icon to select the firmware file, then click "**Update**."



3. **Reboot**: The device will automatically restart upon completion. Wait a moment for the upgrade to finish.

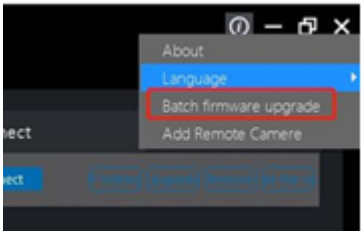
4. **Verify**: Confirm the "Firmware Version" in the "Device Management" interface has been updated.



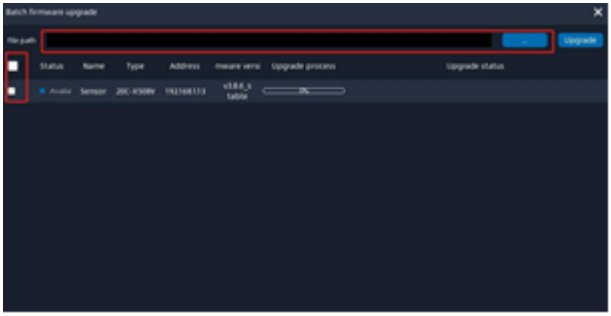
Note: Host software and vision camera firmware are version-dependent. Mismatched versions may cause instability. Ensure software and firmware versions are synchronized after any update.

Batch Firmware Update (Update multiple devices)

1. **Open Batch Update**: Click the icon in the top-right corner and select "Batch Firmware Update."



2. **Execute Update**: In the batch update interface, select the "File Path" of the firmware, check the devices to be updated, and click "Update." The interface will display real-time upgrade progress and status.



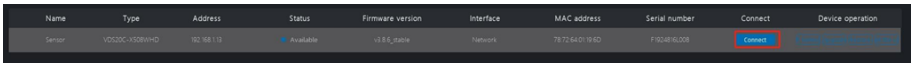
Note: Host software and vision camera firmware are version-dependent. Mismatched versions may cause instability. Ensure software and firmware versions are synchronized after any update.

Software Features

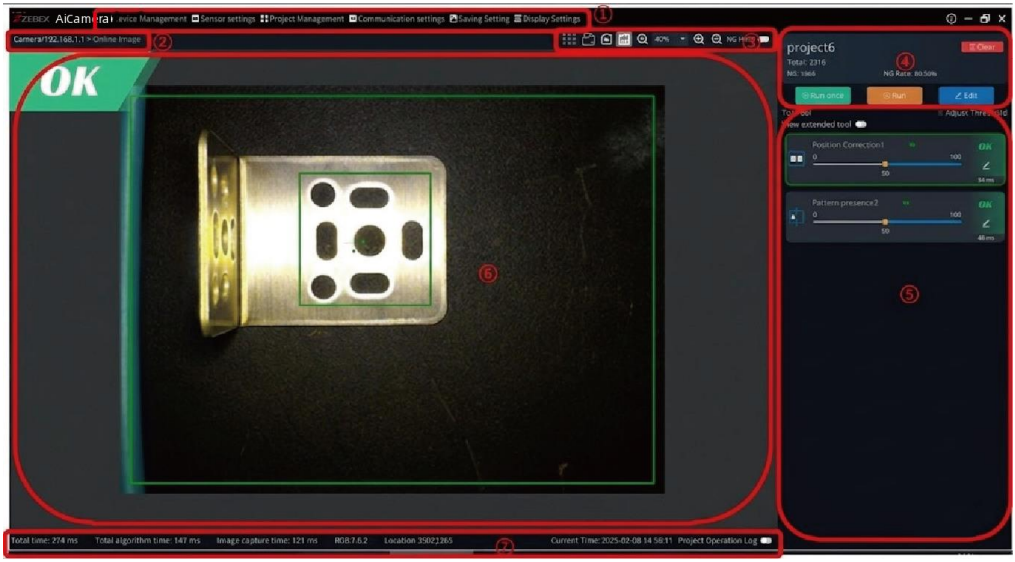
Main Interface

The ZX-4020 is operated via the host PC software. Follow these steps:

1. Connect Device: In the Device Management interface, locate your device and click "Connect" to establish communication.



2. Access Main Interface: Once connected, the device's Main Interface will appear (as shown below). Refer to the following sections for detailed module descriptions.



#	Functional Module	Description
1	**Menu Bar**	Controls basic camera settings.
2	**IP Address**	Displays the network address of the connected device.
3	**View Toolbar**	Controls image zoom, saving, offline testing, and display functions.
4	**Current Solution**	Displays solution name and status; controls start, stop, and editing.
5	**Tool List**	Displays operational status and all configuration tools in the solution.
6	**Preview Window**	Previews image acquisition and algorithm results; used for ROI drawing.
7	**Execution Time Bar**	Displays solution execution time, RGB values, and pixel coordinates at mouse position.

Quick Start Workflow

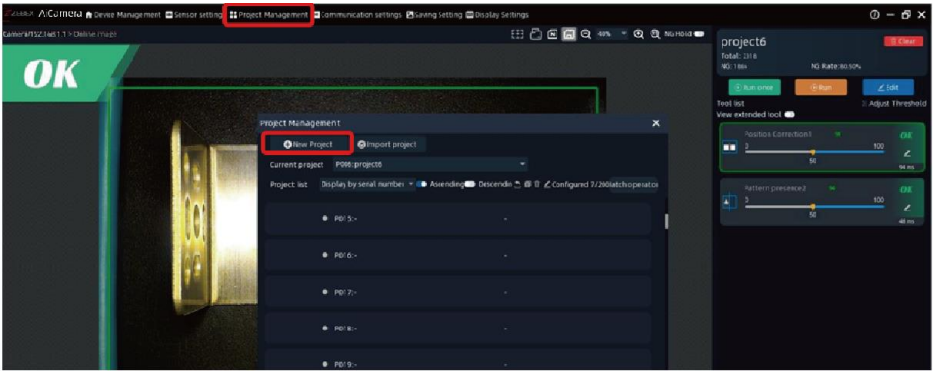
To fully configure an inspection solution, the vision camera must be set up via the client software following these steps:

#	Step	Description
1	**New Solution**	Create a new inspection solution.
2	**Solution Configuration**	Configure the following based on inspection needs: • Set imaging effects and trigger modes. • Configure the master template image. • Select and configure algorithm tools. • Set result output methods.
3	**Communication Setup**	Use I/O or network communication to link the camera with external devices for triggers or data output: • **I/O Mode**: Complete physical I/O wiring. • **Network Mode**: Configure communication parameters. Perform joint debugging with external hardware after setup.
4	**Test & Debug**	Run live inspections to verify if detection results meet expectations.
5	**Image Saving/Offline Test**	(Optional) Use the image saving function to record captures during errors or anomalies for later solution optimization.
6	**Export & Import**	(Optional) Export the verified solution and import it into other vision cameras for deployment.

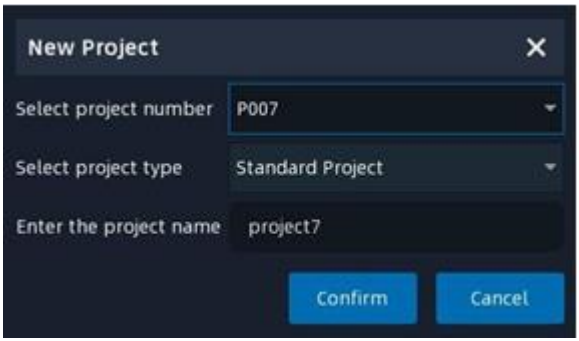
Solution Creation Steps

Using "Presence/Absence Detection" as an example:

1. Enter Management Interface: Click "**Solution Management**" and select "**New Solution**."

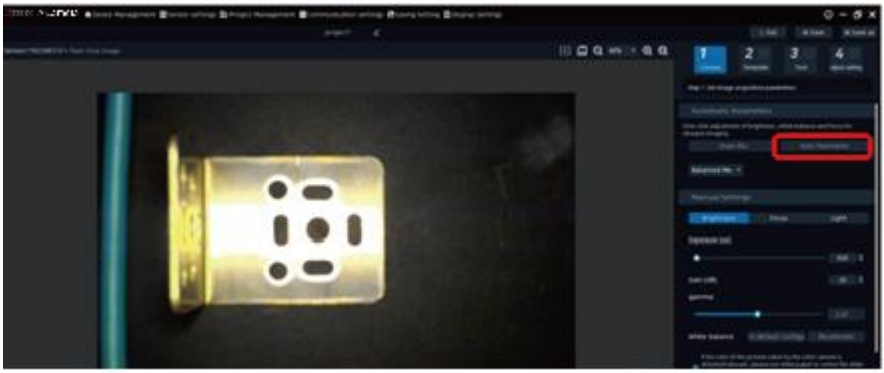


2. **Name the Solution**: In the pop-up window, select a solution number, enter a name, and click Confirm to enter the configuration interface.



3. **Image Tuning:**

- Place the target object within the field of view (FOV).
- Click "**One-Click Tune**" to automatically optimize focus, exposure, and white balance.



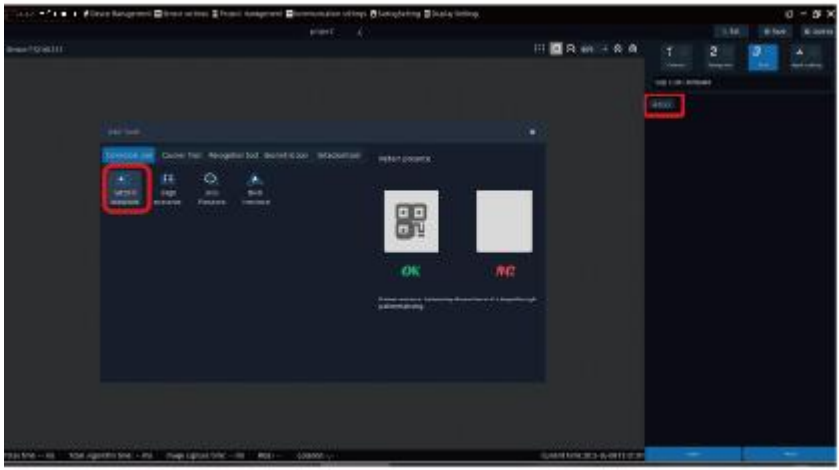
4. **Set Trigger**: Select the trigger mode (e.g., External Communication), and set the corresponding trigger string (e.g., default value "ABC").



5. **Register Template**: In configuration step 2, click the "**+**" icon to register the current qualified sample image as the reference benchmark, then click Next.



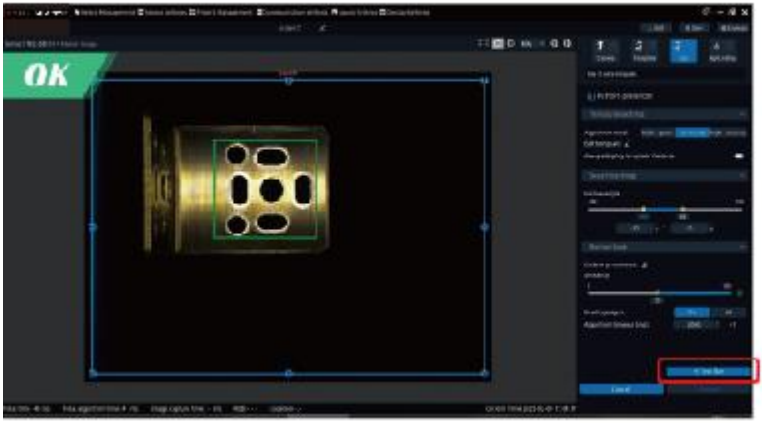
6. In step 3 of the solution configuration, click the "**+**" icon and select the required tool from the tool list. This example uses the "Pattern Recognition (Presence Detection)" tool. Upon selection, the system enters the tool configuration interface.



7. Within the "**Presence Detection**" configuration interface, drag the orange ROI frame in the Preview Window to select the target pattern for detection.



8. In the Parameter Configuration interface, adjust settings as needed, then click "**Test Run**" to verify results. Click "**Confirm**" once the tool configuration is complete.



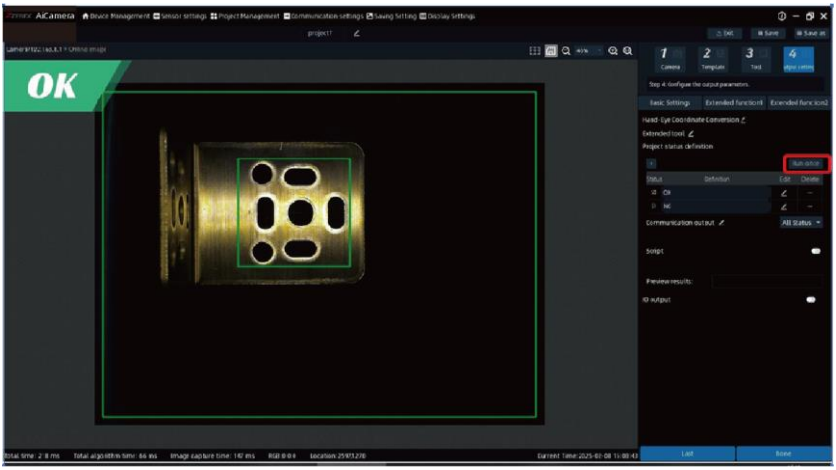
9. After setting up the "Presence Detection" tool, click "**Next**" to proceed to step 4 for output configuration. This example uses Network Communication for data output. Select "All Status" under "Communication Output," then click "**Edit**" to define specific output content.



10. In the Communication Output interface, click the "**+**" icon to select the items for external output.

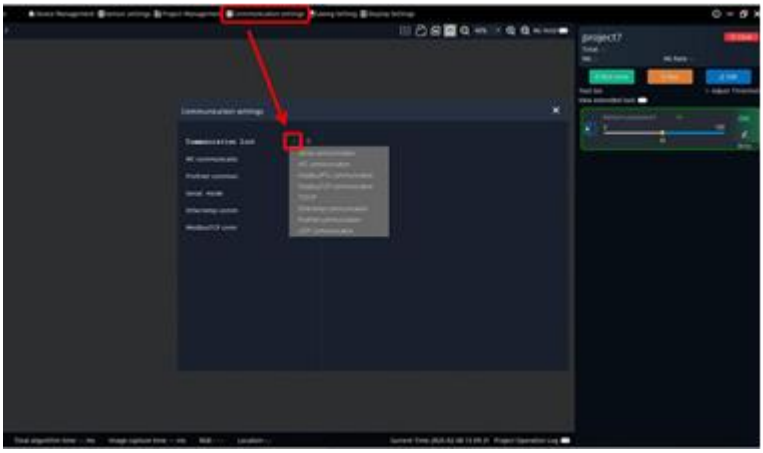


11. After configuring the output, debug the solution results. Click "**Run Once**"; the corresponding result will appear in the bottom-left corner of the image. Once verified, click "**Finish**" to exit the configuration.

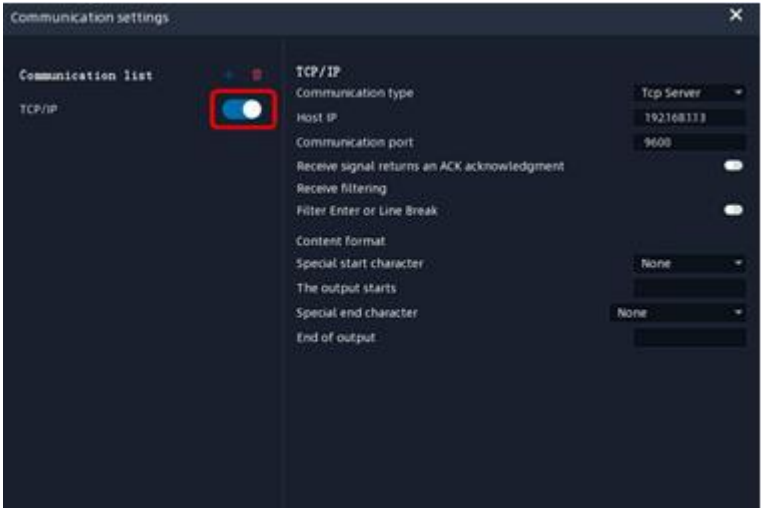


Note: Internal configuration is now complete. The following steps cover external communication setup and debugging.

12. Return to the Main Interface and click "**Communication Settings**" on the toolbar. Click the **"+"** icon; this example uses the TCP/IP protocol.

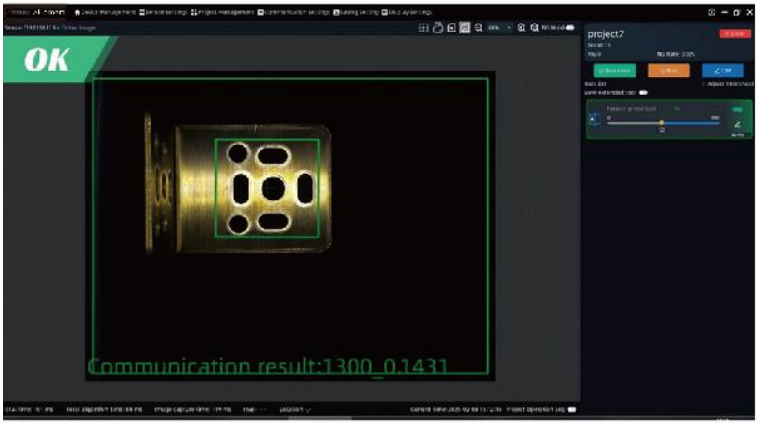


13. Select TCP/IP and configure it according to the specifications. After setup, click "**Start**" to enable communication with external devices.

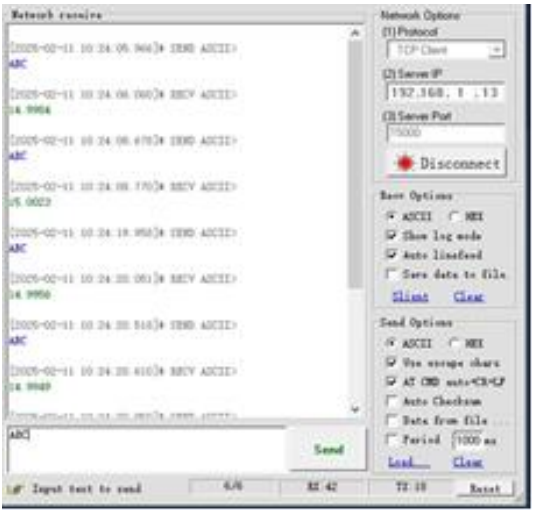


Note: For detailed communication settings, refer to the subsequent chapters.

14. Click "**Start Run**" on the Main Interface. The solution will enter the operating state and await a trigger signal.

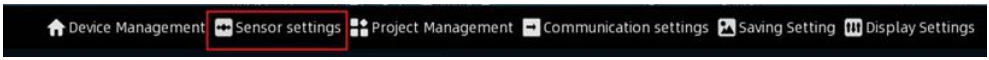


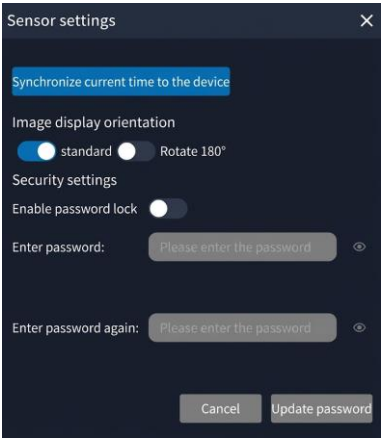
15. Connect an external device (e.g., PLC, IPC) to the vision camera. Use communication debugging software to connect and send the trigger command. As shown below, sending the trigger string "ABC" executes the solution and retrieves the inspection results. This concludes the solution configuration and debugging process.



Basic Sensor Settings

Click "**Sensor Settings**" in the menu bar to adjust the following device parameters:





- **Time Sync**: Click "Sync Current Time to Camera" to ensure the device system time matches real-time, essential for logging production timestamps.
- **Image Orientation:**
    - Options: "Standard" and "Rotate 180°".
    - Note: The coordinate system (algorithm origin) is fixed at the top-left of the image and does not change with the display orientation.

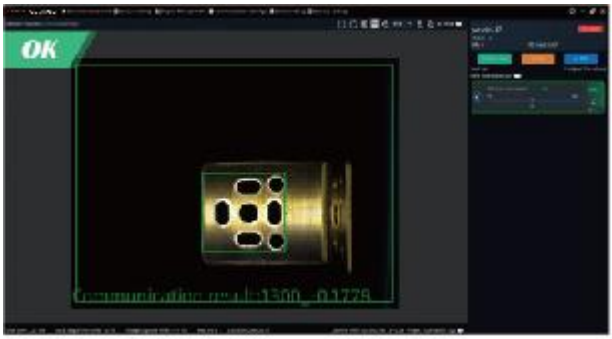
- **Security Settings (Password Lock):**
    - Enable to set a user password.
    - When locked, functions like "Clear Data" and "Edit Solution" are disabled to prevent accidental modifications by operators.
    - Click the unlock icon and enter the password to restore editing permissions.

Image Orientation Example

1. **Standard**: Captured image appears in default orientation.



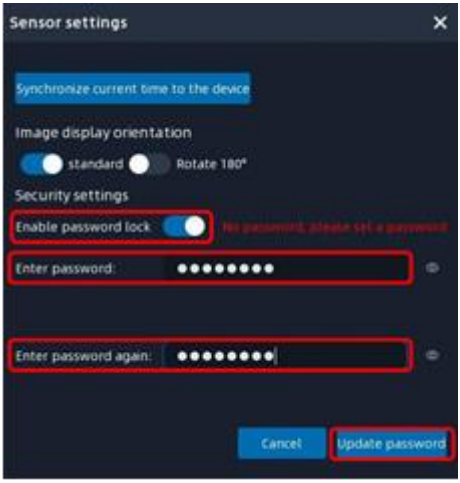
2. **Rotate 180°**: With the camera and target fixed, the image flips 180°.



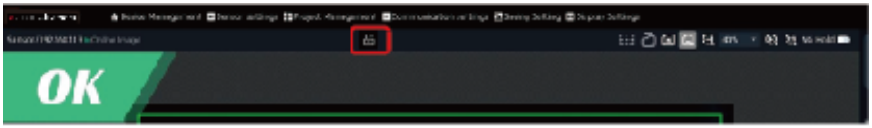
Note: Regardless of orientation settings, the coordinate origin (0,0) for tool calculations and position output always remains at the top-left of the image.

Security Settings - Enabling Password Lock

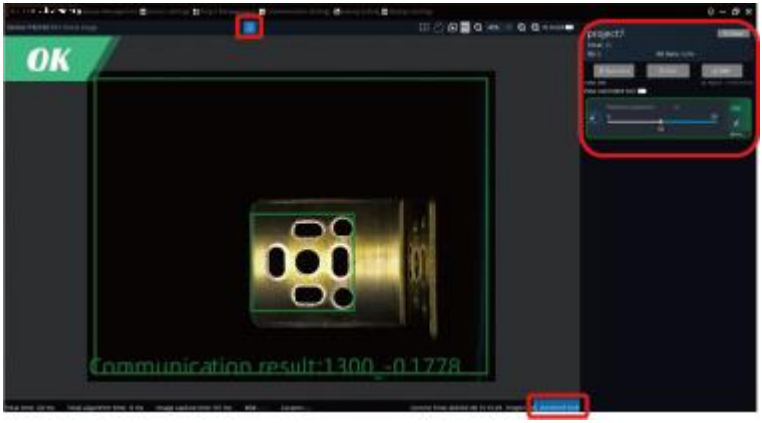
1. **Enable**: Toggle "**Enable Password Lock**," set a password, and click "Update Password."



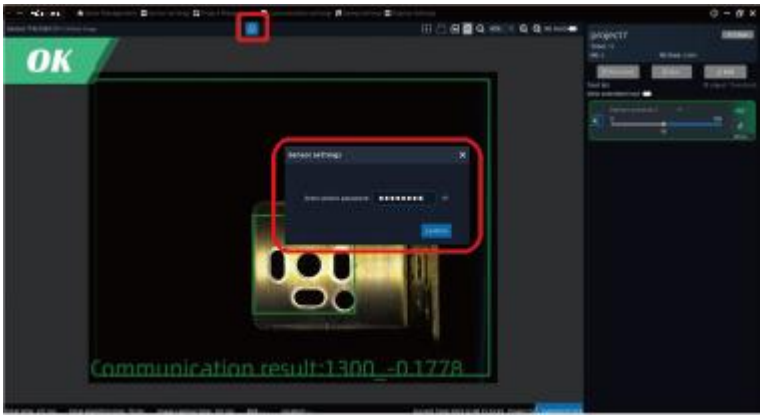
2. **Lock Icon**: Once enabled, a lock button appears in the view toolbar.



3. **Locked State**: Clicking the lock button switches the interface to "Password Locked." Configuration functions (e.g., "Clear Data" or "Edit Solution") are disabled.



4. **Unlock**: Click the unlock button, enter the password, and confirm to restore access.



Project Management

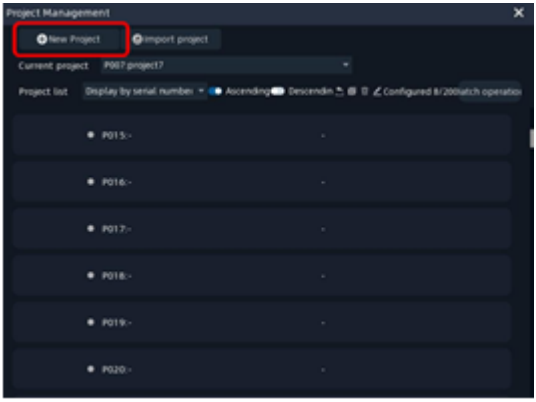
Create New Project

The first step in establishing an inspection task to distinguish between different production lines or products.

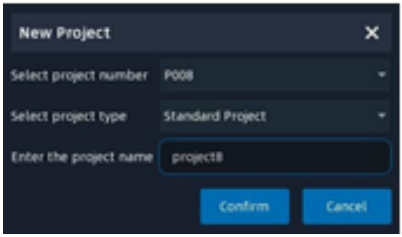
1. Open the "**Project Management**" menu in the software.



2. Click "**New Project**" and select an empty slot (IDs 1–200).



3. Enter a custom name (e.g., project8) and confirm.



Project Configuration

The core setup stage that determines what the camera "sees" and how it "judges."

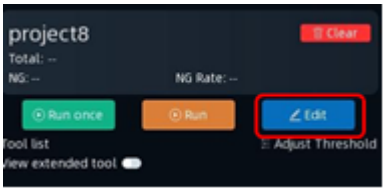
- **Image Tuning**: Place the workpiece and click "One-Click Tune" for auto-focus and auto-exposure to ensure image clarity.
- **Set Trigger**: Define image acquisition timing (e.g., continuous capture or single shot upon signal).
- **Base Template**: Frame a "qualified sample" area as the comparison benchmark.
- **Tool Selection**: Drag tools like "Pattern Presence," "Code Reading," or "Measurement" from the toolbox and adjust judgment thresholds.

After confirming the new project name, the software enters the "Project Configuration" interface.

Edit Project

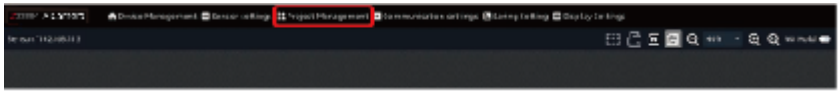
Method 1:

- On the main interface, click the "**Edit**" button next to the "Current Project."

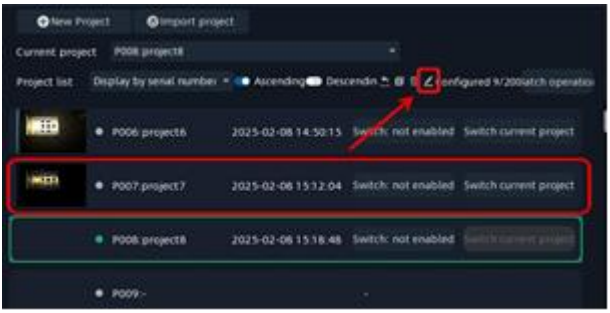


Method 2:

1. Click "**Project Management**."



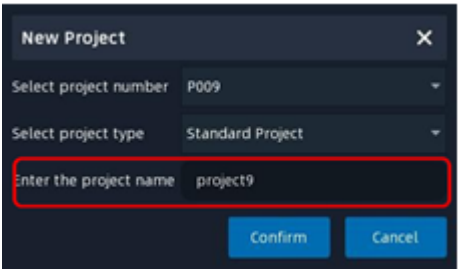
2. In the pop-up window, select the target project and click "**Edit**."



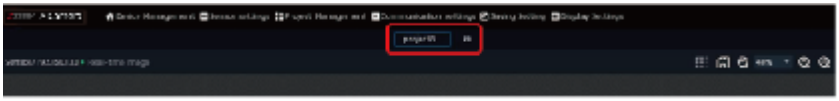
Configure Project Name

Note: Duplicate project names are not allowed on a single device. A prompt will appear if the entered name conflicts with an existing project.

- You can specify the name when creating a new project.



- The name can also be modified during the editing process.

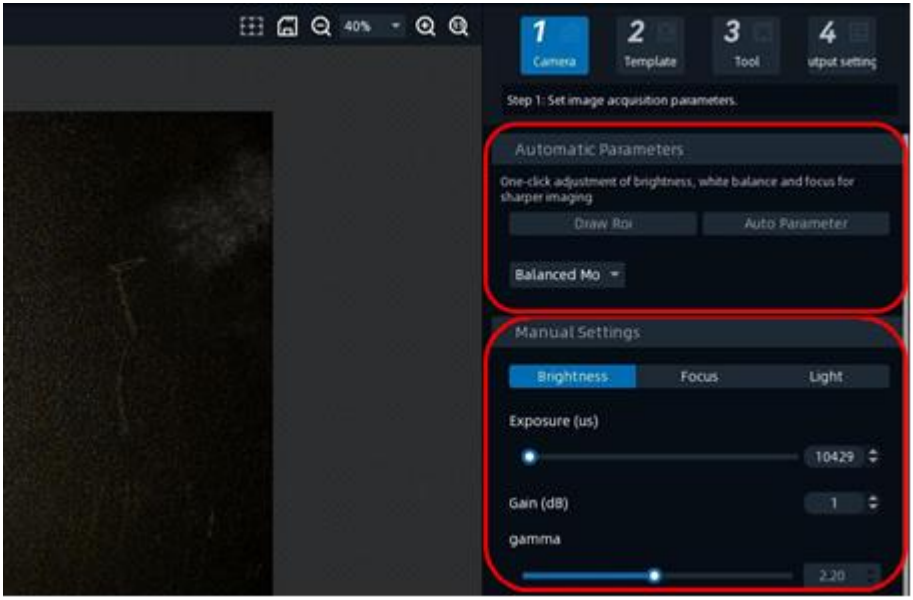


Camera Debugging

The first configuration step is "Camera Debugging," which involves two tasks:

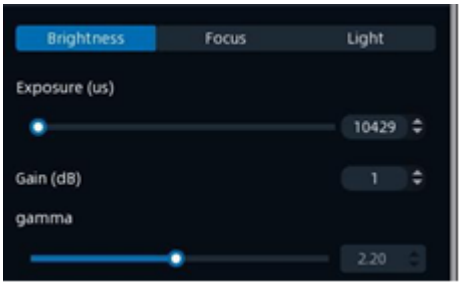
- **One-Click Tune**: Analyzes the full FOV to optimize focus and imaging.
- **ROI Drawing**: Optimizes parameters specifically for a selected local area.

Adjusting Imaging Parameters

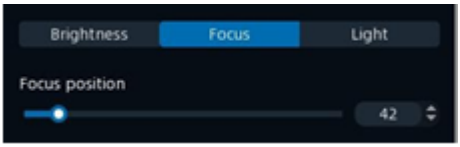


- **Auto Adjustments:**
    - **One-Click Tune**: Analyzes the full FOV to optimize focus and imaging.
    - **ROI Drawing**: Optimizes parameters specifically for a selected local area.

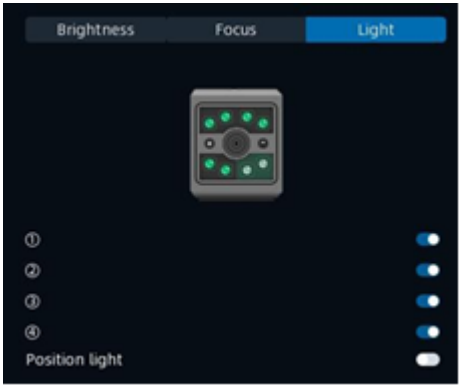
- **Manual Settings:**
  - **Brightness**: Adjust Exposure (us), Gain (dB), and Gamma.



  - **Focus**: Manually fine-tune focus via the slider.



  - **Lighting Control**:

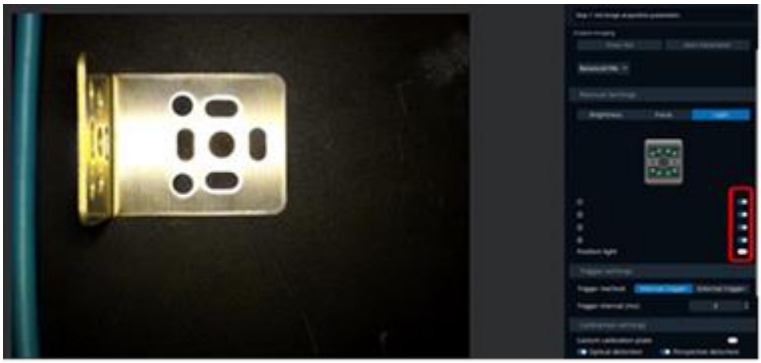


    - Supports four independent light groups.
    - **Polarization**: On semi-polarized models, Groups 1 & 2 are non-polarized; Groups 3 & 4 are polarized. To reduce glare on reflective surfaces, turn off Groups 1 & 2 and use only Groups 3 & 4. (Manual

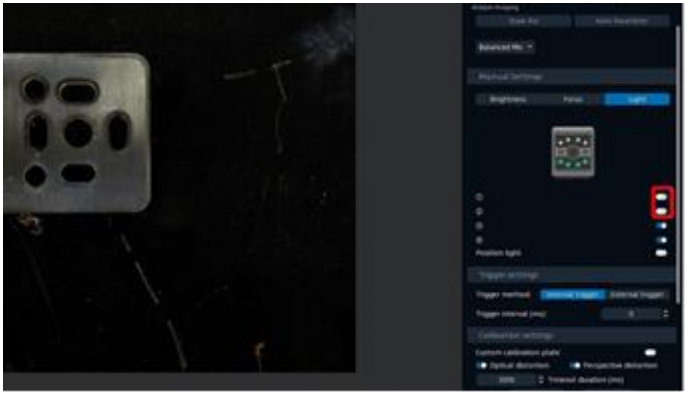
brightness adjustment may be required after disabling groups).

Note: For "semi-polarized" models, Groups 1 & 2 are non-polarized, while Groups 3 & 4 are polarized. To reduce overexposure on reflective surfaces, turn off Groups 1 & 2 and use only Groups 3 & 4 (manual brightness adjustment may be required).

- **All Lights On**: Reflective background causes overexposure.



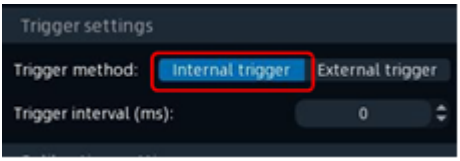
- **Groups 1 & 2 Off**: Overexposure is reduced after disabling non-polarized lights and increasing brightness.



Project Trigger Settings

Set image acquisition timing in Camera Debugging:

- **Internal Trigger**: Auto-triggers without external signals. Set Trigger Interval (rest time between runs, default 0ms).



- **External Trigger**: Runs on external signals.
- **I/O Trigger**: Signals from photo-cameras or PLCs via physical wiring.



- **Communication Trigger**: Network commands from PC/PLC. Supports custom Trigger Strings (e.g., "ABC") and Trigger Delay.

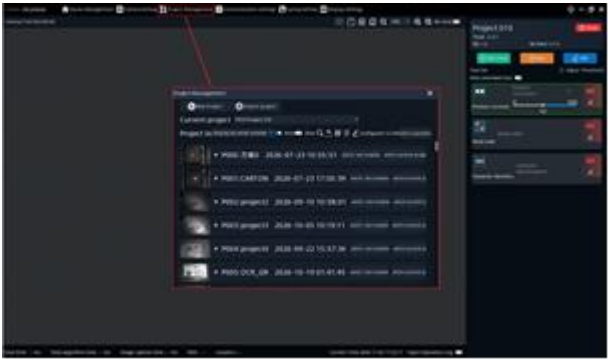


External Communication Project Switching

Each camera supports storage for up to **200 recipes (projects)**. You can configure the system to switch between projects automatically via network commands, hardware I/O triggers, or manually through the user interface.

Accessing Switch Settings

1. In the main menu bar, click "**Project Management**" to open the *Project Management* screen.



2. Locate the target project in the **Project List** and click **Switch Settings** on the right side of the row. The *External Communication Switch* configuration window will appear.



3. From the **Switch Mode** drop-down menu, select one of the following modes:

   - **Off**: Disables external project switching for this recipe.
   - **IO Switching**: Switches projects using a hardware digital input signal.
   - **Communication Switching**: Switches projects via a network command string.



Configuration Methods

Method A: Communication Switching (Network Command)

Use this mode when an external device (such as a PLC or PC) triggers project changes by sending a command string over the network.

Parameter	Description & Configuration
Project Switching String	Enter the exact string the external device will transmit to activate this project (e.g., P001).
Use Hex Switching	Enable this option if the command string includes non-printable control characters such as CR (Carriage Return), LF (Line Feed), STX, or ETX. Enter the entire string in ASCII hexadecimal format. *(Example:* "P001" + CR *is entered as* 503030310D*)*
Communication Success Response	Define the acknowledgment string sent back to the external device when the project switch succeeds (e.g., Pass or OK).
Communication Failure Response	Define the error string sent back to the external device if the project switch fails (e.g., Fail or NG).

Operation: Click **Save** to apply the settings. When the camera receives a matching command string over the network, it automatically loads the corresponding project and returns the configured response string.

Method B: IO Switching (Hardware Trigger)

Use this mode to switch projects automatically when an external device sends a digital signal to the camera's I/O port.

Set **Switch Mode** to **IO Switching**.

1. From the **Trigger Source** drop-down menu, select the designated digital input line (e.g., LINE_IN0 or LINE_IN1).
2. Click **Save** to apply the configuration.

Note: The camera detects both **rising-edge** and **falling-edge** transitions on the selected input line to trigger the project switch immediately.

Method C: Manual Switching (Software UI)

When external switching is not required, you can change the active project directly within the software using either of the following methods:

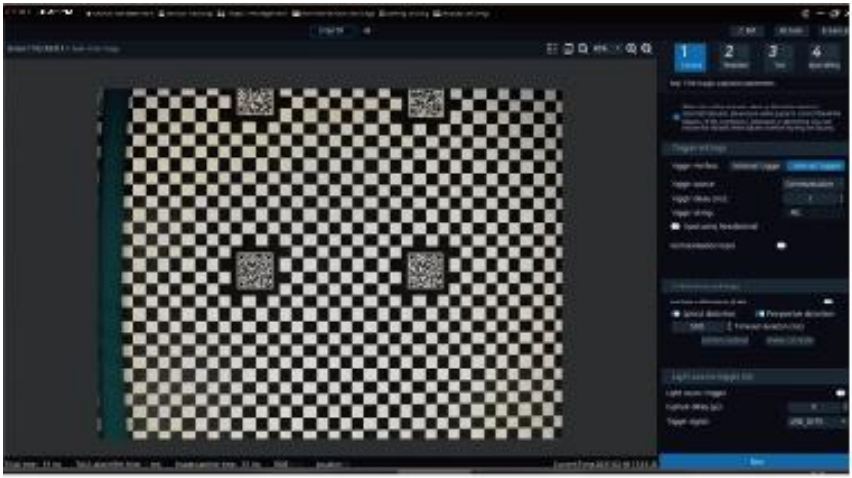
Select the desired recipe from the **Current Project** drop-down menu in the top toolbar.

- Navigate to the **Project List** and click **Switch Current Project** next to the target recipe.

Coordinate Calibration

Converts pixels to physical units for high-precision tasks:

- **Calibration Plate**: Uses checkerboard; input row/column counts and grid size.
- **Distortion Correction:**
    - **Optical Distortion**: Fixes image offset between the lens center and edges.
    - **Perspective Distortion**: Fixes deformation (e.g., keystone effect) from non-perpendicular mounting angles.
    - **Preview**: Click calibrate to verify results and coordinate accuracy.

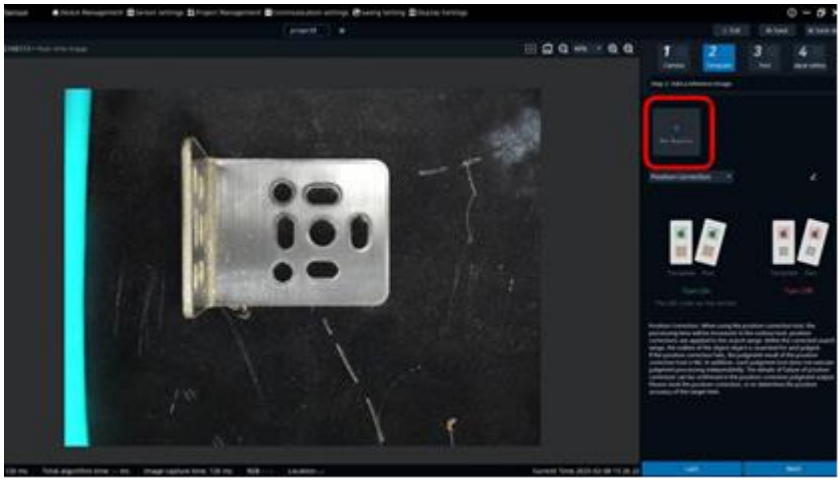


Set Template

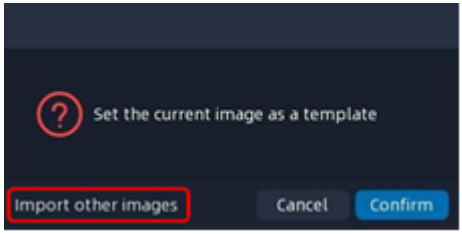
Template Addition is the second step of project configuration:

Add Template Image:

- Click **"+"** to register the live image as the reference benchmark. Supports deletion and replacement.



- Supports Importing Offline Images (resolution must match the camera).



Note: Only one template image is allowed per project.

Position Correction (Optional)

Adapts to target shifting within the FOV. When enabled, it controls the detection areas of all tools in the project. Setup follows the Pattern Presence Detection workflow.



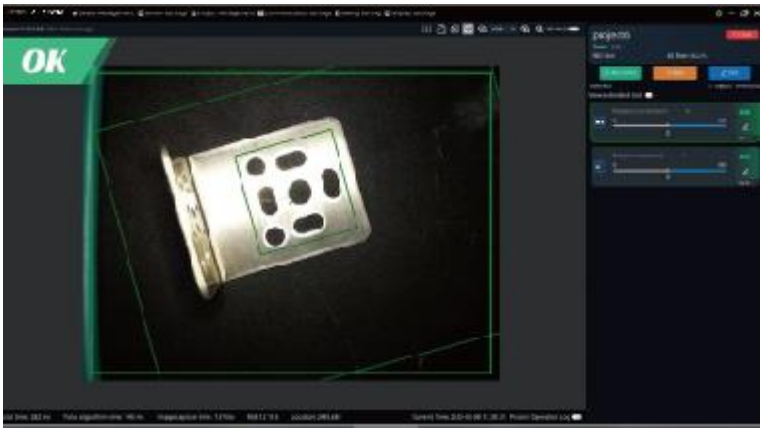
Note: Only one template image is allowed per project.

Usage Examples:

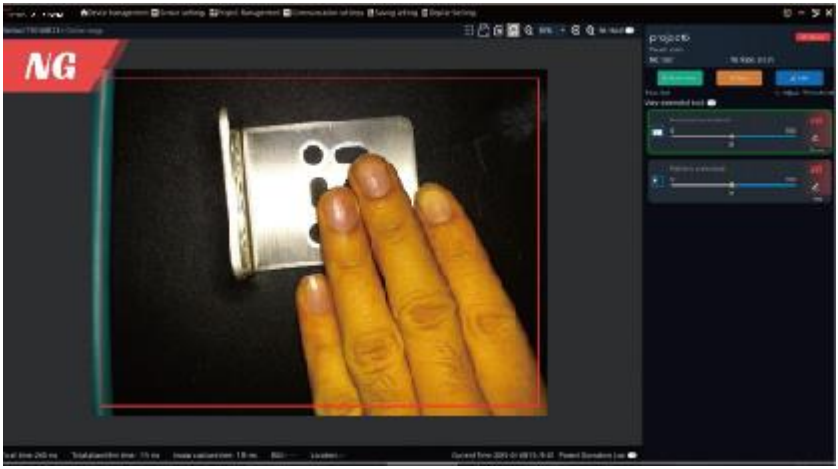
- **Combining Tools**: Position Correction can be used in combination with other inspection tools within a single project.



Feature Description 1: Pairing with Blob Counter. Position Correction locates the character; the Blob Counter counts black dots.



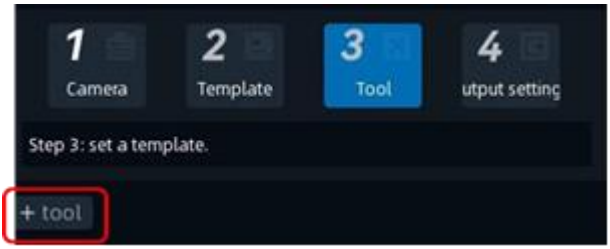
Feature Description 2: When the target shifts, Position Correction first locates the feature, then re-aligns the Blob Counter's detection area to follow the target.



Feature Description 3: If Position Correction is unconfigured or returns NG, subsequent tools (e.g., Width Detection) fail to shift, causing misalignment and incorrect results.

Tool Configuration

The third step of project configuration is "Tool Configuration." A single project supports up to 32 inspection tools. Click "**+ Tool**" to open the tool list and select the algorithm that matches your application requirements.



Presence Detection Tools



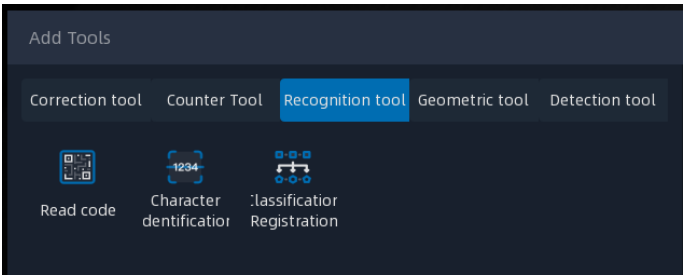
Tool Name	Description
Pattern Presence	Uses **Template Matching** to search for a target pattern within a defined area.
Blob Presence	Uses **Blob Analysis** to detect if a region meeting threshold criteria exists; ideal for high-contrast scenarios.
Circle Presence	Detects the presence of circular features within the search area.
Edge Presence	Detects the presence of specific edges within the search area.

Counting Tools



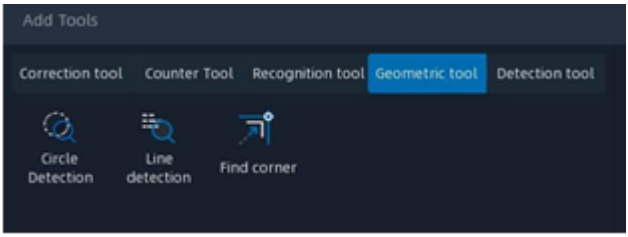
Tool Name	Description
Pattern Counting	Searches and counts targets using pattern matching.
Edge Counting	Detects and counts edges based on contrast settings.
Blob Counting	Detects and counts all blobs within a specified area range.

Recognition Tools



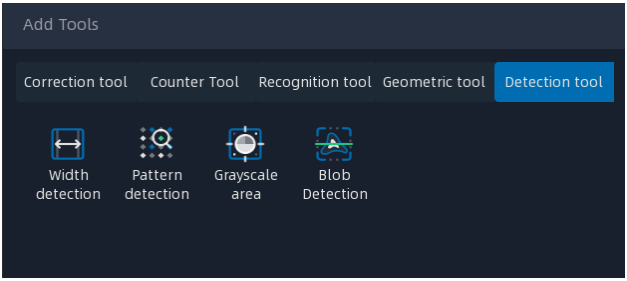
Tool Name	Description
Read Code	Reads 1D or 2D codes (e.g., QR, DM); supports simultaneous multi-code reading.
Character Identification	Read Character (OCR) and verification character(OCV)
Classification Registration	Registering sample and classify the target

Geometric Tools



Tool Name	Description
Circle Detection	Uses edge calipers to locate circle center coordinates and output diameter.
Line Detection	Uses edge calipers to precisely locate lines and output line angles.
Find Corner	Calculate the corner position of the part

Detection Tool



Tool Name	Description
Width Detection	Measures target width based on edge contrast settings.
Pattern Detection	Uses pattern matching to detect target position and rotation angle.
Grayscale Area	Calculates target area by counting pixels within a specific grayscale range.
Blob Detection	Detects all blobs within an area range and returns their position and angle.

Output Configuration

Once tool parameter configurations and test runs are completed in Step 3, proceed to **Step 4: Output Configuration**. This section governs how the ZX-4020 processes inspection outcomes, formats data payloads, and transmits signals to external control systems (e.g., PLCs, PCs, robot controllers, or reject mechanisms).



Output settings are organized into three tabs:

- **Basic Settings**: Project status definitions, communication output formatting, script-based payload formatting, and discrete I/O line behavior.

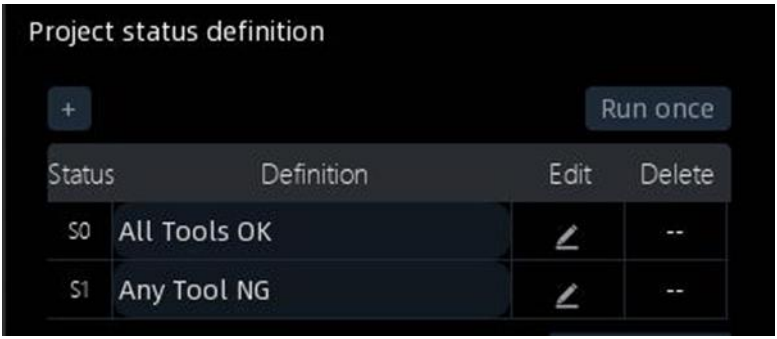
- **Extended Function 1**: Multi-tool custom logic combinations and numerical value ranking.
- **Extended Function 2**: Custom image-saving naming rules.

Project Status Definitions

Project status definitions consolidate the individual inspection results of all active tools into unified, project-level operational statuses.

Preset & Custom Statuses

- **Default Statuses**: The system provides two preset statuses:
  - **S0**: Preset as **OK** (All tools pass).
  - **S1**: Preset as **NG** (Any tool fails).



- **Adding Custom Statuses (+ Button)**: Click the **+** button above the status table to define additional statuses (e.g., **S2**, **S3**). This enables multi-grade sorting, classification of specific defect categories (e.g., dimension defect vs. OCR mismatch), or routing parts to separate rework bins.

- **Customizing Status Labels**: Click the text field in the **Definition** column to edit the status string (e.g., changing S0 from "OK" to "Pass" or "Model_A_OK").



Achievement Conditions (Status Logic)

Click the **Edit** (pencil) icon next to any status to open the **Status Definition Editing** window:

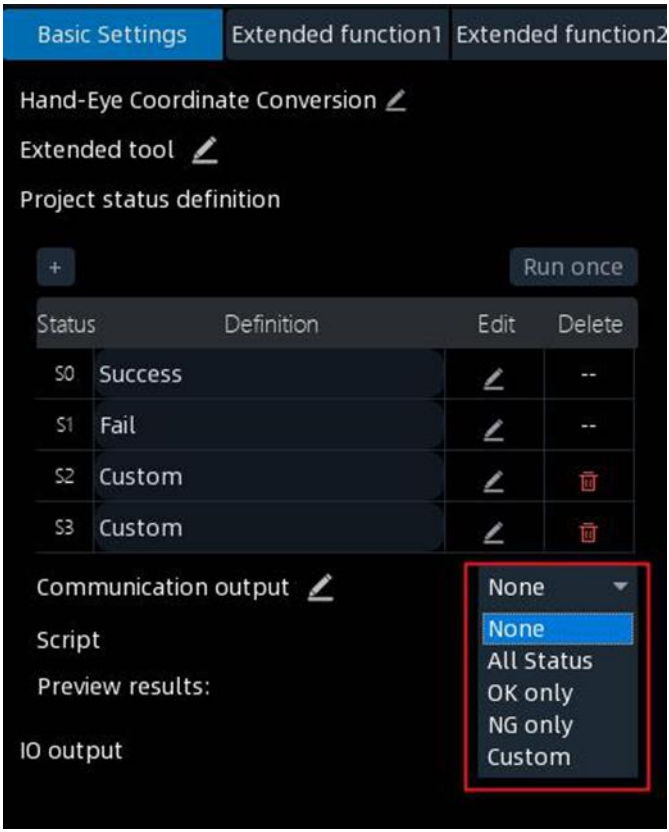


1. **Output Condition**:
    - **All Met (AND / Satisfy simultaneously)**: The status is achieved only when **all** enabled tools fulfill their required outcomes.
    - **Any Met (OR / Satisfy any)**: The status is achieved if **at least one** enabled tool fulfills its required outcome.
2. **Tool Result**: Set the required state for each tool to satisfy the condition (**OK** or **NG**).
3. **Tool Enable**: Toggle the switch beside each tool to include or exclude it from this specific status calculation.

Status	Default Definition	Output Condition	Tool Result Requirement	Tool Enable
S0	OK	All Met (AND)	All tools must be **OK**	All tools selected
S1	NG	Any Met (OR)	Any tool is **NG**	All tools selected
S2+	Custom	Configurable (AND/OR)	User-defined per tool (OK/NG)	Selectively enabled

Communication Output

Communication Output configures the transmission of inspection results, positional data, and decoded strings over Ethernet (TCP/IP, Profinet, EtherNet/IP, Modbus TCP, MC Protocol) or Serial (RS-232).



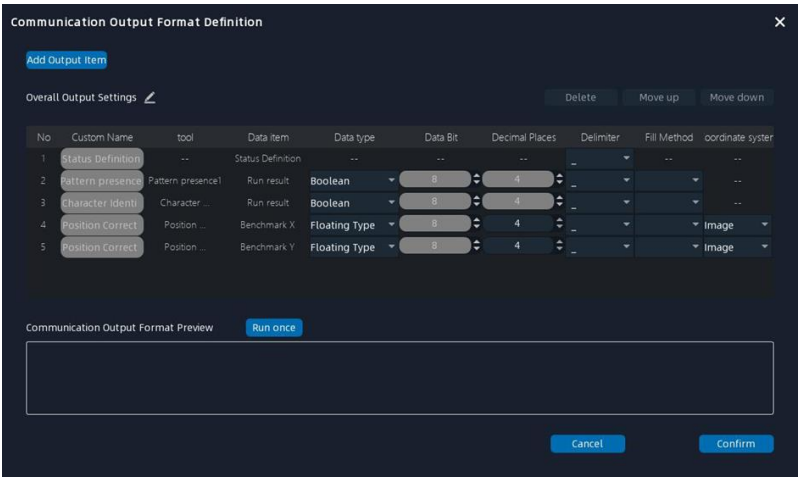
Trigger Output Conditions

Select when the camera transmits data packets via the **Communication output** drop-down menu:

- **None**: Disables communication output.
- **All Status**: Transmits the configured data packet on every inspection cycle, regardless of pass or fail.
- **OK only**: Transmits data only when the overall project result is OK.
- **NG only**: Transmits data only when the overall project result is NG.
- **Custom**: Enables state-specific packet formatting; each project status (S0, S1, S2...) transmits its own distinct data packet.

Configuring Output Content & Formatting

Click the **Edit** (pencil) icon beside Communication output to open the **Communication Output Format Definition** window:



1. **Add Output Items**: Click **Add Output Item** and select data fields generated by the project's tools:
    - **System / Project Items**: Status Definition string, overall Run Result, Timestamp.
    - **Character Identification (OCR/OCV)**: Run Result (Boolean), Status Label, Decoded Character String.
    - **Code Reading**: Decoded 1D/2D Barcode string, Code Type, Total Count.
    - **Geometric / Measurement Tools**: Coordinates (\(X, Y\)), Angle, Width, Height, Area, Offset values.
2. **Column Parameters**:
    - **Data Type**: Select between *Boolean*, *Integer*, *Floating Type*, or *String*.
    - **Data Bit / Length**: Specify fixed bit lengths or character widths.
    - **Decimal Places**: Define floating-point precision (0 to 6 decimal digits).
    - **Delimiter**: Select intra-item separators (Comma ,, Semicolon ;, Underscore _, Space, Tab, or None).
    - **Coordinate System**: Choose between **Image Coordinates** (raw pixels) or **Manipulator / Physical Coordinates** (requires prior coordinate calibration).

3. **Overall Output Settings**:

    - **Include Custom Name**: Appends a user-defined field header before each data item.
    - **Fixed Data Bit / Padding**: Pads shorter values with leading zeros or spaces to maintain fixed-width telegrams required by legacy PLCs.
    - **Output Project Status**: Automatically prepends the current project status label to the beginning of the packet.
    - **Other Delimiter Types / No Delimiter**: Customize or strip delimiters entirely.

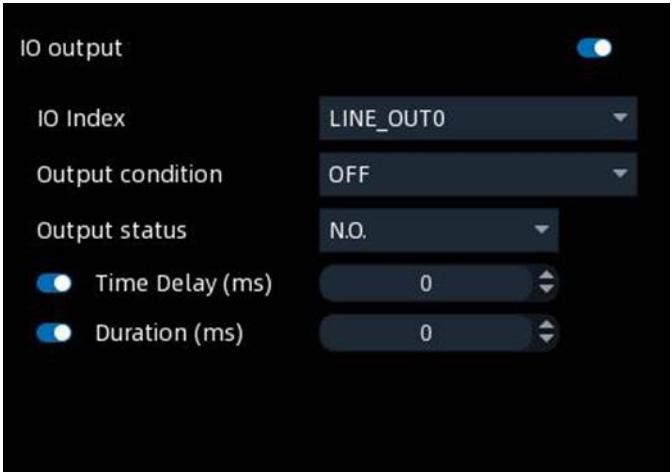
Custom Mode Operation (State-Based Independent Formatting)

When **Custom** is selected as the output condition, an additional **Custom Mode** bar appears at the bottom of the editor:

1. Select a target status from the drop-down menu (e.g., **S0**).
2. Configure the specific items to send for that status (e.g., transmitting complete coordinate arrays on S0).
3. Click **Synchronize Current Status** to lock the configuration.
4. Switch to another status (e.g., **S1**) and configure different items (e.g., transmitting only an error code ERR_01 on S1).
5. Click **Run once** to preview the exact output string generated for the selected status.

Physical I/O Output

Physical I/O outputs control external hardware devices (indicator lamps, audible alarms, reject diverters, or PLC digital input modules) via the camera's optically isolated digital output lines (LINE_OUT0, LINE_OUT1, LINE_OUT2).



- **Enabling I/O**: Toggle the **IO output** switch to **ON**.
- **Configurable Parameters**:
    - **IO Index**: Select the physical output terminal to configure (**LINE_OUT0**, **LINE_OUT1**, or **LINE_OUT2**). Each line is configured independently.
    - **Output Condition**: Select the trigger condition:
        - **OFF**: Line remains inactive.
        - **All Status / S0 (OK) / S1 (NG) / S2+ (Custom)**: Line fires based on the achieved project status.

- **Communication triggers**: Line is pulsed on-demand via network commands rather than inspection outcomes.

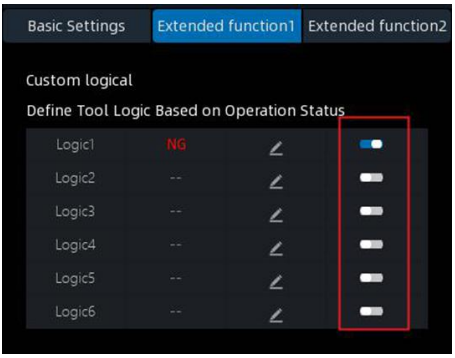
- **Output Status (Effective Level)**:
  - **N.O. (Normally Open / High Level)**: Terminal pulls high/conducts when the condition is met.
  - **N.C. (Normally Closed / Low Level)**: Terminal conducts by default and breaks when the condition is met.

- **Time Delay (ms)**: Delay between inspection completion and signal assertion (0 to 10,000 ms). Used to synchronize with downstream reject stations based on conveyor belt speed.

- **Duration (ms)**: Duration of the asserted electrical pulse (default: 10 ms).
  - ***Duration Enabled (On)***: Outputs a clean pulse of fixed duration, ensuring PLC scan cycles capture the edge without signal latching.
  - ***Duration Disabled (Off)***: The signal latches and remains asserted continuously until the next inspection cycle updates the outcome.

Custom Logic (Extended Function 1)

Custom Logic enables multi-tool boolean combinations to evaluate complex inspection criteria beyond simple project-level pass/fail rules. Up to **4 independent logic groups** (Logic 1 to Logic 4) can be created and mapped to I/O or communication channels.



1. Navigate to **Extended function 1** and toggle **Custom logical** to **ON**.
2. Click the **Edit** (pencil) icon next to a logic channel (e.g., Logic1).
3. **Logic Operator**: Select either **AND** or **OR**.
4. **Tool State Assignment**: All project tools are listed. Assign each tool one of three states:
    - **Not use**: Tool does not participate in this logic calculation.
    - **Use**: Tool's standard result is evaluated directly (\(OK = 1, NG = 0\)).
    - **Use (REV) / Use (Inverse)**: Inverts the tool's result (\(NG = 1, OK = 0\)).

Application Truth Table Example (AND with Inversion)

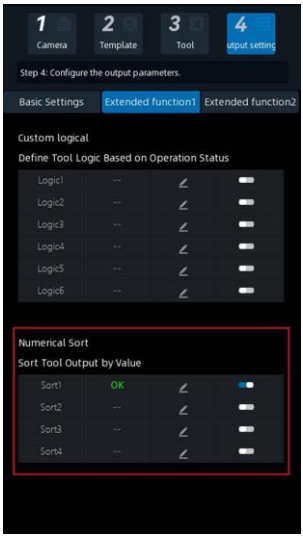
In an assembly check where **Tool 1 (Part Present)** and **Tool 2 (Part Aligned)** must be OK, but **Tool 3 (Defect Detected)** must be NG (no defect present) for the overall process to pass:

Tool 1	Tool 2	Tool 3 Mode	Tool 3 Result	Logic Calculation Output
OK	OK	Use (REV)	OK (Defect Found)	**NG**
OK	**OK**	**Use (REV)**	**NG (No Defect)**	**OK (Passed)**
NG	OK	Use (REV)	NG	**NG**
OK	NG	Use (REV)	NG	**NG**



Value Ranking (Extended Function 1)

Value Ranking sorts numerical measurements produced by multiple tools and evaluates whether their rank order matches a predefined expected sequence. Up to **4 Value Ranking groups** can be configured.



- **Application**: Sorting objects by size, verifying component height gradients, or checking step-wise structural profiles.
- **Configuration**:
    1. Under *Extended function 1*, enable **Value Ranking**.
    2. Select the participating tools and assign the target numerical property (e.g., Area, Width, or Diameter).
    3. Define the **Expected Rank** order (e.g., Tool 1 < Tool 2 < Tool 3).
    4. If the physical parts match the expected order, the tool outputs **OK**; if parts are reversed or out of order, it outputs **NG**.

Custom Save-Image Naming Rules (Extended Function 2)

When image logging is enabled, captured raw images and rendered tool graphics are saved to the PC storage drive. By default, images use a standard timestamped naming format: YYYYMMDD.HHMMSS.mmm.ImageID.render.jpg

Customizing File Naming Rules

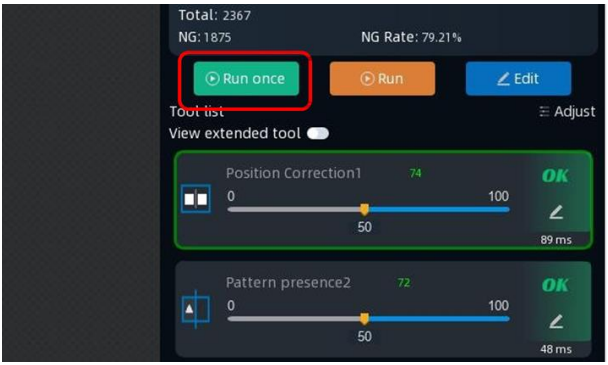
Navigate to **Extended function 2** and toggle **Custom image saving naming rule** to **ON**:

1. **Delimiter**: Select the separator between name components (Dot ., Hyphen -, Underscore _, Plus +, Space, or None).
2. **Add Filename Components (+ Button)**: Assemble custom naming strings by appending:
    - Date & Time (Year, Month, Day, Hours, Minutes, Seconds, Milliseconds).
    - Image Serial Number / Frame ID.
    - Overall Project Result (OK / NG).
    - Specific Tool Results (e.g., <Character Identification> Run result or decoded text strings).
    - Custom Strings (e.g., Batch numbers or Line identifiers).

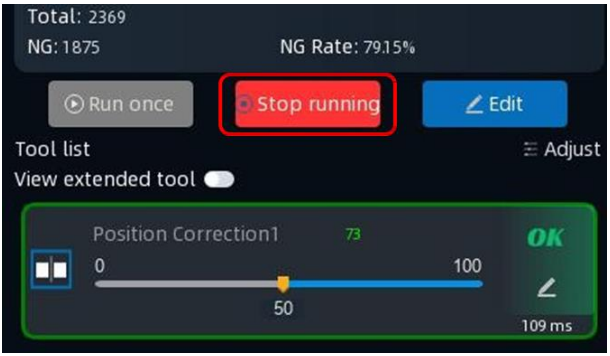
Project Operation & Testing

Online Operation/Testing

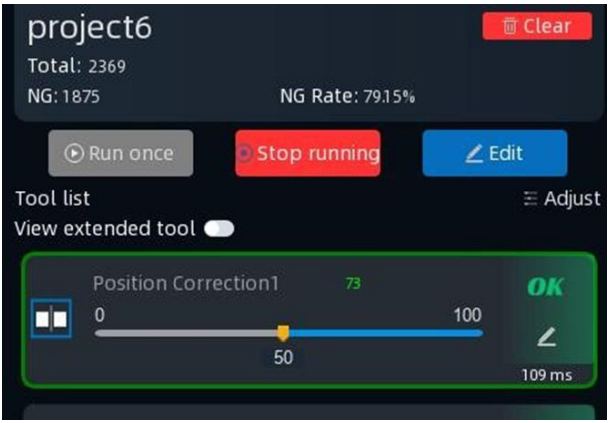
- **Run Once**: Manually triggers a single inspection cycle.



- **Start Run**: Enters the Active state; the camera awaits internal or external trigger signals.



- **Stop**: Manually halts operation. The device state persists after software restart.

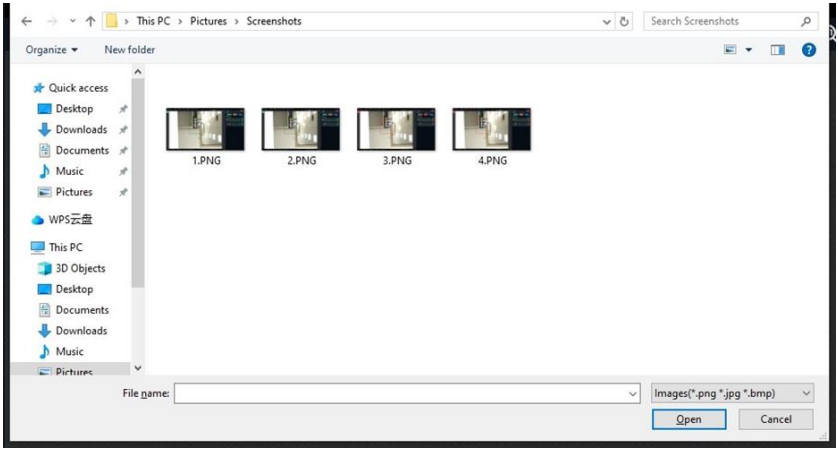


Offline Mode/Testing

- **Algorithm Testing**: Click "**Offline Mode**" while standby to import local PC images for testing.
- **Import Requirements**: Resolution of imported images must match the current camera.



- **File Import**: You must import image files from your computer before entering "**Offline Mode**."
- **Batch Addition**: You may click the button multiple times to add additional images.



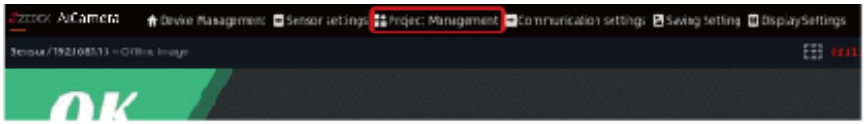
Note: For compatibility, it is recommended to use images previously saved by the current device (see the Image Saving chapter).

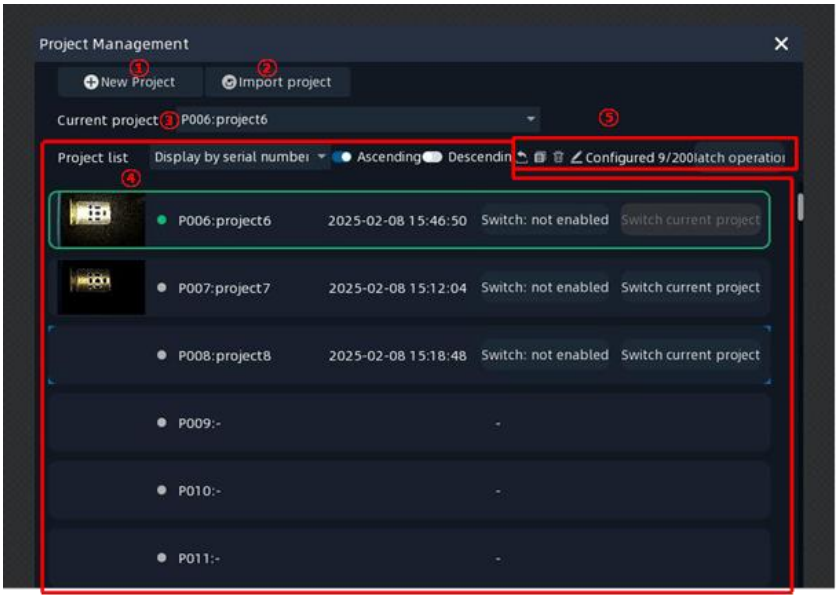
Project Management

Vision cameras can store multiple projects tailored to different inspection targets. A single device supports up to 200 projects.

Access Project Management

- Click "**Project Management**" in the menu bar to open the management interface.





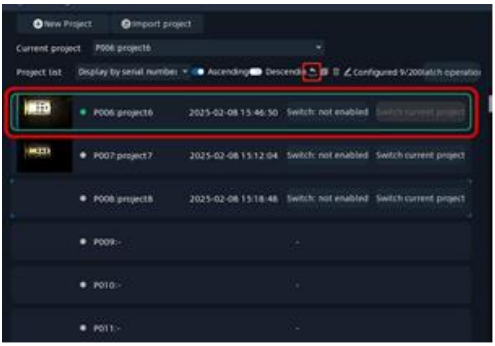
Project Management Interface Overview

#	Function	Description	Details
1	**New Project**	Create a new project.	Refer to the **New Project** chapter.
2	**Import Project**	Load project files into the device project list.	Supports single or batch imports.
3	**Current Project**	Displays the active project; use the dropdown for manual switching.	Only fully configured projects can be selected.
4	**Project List**	Displays ID, Name, and Creation Time for all projects.	Supports storage for up to 200 groups.
5	**Operations**	Access for Export, Copy, Delete, Edit, and Batch actions.	Select a specific project to execute management tasks.

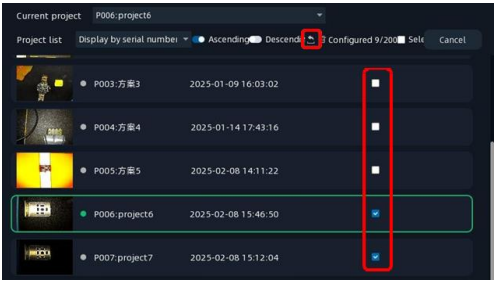
Project Export & Import

Export Project (Single/Batch)

- **Export Single**: Select a project from the Project List and click the export button.



- **Export Multiple**: Click "**Batch Operation**," select multiple projects, and click export.



- **File Format**: Projects are saved as .projs files. This allows for rapid deployment across multiple cameras at the same inspection station.



Import Project (Single/Batch)

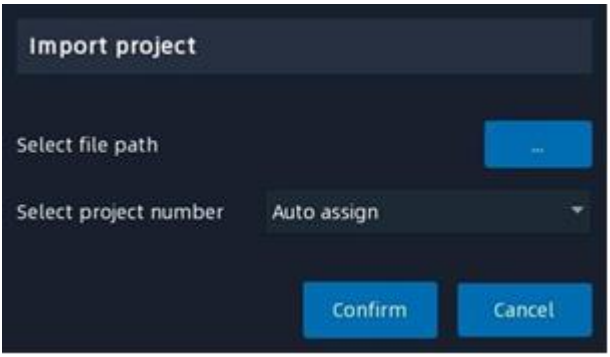
Note:

1. Cross-series project imports are not allowed.
2. Resolution mismatch (e.g., 1MP to 2.3MP) will cause import failure.
3. Large firmware version gaps between export and import devices may lead to failure.

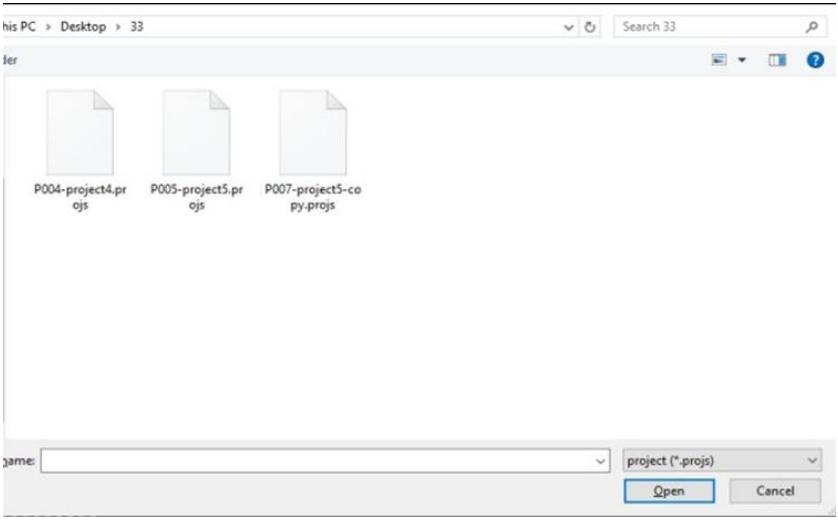
Import Process:

1. Click "**Import Project**" in the Management Interface and select "**Choose File Path**."

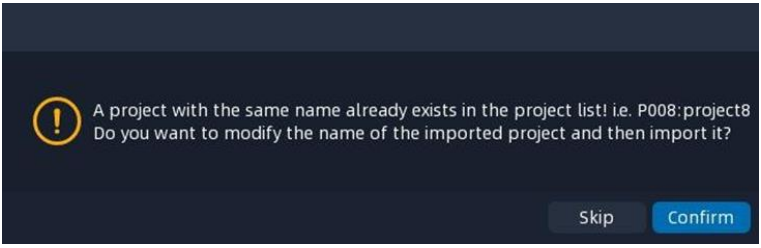




2. Select one or more .projs files and click Open.



3. If a name conflict occurs, the system will prompt for a rename.



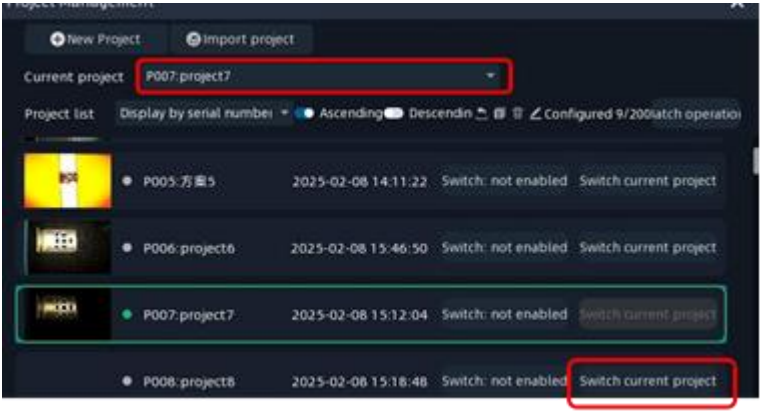
Note: Project Import Compatibility Constraints

- Cross-Model / Cross-Series Prohibition: Importing a project created on a different camera is blocked by the software.
- Cross-Resolution Prohibition: Importing a project between different sensor resolutions (e.g., 1.3MP into a 2.3MP sensor) is prohibited to prevent coordinate scaling corruption.
- Firmware Mismatch: Projects exported from older major firmware releases should be verified and re-tested upon import into updated firmware.

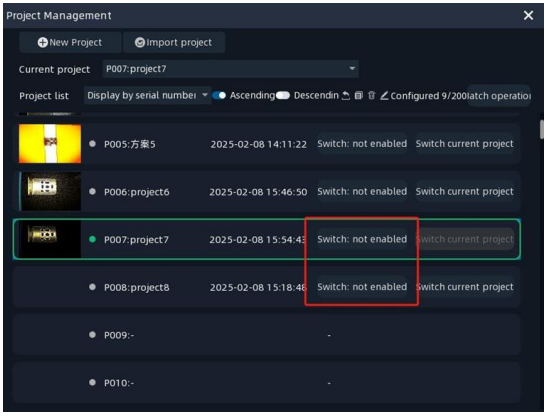
Switch Project

Manual Switching

- Use the dropdown menu next to "**Current Project**."



- Click the "**Switch to Current"** button next to a project in the Project List.



External Switching

The camera supports automatic switching via external signals. Switching Configuration must be set independently for each project.



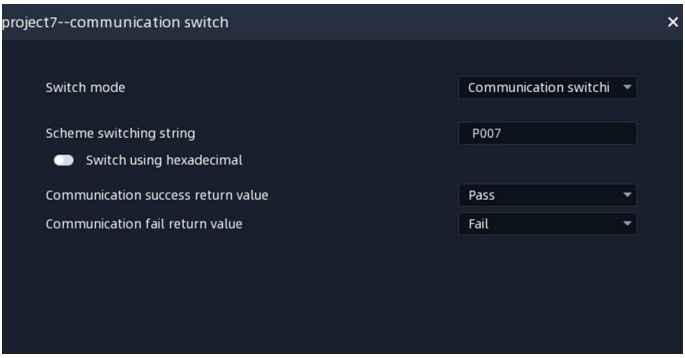
- **I/O Switch Mode:**

  Specify the Trigger Source (e.g., LINE_IN0 or LINE_IN1). The camera switches to the project upon detecting a signal (Rising or Falling Edge).



- **Communication Switch Mode:**

  External devices send a "Project Switch String" via network communication. The camera switches automatically based on the received string content.



Configuration Item Overview

Configuration Item	Purpose	Details
Project Switch String	Enter specific identification content for switching.	User-defined custom string.
Use Hexadecimal	Enables input in hexadecimal format.	Supports ASCII special characters (e.g., Enter, Newline, STX, ETX).
Return Value (Success/Fail)	Status message sent to external devices after switching.	**Success**: Pass, OK; **Failure**: Fail, NG.

Example: If the communication protocol requires messages to end with an "Enter" (CR) symbol, and the switch string is P001 + Enter, enable "Use Hexadecimal" and input the hex code 503030310D.

Communication Protocol Overview

Transmit inspection results to PLCs, robotic arms, or databases.

- **Protocol Selection**: Choose RS232, TCP/IP, or industrial protocols (e.g., Modbus, Profinet) based on electrical control requirements.
- **Data Format**: Define the output string content (e.g., OK/NG status, barcode text).
- **Hardware Linking**: For I/O triggering, verify the input/output signal logic and electrical levels here.

Communication Settings

External Communication

The vision camera workflow typically involves multiple data exchange stages with external systems, including Project Triggering, Project Switching, and Result Output. Select the appropriate protocol based on your specific application and onsite equipment.

Workflow	Description
Project Trigger - External	The camera executes a single inspection cycle upon receiving an external trigger signal.
Project Switch - External	The camera switches the active project based on commands received via external communication.
Communication Output	Inspection results are transmitted to the upper-level computer or control equipment.

Note:

- **Prerequisites**: Ensure hardware wiring is complete and the network environment is stable. The corresponding communication protocol must be enabled and correctly configured on the camera.
- **Protocol Limit**: Only one communication protocol can be active at a time.
- **I/O Communication**: For physical I/O synchronization, refer to the **Project Trigger (I/O)** and **I/O Output** chapters.
- **Feature Support**: Some protocols currently do not support project switching. See the table below:

Communication Protocol	Project Trigger	Project Switch	Result Output
Serial Port (RS232)	Supported	Supported	Supported
TCP/IP	Supported	Supported	Supported
Modbus TCP	Supported	Not Supported	Supported
MC Protocol (Mitsubishi)	Supported	Not Supported	Supported
Modbus RTU	Supported	Not Supported	Supported
EtherNet/IP	Supported	Supported	Supported
Fins (Omron)	Supported	Not Supported	Supported
Profinet	Supported	Supported	Supported

Using Communication Settings

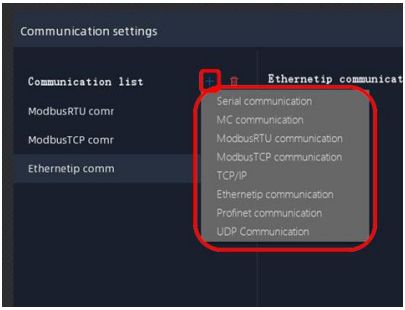
1. Click "Communication Settings" in the menu bar to open the configuration interface.



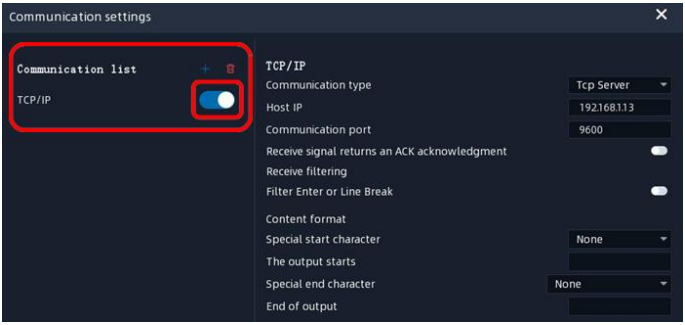
2. Click the "+" icon to select and add a communication protocol. Each protocol features independent parameter settings.



3. The Communication List will display all added protocols.

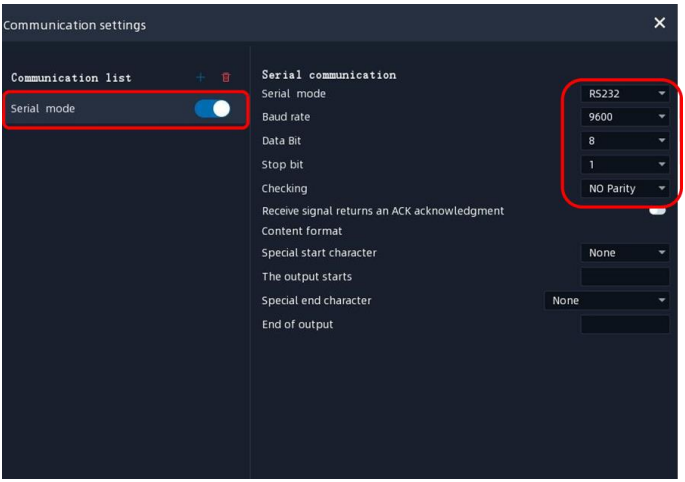


4. Toggle the Enable Switch to activate the desired communication function.



Serial Port Mode (RS232)

When the communication protocol is set to "**Serial Port Mode**," the following parameters can be configured:



Configuration Item	Description	Configuration Item	Description
Port	Select the physical serial port (e.g., COM1) used for connection.	**Port**	Select the physical serial port (e.g., COM1) used for connection.
Baud Rate	Set the data transmission speed (e.g., 9600, 115200).	**Baud Rate**	Set the data transmission speed (e.g., 9600, 115200).
Data Bits	Define the number of bits per character (typically 8).	**Data Bits**	Define the number of bits per character (typically 8).
Stop Bits	Specify the end of a character (typically 1).	**Stop Bits**	Specify the end of a character (typically 1).
Parity	Error-checking method (None, Odd, or Even).	**Parity**	Error-checking method (None, Odd, or Even).

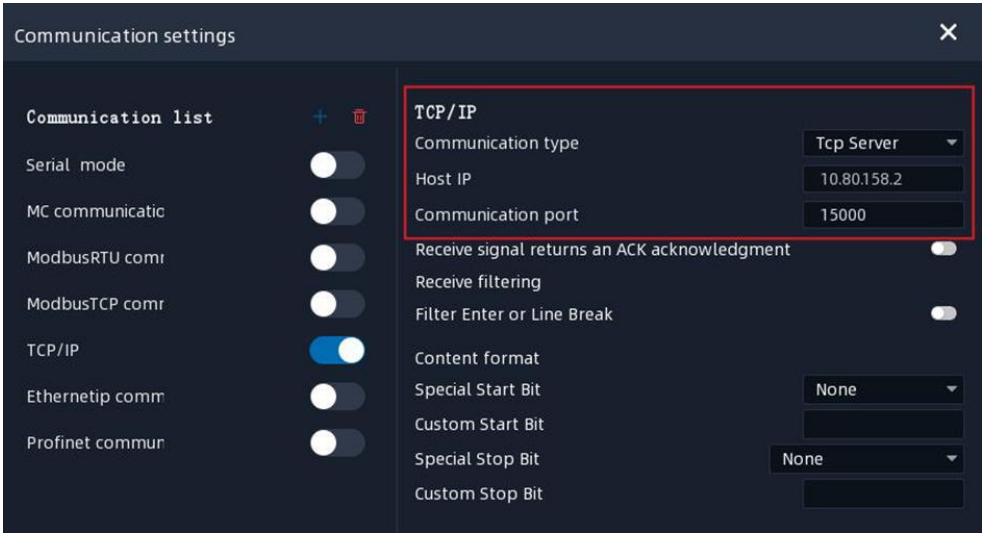
TCP/IP Communication

The ZX-4020 supports standard Ethernet socket communication in either **TCP Server** or **TCP Client** mode. This interface allows the camera to transmit inspection outcomes, send decoded barcode/OCR strings, receive trigger commands, and switch project recipes dynamically.

TCP Server Mode

In Server mode, the camera listens passively for incoming socket connection requests from an external host (e.g., PC, PLC, or robot controller).

- **Communication Port**: Specifies the local listening port for the camera server. The default port is **15000** (user-configurable from 1 to 65535).
- **Receive signal returns an ACK acknowledgment**: When enabled, the camera automatically transmits an ACK response frame back to the client immediately upon successfully receiving a valid command string.
- **Receive Filtering (Filter Enter or Line Break)**: Automatically strips trailing Carriage Return (\r / 0x0D) and Line Feed (\n / 0x0A) characters from received command packets before parsing.
- **Content Format**: Configures optional framing characters for outgoing payloads:
    - **Special Start Character / Start of Output**: User-defined framing header (e.g., STX 0x02).
    - **Special End Character / End of Output**: User-defined framing terminator (e.g., ETX 0x03, CR, or LF).

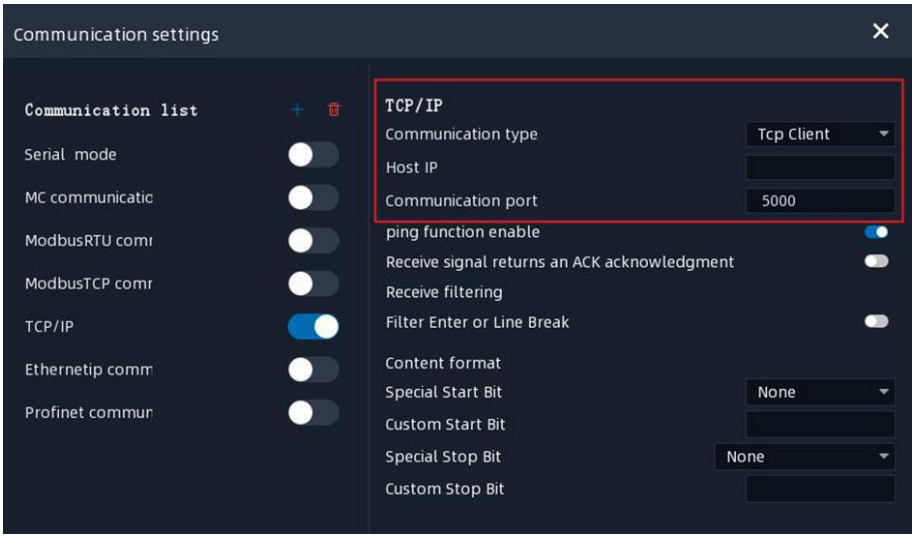


TCP Client Mode

In Client mode, the camera actively initiates and maintains a socket connection to an external listening server.

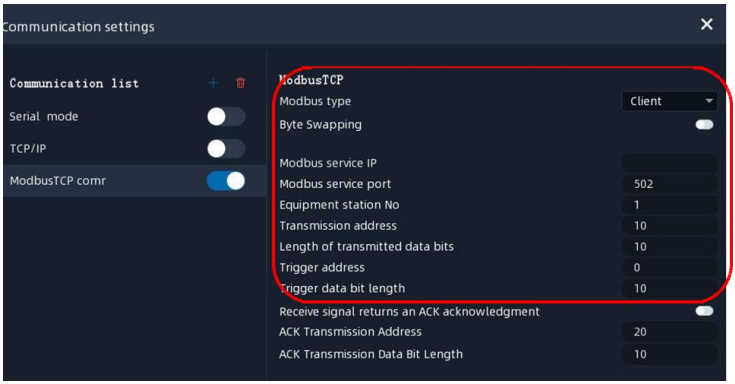
- **Host IP**: Enter the IPv4 address of the target host server (e.g., 192.168.1.100).
- **Communication Port**: Enter the destination listening port of the host server (e.g., 5000).
- **Ping Function Enable**: When toggled **ON**, the camera automatically executes an ICMP ping to the Host IP prior to establishing the TCP socket. This verifies physical network routing and cable integrity, preventing socket hang-ups.
- **Receive signal returns an ACK acknowledgment**: When enabled, the camera replies with an ACK frame upon receiving commands from the server.

- **Receive Filtering (Filter Enter or Line Break)**: Automatically strips trailing \r and \n characters from received commands.
- **Content Format**: Defines user-specified start and end framing characters for outgoing data packets.



Modbus TCP Communication

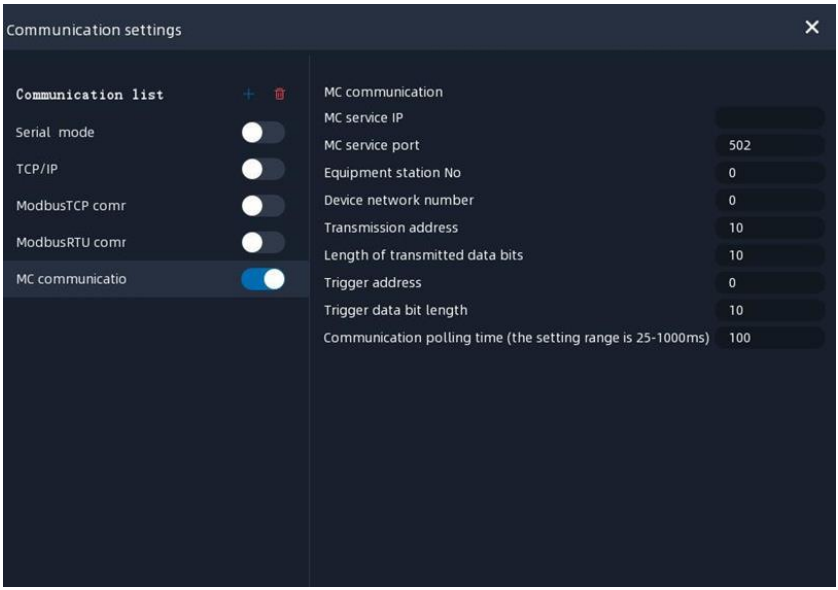
When selecting the Modbus TCP protocol, configure the Service IP and Service Port as follows:



Configuration Item	Description	Default	Details
Modbus Type	Set Master/Slave mode	**Server**	Options: **Server**, **Client**
Modbus Service IP	Configure Host IP	—	Visible in **Client** mode only
Modbus Service Port	Set service connection port	**502**	
Byte Swap	High/Low byte swap	**Off**	Enable based on data alignment needs
Device Station ID	Connected device station number	**1**	
Transfer Address	PLC data transfer address	**10**	
Transfer Length	Data byte length	**10**	
Trigger Address	Address for PLC to trigger camera	**0**	
Trigger Data Length	Length of trigger signal bits	**10**	

MC Protocol Communication (Mitsubishi)

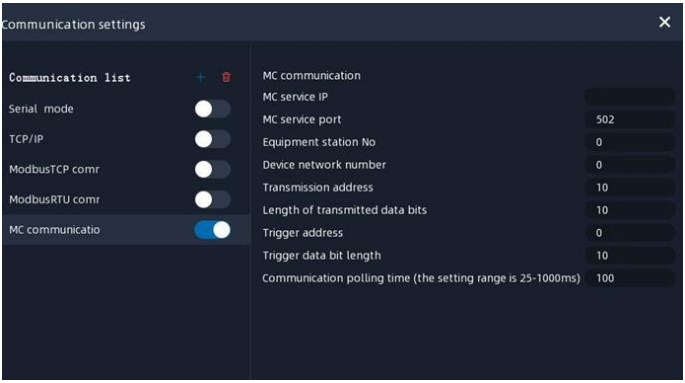
When selecting the MC Protocol, configure the following settings to connect with a Mitsubishi PLC:



Configuration Item	Description	Default
MC Service IP	The IP address of the PLC device.	—
MC Service Port	The connection port of the PLC device.	**502**
Device Station ID	The station number corresponding to the device.	**0**
Device Network No.	The network number corresponding to the device.	**0**
Transfer/Trigger Addr	The memory addresses used for data exchange.	**10 / 0**

Modbus RTU Communication

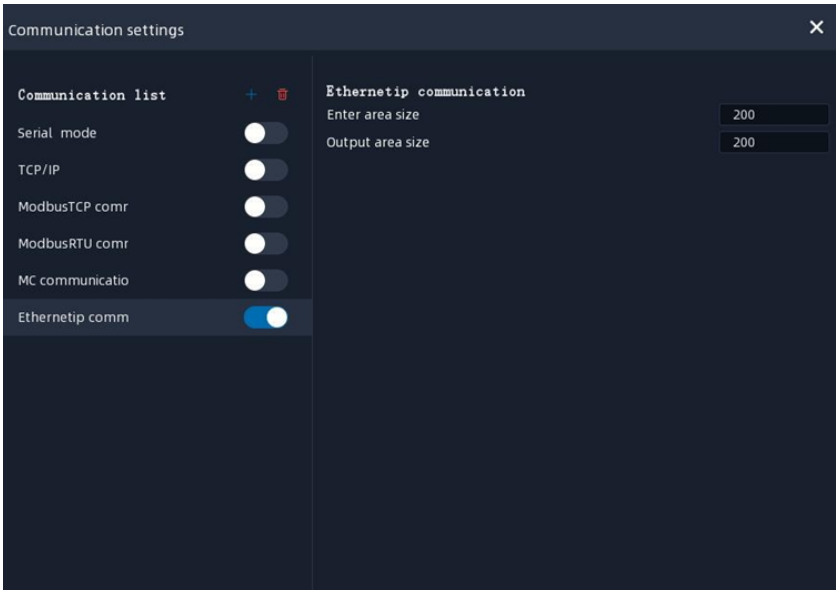
When using Modbus RTU, configure the following parameters to ensure proper data synchronization with your controller:



Configuration Item	Description	Default	Details
Comm Type	Sets the Modbus RTU mode.	**Client**	Options: **Server** or **Client**.
Byte Swap	Enables High/Low byte swapping.	**Disable**	Adjust based on PLC data format.
Device Station ID	The station ID of the connected device.	**2**	
Transfer Address	PLC memory address for data transfer.	**10**	
Transfer Length	Length of the data in bytes.	**10**	
Trigger Address	Memory address for the PLC to trigger the camera.	**0**	
Trigger Length	Length of the trigger data bits.	**10**	

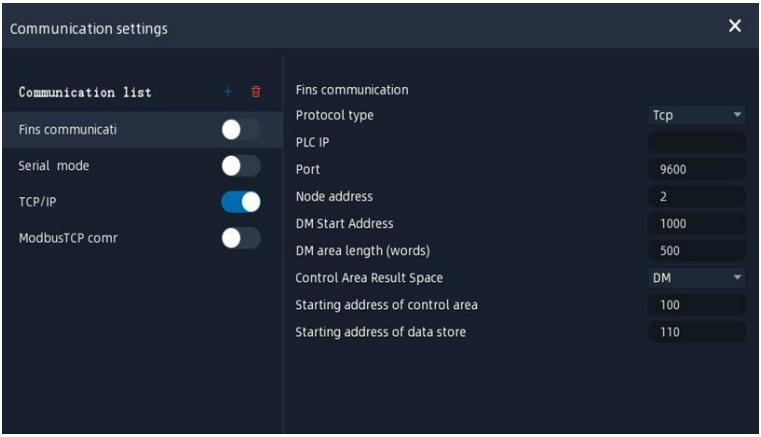
EtherNet/IP Communication

When selecting the EtherNet/IP protocol, configure the input and output data sizes for cyclic communication.



Fins Communication (Omron)

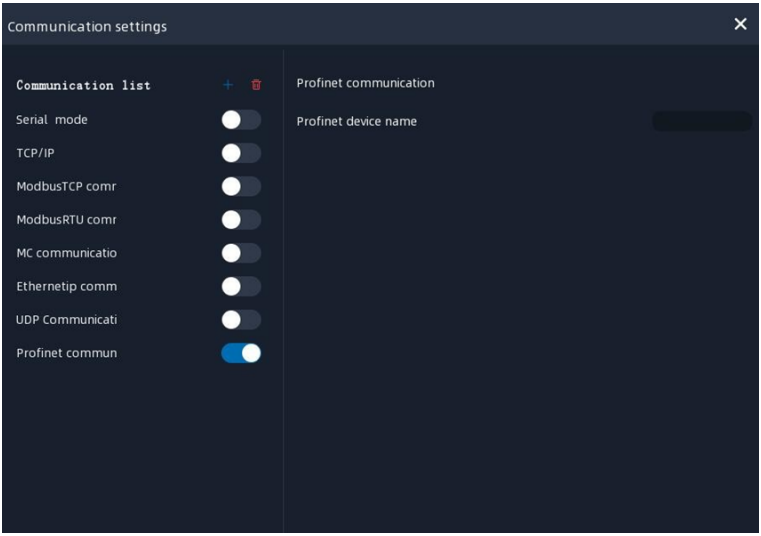
When selecting the Fins protocol, configure the following parameters to establish communication with an Omron PLC:



Configuration Item	Description	Default	Details
Protocol Type	Selects the Fins communication type.	**UDP**	Options: **UDP** or **TCP**.
PLC IP	The IP address of the connected PLC.	—	
Port Number	The communication port of the PLC.	**9600**	
Node Address	The node ID for sending commands.	**2**	
DM Start Addr	Starting address for inspection results.	**1000**	
DM Area Length	Total storage length for results.	**500**	Measured in **Words**.
Control Area	Storage type for the control area.	**DM**	Options: **DM** or **CIO**.
Control Start Addr	Starting address for control commands.	**0**	
Data Start Addr	Starting address for the data area.	**0**	

Profinet Communication

When using Profinet, configure the unique identification for the camera on the industrial network:

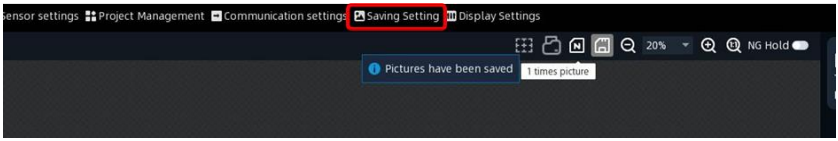


Note: Profinet Handshake & Result Clearing

- **Profinet Device Name**: Must be entered in English alphanumeric characters only (special characters or non-ASCII characters are not supported).
- **ResultAck Clears Results**: When toggled **ON**, the camera automatically clears its output data register as soon as the PLC master acknowledges packet receipt by asserting the ResultAck handshake bit. When toggled **OFF**, the camera retains the previous inspection data in the output register until the next inspection cycle overwrites it.

Image Saving Settings

- Click "**Image Saving Settings**" in the menu bar.



- The "**Image Saving Settings**" configuration window will appear.

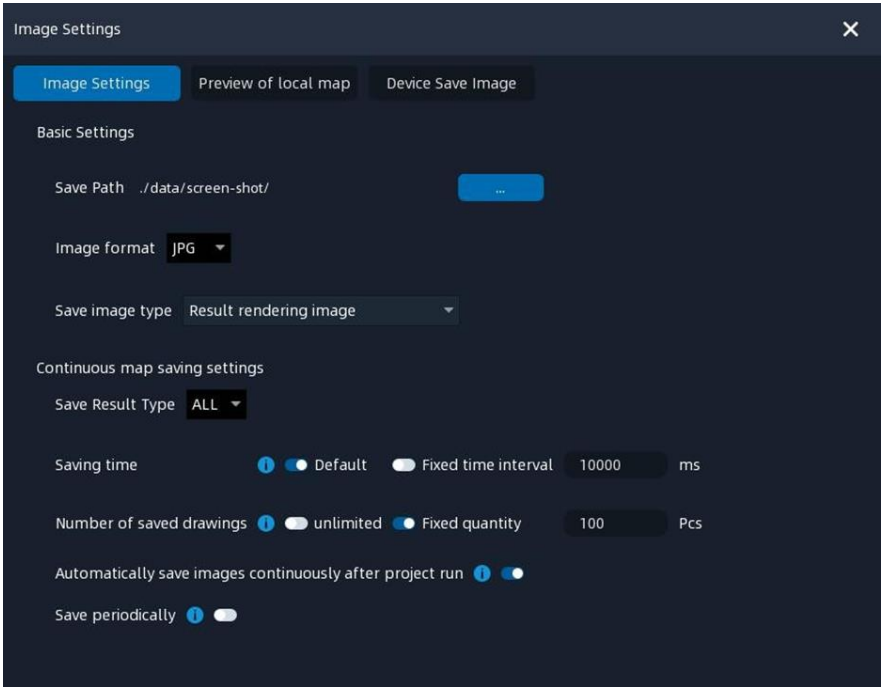


Image Saving Configuration Table

Category	Configuration Item	Details
Basic Settings	**Storage Path**	Specifies the save location on the PC. Default: ./data/screen-shot.
	Image Format	Sets the file format. Default: **JPG**. Options: **PNG**, **BMP**, **JPG**.
	Image Type	Selects content: **Raw Image**, **Rendered Result**, or **Both**.
Continuous Save	**Result Type**	Save based on outcome. Default: **ALL**. Options: **ALL**, **OK**, **NG**.
	Save Timing	Save per execution or at fixed time intervals.
	Save Quantity	Limits total images. Default: **Unlimited** or a fixed count.
	Auto-Save on Run	Automatically begins saving when the project starts running.
	Cycle-Based Save	Auto-clears history. Options: **1 Hour**, **1 Day**, **7 Days**, **30 Days**.

Storage Path & Naming

Directory Structure

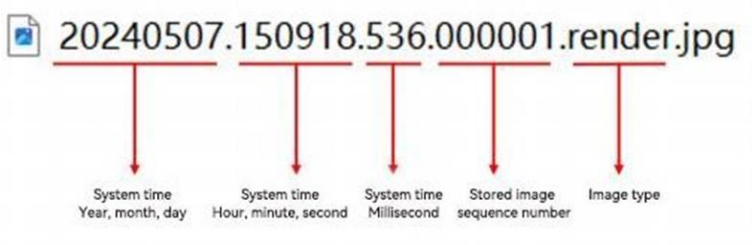
- The system automatically creates sub-directories based on the "Date" and "Inspection Result" to organize saved images.



Note: The root "Storage Path" can be modified in the Image Saving Settings.

Default Naming Convention

By default, filenames include the Project Name, Timestamp, and Result.



- **Note 1**: The period (.) is used as a standard delimiter within the filename.
- **Note 2**: If "Custom Image Naming Rules" are enabled, you can tailor filenames to specific site requirements. For example, you can dynamically include data from tools, such as the text decoded by a Code Reading tool, directly in the filename.

Tool Debugging

In Step 3: Tool Settings of the project configuration, you can add one or more tools of various types to your project.

Presence Detection Tools

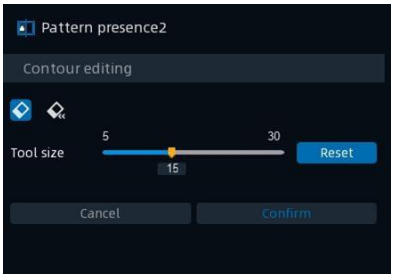
Pattern Presence Detection

Click "**Tool**," navigate to the "**Pattern**" section, and select "**Pattern**" to enter the template editing interface and configure your pattern template.

Functions & Parameters

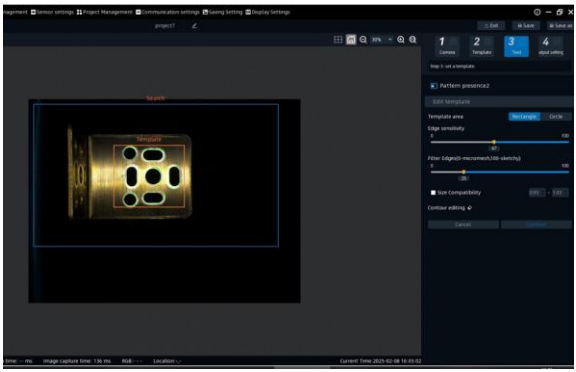
Function / Parameter	Purpose / Details
Preview Window	The left preview window displays the template image. • **Blue Box**: Search box (search range); supports translation and scaling. • **Orange Box**: Pattern template box; supports translation, scaling, and rotation. • **Green Outlines**: Recognized pattern template features.
Template Area	Select a **Rectangular** (default) or **Circular** template box. Selecting circular changes the image template frame accordingly.
Contour Editing	Accesses the contour editing interface. Click the button to enter.

Contour Editing



Function	Purpose / Details
Erase	Click to activate. An orange circle cursor appears over the image; press and hold the left mouse button to remove specific green contour features.
Erase Rollback	Click to activate. A green circle cursor appears; use this to undo erasures and restore the original green contour features.
Tool Size	Adjusts the diameter of the erase/rollback cursor. Choose a size based on the detail level of your template. **Default: 15**.
Reset	Discards all manual edits and restores the template contours to their original detected state.

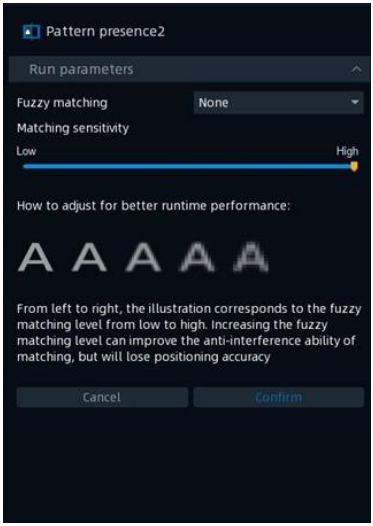
- Once editing is complete, click OK to return to the Tool Configuration interface.



Tool Configuration Interface

Function / Parameter	Purpose / Details
Preview Window	Adjust the **Blue Box** (Search ROI) by scaling or moving it. The **Green Dashed Box** indicates the actual pattern matching result.
Algorithm Mode	• **High Speed**: Optimized for short cycle times; ideal for high-speed lines. • **Standard**: Balanced speed and precision; suitable for most applications. • **High Precision**: Maximizes accuracy and stability for complex features.
Template Edit	Refer to the **Template Editing** section above.
Tracking Angle	Sets the allowable rotation range (-180° to 180°). Default: **-45 to 45**.
Custom Parameters	Default is **OFF**. Enable this to access advanced tool configurations.
Similarity	Sets the matching threshold (0–100). Default: **50**. If the detected similarity exceeds this value, the result is **OK**.
Result Logic	• **OK**: Result is Pass if the pattern is detected. • **NG**: Result is Pass if the pattern is **not** detected.
Timeout	Sets the maximum execution time. If exceeded, the tool returns **NG**. Default: **2000ms**.

- **Custom Parameters Interface**: For detailed settings, refer to the software UI documentation as shown in the interface layout.

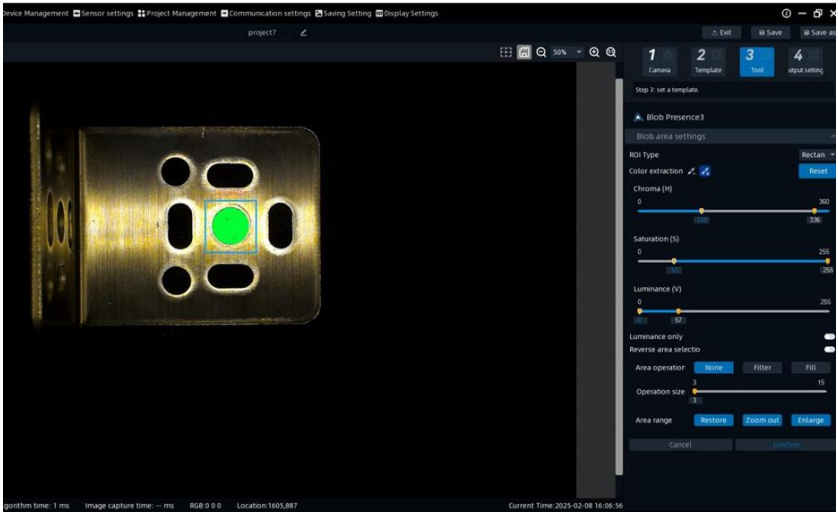


Test Run: Click **"Test Run"** to enter online testing mode.

- **Locked Features**: Search ROI, Template Editing, and Algorithm Mode cannot be changed.
- **Visual Feedback**: Successful detections (**OK**) appear in **Green**; failures (**NG**) appear in **Red**.
- **Live Adjustments**: Other parameters (like Similarity) remain editable for real-time fine-tuning.

Blob Presence Detection

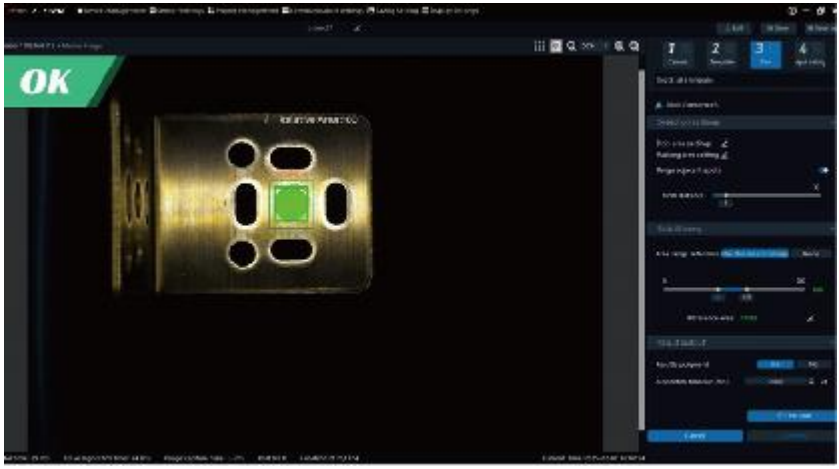
- Click "**Tool**" and select **"Blob"** to enter the region configuration interface.



Configuration Items

Function / parameter	Purpose / Details
ROI Region	The blue detection area in the preview window; supports translation, scaling, and rotation.
Grayscale Extraction	Functions identically to Color Extraction, but for grayscale values.
Grayscale Threshold	Adjusts the threshold specifically for the grayscale dimension.
Use Brightness Only	Default: **OFF**. When enabled, Hue and Saturation thresholds are disabled, leaving only the **Value (V)** threshold adjustable.
Invert Region	Default: **OFF**. When enabled, non-blob areas become blob areas and vice versa.
Region Operation	**None**, **Filter**, or **Fill**. • **Filter**: Removes blobs smaller than "Size * Size". • **Fill**: Fills holes smaller than "Size * Size".
Operation Size	Sets the filter/fill diameter (Range: 3–15). Default: **3**.
Area Range	Use **Shrink/Expand** buttons to decrease or increase the blob area by 1 pixel per click. Click **Restore** to undo these changes.
Result Logic	• **OK**: Pass if a matching blob is detected. • **NG**: Pass if **no** matching blob is detected.
Timeout	Max execution time. Returns **NG** if exceeded. Default: **2000ms**.

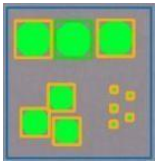
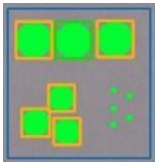
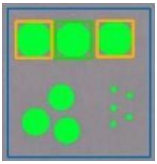
- Once the blob region is configured, proceed to the Tool Settings interface.



Functions & Parameters

Function / Parameter	Purpose / Details
ROI Region	Choose between **Rectangular** or **Circular**; supports translation, scaling, and rotation.
Blob Settings	Refer to the **Blob Region Configuration** section above.
Merge Adjacent	Default: **OFF**. When enabled, multiple blobs within the specified "Blob Distance" will be merged into one.
Blob Distance	Adjustable range: **1–15**.
Area Range (Single)	Filters blob results based on size. The **Green Box** indicates the largest blob (the reference blob for the tool); **Orange Boxes** indicate other detected blobs.
Result Logic	• **OK**: Pass if a matching blob is detected. • **NG**: Pass if **no** matching blob is detected.
Timeout	If execution time exceeds this value, the result returns **NG**. Default: **2000ms**.

Example: Adjusting the Single Blob Area Range

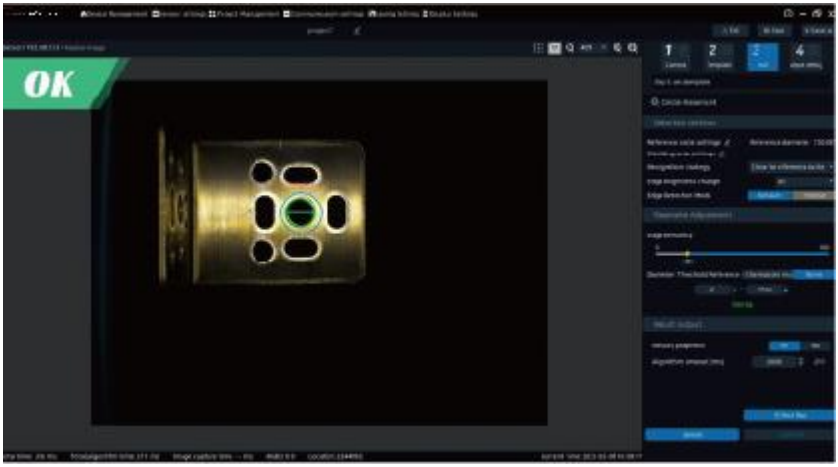
Area Range	9-15000	5000-15000	10000-1500
Blob Area in ROI			

Test Run: Click "**Test Run**" to enter online testing mode.

- **Locked**: Blob settings, ROI type, and ROI position are non-editable.
- **Feedback**: Green indicates OK; Red indicates NG.

Circle Presence Detection

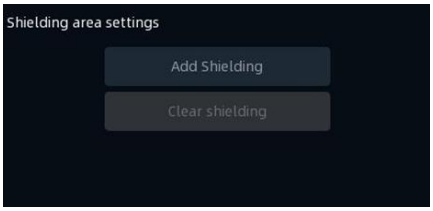
- Click "**Tool**" and select **"Circle"** to enter the configuration interface.

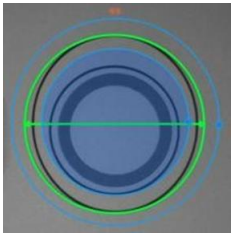
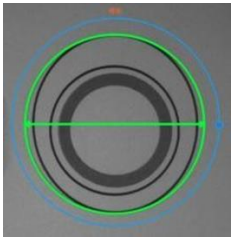


Functions & Parameters

Function / Parameter	Purpose / Details
ROI Region	Circular blue ROI in the preview window; supports translation and scaling.
Masking Settings	Click to configure masked areas; see **"Masking Area Settings"** below.
Ref. Circle Settings	Click to configure the reference; see **"Reference Circle Settings"** below.
Recognition Strategy	Four priority options: **Closest to Reference**, **Strongest Edge**, **Max Diameter**, or **Min Diameter**.
Edge Polarity	Transition types: **All**, **White to Black**, or **Black to White**.
Edge Settings	Adjusts detection precision. Use **Fine Mode** if the gap between circles is very small.
Edge Sensitivity	Range: **0–100**; Default: **80**.
Diameter Logic	Set the **Maximum** and **Minimum** diameter constraints for judgment.
Result Logic	**OK**: Pass if diameter meets criteria. **NG**: Pass if diameter does not meet criteria.
Timeout	Returns **NG** if execution exceeds this limit. Default: **2000ms**.

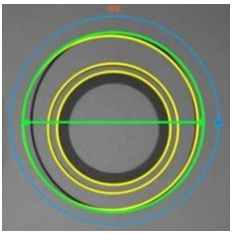
Masking Area Settings



Function / Parameter	Purpose / Details
Add Mask	Click to add a solid blue circle (concentric with the ROI) within the preview window. This area supports scaling; detection results inside this circle will be masked/filtered. 
Clear Mask	Click to remove the masking area; the solid blue circle will disappear. 

Reference Circle Settings



Function / Parameter	Purpose / Details
ROI Region	All circles identified within the ROI are rendered. The Green circle is the reference circle, while other candidates are shown in Yellow. 
Detection Sensitivity	Options: High, Medium, Low. Higher sensitivity detects circles with lower contrast.
Switch Ref. Circle	Use the Larger/Smaller buttons to select the appropriate reference circle; the selected circle turns Green.

Test Run: Click **"Test Run"** to enter online testing mode.

- **Locked**: The Search ROI and detection settings (including Masking and Reference Circle settings) are non-editable.
- **Feedback**: The Search ROI and detected circle turn **Green** for **OK** and **Red** for **NG**.

Edge Presence Detection

- Click "**Tool**" and select "**Edge Detection**" from the Presence Detection toolbar to enter the tool configuration interface.

Functions & Parameters

Function / Parameter	Purpose / Details
Edge Polarity	Select transition type based on contrast: **All**, **White to Black**, or **Black to White**.
Recognition Strategy	Select edge priority: **Strongest Edge**, **Closest to Center**, or **Closest to Start**.
Edge Sensitivity	Range: **0–100**; Default: **80**.
Result Logic	•**OK**: Pass if a valid edge is detected. •**NG**: Pass if no valid edge is detected.
Timeout	Returns **NG** if execution exceeds this limit. Default: **2000ms**.

- **Test Run**: Click **"Test Run"** to enter online testing mode.
    - **Locked**: The ROI region is non-editable in this mode.
    - **Feedback**: The tool status displays in **Green** for **OK** and **Red** for **NG**.
- **Recognition Strategy**: You may choose between **Strongest Edge**, **Closest to Center**, or **Closest to Start**. The tool returns **OK** when a matching edge is identified.

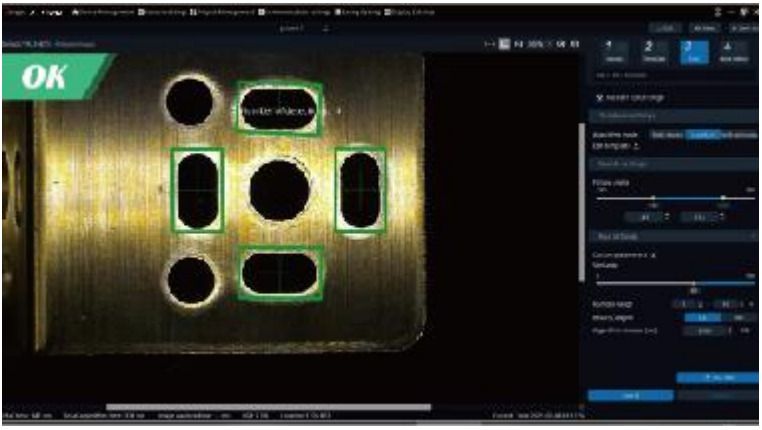
Counting Tools

The configuration process for counting tools is similar to Presence Detection. Its primary function is to identify all targets within the matching area and judge the outcome based on the detected quantity. Users must define a Quantity Range as the condition for OK/NG results.



Pattern Counting

- Click Add Tool and select Pattern Counting. For template editing methods, please refer to the Pattern Presence Detection section.



Tool Parameter Configuration

Function / Parameter	Description & Details
Preview Window	Adjust the **Blue Box** (Search ROI) via scaling and translation; the **Green Dashed Boxes** represent feature matching results.
Algorithm	**High Speed**: Shortest cycle time for high-speed lines.

Function / Parameter	Description & Details
Mode	**Standard**: Balanced speed and precision for most scenarios. **High Precision**: Maximizes stability and accuracy for complex identification.
Template Edit	Refer to the **Pattern Presence Detection** section.
Tracking Angle	Sets the allowable rotation range (-180° to 180°). Default: **-45 to 45**.
Custom Parameters	Refer to the **Pattern Presence Detection** section.
Similarity	Comparison threshold between targets and the template. Default: **50**. Only targets exceeding this value are identified.
Quantity Range	Sets the required number of results for a Pass condition.
Result Logic	Determines the final result (OK/NG) based on the defined conditions.
Timeout	Directly returns **NG** if execution exceeds this value. Default: **2000ms**.

Online Testing: After configuration, click "**Test Run**" to enter online testing mode.

- Locked Items: Template editing interface, Algorithm Mode, and ROI cannot be modified.
- **Visual Presentation**:
    - Detected features are rendered with Green Boxes.
    - The Detected Quantity is displayed in the upper-left corner of the interface.
    - Tool status displays in Green for OK and Red for NG.

Edge Counting

- Click "**Tool**" and select "**Edge Counting**" from the counting tools category to enter the configuration interface.

Edge Counting Parameter Configuration

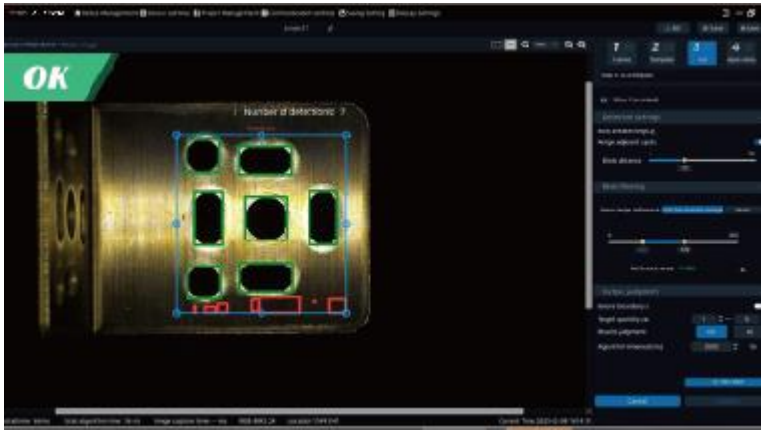
Function / Parameter	Description & Details
Edge Polarity	Select based on contrast transitions. Options: **All**, **White to Black**, **Black to White**.
Edge Sensitivity	Range: **0–100**; Default: **80**.
Target Quantity Range	Set the specific range of results required for a valid detection.
Result Logic	• **OK**: Pass if the detected count is **within** the target range. • **NG**: Pass if the detected count is **outside** the target range.
Algorithm Timeout	Returns **NG** if execution exceeds this value. Default: **2000ms**.

Online Testing: After setting parameters, click **"Test Run"** to enter online testing mode.

- **Locked**: The ROI region is non-editable in this mode.
- **Feedback**: The tool status displays in **Green** for **OK** and **Red** for **NG**.
- **Display**: The current count of detected edges is shown in the upper-left corner of the interface.

Blob Counting

1. Click "**Tool**" and select "**Blob Counting**" to enter the blob region configuration interface (refer to the Blob Presence Detection section for setup methods).
2. Once the blob region is configured, proceed to the Blob Counting tool configuration interface.



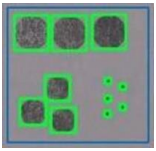
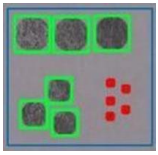
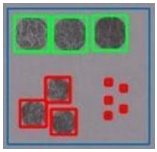
Blob Counting Parameter Configuration

Function / Parameter	Description & Details
Type	The ROI detection area type (Rectangular or Circular); supports translation, scaling, and rotation.
Blob Settings	Refer to the **Blob Presence Detection** section.
Merge Adjacent	Default: **OFF**. When enabled, blobs within the "Blob Distance" will be merged.
Blob Distance	Range: **1–15**.
Area Threshold	Filters blob results. The **Green Box** represents the largest blob (reference); **Orange Boxes** represent other detected blobs.

Function / Parameter	Description & Details
Target Quantity Range	Defines the count required for an OK result.
Result Logic	• **OK**: Pass if count is **within** range. • **NG**: Pass if count is **outside** range.
Timeout	Returns **NG** if execution exceeds this value. Default: **2000ms**.

Area Threshold Example

Area Threshold refers to the area ratio between a specific blob and the largest (reference) blob. You can filter for specific blobs by defining an area range:

Area Range	0-110	20-110	65-110
Blobs in ROI	Retain All 	Filter Tiny Blobs 	Retain Large Blobs Only 

Online Testing: After clicking **"Test Run"**, the Blob Region Settings, ROI Type, and ROI Region become non-editable.

- **Visuals**: Detected blobs are highlighted with **Green Boxes**.
- **Display**: The current count is shown in the upper-left corner of the interface.
- **Status**: **Green** indicates **OK**; **Red** indicates **NG**.

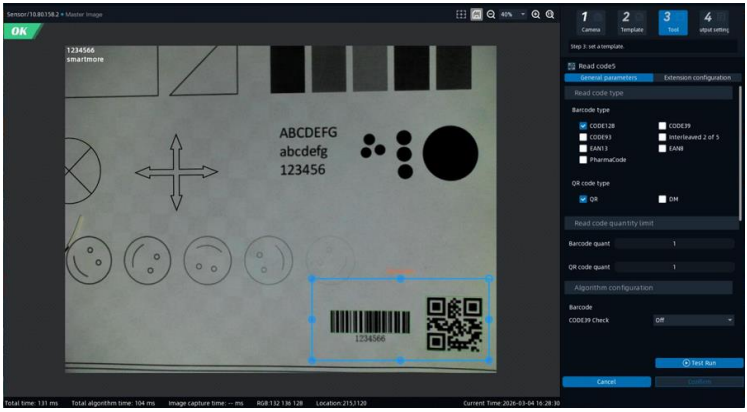
Identification Tools

Code Reading

The **Code Reading** tool decodes standard 1D barcodes and 2D matrix codes printed or direct-part-marked (DPM) on target items. It supports omnidirectional reading, multi-code batch decoding within a single field of view, warped/distorted code compensation, and sorting decoded results based on physical spatial coordinates.

Adding the Code Reading Tool

1. In the top workflow bar of the client software, navigate to **Step 3: Tool**.
2. Click the **+ tool** button in the right-hand panel.
3. In the pop-up **Add Tools** library, select the **Recognition tool** category tab.
4. Click the **Code Reading** icon. The software initializes the tool and opens its parameter configuration panel.

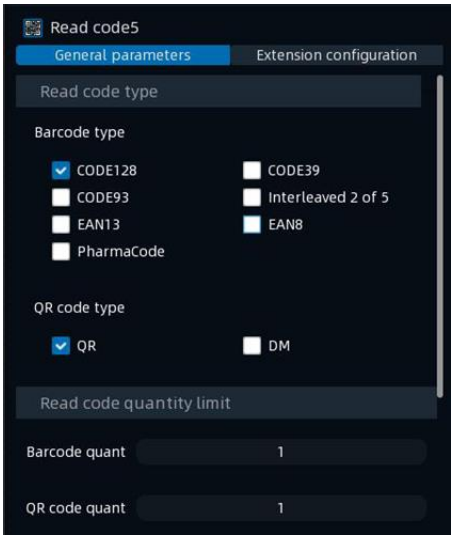


Detection Region (ROI) and Code Selection

1. **Adjusting the Search ROI**: In the image preview window, drag, scale, and rotate the blue rectangular search box to enclose the target barcode or 2D code area. Ensure adequate margin around the code to accommodate quiet zones and physical placement jitter on the conveyor line.

2. **Selecting Code Types**: Under the **General parameters** tab, locate **Read code type** and check only the target symbologies present on your production line to maximize processing speed and prevent false decodes:

    - **1D Barcodes**: CODE128, CODE39, CODE93, Interleaved 2 of 5, EAN13, EAN8, and **PharmaCode**.
    - **2D Matrix Codes**: **QR Code** and **Data Matrix (DM)**.



General Parameter Configuration

Parameter	Options / Range	Default	Function & Engineering Tuning Guide
Read Code Type	1D / 2D Symbologies	Selected	Enables target decoding libraries. Deselect unused code formats to shorten cycle time.
Max Number of Codes	1 – 100	1	Sets the maximum number of codes to decode in a single trigger. For multi-pack or blister tray scanning, set this to the expected item count.
Algorithm Timeout	100 – 5000 ms	2000 ms	Processing threshold limit. If code decoding exceeds this duration, the tool terminates and returns **NG**.
Algorithm Mode	Standard / High-accuracy	Standard	• **Standard**: High-throughput processing for clean labels. • **High-accuracy**: Engages deeper morphological enhancement for degraded, low-contrast, or blurred markings.
Polarity	White on black / Black on white / Compatibility mode	Compatibility mode	Defines print contrast: • **Black on white**: Standard printed labels. • **White on black**: Direct laser etching or dot-peen markings. • **Compatibility mode**: Evaluates both polarities alternately (recommended when substrate reflectance varies).
Recognize Similarity	0 – 100	50	Minimum edge gradient and module contrast required for decoding acceptance.

Dedicated 2D Code Optimization Settings

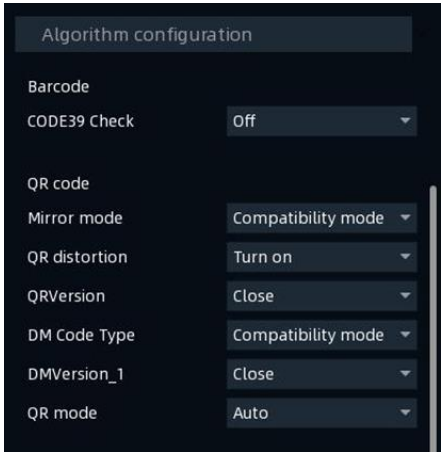
Under the **2D Code Algorithm** section, configure format-specific decoding parameters for **QR Codes** and **Data Matrix (DM)**:

QR Code Specific Parameters

- **QR Version**:
    - **Options**: *Close* (Auto-detect) or fixed version numbers (**Version 1 to Version 40**).
    - **Tuning Guide**: Default is *Close*. When product packaging uses a fixed, standardized QR code version, selecting the exact version number bypasses multi-version matrix scaling, significantly accelerating inspection cycle times.
- **QR Distortion (Curved Surface Correction)**:
    - **Options**: **Turn on** / **Turn off** / **Compatibility mode**.
    - **Tuning Guide**: Set to **Turn on** when reading codes printed on cylindrical parts, cans, bottles, or flexible packaging pouches. The algorithm applies cylindrical de-warping transformations to restore distorted quiet zones and module grids.
- **QR Mode**:
    - **Options**: **Auto** / **Model 1** / **Model 2**.
    - **Tuning Guide**: Keep at **Auto** or select **Model 2** (the modern ISO/IEC 18004 standard featuring alignment patterns). Use *Model 1* only for legacy industrial formats.

Data Matrix (DM) Specific Parameters

- **DM Code Type**:
    - **Options**: **Square** / **Rectangular** / **Compatibility mode**.
    - **Tuning Guide**: Constrains the aspect ratio search. Select *Square* (e.g., 14×14) or *Rectangular* (e.g., 8×18) based on physical part geometry to reduce false-positive search regions.
- **DM Version_1 (Matrix Dimension Lock)**:
    - **Options**: *Close* (Auto-detect) or fixed dimensions (e.g., $10\times 10, 12\times 12, 14\times 14, 16\times 16$, etc.).
    - **Tuning Guide**: Default is *Close*. Locking the matrix size directly prevents the engine from iterating across unsupported matrix grids, reducing decoding latency on high-speed lines.



Judgement Settings (Pass/Fail Quality Criteria)

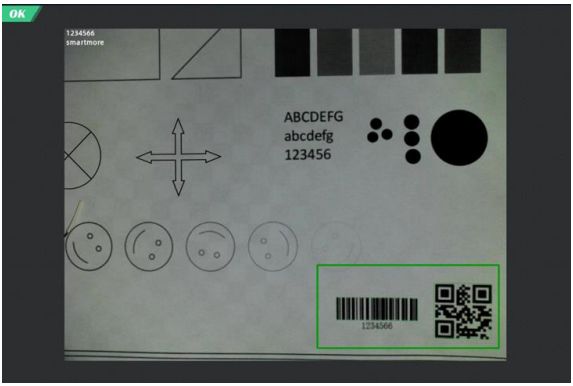
Under the **Judgement settings** section, configure the inspection criteria to validate code presence or item counts:

1. **Code Presence (Existence Check)**:
    - **Code Present = OK**: The tool outputs **OK** if at least one valid code is detected and decoded; outputs **NG** if no code is found (verifies label application).
    - **Code Present = NG**: The tool outputs **OK** if **no** code is found; outputs **NG** if a code is detected (verifies blank label rejection or unprinted space).
2. **Code Count Range (Quantity Verification)**:
    - Define the acceptable code quantity range (**Min – Max**).
    - *Example*: On a 4-pack battery blister pack, set the range to 4 – 4. If exactly 4 codes are decoded, the result is **OK**; if an item is missing or unreadable (yielding 3 codes), the tool outputs **NG**.

Multi-Code Sorting Rules (Tray & Pallet Inspection)

When **Max Number of Codes** is set to >1, the camera decodes multiple codes within the field of view. The **Sorting rule** determines the sequence in which decoded strings and coordinates are arranged in the output communication telegram:

Sorting Rule	Ordering Criterion	Target Production Scenario
None	Internal decoding sequence order	High-speed single-item tracking where spatial order is irrelevant.
Code Type	Grouped by symbology (e.g., 1D barcodes first, 2D codes second)	Dual-coded labels containing both logistics barcodes and DPM serial matrices.
Code Center X	Sorted strictly from Left to Right	Single-row multi-product conveyor flow.
Code Center Y	Sorted strictly from Top to Bottom	Vertical multi-lane packaging or drop-chute sorting.
Code Position XY	**Primary sort along X-axis, secondary sort along Y-axis**	**Palletized tray grids, wafer boats, multi-panel PCBs, and blister packs.**



Character Identification

The **Character Identification** tool employs deep learning algorithms to learn registered character samples, recognize printed alphanumeric text, and verify character correctness (OCR/OCV). It supports single-line or multi-line reading and can validate string length, exact or masked content, and dynamic dates against the system clock.

Operational Limits and Specifications

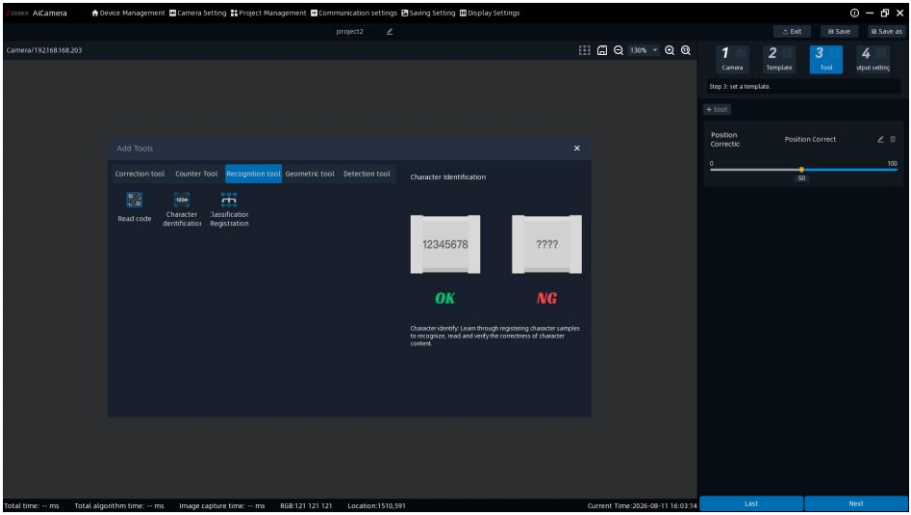
Before deploying the tool, ensure your application requirements conform to the system boundaries outlined below:

Specification / Parameter	Operational Limit & Supported Scope
Supported Character Sets	• **Numerical Digits**: 0 1 2 3 4 5 6 7 8 9• **Uppercase Letters**: A through Z (26 letters)• **Lowercase Letters**: a through z (26 letters)• **Symbols & Delimiters**: . - : / ( ) + # *
Lines to Read	Single or multi-lines, up to 5 lines per region.
Characters per Line	Up to **30 characters** per line.
Maximum Number of Tools	Up to **10 Character Identification tools** per project.
Algorithm Timeout	Default: **2000 ms**. If tool execution exceeds this threshold, it automatically returns **NG**.
Validation Methods (OCV)	Character length check, content match (exact or wildcard masks), and dynamic date validation.

Adding the Character Identification Tool

Follow these steps to instantiate the tool in your inspection project:

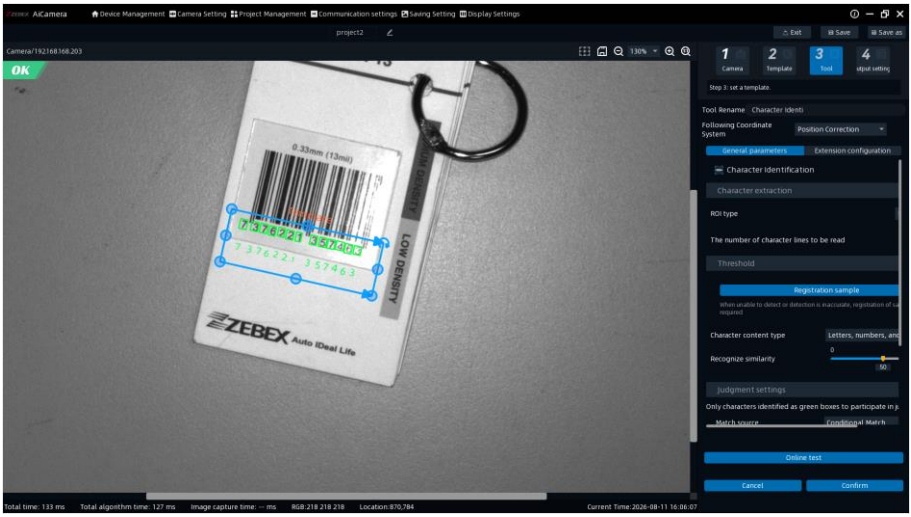
1. In the top workflow bar of the client software, navigate to **Step 3: Tool**.
2. Click the **+ tool** button located in the right-hand panel.
3. In the pop-up **Add Tools** library window, click the **Recognition tool** category tab.
4. Select the **Character identification** tool icon.
5. The software will create the tool instance and automatically open its **Tool Configuration** interface.



Detection Region (ROI) and Multi-Line Setup

1. **Adjusting the Search ROI**: In the image preview window, click and drag the blue rectangular frame (Search ROI) to enclose the target text. The frame supports translation, scaling, and rotation to accommodate angled or skewed text labels. Ensure the blue box comfortably encloses all target lines while leaving an adequate margin to account for physical part drift on the conveyor.

2. **Allocating Lines to Read**: Under the **General parameters** tab, locate **The number of character lines to be read** (or Number of lines) and set the value from 1 to 5. The system automatically subdivides the primary search region into individual orange line extraction boxes.



Parameter Configurations

The character extraction engine operates across **General parameters** and **Extension configuration** tabs:

General Parameters

Parameter	Range / Options	Default	Function and Tuning Guide
Character Extraction Threshold	0 – 100	50	Filters candidate character strokes. **Increase** the value to suppress background grain, reflections, or noise falsely extracted as characters; **decrease** it if faint, broken, or low-contrast characters fail to extract.
Algorithm Mode	Standard / High-accuracy	Standard	• **Standard**: Balanced processing speed and extraction accuracy.• **High-accuracy**: Enhances fine stroke segmentation; recommended for small characters, tight kerning, or dot-matrix printing.
Character Content Types	Letters, Digits, Symbols	All selected	Restricts candidate filtering to designated character classes. Unselected classes will be ignored during classification.
Recognize Similarity	0 – 100	50	Sets the minimum confidence score required for an extracted character to be accepted as recognized.

Extension Configuration

Click the **Extension configuration** tab in the parameter panel to access advanced stroke segmentation parameters:

Parameter	Range / Options	Default	Function and Tuning Guide
Allowed Overlap	0 – 100	20	Controls permissible bounding box overlap between adjacent characters. Prevents duplicate overlapping boxes when characters bleed together.
Character Extended Compatibility	0 – 100	20	Adjusts tolerance to font stroke thickness variation, deformation, or rough edges within the same character class. Higher values permit wider printing variations.
Register Sample Dependency	0 – 100	8	Controls matching strictness against registered training samples. Higher values enforce stricter resemblance to registered samples.
Show all Localised Characters	On / Off	On	Controls runtime display of candidate bounding boxes:• **On**: Displays both green (recognized) and orange (unrecognized) boxes.• **Off**: Suppresses orange candidate boxes to display only verified green characters.

Sample Registration Workflow and Status Indicators

The ZX-4020 uses sample-based deep learning. Characters that have not been explicitly registered and labeled cannot be recognized by the runtime engine.

Step-by-Step Sample Registration

1. Under **General parameters**, click the blue **Registration sample** button to open the sample training window.

2. Click **+ add samples** in the upper-right corner. The algorithm automatically segments character glyphs from the current ROI and displays them as individual thumbnail slices.

3. In the input box directly beneath each slice, enter the true character value (digits 0–9, uppercase A–Z, lowercase a–z, or allowed symbols).

4. If a slice contains background noise, glare, or a partial stroke, click the delete icon on that slice to exclude it from training.

5. Once all characters are labeled, click **Confirm**. The labeled characters are added to the **Registered samples list** on the right, and the model updates its feature database automatically.

6. **Multi-Image Training**: To build tolerance against production variations, register samples across multiple sample images. The system supports registering samples from the **Template image**, **Online test images**, and **Offline imported images**.

7. Click the **X** icon at the top-right of the sample list to exit the training interface.

Visual Diagnostic Indicators

In the preview display, extracted characters are rendered in two color-coded states:

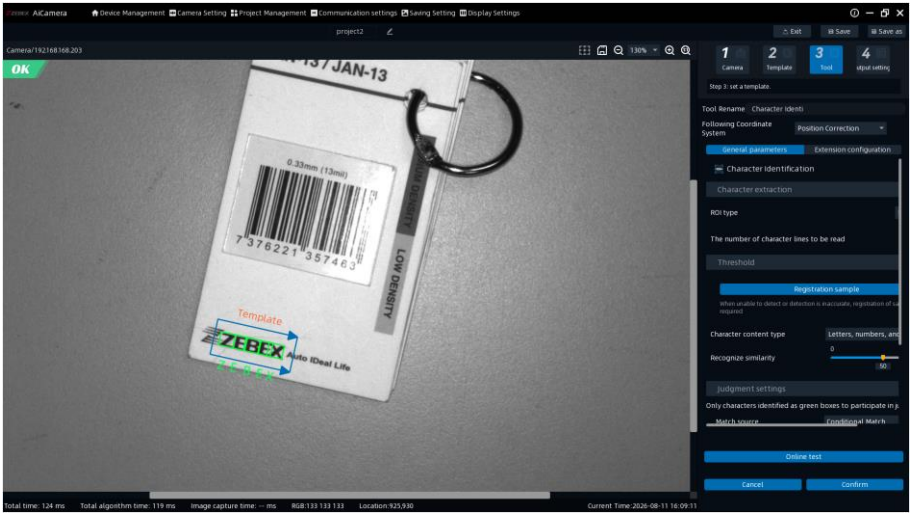
- **Green Box**: The character stroke was successfully extracted, matched with a registered sample, and scored above the similarity threshold. **Only characters identified in green boxes participate in pass/fail judgement criteria**.

- **Orange Box**: The stroke was detected by the extractor but could not be recognized. Common causes include:

    1. The character has not yet been registered in the sample library.

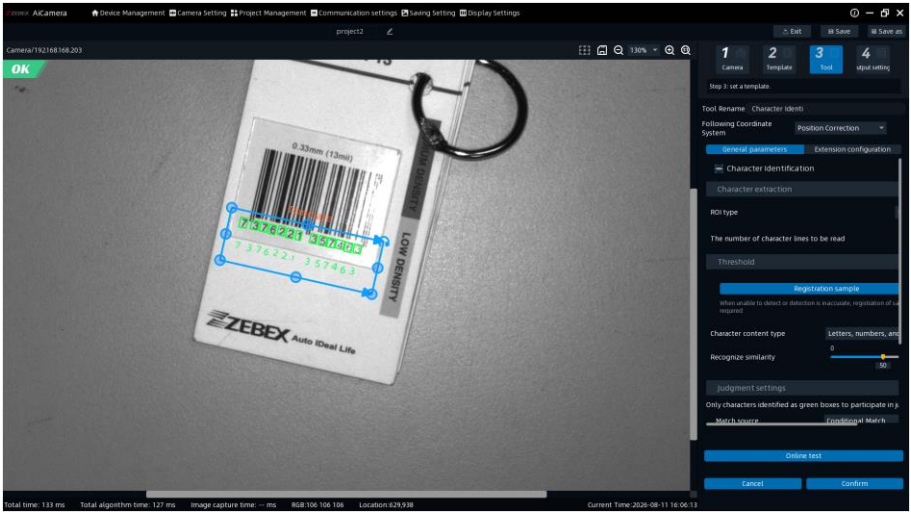
    2. The character was filtered out by *Character Content Types* or scored below *Recognize similarity*.

    3. Background glare or edge grain was falsely extracted as a stroke.



Content Match Verification Rule (Judgement Setup)

Under the Judgement settings section of the tool configuration panel, set Match source to Conditional Match. Each line of text can be assigned independent validation criteria.



Select one of the three **Match method** verification engines:

1. Length Match (Character Count Check)

Verifies that the total count of recognized valid characters falls within an acceptable numerical span.

- **Configuration**: Set **Match method** to **Length Match** and define the **Character length range** (lower limit and upper limit).

- **Judgement Example**:
    - Configured range: 6 to 6.
    - Actual text reads 123456 (count = 6) \(\rightarrow\) **OK**.
    - Actual text reads 1234567 (count = 7, exceeds range) \(\rightarrow\) **NG**.

2. Content Match and Wildcard Masking

Validates that decoded strings match exact text or adhere to structural format masks up to 62 characters:

- **Exact String**: Entering ABC123 requires the target to match those exact characters.
- **Wildcard Syntax**: Use dedicated masking symbols to enforce character-type rules by position:

Wildcard Symbol	Permitted Character Class	Application Description
?	Any character type	Accepts any supported digit, letter, or symbol.
$	Uppercase letter strictly	Enforces capital letters (A through Z).
#	Lowercase letter strictly	Enforces lowercase letters (a through z).
%	Numerical digit strictly	Enforces decimal digits (0 through 9).
^	Symbol strictly	Enforces standard punctuation/delimiters.

-

- **Judgement Example**:
    - Configured format mask: ???%%% (first 3 characters unconstrained, last 3 must be digits).
    - Actual text reads ABC123 \(\rightarrow\) **OK**.
    - Actual text reads ABC12S (sixth character is a letter 'S' instead of a digit) \(\rightarrow\) **NG**.

3. Date Match (Dynamic Calendar Verification)

Validates printed manufacturing or expiration dates against the sensor's internal real-time clock.

- **Configuration**:
    1. Set **Match method** to **Date Match**.
    2. Enter the expected date format string (e.g., YYYYMMDD or [YYYYMMDDHHmm]), including any fixed delimiters or prefixes.
    3. Enable the checkbox for **Check dates with system calendar**.
    4. Specify the **Allowed error (minutes)** tolerance window to allow for conveyor line transit delays.
- **Judgement Example**:
    - Sensor internal system clock reads: 2024-06-24 12:00 with a 5-minute tolerance.

- Extracted text reads 2024 06 24 \(\rightarrow\) Within tolerance \(\rightarrow\) **OK**.
- Extracted text reads 2024 06 25 \(\rightarrow\) Date mismatch \(\rightarrow\) **NG**.

*(Note: Prior to running Date Match, ensure the device clock has been synchronized via **Sensor Settings > Synchronize current time to the device**).*

Online Testing and Runtime Retraining

- Click "**Online test**" at the bottom of the tool interface to begin real-time verification.
- If an unpredicted print variant appears as an orange box during line commissioning, click **Pause**, open the sample editor to label and register the variant, click **Confirm**, and resume testing immediately without losing inspection parameters.

Geometry Tools

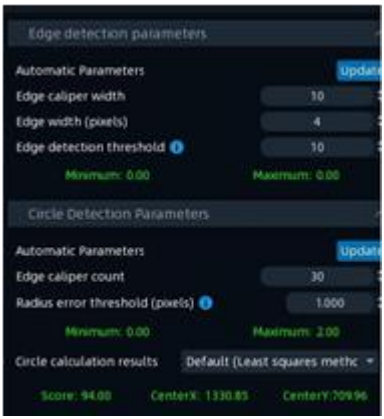
Circle Search

- Click "**Tool**" and select "**Circle Search**" from the Geometry Tools category to enter the editing interface.

Functions & Parameters

Function / Parameter	Purpose / Details
Use Ring	Default: **ON**. Allows independent scaling of the inner and outer circular ROI frames. The annular area between them defines the **Search ROI**.
Edge Polarity	Select transition type based on contrast: **Bipolar**, **White to Black**, or **Black to White**.
Recognition Strategy	Select edge priority: **Closest to Default**, **Strongest Edge**, **Closest to Start**, or **Closest to End**.
Advanced Parameters	Enter advanced configuration; see the detailed description below.
Circle Score	Default: **80**. Circles with a matching score lower than this value will be filtered out.
Diameter Logic	Select **"Image"** mode to set maximum and minimum diameter limits. Results within this range are **OK**.
Roundness Threshold	Range: **0–100**. When enabled, circles above this threshold are **OK**; those below are **NG**.
Timeout	Returns **NG** if execution exceeds this value. Default: **2000ms**.

Advanced Parameter Settings

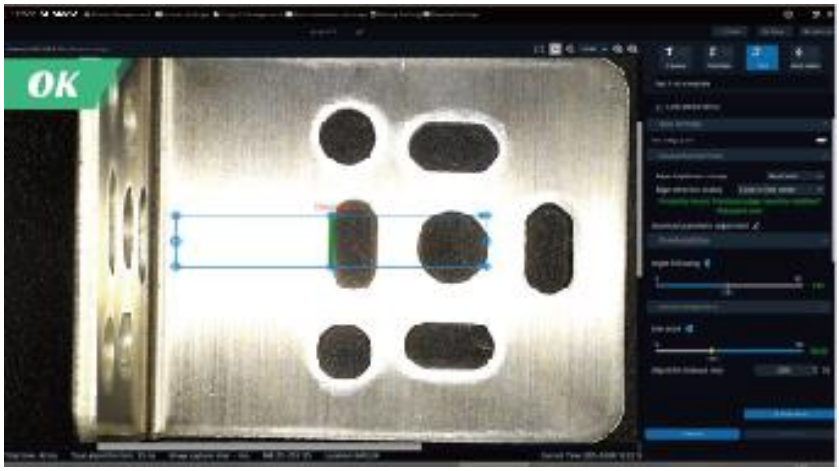


Function / Parameter	Purpose / Details
Edge Width	**Higher values**: Easier to detect blurred edges. **Lower values**: Higher precision for edge point positioning.
Edge Threshold	**Higher values**: Better noise resistance for edge detection. **Lower values**: Easier to detect low-contrast edges.
Radius Error Threshold	**Higher values**: Reduces fluctuations in detection results. **Lower values**: Increases the positioning accuracy of the detected circle.
Calculation Results	Displays the detected circle's **Score**, **Center X**, and **Center Y** coordinates.

- Test Run: Click "**Test Run**" to enter online testing mode.
- Interface Behavior: The blue Search ROI becomes non-editable, and only the outer circle is displayed. Parameters can still be adjusted during execution.
- Visual Feedback: When the result is OK, the outer ROI circle and the detected circle turn Green. If the result is NG, they turn Red.

Line Search

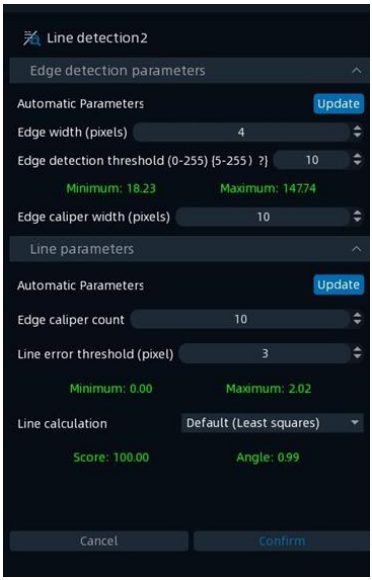
- Click "**Tool**" and select "**Line Search**" from the Geometry Tools category to enter the configuration interface.



Functions & Parameters

Function / Parameter	Purpose / Details
ROI Region	The blue search area in the preview window. Adjust via translation, scaling, and rotation to define the search range. The **Blue Arrow** indicates the search direction.
Use Edge Pair	Default: **OFF**. Enable this for dual-edge detection; once active, you can configure edge pair strategies and distance ranges.
Edge Polarity	Select based on contrast transitions. Options: **Bipolar**, **White to Black**, or **Black to White**.
Recognition Strategy	Select edge priority: **Closest to Default**, **Strongest Edge**, **Closest to Start**, or **Closest to End**. Descriptions appear below the selection.
Advanced Config	Access advanced parameter adjustments; see the section below for details.
Angle Tracking	Range: **0–30°**; Default: **10°**. The detected line must be within 10 degrees of the search ROI's perpendicular direction.
Line Score	Range: **0–100**; Default: **40**. Lines with a score lower than this threshold will be filtered out.
Timeout	Returns **NG** if execution exceeds this limit. Default: **2000ms**.

Advanced Parameter Settings



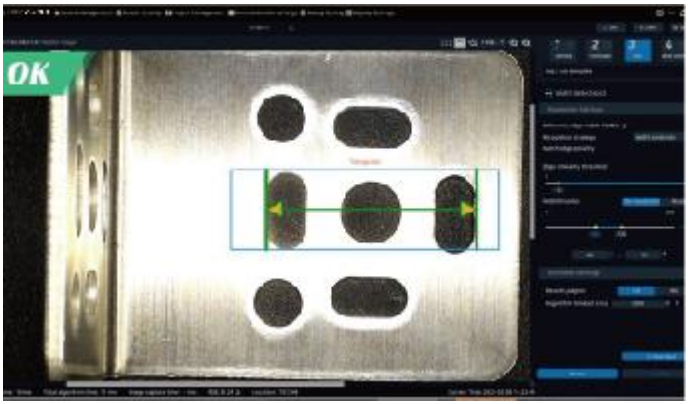
Function / Parameter	Sub-item	Purpose / Details
Detection ROI		-
Edge Parameters	**Auto Parameters**	Enabled by default; the system automatically calculates optimal values.
	Edge Width	**Higher**: Easier to detect blurred edges. **Lower**: Increases position accuracy of edge points.
	Edge Threshold	**Higher**: Better noise resistance. **Lower**: Easier to detect low-contrast edges.
	Caliper Width	**Higher**: Stronger noise suppression. **Lower**: Higher position precision.
Line Parameters	**Auto Parameters**	Enabled by default; automatically calculates values.
	Caliper Count	Number of edge points used for line calculation. **Higher**: More stable; **Lower**: Faster execution.
	Error Threshold	**Higher**: Reduces result fluctuations. **Lower**: Increases the location accuracy of the line.
	Fitting Method	**Default (Least Squares)**: Best for noise-only scenarios. **Anti-Interference (RANSAC)**: Best for scenarios with competing edge lines.

- Test Run: Once parameters are set, click "**Test Run**" to enter online testing mode.
- Interface Behavior: The blue Search ROI becomes non-editable. However, parameters can still be adjusted during the test execution.
- Visual Feedback:
    - OK: The Search ROI and the detected line turn Green.
    - NG: The Search ROI and the line (if detected but failing criteria) turn Red.

Measurement Tools

Width Measurement

- Click "**Tool**" and select "**Width Detection**" from the Measurement Tools category to enter the configuration interface.



Functions & Parameters

Function / Parameter	Purpose / Details
ROI Region	The blue area in the preview window; the **Blue Arrow** indicates the detection direction. Supports translation, scaling, and rotation.
Recognition Strategy	Select edge pair priority: **Similar Width**, **Closest to Center**, or **Closest to Sides**.
Edge Settings	Access detailed edge configurations; see the section below.
Edge Sensitivity	Range: **0–100**; Default: **80**.
Width Settings	The width threshold represents the ratio of the **"Current Detected Width"** to the **"Master Image Width."** Range: **0–200**. Set Max/Min values as judgment conditions.
Result Logic	**OK**: Pass if the detected width falls within the threshold range. **NG**: Pass if the detected width falls outside the threshold range.
Timeout (ms)	Returns **NG** if execution exceeds this limit. Default: **2000ms**.

Edge Settings

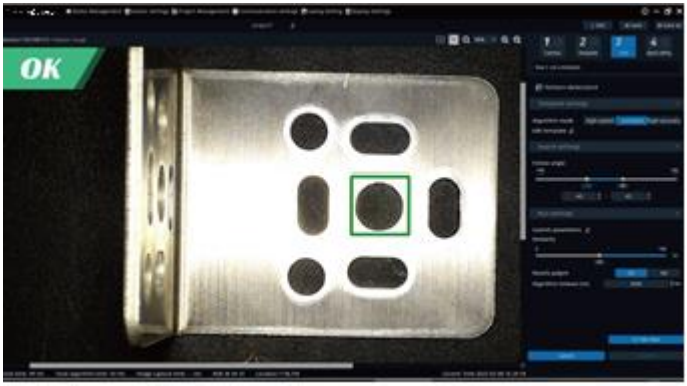


Function / Parameter	Purpose / Details
Edge Sensitivity	Options: Low, Medium, High. Higher sensitivity enables the detection of edges with lower contrast.
Edge Selection	Zoom into the preview window and hover over the green edges detected by the interface. The screen will display "**Edge 1**" and "**Edge 2**," which can then be selected in the right-hand panel. 

- **Test Run**: Click "**Test Run**" to enter online testing mode once parameters are configured.
- **Mode Restrictions**:
  - The ROI Region becomes non-editable.
  - Recognition Strategy and Edge Settings are locked and cannot be modified.
- **Visual Feedback**:
  - OK Status: The tool and indicators are displayed in Green.
  - NG Status: The tool and indicators are displayed in Red.

Pattern Inspection

- Click "**Tool**" and select "**Pattern Inspection**" from the Measurement Tools category to enter the template editing interface.
- The template setup process is identical to the Pattern Presence Detection tool. Once the template is defined, you will proceed to the tool configuration interface.



Functions & Parameters

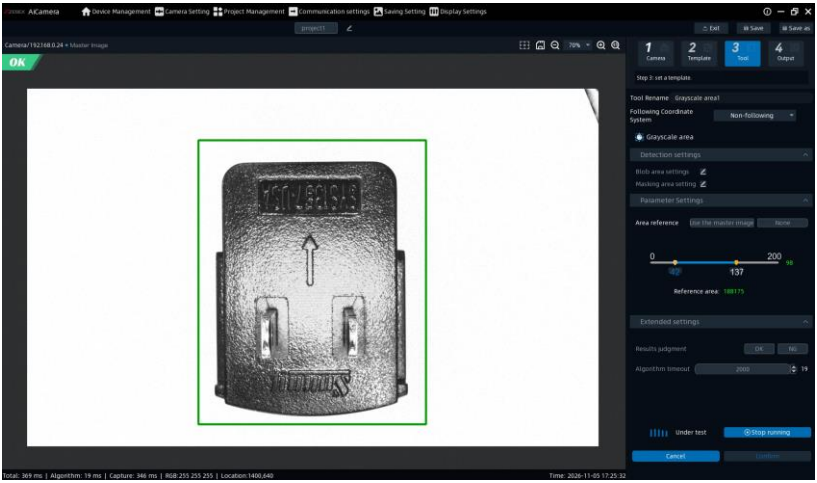
Function / Parameter	Purpose / Details
ROI Region	In the preview window, the **Blue Search Box** supports rotation and translation. The **Green Dashed Box** represents the pattern matching result.
Algorithm Mode	**High Speed**: Optimized for short cycle times in high-speed scenarios. **Standard**: Balanced speed and precision, suitable for most detection applications.
Template Edit	Refer to the **Pattern Presence Detection** section for detailed instructions.
Tracking Angle	Sets the allowable rotation range (-180° to 180°). Default: **-45 to 45**.

Function / Parameter	Purpose / Details
Custom Parameters	Access advanced configuration settings; see the "Custom Parameters" interface description.
Similarity	Comparison threshold between the searched pattern and the template. Default: **50**. Results above this value are judged **OK**.
Timeout	Returns **NG** if execution exceeds this limit. Default: **2000ms**.

- Click "Test Run" to enter online testing mode after tool configuration is complete.
- In this mode, the Search ROI, Template Editor, and Algorithm Mode cannot be edited.
- OK results are displayed in Green, while NG results are displayed in Red. Other parameters remain editable.

Grayscale Area Inspection

1. Click "Tool."
2. Select "Grayscale Area" in Measurement Tools.



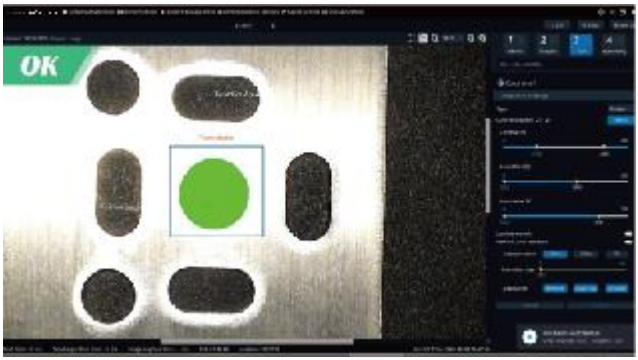
Functions & Parameters

Function / Parameter	Purpose / Details
ROI Region	In the preview window, the **Blue Search Box** supports rotation and translation. The **Green Dashed Box** represents the pattern matching result.
Algorithm Mode	**High Speed**: Shortest cycle time for high-speed scenarios. **Standard**: Balanced speed and precision for most scenarios. **High Precision**: For high-accuracy requirements; improves matching and stability.
Template Edit	Refer to the **Pattern Presence Detection** section for detailed instructions.
Tracking Angle	Sets the allowable rotation range (-180° to 180°). Default: **-45 to 45**.
Custom Parameters	Default: **OFF**. When enabled, enter the custom parameter configuration interface.
Similarity	Comparison threshold between the searched pattern and the template. Default: **50**. Results above this value are judged **OK**.
Timeout	Returns **NG** if execution exceeds this limit. Default: **2000ms**.

- Click "Test Run" to enter online testing mode after parameters are set.
- In this mode, Blob Settings and Area Reference Mode are non-editable; the ROI Region cannot be moved or scaled.
- The current Relative Area or Absolute Area is displayed in the upper-left corner.
- OK status is displayed in Green, while NG is displayed in Red.

Blob Inspection

Click “Tool” and select "Blob Inspection" from the Measurement Tools category to enter the blob area configuration interface.



- Refer to the **"Blob Presence Detection"** for setup. Once configured, you will enter the **Blob Inspection** tool editing interface.

Functions & Parameters

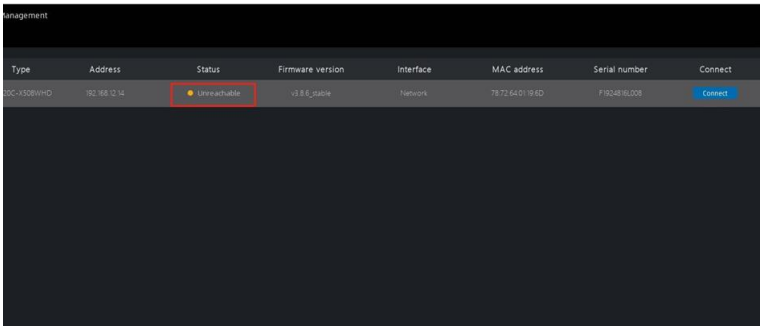
Function / Parameter	Purpose / Details
ROI Region	Choose between **Rectangular** or **Circular**; supports translation, scaling, and rotation.
Blob Settings	Refer to the **Blob Presence Detection** section for detailed instructions.
Merge Adjacent	Default: **OFF**. When enabled, two or more blobs within the defined **"Blob Distance"** will be merged.
Blob Distance	Range: **1–15**.
Area Threshold	Filters blobs based on size. Refer to the **"Pattern Counting"** tool for details.
Angle Threshold	Filters targets based on orientation. Range: **-90° to 90°**; Default: **-10° to 10°**.
Boundary Blobs	Defines how to handle blobs touching the search box edge. Default: **"Do Not Ignore"** (includes boundary blobs in detection).
Quantity Range	Sets the required number of target blobs for a Pass condition.
Timeout	Returns **NG** if execution exceeds this limit. Default: **2000ms**.

- Click "Test Run" after setting parameters to enter online testing mode.
- Mode Restrictions: In this mode, the Blob Settings interface and ROI Type are non-editable. The ROI cannot be moved or scaled.
- Visual Feedback: The tool status displays in Green for OK and Red for NG.

Troubleshooting (FAQ)

Device Connection Issues

- **Software Status "Unreachable"**: Usually indicates that the camera IP and the computer's network card are not on the same subnet.



  - **Solution**: Modify the device IP or the computer's IP settings. Alternatively, run netsh winsock reset with administrator privileges and restart the computer.

- **Unstable Connection**: May be caused by interference from Windows Firewall or antivirus software.

  - **Solution**: Add the ZX-4020 host software to the firewall whitelist.

External Trigger Failure

Key Checkpoints

- Ensure the project has been manually set to **"Start Running."**
- Verify that the **Trigger Source** (IO or Communication) in the project is configured correctly.
    1. **IO Trigger Wiring**: Confirm whether the wiring is **NPN** or **PNP** and check the **IN_COM** potential reference.

Software Startup Abnormalities



- **Missing DLL Files**: Execution environments may be missing due to differences in Windows versions.
    - **Solution**: Install vc_redist.x64.exe found in the software installation path.

How to Debug and Test Trigger Modes

Network Communication Trigger

- Test triggering first using a third-party socket testing tool or terminal.
- In the software, verify that the camera is set to **External Trigger > Communication**, and confirm that the listening port, IP subnet, and trigger string (e.g., ASCII ABC) match.
- If the trigger string contains non-printable characters (e.g., CR/LF), ensure **Use Hexadecimal** is toggled ON.

Hardware I/O Trigger

- In the software, verify the camera is set to **External Trigger > IO**.
- Ensure physical wiring corresponds to the selected terminal (**LINE_IN0** or **LINE_IN1**) and matches the signal polarity:
  - **NPN (Sinking)**: Connect the external signal to LINE_IN, and connect IN_COM to $+24\text{V}$.
  - **PNP (Sourcing)**: Connect the external signal to LINE_IN, and connect IN_COM to GND.
- Verify that the trigger pulse duration is greater than the configured **IO Debouncing Time** (default: 10,000 μs / 10 ms).

Serial Port (RS-232) Trigger

- Ensure the DB9 serial cable is wired with a TX/RX crossover: **Pin 2 (RX)**, **Pin 3 (TX)**, and **Pin 5 (GND)**.
- Verify that the baud rate, data bits, stop bits, and parity match the transmitting controller.

Software Trigger

- Click **Run once** in the client software toolbar to verify that inspection algorithms execute properly without relying on external wiring.