DMV3000G Technical Manual V1.1

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Thank you for selecting the high-performance Digital Machine Vision System DMV3000G series from Delta Electronics Inc. This Operating Manual contains descriptions of all the components and provides information on installation, process configuration, operation, troubleshooting, peripherals, and maintenance.

If it is not used according to the manual, it may lead to danger and error. To guarantee proper installation and operation of the system, please carefully read this Operating Manual and keep it in a safe place for future reference.

Caution

1. This product needs to be installed and protected in an industrial switchboard. The power input must be UL recognized 61010-2-201 power input SELV.

2. To prevent damage due to an incorrect input voltage level, please ensure that all signal connections, such as input voltage and polarity, are correct before powering on any component.

3. Please ensure that system power is turned off before inspecting the input power source or connecting the wires. To avoid electrical shock, never touch the terminals or connect the wires while system power is turned on.

4. Please do not attempt to disassemble or modify the internal components of the controller.

5. The controller unit is an open-type chassis and must be installed within an appropriate panel box that repels dust, water, and moisture; and prevents electrical shock and damage from impacts.

6. Keep the components away from scrap metal or installed in the environment of pollution degree 2, which could interfere with operation or cause damage to the components.

7. During installation, keep the components away from sources of electrical interference such as high voltage and high frequency noise. Avoid system operation under the following situations:
   (a) Excessive dust and corrosive gasses; (b) high temperature, high humidity, and high levels of radiation; (c) shock and impact; (d) exposure to direct sunlight

8. Please clean the system with a dry cloth. Do not use cleaning solutions containing acidic or alkaline chemicals.

9. Ensure a proper connection is established between the ground terminal and the power source. Ensure that all terminals are securely connected. Input terminal for 24VDC, current less than 10mA; output terminal for 24VDC, current less than 50mA. The I/O terminals are all general use, SELV circuit only.

10. Use only compressed air to remove dust from the camera sensor and lens. To avoid getting moisture on the components, never blow on any of the components with your mouth.

11. Gently wipe dust off of the lens using a lens cloth to remove attached dirt. Using excessive force or inappropriate materials may scratch the lens.

12. Allow at least 10 seconds to pass before you restart the system after powering the system off to avoid damage to the components.

13. The torque value for each terminal is 1.7 lb-in. The power connection diameter is greater than 20 AWG, the I/O connection diameter is greater than 28 AWG, and the rated line temperature is 105 degrees.

Chapter 1

Components and Specifications

1.1 Packaging and Optional Parts

A complete DMV3000G system includes the following basic components:

1) Controller unit and mouse

2) Camera and transmission cable (optional)

3) Lens (optional)

4) Light source and dimmer (optional)

1.1.1 Controller Unit Packaging

The following is included:

1) DMV3000G-GE2-VL controller unit

2) Mouse

Chapter 1 Components and Specifications
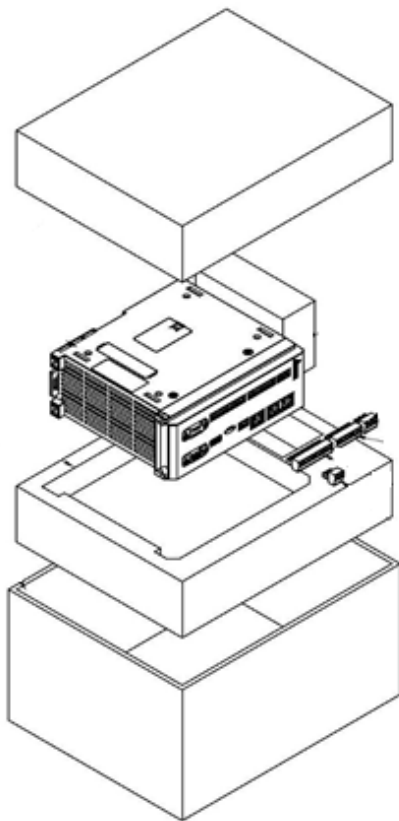
1.1.2 Camera (Optional)

◎ **0.3 MP Camera**

Specifications: 1/3.6" COMS chip, C mount port, 120fps, 4.8um chip size

➢ 0.3 MP (640*480) color camera: DMV-CM30CGE-D

➢ 0.3 MP (640*480) gray-scale camera: DMV-CM30GGE-D

◎ **2 MP Camera**

Specifications: 1/1.8" COMS chip, C mount port, 50fps, 4.7um chip size

➢ 2 MP (1600*1200) color camera: DMV-CM2MCGE-D

➢ 2 MP (1600*1200) gray-scale camera: DMV-CM2MGGE-D

1.1.3 Lens (Optional)

◎ **2/3" Normal Lens:** 2/3" image size, C-mount port
Applicable for 0.3 MP camera

➢ 6 mm focal length lens: DMV-LN06W40

➢ 8 mm focal length lens: DMV-LN08W40

➢ 12 mm focal length lens: DMV-LN12W40

➢ 16 mm focal length lens: DMV-LN16W40

➢ 25 mm focal length lens: DMV-LN25W40

➢ 35 mm focal length lens: DMV-LN35W40

➢ 50 mm focal length lens: DMV-LN50W40

➢ 75 mm focal length lens: DMV-LN75W40

➢ 100 mm focal length lens: DMV-LN100W40

◎ **2/3" Megapixel Lens (less distortion):** 2/3" image size, C-mount port
Applicable for 2 MP camera

➢ 5 mm focal length lens: DMV-LN05M

➢ 6 mm focal length lens: DMV-LN06M

➢ 8 mm focal length lens: DMV-LN08M

➢ 12 mm focal length lens: DMV-LN12M

➢ 16 mm focal length lens: DMV-LN16M

➢ 25 mm focal length lens: DMV-LN25M

➢ 35 mm focal length lens: DMV-LN35M

➢ 50 mm focal length lens: DMV-LN50M

◎ **Parallel Light Lens (Telecentric Lens)**

➢ 50 mm focal length: DMV-LN50T

1.1.4 LED Light Source (Optional)

◎ **Ring Light Source**

➤ Red light: DMV-DR6736R

➤ White light: DMV-DR6736W

➤ Diffuser Plate: DMV-DR6736D

30° lighting angle; 36 mm inner radius; 67 mm outer radius for general text surfaces

◎ **Coaxial Light Source**

➤ White Light: DMV-CX40W

40 mm * 40 mm glass window for highly reflective (e.g., metal) surfaces

◎ **Backlight**

➤ Red Light: DMV-BL60R

60 mm * 60 mm for backlight illumination during size measurement

◎ **Power Supply**

| ➤ One channel output: | ➤ Two channel output: | ➤ Power extension cord: |
| DMV-PS12C1 | DMV-PS12C2 | DMV-CA30P |

The flashlight controller is built into the power supply and the DMV-CA30 (3 m) is included when you purchased a light source.

1.2 Controller Unit

1.2.1 Specifications

◆ **General Specifications**

Input power	24 VDC
Operation voltage	90%–110% of rated voltage
Current consumption	Two cameras: <2.5 A
Vibration resistance	5 ~ 8.4Hz/3.5mm, 8.5 ~ 150Hz/1G; 1 hr; 3-axis
Shock resistance	Max. 15G; 3 axis 6 directions; 3 drops
Operating temperature	0°C ~ 45°C
Storage temperature	-20°C ~ 65°C
Operating humidity	35–65% RH (non-condensing)
Operating altitude	Lower than 2,000 m
Battery lifespan	More than 5 years

◆ **Functional Specifications**

Camera	Type	GigE digital color/gray-scale camera
	Resolution	0.3 MP Camera: 640 (H)*480 (V), 120 fps
		2 MP Camera: 1600 (H)*1200 (V), 50 fps
	Connected systems	Up to 2 units
	Shutter speed	0.3 MP/ 2MP: 17us–1.8s
	Lens mount	C mount
	Operating temperature	0°C ~ 45°C
	Storage temperature	-20°C ~ +65°C
Project quantity		Internal memory: 1000 Memory card: additional memory space; upper limit at 9999 May switch through communication ports (RS232/ RS485, Ethernet)
Inspection window	Quantity	Maximum 512 per process, up to 2 processes per project; maximum 1024 per project
	Inspection component	Area, blob, stain, edge angle, edge count, edge pitch, edge position, edge width, shape, intensity, position trace, width trace, OCV, Bar Code, 2D Bar Code
	ROI type	Rectangle, circle, polygon, ellipse, circle, arc, rotation rectangle
	Number of	1

	ROIs	
	Mask type	Rectangle, circle, polygon, ellipse, circle, arc, rotation rectangle
	Mask quantity	8 (each inspection window)
Preprocess	Quantity	13
	Type	Binary, dilation, erosion, average, median, Laplacian, Sobel X, Sobel Y, Sobel XY, subtraction, custom, contrast, shade, brightness 6 kinds of color to gray scale: RGB Grayscale、Color Binary, Color Distance, R Grayscale, G Grayscale, B Grayscale
Run mode		Always execution, never execution, Reference Execution
Calculation processing	Quantity	Maximum 1024 sets (each project)
	Arithmetic	Add, subtract, multiply, divide
	Function (71 types)	Complete Flag: EQ；NOT_EQ；LT；LE；GT；GE；AND Logic: AND；BIT_AND；OR；BIT_OR；XOR；BIT_XOR；NOT；BIT_NOT Lookup: INRANGE；CHOOSE；MAXN；MINN；MAXthN；MINthN Math: ABS；POW；MOD；LOG10；LN；EXP；SQR；SQRT；SUM；TRUNC；ROUND；CEIL；FLOOR Trigo: SIN；SINH；COS；COSH；TAN；TANH；ASIN；ACOS；ATAN；ATAN2；RAD；DEG；PI Stat Func.: MAX；AVG；AVG_RANGE；MIN；SDEV；MEDIAN Geometry: LINE_DIST；LINE_ISECT_X；LINE_ISECT_Y；CIRCLE_CX；CIRCLE_CY；CIRCLE_CR；ANGLE_H_POS；ANGLE_H_LINE；ANGLE_LINE；LINE_FITM；LINE_FITC；CIRCLE_FITD；CIRCLE_FITE；CIRCLE_FITF；POS_LINE_DIST；POS_LINE_DIST_X；POS_LINE_DIST_Y；POS_CIRCLE_DIST；ISEC_LINE_CIRCLE_CNT； ISEC_LINE_CIRCLE_X0；ISEC_LINE_CIRCLE_Y0；ISEC_LINE_CIRCLE_X1；ISEC_LINE_CIRCLE_Y1；ISEC_ CIRCLE_CIRCLE_CNT； ISEC_ CIRCLE_CIRCLE_X0；ISEC_ CIRCLE_CIRCLE_Y0；ISEC_CIRCLE _CIRCLE_X1；ISEC_ CIRCLE_CIRCLE_Y1；PANEL_ANGLE；PANEL_DIST；PANEL_OFFSET_X；PANEL_OFFSET_Y；CAM_CALI_CONV_X；CAM_CALI_CONV_Y
Communication port		Programmable input pins: 8 Programmable output pins: 8 RS232 (maximum 234,000 bps), RS485 (maximum 230,400 bps), Ethernet (10/100/1000BASE-T)
Display	Monitor Display	Resolution: 1024*768
	Operating	Traditional Chinese, Simplified Chinese, English

	language	
	Output interface	VGA
Operating interface	Mouse	Standard 3-button
Flash control		Setup output control through I/O contact, supports a maximum of 2 sets
Type of memory card		MicroSD card (supports maximum 32GB); Class 10

1.2.2 Names of Controller Components
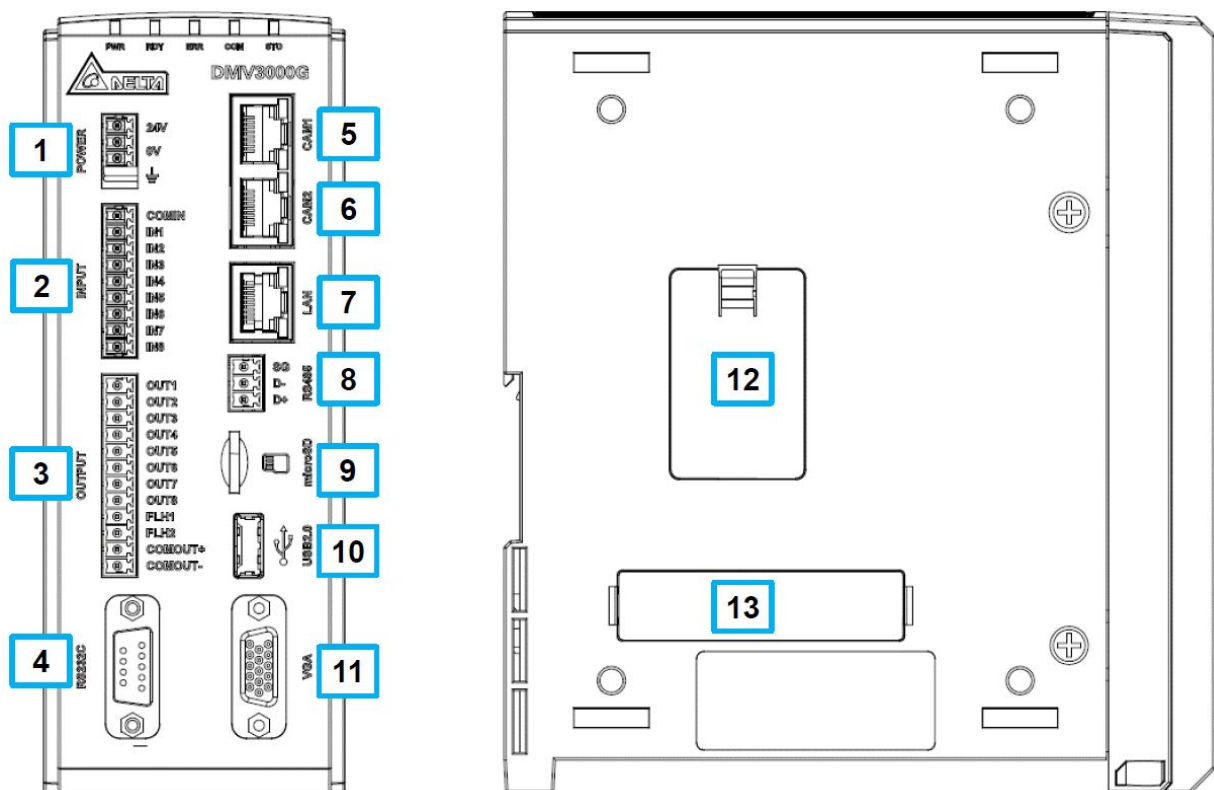
Serial No.	Name	Description
1	Power input terminal block	24V power input
2	Input I/O terminal block	Input terminal (9 pin)
3	Output I/O terminal block	Output terminal (12 pin)
4	RS-232 serial port	Supports master/slave serial communication
5	Camera 1 port	GigE port
6	Camera 2 port	GigE port
7	Ethernet port	10/100/1000 BASE-T communication
8	RS-485 serial port	Supports master/slave serial communication
9	SD card	Saves project configuration and image backup
10	USB 2.0 port	Mouse interface
11	VGA output port	Connects to commercial VGA interfaced displays
12	Button cell port	Powers system clock operation
13	Expansion port	Light source control, I/O extension

1.2.3 Camera Installation and Dimensions

◎ **0.3 MP/ 2MP Camera**

Dimensions in millimeters.

尺寸	A	B
DMV-CM2MXGE-D	17.30 mm	51.80 mm
DMV-CM30XGE-D	16.18 mm	50.68 mm
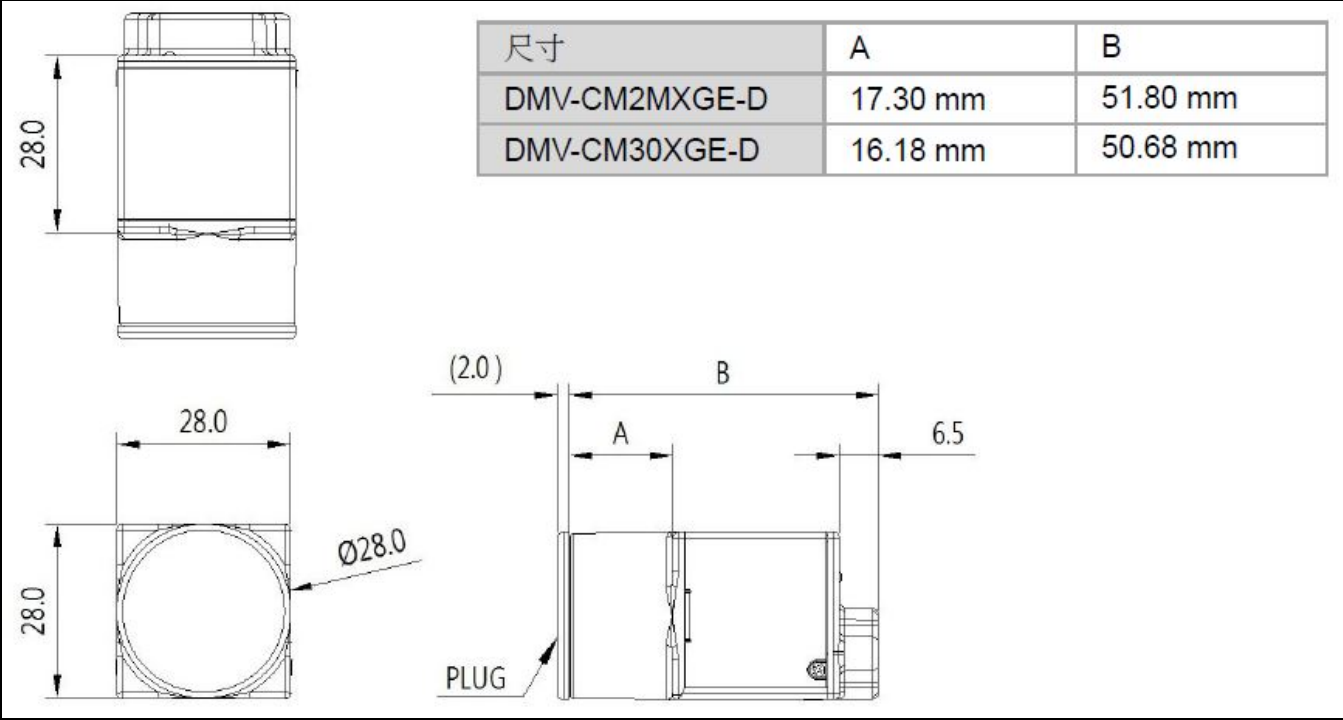
1.3 Grounding and Installation

1.3.1 Grounding

Caution:

1) Do not connect or disconnect the wires while system is powered on.

2) The grounding wire should be the minimum length using the wire gauge specified by relevant laws and regulations. The grounding resistance must be under 100 Ω.

3) Please ground the DMV controller separately from other devices. Do not directly connect to other power devices.
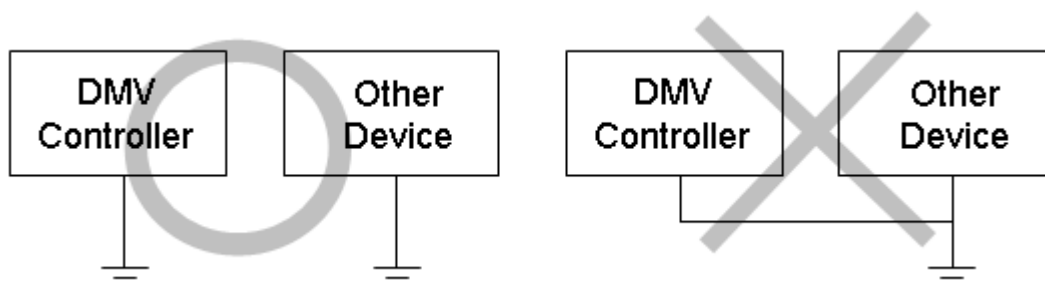
1.3.2 Installation

The DMV system provides DIN rail installation

➤ Installation method (must be installed in standard 35-mm rail groove)
  1) Place the controller unit onto the aluminum rails.
  2) Gently push down on the controller and slide it into place on the aluminum rails.

➤ Disassembly
  1) Insert the screwdriver into the DIN rail latch.
  2) Push down on the holding latch to release the controller and then remove it.
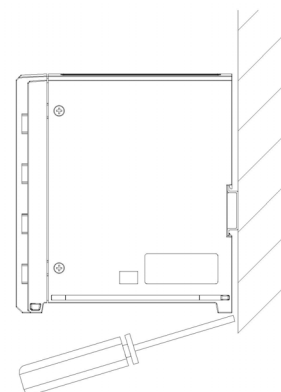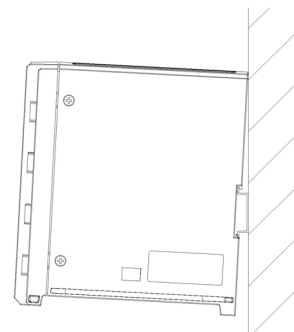
Please keep at least 50 mm above and 30 mm to the left and right of the controller for proper ventilation. Excessive operating temperature due to insufficient cooling will damage the controller.

Please keep at least 100 mm of space in front of the wiring panel for ease of access.

1.4 Camera and Lens Selections

The camera paired with the DMV3000G controller is GigE compatible. It's recommended to use Delta model DMV-CM series camera. Before selecting the lens, please confirm the field of view and working distance between the lens and test object. Refer to the following table for a suitable lens.

■   0.3MP Camera

Field of view (mm) Horizontal (H) * Vertical (V)	Focal length 8mm		Focal length 12mm		Focal length 16mm		Focal length 25mm		Focal length 35mm		Focal length 50mm		Resolution um/pixel 1600 * 1200
	Dis.	R	Dis.	R	Dis.	R	Dis.	R	Dis.	R	Dis.	R	
250(H)*188(V)	665	0											
225(H)*169(V)	593	0											
200(H)*150(V)	526	0											
175(H)*131(V)	458	0											
150(H)*113(V)	390	0	610	0									
140(H)*105(V)	362	0	568	0									
130(H)*98(V)	337	0	527	0	660	0							
120(H)*90(V)	308	0	485	0	630	0							
110(H)*83(V)	281	0	442	0	573	0							
100(H)*75(V)	255	0	400	0	522	0							
90(H)*68(V)	229	0	362	0	468	0							
80(H)*60(V)	204	0	318	0	414	0	654	0					
75(H)*56(V)	190	0	298	0	385	0	619	0					
70(H)*53(V)	175	0	277	0	360	0	578	0					
65(H)*49(V)	160	0	255	0	335	0	540	0					
60(H)*45(V)	148	0	234	0	307	0	492	0					
55(H)*41(V)	133	0	214	0	280	0	450	0	640	0			
50(H)*38(V)	120	0.5	194	0	254	0	410	0	580	0			
45(H)*34(V)	108	0.5	174	0	224	0	368	0	520	0			
40(H)*30(V)	96	0.5	154	0	200	0	328	0	460	0			
35(H)*26(V)	78	0.5	130	0.5	172	0.5	280	0	410	0	624	0	
32.5(H)*24.4(V)	72	0.5	120	0.5	158	1	260	0	378	0	580	0	
30.0(H)*22.5(V)	68	0.5	110	0.5	145	1	240	0	350	0	538	0	
27.5(H)*20.6(V)	60	1	100	0.5	130	1	220	0	320	0	495	0	
25.0(H)*18.8(V)	53	1	89	1	118	1	200	0	291	0	450	0	
22.5(H)*16.9(V)	45	1	78	1	104	2	180	1	264	0	408	0	
20.0(H)*15.0(V)	37	1	66	1	90	2	160	1	235	0	368	0	
18.0(H)*13.5(V)			60	1	79	2	142	2	211	0	335	0	

Field of view (mm) Horizontal (H) * Vertical (V)	Focal length 8mm		Focal length 12mm		Focal length 16mm		Focal length 25mm		Focal length 35mm		Focal length 50mm		Resolution um/pixel
	Dis.	R	Dis.	R	Dis.	R	Dis.	R	Dis.	R	Dis.	R	1600 * 1200
17.0(H)*12.8(V)			55	2	73	2	134	2	202	0	313	0	
16.0(H)*12.0(V)			51	2	70	2	125	2	189	0.5	297	0	
15.0(H)*11.3(V)			48	2			115	5	178	1	281	0	
14.0(H)*10.0(V)			43	2			108	5	166	2	264	0	
13.0(H)*9.8(V)			38	2			100	5	155	2	245	0	
12.0(H)*9.0(V)							92	5	140	5	230	0	
11.0(H)*8.3(V)							84	5	128	5	212	0	
10.0(H)*7.5(V)							74	5	118	5	196	1	
9.0(H)*6.75(V)							65	7	105	7	177	5	
8.0(H)*6.00(V)							57	7	94	10	162	5	
7.5(H)*5.63 (V)							53	10	88	10	150	10	
7.0(H)*5.25(V)							49	10	82	10	142	10	
6.5(H)*4.88(V)									77	15	133	10	
6.0(H)*4.50(V)									70	15	124	15	
5.5(H)*4.13(V)									65	17	115	15	
5.0*H)*3.75(V)									58	20	108	20	
4.5(H)*3.38(V)											99	30	
4.0(H)*3.00(V)											93	40	

■ 2MP Camera

Field of view (mm) Horizontal (H) * Vertical (V)	Focal length 8mm		Focal length 12mm		Focal length 16mm		Focal length 25mm		Focal length 35mm		Focal length 50mm		Resolution um/pixel
	Dis.	R	Dis.	R	Dis.	R	Dis.	R	Dis.	R	Dis.	R	1600 * 1200
600(H)*450(V)	660	0											375
500(H)*375(V)	560	0											313
400(H)*300(V)	448	0	690	0									250
350(H)*263(V)	388	0	620	0									219
300(H)*225(V)	325	0	515	0	675	0							188
250(H)*188(V)	270	0	428	0	558	0							156
225(H)*169(V)	240	0	380	0	498	0							141
200(H)*150(V)	212	0	340	0	440	0							125
175(H)*131(V)	184	0	294	0	384	0	612	0					109
150(H)*113(V)	156	0	250	0	328	0	525	0					94
140(H)*105(V)	145	0	232	0	304	0	496	0					88

Field of view (mm) Horizontal (H) * Vertical (V)	Focal length 8mm		Focal length 12mm		Focal length 16mm		Focal length 25mm		Focal length 35mm		Focal length 50mm		Resolution um/pixel 1600 * 1200
	Dis.	R	Dis.	R	Dis.	R	Dis.	R	Dis.	R	Dis.	R	
130(H)*98(V)	133	0	214	0	280	0	455	0	642	0			81
120(H)*90(V)	125	0	198	0	258	0	420	0	595	0			75
110(H)*83(V)	114	0	180	0	235	0	385	0	542	0			69
100(H)*75(V)	98	0.5	162	0	214	0	347	0	493	0			63
90(H)*68(V)	87	0.5	148	0.5	190	0	310	0	448	0			56
80(H)*60(V)	77	0.5	128	0.5	167	0.5	278	0	398	0	605	0	50
75(H)*56(V)	71	0.5	120	0.5	155	0.5	260	0	375	0	572	0	47
70(H)*53(V)	67	0.5	110	0.5	144	0.5	243	0	350	0	532	0	44
65(H)*49(V)	60	0.5	102	0.5	132	1	224	0	327	0	500	0	41
60(H)*45(V)	55	0.5	90	1	120	1	207	0	302	0	465	0	38
55(H)*41(V)	50	1	81	1	109	2	188	1	278	0	425	0	34
50(H)*38(V)	44	1	72	1	96	2	170	1	255	0	392	0	31
45(H)*34(V)	39	1	62	1	85	2	151	2	225	0	355	0	28
40(H)*30(V)	33	1.5	54	1.5	75	2	135	2	203	0	312	0	25
35(H)*26(V)	27	1.5	45	1.5			115	5	176	1	277	0	22
32.5(H)*24.4(V)	23	1.5	42	1.5			105	5	162	2	260	0	20
30.0(H)*22.5(V)	20	2	38	2			97	5	150	2	239	0	19
27.5(H)*20.6(V)							88	5	136	5	222	0	17
25.0(H)*18.8(V)					40	5	79	5	125	5	200	0	16
22.5(H)*16.9(V)					34	5	70	7	113	7	186	2	14
20.0(H)*15.0(V)					28	5	63	7	99	7	166	5	13
18.0(H)*13.5(V)			16	5	24	6	55	9	89	10	155	5	11
17.0(H)*12.8(V)			13	5			52	10	84	10	145	7	11
16.0(H)*12.0(V)							48	10	80	12	136	10	10
15.0(H)*11.3(V)							44	10	75	15	130	10	9
14.0(H)*10.0(V)									70	15	123	15	9
13.0(H)*9.8(V)									65	17	116	15	8
12.0(H)*9.0(V)									60	17	110	20	8
11.0(H)*8.3(V)									55	20	103	20	7
10.0(H)*7.5(V)									50	20	95	25	6
9.0(H)*6.75(V)									45	25	87	30	6
8.0(H)*6.00(V)									40	25			5

Remark Dis. is the working distance and R is the size of the extension circle.

Increasing depths of field increases the range of focus. The following characteristics affect the depth of field:

➤ Longer extension circles results in shallower depths of field; thus the depth of field increases when using shorter extension circles.

➤ Longer working distance results in a deeper depth of field.

➤ Smaller aperture results in a deeper depth of field.

➤ Shorter focal length of the lens results in a deeper depth of field.

Chapter 2

Input and Output Interface

The DMV3000G input and output interfaces include the following:

- I/O terminal
- RS232
- RS485
- Ethernet
- Micro SD card

The pins and wiring connections are defined and detailed below.

2.1 Input / Output (I/O) Terminal Block

The input/output terminals are 9 pin (input) and 12 pin (output) removable terminals. The contact functions and default values are defined in the following picture. You can define each input/output function according to your needs.

➤ On the DMV3000G terminal, in the Main window, click **Tool**, then click **Communication**, then click **I/O**, then click **Input /Output**, and finally click **External Terminal**.
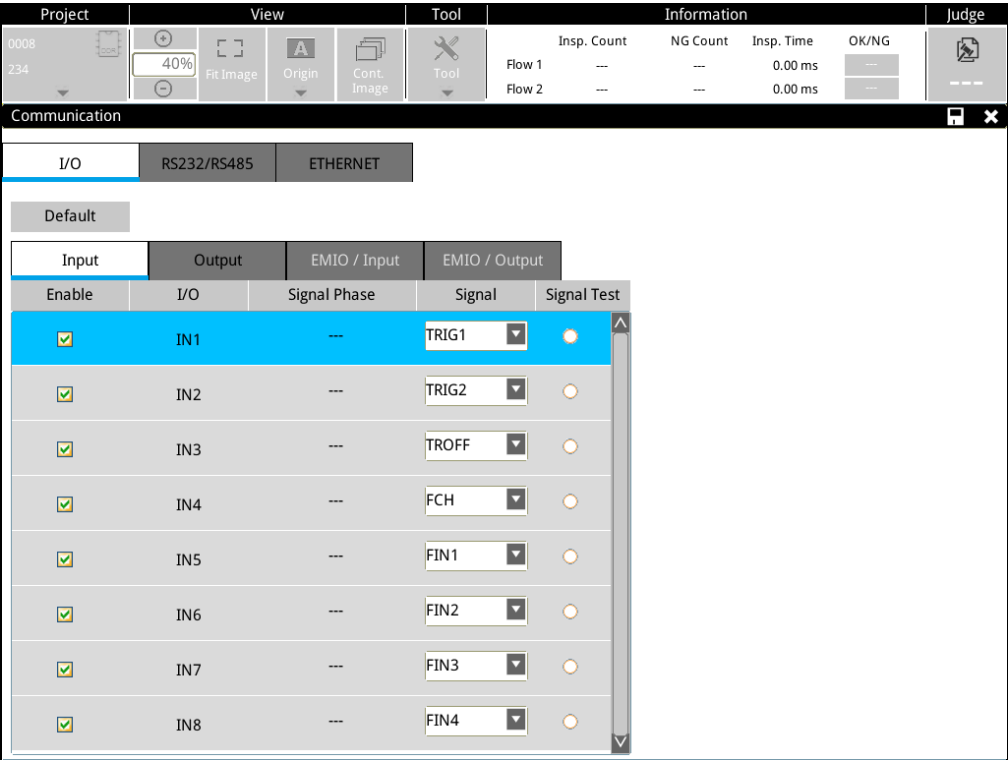
| 🗐 Reference | Please refer to Chapter 7 for the purpose and sequence of each terminal. |

2.1.1 9-Pin Input Terminal

The following table lists the input functions with the default values, and can be changed according to your application.

Serial No.	Name	Description
1	COMIN	Input common contact
2	IN1	Input 1
3	IN2	Input 2
4	IN3	Input 3
5	IN4	Input 4
6	IN5	Input 5
7	IN6	Input 6
8	IN7	Input 7
9	IN8	Input 8

COMIN
IN1
IN2
IN3
IN4
IN5
IN6
IN7
IN8
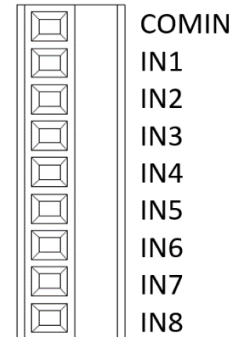
◆ **Input schematic** (NPN input)
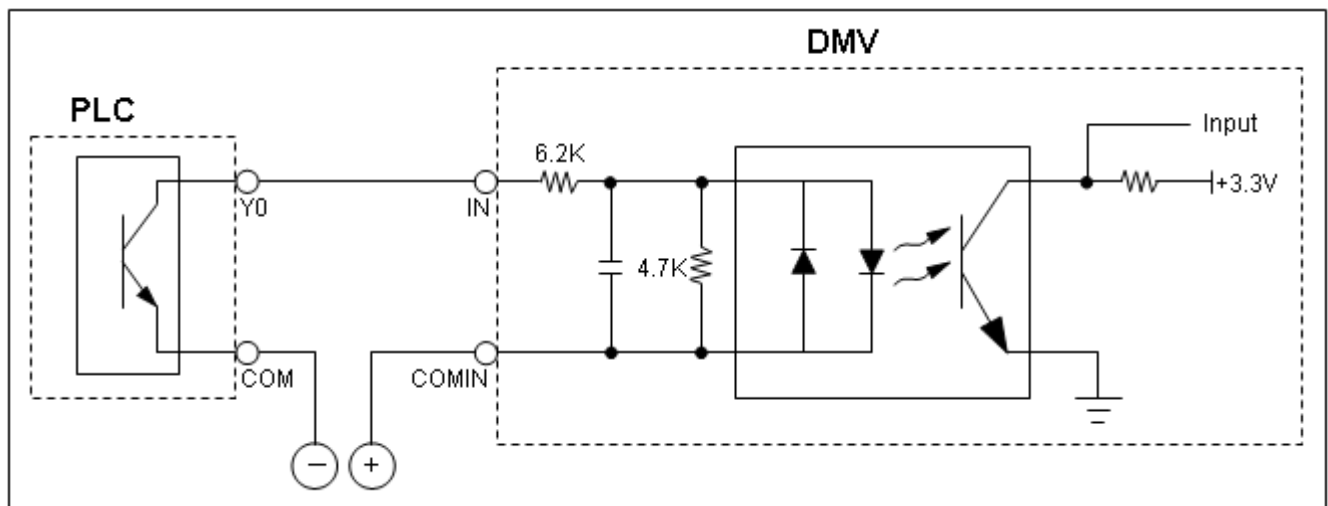
◆ **Input schematic** (PNP input)
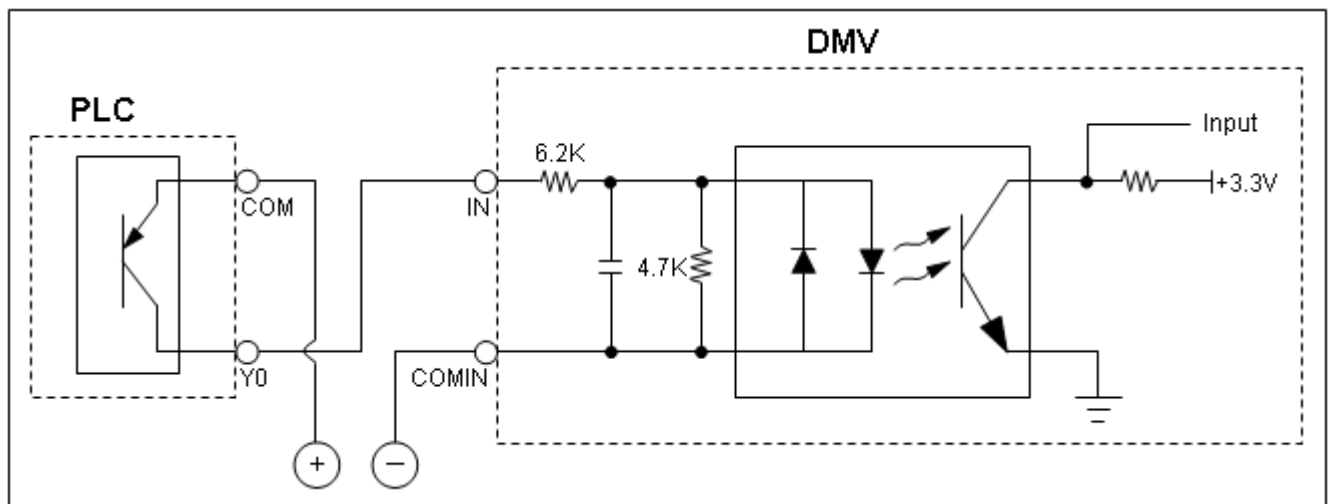
2.1.2 12-Pin Output Terminal

The following table lists the output functions with the default values, which can be changed according to your application.

Serial No.	Name	Description
1	OUT1	Output 1
2	OUT2	Output 2
3	OUT3	Output 3
4	OUT4	Output 4
5	OUT5	Output 5
6	OUT6	Output 6
7	OUT7	Output 7
8	OUT8	Output 8
9	FLH1	Camera 1 light source strobe control output
10	FLH2	Camera 2 light source strobe control output
11	COMOUT+	Output common contact. Connect the positive terminal of the power source
12	COMOUT-	Output common contact. Connect the negative terminal of the power source

OUT1
OUT2
OUT3
OUT4
OUT5
OUT6
OUT7
OUT8
FLH1
FLH2
COMOUT+
COMOUT-

◆ **Normal output circuit diagram** (fixed to NPN output)

◆ **Normal output circuit diagram** (fixed to PNP output)
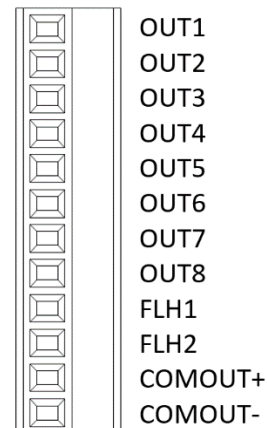
◆ **Light source dimmer strobe control output circuit diagram** (fixed to NPN output)
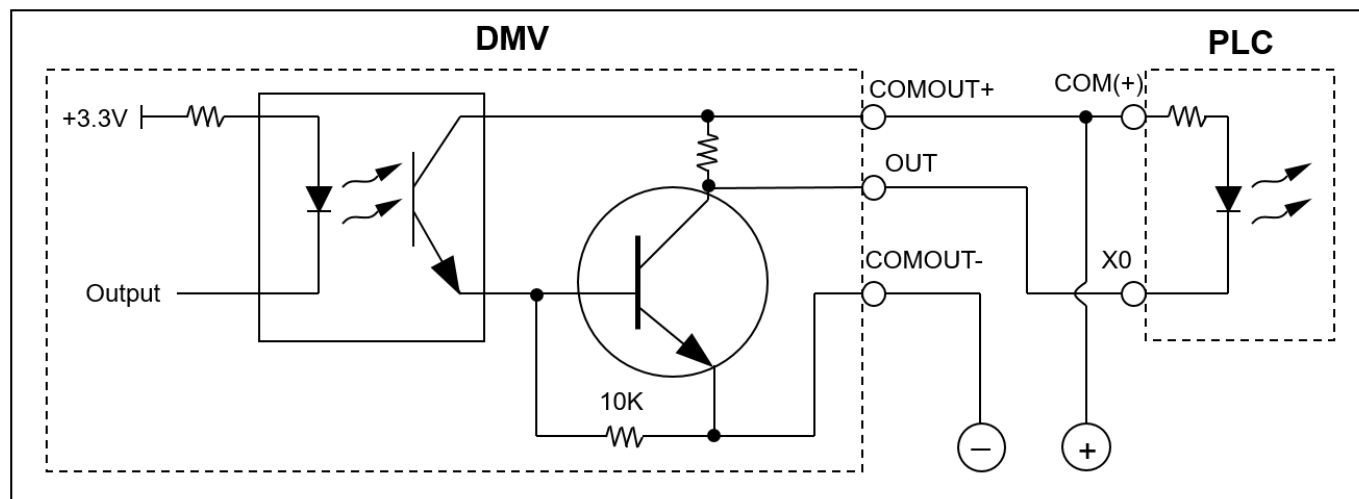
2.1.3 Input / Output Contacts Descriptions

Name	Description	Mode	Name	Description	Mode
TRIG1	Trigger capture 1	Input	READY1	Controller ready output indicator 1	Output
TRIG2	Trigger capture 2	Input	READY2	Controller ready output indicator 2	Output
TEST	Test status (results are not generated in the output)	Input	REND1	Camera 1 captured	Output
TROFF	Trigger disabled (inspection disabled)	Input	REND2	Camera 2 captured	Output
RST	System reset	Input	RUN	Run status indicator	Output
			ERR	Error status indicator	Output
			TOUT1	Result output 1	Output
			TOUT2	Result output 2	Output
			TOUT3	Result output 3	Output
			TOUT4	Result output 4	Output
			TOUT5	Result output 5	Output
			TOUT6	Result output 6	Output
			TOUT7	Result output 7	Output
			TOUT8	Result output 8	Output
			FLH1	Camera 1 light source strobe control output	Output
			FLH2	Camera 2 light source strobe control output	Output

Reference Please refer to Section 2.1.1 and 2.1.2 for input and output connection.

2.2 RS232/RS485 Serial Output

The system includes both RS232 and RS485 serial communication interfaces. The two interfaces operate independently and you can configure different baud rates and protocols for each serial port.

➤ On the DMV3000G terminal in the Main window, click **Tool**, then click **Communication**, and finally click **RS232** /**RS485**.

Select the DMV3000G's communication station number in the RS485 settings (**ID**).
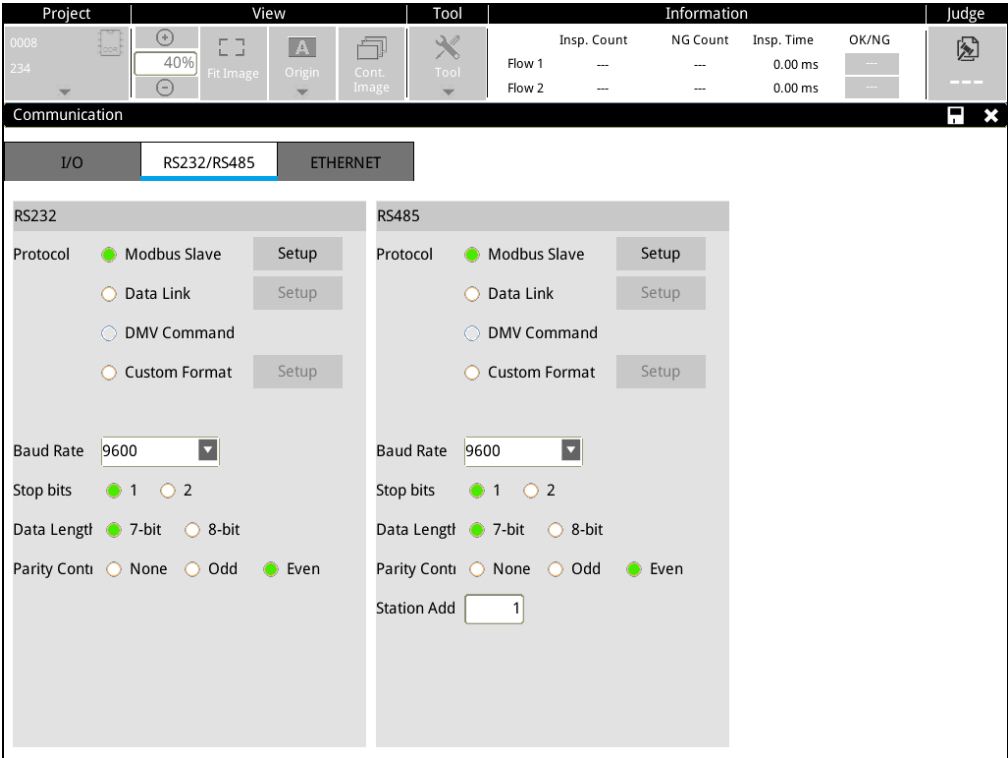
![Reference] Please refer to Chapter 8 for communication.

2.2.1 RS232/RS485 Pins

◎ **RS232**

The DMV can connect directly to the PC.

DMV	2 TX	2 RX	PC& DOP-HMI
	3 RX	3 TX	
	5 GND	5 GND	
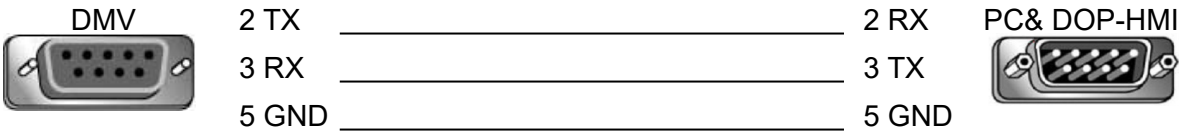
You must reverse RX and TX when connecting to a Delta PLC (using the COM3 RS232 expansion card).

DMV	2 TX	3 RX	DVP-PLC
	3 RX	2 TX	
	5 GND	5 GND	
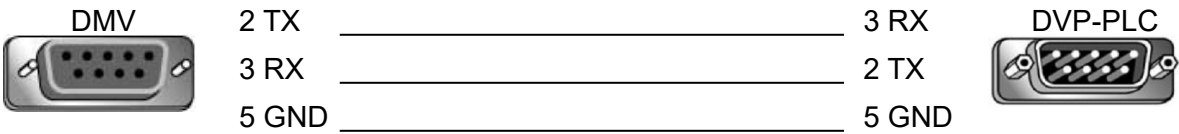
◎ **RS485**

The main DMV3000G unit has a three-wire RS485 port, which is capable of executing one-to-many communication. When making wire connections, you can directly connect D+ and D- to the D+ and D- terminals on the component.

2.3 Ethernet Output

The DMV3000G Ethernet port uses the TCP/IP communication protocol.

➤ Configure the IP location of the unit. In the Main window, click **Tool**, click **Communication**, then click **Ethernet**, and finally click **Local**.

2.4 Micro SD Card

The unit supports MicroSD cards of up to 32 GB capacity for storing more projects and image files than you can store in the DMV internal memory.

1)   Expansion for the Number of Projects

The system memory is limited, but you can use a MicroSD card to expand the number of stored projects. You can select whether to store a project in the Micro SD card or the internal memory when adding a new project.
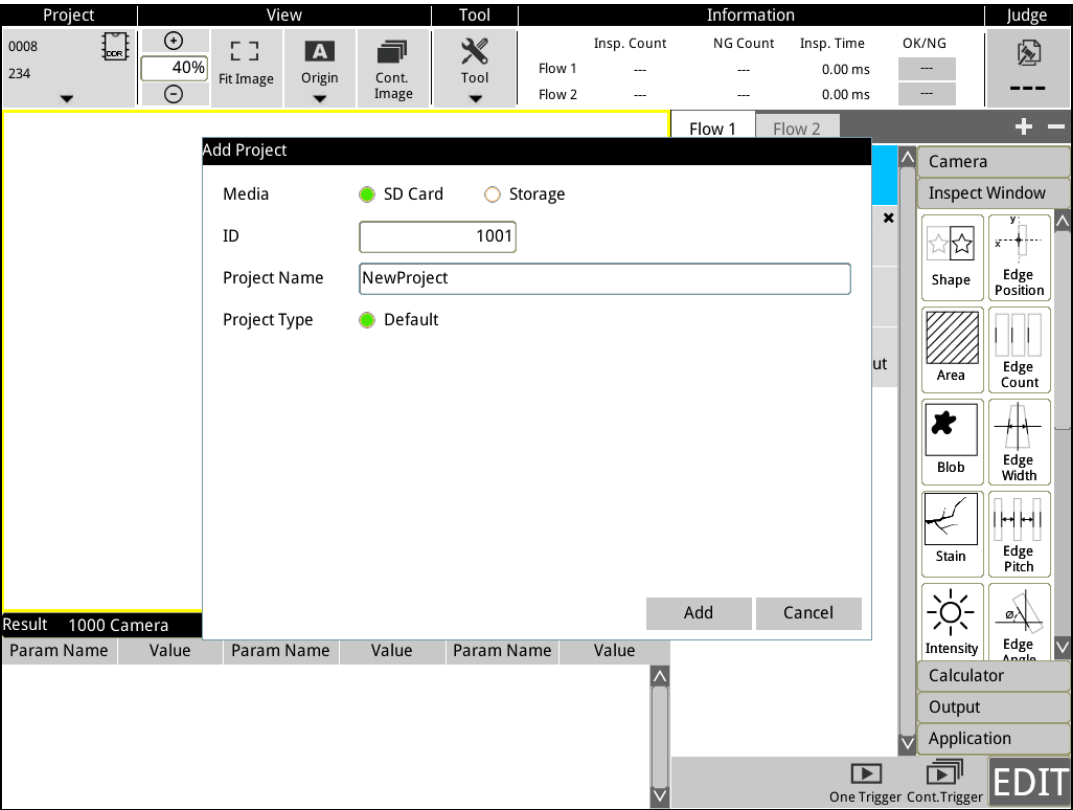
◎   **Storage for Inspection Image Files**

You can also use a MicroSD card to store the images from the inspection process for later analysis.

Chapter 3

Basic Operation

DMV3000G uses mouse or keyboard as interfaces for operating commands. This chapter primarily explains the page functions and project setting methods, which include main page, tool settings, and system settings.

3.1 Main Page Introduction

The following picture shows the Main window when you start the DMV3000G controller. Each feature is introduced and explained below.
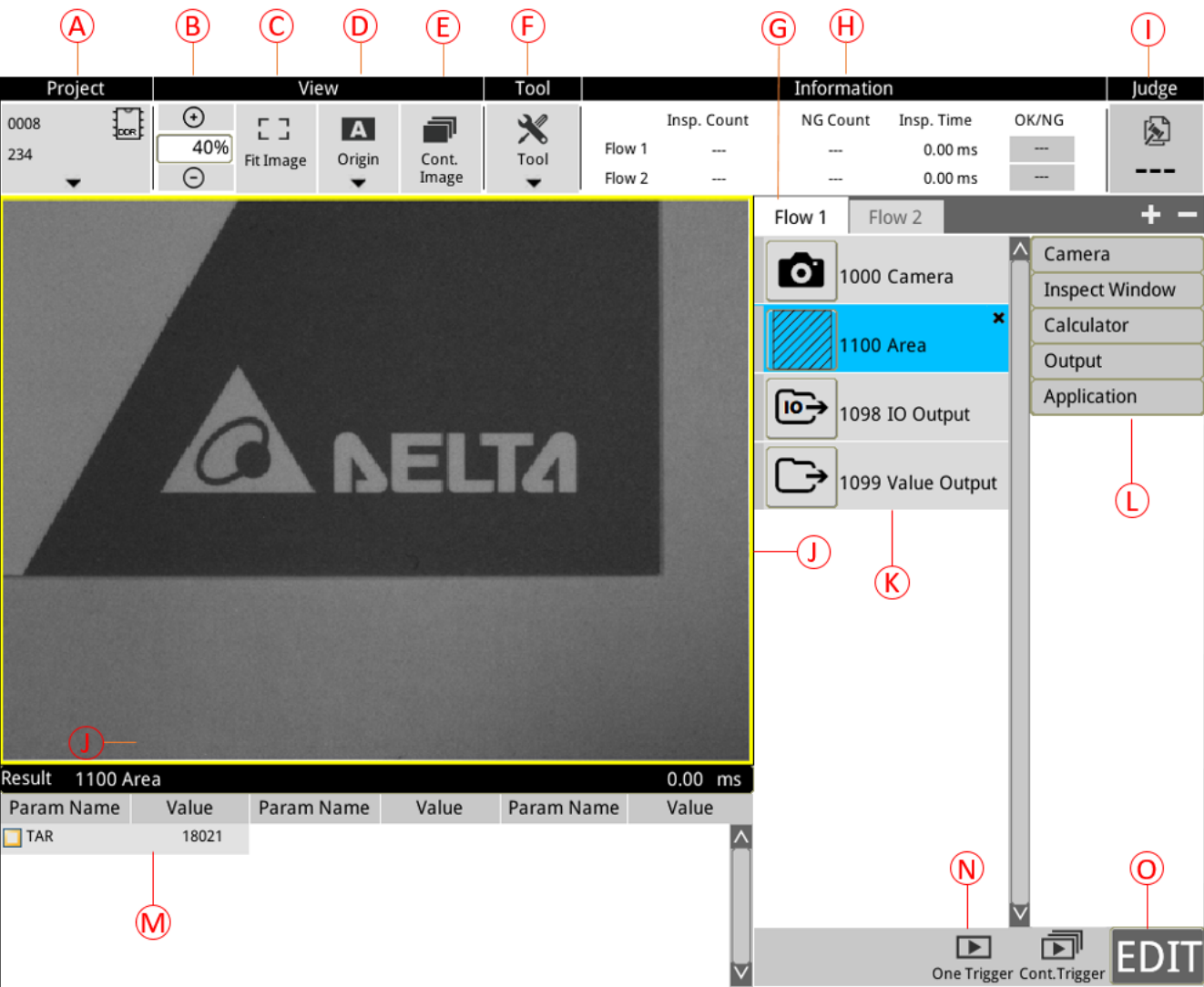
◎ **Project**

Project management, includes [add],, [delete] and [copy].

◎ **View > Zoom ratio**

Displays the current zoom ratio of the camera image.

◎ **View > Fit Image**

The camera image will be displayed in full-screen mode.

◎ **View > Origin**

Select the image and display as [Original Image], [Filter Image], and [Character Image].

◎ **View > Cont. Image**

After this is selected, the camera will automatically update and capture the screen.

◎ **Tool**

Configure [Trigger], [Flash], [Communication], [Environment].

◎ **Flow**

The system support up to 2 inspection processes at the same time (independent output). The 2 processes are both independent programs, and processes can be added and deleted using the [+] and [-] symbols on the right.

◎ **Information**

Displays the [Insp. Count], [Insp. NG Count], [Insp. Time], and [OK/NG] results of two processes. The source for determining OK/NG result is set by the user after clicking.

◎ **Judge**

Displays the final OK/NG result of the inspection.

◎ **Camera image**

Displays the camera image that is captured.

◎ **Inspection Flow Settings**

The inspection items can be separately set for each flow, and a maximum 128 inspection tools (inspect window + calculator) can be created for each inspection process.

◎ **Flow tools**

Flow tools include [Camera], [Inspection window], [Calculator], [Output], and [Other]. You may added tools to the inspection flow as needed by clicking on the tools.

◎ **Result**

When a different [Inspect window] is selected for an inspection flow, results of the inspection window that is selected will be displayed here. The number of results and items vary with each inspection window.

◎ **Trigger**

After configuring inspection flow settings, select [One Trigger] and [Cont.Trigger]. After triggering, the system will use the current image (not the register image) for inspection, and inspection results will be displayed under [Result] at the bottom of the screen, then select different inspection windows to view other results.

◎ **EDIT**

Switch between two modes, [Edit] and [Run].

3.2 Project Setup

Project setup is the first step of system operations. All subsequent inspection settings will be stored according to the selected project.

1) When a new project needs to be opened, please select [Add Project].
2) To run between Edit and Switch, please select [Switch/Copy/Delete/Rename...]
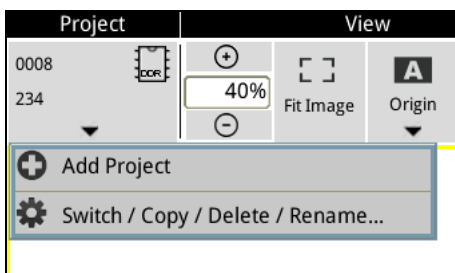
◎ When Add project is selected:

1) Media: Select whether to store the project in [SD card] or [Storage] (internal register).

2) ID: Set the project number. (Project number can be used in communications to switch between projects)

3) Project Name: Set the project name for more convenient access and management.

4) Project Type: Please select [Default], other options are for specific customers.
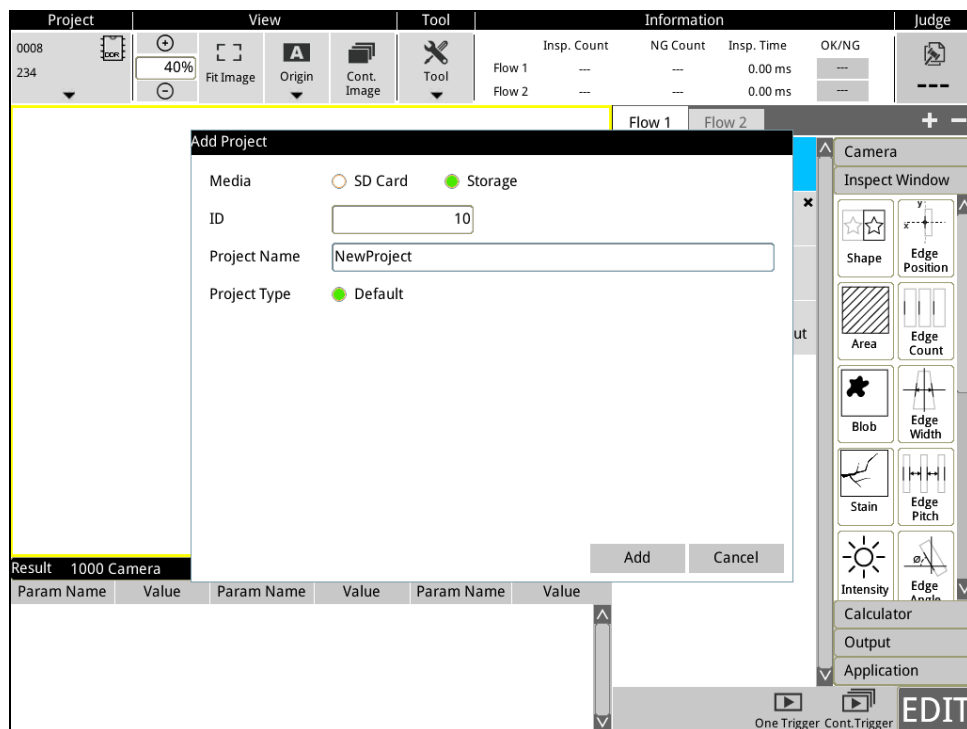
◎ When selecting Switch/Copy/Delete/Rename...:

1) Click on the [X] symbol on the right to delete a single project.
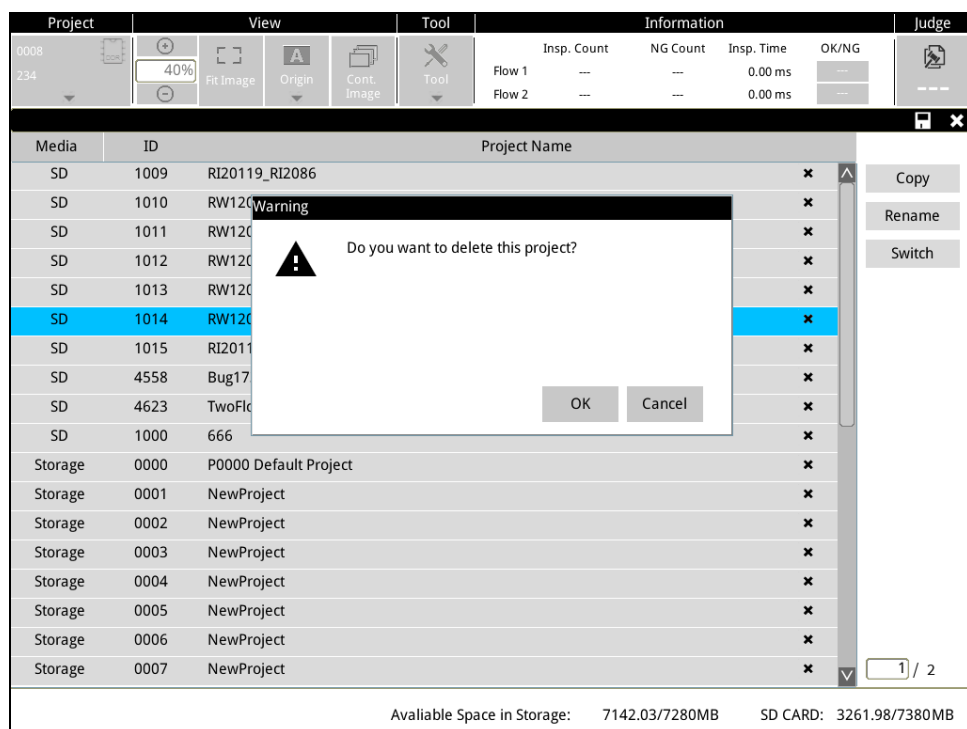
2) First select the project (e.g. P0002 in the figure below), then select [Copy] on the right and a copy of the page will be displayed, and then execute copy to the target location.
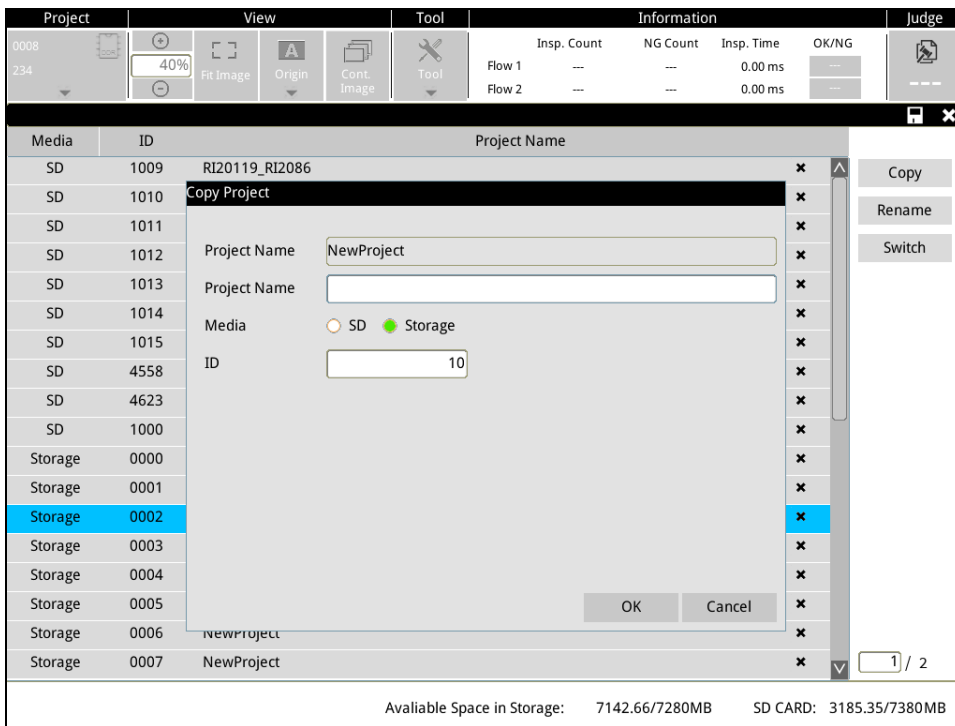
3) First select the project (e.g. P0002 in the figure below), then select [Rename] on the right to rename the project.
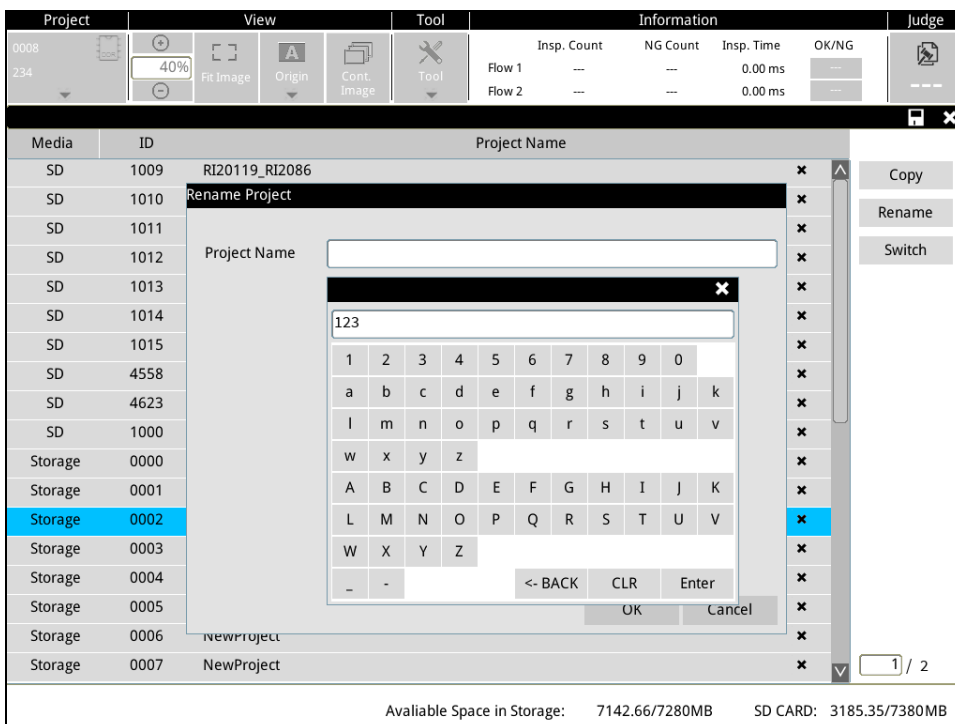
4) First select the project (e.g. P0002 in the figure below), then select [Switch] on the right to switch to the project that will be executed by the system.
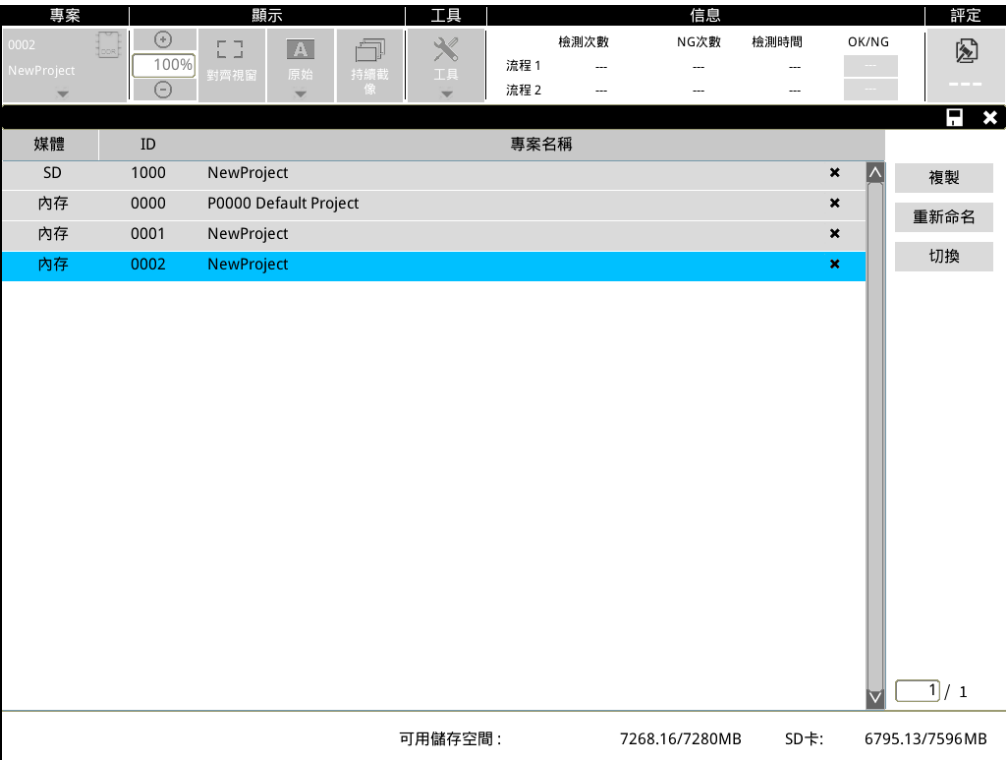
3.3 View Settings

Configure the camera image display method.

1) View percentage

Display an actual pixel of the camera image zoomed to the aspect ratio of the screen. Click on [+] or [-] to zoom in or out 5%.

2) Fit Image

Regardless of the ratio of the camera image, it will be displayed at 100% after clicking on resize window.

3) Origin

Select the camera image display method.

Original: The original image of the camera.

Filter: When a filter is set in the inspection window (e.g. binarization filter), the camera will be displayed after filtering for users to observe the filtered image.

Feature: Observe features of the image when using [Area], [Blob], [Stain], [Shape], [Position Trace], and [Width Trace] on the inspection window.
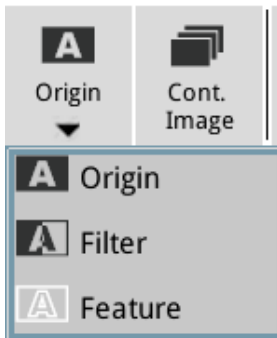
4) Cont. Image

After selecting [Cont. Image], the camera image captured will automatically be updated. If [Cont. Image] is not enabled, then the camera is updated once when the [One Trigger] button at the bottom of the screen is clicked.

3.4 Tool Settings

System functions and related parameter settings of DMV3000G include [Register], [Trigger Setting], [Flash Setting], [Communication], [Environment], and [Message].
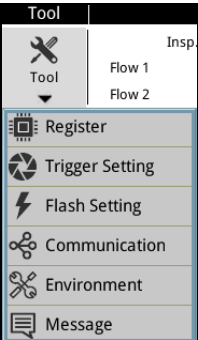
3.4.1 Register

The system provides 8000H-80FEH 256 DW registers in total. The values stored in these registers can be manually modified by users in the Edit page using their mouse, and can also be set via communications (RS232/RS485/Ethernet).

1)   Click on the [Edit] button on the right to define which inspection result will be written in this register after each inspection is completed. The name of the source of the result is displayed in [Item name].

2)   Click [X] on the right to delete settings.

3)   When the four point calibration [Coord. Conversion] function is selected, reference the number of the four point calibration coordinate conversion, inspection results will go through coordinate conversion before being stored in the register.

3.4.2 Trigger Setting

Set actions for [Trigger Source] and [Group Trigger].
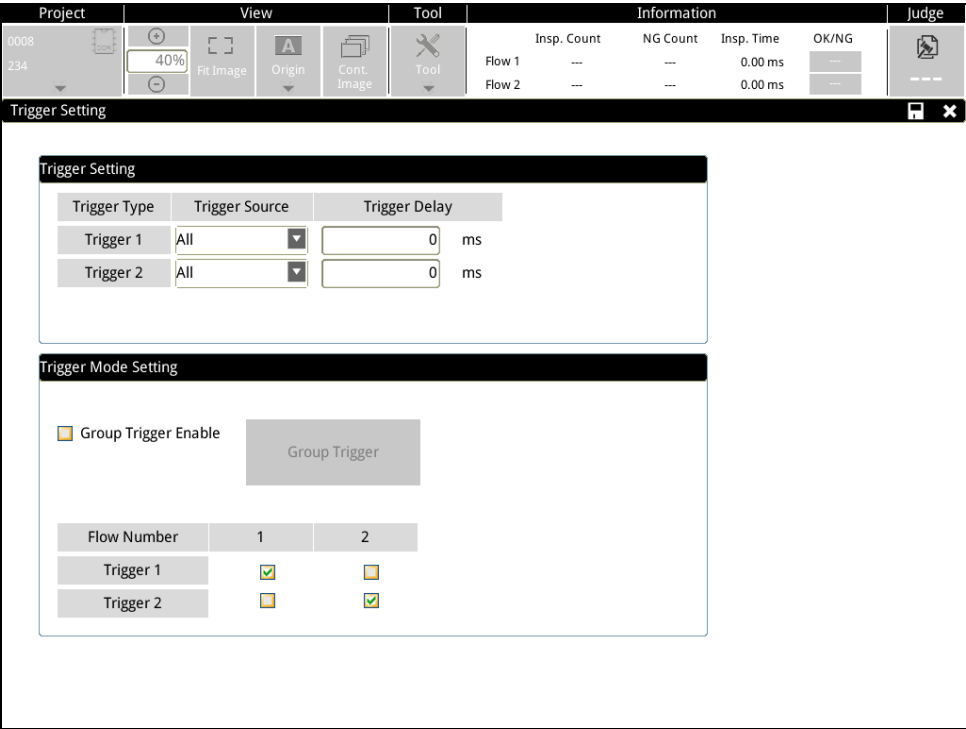
◎ Trigger Setting

1) When the [Trigger Source] is [All], all trigger interfaces, i.e., [I/O], [Ethernet], [RS232], and [RS485], can support trigger signal input. It is possible to select only one item to restrict the trigger sources.

2) [Trigger delay] delays the timing of the camera shutter. For example, if it is set at 3 ms, the system will activate the shutter 3 ms after the trigger.
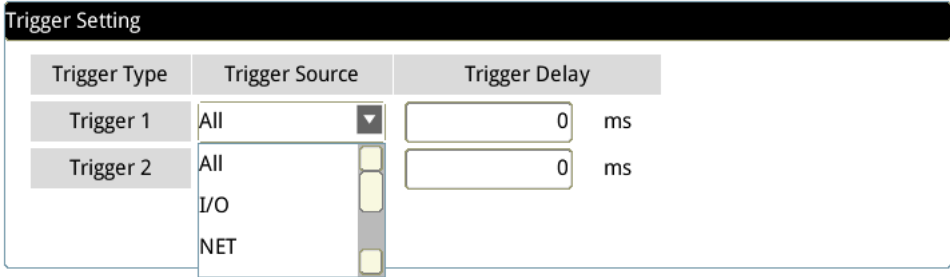
◎   Triggering mode setting:

Set the timing for actions of [Group Trigger] and the process number corresponding to Trigger 1 and 2.

1)   After [Group Trigger Enable], it enables the group trigger function.

2)   As shown in the figure below, Trigger1 is set as the trigger source. When it is triggered the first time, it will execute area inspection windows 1100 and 1101 of Flow1 in Group1.

3) Next, it will still use Trigger1 as the trigger source. When it is triggered the second time, it will execute area inspection windows 1102 and 1103 of Flow1 in Group2.
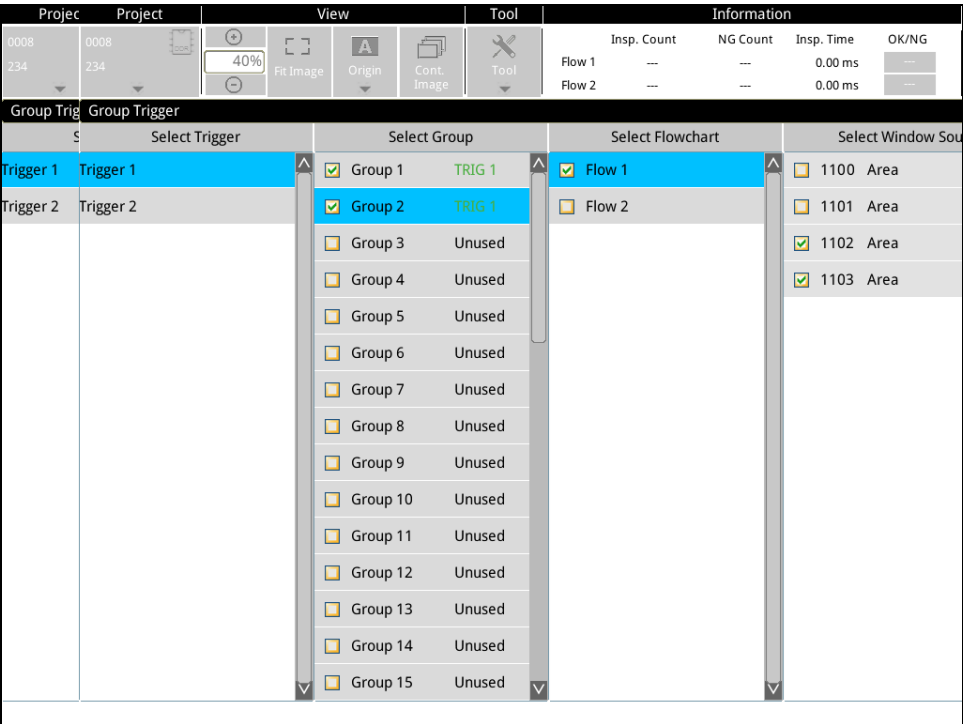
4) Therefore, in the settings above, if Trigger1 is triggered, only the inspection windows selected in Group1 are executed when it is triggered the first time, and only the inspection windows selected in Group2 are executed when it is triggered the second time. When it is triggered the third time, the inspection windows selected in Group1 are executed again.

5) The system may configure up to 2 independent inspection processes. As shown in the figure below, Process 1 may by triggered by Trigger 1 and Process 2 triggered by Trigger 2.
   Process 1 and 2 may also share the same trigger (e.g. both use Trigger 1) to be triggered at the same time.

Flow Number	1	2
Trigger 1	☑	☐
Trigger 2	☐	☑

3.4.3 Flash Setting

Configure light control [Flash] enable and action timing.

1) The flash is enabled after [Flash Source] is selected.

    The output control I/O pin for flash is established on the output end of the DMV3000G main unit. [FLH1] and [FLH2] are the I/O terminals for Flash 1 and 2, please connect them to the trigger input pins of the light controller.

2) [Output delay time] configures how long the shutter will be delayed after flash action. By delaying the time of the action after the light is turned on when the FLH signal of the flash is output to the light controller, the issue of the shutter already acting before the light source is full lit can be avoided.

    The response time of a typical light source is about 2 ms.

3) [During Time] configures the amount of time the light source is lit. The configured value generally needs to be greater than the shutter time to ensure that the light source is lit when the shutter opens to capture an image.

4) [Camera] configures the flash function when camera 1 or 2 is capturing an image.

Flash Setting

Flash Enable	Output Delay Time	During Time	Camera	
☑ Flash 1	2 ms	30 ms	● Camera 1	○ Camera 2
☐ Flash 2	0 ms	30 ms	○ Camera 1	● Camera 2

3.4.4 Communication

Provides 3 communications interfaces, namely [I/O], [RS232/ RS485], and [Ethernet]. In the inspection process, the three interfaces can operate independently and communicate with different devices.

Project		View			
0008		⊕	⌐ ⌐	A	
234		40%	Fit Image	Origin	Cont. Image
▼		⊖			▼

Communication

I/O	RS232/RS485	ETHERNET

◎   I/O interface
Input point I/O

1)   There are 8 input points IN1-IN8. After selecting [Open] on the left, the input point is activated.

2)   The NPN and PNP signals of the input point are changed through wiring.

3)   [Signal] specifies the function of this input point.

4)   [Signal Test] When there is an incoming input signal, the status turns green, making it convenient to determine if the wiring is correct during signal testing.

Output point I/O

1) There are 8 output points OUT1-OUT8. After selecting [Open] on the left, the output point is activated.

2) The NPN and PNP signals of the output point can be selected from [Output Type] at the upper right of the screen. (Hardware wiring also needs to be matched)

3) Select [Normal Output (NO)] or [Inverse Output (NC)] in [Signal Phase].

4) [Signal] can freely specify the function of this output point.

5) [Signal Test] Allows alternating actions to be manually selected, and the status turns green when this output point is in action, making it convenient to determine if the wiring is correct during signal testing.
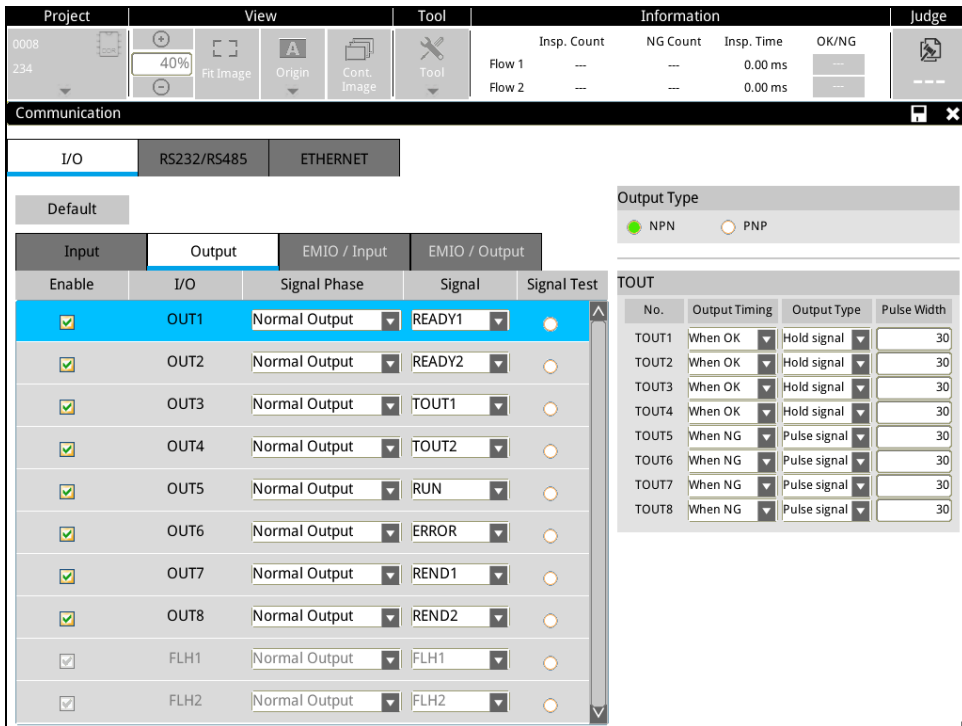
Expansion unit/Input and Expansion unit/Output

1) Can only be used after the left side of the DMV3000G main unit is connected to the I/O expansion unit.

TOUT

1) When the [Signal] is TOUT (the result is determined to be output), there are three settings.

　1-1) [Output Timing] defines the reference conditions of TOUT, and output is only executed when TOUT is OK or NG.

　1-2) When [Hold signal] is selected for [Output Type], the output will be maintained until the result of the next inspection changes the I/O status.

In contrast, when [Pulse Signal] is selected, the output action will only be maintained for the time defined in [Pulse Width].

TOUT

No.	Output Timing	Output Type	Pulse Width
TOUT1	When OK	Hold signal	30
TOUT2	When OK	Hold signal	30
TOUT3	When OK	Hold signal	30
TOUT4	When OK	Hold signal	30
TOUT5	When NG	Pulse signal	30
TOUT6	When NG	Pulse signal	30
TOUT7	When NG	Pulse signal	30
TOUT8	When NG	Pulse signal	30

◎   RS232/RS485

1)   RS232 and RS485 interfaces can operate independently at the same time.

2)   [Protocol] Select the communication protocol that will be used. (Explained below)

3)   The communication protocol can be freely defined; the default value is 9600, 7, E, 1.

4)   The DMV3000G station number can be set for RS485 (the default is number 1)

5) When Modbus Slave is selected, the master computer must send a Modbus command to access data from the DMV.

   5-1) Based on the contents of the DMV results, the result must be returned in 16-bit (word) or 32-bit (double word).

   5-2) Supports two communication protocols, Modbus ASCII and Modbus RTU.
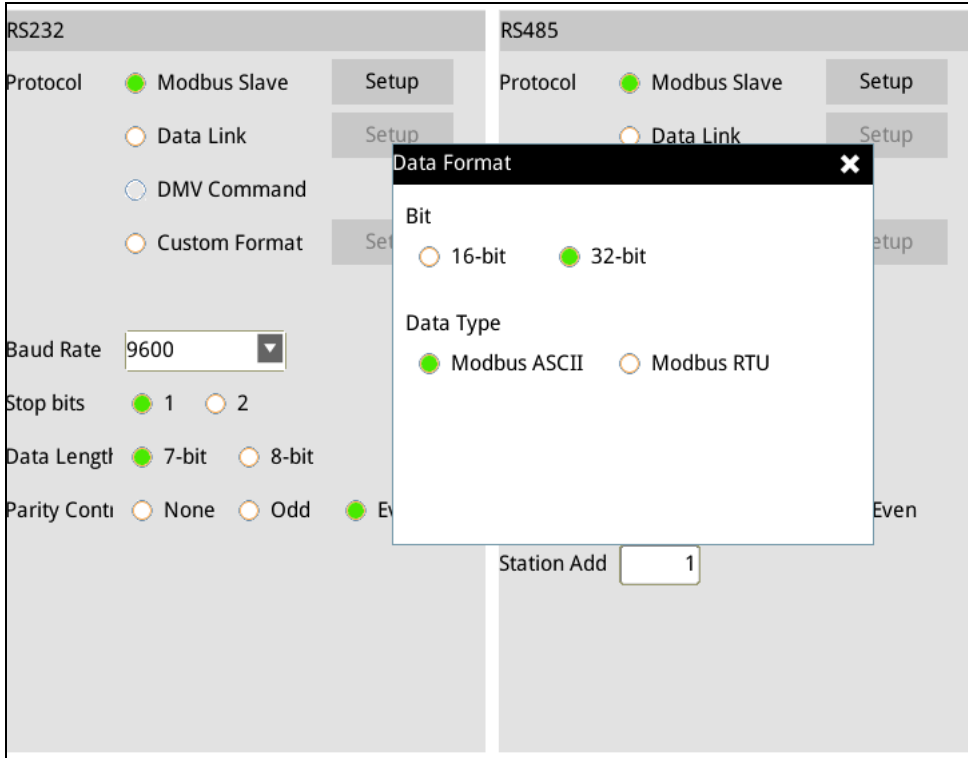
6) [Data Link] DMV3000G is the master. After each inspection is completed, DMV will actively write results into the register of the upper controller. (Currently only supports Delta Electronics industrial control products, such as PLC, SCALA...)

   6-1) [Bit] Configures whether DMV3000G outputs data in the 16-bit or 32-bit format.

   6-2) [Start address] Configuration results must be written into the starting register position of the upper controller.

   6-3) [Complete Flag] When results are written into the register, 1 is written into the position of this complete flag, so that the upper controller can determine that results writing was complete.

   6-4) [Timeout] When DMV3000G is writing into the upper controller, it can wait until the response timeout. Timeout indicates a communication error, and the output pin and status of ERROR will be ON.

   6-5) The station number of the upper controller must be written into [ID].

7) Custom format

7-1) DMV3000G is the master and the user freely defines the format of text that is output. Due to the numerous communication protocols of upper controllers in the market, allowing the text output format to be freely set, the requirements of different protocols can be satisfied.

Reference Please refer to Section 8.4 for detailed settings of RS232 private code.

◎   Ethernet

1)   When the [Protocol] selected is Modbus Slave, the DMV is the Server end and data is being read. Please configure the DMV main unit's IP in [Main unit].

2)   When the [Protocol] selected is custom format, the DMV is the client end and data is being output. Please configure the IP that will be written into the device in [Remote].

3)   When the [Protocol] selected is [Modbus Slave], select [Settings] to set 16/32 bits and the communication format ASCII/RTU.

4) When the [Protocol] selected is [Custom Format], select [Settings] for the user to freely define the format of text that is output. Due to the numerous communication protocols of upper controllers in the market, allowing the text output format to be freely set, the requirements of different protocols can be satisfied.

Screen displayed for custom format

Reference Please refer to Section 8.8 for detailed settings for the Ethernet private code.

## 3.4.5 Environment

Configure the system's initial state.

◎ General

1) Machine name: Displays the model of the current DMV.

2) Date/Time: Configures the calendar and time in the DMV main unit.

3) Language: Select the language. Currently supports Traditional Chinese, Simplified Chinese, and English.

4) Startup mode: Select the mode that the DMV system automatically enters after the machine is powered on again. Generally after inspection function configuration is completed, [Run Mode] will be selected so that the system directly enters the RUN status after being powered on again.

5) Screen Resolution: Currently only supports 1024*768

6) Enable grid: After this is selected, a grid will be displayed on the camera image based on the configured value (pixels) for customers to align the image.

7) Enable ruler: After this is selected, a scale is displayed on the left and top of the camera image.

8) Overlay Optimization: After this is selected, when multiple inspection functions use the filter function, the filtering results of all inspection windows will be independently displayed, making it convenient for users to see the filtering results of all inspection windows on the screen.

◎   System

1)   Displays the version of MCU and FPGA in the current system. The system will irregularly update the version of internal software due to function upgrades.

2)   Camera information: Displays the model information of each camera.

3)   Storage information: Displays the available space and total capacity of the system and SD memory.
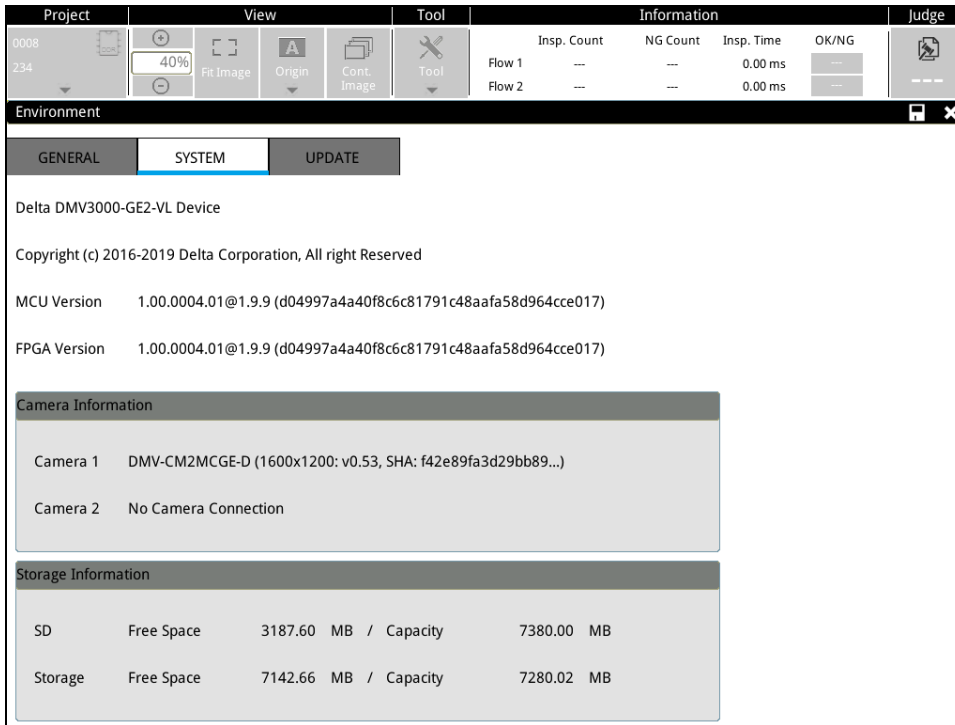
◎   Update

Provides 4 functions.

1)   Format SD: Formats the SD card.

2)   Clear projects: Deletes all projects stored in internal memory, and restores the default values.

3)   All update: Requires software updates provided by Delta Electronics, Inc. After selecting update all, it will upgrade system software.

4)   Update resource: Used for updates to add character resources in the system. Such as adding resources required for Korean, Turkish, and other languages.
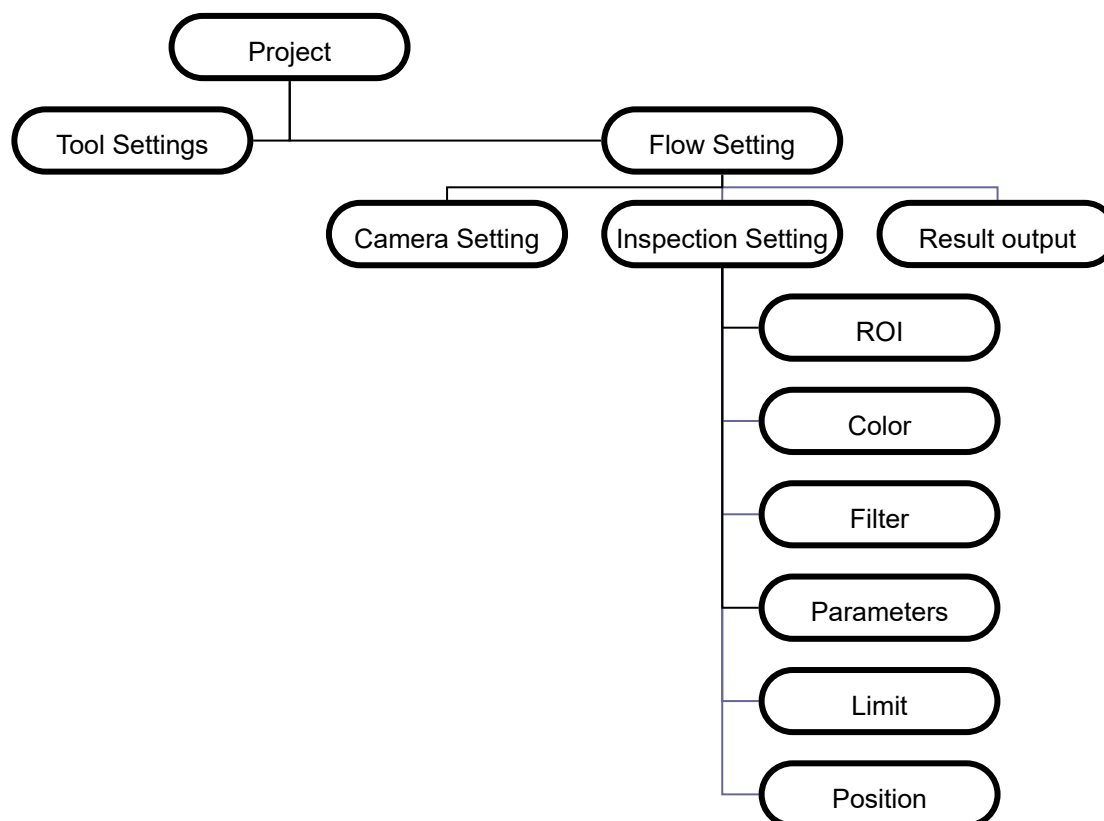
Chapter 4

Inspection System and Flow Settings

DMV3000G configures the inspection system using a flow scheme. After you set relevant parameters based on each flow icon through the processing steps, you can quickly create the required inspection system project.

DMV3000G can connect to 1 or 2 cameras. Therefore, a single project can execute 2 parallel inspection flows. Additionally, the controller can store up to 1000 built-in projects in the internal memory, and up to 9999 projects in a Micro SD card. You can add, delete, copy, rename, and switch projects.

After adding a new project, the configuration framework for inspections is as follows:

```
                    ┌─────────┐
                    │ Project │
                    └────┬────┘
                         │
  ┌──────────────┐       │       ┌──────────────┐
  │ Tool Settings│───────┴───────│ Flow Setting │
  └──────────────┘               └──────┬───────┘
            ┌───────────────────────────┼───────────────────────┐
   ┌────────────────┐        ┌──────────────────┐      ┌──────────────┐
   │ Camera Setting │        │Inspection Setting│      │ Result output│
   └────────────────┘        └────────┬─────────┘      └──────────────┘
                                      │
                               ┌──────────────┐
                               │     ROI      │
                               └──────────────┘
                               ┌──────────────┐
                               │    Color     │
                               └──────────────┘
                               ┌──────────────┐
                               │    Filter    │
                               └──────────────┘
                               ┌──────────────┐
                               │  Parameters  │
                               └──────────────┘
                               ┌──────────────┐
                               │    Limit     │
                               └──────────────┘
                               ┌──────────────┐
                               │   Position   │
                               └──────────────┘
```

4.1 Add Project

Each complete inspection requirement is an individual project. A new project is created specifically for the inspection requirements of different test subjects, and project settings do not overlap.

For example: Performs Edge Position and Edge Angle for Inspection Object A and Area and Stain for Inspection for Object B; A and B require different inspections and therefore have independent inspection projects.

Reference Please refer to Section 3.2 for a detailed project description.

4.2 Create Inspection Flow

According to varying inspection requirements, each project can simultaneously execute 1~2 flows. When only one camera is used, only one inspection flow is needed (the system will automatically generate Flow 1). However, when two cameras are used at the same time, the second flow will need to be added. The two flows operate and output results independently.
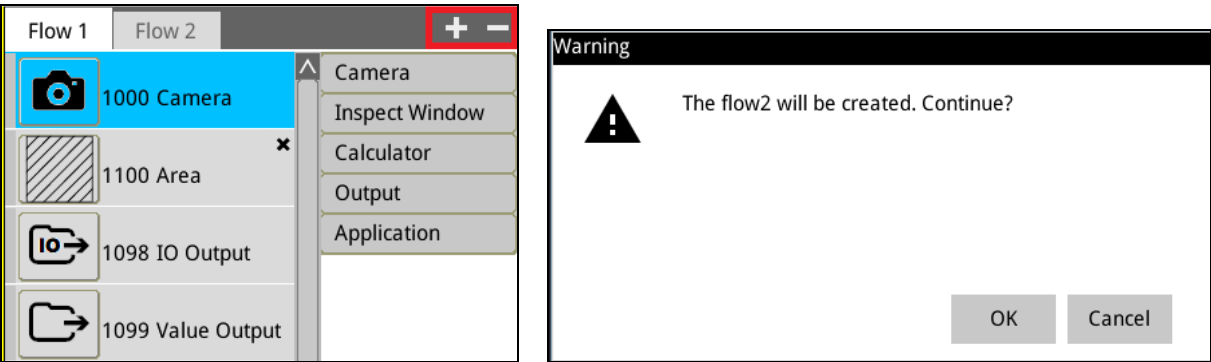
A single flow includes [Camera], [Inspect window], [Calculator], and [Output], and may contain up to 1000 inspection windows.

4.2.1 Add/ Delete Flow

When two cameras are used, the system can create 2 inspection flows at the same time. The two flows operate and output results independently.
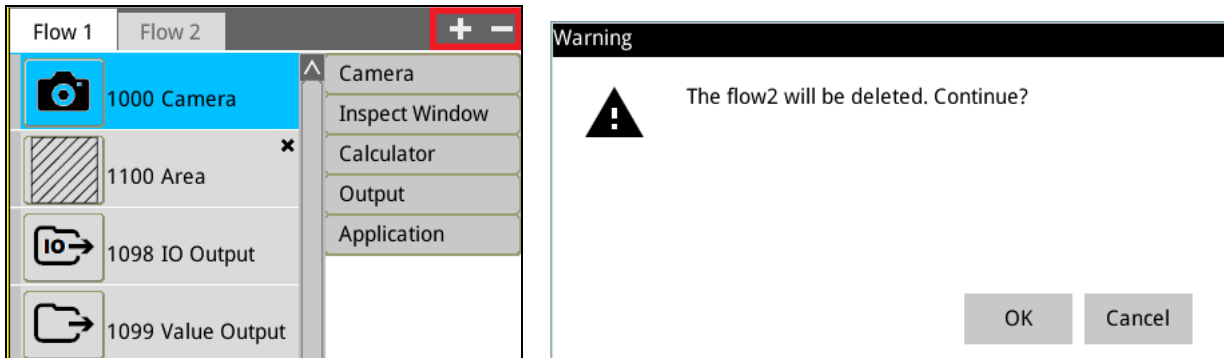
1)   Add Flow

On the right of the flow in the screen, a message box will appear after selecting [+], confirm to add flow.

2) Delete Process

On the right of the flow in the screen, a message box will appear after selecting [-], confirm to delete flow.
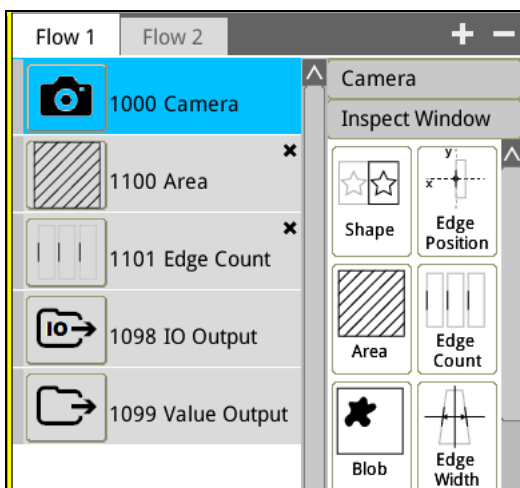
4.3 Inspection Flow Settings

A single flow includes four items, [Camera], [Inspect window], [Calculator], and [Output], in which camera, inspection window, and output must be configured to establish the basic inspection framework.

4.3.1 Camera Setting

Click the camera icon to enter and configure the following settings:

1) **Register Image**

When executing inspections, the image of interest must first be registered here to provide a basis for inspection settings. Here, [Register Image] is the register image management for the current flow, and can [Register], [Capture], [Rename], and [Delete] the images captured by the connected camera. To register images, verify the position for image capture after adjusting the camera, and then click on [Register Image] to complete the action. When [Continuous image capture] is selected, the camera will automatically capture images for the user to adjust the position of the camera.
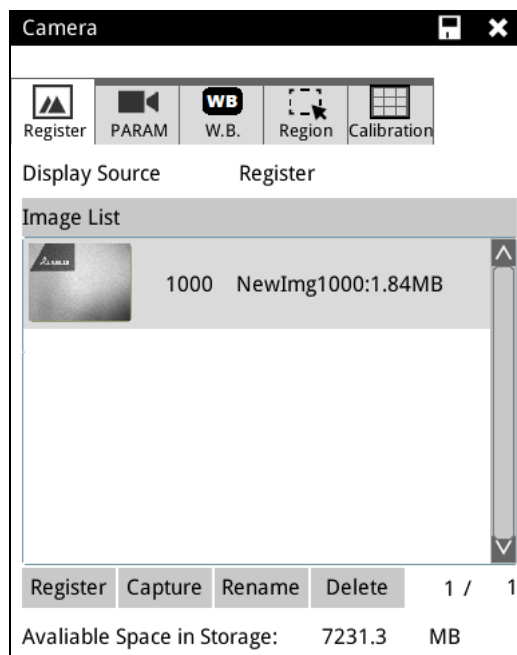
➤ Image List

Displays currently registered images.

➤ Register

Registers the image captured by the camera in the [Image list]. (Adds image to the image list)

➤ Capture

The camera captures an image when this is clicked.

If [Display] > [Cont. Image] is activated, clicking on it once will automatically deactivate continuous image capture, and the camera will stop at the last image for subsequent image registration.
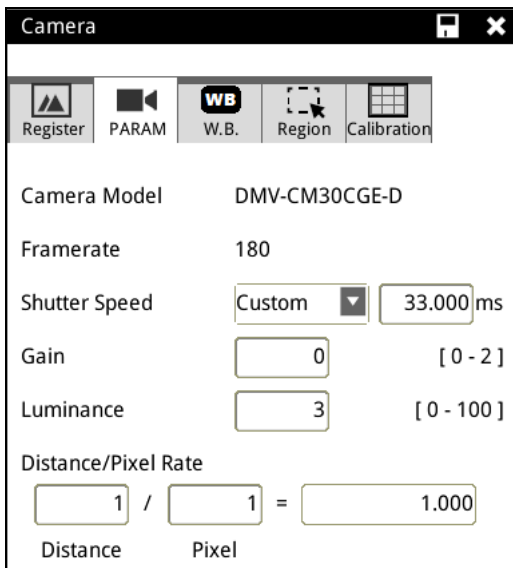
➤ Rename

Select the registered image to be renamed and then enter the new name.

➤ Delete

Delete a registered image.

2)   Parameters

Cameras can be colored or gray-scaled. After connecting the camera, the controller will automatically detect the camera model.

➤   Camera Model

The system will automatically detect and display the current camera model.

➤   Frame Rate

The system will automatically detect the current frame rate of the camera. (FPS, Frame per second)

➤   Shutter Speed

The camera shutter speed can be selected or freely input.

➤   Gain

Higher gain results in a brighter image.

It is recommended to increase the brightness of the image by increasing the external light source and opening up the aperture. Even though increasing gain will increase brightness, it will also increase noise in the camera image.

➤   Brightness (Intensity)

Higher brightness results in a brighter image. As described above, increasing gain has the negative effect of increasing noise in the camera image.

➤   Distance/ Pixel Rate

Input the ratio of the distance and pixels. The inspection results will be converted for output on this basis. Generally used to measure size. For example, when using 1x parallel light lens and the 4.8 mm distance corresponds to 1024 pixels, after inputting 4800 (um) and 1024 (pixels), the system will automatically convert inspection results to um for output and display.

3) White Balance

In colored cameras, white perceived by users often has yellowish gray colors. The white balance function can be used at this time. After selecting the area determined by users to be white, the system will automatically make adjustments, and adjust the image to better match the color white perceived by users.

➤ Screen with uncalibrated white balance.
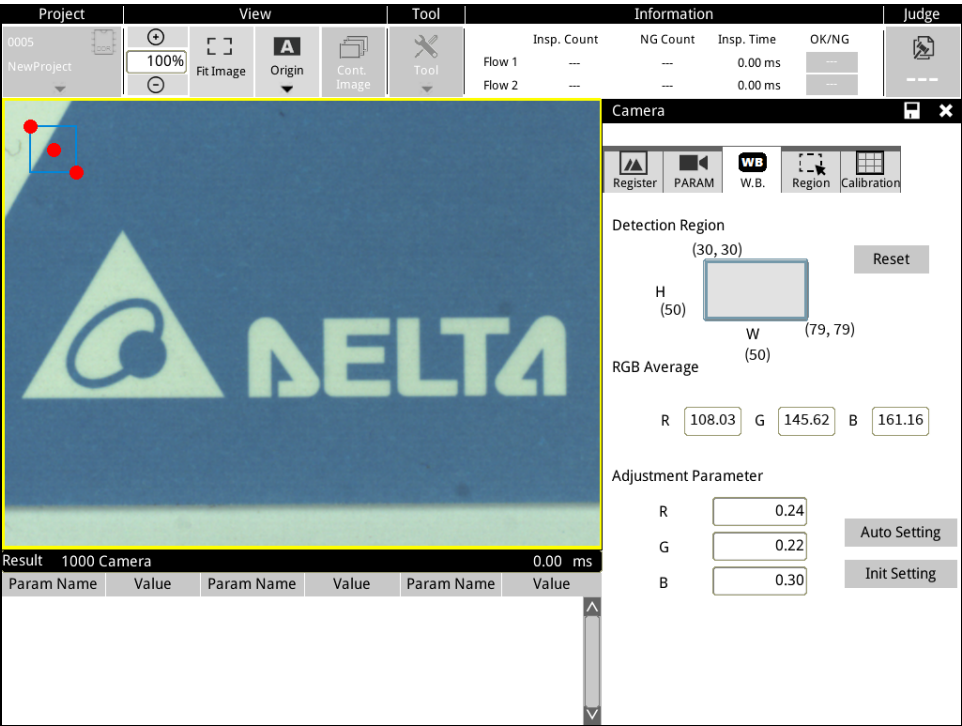
➤ After selecting the white part on the upper left in ROI, click [Auto Setting] and the system will automatically adjust the white balance.
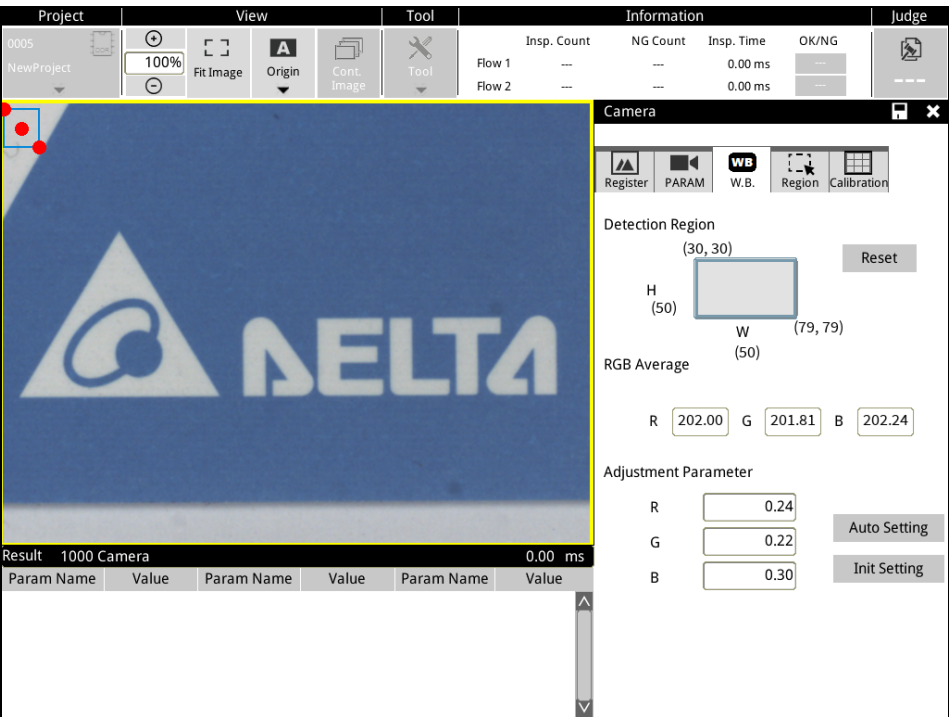
4) Region

When only a portion of the camera image is needed, select the range that will be used. This method can reduce the camera image data that is transferred and shorten inspection time.

Displays the [Width] and [Height] selected and the resolution of the camera.
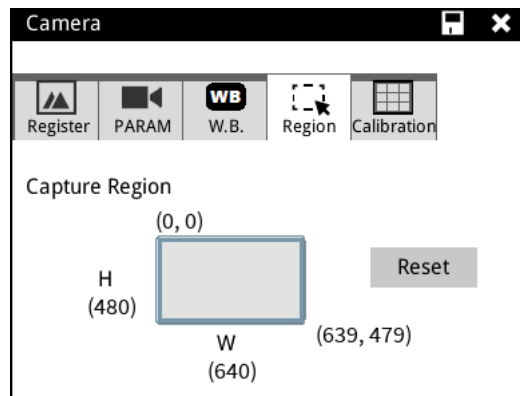
5) Calibration

The system provides 32 groups for [4-Point Coord. Calib.]. First select groups 1-32, then input 4 point image coordinates (drag the positions of four points on the screen, and they will be automatically loaded by the system), and 4 point robot coordinates (the order that the 4 points are input must be the same as the image coordinates). Then click on [Convert] below. The system will convert image coordinates into machine coordinates and save them for subsequent conversion of inspection results.
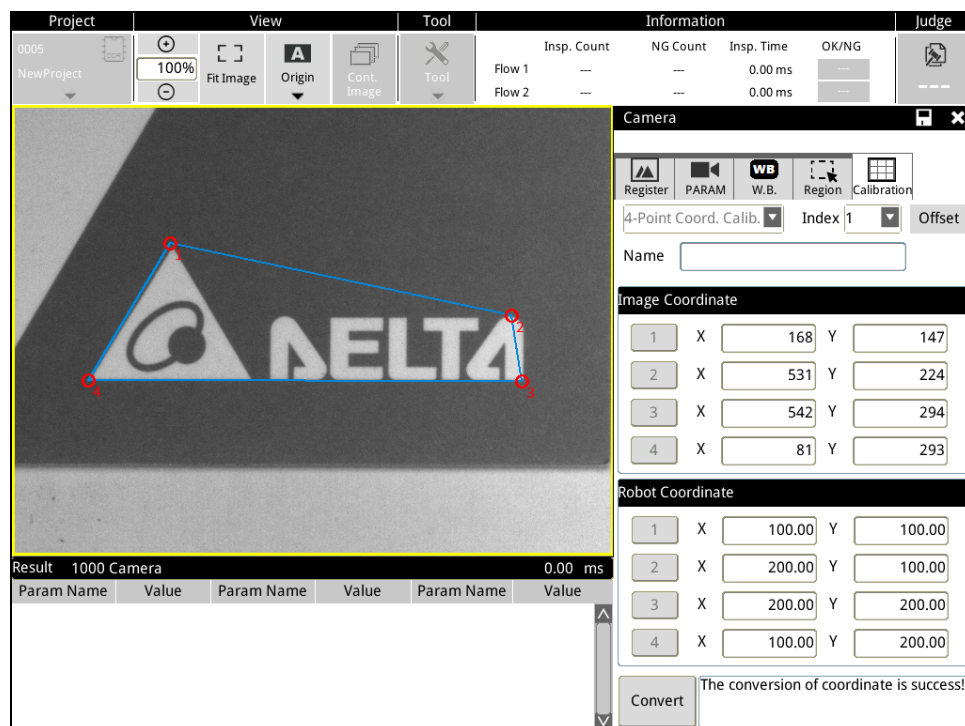
4.3.2 Inspections

When creating an inspection process, click **Add** to add a new inspection. In the **Add Unit** dialog box, you configure the **Inspection** function using visual inspection tools. Visual inspection tools can be categorized as counting numbers, detecting stains, locating coordinates, and measuring dimensions. The DMV3000G provides diversified inspection tools to satisfy different application needs. When you run the inspection application, stable and complete visual inspections usually require simultaneous judgment with several inspection tools to complete the process.

For example, when measuring the dimensions of moving objects, you must configure the coordinates for locating tools, such as [Edge Position] or [Shape], to ensure stabile and accurate measurements. This requires coordinated execution between the inspection and the locating functions.

You must first identify the characteristics and targets of the items to be detected before designing the visual inspection system, as the run length of each inspection may vary. Choosing the optimal method and combination not only improves system stability but also decrease inspection time and improves productivity.

◎ **Inspection Window**

After clicking the icon on the right inspection window, the inspection function can be imported into the inspection flow.
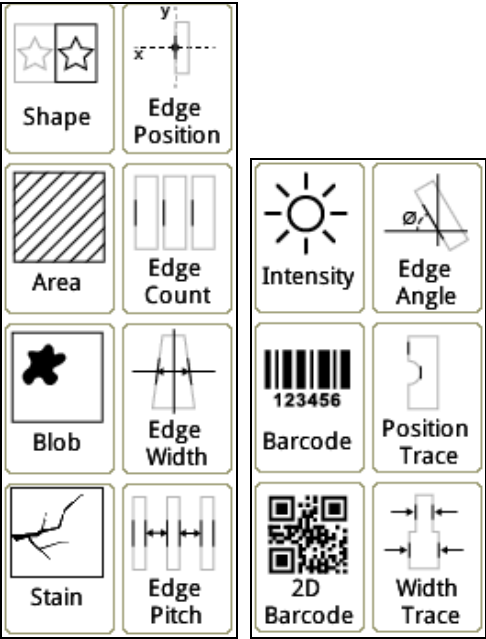
Tool (1) Shape

This function finds the default sample image in the configured region and searches the profile (edge), X coordinate, Y coordinate, and rotation angle of the specific sample, and then compares it with the default sample. In general, it is recommended to use the shape tool first when the object to be inspected is offset, before providing the X and Y coordinates and rotation angles to subsequent inspection tools as reference for correcting offset.

Tool (2) Area

The function calculates the number of black or white pixels in the predefined region. This function uses a binary method to convert the image to only black and white layers for measurements. When the numbers of black or white pixels is in the specified numeric range, the inspection result is OK; otherwise, when the number of pixels exceeds the configured range, the inspection result is NG.

Tool (3) Blob

This function uses a binary method to convert the image so that it consists of only black and white layers, and then calculates groups of black and white pixels. When the number of pixels is in the specified range, the group of pixels is defined as a blob. This method can detect the number, area, and coordinates of multiple blobs.

Tool (4) Stain

This function detects stains in a fixed direction, such as scrapes and smears on the object.

Tool (5) Intensity

This function measures the maximum intensity, minimum intensity, average intensity, and standard deviation of intensity of all the gray-scale pixels in the inspection region.

Tool (6) Edge Position

This function finds edges formed by brightness variations in a gray-scale image. It finds two edges position coordinates through horizontal or vertical scanning.

Tool (7) Edge Count

This function enhances the Edge Position function. The number of edge positions found in the inspection range

Tool (8) Edge Width

This function enhances the Edge Position function. In the inspection range, it is necessary to find more than 2 edge positions, and calculate the pixel distance by using the coordinates of the two edge positions.

Tool (9) Edge Pitch

The edge pitch function can be used when there are multiple edge widths to inspect. The system will measure all width values, width maximum values, width minimum values and width average values in the inspection range.

Tool (10) Edge Angle

In the inspection range, two edge positions are simultaneously found, and the inclination angle of the line with respect to the horizontal is calculated by the two coordinate positions.

Tool (11) Position Trace

This function enhances the Edge Position function, which can only find one edge. Position Trace searches for edge positions using brightness variations that agree with the measured widths through horizontal or vertical scanning. It can find multiple edge positions on the same surface and output the coordinates.

Tool (12) Width Trace

This function enhances the Edge Width function, and finds the distances between edges by searching for outer or inner edges through horizontal or vertical scanning. It can output the maximum and minimum distances measured.

Tool (13) Bar Code

This function reads 1D bar codes by searching for a valid 1D bar code in the ROI (region of interest). Once detected, the function decodes the bar code and outputs the result. When the scanned bar code agrees with the specified value, the inspection result is OK; otherwise, when the scanned bar code disagrees with the specified value, the inspection result is NG.

Tool (14) 2D Bar Code

This function reads 2D bar codes by searching for a valid 2D bar code in the ROI. Once the function detects the bar code, the function decodes the bar code and outputs the result. When the scanned bar code agrees with the specified value, the inspection result is OK; otherwise, when the scanned bar code disagrees with the specified value, the inspection result is NG.

4.3.3 Inspect window function settings

◎   **Flow Process Page**

After creating a project, begin configuring the inspection process on the right of the screen.
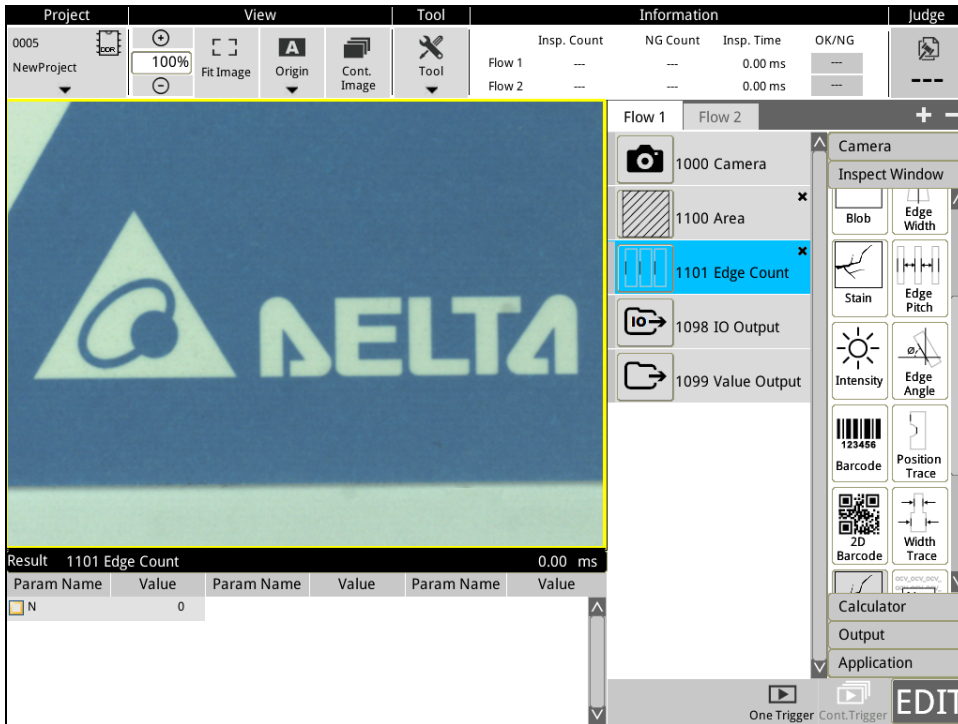


◎   **Color of text in flow box**

Red text in the inspect window indicates that configuration was not completed, and black text indicates that configuration was completed. When configuration was not completed for the inspection process, the project will also be displayed in red text.

◎   **Flow Box**

Flow box must first be clicked to add, delete, copy, or insert inspections. The order of flow boxes directly relates to the sequence of execution, and the system executes from top to bottom.

1)   Add: When adding an inspect window, first put the focus on the position where the new process will be added, and then click on the inspect window tool on the right to add.

For example, to add an [Edge Count] below the [Area] inspect window, first focus the mouse on the area process, and then click on the edge count inspect window tool on the right to add an edge count under area.
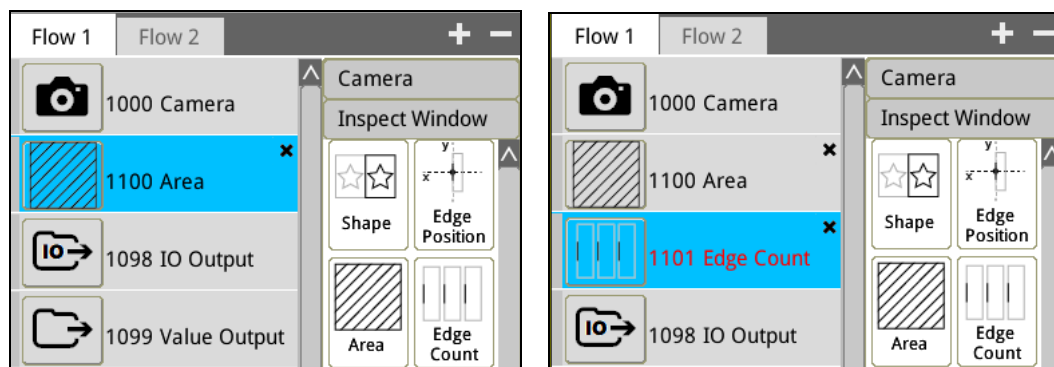
2) Delete: Click [X] on the right to delete, and a message box will pop up for confirmation.
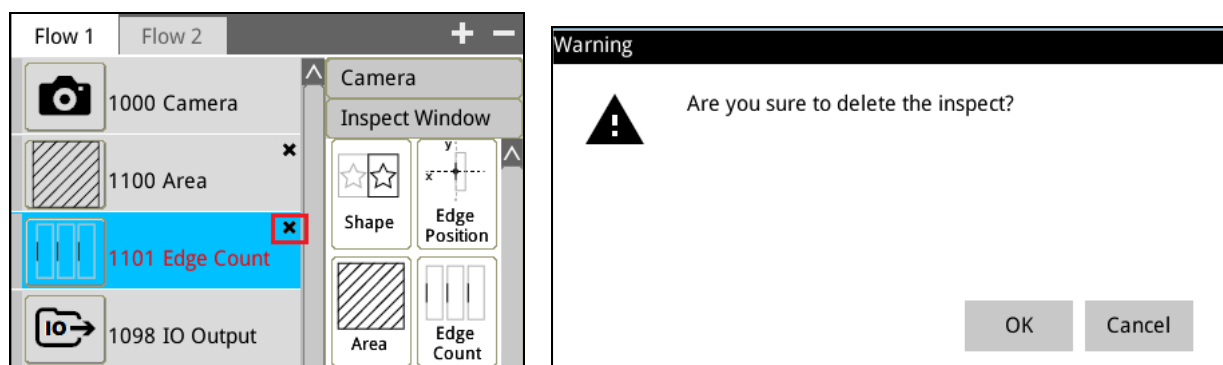
3) Copy: Select the inspect window to copy, right click and select copy.
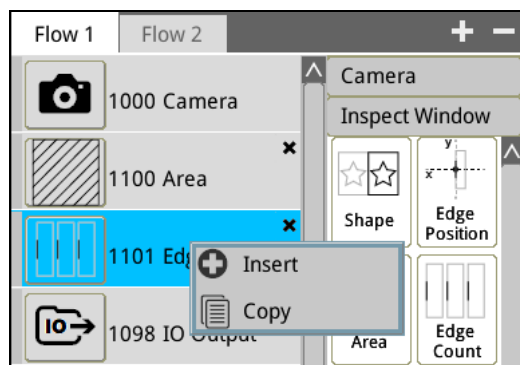

4) Paste: Select the position to insert the inspect window, right click and select insert. The copied inspect window will be added below.
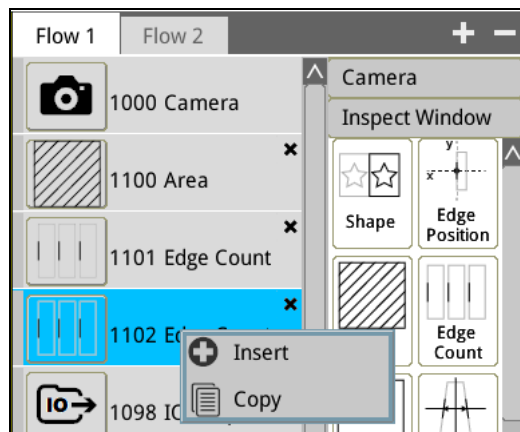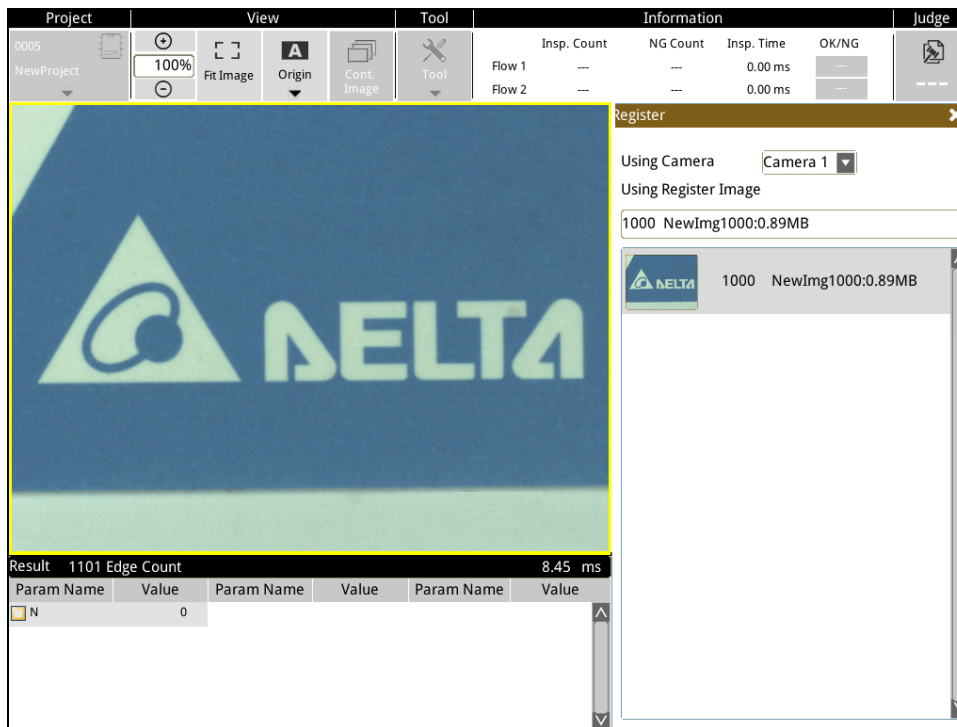
◎ **Enter inspect window settings**

The inspect window icon must be clicked to enter the inspect window's parameter settings.

For example, when setting the [Edge Count] inspect window shown below, please click on the icon of the left to enter.
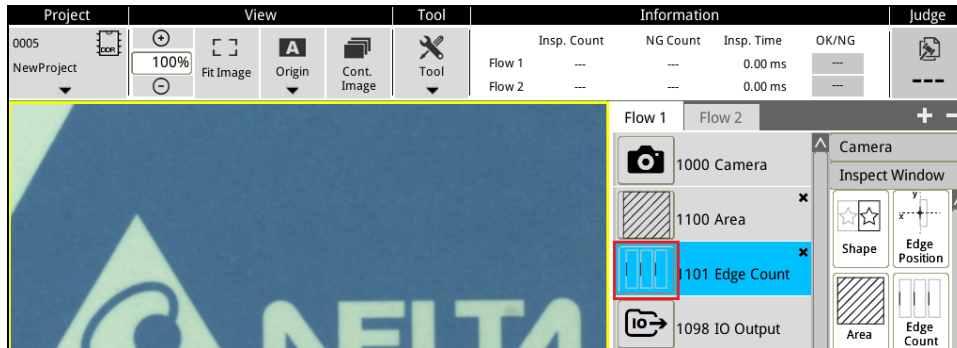
1) First select [Register Image] as reference for subsequent settings. After selecting, press ✖ to close.
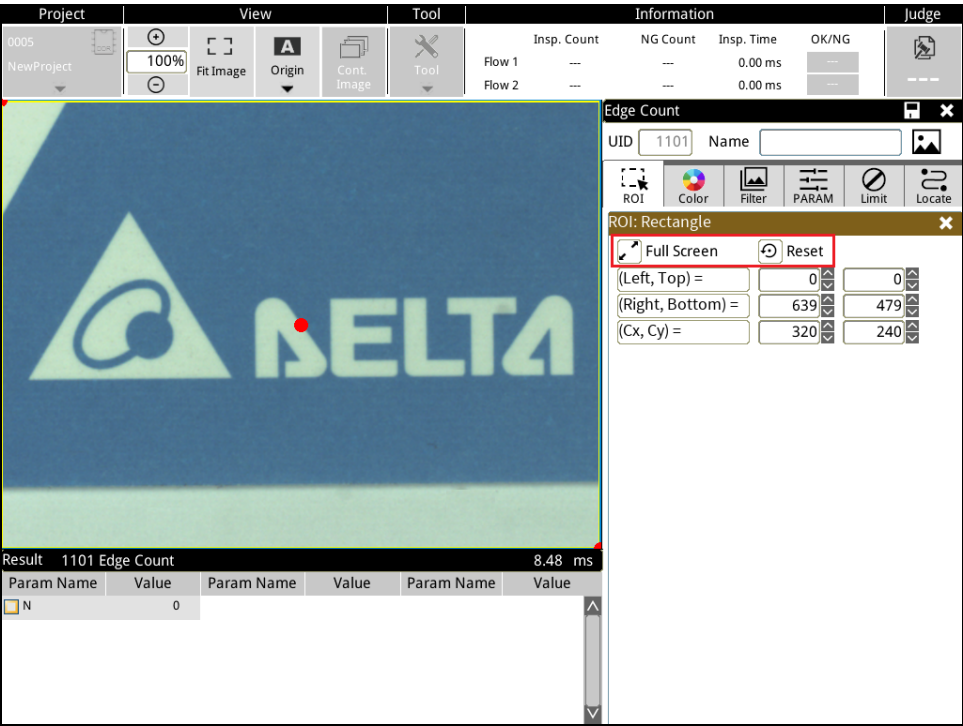
2) The screen will show 6 setting options, [ROI], [Color], [Filter], [Parameter], [Limit], and [Position].

To return and change [Register Image] again, please click on the [icon] icon.
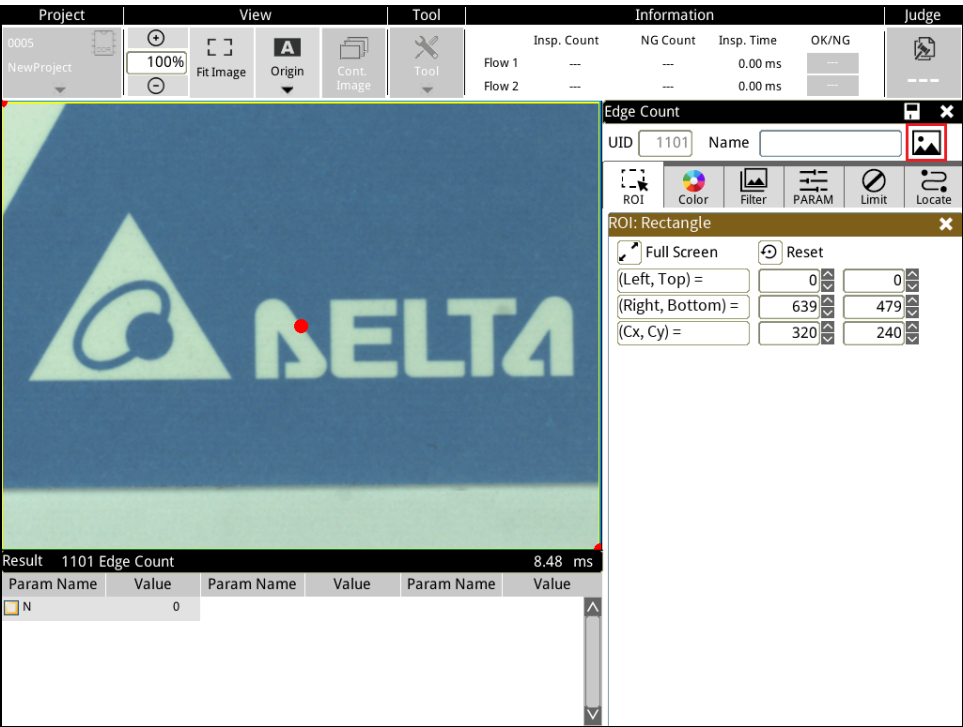
3) [ROI] (range of inspection area)

Based on different ROI shapes, use the mouse to adjust the range to be inspected, and two shortcut icons [Full Screen] and [Reset] are provided.
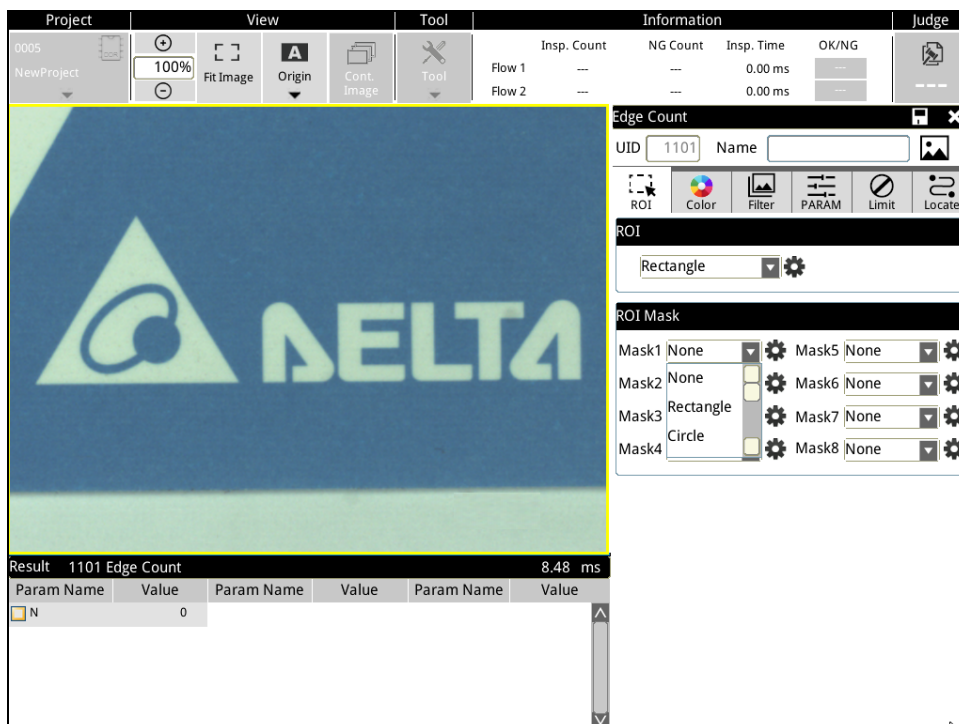

Reference Please refer to Section 4.5 on how to draw ROI.

➤ ROI provides seven patterns: [Rectangle], [Circle], [Polygon], [Ellipse], [Ring], [Sector], and [Rotated rectangle].
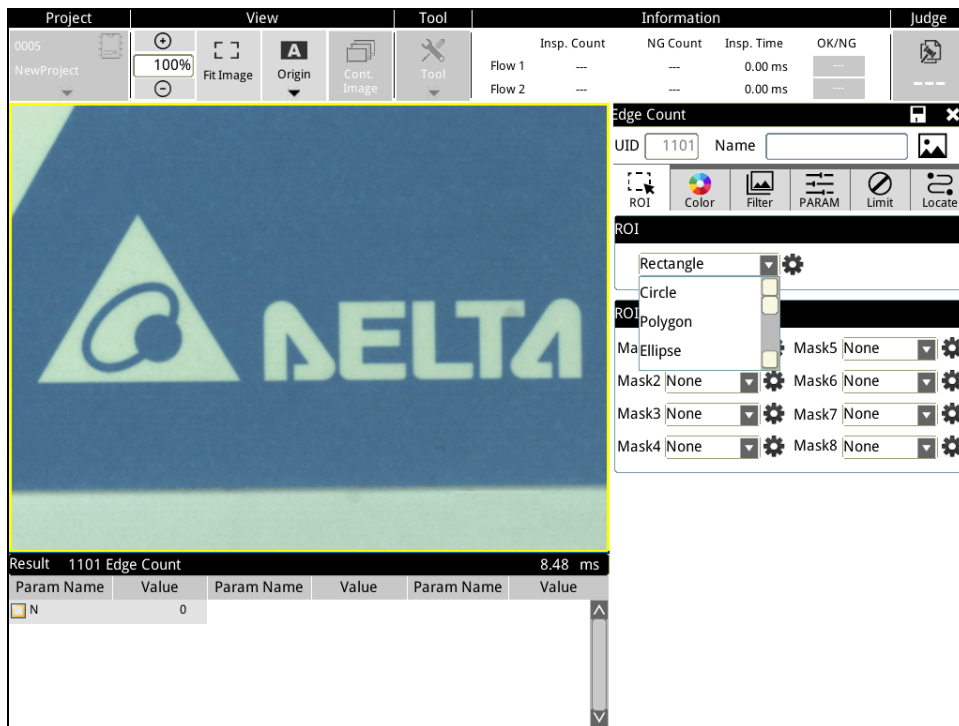
➤ Provides 8 mask functions [Mask 1-Mask 8]; a mask sets the area that is not detected and will be neglected during inspection.
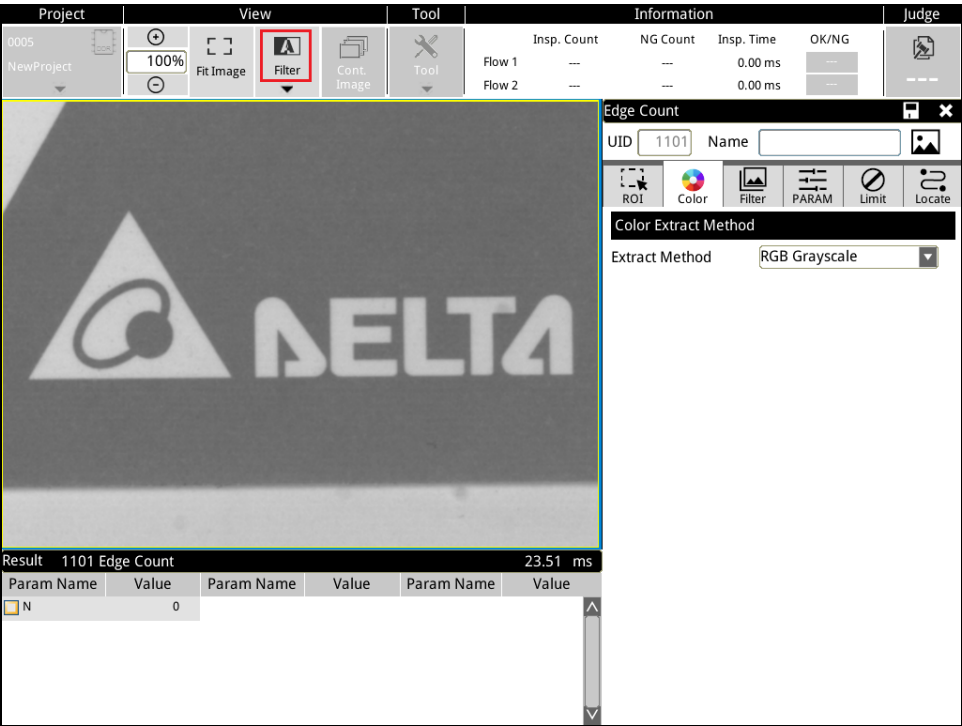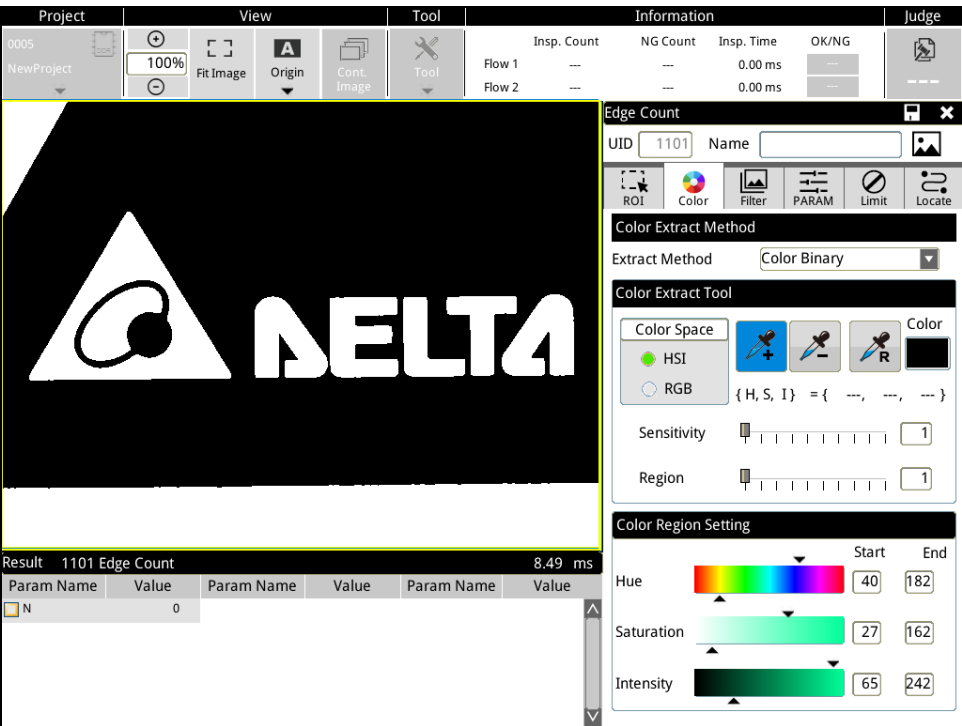
4) [Color]

When a colored camera is used, the color function must be executed first to convert the color image to a grayscale image for subsequent inspection configuration.

➤ RGB grayscale

The most commonly used conversion method is to convert the average RGB color to grayscale.

(Please select [Filter] in [View] above to display the image after being converted to grayscale)

➤ Color Binary

➤ Color Distance

➤ R Grayscale

A color closer to R (Red) is closer to white when converted to grayscale.

➤ G Grayscale

A color closer to G (Green) is closer to white when converted to grayscale.
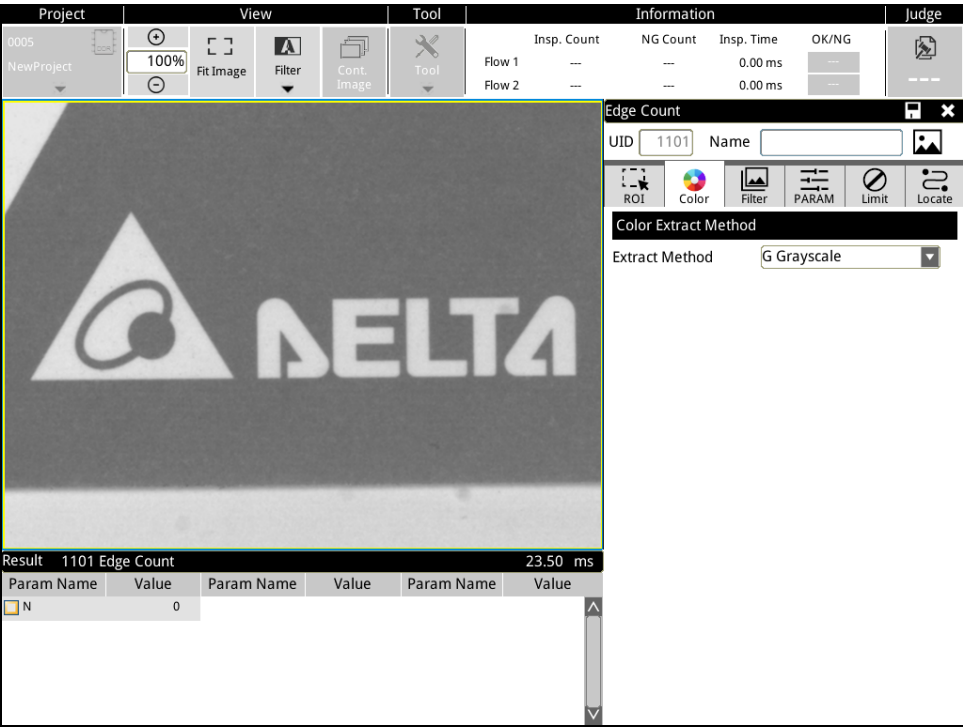
➤ B Grayscale

A color closer to B (Blue) is closer to white when converted to grayscale.
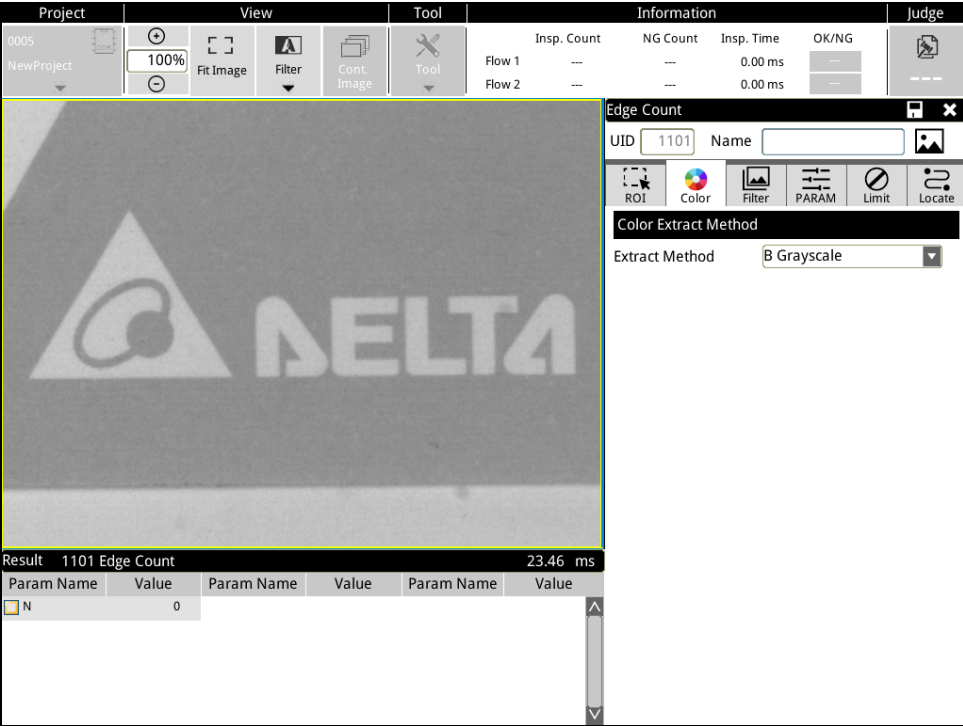
5) [Filter]

Configure the image pre-processing function. The image filter function aims to enhance features of the area being inspected to increase the stability of inspection.
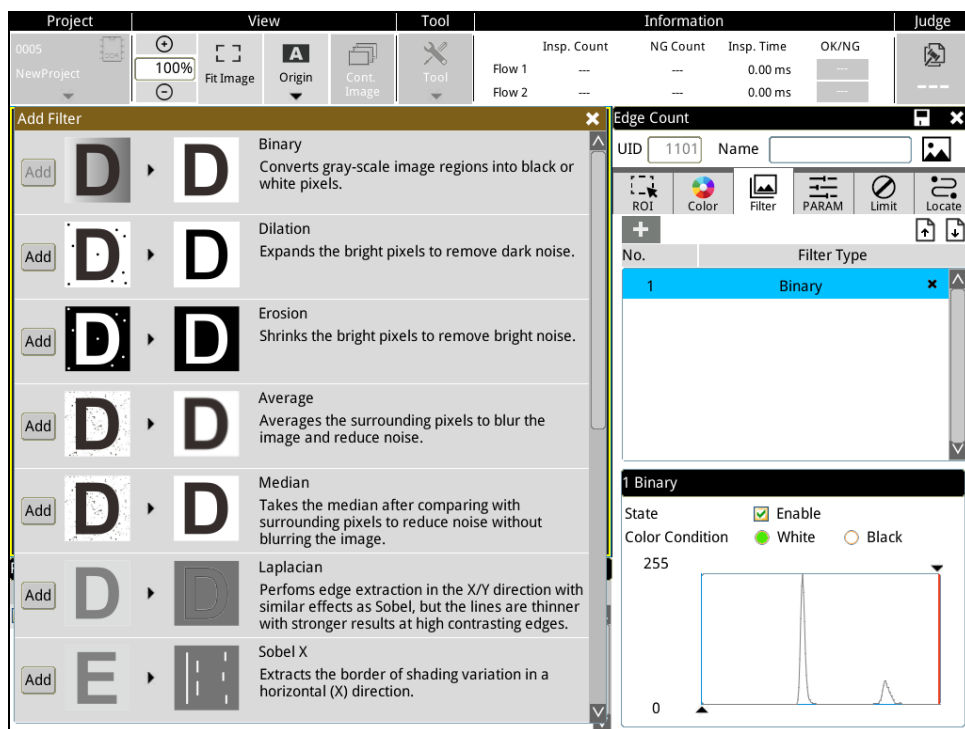
📖 **Reference** Please refer to Section 9.2 for a detailed description of filter function effects.

➤ First click on the ➕ icon to open filter functions for selection.
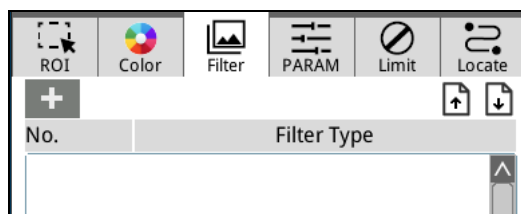
➤ All available filter functions are displayed on the left. Click on the [Add] icon to add.
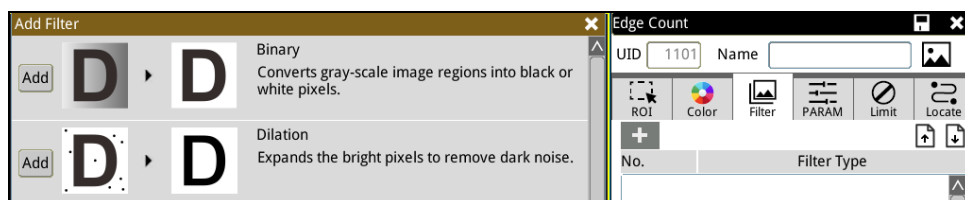
➤ After adding the filter item needed, click on the ✖ icon to close the add page.
  As shown in the figure below, 2 filter items were added, [Dilation] and [Binary].
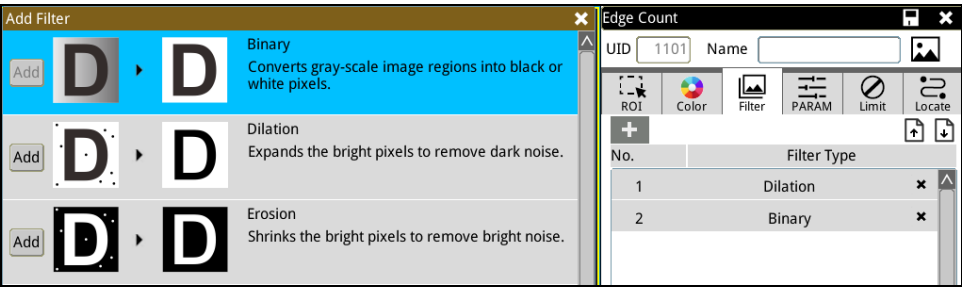
➤ After setting multiple filter functions, click on the ⬆⬇ icon to arrange the order of filtering. Filtering starts from top to bottom, so different orders of processing will have different effects.

➤ When the filter function selected in [Filter Type] was already configured, then related parameters will appear below.
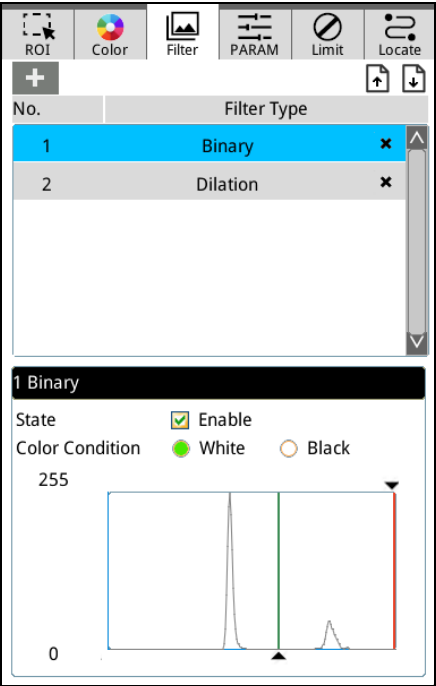
➤ To observe filtering effects in the screen, select [Filter] in [View] above.
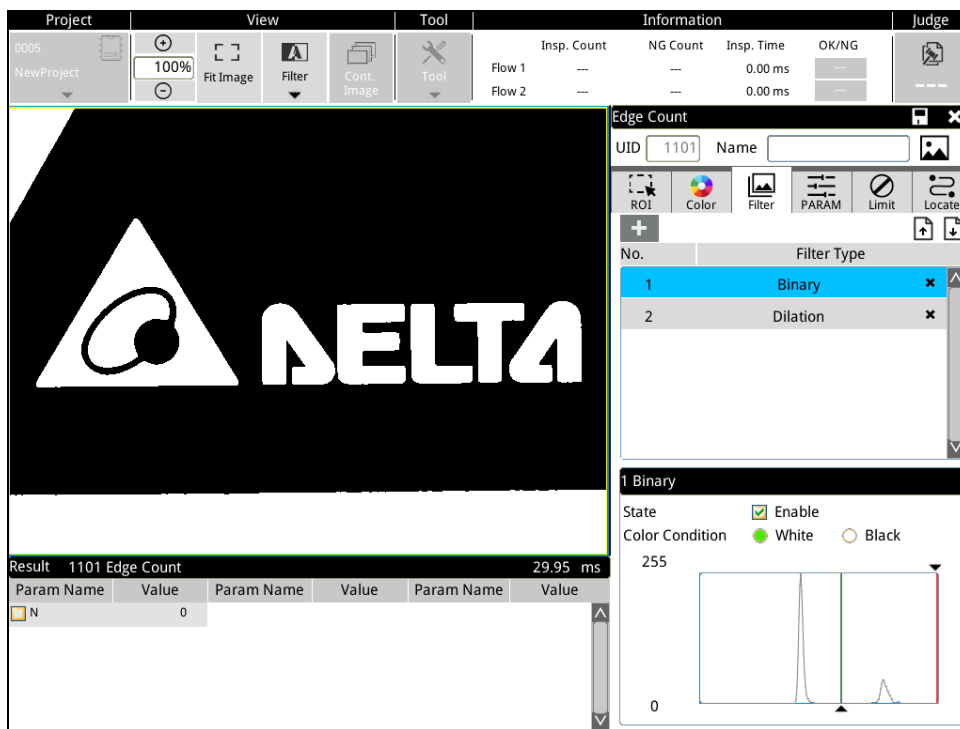
6) [Parameter]

➤ The figure below shows the parameter setup page for [Edge Count]. Different inspection windows provide different parameter settings.
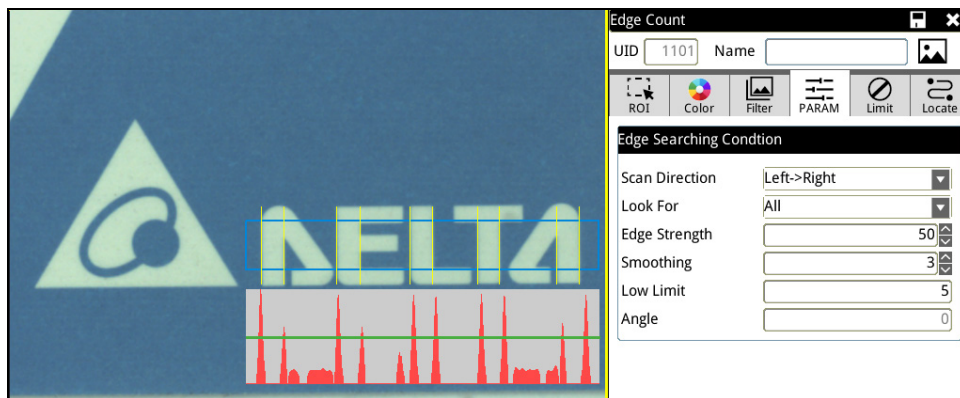
➤ The figure below shows the parameter setup page for [Compare shape], in which the parameters are different from Edge Count.

Reference Please refer to Chapter 5 for a detailed description of inspection window parameters.

7) [Limit]

➤ The upper/lower limit setting is used to determine if the result of the inspection window is OK/NG.

As shown in the figure below, if the inspection result is 10 and exceeds the upper/lower limit, the result will be determined to be NG. If the inspection result is within the upper/lower limit, then the result will be determined to be OK.
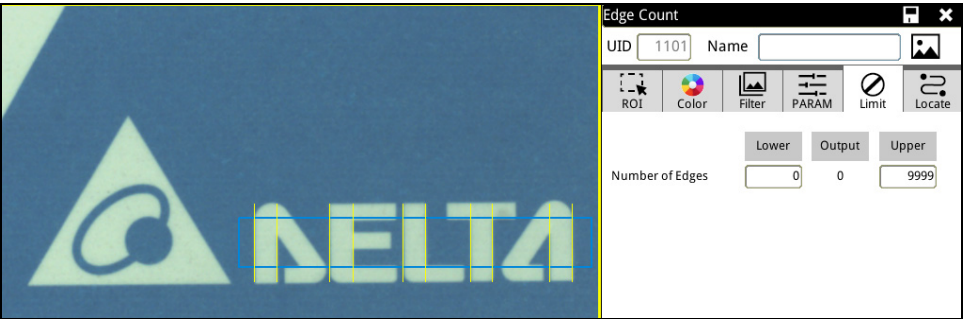
➤ Limits can be set for different items for different inspection window functions.

The figure below shows limit items in [Shape], in which only 1 of the 5 items is NG, so the inspection result of compare shape is NG.

The maximum value is the default value for the upper/lower limit, and inspection results are generally OK before any adjustments are made.

8) [Position]

Position is for determining whether if preliminary position compensation needs to be executed for the ROI area measured by the current inspection window based on the previous position function that was executed.

➤ [Ref. X], [Ref. Y], and [Ref. Angle] can be independently selected as reference for position compensation.
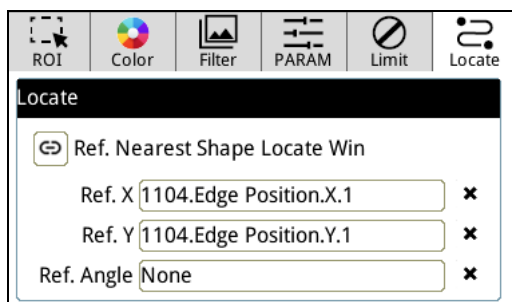
➤ A shortcut ⊖ is provided. After clicking on it, it will directly use the closest [Shape] inspection as reference for position compensation.
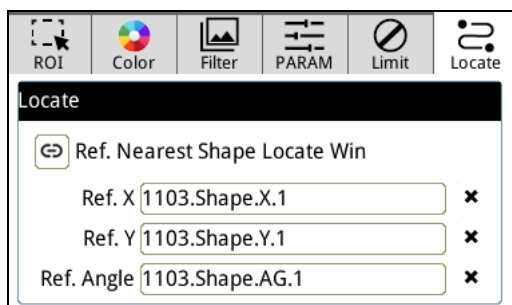
🗐 **Reference** Please refer to Section 9.1 for a detailed description of position functions.
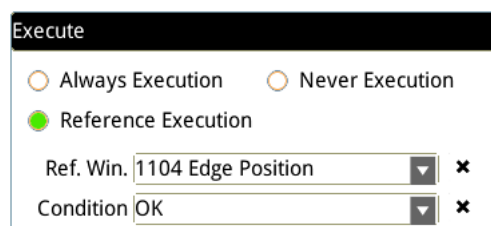
◎ Execute

➤ Always Execution: The default is to execute for each inspection of the inspection window.

➤ Never Execution: The inspection window will stop execution. In the initial inspection settings testing process, if this inspection window needs to be temporarily suspended and not deleted, select Never Execute to stop the inspection but not delete the entire inspection window settings.

➤ Ref. Win.

● Ref. Win.: 1103 Edge Position; conditions: OK

When the logic flag of 1103 edge position inspection window is OK, the inspection window will execute the inspection.
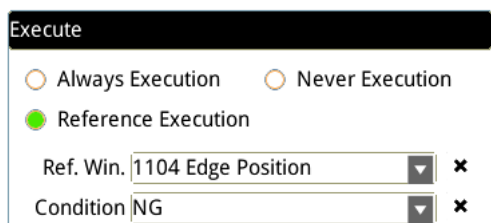
Execute
- ○ Always Execution   ○ Never Execution
- ● Reference Execution
- Ref. Win. 1104 Edge Position ▼ ✖
- Condition OK ▼ ✖

➤ Ref. Win.

● Ref. Win.: 1103 Edge Position; conditions: NG

When the logic flag of 1103 edge position inspection window is NG, the inspection window will execute the inspection.

Execute
- ○ Always Execution   ○ Never Execution
- ● Reference Execution
- Ref. Win. 1104 Edge Position ▼ ✖
- Condition NG ▼ ✖

◎   Inspect window calculation result

➤   In the process of configuring the inspect window, view the lower left of the screen, where the system will display inspection results using the registered image as a source.

The inspection time is also displayed. In the case of this inspection window, the inspection took 8.49 ms.
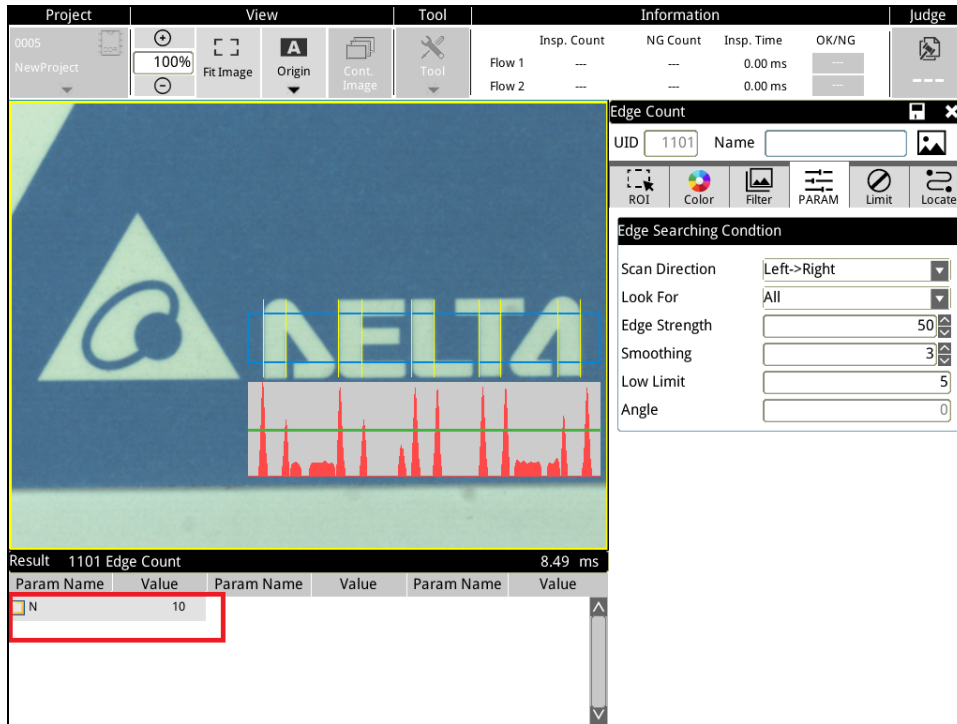
➤   Different inspect windows will have different inspection results.

The figure below shows the inspection function of [Edge Pitch] has more results compared with [Edge Count] above.
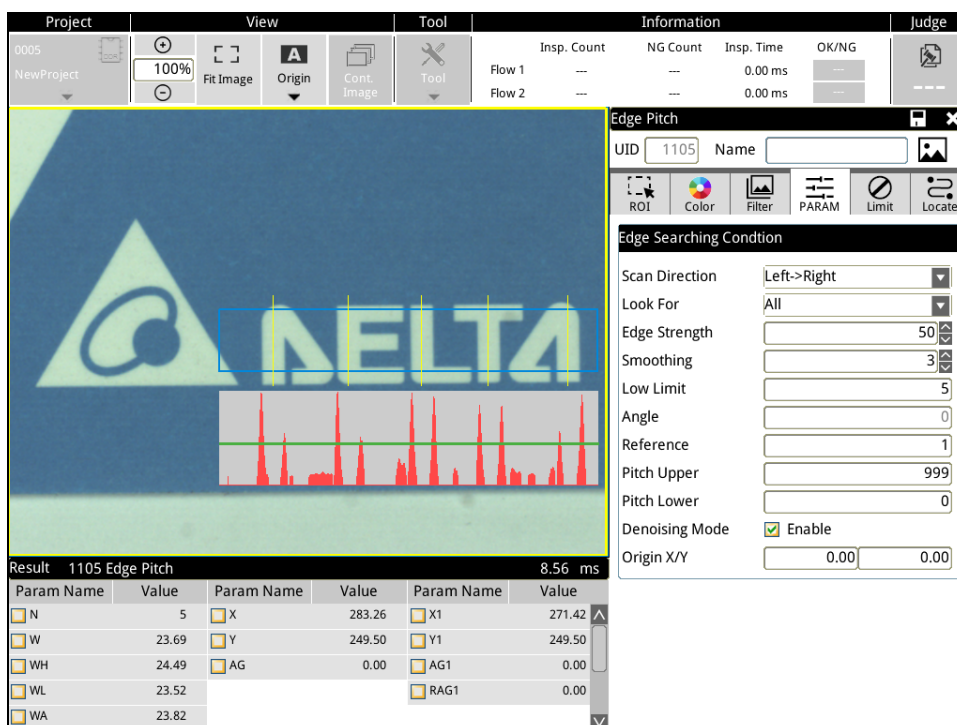
4.3.4 Calculator

Enter numeric [Inspect Window] data for arithmetic or function computations to obtain new values. The new values will be provided for subsequent configurations in [Output] options. In addition, this new data can be used to configure the upper/lower limits in calculator functions to obtain the calculator ID-specific logic flag, and the result can be provided for I/O output and determination.

◎ Calculator process screen

Click on [Calculator] on the right of the process to open the list of functions.
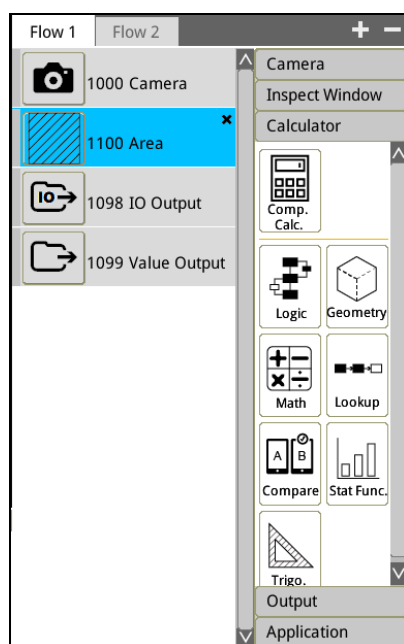
◎ Operation description

1) To insert a calculator element under [Edge Pitch], please focus the cursor on the Edge Pitch and then click the required calculator function element on the right to add the element.

As shown in the figure below, a [Comp. Calc.] element is added.
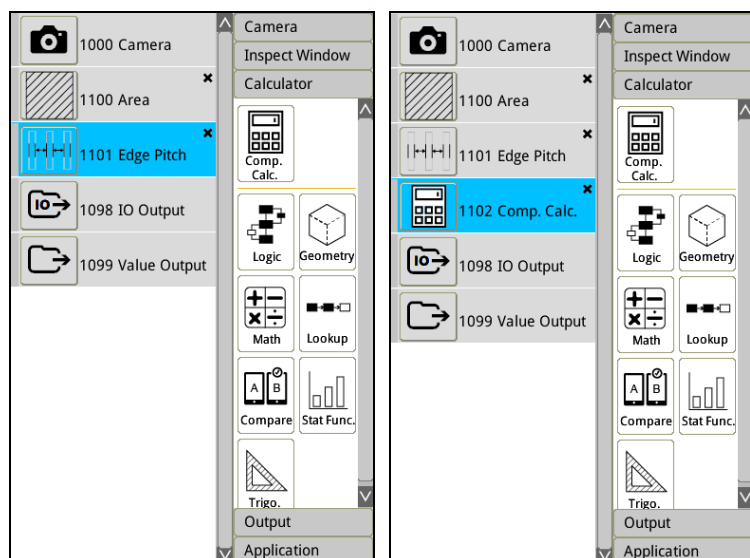
2) Click on the [Comp. Calc.] icon to enter the setup page (dialog).

Total calculation contains all calculation functions. Users may freely choose and use multiple functions at the same time.
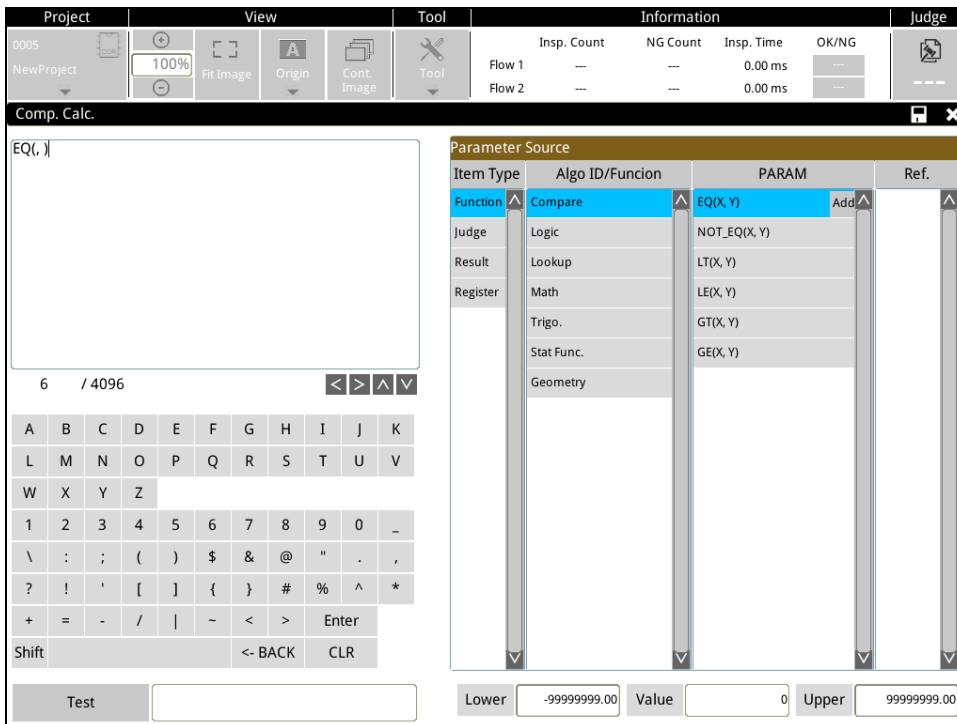
> **Reference** Please refer to Chapter 6 for a detailed description of comprehensive calculation functions.

3) Besides [Comp. Calc.], a single function element can be directly selected. Such as [Math] elements.
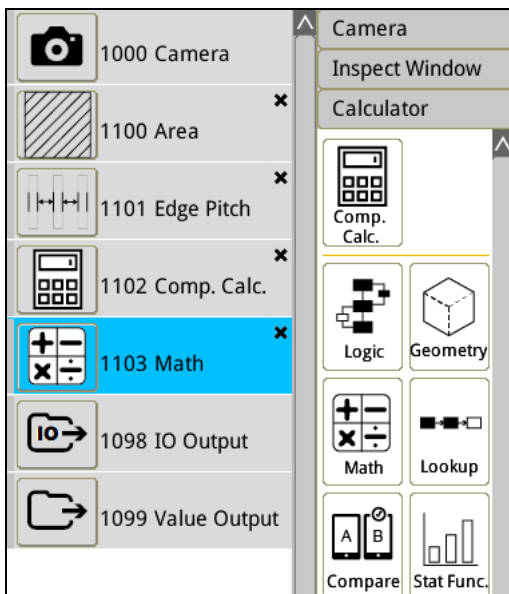
4) Click on the [Math] icon to enter the setup page (dialog).

Mathematical functions only contain this type of calculation functions. Users cannot combine multiple functions, but if only one function is needed for calculation, setup and operation will be simpler.
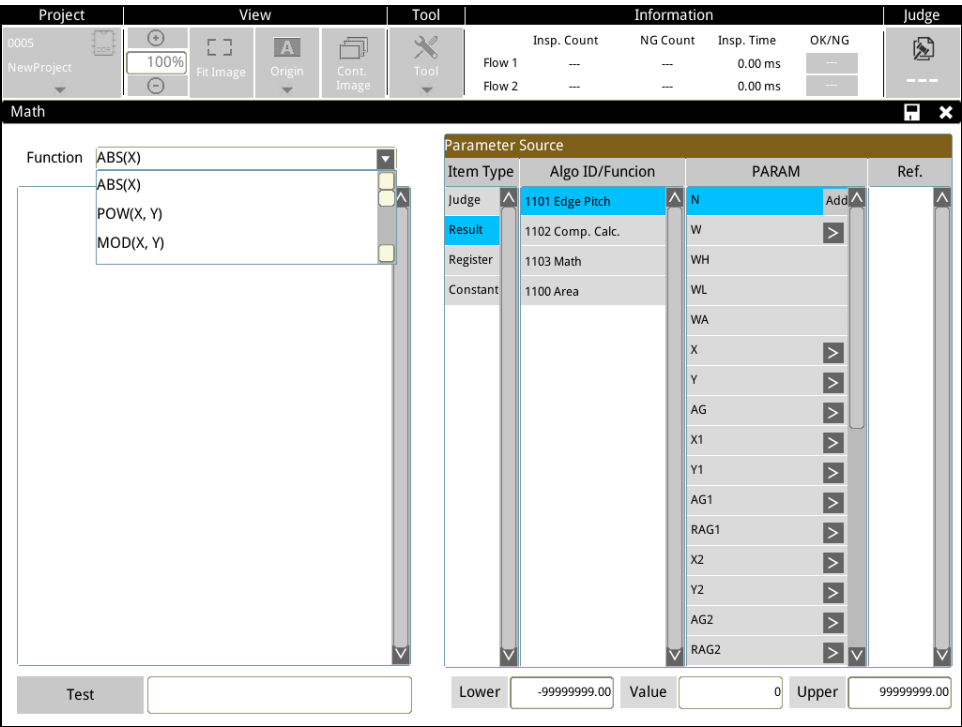
Reference Please refer to Chapter 6 for a detailed description of single function calculation.

5) Comprehensive calculation and single function calculation may be used multiple times in the process.
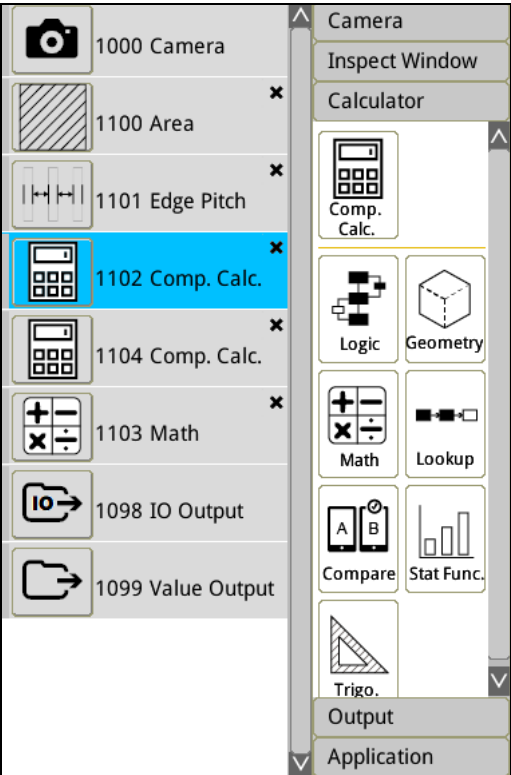
4.3.5 TOUT

The system provides 8 logic flags TOUT1-TOUT8. The user can set which hardware output points will actually output these eight results.

◎　TOUT operation description

Click on the [TOUT] icon in the flow to open TOUT settings.
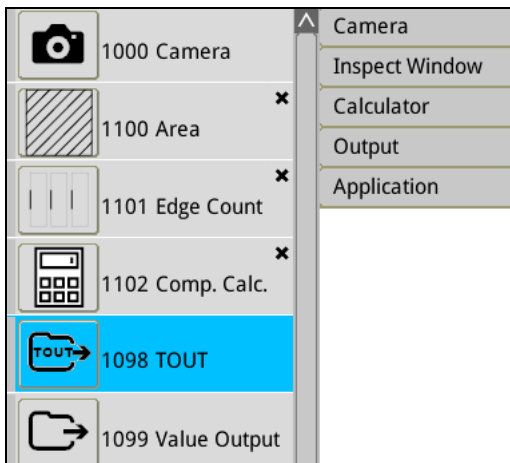
1) An example with [Area], [Edge Count], and [Total Calculation] already on the screen is used for explanation.
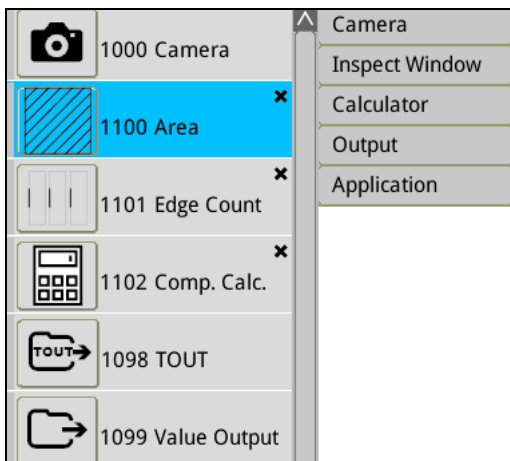
2) First select the output point for TOUT1-TOUT8.
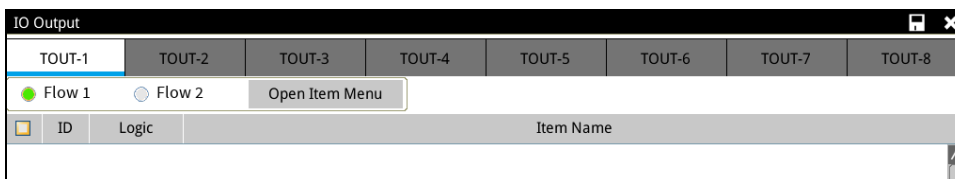
Select if the source for configuration results is [Flow 1] or [Flow 2] ⬤ 1　　　◯ 2

Click on ▢Open Item Menu and prepare to import results from the source

3) Three import contents of [Area], [Edge Count], and [Comp. Calc.].
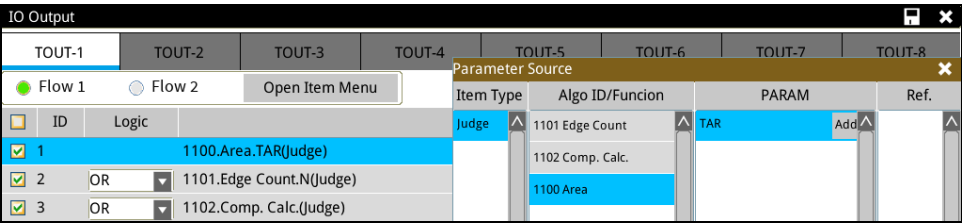
4) Adjust [AND] and [OR] settings.

If the desired outcome is 1 (OK) only when all three logic flags are 1 (OK), then the AND logic gate selected.
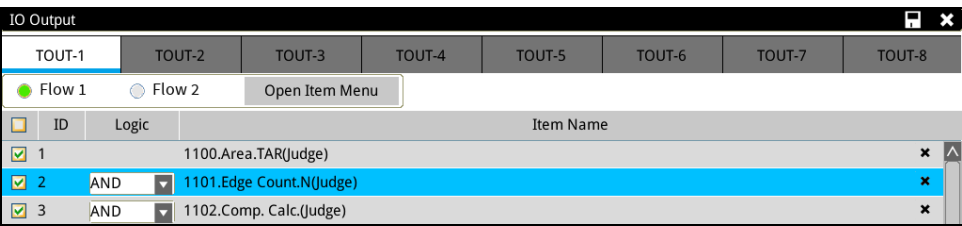
If the desired outcome is 1 (OK) when any one of the three logic flags is 1 (OK), then the OR logic gate selected.

5) Configure TOUT1-TOUT8 using the method described above.

6) This must be used with [Tools] > [Communications] > [Output]

In output items, specify which physical output points will output results of TOUT1-TOUT8.

Specify the output timing and actions of TOUT1-TOUT8.

Output Type			
● NPN	○ PNP		

TOUT			
No.	Output Timing	Output Type	Pulse Width
TOUT1	When OK ▼	Hold signal ▼	30
TOUT2	When OK ▼	Hold signal ▼	30
TOUT3	When OK ▼	Hold signal ▼	30
TOUT4	When OK ▼	Hold signal ▼	30
TOUT5	When OK ▼	Hold signal ▼	30
TOUT6	When OK ▼	Hold signal ▼	30
TOUT7	When OK ▼	Hold signal ▼	30
TOUT8	When OK ▼	Hold signal ▼	30

Reference Please refer to Chapter 7.1 for a detailed description of single function calculation.

4.3.6 Result Output

Result output specifies the communication method that is used as the data output method.

◎ Result output operation description

Click on the [Result Output] icon in the process to open result output settings.

Flow 1	Flow 2	+ −
📷 1000 Camera	Camera	
🔲 1100 Area ✕	Inspect Window	
║║║ 1101 Edge Count ✕	Calculator	
🖩 1102 Comp. Calc. ✕	Output	
IO→ 1098 IO Output	Application	
🗁→ 1099 Value Output		
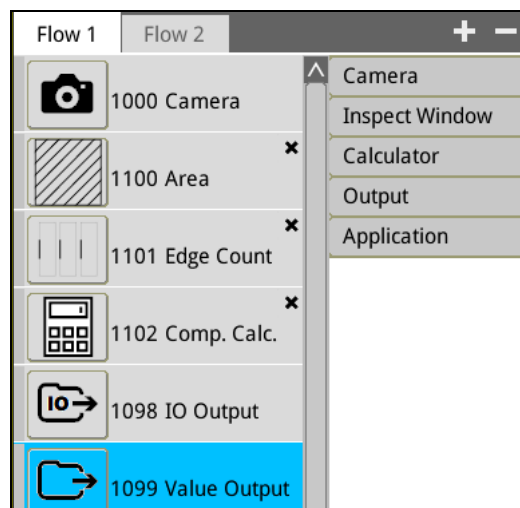
1) An example with [Area], [Edge Count], and [Comp. Calc.] already on the screen is used for explanation.
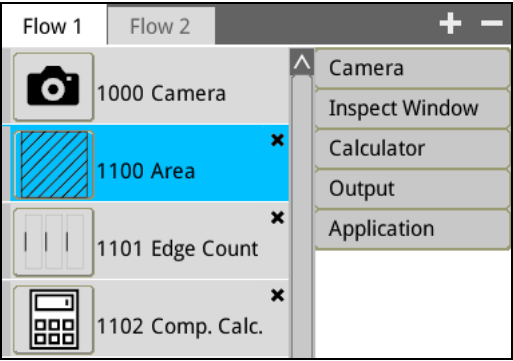
2) Result output setting page.
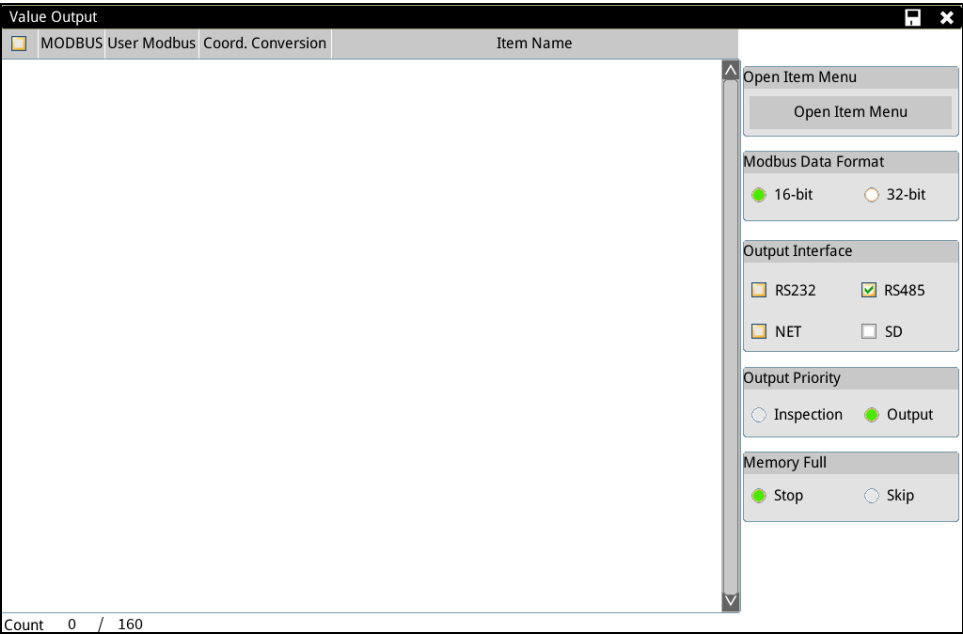
➤ Open Item Menu

After clicking, select the data to output.
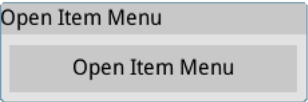
➤   Modbus Data Format

Set whether if the Modbus data is output in the 16-bit or 32-bit format. (If the data exceeds 65535, then the output method must be 32 bits DW)

For example: When the format is 16-bit and there are two entries of data to output, the data will be stored in two registers H1010 and H1011. When the format is 32-bit and there are two entries of data to output, the data will be stored in four registers H1010, H1011 (the first entry), H1013, and H1014 (the second entry).

Modbus Data Format
● 16-bit   ○ 32-bit
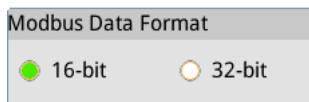
➤   Output interface

Set the communication interface for data output, multiple choice. If both RS232 and RS485 are selected in the figure below, then this numerical result can be output from the two interfaces.

Output Interface
☑ RS232   ☑ RS485
☐ NET   ☐ SD
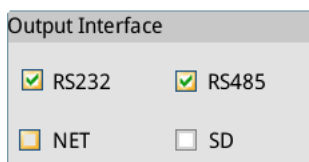
➤   Output Priority

Determines the order of actions when an inspection is completed, the system is in the process of outputting data, and an inspection triggers a command to input.

Inspection priority: If an input is triggered when the system is outputting results, the output action will be suspended and the newly triggered inspection will be executed.

If Output priority, in the process of outputting results, the newly triggered inspection will be ignored before data output is completed.

Output Priority
● Inspection   ○ Output
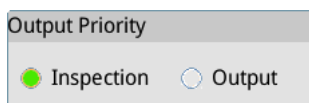
➤   Method for handling full SD Card when data is output to SD Card.

Stop: The system will stop execution and no longer execute the inspection.

Ignore: Save actions will be ignored but inspections can continue.

Memory Full
○ Stop   ● Skip

3) Click [Open Item Menu] and select data to output.
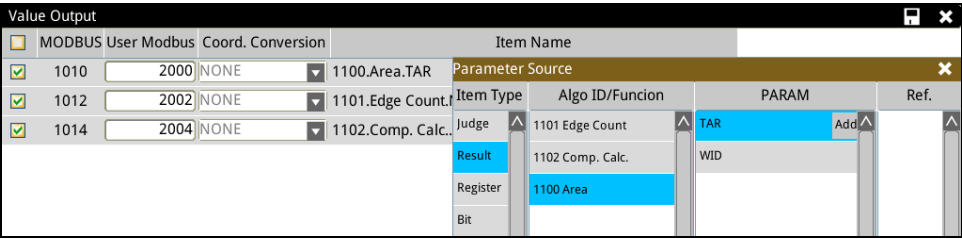
➤ Since the Modbus data format is 16-bit, the communication address generated is H1010, H1011, and H1012.
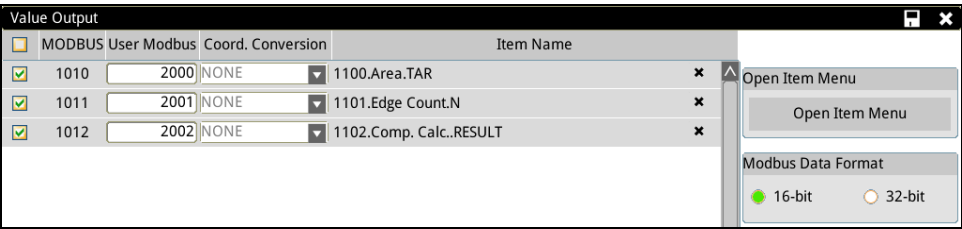
➤ If the Modbus data format is changed to 32-bit, the communication address will be automatically converted to H1010-H1014 and saved as a double word.
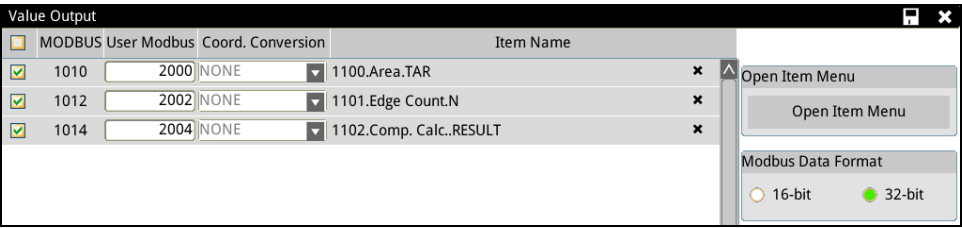
➤ The data that is output can be selected on the left to determine if the data is enabled. The position data in the register will be 0 of it is unchecked.
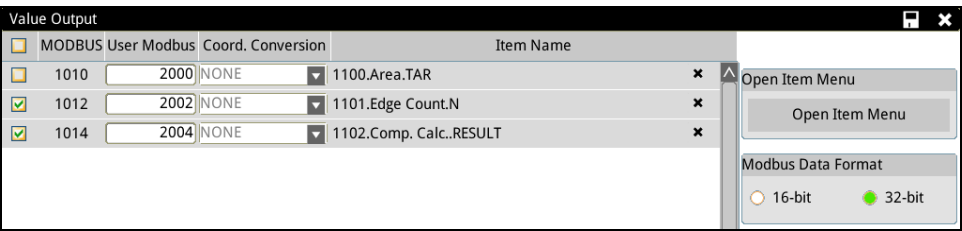
➤ [4-Point Coord. Calib.] may be selected for [Coord. Conversion].

Using H1010 as an example, when 4P-1 (the first group for 4-Point Coord. Calib.) is selected, the output result of H1010 will be converted through the coefficient conversion of 4P-1.
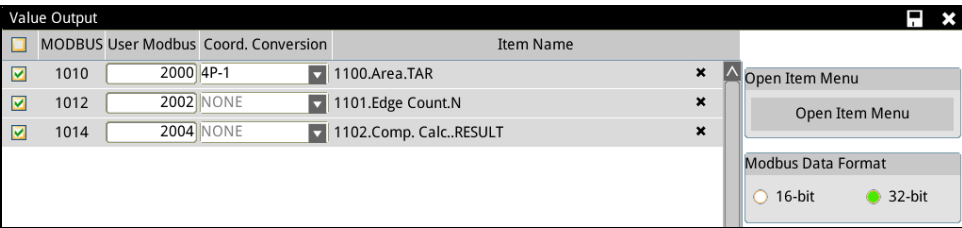
Coordinate conversion is configured and created at [Camera] > [Calibration].
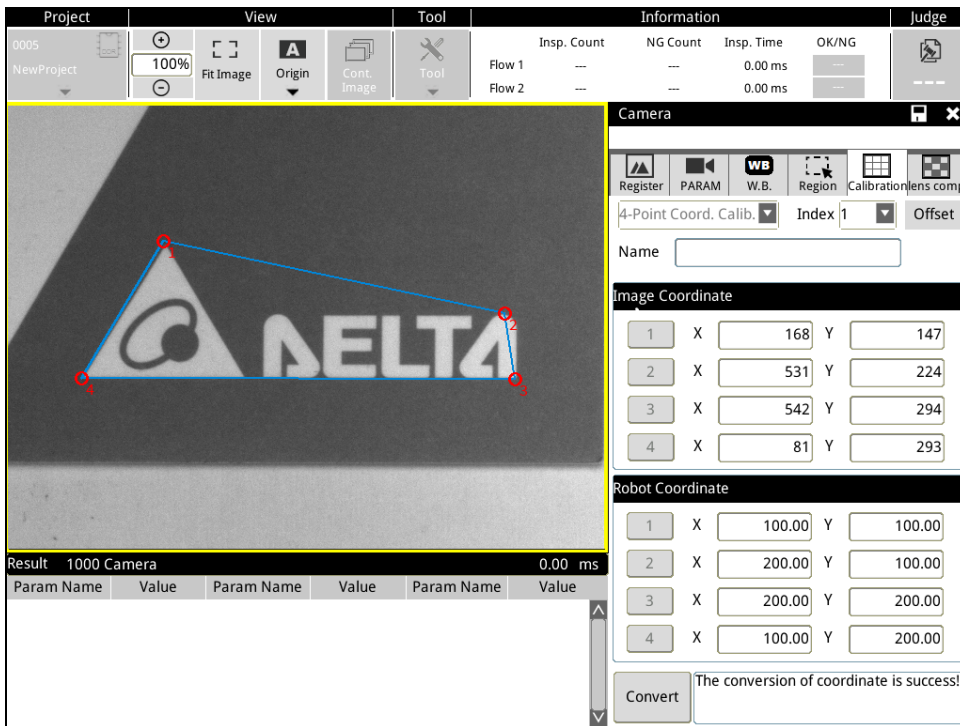
4.4 Inspection Flow

After flow configuration is completed, the entire flow may be executed for testing.

4.4.1 Edit Mode

◎ **Edit Mode Results Testing**

In Edit Mode, when process configuration is completed, manually click on the [One Trigger] or [Cont.Trigger] buttons below, and the system will use the current camera image for testing. (I/O and numerical results are not actually output during testing)

If the inspect window result is OK, the bar on the left of the inspect window will be green; in contrast, if the inspect window result is NG, the bar on the left of the inspect window will be red.
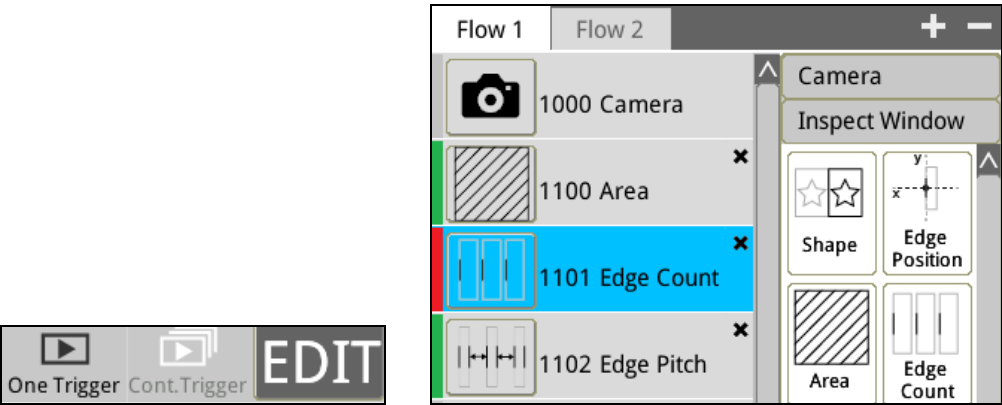
When different inspection windows are selected, the inspection result at the bottom of the screen will also be updated.

As shown in figure below, [Area] is currently selected and the area inspection result shown below is 147.
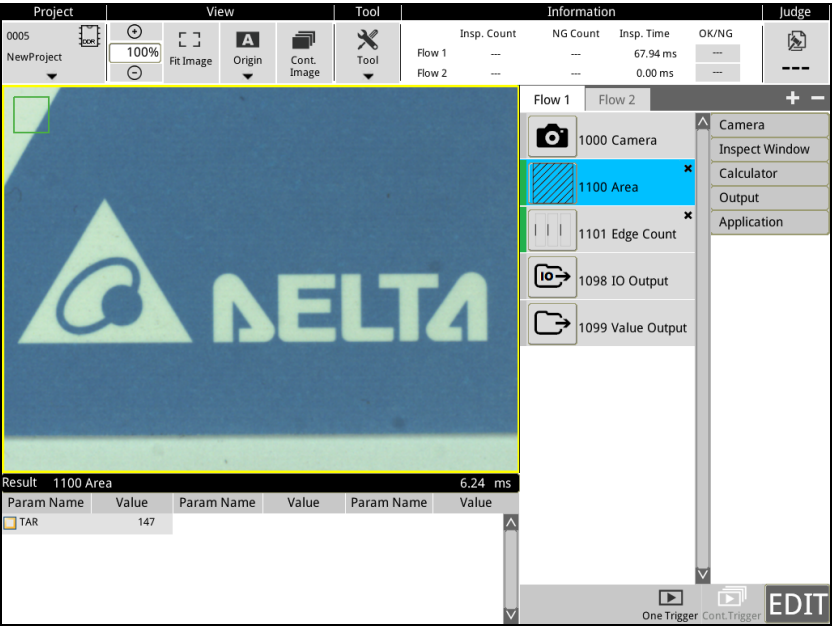
If it is changed to [Edge Count], the edge count inspection result displayed below is 6.
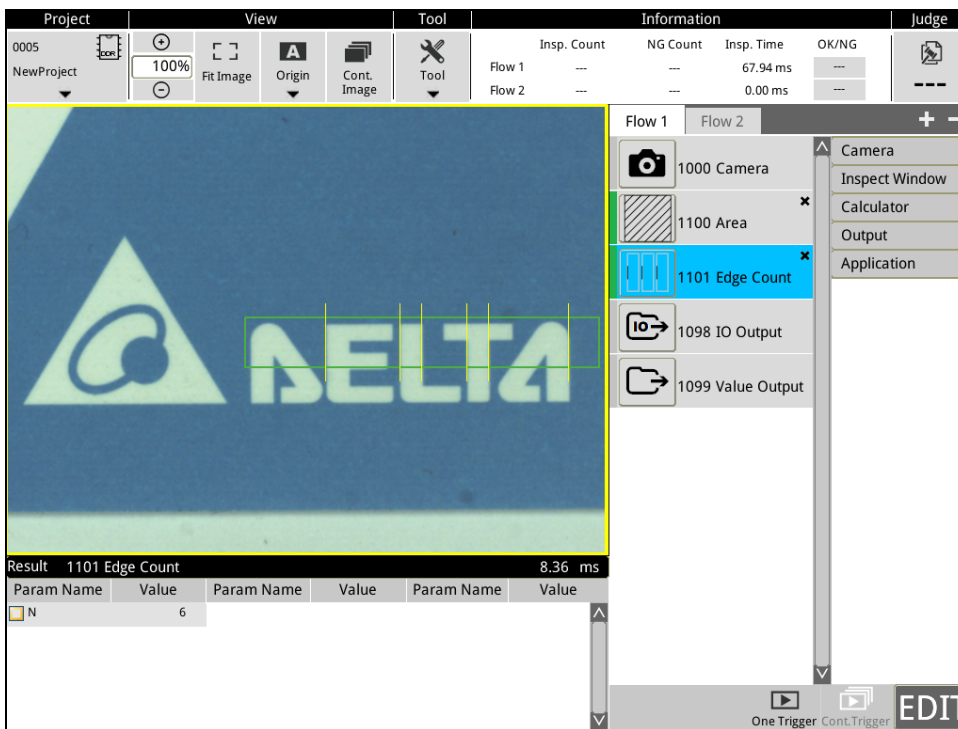
4.4.2 Run Mode

◎   **Run Mode Inspection Result**

1)   Click on the **EDIT** icon at the bottom of the screen and the screen will switch to RUN. Click on the

RUN icon and the screen will switch back to EDIT.
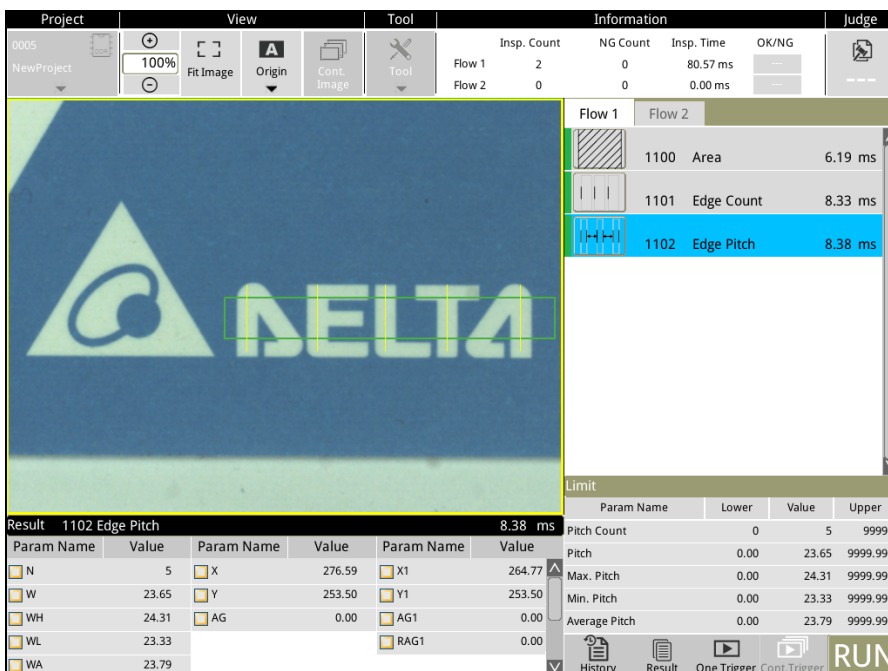
➤ The lower right of the screen displays the [Upper/Lower Limit] settings of the inspection window.

Limit			
Param Name	Lower	Value	Upper
Pitch Count	0	5	9999
Pitch	0.00	23.65	9999.99
Max. Pitch	0.00	24.31	9999.99
Min. Pitch	0.00	23.33	9999.99
Average Pitch	0.00	23.79	9999.99

➤ The lower left of the screen displays the [Inspection Result] settings of the inspection window.

Result 1102 Edge Pitch					8.38 ms
Param Name	Value	Param Name	Value	Param Name	Value
N	5	X	276.59	X1	264.77
W	23.65	Y	253.50	Y1	253.50
WH	24.31	AG	0.00	AG1	0.00
WL	23.33			RAG1	0.00
WA	23.79				

2) In Run Mode, manually click on the [One Trigger] or [Cont.Trigger] buttons below, and the system will use the current camera image for testing. (Run Mode I/O and communications will be output)

If the inspect window result is OK, the bar on the left of the inspect window will be green; in contrast, if the inspect window result is NG, the bar on the left of the inspect window will be red.

Flow 1	Flow 2	
	1100 Area	6.24 ms
	1101 Edge Count	8.35 ms

One Trigger   Cont.Trigger

3) Custom Inspection Results

Click on the [Result] icon at the bottom of the screen, to open custom inspection result settings.

➤ Allows the position of results to be customized. (As shown in the figure below, the blue cursor focus is moved to the second from the bottom on the right)

➤ Then click on the [+] icon

Choose the source of data to be displayed. The figure below selected the area pixel result of the [Area] inspection window.

➤ Add an [Edge Count] inspection window result.

If the result is OK (within the upper/lower limit), the value displayed will be green. In contrast, if the result is NG (outside the upper/lower limit), the value displayed will be red.

➤ Click on the ✎ icon

Open the shortcut setup page (dialog) for the upper/lower limit of the current value.

➤   Click on ![Result] again to return to the original display.

➤   Display results on screen

After the inspection is completed, all results are displayed at the lower left of the screen. Users can select the data they want to view, the data that is selected will be displayed in the image. As shown in the red frame in the figure below, the position where it is displayed is fixed and cannot be freely adjusted.
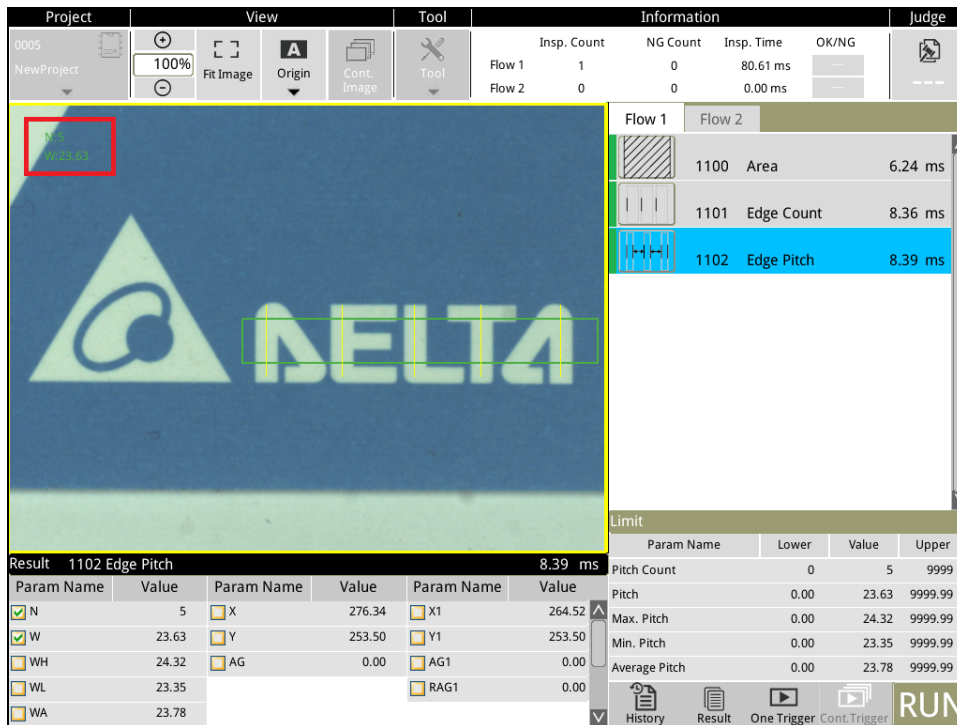
4.4.3 Flow Judge Setting

Judge of the final result of inspections is displayed by the indicator on the screen as OK (Green)/NG (Red), making it convenient for users to quickly see the final result of the inspection when the view the screen.

➤   Click on the gray area of [Flow 1/2] and [Judge] to enter settings. The setting interface and method are the same for all three.

➢ Click on [Open Item Menu] on the lower right of the screen to begin configuring source parameters
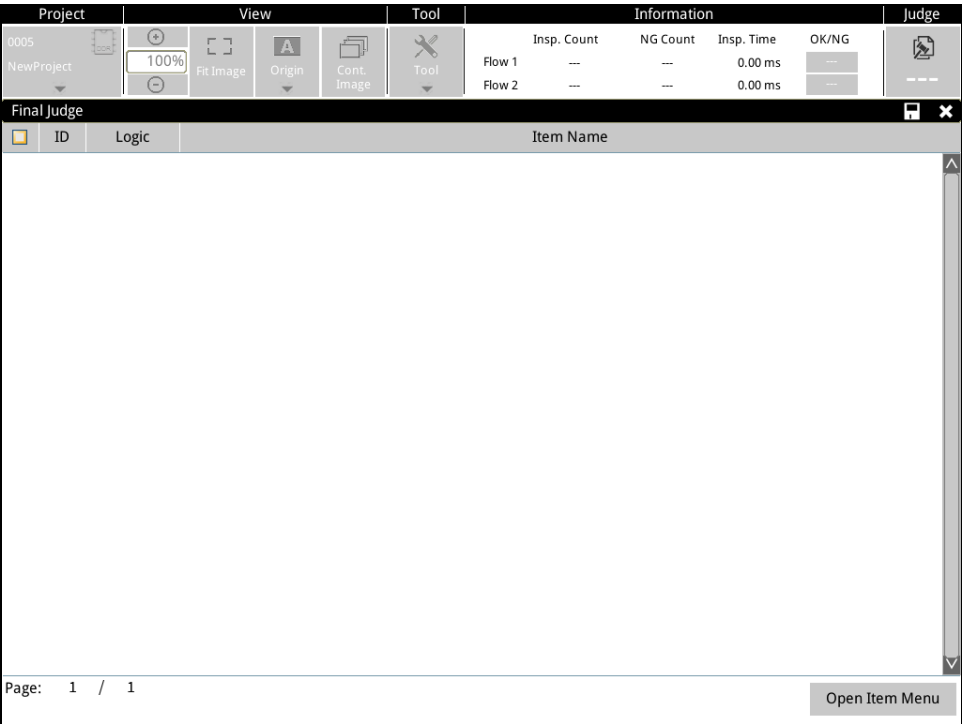
➢ First add an [Area] item
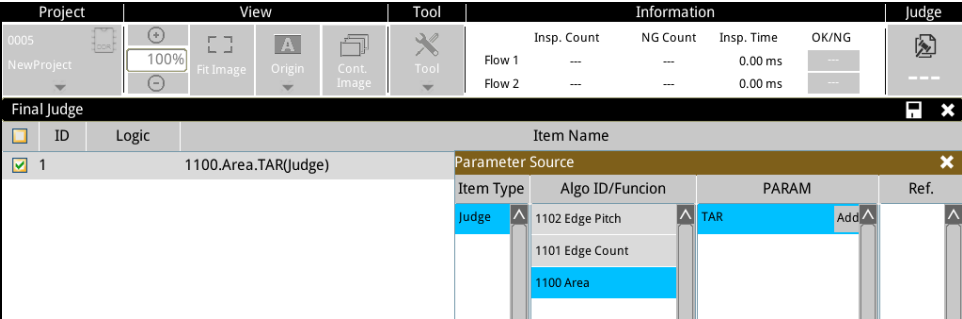
➢ Then add an [Edge Count] item

Up to 128 items can be added, then use [AND] and [OR] to generate the final logical result. (OK=1; NG=0)
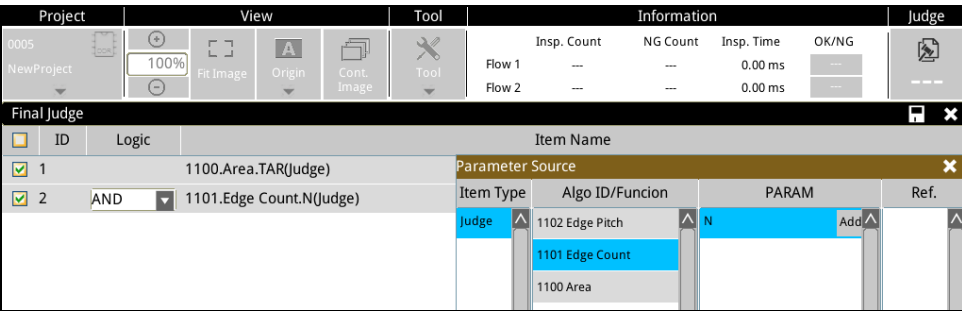
➤ In the figure below, configuration of [Flow 1] and [Judge] were both completed, so the determination result (OK/NG) will be displayed after an inspection is triggered.

4.4.4 Display Settings in Run Mode

The following section describes how users can freely define the display method in Run Mode.

➤ When the cursor is over the camera image, right click to display a screen editing menu, and click on an option to set the display setting.
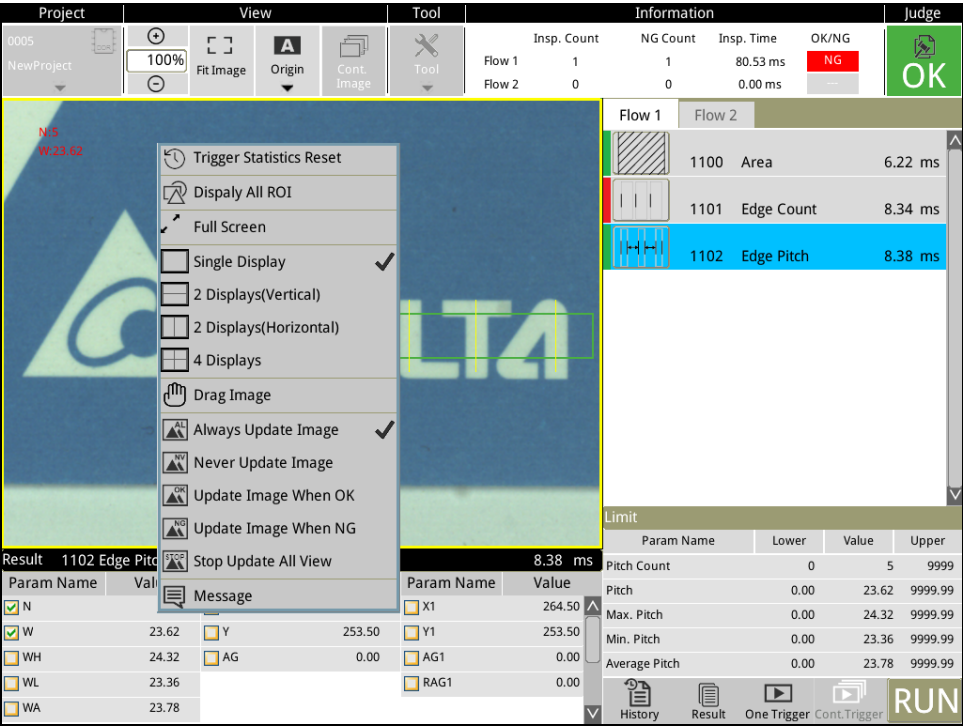
1) Single Display: Only one camera image is displayed.

2 Displays (vertical) (horizontal): Two camera images are displayed at the same time vertically or horizontally. (Usually used when there are two cameras)

4 Displays: Displays four camera images at the same time. (Usually used when there are two cameras)

2) Drag Image

When this is selected, move the cursor over the camera image and hold on to the left mouse button to drag the camera image.

The camera image cannot be dragged when this is not selected.
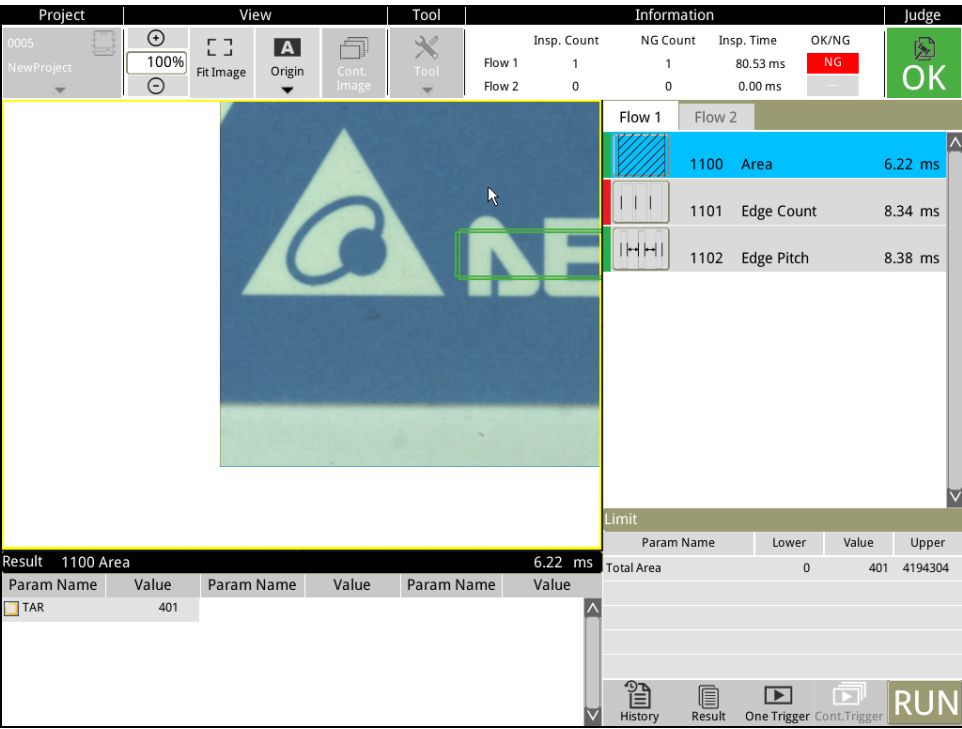
3) **Always Update Image**: This is the default. After each inspection, the camera image and inspection results will update the image.

Never Update Image: The camera image will not be updated while inspection result will execute an update.

Update Image when OK: The camera image is only updated when the [Judge] result is OK, and inspection result will still execute an update.

Update Image when NG: The camera image is only updated when the [Judge] result is NG, and inspection result will still execute an update.

No Update: Camera images and inspection result will not update the image on the screen.

4) Display All ROI: One inspect window has one ROI, so three inspect windows will have three ROI. When Display All ROI is selected, the screen will display three ROI frames at the same time to see the position of all ROI.
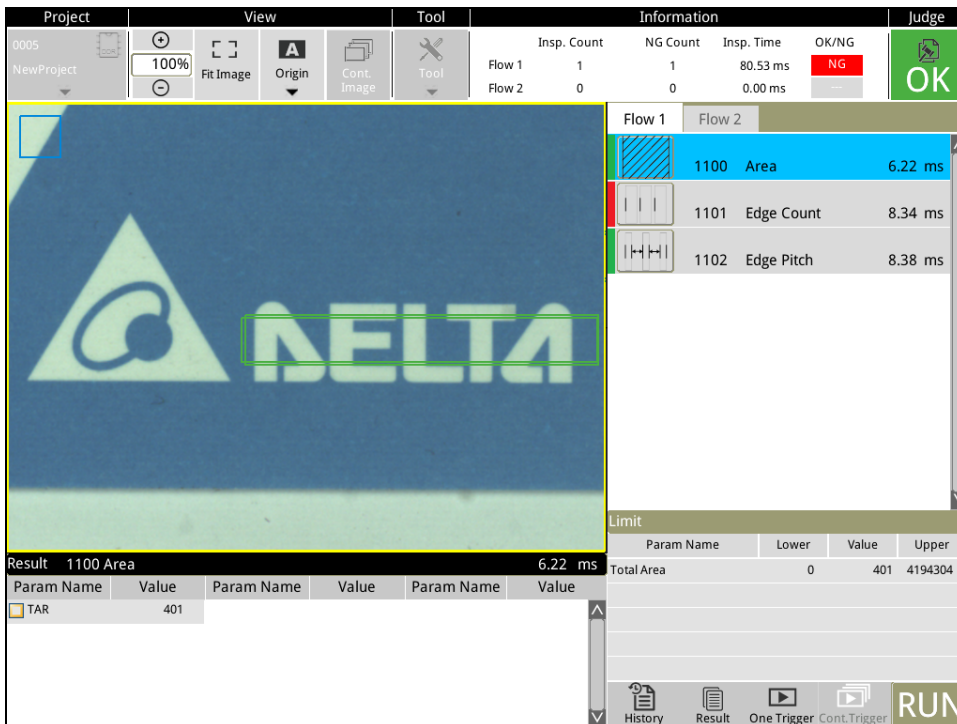
5) Full Screen: The window will be displayed in full screen mode when this is selected.
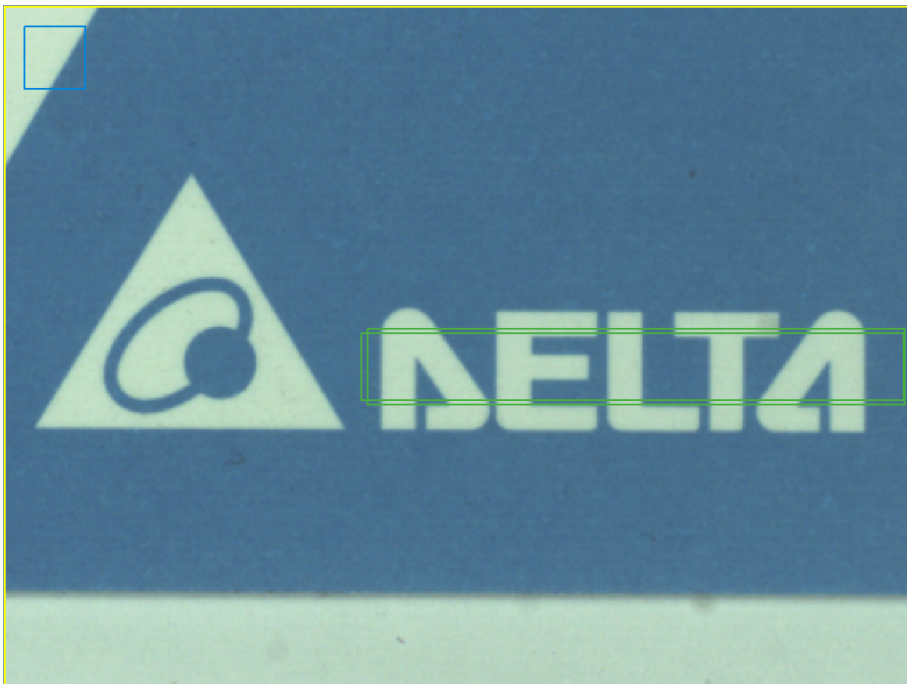
4.5 Draw ROI

When creating a new inspection, you must use the mouse to click-and-drag to select the range of the image to be inspected, which is commonly referred to as ROI (region of interest). You can configure the ROI as follows:

1) Configure the settings in **Inspection** > **ROI**
2) Configure the settings in **Inspection** > **Region Mask**

You can use any of the following shapes when defining the ROI:

1) Rectangle
2) Circle
3) Polygon
4) Ellipse
5) Circle
6) Arc
7) Rotated rectangle

4.5.1 Draw a Rectangle

Follow the steps below to draw a rectangle.

1) The initial state of a rectangle shows the central crosshair and the two upper and lower corners. Drag the central crosshair of the rectangle to move the entire object.
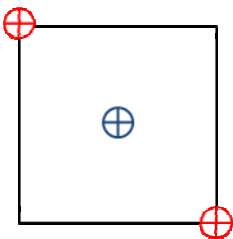
2) Drag the upper left crosshair to adjust the position of the upper corner and select the inspection region.
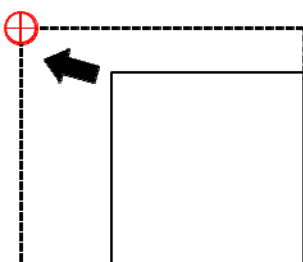
3) Drag the lower right crosshair to adjust the position of the lower corner and select the inspection region.
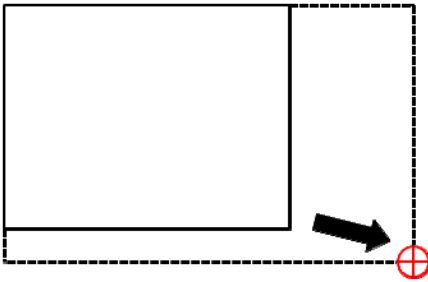
4) Finally, click the central crosshair or the ![×] button to complete setting the coordinate positions of the rectangle.

5) You can use steps 1-4 in coordination with the data in the right column to adjust the numerical values for the rectangle. See the following picture.

Remark Click ![Reset] **Reset** to restore the initial configured value. Click ![Full Screen] **Full Screen** to use the maximum range for the ROI.

4.5.2 Draw a Circle

Follow the steps below to draw a circle.

1) The initial state of a circle shows the central crosshair and four circumference points at the top, bottom, left, and right. Drag the crosshair at the center of the circle to move the entire object.
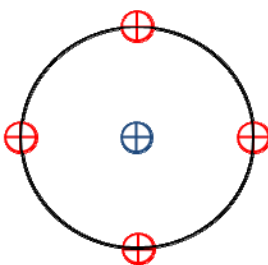
2) Drag any circumference point to adjust the point position and select the inspection range.
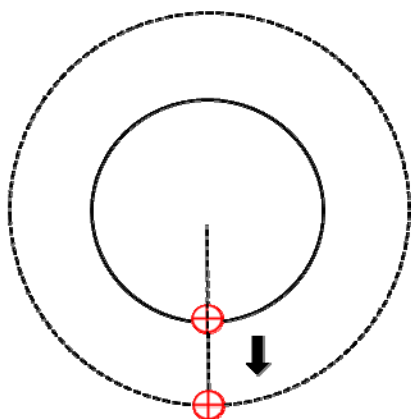
3) Finally, click the central crosshair or the [×] button to complete setting the coordinate positions of

    the circle.

4) You can use steps 1–3 in coordination with the data in the right column to adjust the numerical values for
the circle. See the picture below.

Remark Click ↺ Reset to restore the initial configured value.

4.5.3 Draw a Polygon

Follow the steps below to draw a polygon (up to a maximum of 15 sides—a pentadecagon).

1) The initial state of a polygon shows the central crosshair, there vertices, and three edges. Drag the
    crosshair at the center of the polygon to move the entire object.
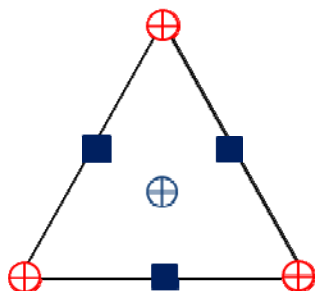
2) Click any one vertex (first vertex), and then move the mouse pointer to adjust the vertex position and inspection range, and then click the mouse button again to locate the vertex in the new position. Note that this is different from moving a vertex in the previous shapes.
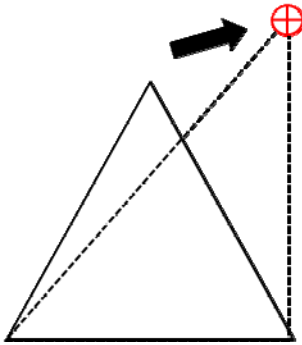
3) Click any one vertex (second vertex), and then move the mouse pointer to adjust the vertex position and inspection range, and then click the mouse button again to locate the vertex in the new position.
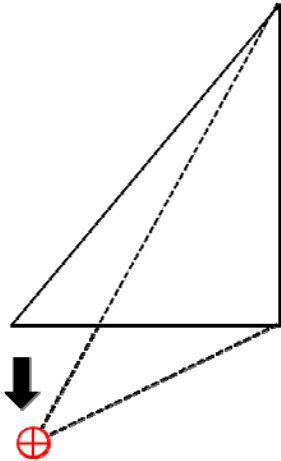
4) After locating all vertices in the desired inspection region, you can adjust each vertex position and coordinate display according to the table of numerical values in the right column of the table (see the picture after the steps).
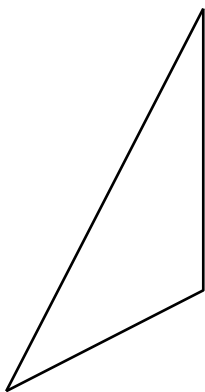
5) Click the ■ on any edge to add a fourth vertex, and then move the mouse pointer to place the new vertex position and inspection range. You can also click ⊕ in the table to the right to add a new vertex from each vertex position.

6) Use steps 1–5 to adjust the polygon to the required area.
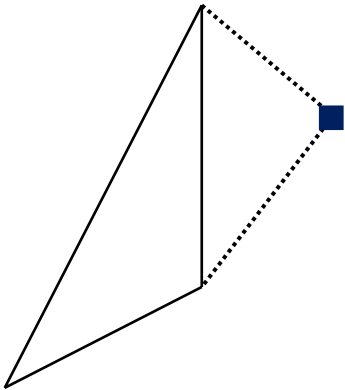
7) You can delete a vertex by right-clicking the vertex to be deleted, or click ⊖ in the table to the right of the vertex to delete (see the picture of the Polygon settings below).
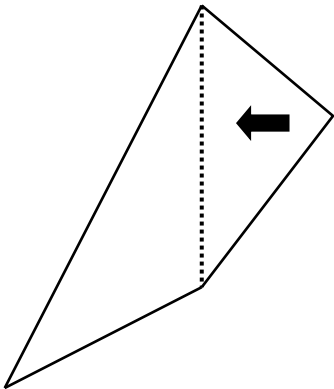
8) Finally, click the central crosshair or click the ❌ button to complete setting the coordinate positions of the polygon.

9) You can use steps 1–8 in coordination with the data in the right column to adjust the numerical values for the polygon.

ROI: Polygon				
⟳ Reset				
(Cx, Cy) =	315	206		
(P1) =	319	120	⊕	⊖
(P2) =	444	153	⊕	⊖
(P3) =	423	299	⊕	⊖
(P4) =	216	300	⊕	⊖
(P5) =	174	161	⊕	⊖

ℹ **Remark** Click ⟳ Reset to restore the initial configured value.

4.5.4 Draw an Ellipse

Follow the steps below to draw an ellipse.

1) The initial state of an ellipse. Drag the crosshair at the center of the circle to move the entire object.
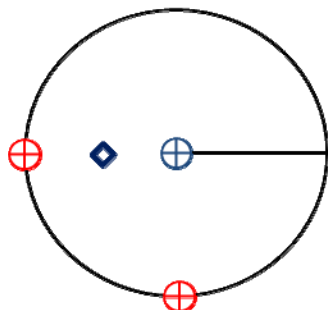
2) Drag one vertex to adjust the width of the ellipse in the corresponding direction.
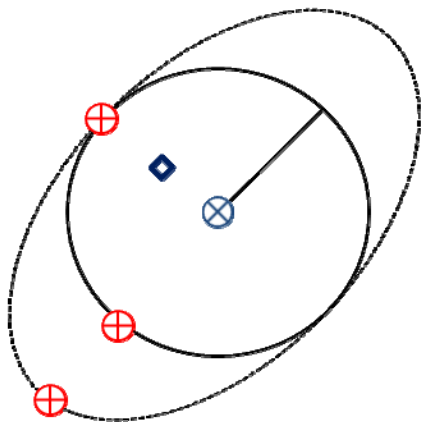
3) Drag the other vertex to adjust the width of the ellipse in the other direction.
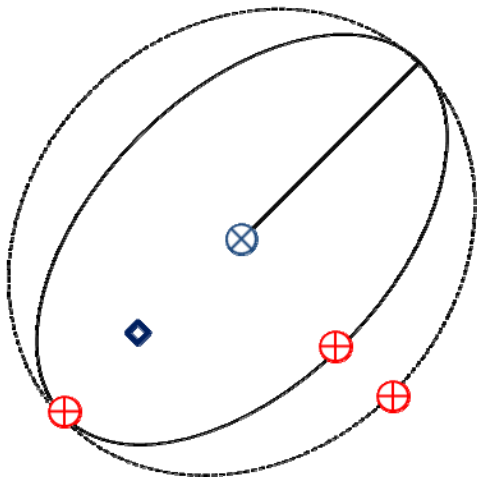
4) Drag the small square inside the ellipse to rotate the angle of the ellipse.
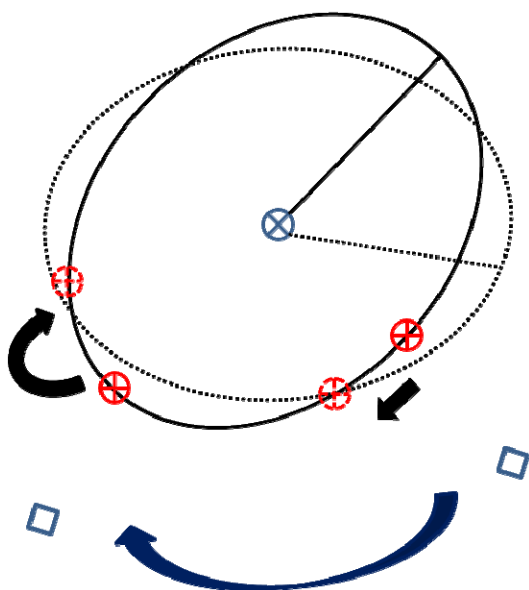
5) Finally, click the central crosshair or click the [×] button to complete setting the coordinate positions

of the ellipse.

6) You can use steps 1–5 in coordination with the data in the right column to adjust the numerical values for

the ellipse. See the picture below.

ROI: Ellipse		✕
↺ Reset		
(Cx, Cy) =	320 ▲▼	240 ▲▼
(Horizontal Axis) =		160 ▲▼
(Vertical Axis) =		120 ▲▼
(Angle) =		0.0 ▲▼

ⓘRemark Click ↺ Reset to restore the initial configured value.

4.5.5 Draw a Ring

Follow the steps below to draw a ring.

1) The initial state of the ring shows the central crosshair, four inner ring circumference vertices, and four outer ring circumference vertices. Drag the crosshair at the center of the ring to move the entire object.
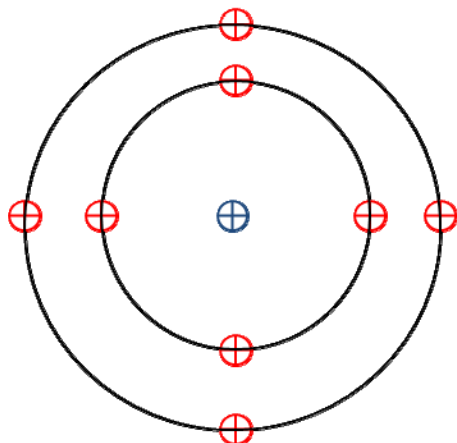
2) Drag the bottom vertex of the inner ring to adjust the inner ring radius.
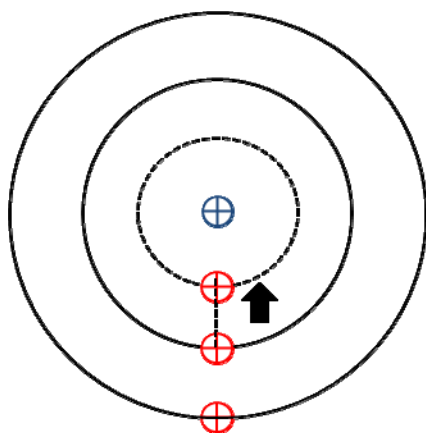
3) Drag the bottom vertex of the outer ring to adjust the outer ring radius.
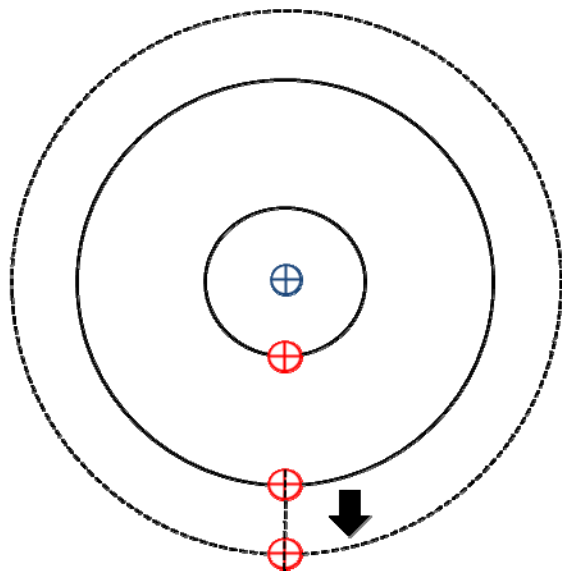
4) Finally, click the central crosshair or click the ![×] button to complete setting the coordinate positions of the ring.

5) You can use steps 1–4 in coordination with the data in the right column to adjust the numerical values for the ring. See the picture below.

ⓘRemark Click ⟳ Reset to restore the initial configured value.

4.5.6 Draw an Arc

Follow the steps below to draw an arc.

1) The initial state of the arc shows the central crosshair, inner arc circumference vertex, outer arc circumference vertex, and the two centroids of the lines connecting the inner and outer arc. Drag the crosshair at the center of the ring to move the entire object.

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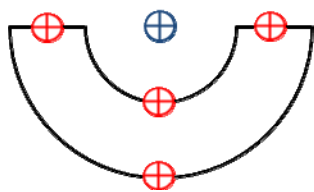
2) Drag the bottom circumference vertex of the inner ring to adjust the inner ring radius.
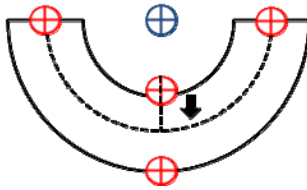
3) Drag the bottom circumference vertex of the outer ring to adjust the outer ring radius.
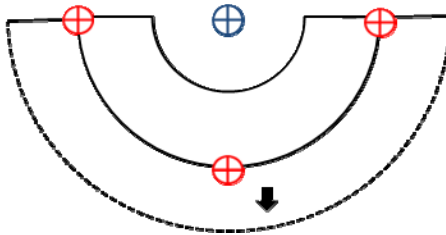
4) Drag one of the two centroids of the lines connecting the inner and outer arc to adjust the arc angle.
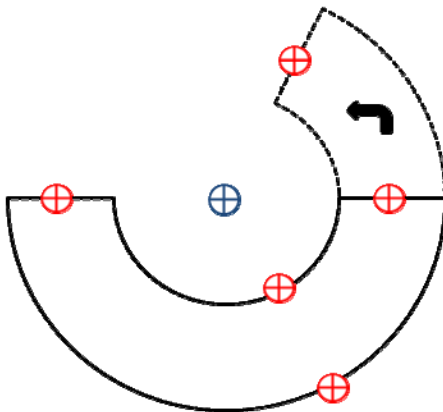
5) Finally, click the central crosshair or click the [×] button to complete setting the coordinate positions of the arc.

6) You can use steps 1–5 in coordination with the data in the right column to adjust the numerical values for the arc. See the picture below.

ROI: Arc		×
↺ Reset		
(Cx, Cy) =	320	240
(Inner Radius) =		60
(Outer Radius) =		120
(Start Angle) =		0.0
(End Angle) =		180.0

ⓘ Remark Click ↺ Reset to restore the initial configured value.

4.5.7 Draw a Rotated Rectangle

Follow the steps below to draw a rotated rectangle.

1) The initial state of the rotated rectangle shows the central crosshair, the small square in the rectangle, and the straight line and the bottom and left vertices corresponding to the position of the small square. Drag the crosshair at the center of the rectangle to move the entire object.
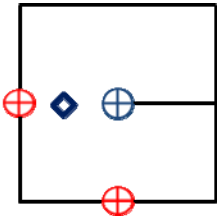
2) Drag one vertex to adjust the width of the rectangle in the corresponding direction
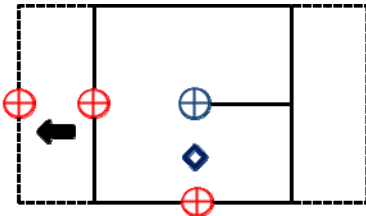
3) Drag the other vertex to adjust the width of the rectangle in the other corresponding direction
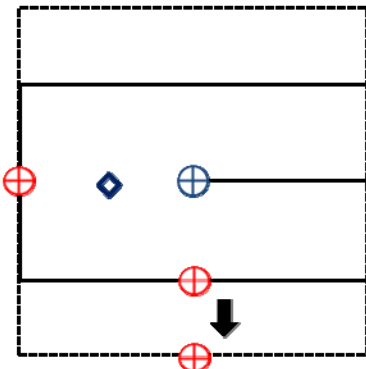
4) Drag the small square inside the square to rotate the angle of the rectangle.
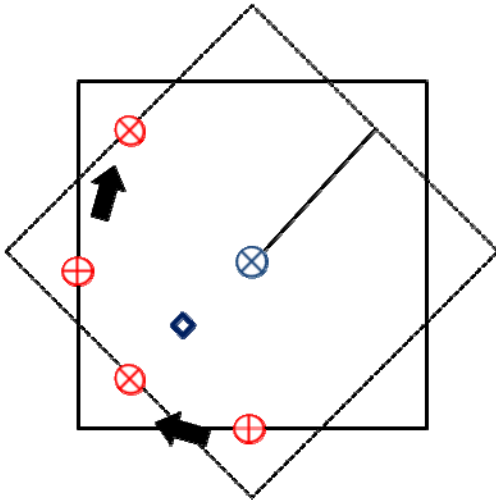
5) Finally, click the central crosshair or click the [✕] button to complete setting the coordinate positions of the rectangle.

6) You can use steps 1–5 in coordination with the data in the right column to adjust the numerical values. See the picture below.

ROI: Rotated Rectangle	✕
↻ Reset	
(Cx, Cy) =	320 / 240
(Horizontal Axis) =	160
(Vertical Axis) =	120
(Angle) =	0.0

Remark Click ↻ Reset to restore the initial configured value.

Chapter 5

Inspection

5.1 Area

This image inspection tool uses a binary method to convert the image to black and white, and then count the number of black and white pixels in the area.

◎ **Algorithmic Processing**

The Area tool uses a binary method to convert images to black and white before counting the black or white pixels.

◎ **Procedural Results**

Area returns the following inspection results.

Area: outputs the number of black and white pixels.

ROI (region of interest)

Counts black/white pixels in the region

Object to be tested

◎ **Example**

White area is 250,000 pixels
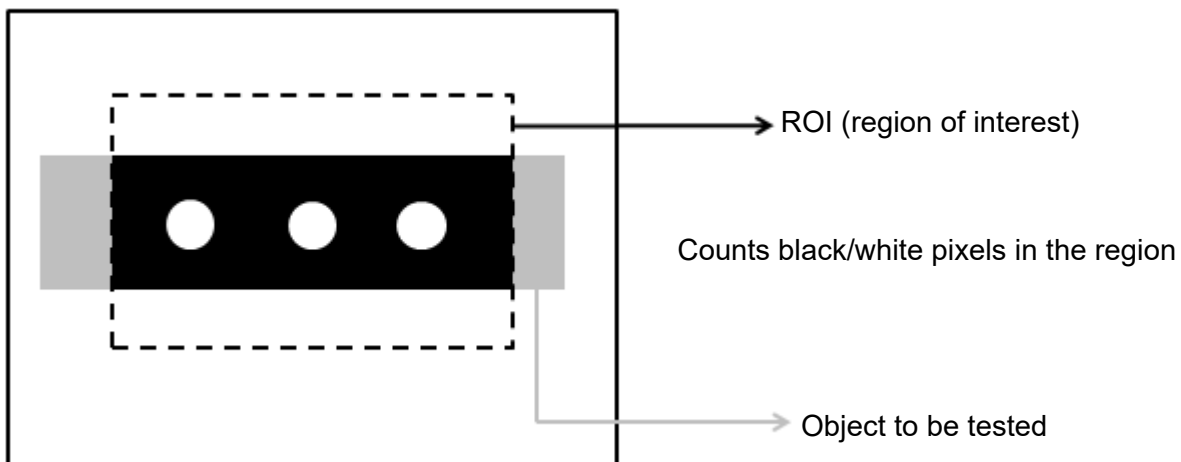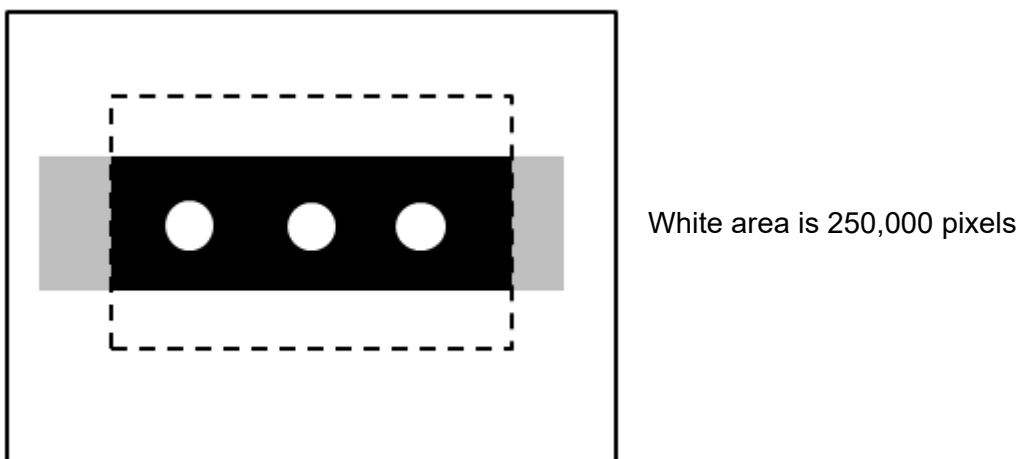
5.1.1 Area dialog box

The following picture shows the Area inspection tool dialog box.

◎ **Image Select** (select Register Image)

Selects the image to be inspected from the register gallery. You can configure source cameras and inspect the image display source. When you select a different camera, the image table also switches to show the registered images acquired from that camera.

◎ **ROI** (configure detection region of interest)

Specifies the inspection regions to be used in the inspection. Optional ROI shapes include Rectangle, Circle, Arc, Ellipse, Ring, Polygon, and Rotated Rect. The Polygon ROI supports up to 16 points. In addition, there are up to eight mask functions to ignore particular segments.

◎ **Color**

Selects the color processing for images from a color camera: Color to Binary, Color to Grayscale, RGB grayscale, R Grayscale, G Grayscale, and B Grayscale.

◎ **Filter**

Specifies the image processing to apply before inspections to enhance certain aspects of the image. Preprocessing methods include Binary, Dilation, Erosion, Average, Median, Laplacian, Sobel X, Sobel Y, Sobel XY, Brightness, Contrast, Shade, and Custom (filter). You can superimpose up to six methods or create a custom method by clicking Custom.

◎   **Parameter**

Adjusts the Area inspection conditions.

Binary Limit

This function configures the upper and lower limits of the binary method that converts pixels in the configured range to white pixels, and converts the remaining pixels to black pixels. As shown in the following diagram, when you set the lower limit to 60 and the upper limit to 200, all gray scale values between 60 and 200 are converted to white, and the remaining pixels are converted to black.

Object

Specifies whether to count pixels in the area of white or black objects.

◎   **Limit**

Specifies the upper and lower limits for inspection results to determine whether the result is qualified.

Area: specifies the upper and lower limits for Area.

◎ **Locate**

Specifies whether the inspection region follows an inspection result by adjusting its coordinates (X, Y) and Angles (Theta). The inspection tools you can use as a reference includes Shape, Blob, Edge Position and Edge Angle. As shown in the following diagram, specific marks (such as the cross on the object) can be used for the Locate function.

ROI

Object

Locate Off   Locate On

Corrected inspection region after using Locate

Target

Manual mode and quick mode are available for this project.

➤ Manual mode: Manually click【Ref. X】、【Ref. Y】and【Ref. Angle】, separately set the source of the reference positioning.

➤ Quick mode: Click【 Ref. Nearest Shape Locate Win】, the system will directly bring in the closest 【Shape】as the【Ref. X】、【Ref. Y】and【Ref. Angle】setting.

➤ Reference Please refer to Section 9.1 for detailed Locate configurations.

◎ **Execution**

Specifies whether to execute the inspection function in the inspection flow.

➤ **Always Execution**

Always execute the inspection function in Run mode.

➤ **Never Execution**

Never execute the inspection function in Run mode.

➤ **Reference Execution**

This test will be executed when the [Reference Detection] item meets the [OK/NG] condition.

◎ **Output Item**

➤ **Window**

Selects the output window for the total Judge result for the Area tool on the designated interface.

➤ **Item**

● **Area**: outputs the pixel count from the Area tool.

● **Area ID**: outputs the ID of the inspection tool.

● **Total Area (J)**: outputs the logical (Judge) result of the pixel count obtained by the Area tool.

5.2 Blob

This image inspection tool uses a binary method to convert the image to black and white and then count the number and area of contiguous black or white pixel groups, and then calculates the coordinates of each contiguous pixel group.

◎ **Algorithmic Processing**

The Blob tool uses a binary method to convert images to black and white before counting the black or white contiguous pixel groups.
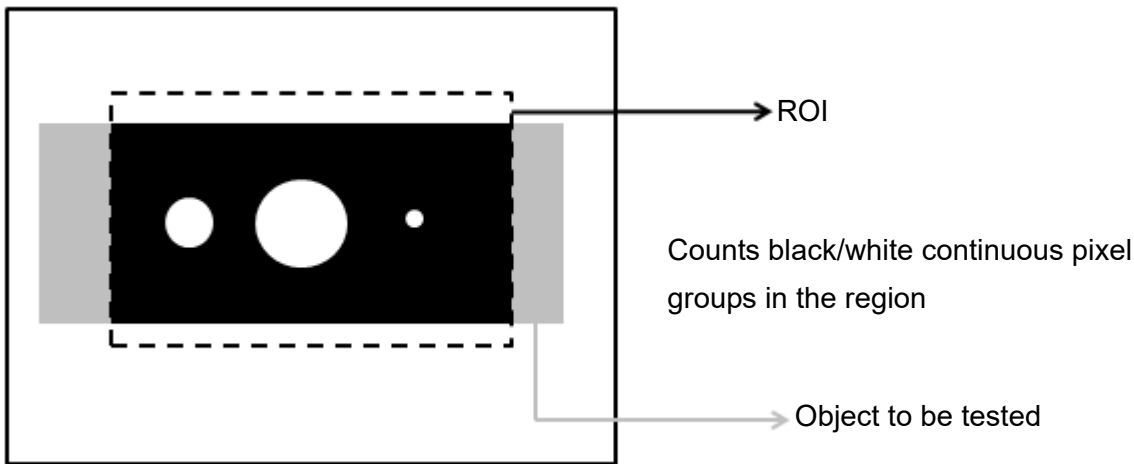
◎ **Procedural Results**

The Blob tool returns the following inspection results.

➤ Number of Blobs: outputs the number of black or white contiguous pixel groups.

➤ Blob Centroid Position X [N]: outputs the X coordinate of the centroid of the Nth black or white contiguous pixel group.

➤ Blob Centroid Position Y [N]: outputs the Y coordinate of the centroid of the Nth black or white contiguous pixel group.

➤ Blob Area [N]: outputs the area of the Nth black or white contiguous pixel group.

➤ Blob Perimeter [N]: outputs the perimeter of the Nth black or white contiguous pixel group.

◎ **Example**
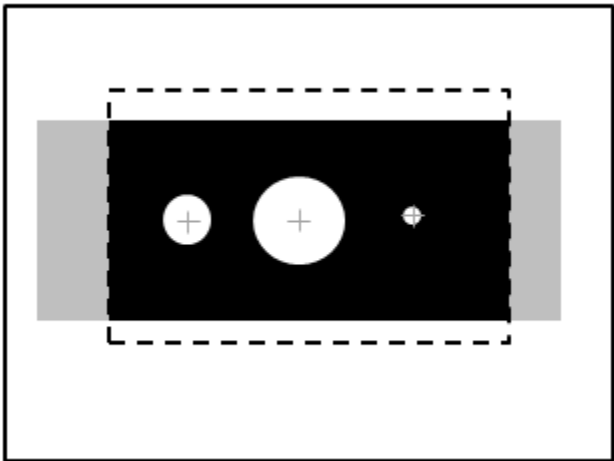
Number of Blobs: 3

Blob Centroid Position X [1]: 1000

Blob Centroid Position Y [1]: 500

Blob Area [1]: 4000

Blob Perimeter [1]: 1500

5.2.1 Blob dialog box

The following picture shows the Blob inspection tool dialog box.

◎ **Image Select** (select Register Image)

Selects the image to be inspected from the register gallery. You can configure source cameras and inspect the image display source. When you select a different camera, the image table also switches to show the registered images acquired from that camera.

◎ **ROI** (configure detection region of interest)

Specifies the inspection regions to be used in the inspection. Optional ROI shapes include Rectangle, Circle, Arc, Ellipse, Ring, Polygon, and Rotated Rect. The Polygon ROI supports up to 16 points. In addition, there are up to eight mask functions to ignore particular segments.

◎ **Color**

Selects the color processing for images from a color camera: Color to Binary, Color to Grayscale, RGB grayscale, R Grayscale, G Grayscale, and B Grayscale.

◎ **Filter**

Specifies the image processing to apply before inspections to enhance certain aspects of the image. Preprocessing methods include Binary, Dilation, Erosion, Average, Median, Laplacian, Sobel X, Sobel Y, Sobel XY, Brightness, Contrast, Shade, and Custom (filter). You can superimpose up to six methods or create a custom method by clicking Custom.

◎ **Parameter**

Adjusts the Area inspection conditions.

Binary Limit

This function configures the upper and lower limits of the binary method that converts pixels in the configured range to white pixels, and converts the remaining pixels to black pixels. As shown in the following diagram, when you set the lower limit to 60 and the upper limit to 200, all gray scale values between 60 and 200 are converted to white, and the remaining pixels are converted to black.

Detect Object

Specifies whether to count the number of blobs in white or black objects.

Blob Condition

  Sort Rule: When searching multiple blobs, you can choose from the following blob sorting methods.

1) **Area Ascend/Descend**: When you configure Area Ascend, smaller areas are numbered first. For Area Descend, larger areas are numbered first.
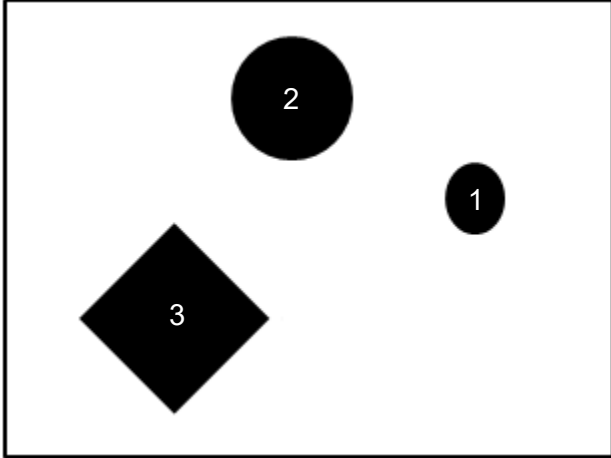
2) **Perimeter Ascend/Descend**: When you configure Perimeter Ascend, shorter perimeters are numbered first. For Perimeter Descend, longer perimeters are numbered first.
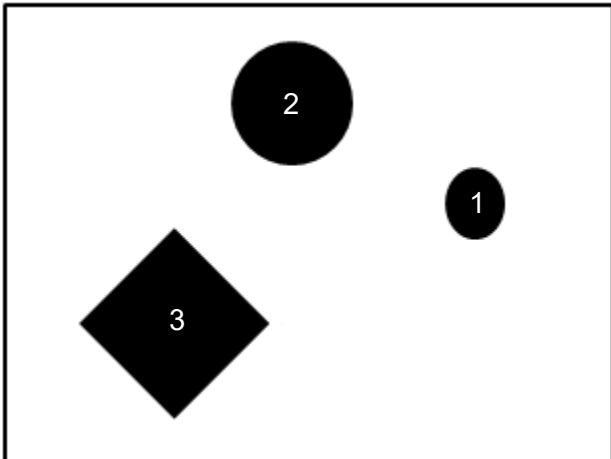
3) **Horizontal Center Position Ascend/Descend**: When you configure Horizontal Center Position Ascend, smaller Horizontal Center Position (coordinate values) are numbered first. For Horizontal Center Position Descend, larger Horizontal Center Position (coordinate values) are numbered first.
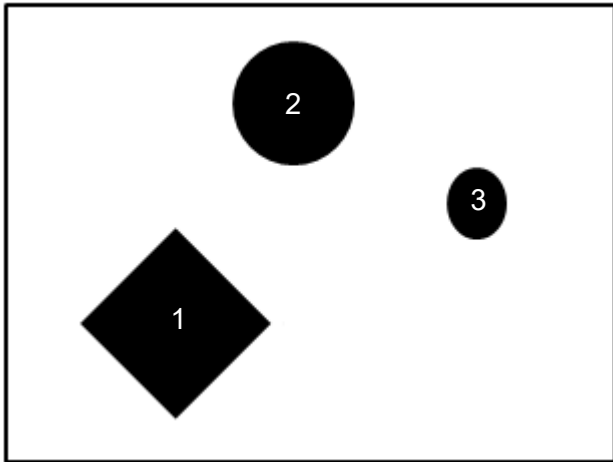
4) **Vertical Center Position Ascend/Descend**: When you configure Vertical Center Position Ascend, smaller Vertical Center Position (coordinate values) are numbered first. For Vertical Center Position Descend, larger Vertical Center Position (coordinate values) are numbered first.
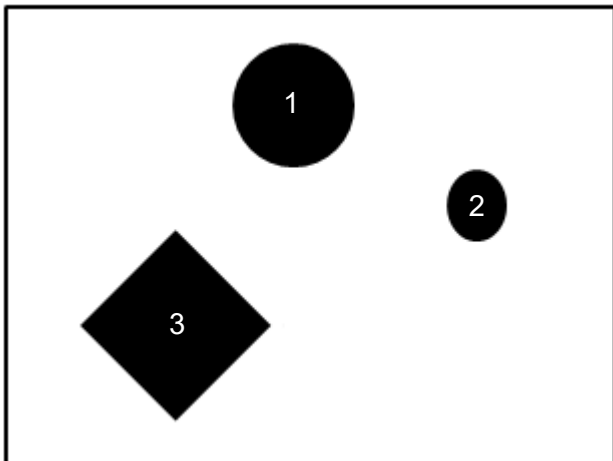
5) **Bounding Rectangle Horizontal Position Ascend/Descend**: When you configure Bounding Rectangle Horizontal Position Ascend, smaller Bounding Rectangle Horizontal Position (coordinate values) are numbered first. For Bounding Rectangle Horizontal Position Descend, larger Bounding Rectangle Horizontal Position (coordinate values) are numbered first.
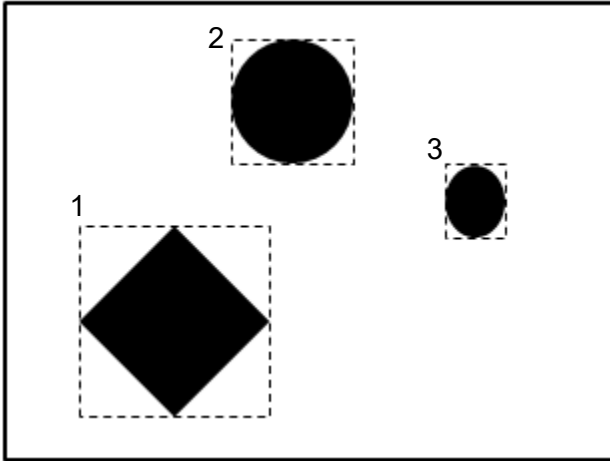
6) **Bounding Rectangle Vertical Position Ascend/Descend**: When you configure Bounding Rectangle Vertical Position Ascend, smaller Bounding Rectangle Vertical Position (coordinate values) are numbered first. For Bounding Rectangle Vertical Position Descend, larger Bounding Rectangle Vertical Position (coordinate values) are numbered first.
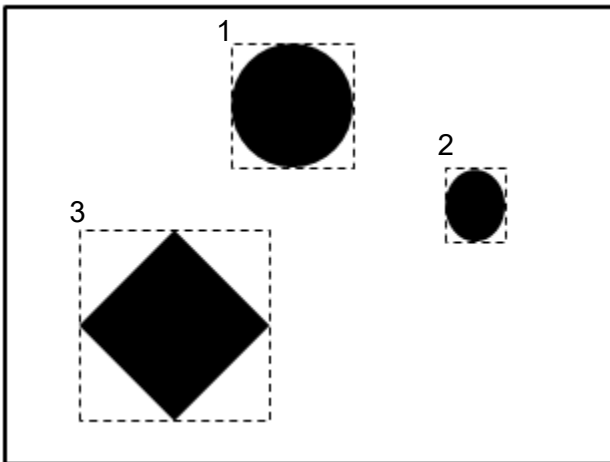
7) **Bounding Rectangle Width Ascend/Descend**: When you configure Bounding Rectangle Width Ascend is configured, shorter bounding rectangle widths are numbered first. For Bounding Rectangle Width Descend, longer bounding rectangle widths are numbered first.
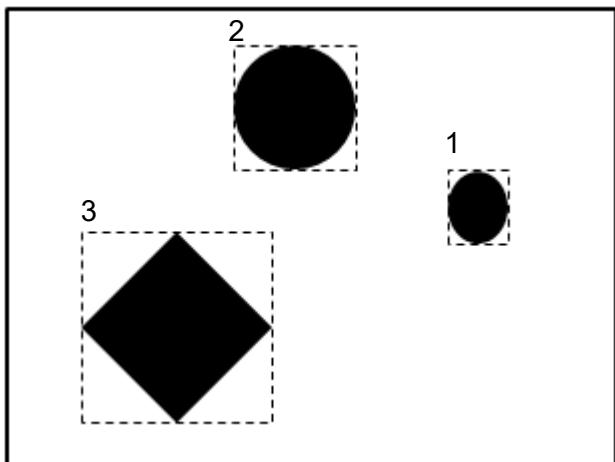
8) **Bounding Rectangle Height Ascend/Descend**: When you configure Bounding Rectangle Height Ascend, shorter bounding rectangle heights are numbered first. For Bounding Rectangle Height Descend, longer bounding rectangle heights are numbered first.
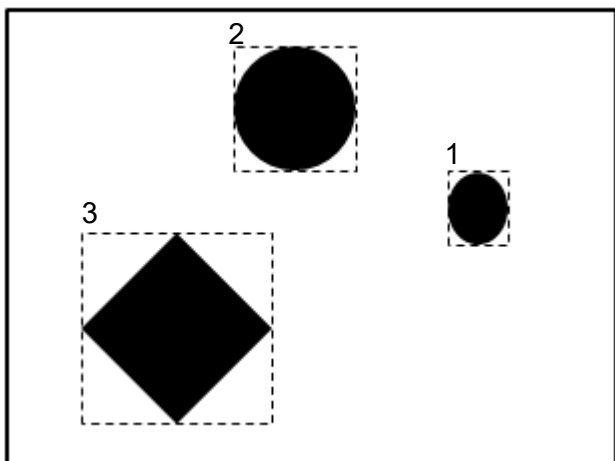
9) **Roundness Ascend/Descend**: When you configure Roundness Ascend, lesser roundness results are numbered first. For Roundness Descend, greater roundness results are numbered first.
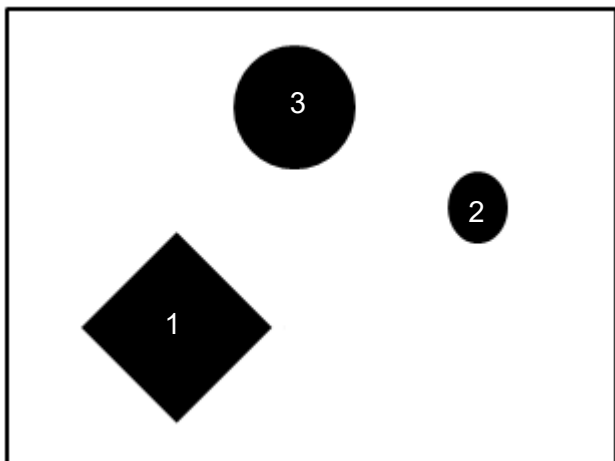
10) **Major Axis Angle Ascend/Descend**: When you configure Major Axis Angle Ascend (the white dotted line is the major axis), smaller angles between the major axis and the horizontal line are numbered first. For Major Axis Angle Descend, greater angles between the major axis and the horizontal line are numbered first.
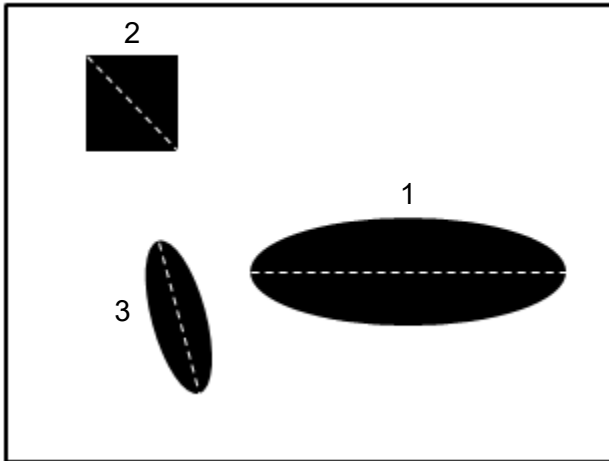
11) **Major Axis Length Ascend/Descend**: When you configure Major Axis Length Ascend (the white dotted line is the major axis), shorter major axis lengths are numbered first. For Major Axis Length Descend, longer major axis lengths are numbered first.
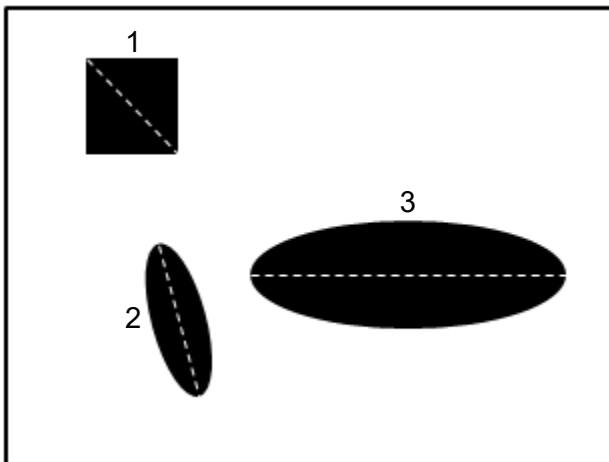
Reference

Output the Nth result when scanning multiple targets.

Origin

The position of the origin (0, 0) in System Setting is displayed on the upper left corner of the screen. You can enter the coordinates to change and move the origin to the new coordinates.

◎ **Limit**

After you complete the configurations, you can view the inspection results using register images through **Test Mode**. You can then configure the upper and lower limits in the Limit dialog box. You can configure the following items for the Blob tool.

Number of Blobs: the upper and lower limits for the number of blobs.

Blob Centroid Position X: the upper and lower X coordinate limits of blob centroids.

Blob Centroid Position Y: the upper and lower Y coordinate limits of blob centroids.

Blob Area: the upper and lower limits of Blob Area.

Blob Perimeter: the upper and lower limits of Blob Perimeter.

◎ **Locate**

Specifies whether the inspection region follows an inspection result by adjusting its coordinates (X, Y) and Angles (Theta). The inspection tools you can use as a reference includes Shape, Blob, Edge Position and Edge Angle. As shown in the following diagram, specific marks (such as the cross on the object) can be used for the Locate function.

Manual mode and quick mode are available for this project.

➤ Manual mode: Manually click【Ref. X】、【Ref. Y】and【Ref. Angle】, separately set the source of the reference positioning.

➤ Quick mode: Click【⊖Ref. Nearest Shape Locate Win】, the system will directly bring in the closest 【Shape】as the【Ref. X】、【Ref. Y】and【Ref. Angle】setting.

➤ 🗐 Reference Please refer to Section 9.1 for detailed Locate configurations.

◎ **Execution**

Specifies whether to execute the inspection function in the inspection flow.

```
Execute
  ● Always Execution      ○ Never Execution
  ○ Reference Execution
  Ref. Win. None        ▼  ✖
  Condition OK          ▼  ✖
```

➤ **Always Execution**

Always execute the inspection function in Run mode.

➤ **Never Execution**

Never execute the inspection function in Run mode.

➤ **Reference Execution**

This test will be executed when the [Reference Detection] item meets the [OK/NG] condition.

◎ **Output Item**

➤ **Window**

Selects the output window for the total Judge result for the Blob tool on the designated interface.

➤ **Item**

1) **Number of Blobs**: outputs the number of blobs counted by the Blob tool.

2) **Blob Centroid Position X [N]**: outputs the centroid's X coordinate of the Nth blob found by the Blob tool.

3) **Blob Centroid Position Y [N]**: outputs the centroid's Y coordinate of the Nth blob found by the Blob tool.

4) **Maximum Blob Centroid Position X**: outputs the maximum centroid X coordinate found by the Blob tool.

5) **Minimum Blob Centroid Position X**: outputs the minimum centroid X coordinate found by the Blob tool.

6) **Maximum Blob Centroid Position Y**: outputs the maximum centroid Y coordinate found by the Blob tool.

7) **Minimum Blob Centroid Position Y**: outputs the minimum centroid Y coordinate found by the Blob tool.

8) **Blob Area [N]**: outputs the area of the Nth blob found by the Blob tool.

9) **Maximum Blob Area**: outputs the maximum area found by the Blob tool.

10) **Minimum Blob Area**: outputs the minimum area found by the Blob tool.

11) **Blob Roundness [N]**: outputs the roundness of the Nth blob found by the Blob tool.

12) **Maximum Blob Roundness**: outputs the maximum roundness found by the Blob tool.

13) **Minimum Blob Roundness**: outputs the minimum roundness found by the Blob tool.

14) **Blob Major Axis Angle [N]**: outputs the angle of the Nth blob relative to the major axis found by the Blob tool.

15) **Maximum Blob Major Axis Angle**: outputs the maximum angle relative to the major axis found by the Blob tool.

16) **Minimum Blob Major Axis Angle**: outputs the minimum angle relative to the major axis found by the Blob tool.

17) **Blob Perimeter [N]**: outputs the perimeter of the Nth blob found by the Blob tool.

18) **Maximum Blob Perimeter**: outputs the maximum perimeter found by the Blob tool.

19) **Minimum Blob Perimeter**: outputs the minimum perimeter found by the Blob tool.

20) **Blob X Feret Diameter [N]**: outputs the Feret diameter of the Nth blob in the X direction found by the Blob tool.

21) **Blob Y Feret Diameter [N]**: outputs the Feret diameter of the Nth blob in the Y direction found by the Blob tool.

22) **Maximum Blob X Feret Diameter**: outputs the maximum Feret diameter in the X direction found by the Blob tool.

23) **Minimum Blob X Feret Diameter**: outputs the minimum Feret diameter in the X direction found by the Blob tool.

24) **Maximum Blob Y Feret Diameter**: outputs the maximum Feret diameter in the Y direction found by the Blob tool.

25) **Minimum Blob Y Feret Diameter**: outputs the minimum Feret diameter in the Y direction found by the Blob tool.

26) **Blob Bounding Rectangle Upper Left Position X [N]**: outputs the upper left X coordinate of the bounding rectangle for the Nth blob found by the Blob tool.

27) **Blob Bounding Rectangle Upper Left Position Y [N]**: outputs the upper left Y coordinate of the bounding rectangle for the Nth blob found by the Blob tool.

28) **Blob Major Axis Length [N]**: outputs the length of the major axis for the Nth blob found by the Blob tool.

29) **Maximum Blob Major Axis Length**: outputs the maximum length of the major axis found by the Blob tool.

30) **Minimum Blob Major Axis Length**: outputs the minimum length of the major axis found by the Blob tool.

31) **Blob ID**: outputs the ID of the inspection tool.

32) **Number of Blobs (J)**: outputs the logical (Judge) result for the number of blobs counted by the Blob tool.

33) **Blob Centroid Position X (J) [N]**: outputs the logical (Judge) result for the centroid's X coordinate of the Nth blob found by the Blob tool.

34) **Blob Centroid Position Y (J) [N]**: outputs the logical (Judge) result for the centroid's Y coordinate of the Nth blob found by the Blob tool

35) **Blob Area (J) [N]**: outputs the logical (Judge) result for the area of the Nth blob found by the Blob tool

36) **Blob Perimeter (J) [N]**: outputs the logical (Judge) result for the perimeter of the Nth blob found by the Blob tool.

5.3 Stain

You can use the Stain tool to detect stains in a fixed direction, such as scrapes and smears on the object.

◎ **Algorithmic Processing**

You must first specify the scan direction and the width, height, and offset of the scanned segment. During each scan, the controller calculates the average gray scale value within the scanned segment, and compares this value with the previously scanned result. When the difference exceeds the Stain Threshold and the area exceeds Stain Area, the system recognizes the segment as a stain.
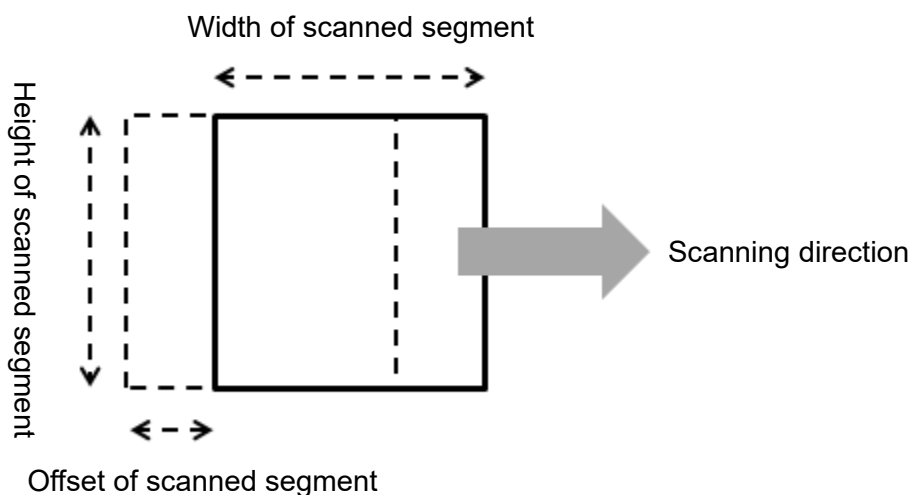
➤ Stain Scanning Methods

Stain includes various ROI options when you choose the Stain scanning methods. All types of ROIs can be scanned in horizontal, vertical, or horizontal–vertical directions. You can still use horizontal and vertical scanning to inspect stains in the vertical and horizontal directions.

Scanned segment

ROI

Horizontal

scanning

Scanned segment

ROI
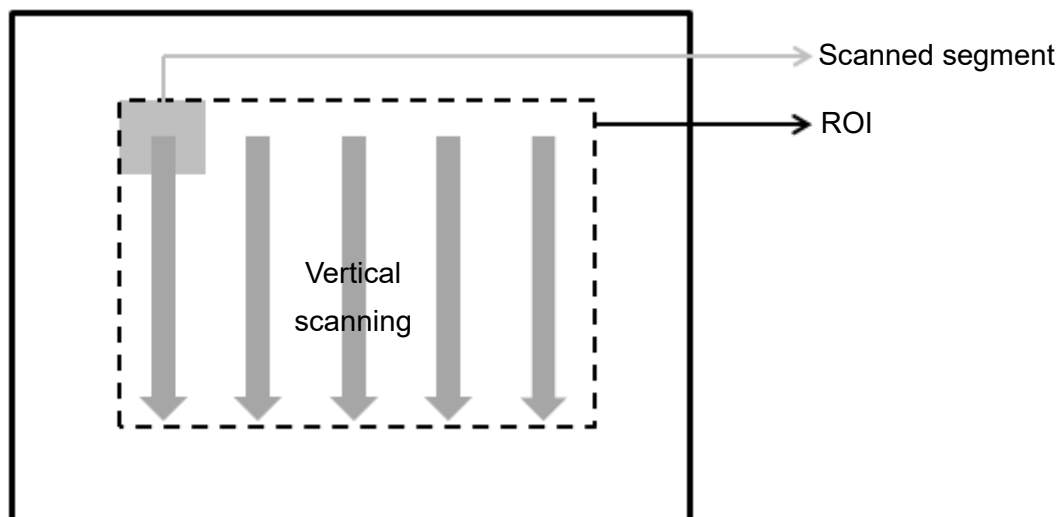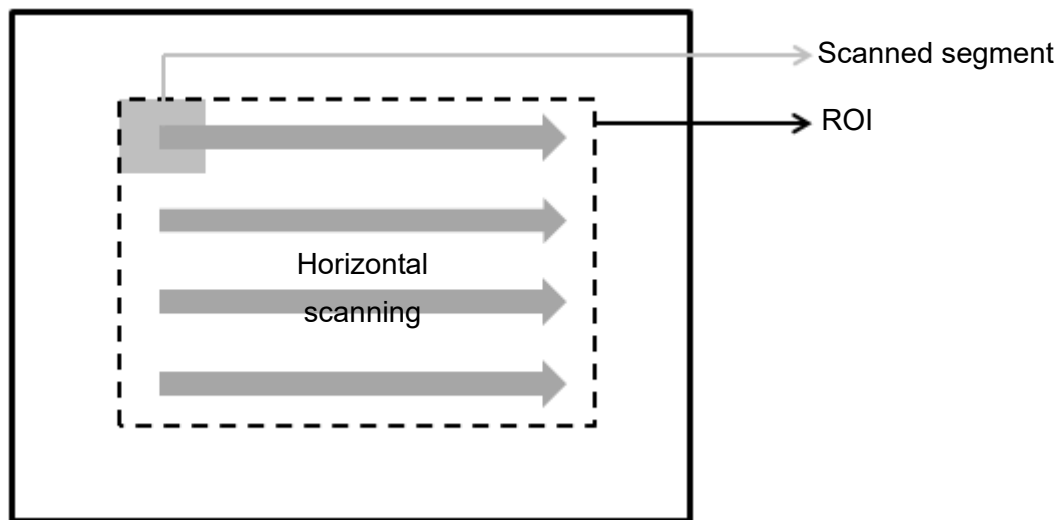
Vertical

scanning

◆ When the ROI is Circle, Ring, or Arc, you can also select the tangential and radial directions in addition to horizontal, vertical, and horizontal–vertical scanning. You can use tangential and radial scanning to inspect stains in the radial and tangential directions.

Scanned segment

ROI

Tangential scanning

Scanned segment

ROI

Radial scanning
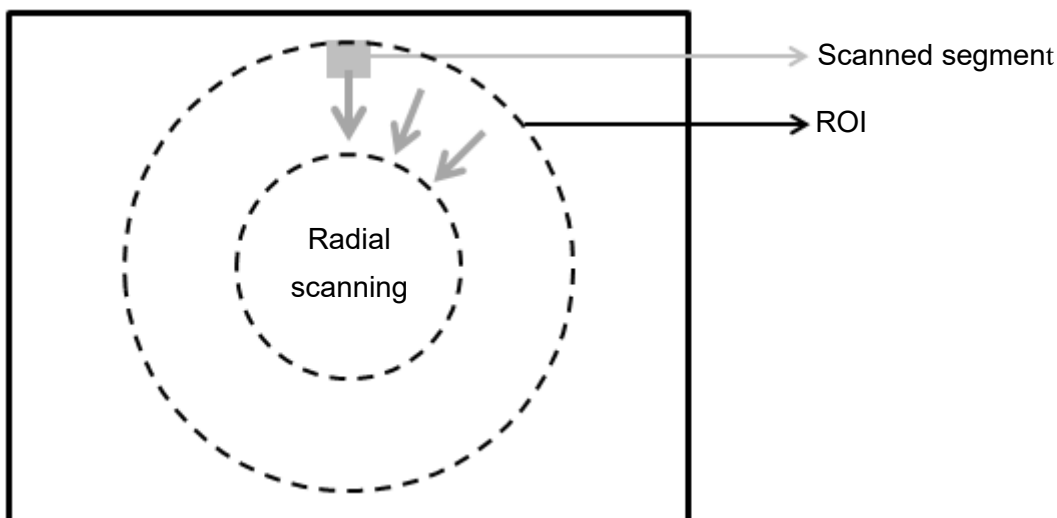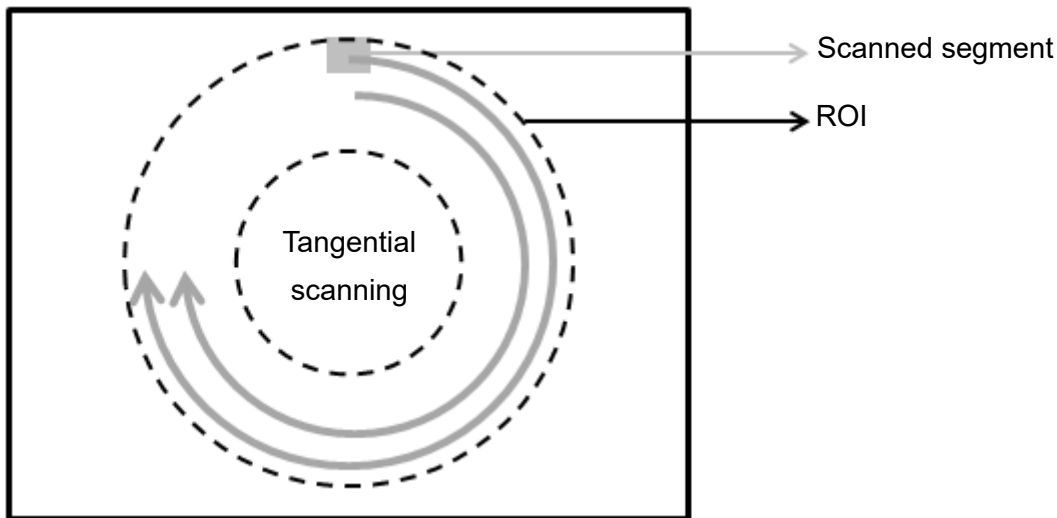
◎ **Procedural Results**

The Stain tool returns the following inspection results.

➤ Total Area of Stains: outputs the sum of stain area inspected.

➤ Stain Area [N]: outputs the area of the Nth stain inspected.

➤ Stain Centroid Position X [N]: outputs the X coordinate of the Nth stain inspected.

➤ Stain Centroid Position Y [N]: outputs the Y coordinate of the Nth stain inspected.

➤ Stain Search Count: outputs the number of stains inspected.

◎ **Example**

As shown in the following picture, the system finds three scrapes in the vertical direction using horizontal scanning.

Object to be inspected, with 3 vertical and 2 horizontal scrapes

ROI

Total Area of Stains: 9000
Stain Area [1]: 3000
Stain Centroid Position X [1]: 200
Stain Centroid Position Y [1]: 300
Stain Search Count: 3
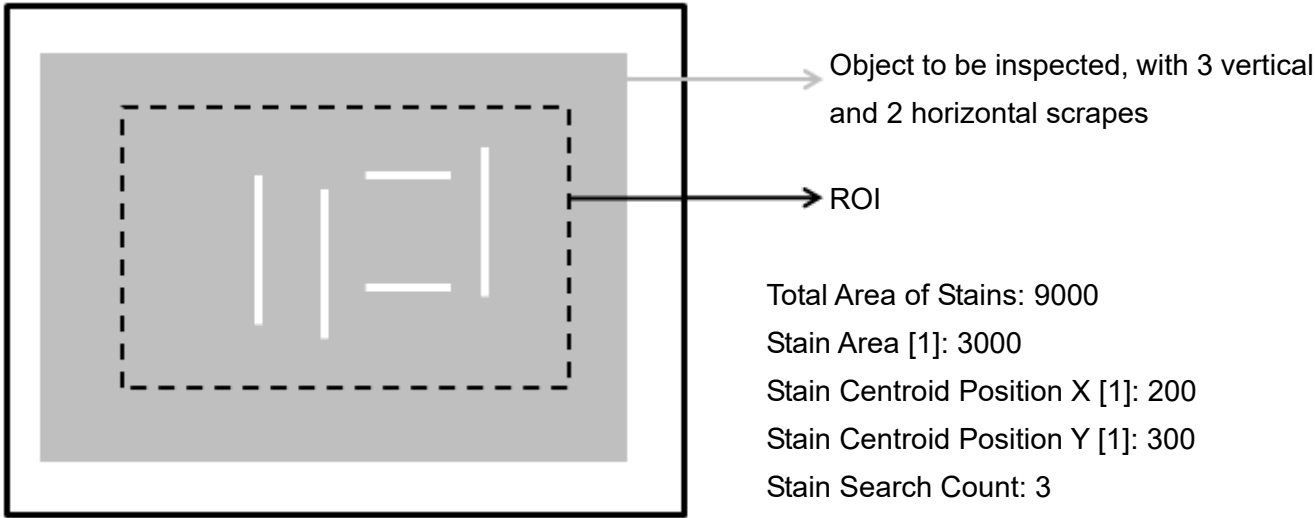
As shown in the following diagram, the system finds two scrapes in the horizontal direction using vertical scanning.

Object to be inspected, with 3 vertical and 2 horizontal scrapes

ROI

Total Area of Stains: 5000
Stain Area [1]: 2500
Stain Centroid Position X [1]: 800
Stain Centroid Position Y [1]: 100
Stain Search Count: 2
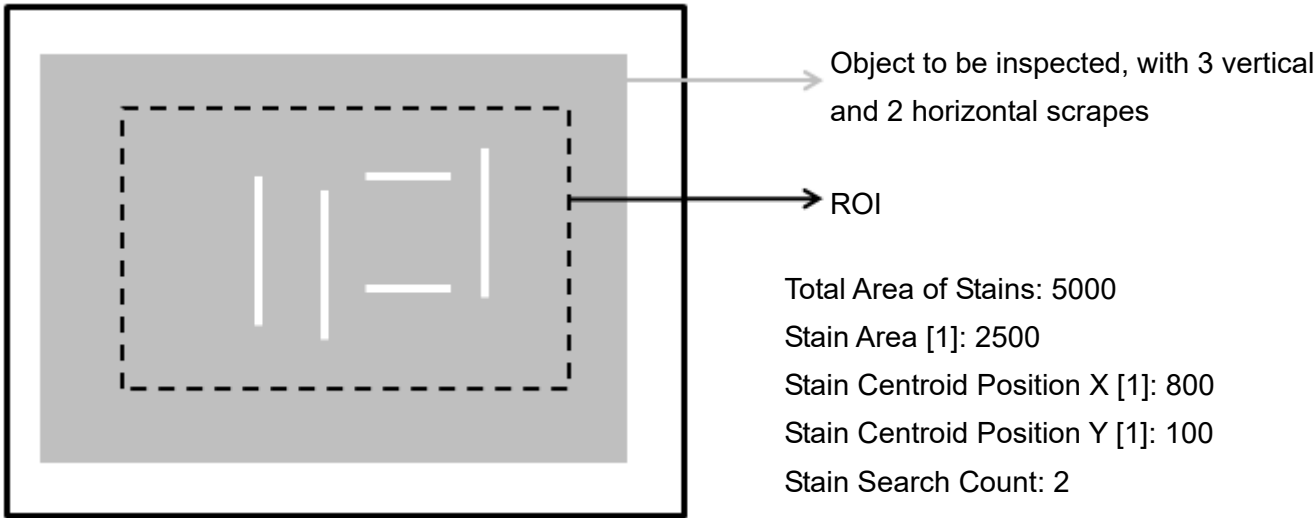
As shown in the following diagram, the system finds five scrapes in the vertical and horizontal directions using horizontal and vertical scanning.

Object to be inspected, with 3 vertical and 2 horizontal scrapes

ROI

Total Area of Stains: 14000
Stain Area [1]: 3000
Stain Centroid Position X [1]: 200
Stain Centroid Position Y [1]: 300
Stain Search Count: 5
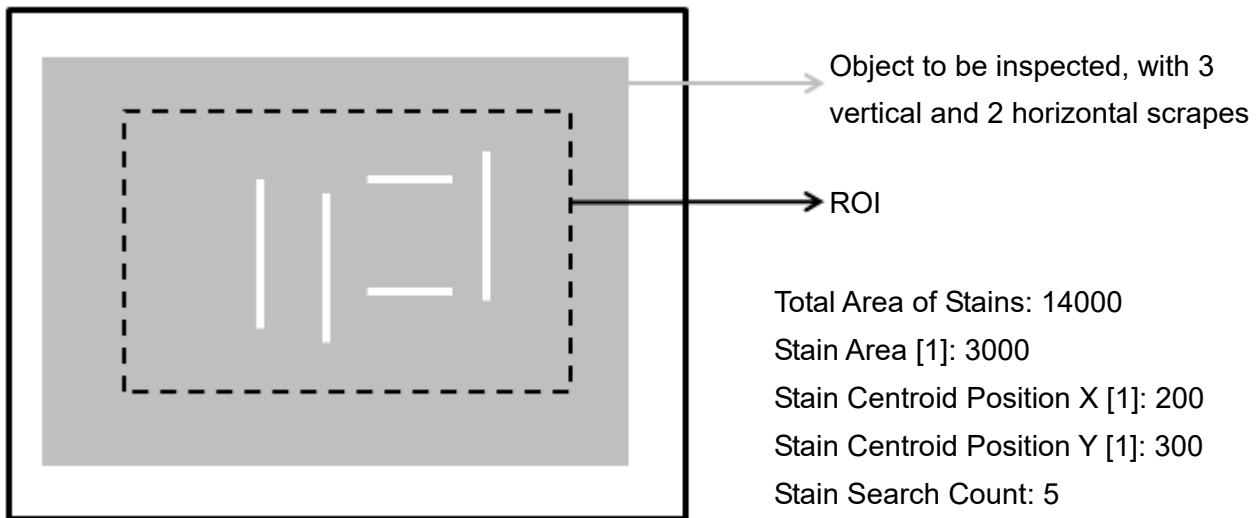
As shown in the following diagram, the system finds one scrape in the radial direction using tangential scanning.

Object to be inspected, with 1 scrape in the radial direction

ROI

Total Area of Stains: 1500
Stain Area [1]: 1500
Stain Centroid Position X [1]: 250
Stain Centroid Position Y [1]: 200
Stain Search Count: 1
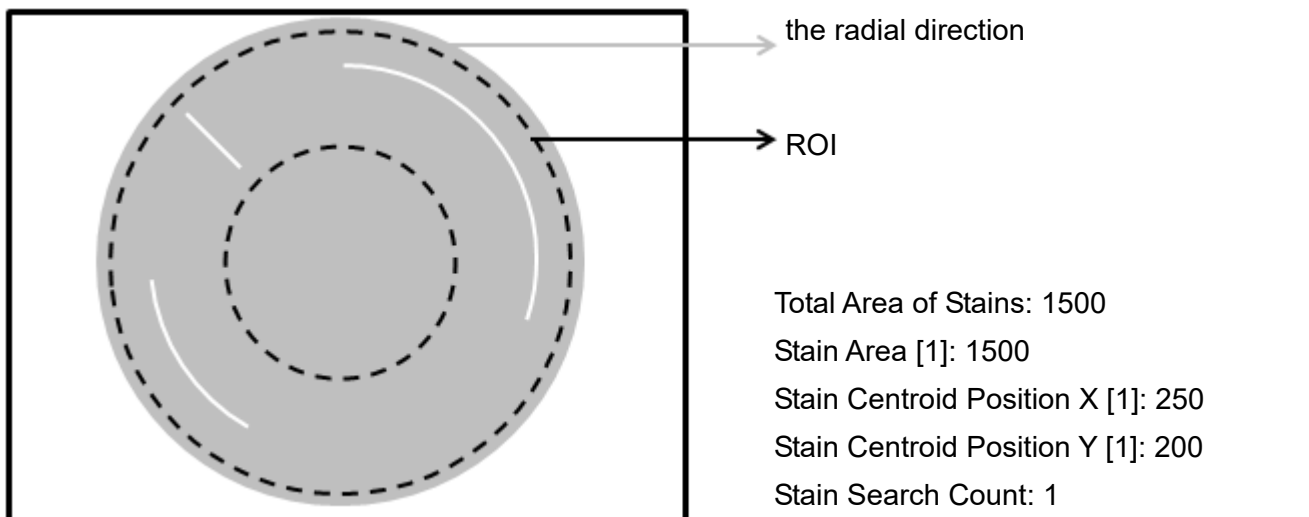
As shown in the following diagram, the system finds two scrapes in the tangential direction using radial scanning.

Object to be inspected, with 2 tangential and 1 radial scrapes

ROI
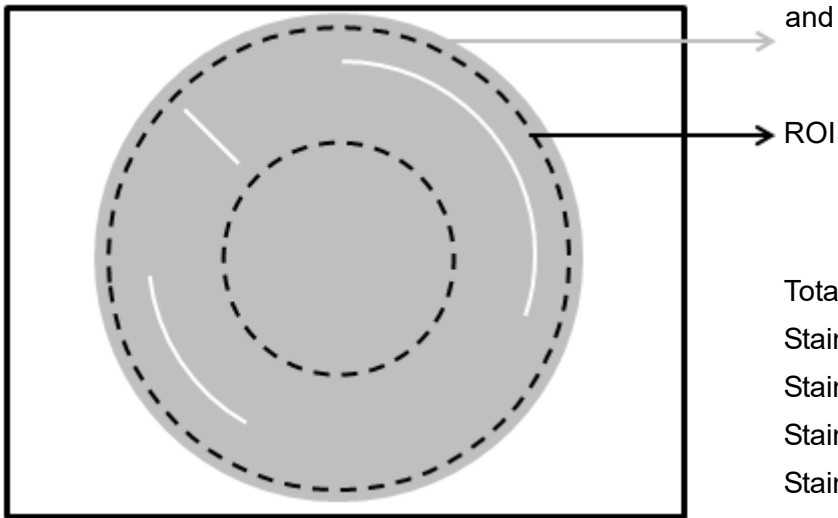
Total Area of Stains: 9000

Stain Area [1]: 6000

Stain Centroid Position X [1]: 900

Stain Centroid Position Y [1]: 250

Stain Search Count: 2

5.3.1 Stain dialog box

The following picture shows the Stain inspection tool dialog box.

◎ **Image Select** (select Register Image)

Selects the image to be inspected from the register gallery. You can configure source cameras and inspect the image display source. When you select a different camera, the image table also switches to show the registered images acquired from that camera.

◎ **ROI** (configure detection region of interest)

Specifies the inspection regions to be used in the inspection. Optional ROI shapes include Rectangle, Circle, Arc, Ellipse, Ring, Polygon, and Rotated Rect. The Polygon ROI supports up to 16 points. In addition, there are up to eight mask functions to ignore particular segments.

◎ **Color**

Selects the color processing for images from a color camera: Color to Binary, Color to Grayscale, RGB grayscale, R Grayscale, G Grayscale, and B Grayscale.

◎ **Filter**

Specifies the image processing to apply before inspections to enhance certain aspects of the image. Preprocessing methods include Binary, Dilation, Erosion, Average, Median, Laplacian, Sobel X, Sobel Y, Sobel XY, Brightness, Contrast, Shade, and Custom (filter). You can superimpose up to six methods or create a custom method by clicking Custom.

◎ **Parameter**

Adjusts the Stain inspection tool conditions.

Scanning Direction

Specifies the scanning directions for horizontal/vertical scanning; you can select tangential or radial scanning for Circle, Ring, and Arc ROIs.
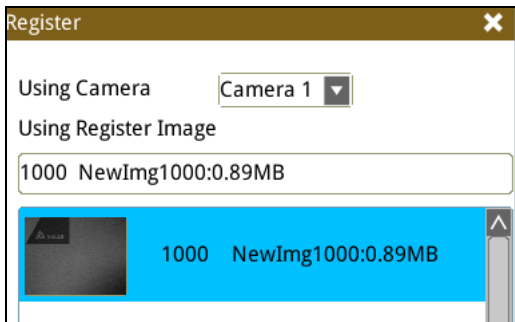
Sort Rule

Specifies the basis for sorting stains; options include Horizontal Ascend, Horizontal Descend, Vertical Ascend, Vertical Descend, Area Ascend, Area Descend, Level Ascend, and Level Descend.

Segment Width/Height

Specifies the segment size to be scanned.

Segment Offset

Specifies the offset of the segment to be scanned.

Stain Threshold

Specifies the threshold for stains. The system finds the difference between the average gray scale values during each scan. When this difference exceeds the Stain Threshold, the system recognizes the segment as a stain. You can use this parameter as the basis for determining the shade of the stain.

Stain Area

Specifies the area required to recognize a segment as a stain; this parameter can be used as a basis for determining stain size.

Reference

Outputs the Nth result when scanning multiple targets.

Number

Specifies the number of stains to search for, up to a maximum of 9999.

Origin

The position of the origin (0, 0) in System Setting is displayed on the upper left corner of the screen. You can enter new coordinates to move the origin to the new coordinates.

◎   **Limit**

After you complete the configurations, you can view the inspection results using register images through **Test Mode**. You can then configure the upper and lower limits in the Limit dialog box. The following items can be configured for the Stain tool.

Total Area: the upper and lower limits of Total Area.

Area: the upper and lower limits of Area.

Centroid Position X: the upper and lower limits of centroid position in the X direction.

Centroid Position Y: the upper and lower limits of centroid position in the Y direction.

Search Count: the upper and lower limits for Search Count.

◎ **Locate**

Specifies whether the inspection region follows an inspection result by adjusting its coordinates (X, Y) and Angles (Theta). The inspection tools you can use as a reference includes Shape, Blob, Edge Position and Edge Angle. As shown in the following diagram, specific marks (such as the cross on the object) can be used for the Locate function.

ROI

Object

Locate Off　　　　　　　　　　　Locate On

Corrected inspection region after using Locate

Target

Manual mode and quick mode are available for this project.

➤ Manual mode: Manually click【Ref. X】、【Ref. Y】and【Ref. Angle】, separately set the source of the reference positioning.

➤ Quick mode: Click【⊖Ref. Nearest Shape Locate Win】, the system will directly bring in the closest 【Shape】as the【Ref. X】、【Ref. Y】and【Ref. Angle】setting.

➤ **Reference** Please refer to Section 9.1 for detailed Locate configurations.

◎   **Execution**

Specifies whether to execute the inspection function in the inspection flow.

```
Execute
  ● Always Execution      ○ Never Execution
  ○ Reference Execution
  Ref. Win. None          ▼  ✕
  Condition OK            ▼  ✕
```

➤   **Always Execution**

Always execute the inspection function in Run mode.

➤   **Never Execution**

Never execute the inspection function in Run mode.

➤   **Reference Execution**

This test will be executed when the [Reference Detection] item meets the [OK/NG] condition.

◎   **Output Item**

➤   **Window**

Selects the output window for the total Judge result for the Stain tool on the designated interface.

➤   **Item**

1)   **Total Area of Stains**: outputs the total area accumulated by the Stain tool.

2)   **Stain Search Count**: outputs the number of Stains found by the Stain tool.

3)   **Stain Area [N]**: outputs the area of the Nth stain found by the Stain tool.

4)   **Maximum Stain Area**: outputs the maximum area found by the Stain tool.

5)   **Minimum Stain Area**: outputs the minimum area found by the Stain tool.

6)   **Stain Centroid Position X [N]**: outputs the centroid's X coordinate of the Nth stain found by the Stain tool.

7)   **Stain Centroid Position Y [N]**: outputs the centroid's Y coordinate of the Nth stain found by the Stain tool.

8)   **Maximum Stain Centroid Position X**: outputs the maximum centroid X coordinate found by the Stain tool.

9)   **Minimum Stain Centroid Position X**: outputs the minimum centroid X coordinate found by the Stain tool.

10)   **Maximum Stain Centroid Position Y**: outputs the maximum centroid Y coordinate found by the Stain tool.

11)   **Minimum Stain Centroid Position Y**: outputs the minimum centroid Y coordinate found by the Stain tool.

12)   **Stain ID**: outputs the ID of the inspection tool.

13)   **Total Area of Stains (J)**: outputs the logical (Judge) result of the total area accumulated by the Stain tool.

14)   **Stain Search Count (J)**: outputs the logical (Judge) result for the number of stains found by the Stain

tool.

15) **Stain Area (J) [N]**: outputs the logical (Judge) result for the area of the Nth stain found by the Stain tool.

16) **Stain Centroid Position X (J) [N]**: outputs the logical (Judge) result for the centroid X coordinate of the Nth stain found by the Stain tool.

17) **Stain Centroid Position Y (J) [N]**: outputs the logical (Judge) result for the centroid Y coordinate of the Nth stain found by the Stain tool.

5.4 Edge Angle

This tool searches for the two edge points formed by brightness differences on a gray scale image, and finds the relative angle created by the average coordinates. You can configure the search region and the scanning width on each side. The tool finds the two edge points at the two ends of the search region through horizontal scanning. Next, the tool regresses two points through the Average function to draw a straight line, and calculates the angle of inclination of the straight line against the horizontal axis. When scanning wider edges, more points are acquired, leading to more accurate measurement of the angles.
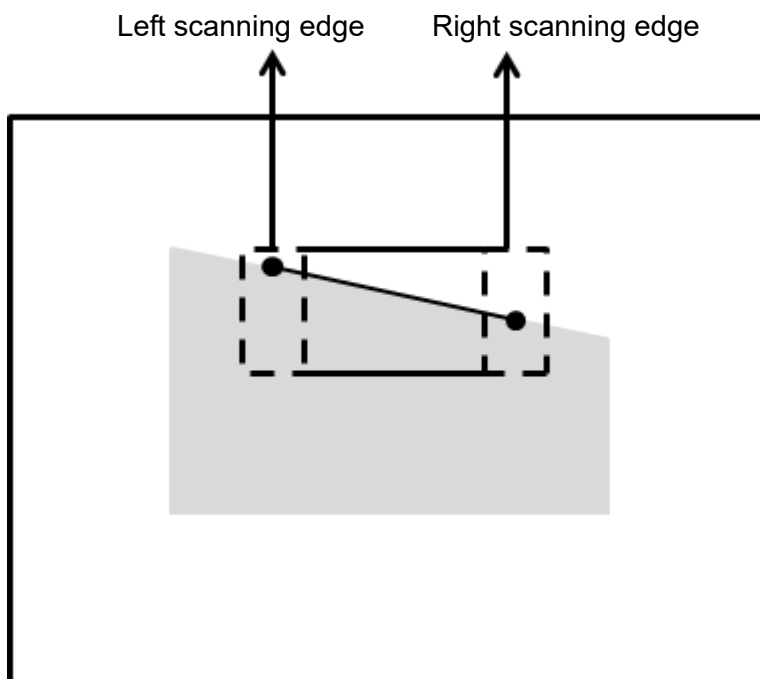
◎ **Algorithmic Processing**

➤ Edge Angle Scan Methods

Specifies the ROI and calculates the relative angles according to the four scanning directions.

Scanning direction: Downward
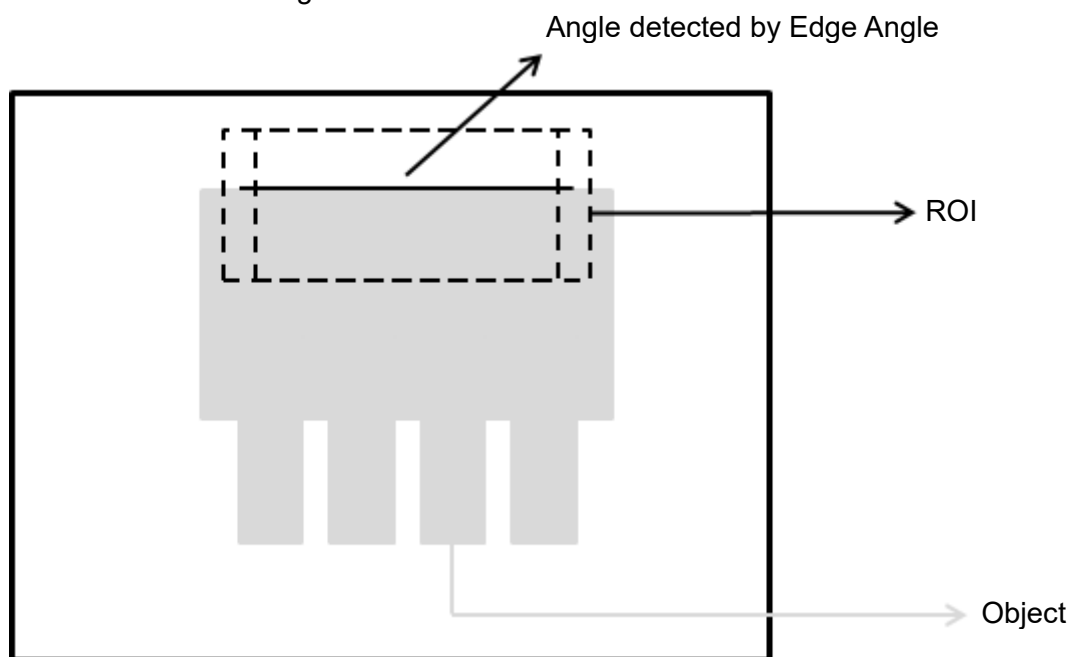
Search method: All edges

Angle detected by Edge Angle

ROI

Object

Scanning direction: Right to left

Search method: Bright to dark

ROI

Edge angle detected

Object
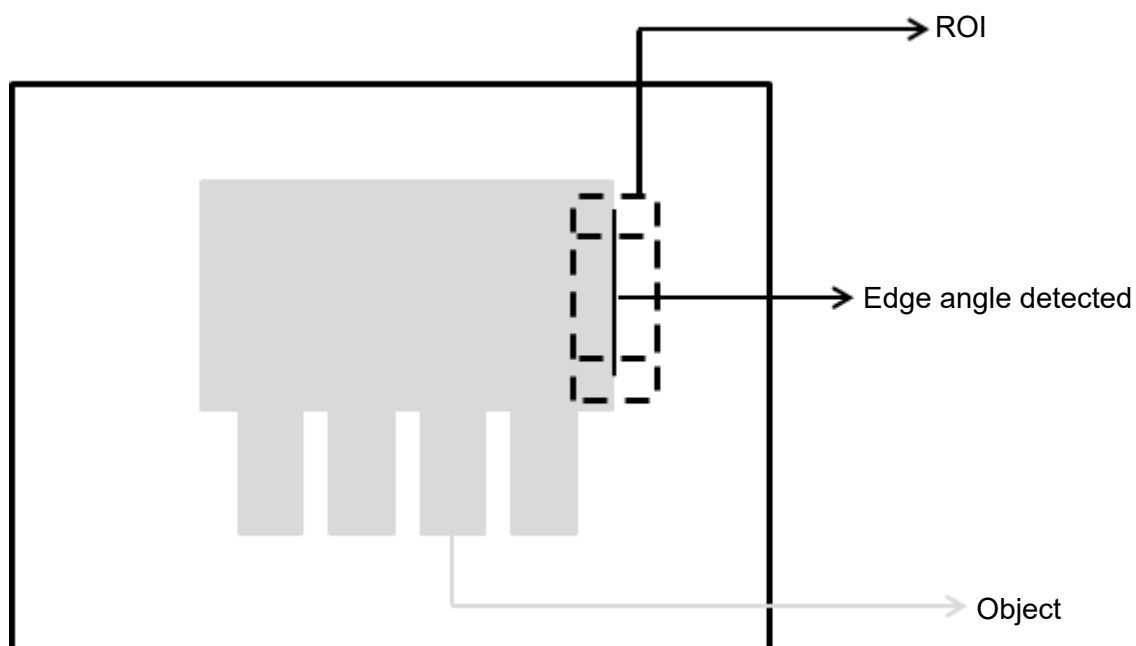
◎   **Procedural Results**

The Edge Angle tool returns the following inspection results.

➤   Edge Angle: outputs the angle from two points on the edge found by the Edge Angle tool.

➤   Upper Edge Position X: outputs the X coordinate of the first edge position encountered in the scanning direction from the two points found by the Edge Position tool.

➤   Upper Edge Position Y: outputs the Y coordinate of the first edge position encountered in the scanning direction from the two points found by the Edge Position tool.

➤   Lower Edge Position X: outputs the X coordinate of the second edge position encountered in the scanning direction from the two points found by the Edge Position tool.

➤   Lower Edge Position Y: outputs the Y coordinate of the second edge position encountered in the scanning direction from the two points found by the Edge Position tool.

◎   **Example**

Scanning direction: Downward

Search method: All edges

Inspection result: Absolute angle is 0 degrees
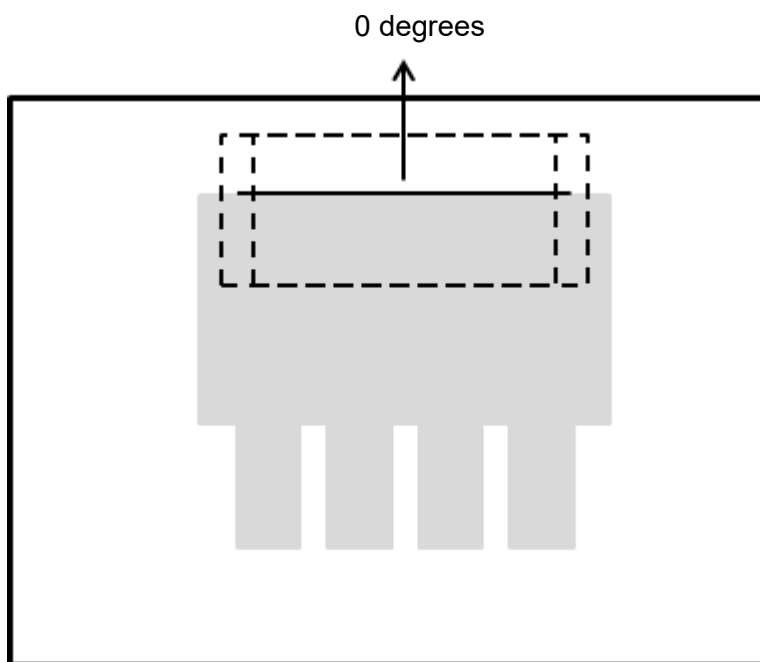
0 degrees

Scanning direction: Right to left

Search method: Bright to dark

Inspection result: Absolute angle is 14 degrees
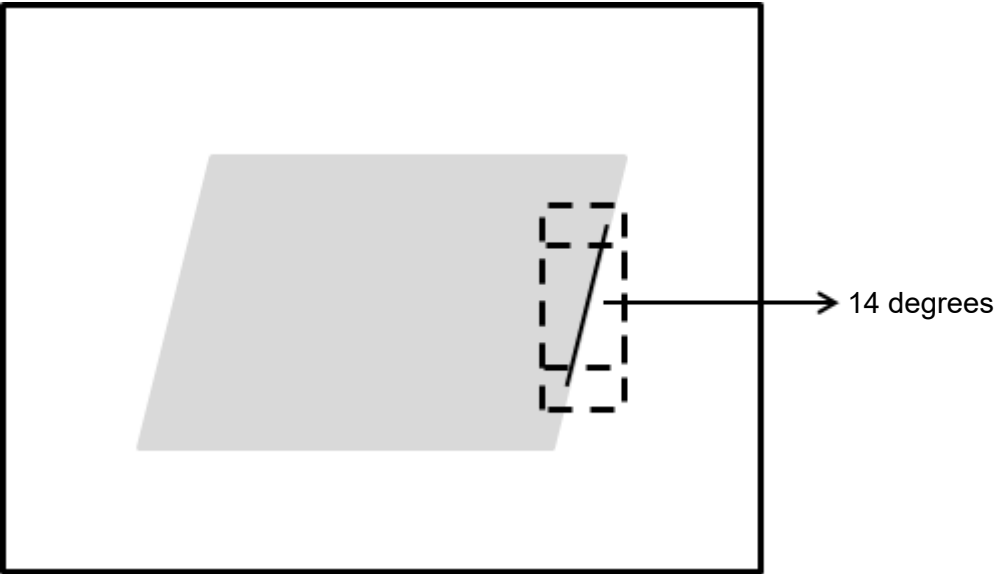
5.4.1 Edge Angle dialog box

The following picture shows the Edge Angle inspection tool dialog box.

◎ **Image Select** (select Register Image)

Selects the image to be inspected from the register gallery. You can configure source cameras and inspect the image display source. When you select a different camera, the image table also switches to show the registered images acquired from that camera.

◎ **ROI** (configure detection region of interest)

Specifies the inspection regions to be used in the inspection. Optional ROI shapes include Rectangle, Circle, Arc, Ellipse, Ring, Polygon, and Rotated Rect. The Polygon ROI supports up to 16 points. In addition, there are up to eight mask functions to ignore particular segments.

◎ **Color**

Selects the color processing for images from a color camera: Color to Binary, Color to Grayscale, RGB grayscale, R Grayscale, G Grayscale, and B Grayscale.

◎ **Filter**

Specifies the image processing to apply before inspections to enhance certain aspects of the image. Preprocessing methods include Binary, Dilation, Erosion, Average, Median, Laplacian, Sobel X, Sobel Y, Sobel XY, Brightness, Contrast, Shade, and Custom (filter). You can superimpose up to six methods or create a custom method by clicking Custom.

◎ **Parameter**

Adjusts the Edge Angle inspection conditions.

Edge Filter

Direction

Rectangle is the only ROI option in Edge Angle. You can select the scanning mode: Left to Right, Right to Left, Downward, and Upward.

Look For

You can configure the search method and choose the search modes: All Edges, Light to Dark, and Dark to Light.

Edge Strength

Specifies the threshold for the edge search (**Look For**), and you can fine-tune it between 0–100 based on the waveform displayed in the preview. When the peak is larger than the configured edge strength, **Look For** identifies the segment as an edge. As shown in the lower left picture, the system finds two edges when Edge Strength is set to 50. As shown in the lower right diagram, the system finds only one edge that is greater than the configured Edge Strength threshold of 70.

Lower

Use the Lower (limit) to filter small noise signals on the image, and the range is between 0–255. Peaks lower than the Lower value are filtered from the waveform. As shown in the lower left diagram, some noise appears when Lower is set to 0, but the noise is filtered out when Lower is set to 20.

Smoothing

Sets the RGB Grayscale for edge calculations between 1–30. When you increase Smoothing, the slope of waveform changes, attenuating the effect caused by noise signals.

◎ **Limit**

After you complete the configurations, you can view the inspection results using register images through **Test Mode**. You can then configure the upper and lower limits in the Limit dialog box. The following items can be configured for the Edge Angle tool.

Angle

Specifies the Upper and Lower limits of the angles detected by Edge Angle.

◎ **Locate**

Specifies whether the inspection region follows an inspection result by adjusting its coordinates (X, Y) and Angles (Theta). The inspection tools you can use as a reference includes Shape, Blob, Edge Position and Edge Angle. As shown in the following diagram, specific marks (such as the cross on the object) can be used for the Locate function.

Locate Off   Locate On

Manual mode and quick mode are available for this project.

➤ Manual mode: Manually click【Ref. X】、【Ref. Y】and【Ref. Angle】, separately set the source of the

   reference positioning.

➤ Quick mode: Click【 ⊖ Ref. Nearest Shape Locate Win】, the system will directly bring in the closest

【Shape】as the【Ref. X】、【Ref. Y】and【Ref. Angle】setting.

➤ 📖 Reference Please refer to Section 9.1 for detailed Locate configurations.

◎ **Execution**

Specifies whether to execute the inspection function in the inspection flow.

```
Execute
  ● Always Execution      ○ Never Execution
  ○ Reference Execution
  Ref. Win. None              ▼   ✖
  Condition OK                ▼   ✖
```

➤ **Always Execution**

Always execute the inspection function in Run mode.

➤ **Never Execution**

Never execute the inspection function in Run mode.

➤ **Reference Execution**

This test will be executed when the [Reference Detection] item meets the [OK/NG] condition.

◎ **Output Item**

Selects the output window for the total Judge result for the Edge Angle tool on the designated interface.

➤ **Item**

1) **Edge Angle (EAG)**: outputs the angle from two points on the edge found by the Edge Angle tool.

2) **Upper Edge Position X (X1)**: outputs the X coordinate of the first edge position encountered in the scanning direction between the two points found by the Edge Position tool.

3) **Upper Edge Position Y (Y1)**: outputs the Y coordinate of the first edge position encountered in the scanning direction between the two points found by the Edge Position tool.

4) **Lower Edge Position X (X2)**: outputs the X coordinate of the second edge position encountered in the scanning direction from the two points found by the Edge Position tool.

5) **Lower Edge Position Y (Y2)**: outputs the Y coordinate of the second edge position encountered in the scanning direction from the two points found by the Edge Position tool.

6) **Edge Angle ID**: outputs the ID of the inspection tool.

7) **Edge Angle (J) (EAG)**: outputs the selected standard Judge result found by the Edge Angle tool.

5.5 Edge Count

This tool searches for a defined type of edge using a fixed scanning path on a gray scale image. Any edge the system finds in the scanning path that satisfies the edge type and demonstrates enough difference in gray scale is recognized as one edge. The tool counts the total number of edges after completing the scan.

◎ **Algorithmic Processing**

➤ Edge Position Scan Methods

Specifies the ROI. The ROI options provide differing edge scanning methods.

◆ When the ROI is Rectangle, Circle, Polygon, Ellipse, and Rotated Rect, you can define the scanning direction mode as left to right, right to left, downward, or upward.

1) When the scanning direction is left to right, and the edge type is light to dark, four edges are found in the following image.
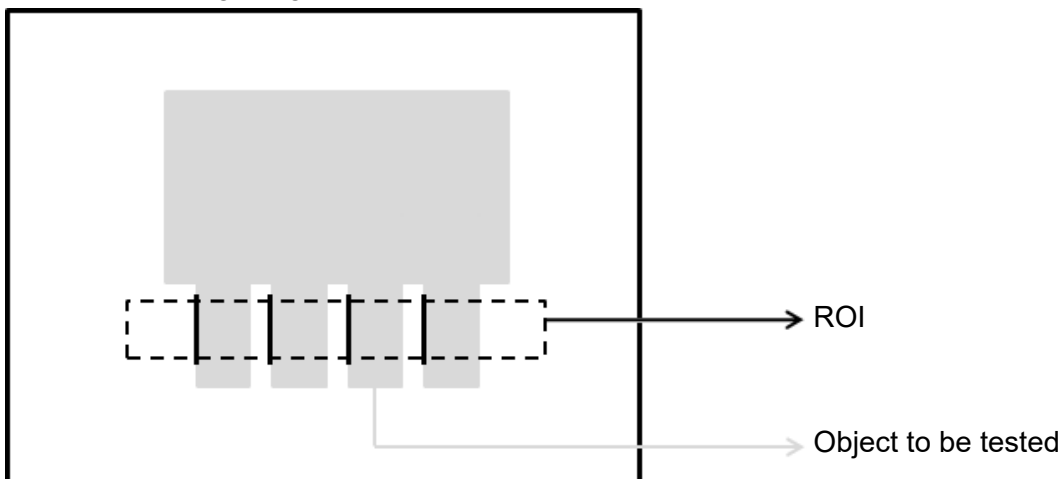
2) When the scanning direction is left to right, and the edge type is dark to light, four edges are found in the following image.
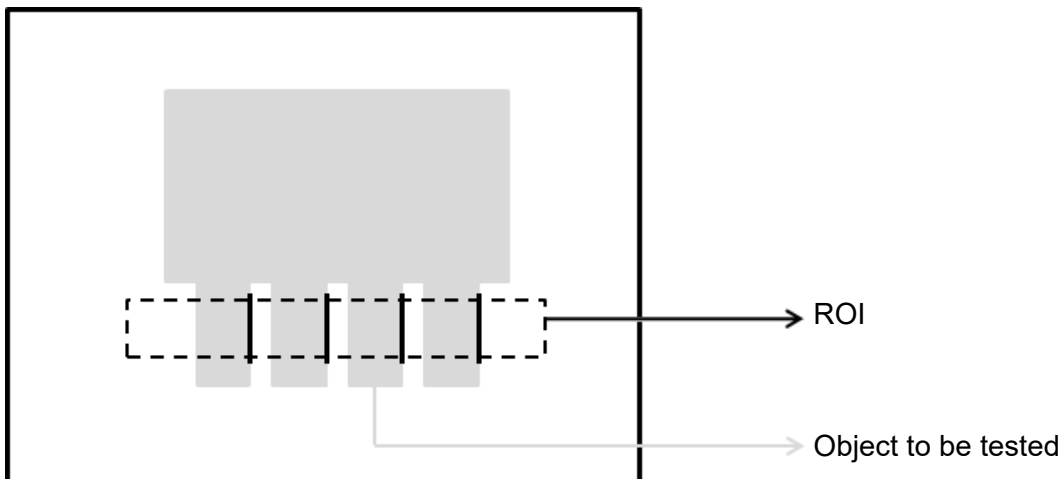
3) When the scanning direction is left to right with all edge types included, eight edges are found in the following image.
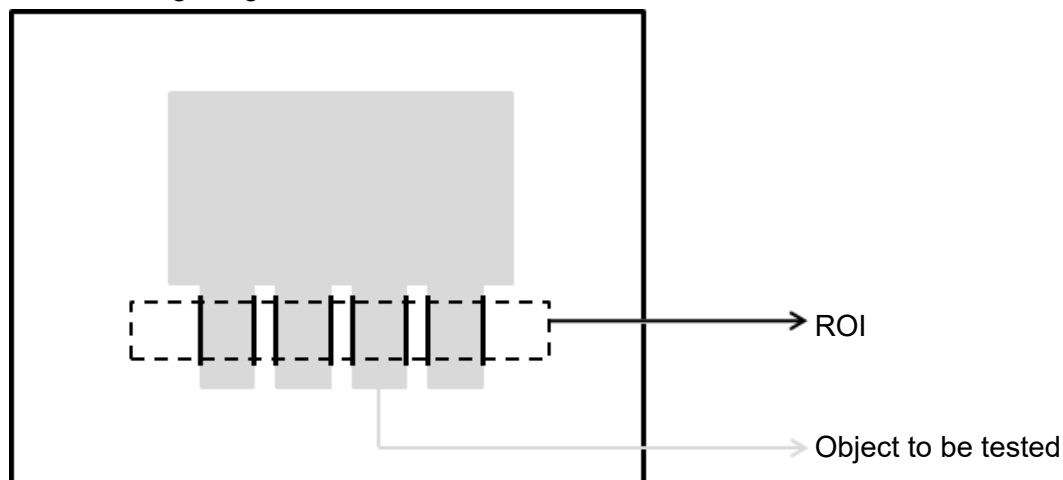
◆   When the ROI is Ring and Arc, the scanning direction can be clockwise or counterclockwise.

1) When the scanning direction is clockwise, and the edge type is light to dark, two edges are found in the following image.
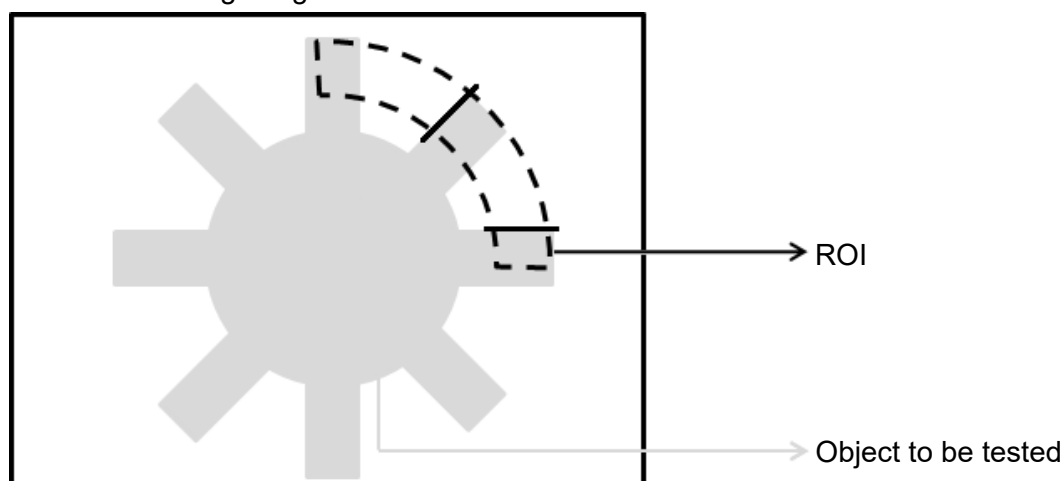
2) When the scanning direction is clockwise, and the edge type is dark to light, two edges are found in the following image.
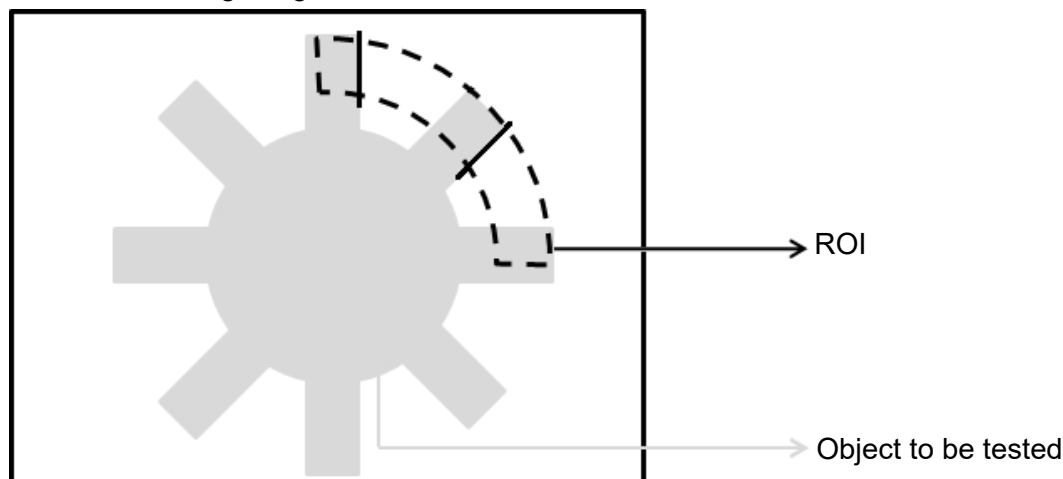
3) When the scanning direction is clockwise with all edge types included, five edges are found in the following image.
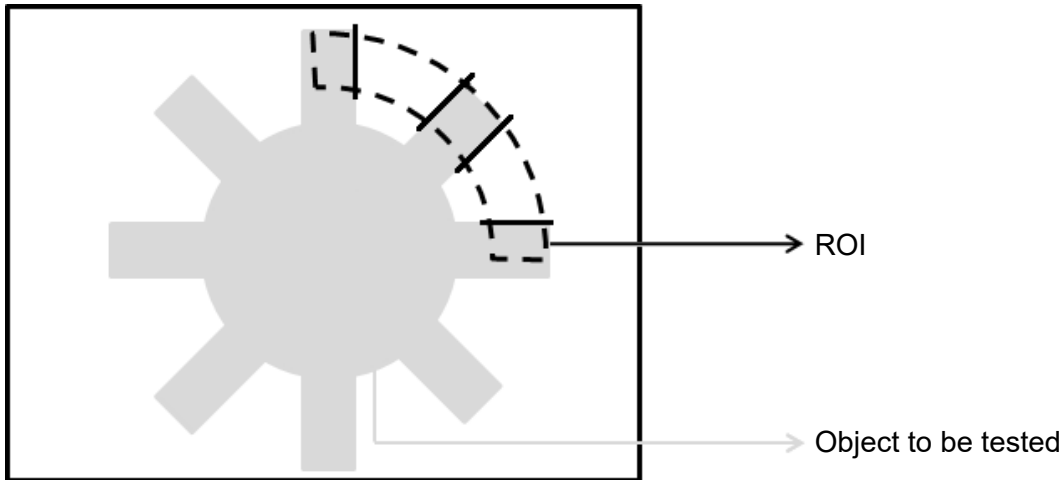
◎ **Procedural Results**

The Edge Count tool returns the following inspection results.

➤ Edge Count Number of Edges: outputs the total number of edges

5.5.1 Edge Count dialog box

The following picture shows the Edge Count inspection tool dialog box.

◎ **Image Select** (select Register Image)

Selects the image to be inspected from the register gallery. You can configure source cameras and inspect the image display source. When you select a different camera, the image table also switches to show the registered images acquired from that camera.

◎ **ROI** (configure detection region of interest)

Specifies the inspection regions to be used in the inspection. Optional ROI shapes include Rectangle, Circle, Arc, Ellipse, Ring, Polygon, and Rotated Rect. The Polygon ROI supports up to 16 points. In addition, there are up to eight mask functions to ignore particular segments.

◎ **Color**

Selects the color processing for images from a color camera: Color to Binary, Color to Grayscale, RGB grayscale, R Grayscale, G Grayscale, and B Grayscale.

◎ **Filter**

Specifies the image processing to apply before inspections to enhance certain aspects of the image. Preprocessing methods include Binary, Dilation, Erosion, Average, Median, Laplacian, Sobel X, Sobel Y, Sobel XY, Brightness, Contrast, Shade, and Custom (filter). You can superimpose up to six methods or create a custom method by clicking Custom.

◎ **Parameter**

Adjusts the Edge Position inspection tool conditions.

Edge filter

Direction

When you select Ring or Arc for the ROI, you can then select Clockwise or Counterclockwise for the scanning direction. For other ROI shapes, you can select Left to Right, Right to Left, Upward, or Downward for the scanning direction.

Look For

Selects the search method: All Edges, Light to Dark, and Dark to Light.

Edge Strength

Specifies the threshold for the edge search (**Look For**), and you can fine-tune it between 0–100 based on the waveform displayed in the preview. When the peak is larger than the configured edge strength, **Look For** identifies the segment as an edge. As shown in the lower left picture, the system finds two edges when Edge Strength is set to 50. As shown in the lower right diagram, the system finds only one edge that is greater than the configured Edge Strength threshold of 70.

Lower

Use the Lower (limit) to filter small noise signals on the image, and the range is between 0–255. Peaks lower than the Lower value are filtered from the waveform. As shown in the lower left diagram, some noise appears when Lower is set to 0, but the noise is filtered out when Lower is set to 20.

Smoothing

Sets the RGB Grayscale for edge calculations between 1–30. When you increase Smoothing, the slope of waveform changes, attenuating the effect caused by noise signals.

Angle

When the ROI is Ring or Arc, this sets the starting angle for the edge scan. The following pictures show starting angles of 0 and 45 degrees, respectively.

Angle = 0

Angle = 45

◎ **Limit**

After you complete the configurations, you can view the inspection results using register images through **Test Mode**. You can then configure the upper and lower limits in the Limit dialog box. The following items can be configured for the Edge Count tool.
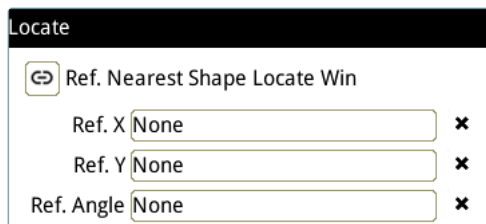
Number of Edges: specifies the upper and lower limits for the number of edges.

◎ **Locate**

Specifies whether the inspection region follows an inspection result by adjusting its coordinates (X, Y) and Angles (Theta). The inspection tools you can use as a reference includes Shape, Blob, Edge Position and Edge Angle. As shown in the following diagram, specific marks (such as the cross on the object) can be used for the Locate function.
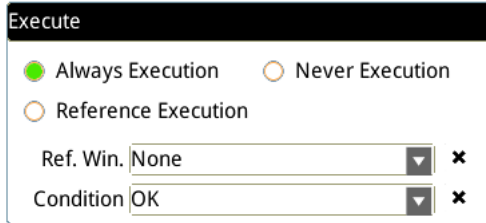

ROI

Object

Locate Off   Locate On

Corrected inspection region after using Locate

Target

Manual mode and quick mode are available for this project.

➤ Manual mode: Manually click【Ref. X】、【Ref. Y】and【Ref. Angle】, separately set the source of the reference positioning.

➤ Quick mode: Click【⊖Ref. Nearest Shape Locate Win】, the system will directly bring in the closest 【Shape】as the【Ref. X】、【Ref. Y】and【Ref. Angle】setting.

➤ **Reference** Please refer to Section 9.1 for detailed Locate configurations.

◎ **Execution**

Specifies whether to execute the inspection function in the inspection flow.

Execute
◉ Always Execution ○ Never Execution
○ Reference Execution
Ref. Win. None ▼ ✖
Condition OK ▼ ✖

➤ **Always Execution**

Always execute the inspection function in Run mode.

➤ **Never Execution**

Never execute the inspection function in Run mode.

➤ **Reference Execution**

This test will be executed when the [Reference Detection] item meets the [OK/NG] condition.

◎ **Output Item**

➤ **Window**

Selects the output window for the total Judge result for the Edge Count tool on the designated interface.

➤ **Item**

1) **Number of Edges (N)**: outputs the total number of edges found by the Edge Count tool.

2) **Edge Count ID**: outputs the ID of the inspection tool.

3) **Number of Edges (J)**: outputs the logical (Judge) result of the total number of edges found by the Edge Count tool.

5.6 Edge Pitch

Edge Pitch is an enhanced function of the Edge Width tool. This tool measures multiple widths instead of just between two edges (as in Edge Width). The tool calculates the individual width, maximum width, minimum width, and average width.

◎ **Algorithmic Processing**

➤ Edge Pitch Scan Methods

Specifies the type of ROI. The ROI options provide differing edge scanning methods.

◆ The two following examples are for ROIs other than Ring and Arc.

Scanning direction: Left to Right

Search method: All edges
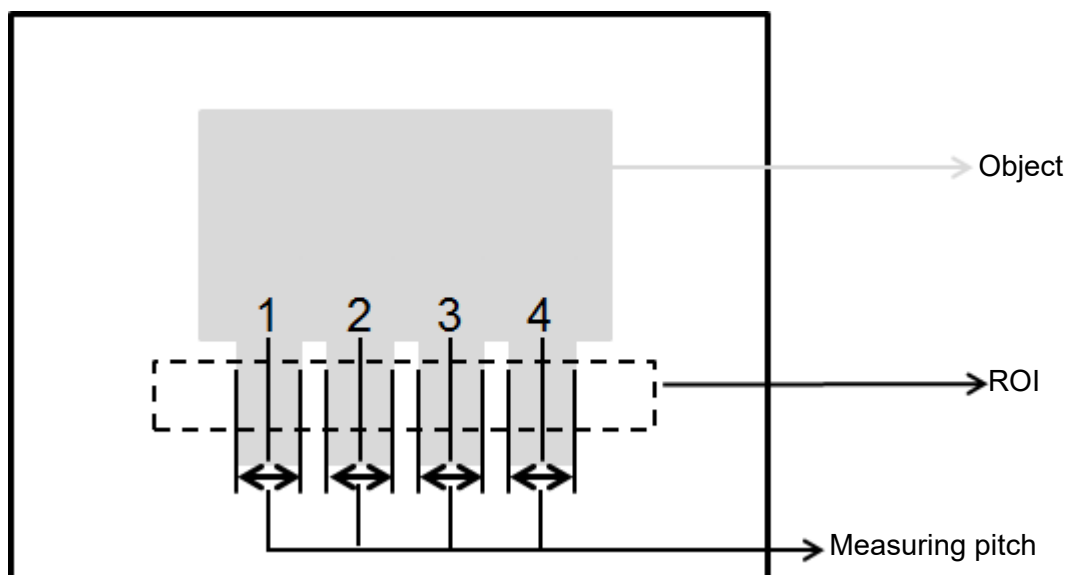
Reference: 1

Scanning direction: Left to Right
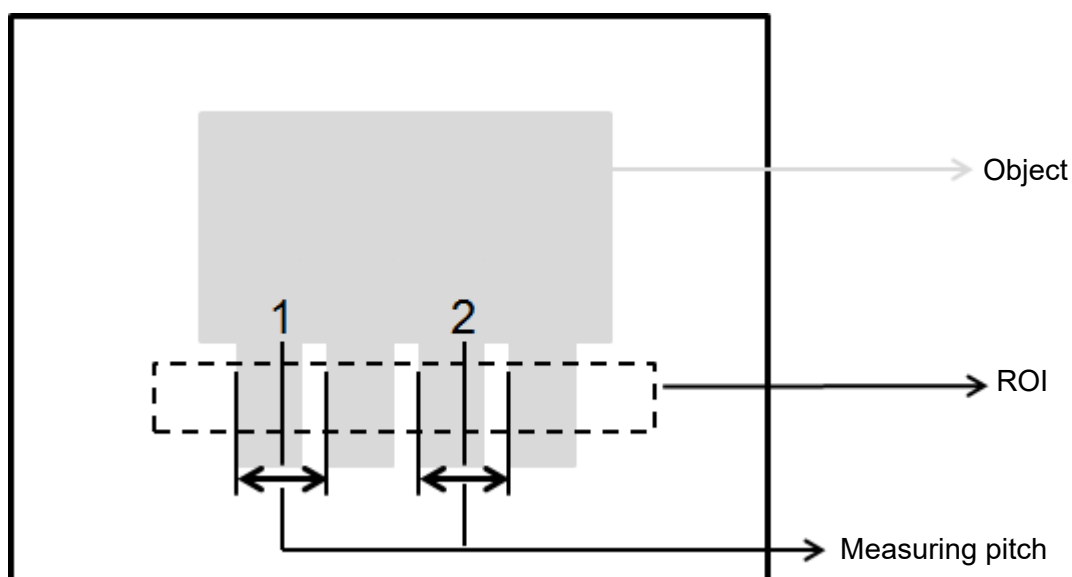
Search method: Bright to dark

Reference: 1

◆   The two following examples are for Ring and Arc ROIs.

Scanning direction: Clockwise

Search method: All edges

Angle: -45

Reference: 1
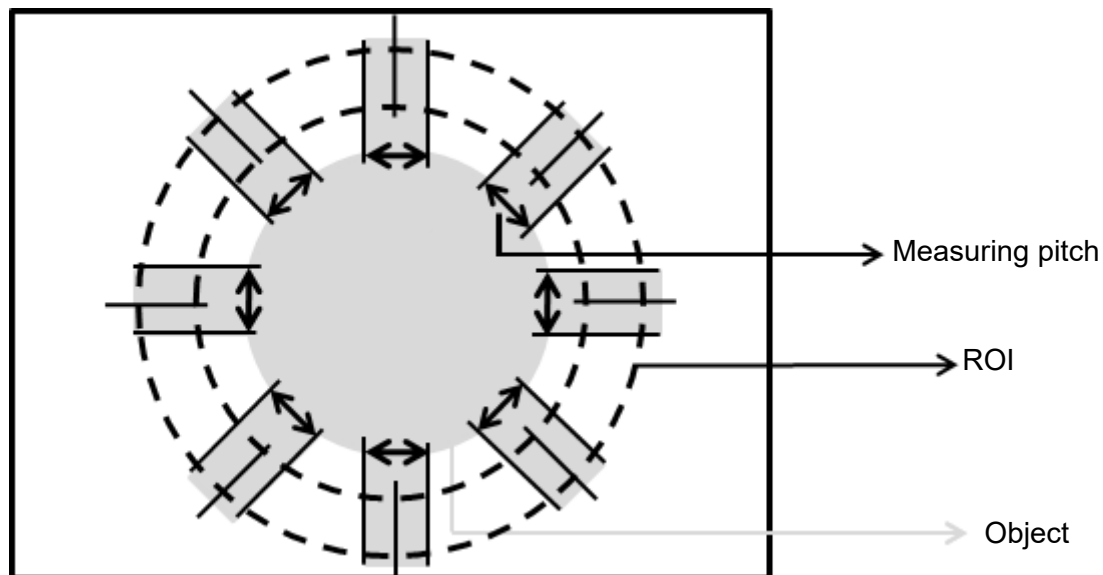
Scanning direction: Clockwise

Search method: All edges

Reference: 1
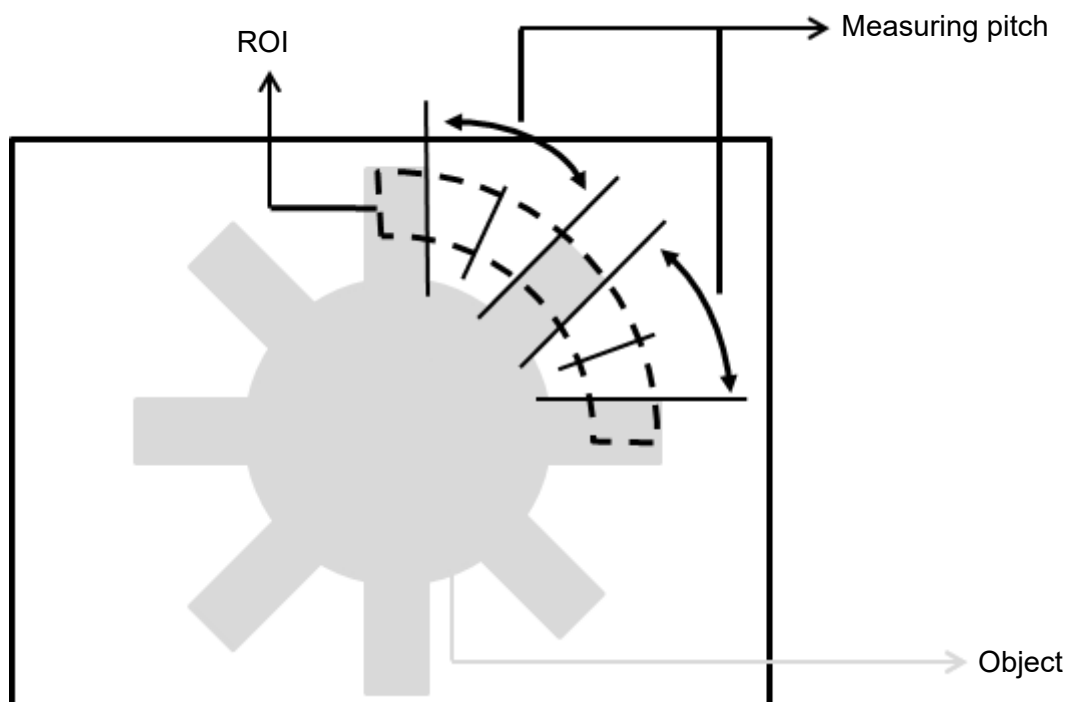
◎ **Procedural Results**

The Edge Pitch tool returns the following inspection results.

➤ Pitch Count: outputs the total number of pitches found by the Edge Pitch tool.

➤ Maximum Pitch: outputs the width data of the maximum pitch found among all pitch data by the Edge Pitch tool.

➤ Minimum Pitch: outputs the width data of the minimum pitch found among all pitch data by the Edge Pitch tool.

➤ Average Pitch: outputs the total average of all pitch data found by the Edge Pitch tool.

◎ **Example**

◆ The first example is for ROIs other than Ring and Arc; the second example is for Ring and Arc.

Scanning direction: Left to Right

Search method: All edges

Reference: 1

Inspection result: Pitch1 = 90, Pitch2 = 91, Pitch3 = 94, Pitch4 = 91
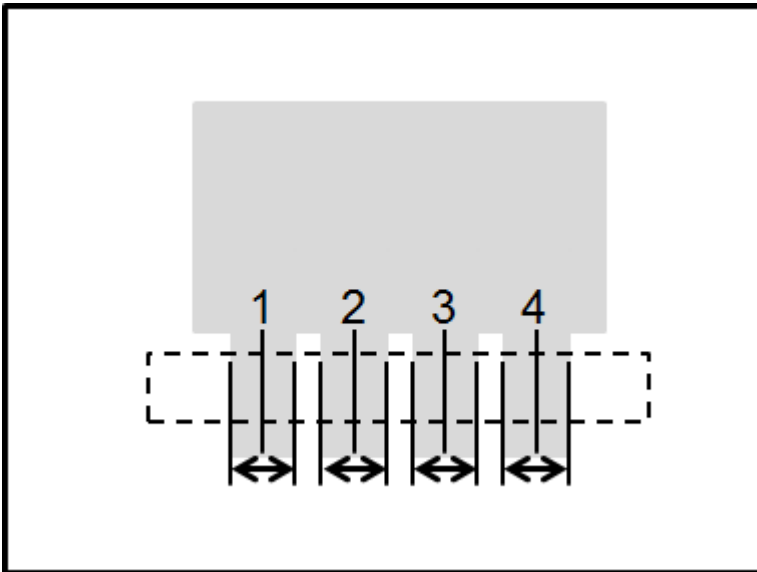
Scanning direction: Left to Right

Search method: All edges

Reference: 1

Inspection result: Pitch1 = 201, Pitch2 = 200
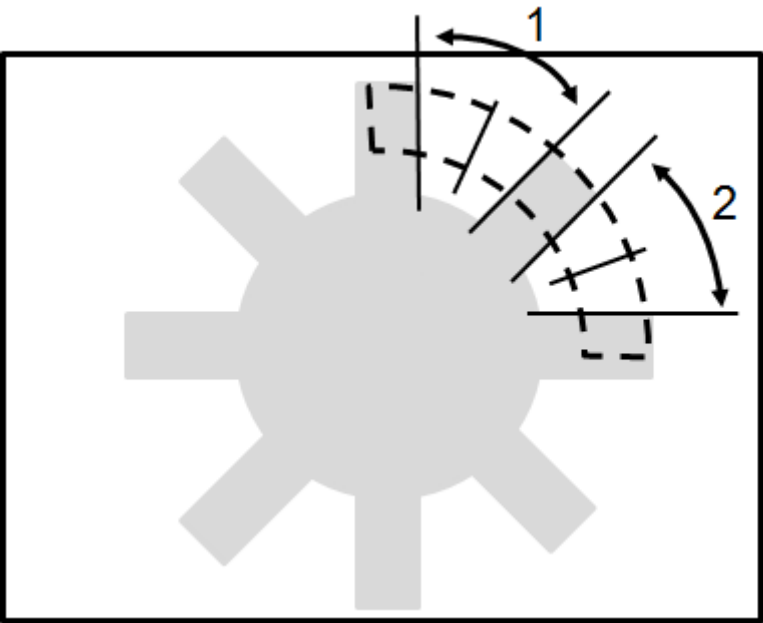
5.6.1 Edge Pitch Dialog Box

The following picture shows the Edge Pitch inspection tool dialog box.

◎ **Image Select** (select Register Image)

Selects the image to be inspected from the register gallery. You can configure source cameras and inspect the image display source. When you select a different camera, the image table also switches to show the registered images acquired from that camera.

◎ **ROI** (configure detection region of interest)

Specifies the inspection regions to be used in the inspection. Optional ROI shapes include Rectangle, Circle, Arc, Ellipse, Ring, Polygon, and Rotated Rect. The Polygon ROI supports up to 16 points. In addition, there are up to eight mask functions to ignore particular segments.

◎ **Color**

Selects the color processing for images from a color camera: Color to Binary, Color to Grayscale, RGB grayscale, R Grayscale, G Grayscale, and B Grayscale.

◎ **Filter**

Specifies the image processing to apply before inspections to enhance certain aspects of the image. Preprocessing methods include Binary, Dilation, Erosion, Average, Median, Laplacian, Sobel X, Sobel Y, Sobel XY, Brightness, Contrast, Shade, and Custom (filter). You can superimpose up to six methods or create a custom method by clicking Custom.
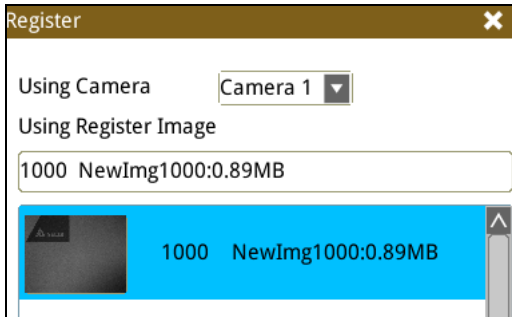
◎ **Parameter**

Adjusts the Edge Pitch inspection tool conditions.

Direction

When you select the Ring or Arc ROI, you can then select Clockwise or Counterclockwise for the scanning direction. For other ROI shapes, you can select Left to Right, Right to Left, Upward, or Downward for the scanning direction.

Look For

Specifies the search method: All Edges, Light to Dark, and Dark to Light.

Edge Strength

Specifies the threshold for the edge search (**Look For**), and you can fine-tune it between 0–100 based on the waveform displayed in the preview. When the peak is larger than the configured edge strength, **Look For** identifies the segment as an edge. As shown in the lower left picture, the system finds two edges when Edge Strength is set to 50. As shown in the lower right diagram, the system finds only one edge that is greater than the configured Edge Strength threshold of 70.

Edge Strength = 50

Edge Strength = 70

Lower

Use the Lower (limit) to filter small noise signals on the image, and the range is between 0–255. Peaks lower than the Lower value are filtered from the waveform. As shown in the lower left diagram, some noise appears when Lower is set to 0, but the noise is filtered out when Lower is set to 20.

Lower = 0

Lower = 20

Smoothing

Sets the RGB Grayscale for edge calculations between 1–30. When you increase Smoothing, the slope of waveform changes, attenuating the effect caused by noise signals.

Smoothing = 3

Smoothing = 10

Angle

When the ROI is Ring or Arc, this sets the starting angle for the edge scan. The following pictures show starting angles of 0 and 45 degrees, respectively.

Angle = 0   Angle = 45

Reference

Output the Nth result when scanning multiple targets.

Pitch Upper

Specifies the threshold for retaining edge pitch. The edge pitch is kept if the measured value is below the upper pitch limit. Values exceeding the limit are discarded. The maximum value for the limit is 999.

Pitch Lower

Specifies the threshold for retaining edge pitch. The edge pitch is kept if the measured value is above the lower pitch limit. Values below the limit are discarded. The minimum value for the limit is 0.

Origin

The position of the origin (0, 0) in System Setting is displayed on the upper left corner of the screen. You can enter new coordinates to move the origin to the new coordinates.
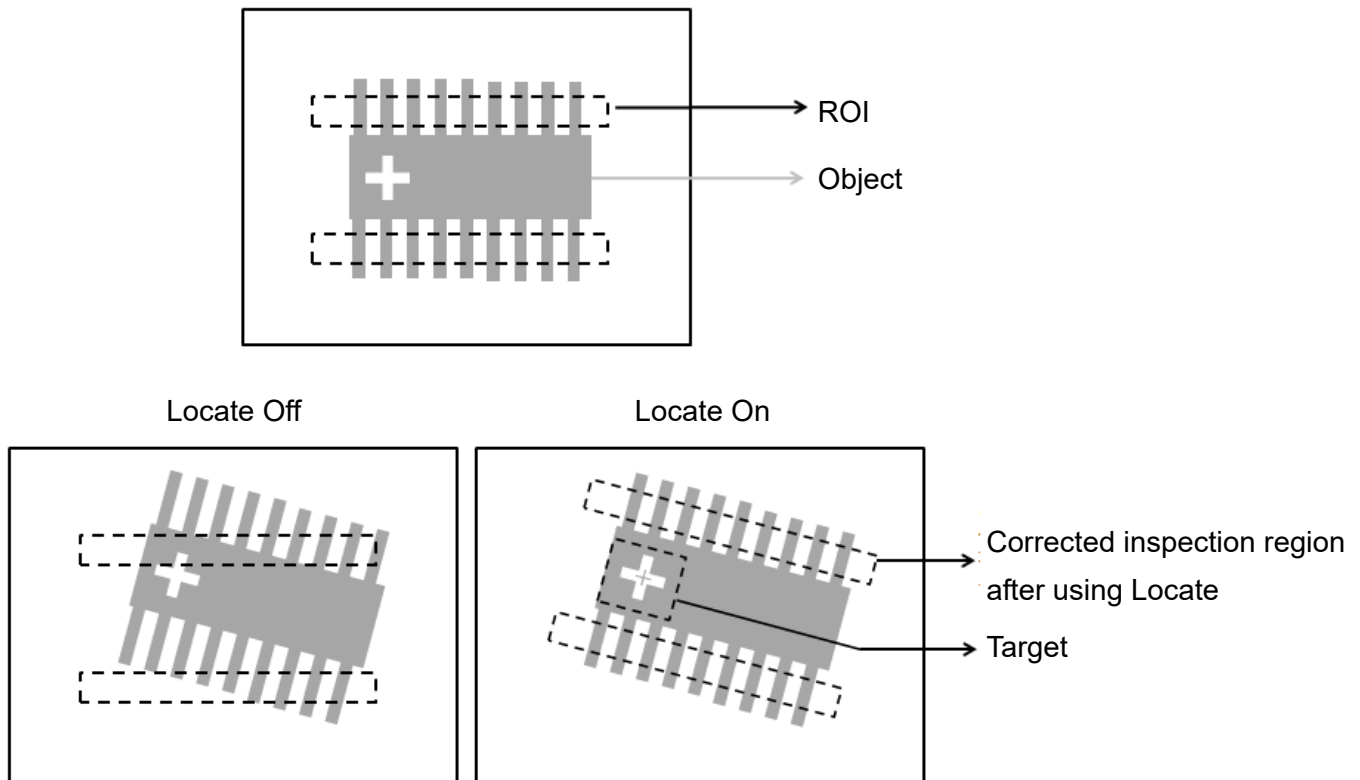
◎ Limit

After you complete the configurations, you can view the inspection results using register images through **Test Mode**. You can then configure the upper and lower limits in the Limit dialog box. The following items can be configured for the Edge Pitch tool.

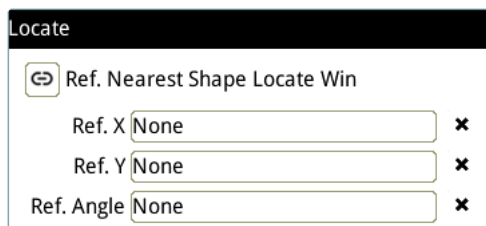1) **Pitch Count**: specifies the upper and lower limits for the number of pitch values.
2) **Pitch**: specifies the upper and lower width limits of the assigned pitch for system reference.
3) **Maximum Pitch**: specifies the upper and lower limits for the maximum pitch found from all pitch data.
4) **Minimum Pitch**: specifies the upper and lower limits for the minimum pitch found from all pitch data.
5) **Average Pitch**: specifies the upper and lower limits for the average pitch found from all pitch data.

◎ **Locate**

Specifies whether the inspection region follows an inspection result by adjusting its coordinates (X, Y) and Angles (Theta). The inspection tools you can use as a reference includes Shape, Blob, Edge Position and Edge Angle. As shown in the following diagram, specific marks (such as the cross on the object) can be used for the Locate function.

Locate Off   Locate On

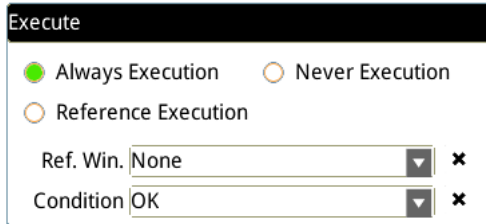
Manual mode and quick mode are available for this project.

➤ Manual mode: Manually click【Ref. X】、【Ref. Y】and【Ref. Angle】, separately set the source of the reference positioning.

➤ Quick mode: Click【⊖Ref. Nearest Shape Locate Win】, the system will directly bring in the closest 【Shape】as the【Ref. X】、【Ref. Y】and【Ref. Angle】setting.

➤ 📖 Reference Please refer to Section 9.1 for detailed Locate configurations.

◎ **Execution**

Specifies whether to execute the inspection function in the inspection flow.

Execute
● Always Execution   ○ Never Execution
○ Reference Execution
Ref. Win. None   ▼   ✖
Condition OK   ▼   ✖

➤ **Always Execution**

Always execute the inspection function in Run mode.

➤ **Never Execution**

Never execute the inspection function in Run mode.

➤ **Reference Execution**

This test will be executed when the [Reference Detection] item meets the [OK/NG] condition.

◎ **Output Item**

➤ **Window**

Selects the output window for the total Judge result for the Edge Pitch tool on the designated interface.

➤ **Item**

1) **Pitch Count (N)**: outputs the total number of pitches found by the Edge Pitch tool.

2) **Pitch (W)**: outputs the width data of the assigned pitch found among all pitch data by the Edge Pitch tool.

3) **Maximum Pitch (WH)**: outputs the width data of the maximum pitch found among all pitch data by the Edge Pitch tool.

4) **Minimum Pitch (WL)**: outputs the width data of the minimum pitch found among all pitch data by the Edge Pitch tool.

5) **Average Pitch (WA)**: outputs the total average of all pitch data found by the Edge Pitch tool.

6) **Pitch Center Position X (X)**: outputs the center position X coordinate of the assigned reference pitch found among all pitch data by the Edge Pitch tool.

7) **Pitch Center Position Y (Y)**: outputs the center position Y coordinate of the assigned reference pitch found among all pitch data by the Edge Pitch tool.

8) **Pitch Center Absolute Angle (AG)**: When you select the Ring or Arc ROI, Pitch Center Absolute Angle outputs the absolute angle of the assigned reference pitch found by the Edge Pitch tool.

9) **First Edge Position X (XS)**: outputs the first edge position X coordinate of the assigned reference pitch found among all pitch data by the Edge Pitch tool.

10) **First Edge Position Y (YS)**: outputs the first edge position Y coordinate of the assigned reference pitch found among all pitch data by the Edge Pitch tool.

11) **First Edge Absolute Angle (AGS)**: When you select the Ring or Arc ROI, First Edge Absolute Angle outputs the absolute angle of the first edge encountered from the assigned reference pitch found by the Edge Pitch tool.

12) **First Edge Relative Angle (RAS)**: When you select the Ring or Arc ROI, First Edge Relative Angle outputs the relative angle of the first edge encountered from the assigned reference pitch found by the Edge Pitch tool.

13) **Second Edge Position X (XE)**: outputs the second edge position X coordinate of the assigned reference pitch found among all pitch data by the Edge Pitch tool.

14) **Second Edge Position Y (YE)**: outputs the second edge position Y coordinate of the assigned reference pitch found among all pitch data by the Edge Pitch tool.

15) **Second Edge Absolute Angle (AGE)**: When Ring and Arc ROIs are selected, Second Edge Absolute Angle outputs the absolute angle of the second edge encountered from the assigned reference pitch found by the Edge Pitch tool.

16) **Second Edge Relative Angle (RAE)**: When Ring and Arc ROIs are selected, Second Edge Relative Angle outputs the relative angle of the second edge encountered from the assigned reference pitch found by the Edge Pitch tool.

17) **Edge Pitch ID**: outputs the ID of the inspection tool.

18) **Pitch Count (J) (N)**: outputs the logical (Judge) result of the pitch count obtained by the Edge Pitch tool.

19) **Pitch (J) (W)**: outputs the logical (Judge) result of the assigned reference pitch widths obtained by the Edge Pitch tool.

20) **Maximum Pitch (J) (WH)**: outputs the logical (Judge) result of the maximum assigned reference pitch width obtained by the Edge Pitch tool.

21) **Minimum Pitch (J) (WL)**: outputs the logical (Judge) result of the minimum assigned reference pitch width obtained by the Edge Pitch tool.

22) **Average Pitch (J) (WA)**: outputs the logical (Judge) result of the average assigned reference pitch width obtained by the Edge Pitch tool.

5.7 Edge Position

This tool searches for edges formed by brightness differences on a gray scale image. You can specify the search region and the horizontal or vertical scanning method. When the tool finds image segments of greater brightness differences, the tool recognizes the region as an edge; otherwise the tool is unlikely to detect effective edges in regions of smaller brightness differences.

◎ **Algorithmic Processing**
➤ Edge Position Scan Methods
   Selects the ROI. The ROI options provide differing edge scanning methods.

◆ The two following examples are for ROIs other than Ring and Arc.

Scanning direction: Left to Right

Search method: Bright to dark

Reference: 1

Edge detected by Edge Position

ROI

Object

Scanning direction: Left to Right

Search method: Bright to dark

Reference: 2

Edge detected by Edge Position

ROI

Object

◆ The two following examples are for Ring and Arc ROIs.

Scanning direction: Clockwise

Search method: Bright to dark

Angle: 0

Reference: 1

Edge detected by Edge Position

ROI

Object
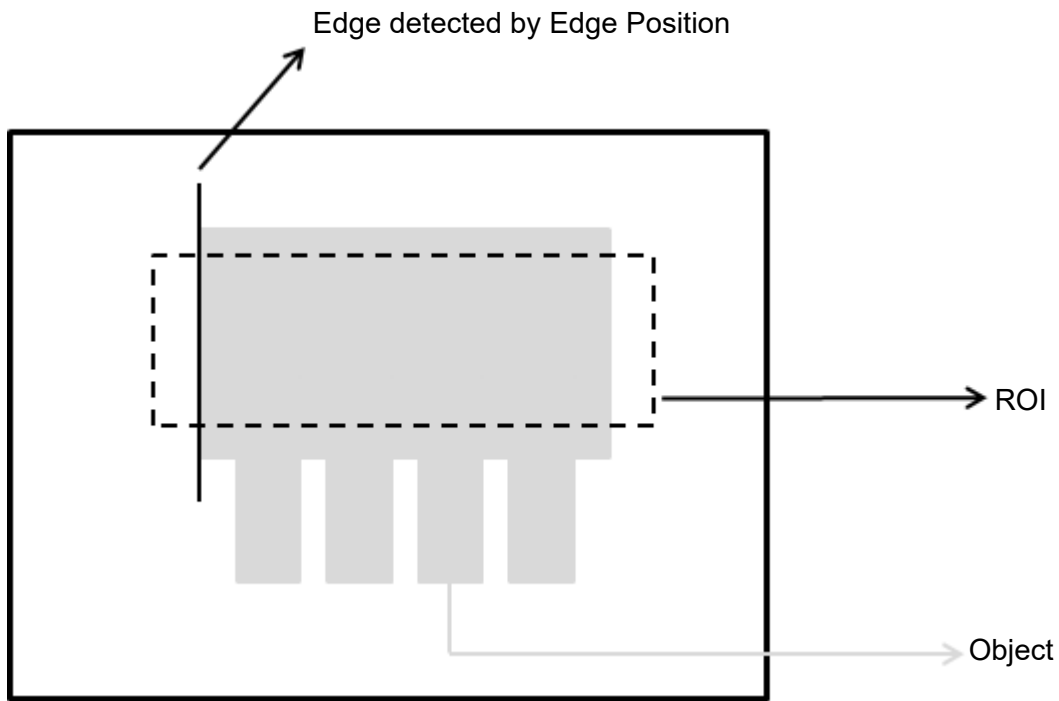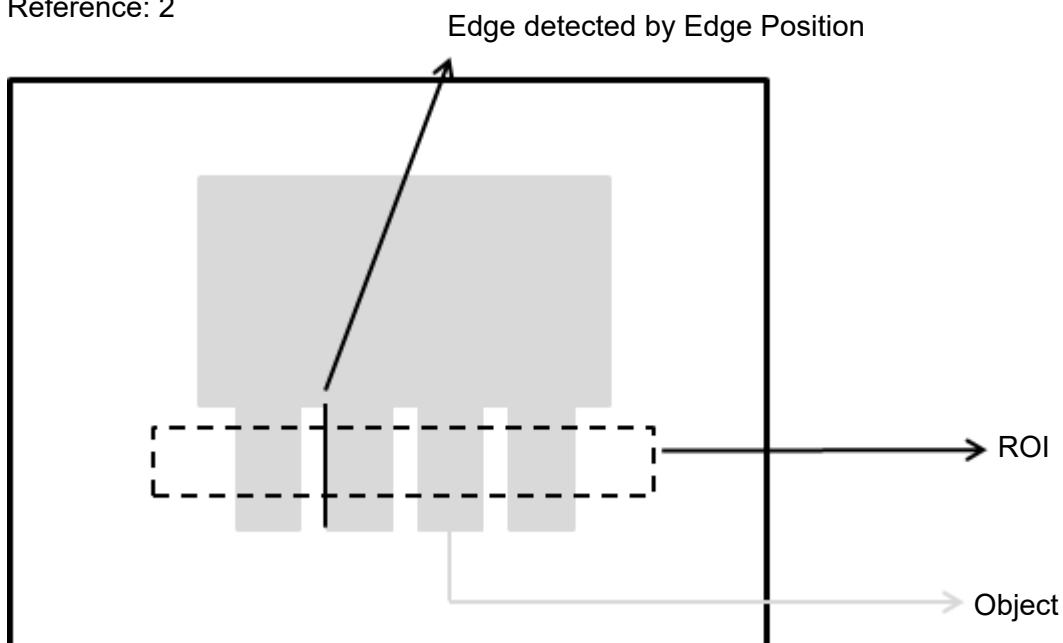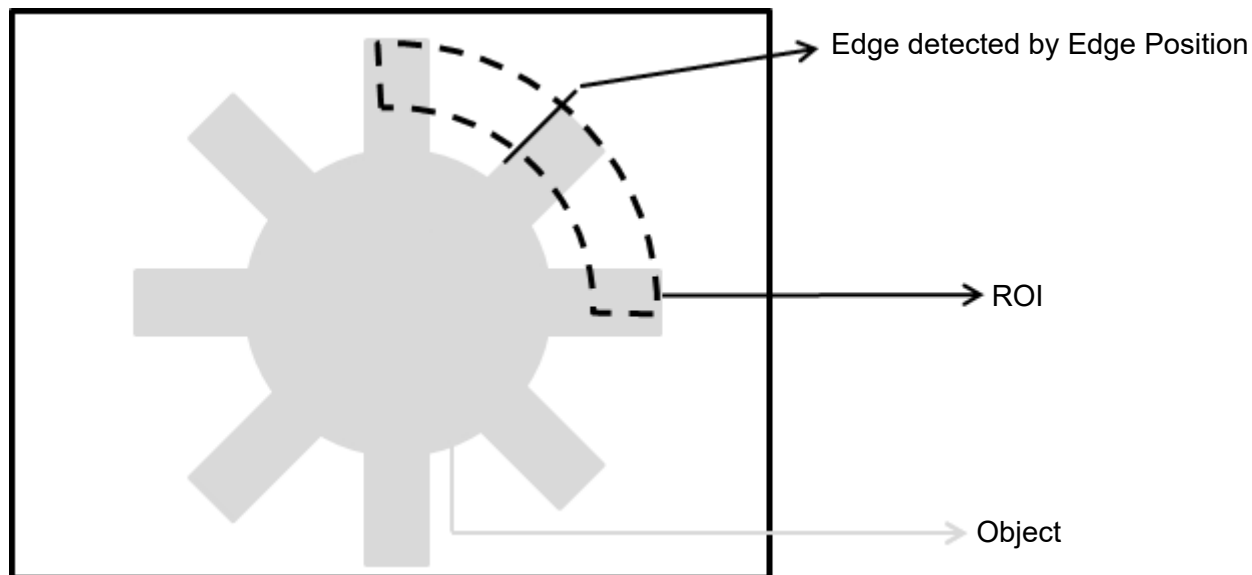
Scanning direction: Counterclockwise

Search method: Bright to dark

Angle: 0

Reference: 1

Edge detected by Edge Position

ROI

Edge detected by Edge

Position

Object
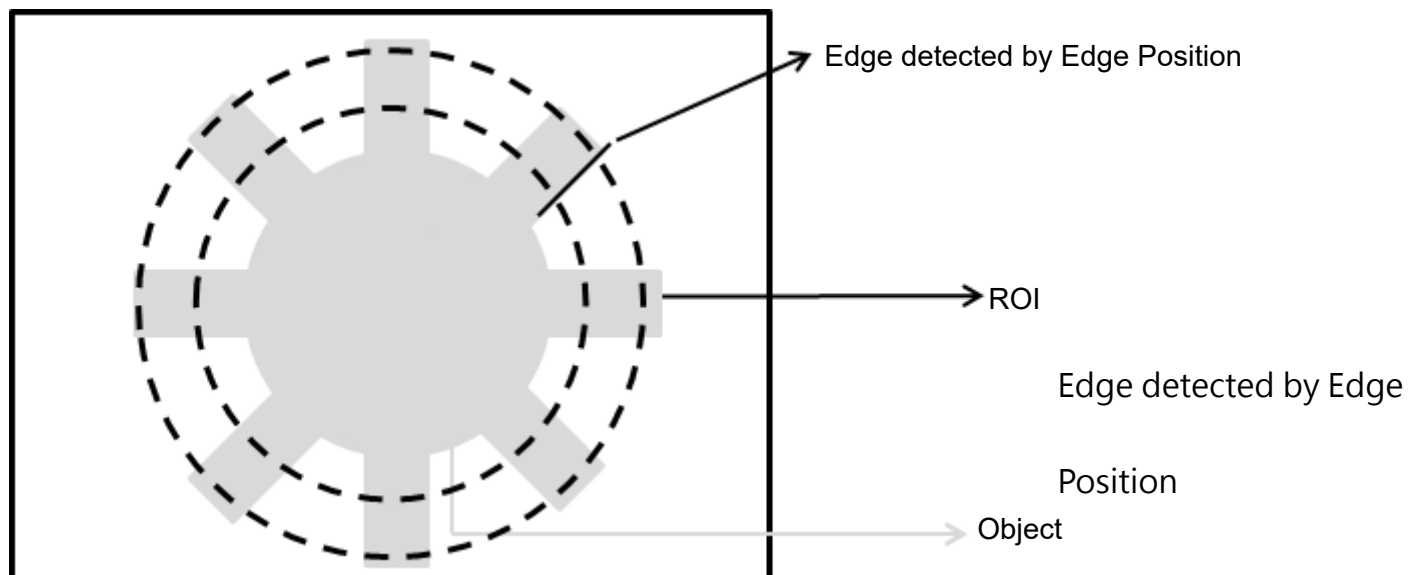
◎ **Procedural Results**

The Edge Position tool returns the following inspection results.

➤ Edge Position X: outputs the X coordinate of the edge found by the Edge Position tool.

➤ Edge Position Y: outputs the Y coordinate of the edge found by the Edge Position tool.

➤ Edge Absolute Angle: if you select the Ring or Arc ROI, the Edge Absolute Angle function outputs the absolute angle of the edge found by the Edge Pitch tool.

➤ Edge Relative Angle: if you select the Ring or Arc ROI, the Edge Relative Angle function outputs the relative angle of the edge found by the Edge Pitch tool.

◎ **Example**

◆ For ROIs other than Ring and Arc

Scanning direction: Left to Right

Search method: Bright to dark

Reference: 1

Inspection result: X coordinate is 200

X coordinate: 200
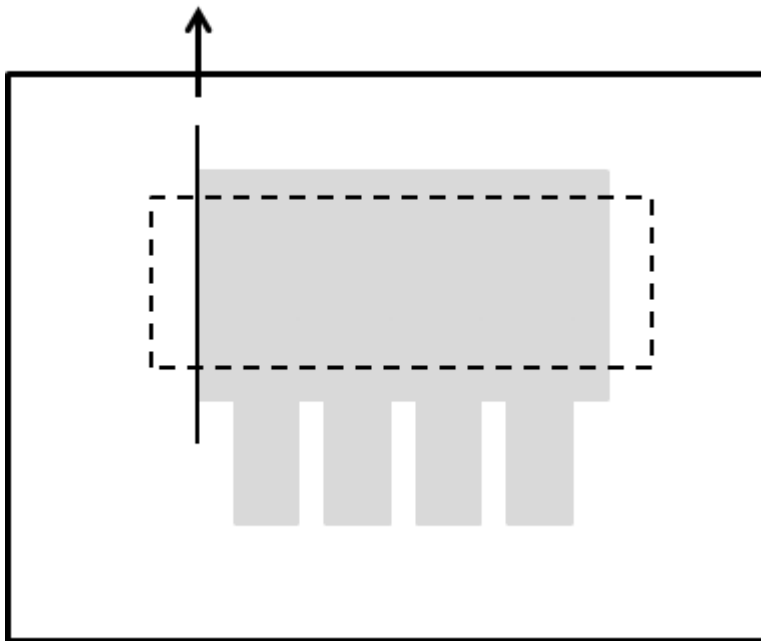
◆ For Ring and Arc ROIs

Scanning direction: Clockwise

Search method: Bright to dark

Angle: 0

Reference: 1

Inspection result: The absolute angle of the edge is 45 degrees.
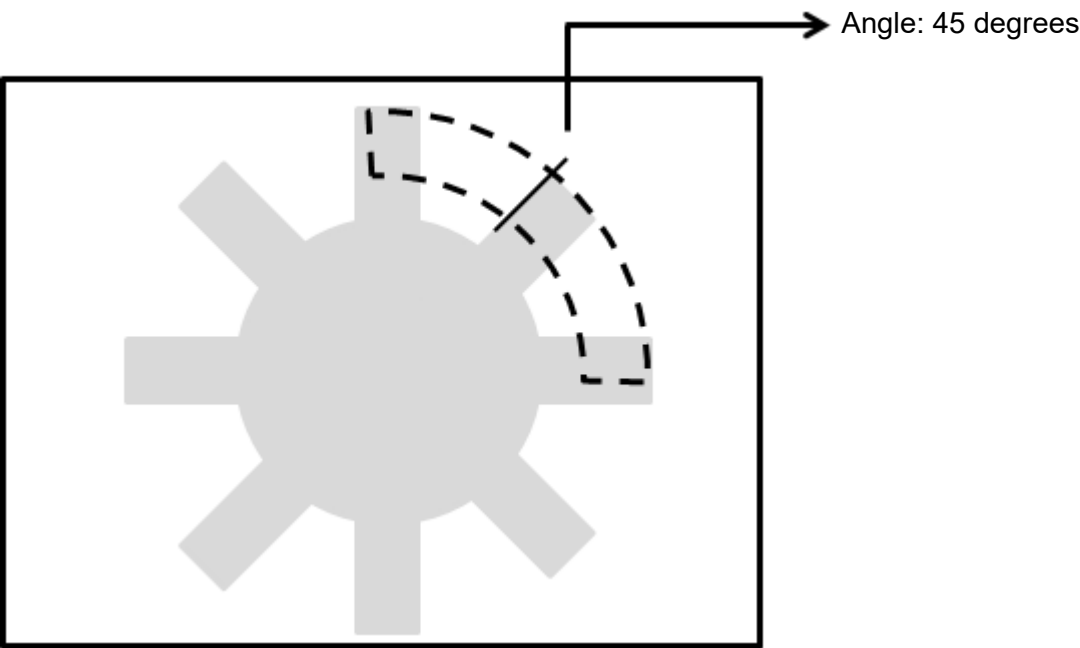
5.7.1 Edge Position dialog box

The following picture shows the Edge Position inspection tool dialog box.

◎ **Image Select** (select Register Image)

Selects the image to be inspected from the register gallery. You can configure source cameras and inspect the image display source. When you select a different camera, the image table also switches to show the registered images acquired from that camera.

◎ **ROI** (configure detection region of interest)

Specifies the inspection regions to be used in the inspection. Optional ROI shapes include Rectangle, Circle, Arc, Ellipse, Ring, Polygon, and Rotated Rect. The Polygon ROI supports up to 16 points. In addition, there are up to eight mask functions to ignore particular segments.

◎ **Color**

Selects the color processing for images from a color camera: Color to Binary, Color to Grayscale, RGB grayscale, R Grayscale, G Grayscale, and B Grayscale.

◎ **Filter**

Specifies the image processing to apply before inspections to enhance certain aspects of the image. Preprocessing methods include Binary, Dilation, Erosion, Average, Median, Laplacian, Sobel X, Sobel Y, Sobel XY, Brightness, Contrast, Shade, and Custom (filter). You can superimpose up to six methods or create a custom method by clicking Custom.

◎ **Parameter**

Adjusts the Edge Position inspection tool conditions.

Direction

When you select Ring or Arc for the ROI, you can then select Clockwise or Counterclockwise for the scanning direction. For other ROI shapes, you can select Left to Right, Right to Left, Upward, or Downward for the scanning direction.

Look For

Selects the search method: All Edges, Light to Dark, and Dark to Light.

Edge Strength

Specifies the threshold for the edge search (**Look For**), and you can fine-tune it between 0–100 based on the waveform displayed in the preview. When the peak is larger than the configured edge strength, **Look For** identifies the segment as an edge. As shown in the lower left picture, the system finds two edges when Edge Strength is set to 50. As shown in the lower right diagram, the system finds only one edge that is greater than the configured Edge Strength threshold of 70.
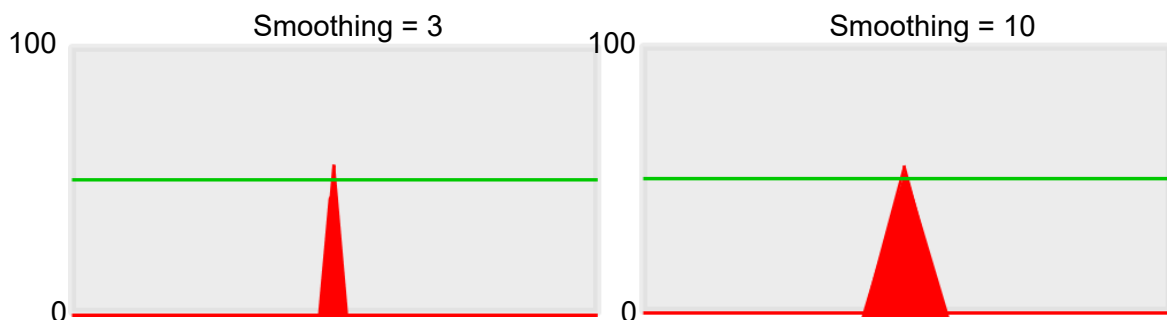
Edge Strength = 50

Edge Strength = 70

Lower

Use the Lower (limit) to filter small noise signals on the image, and the range is between 0–255. Peaks lower than the Lower value are filtered from the waveform. As shown in the lower left diagram, some noise appears when Lower is set to 0, but the noise is filtered out when Lower is set to 20.

Lower = 0

Lower = 20

Smoothing

Sets the RGB Grayscale for edge calculations between 1–30. When you increase Smoothing, the slope of waveform changes, attenuating the effect caused by noise signals.

Smoothing = 3

Smoothing = 10

Angle

When the ROI is Ring or Arc, this sets the starting angle for the edge scan. The following pictures show starting angles of 0 and 45 degrees, respectively.

Reference

Output the Nth result when scanning multiple targets.

Origin

The position of the origin (0, 0) in System Setting is displayed on the upper left corner of the screen. You can enter new coordinates to move the origin to the new coordinates.

◎ **Limit**

After you complete the configurations, you can view the inspection results using register images through **Test Mode**. You can then configure the upper and lower limits in the Limit dialog box. The following items can be configured for the Edge Position tool.

➤ **Edge Position X**: specifies the upper and lower X coordinate limits of edges.

➤ **Edge Position Y**: specifies the upper and lower Y coordinate limits of edges.

➤ **Edge Absolute Angle**: If you select Ring or Arc for ROI, there is an effective absolute edge angle. This value specifies the upper and lower limits for the angle.

◎ **Locate**

Specifies whether the inspection region follows an inspection result by adjusting its coordinates (X, Y) and Angles (Theta). The inspection tools you can use as a reference includes Shape, Blob, Edge Position and Edge Angle. As shown in the following diagram, specific marks (such as the cross on the object) can be used for the Locate function.

Locate Off   Locate On

Manual mode and quick mode are available for this project.

➤ Manual mode: Manually click【Ref. X】、【Ref. Y】and【Ref. Angle】, separately set the source of the reference positioning.

➤ Quick mode: Click【⊖Ref. Nearest Shape Locate Win】, the system will directly bring in the closest 【Shape】as the【Ref. X】、【Ref. Y】and【Ref. Angle】setting.

➤ 📑 Reference Please refer to Section 9.1 for detailed Locate configurations.

◎ **Execution**

Specifies whether to execute the inspection function in the inspection flow.

➢ **Always Execution**

Always execute the inspection function in Run mode.

➢ **Never Execution**

Never execute the inspection function in Run mode.

➢ **Reference Execution**

This test will be executed when the [Reference Detection] item meets the [OK/NG] condition.

◎ **Output Item**

➢ **Window**

Selects the output window for the total Judge result for the Edge Position tool on the designated interface.

➢ **Item**

1) **Number of Edges (N)**: outputs the total number of edges found by the Edge Position tool.

2) **Edge Position X (X)**: outputs the X coordinate of the edge found by the Edge Position tool.

3) **Edge Position Y (Y)**: outputs the Y coordinate of the edge found by the Edge Position tool.

4) **Edge Absolute Angle (AG)**: when you select the Ring or Arc ROI, Edge Absolute Angle outputs the absolute angle of the edge found by the Edge Pitch tool.

5) **Edge Relative Angle (RA)**: when you select the Ring or Arc, Edge Relative Angle outputs the relative angle of the edge found by the Edge Pitch tool.

6) **Edge Position ID**: outputs the ID of the inspection tool.

7) **Edge Position X (J) (X)**: outputs the logical (Judge) result of the X coordinates of the edges found by the Edge Position tool.

8) **Edge Position Y (J) (Y)**: outputs the logical (Judge) result of the Y coordinates of the edges found by the Edge Position tool.

9) **Edge Absolute Angle (J) (AG)**: when you select the Ring or Arc ROI, Edge Absolute Angle (J) outputs the logical (Judge) result of the absolute edge angle found by the Edge Position tool.

5.8 Edge Width

This tool searches for multiple edges formed by the brightness differences on a gray scale images and calculates the edge widths. You specify the search region and the horizontal or vertical scanning method, or the outer or inner edge detection. When the tool detects image segments of larger brightness differences, the tool recognizes the region as an edge and looks for the edge pitch; otherwise, the tool is unlikely to detect effective widths in regions of smaller brightness differences or in regions consisting of only one edge.

◎ **Algorithmic Processing**
1) Edge Width Scan Methods
    Selects the ROI. The ROI options provide differing edge scanning methods.

➤ The three following examples are for ROIs other than Ring and Arc.

Scanning direction: Horizontal
Search method: All edges
Measure method: Out to in
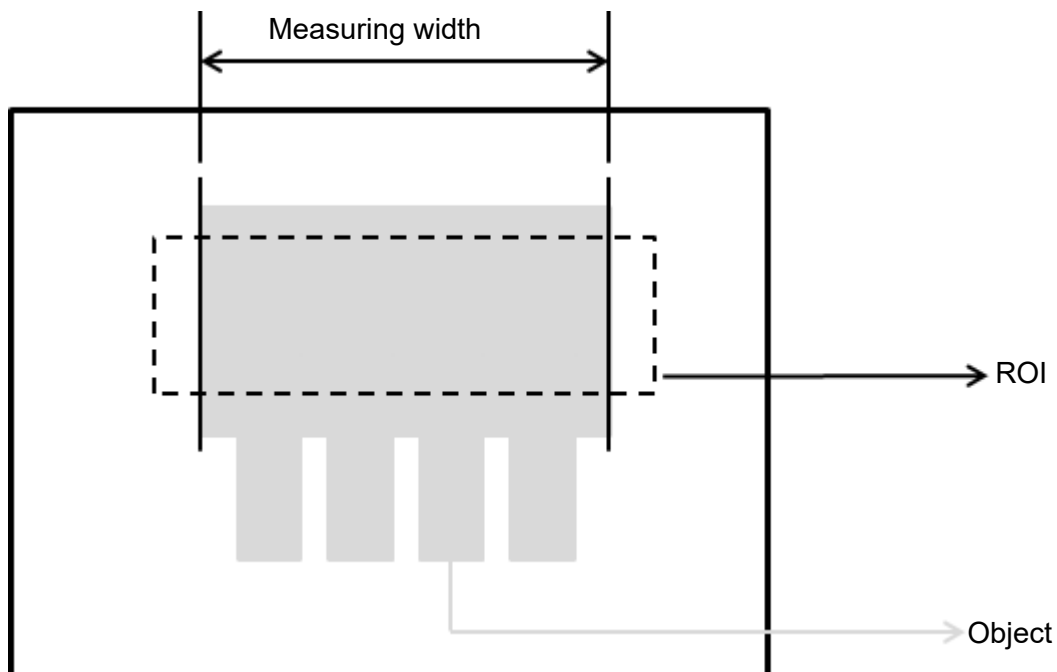
Scanning direction: Horizontal

Search method: All edges

Measure method: Inside-out
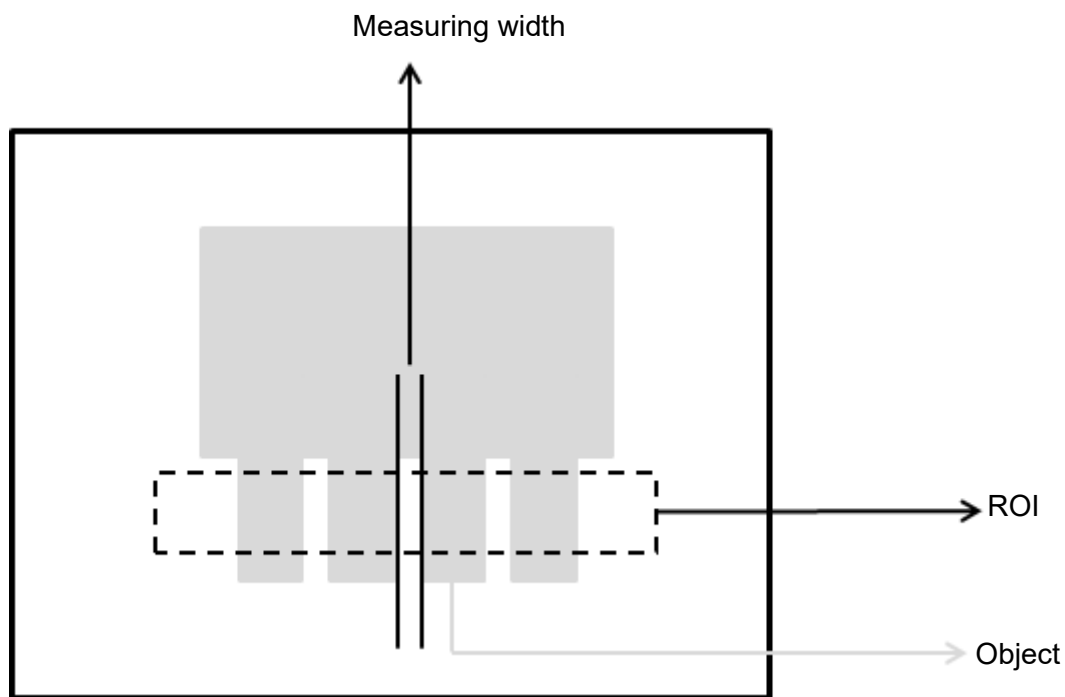
Scanning direction: Horizontal

Search method: Dark to bright

Measure method: Outside-in
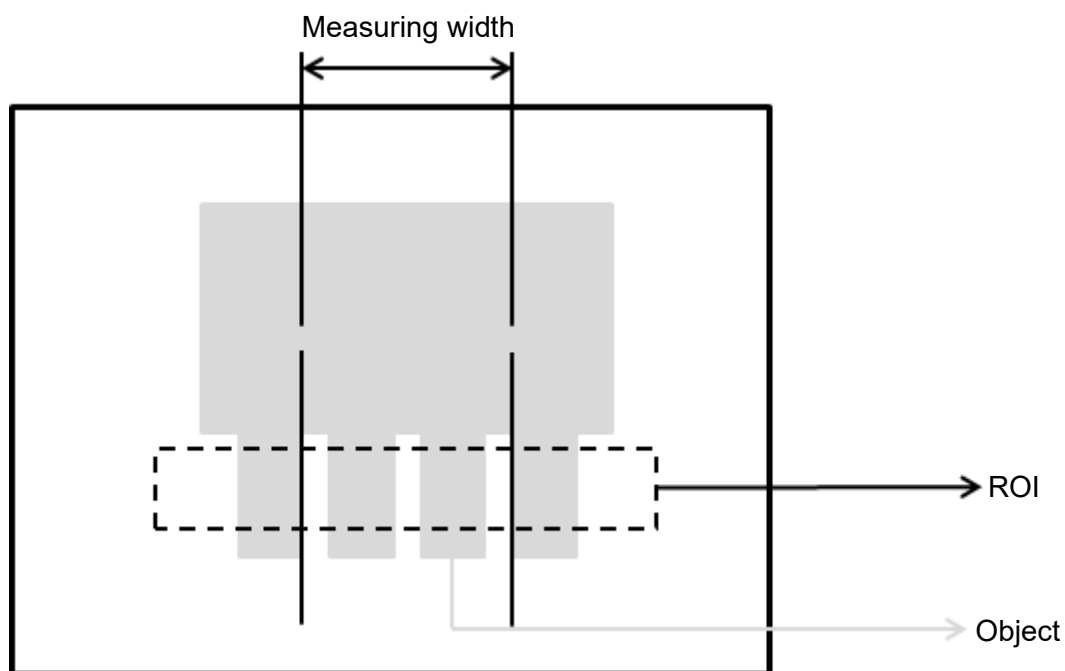
➤ The two following examples are for Ring and Arc ROIs.

Scanning direction: Clockwise

Search method: All edges

Measure method: Inside-out
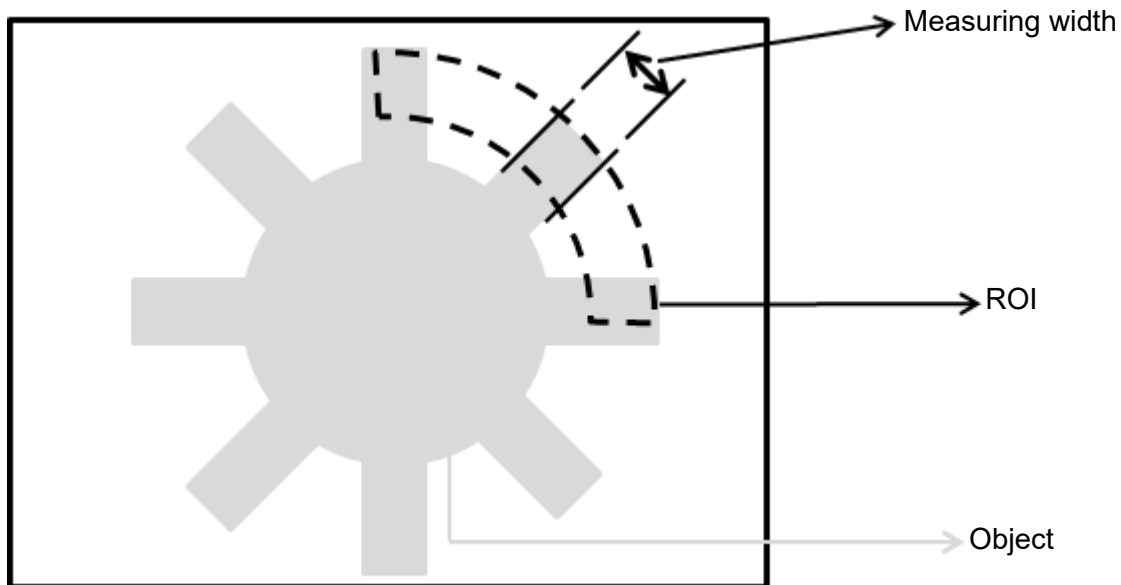
Scanning direction: Clockwise

Search method: Bright to dark

Angle: -15

Measure method: Out to in
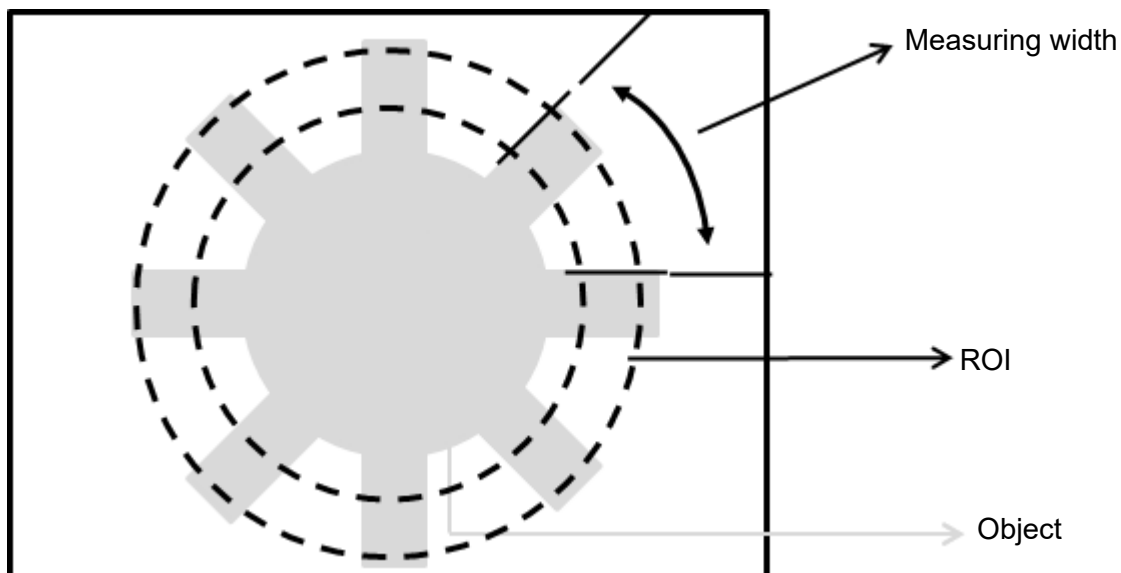
◎ **Procedural Results**

The Edge Width tool returns the following inspection results.

➤ Edge Width: outputs the width data found by the Edge Width tool (unit in pixels).

➤ First Edge Position X: outputs the X coordinate of the first edge position found by the Edge Width tool.

➢ First Edge Position Y: outputs the Y coordinate of the first edge position found by the Edge Width tool.

➢ First Edge Absolute Angle: when you select the Ring or Arc ROI, the First Edge Absolute Angle function outputs the absolute angle of the first edge found by the Edge Width tool.

➢ First Edge Relative Angle: when you select the Ring or Arc ROI, the First Edge Relative Angle function outputs the relative angle of the first edge found by the Edge Width tool.

➢ Second Edge Position X: outputs the X coordinate of the second edge position found by the Edge Width tool.

➢ Second Edge Position Y: outputs the Y coordinate of the second edge position found by the Edge Width tool.

➢ Second Edge Absolute Angle: when you select the Ring or Arc ROI, the First Edge Absolute Angle function outputs the absolute angle of the second edge found by the Edge Width tool.

➢ Second Edge Relative Angle: when you select the Ring or Arc ROI, the Second Edge Relative Angle function outputs the relative angle of the second edge found by the Edge Width tool.

◎ **Example**

➢ The first example is for ROIs other than Ring and Arc; the second example is for Arc.

Scanning direction: Horizontal

Search method: All edges

Measure method: Out to in

Inspection result: Edge width is 750 pixels
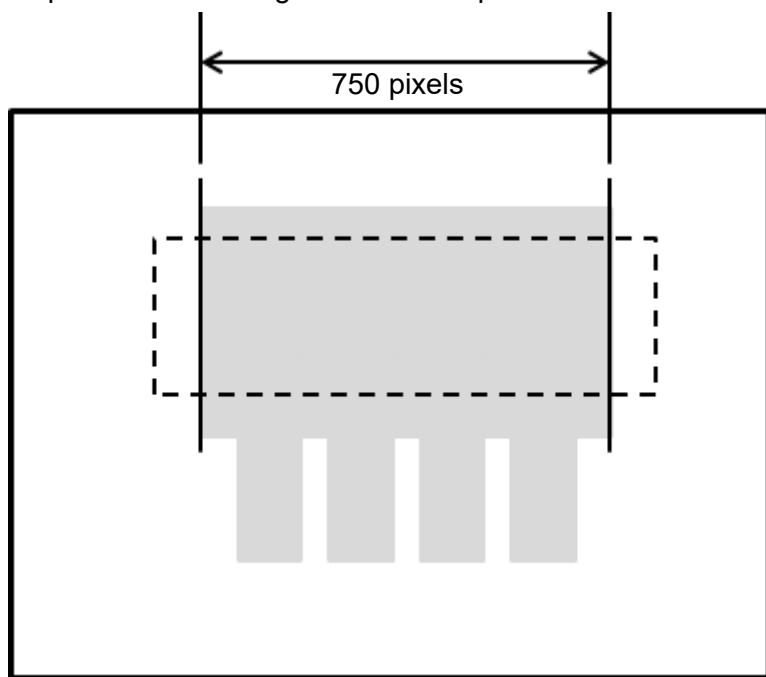
750 pixels

Scanning direction: Clockwise

Search method: All edges

Measure method: Inside-out

Inspection result: Edge width is 100 pixels
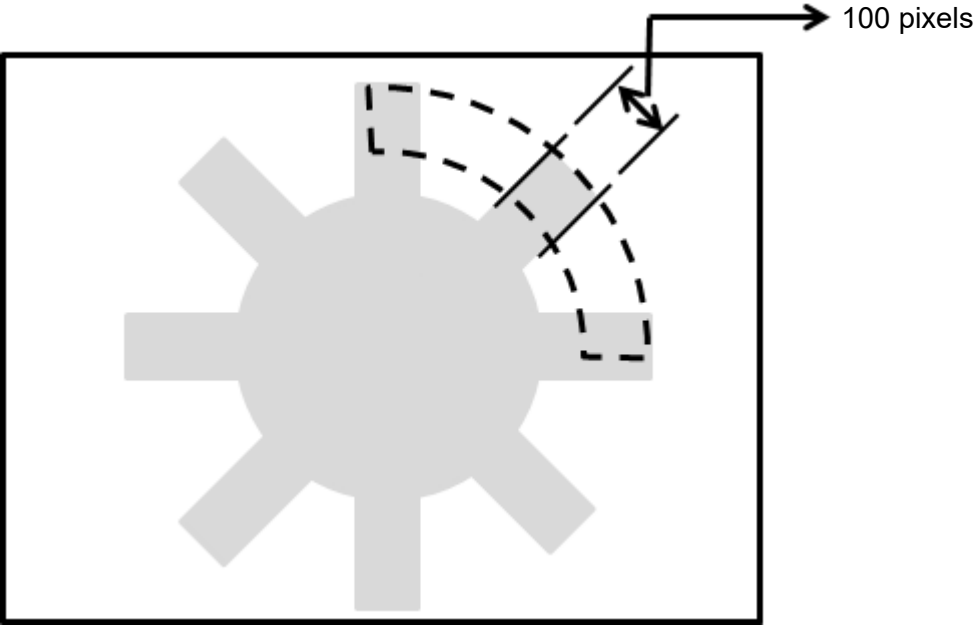
5.8.1 Edge Width dialog box

The following picture shows the Edge Width inspection tool dialog box.

◎ **Image Select** (select Register Image)

Selects the image to be inspected from the register gallery. You can configure source cameras and inspect the image display source. When you select a different camera, the image table also switches to show the registered images acquired from that camera.

◎ **ROI** (configure detection region of interest)

Specifies the inspection regions to be used in the inspection. Optional ROI shapes include Rectangle, Circle, Arc, Ellipse, Ring, Polygon, and Rotated Rect. The Polygon ROI supports up to 16 points. In addition, there are up to eight mask functions to ignore particular segments.

◎ **Color**

Selects the color processing for images from a color camera: Color to Binary, Color to Grayscale, RGB grayscale, R Grayscale, G Grayscale, and B Grayscale.

◎ **Filter**

Specifies the image processing to apply before inspections to enhance certain aspects of the image. Preprocessing methods include Binary, Dilation, Erosion, Average, Median, Laplacian, Sobel X, Sobel Y, Sobel XY, Brightness, Contrast, Shade, and Custom (filter). You can superimpose up to six methods or create a custom method by clicking Custom.

◎ **Parameter**

Direction

When you select Ring or Arc for the ROI, you can then select Clockwise or Counterclockwise for the scanning direction. For other ROI shapes, you can select Left to Right, Right to Left, Upward, or Downward for the scanning direction.

Look For

Selects the search method: All Edges, Light to Dark, and Dark to Light.

Edge Strength

Specifies the threshold for the edge search (**Look For**), and you can fine-tune it between 0–100 based on the waveform displayed in the preview. When the peak is larger than the configured edge strength, **Look**

For identifies the segment as an edge. As shown in the lower left picture, the system finds two edges when Edge Strength is set to 50. As shown in the lower right diagram, the system finds only one edge that is greater than the configured Edge Strength threshold of 70.

Edge Strength = 50

Edge Strength = 70

Lower

Use the Lower (limit) to filter small noise signals on the image, and the range is between 0–255. Peaks lower than the Lower value are filtered from the waveform. As shown in the lower left diagram, some noise appears when Lower is set to 0, but the noise is filtered out when Lower is set to 20.

Lower = 0

Lower = 20

Smoothing

Sets the RGB Grayscale for edge calculations between 1–30. When you increase Smoothing, the slope of waveform changes, attenuating the effect caused by noise signals.

Smoothing = 3

Smoothing = 10

Angle

When the ROI is Ring or Arc, this sets the starting angle for the edge scan. The following pictures show starting angles of 0 and 45 degrees, respectively.

Angle = 0   Angle = 45

Reference

Output the Nth result when scanning multiple targets.

Origin

The position of the origin (0, 0) in System Setting is displayed on the upper left corner of the screen. You can enter new coordinates to move the origin to the new coordinates.

◎ **Limit**

After you complete the configurations, you can view the inspection results using register images through **Test Mode**. You can then configure the upper and lower limits in the Limit dialog box. The following items can be configured for the Edge Width tool.

➤ **Edge Width**: specifies the upper and lower limits of the angles detected by the Edge Width tool.

➤ **First Edge Position X**: specifies the upper and lower X coordinate limits of the first edge.

➤ **First Edge Position Y**: specifies the upper and lower Y coordinate limits of the first edge.

➤ **Second Edge Position X**: specifies the upper and lower X coordinate limits of the second edge.

➤ **Second Edge Position Y**: specifies the upper and lower Y coordinate limits of the second edge.

➤ **First Edge Absolute Angle**: when you select Ring or Arc for the ROI, there is an effective absolute angle for the first edge; specifies the upper and lower limits.

➤ **Second Edge Absolute Angle**: when you select Ring or Arc for the ROI, there is an effective absolute angle for the second edge; specifies the upper and lower limits.

◎ **Locate**

Specifies whether the inspection region follows an inspection result by adjusting its coordinates (X, Y) and Angles (Theta). The inspection tools you can use as a reference includes Shape, Blob, Edge Position and Edge Angle. As shown in the following diagram, specific marks (such as the cross on the object) can be used for the Locate function.

Locate Off   Locate On

Corrected inspection region
after using Locate

Target

Manual mode and quick mode are available for this project.

➤ Manual mode: Manually click【Ref. X】、【Ref. Y】and【Ref. Angle】, separately set the source of the reference positioning.

➤ Quick mode: Click【⊖Ref. Nearest Shape Locate Win】, the system will directly bring in the closest 【Shape】as the【Ref. X】、【Ref. Y】and【Ref. Angle】setting.

➤ **Reference** Please refer to Section 9.1 for detailed Locate configurations.

◎ **Execution**

Specifies whether to execute the inspection function in the inspection flow.

Execute
● Always Execution   ○ Never Execution
○ Reference Execution
Ref. Win. None ▼ ✖
Condition OK ▼ ✖

➤ **Always Execution**

Always execute the inspection function in Run mode.

➤ **Never Execution**

Never execute the inspection function in Run mode.

➤ **Reference Execution**

This test will be executed when the [Reference Detection] item meets the [OK/NG] condition.

◎ **Output Item**

➤ **Window**

Selects the output window for the total Judge result for the Edge Width tool on the designated interface.

➤ **Item**

1) **Edge Width (L)**: outputs the width data found by the Edge Width tool (unit in pixels).

2) **First Edge Position X (X1)**: outputs the X coordinate of the first edge position found by the Edge Width tool.

3) **First Edge Position Y (Y1)**: outputs the Y coordinate of the first edge position found by the Edge Width tool.

4) **First Edge Absolute Angle (AG1)**: when you select the Ring and Arc ROI, the First Edge Absolute Angle function outputs the absolute angle of the first edge found by the Edge Width tool.

5) **First Edge Relative Angle (RA1)**: when you select the Ring or Arc ROI, First Edge Relative Angle outputs the relative angle of the first edge found by the Edge Width tool.

6) **Second Edge Position X (X2)**: outputs the X coordinate of the second edge position found by the Edge Width tool.

7) **Second Edge Position Y (Y2)**: outputs the Y coordinate of the second edge position found by the Edge Width tool.

8) **Second Edge Absolute Angle (AG2)**: when you select the Ring or Arc ROI, First Edge Absolute Angle outputs the absolute angle of the second edge found by the Edge Width tool.

9) **Second Edge Relative Angle (RA2)**: when you select the Ring or Arc ROI, Second Edge Relative Angle outputs the relative angle of the second edge found by the Edge Width tool.

10) **Edge Width ID**: outputs the ID of the inspection tool.

11) **Edge Width (J) (L)**: outputs the logical (Judge) result of the edge widths found by the Edge Width.

12) **First Edge Position X (J) (X1)**: outputs the logical (Judge) result of the X coordinates of the first edge found by the Edge Position tool.

13) **First Edge Position Y (J) (Y1)**: outputs the logical (Judge) result of the Y coordinates of the first edge found by the Edge Position tool.

14) **First Edge Absolute Angle (J) (AG1)**: when you select the Ring or Arc ROI, First Edge Absolute Angle (J) outputs the logical (Judge) result of the absolute edge angle found by the Edge Width tool.

15) **Second Edge Position X (J) (X2)**: outputs the logical (Judge) result of the X coordinates of the second edge found by the Edge Position tool.

16) **Second Edge Position Y (J) (Y2)**: outputs the logical (Judge) result of the Y coordinates of the second edge found by the Edge Position tool.

17) **Second Edge Absolute Angle (J) (AG2)**: when you select the Ring and Arc ROI, First Edge Absolute Angle (J) outputs the logical (Judge) result of the absolute edge angle found by the Edge Width tool.

5.9 Shape

This tool compares samples (Patterns) previously stored in the controller, and then find the number of detections similar to the patterns, as well as the corresponding X and Y coordinates, angles, and degrees of similarity.

◎ **Algorithmic Processing**

You must download the patterns that Shape looks for in advance. You must specify the parameters such as the search angles and range and degrees of similarity.

ROI

Patterns added

Looks for outlines (edges) in the inspection region similar to the patterns
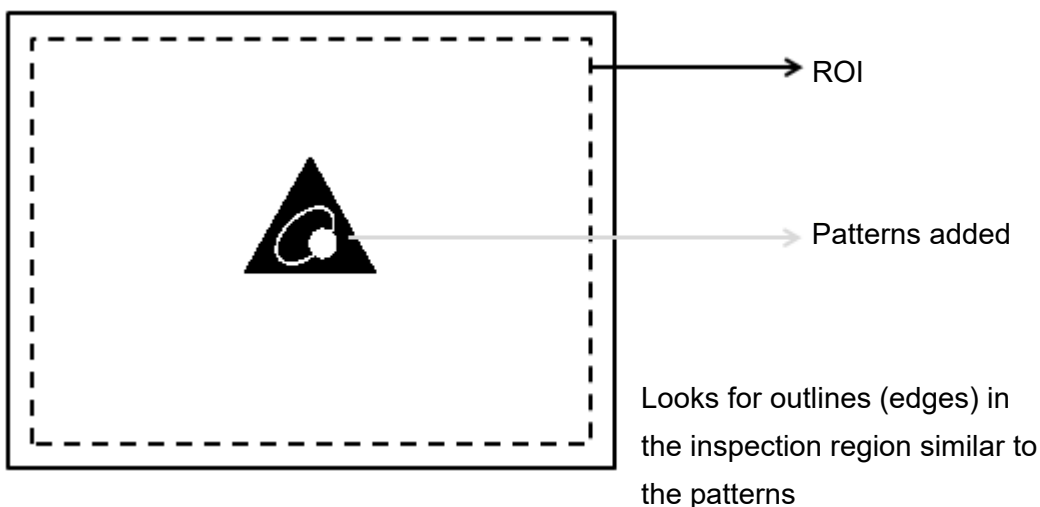
◎ **Procedural Results**

Shape returns the following inspection results.

➤ Number of Shapes: outputs the number of shapes similar to the pattern.

➤ Shape Position X [N]: outputs the X coordinate of the Nth shape similar to the pattern.

➤ Shape Position Y [N]: outputs the Y coordinate of the Nth shape similar to the pattern.

➤ Similarity [N]: outputs the degree of similarity of the Nth shape similar to the pattern.

➤ Shape Angle [N]: outputs the angle of the Nth shape similar to the pattern.

◎ **Example**
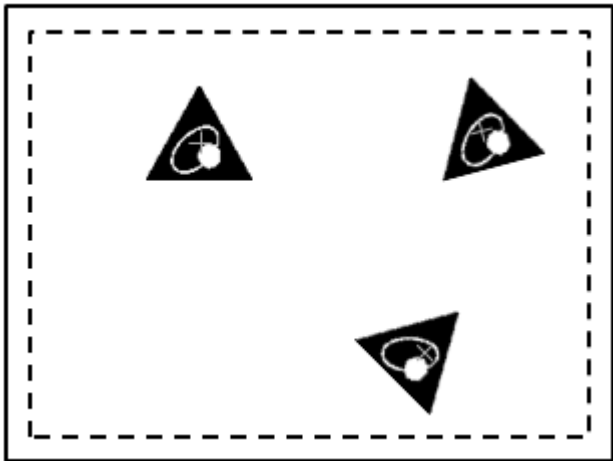
Number of Shapes = 3

Similarity [1] = 95

Shape Position X [1] = 400

Shape Position Y [1] = 200

Shape Angle [1] = 0

5.9.1 Shape dialog box

The following picture shows the Shape inspection tool dialog box.

◎ **Image Select** (select Register Image)

Selects the image to be inspected from the register gallery. You can configure source cameras and inspect the image display source. When you select a different camera, the image table also switches to show the registered images acquired from that camera.

◎ **ROI** (configure detection region of interest)

Specifies the inspection regions to be used in the inspection. Optional ROI shapes include Rectangle, Circle, Arc, Ellipse, Ring, Polygon, and Rotated Rect. The Polygon ROI supports up to 16 points. In addition, there are up to eight mask functions to ignore particular segments.

◎ **Color**

Selects the color processing for images from a color camera: Color to Binary, Color to Grayscale, RGB grayscale, R Grayscale, G Grayscale, and B Grayscale.

◎ **Filter**

Specifies the image processing to apply before inspections to enhance certain aspects of the image. Preprocessing methods include Binary, Dilation, Erosion, Average, Median, Laplacian, Sobel X, Sobel Y, Sobel XY, Brightness, Contrast, Shade, and Custom (filter). You can superimpose up to six methods or create a custom method by clicking Custom.

◎ **Parameter**

Adjusts the Shape inspection conditions.

Add Pattern

◆ **Angle**: specifies the range of angles to search for. A value of 10 means searching from -10 degrees to 10 degrees. A value of 179 means searching from -180 degrees to 180 degrees. A larger range of angles takes longer inspection times.

◆ **Scale Tolerance**: select this setting when the dimensions of the object to search vary.

◆ **Accuracy**: refers to the search accuracy; the options are: **Most Accurate**, **Accurate**, **General**, **Rough**, and **Most Rough**. A higher accuracy takes longer inspection times.

◆ **ROI/MASK**: use **Region** and **Region Mask** to select the shape to look for to build a model for the shape.
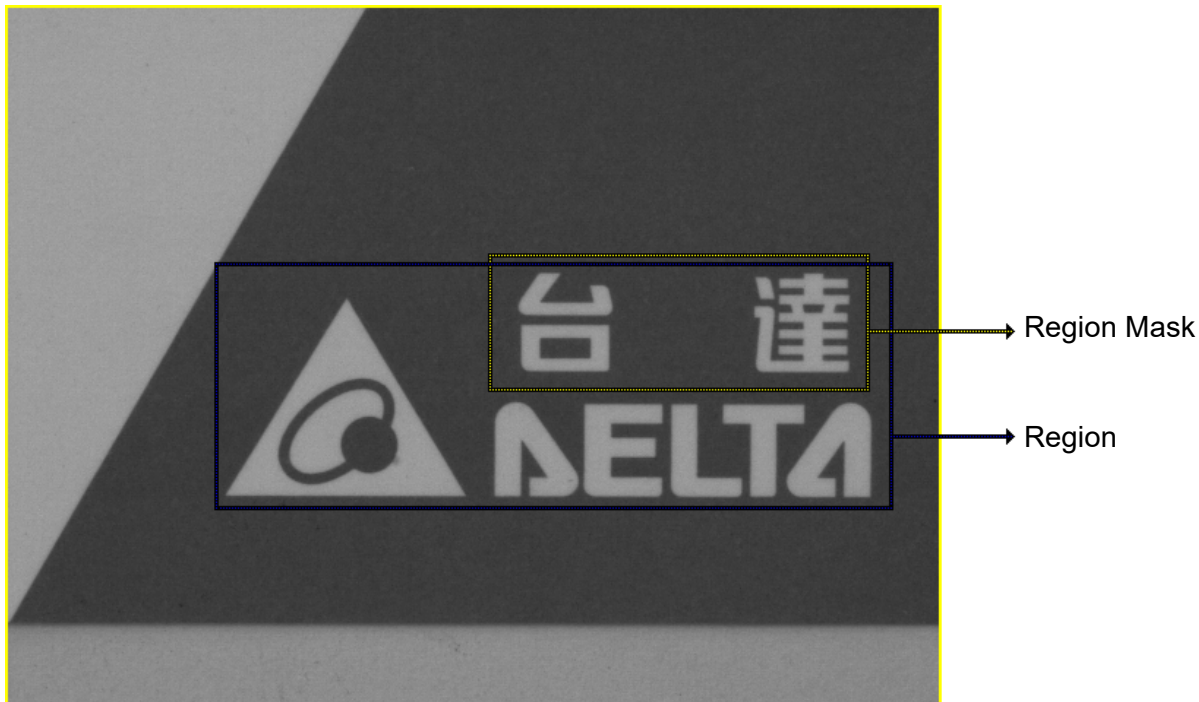
Shape Comparison Setting

◆ **Similarity**: specifies the degree of similarity to pattern for shape recognition.

◆ **Reference**: outputs the Nth result when scanning multiple targets.

◆ **Search Number**: specifies the number of shapes to look for.

◆ **Sort Rule**: when searching for multiple matching shapes, the following sorting methods are provided.

Similarity: sorts shapes based on degrees of similarity; shapes of higher similarities are numbered first.

Horizontal Position Ascend: sorts shapes based on the horizontal positions; smaller horizontal coordinates are numbered first.

Horizontal Position Descend: sorts shapes based on the horizontal positions; larger horizontal coordinates are numbered first.

Vertical Position Ascend: sorts shapes based on the vertical positions; smaller vertical coordinates are numbered first.

Vertical Position Descend: sorts shapes based on the vertical positions; larger vertical coordinates are numbered first.

Top Left to Bottom Right: sorts from top left to bottom right of the screen.

Bottom Right to Top Left: sorts from bottom right to top left of the screen.

Top Right to Bottom Left: sorts from top right to bottom left of the screen.

Bottom Left to Top Right: sorts from bottom left to top right of the screen.

◆ **Contrast Sensitive**: specifies the contrast between shape and background. When the characteristic shape contrast is strong, use **Very Coarse** to speed up the inspection. When the contrast is weak, use **Very Sensitive** to improve the recognition accuracy.

◆ **Ignore Polarity**: specifies whether to ignore edge polarity. As shown below, the tool finds both the black mark on white background and white mark on black background, regardless of edge polarity when any of the two is configured as the pattern.

Black mark on white background

White mark on black background
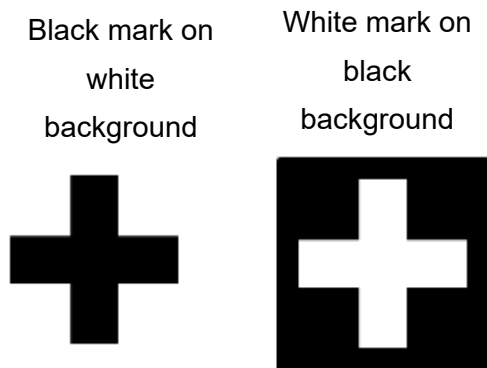
◆ **Enable Rotation Center**: the X and Y outputs from the inspection are both based on the center position of the pattern. When you enable this option, you can manually adjust the X and Y coordinates of the rotation center. The X and Y inspection outputs are then based on the specified position.

◆ **Origin**: the position of the origin (0, 0) in the System Setting is displayed on the upper left corner of the screen. You can enter different coordinates to change and move the origin to the new coordinates.

◎ **Limit**

Specifies the upper and lower limits for inspection results to determine whether the result is qualified. The following items can be configured in Shape.

Number of Shapes: specifies the upper and lower limits of the number of shapes.

Shape Position X: specifies the shapes' upper and lower X coordinate limits.

Shape Position Y: specifies the shapes' upper and lower Y coordinate limits.

Similarity: specifies the upper and lower limits of shape similarity.

Shape Angle: specifies the upper and lower limits of shape angles.

◎ **Locate**

Specifies whether the inspection region follows an inspection result by adjusting its coordinates (X, Y) and Angles (Theta). The inspection tools you can use as a reference includes Shape, Blob, Edge Position and Edge Angle. As shown in the following diagram, specific marks (such as the cross on the object) can be used for the Locate function.

Locate Off   Locate On

Manual mode and quick mode are available for this project.

➤ Manual mode: Manually click【Ref. X】、【Ref. Y】and【Ref. Angle】, separately set the source of the

reference positioning.

➤ Quick mode: Click【⊖Ref. Nearest Shape Locate Win】, the system will directly bring in the closest

【Shape】as the【Ref. X】、【Ref. Y】and【Ref. Angle】setting.

➤ ▣ Reference Please refer to Section 9.1 for detailed Locate configurations.

◎ **Execution**

Specifies whether to execute the inspection function in the inspection flow.

➤ **Always Execution**

Always execute the inspection function in Run mode.

➤ **Never Execution**

Never execute the inspection function in Run mode.

➤ **Reference Execution**

This test will be executed when the [Reference Detection] item meets the [OK/NG] condition.

◎ **Output Item**

➤ **Window**

Selects the output window for the total Judge result for the Shape tool on the designated interface.

➤ **Item**

1) **Number of Shapes**: outputs the number of shapes found by the Shape tool.

2) **Shape Position X [N]**: outputs the X coordinate of the Nth shape found by the Shape tool.

3) **Shape Position Y [N]**: outputs the Y coordinate of the Nth shape found by the Shape tool.

4) **Shape Angle [N]**: outputs the angle of the Nth shape found by the Shape tool.

5) **Similarity [N]**: outputs the degree of similarity of the Nth shape found by the Shape tool.

6) **Maximum Shape Position X**: outputs the maximum X coordinate found by the Shape tool.

7) **Minimum Shape Position X**: outputs the minimum X coordinate found by the Shape tool.

8) **Maximum Shape Position Y**: outputs the maximum Y coordinate found by the Shape tool.

9) **Minimum Shape Position Y**: outputs the minimum Y coordinate found by the Shape tool.

10) **Shape ID**: outputs the ID of the inspection tool.

11) **Number of Shapes (J)**: outputs the logical (Judge) result of the number of shapes found by the Shape tool.

12) **Shape Position X (J) [N]**: outputs the logical (Judge) result of the Nth shape's X coordinate found by the Shape tool.

13) **Shape Position Y (J) [N]**: outputs the logical (Judge) result of the Nth shape's Y coordinate found by the Shape tool.

14) **Shape Angle (J) [N]**: outputs the logical (Judge) result of the angle of the Nth shape found by the Shape tool.

15) **Similarity (J) [N]**: outputs the logical (Judge) result of the Nth shape's degree of similarity found by the Shape tool.

5.10 Intensity

The Intensity tool measures Maximum Intensity, Minimum Intensity, Average Intensity, and Standard Deviation of Intensity on a gray scale image in the inspection region.

◎ **Algorithmic Processing**

As shown in the following picture, the inspection region consists of three different gray scale distributions of 200, 100, and 30; the Intensity tool finds the four following results.

➤ Maximum Intensity = 200

➤ Minimum Intensity = 30

➤ Average Intensity = (30+100+200) / 3 = 110

➤ Standard Deviation of Intensity = 121
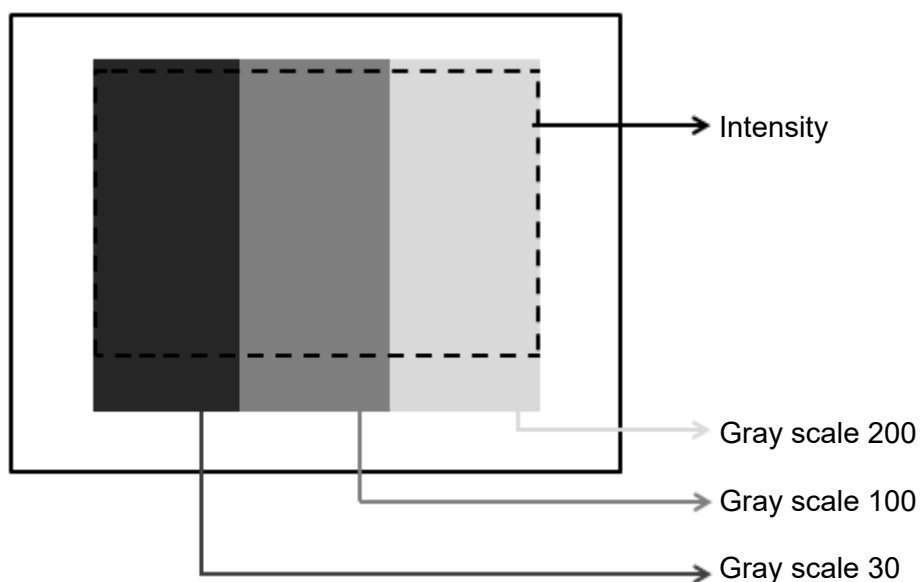
◎ **Procedural Results**

The Intensity tool returns the following inspection results.

➤ Average Intensity: outputs the average intensity in the inspection region.

➤ Standard Deviation of Intensity: outputs the standard deviation of intensity in the inspection region.

➤ Maximum Intensity: outputs the maximum intensity in the inspection region.

➤ Minimum Intensity: outputs the minimum intensity in the inspection region.

◎ **Example**

→ ROI

Maximum Intensity = 200

Minimum Intensity = 30

Average Intensity = 110

Standard Deviation of Intensity = 121
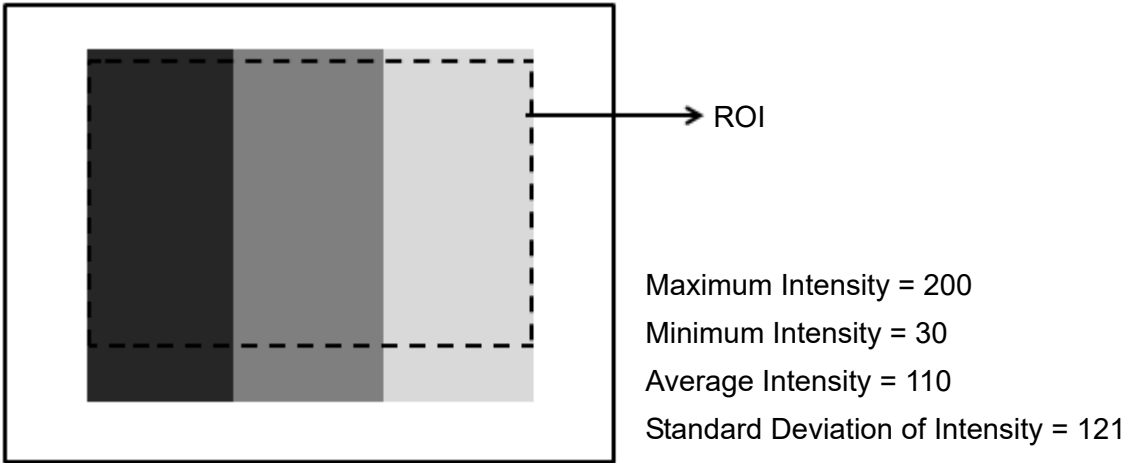
5.10.1 Intensity dialog box

The following picture shows the Intensity inspection tool dialog box.

◎ **Image Select** (select Register Image)

Selects the image to be inspected from the register gallery. You can configure source cameras and inspect the image display source. When you select a different camera, the image table also switches to show the registered images acquired from that camera.

Chapter 5 Inspection

◎ **ROI** (configure detection region of interest)

Specifies the inspection regions to be used in the inspection. Optional ROI shapes include Rectangle, Circle, Arc, Ellipse, Ring, Polygon, and Rotated Rect. The Polygon ROI supports up to 16 points. In addition, there are up to eight mask functions to ignore particular segments.

◎ **Color**

Selects the color processing for images from a color camera: Color to Binary, Color to Grayscale, RGB grayscale, R Grayscale, G Grayscale, and B Grayscale.

◎ **Filter**

Specifies the image processing to apply before inspections to enhance certain aspects of the image. Preprocessing methods include Binary, Dilation, Erosion, Average, Median, Laplacian, Sobel X, Sobel Y, Sobel XY, Brightness, Contrast, Shade, and Custom (filter). You can superimpose up to six methods or create a custom method by clicking Custom.

◎ **Parameter**

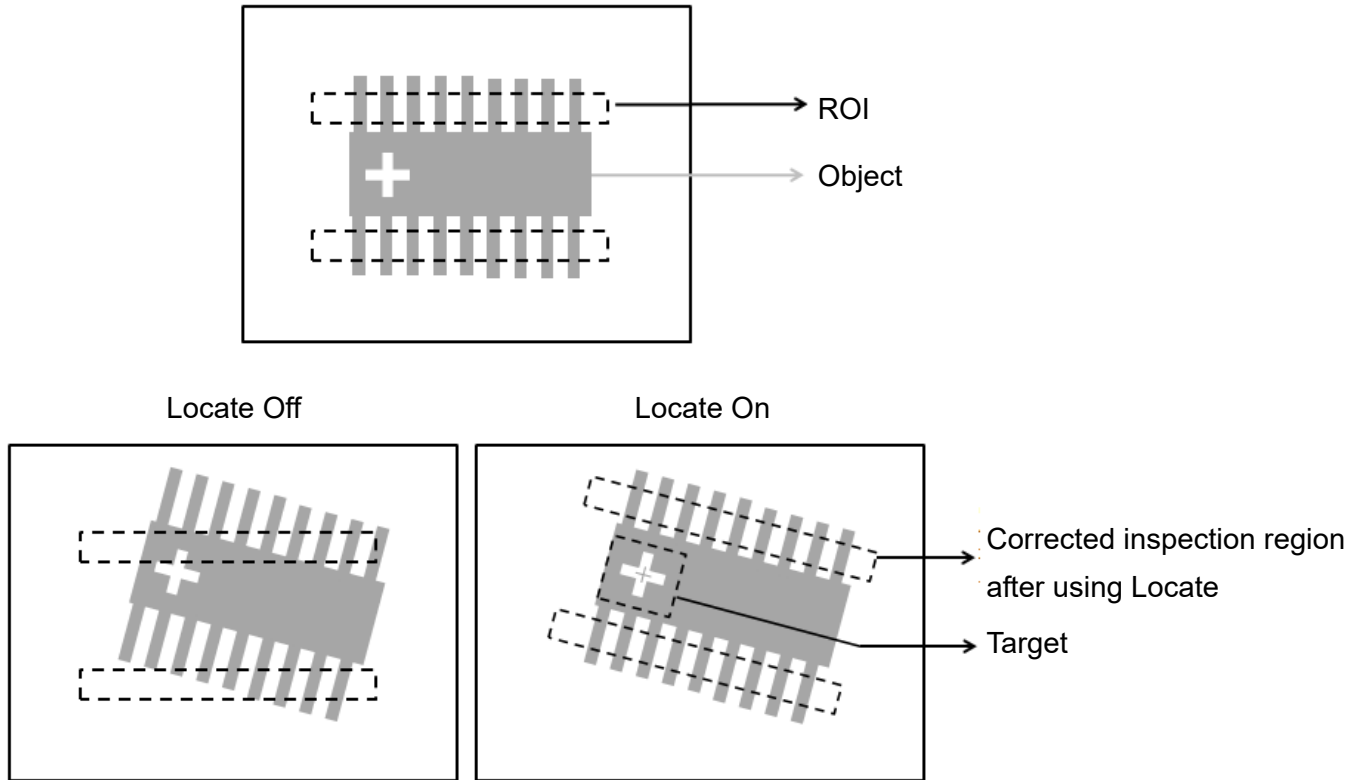Adjusts the Intensity inspection tool conditions.

◎ **Limit**

After you complete the configurations, you can view the inspection results using register images through **Test Mode**. You can then configure the upper and lower limits in the Limit dialog box. The following items can be configured for the Intensity tool:
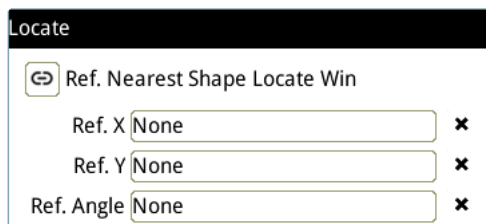
Area: specifies the upper and lower limits of Area.

◎　**Locate**

Specifies whether the inspection region follows an inspection result by adjusting its coordinates (X, Y) and Angles (Theta). The inspection tools you can use as a reference includes Shape, Blob, Edge Position and Edge Angle. As shown in the following diagram, specific marks (such as the cross on the object) can be used for the Locate function.
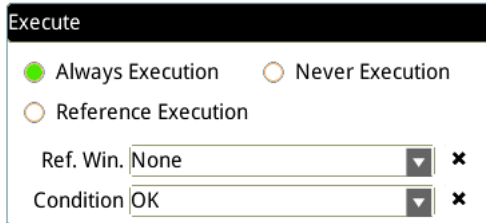

Locate Off   Locate On

Manual mode and quick mode are available for this project.

➤　Manual mode: Manually click【Ref. X】、【Ref. Y】and【Ref. Angle】, separately set the source of the reference positioning.

➤　Quick mode: Click【⊖Ref. Nearest Shape Locate Win】, the system will directly bring in the closest 【Shape】as the【Ref. X】、【Ref. Y】and【Ref. Angle】setting.

➤　🖳 Reference　Please refer to Section 9.1 for detailed Locate configurations.

◎ **Execution**

Specifies whether to execute the inspection function in the inspection flow.

➤ **Always Execution**

Always execute the inspection function in Run mode.

➤ **Never Execution**

Never execute the inspection function in Run mode.

➤ **Reference Execution**

This test will be executed when the [Reference Detection] item meets the [OK/NG] condition.

◎ **Output Item**

➤ **Window**

Selects the output window, the total Judge result for the Intensity tool on the designated interface.

➤ **Item**

1) **Average Intensity**: outputs the average intensity found by the Image Intensity tool.

2) **Standard Deviation of Intensity**: outputs the standard deviation of intensity found by the Image Intensity tool.

3) **Maximum Intensity**: outputs the maximum intensity found by the Image Intensity tool.

4) **Minimum Intensity**: outputs the minimum intensity found by the Image Intensity tool.

5) **Image Intensity ID**: outputs the ID of the inspection tool.

6) **Average Intensity (J)**: outputs the logical (Judge) result of the average intensity found by the Image Intensity tool.

7) **Standard Deviation of Intensity (J)**: outputs the logical (Judge) result of the standard deviation of intensity found by the Image Intensity tool.

8) **Maximum Intensity (J)**: outputs the logical (Judge) result of the maximum intensity found by the Image Intensity tool.

9) **Minimum Intensity (J)**: outputs the logical (Judge) result of the minimum intensity found by the Image Intensity tool.

5.11 Position Trace

Position Trace is an advanced function of the Edge Width tool and has identical search methods. Using a rectangular ROI as an example, you can configure the search range to find edges through horizontal or vertical scanning. When the tool detects segments of increased contrast on the image, the tool identifies the region as a target edge. A feature of Position Trace is that it can simultaneously find multiple edge positions on a surface and output the coordinates.

➤ **Algorithmic Processing**

➤ Position Trace Scan Methods

Selects the ROI. The ROI options provide differing edge scanning methods.

➤ When you select an ROI other than Ring or Arc, Position Trace calculates the furthest and the nearest edges relative to the screen origin and marks the two edges. This includes the two common conditions shown below.

Scanning direction: Left to Right

Search method: Bright to dark

Minimum edge detected by Position Trace
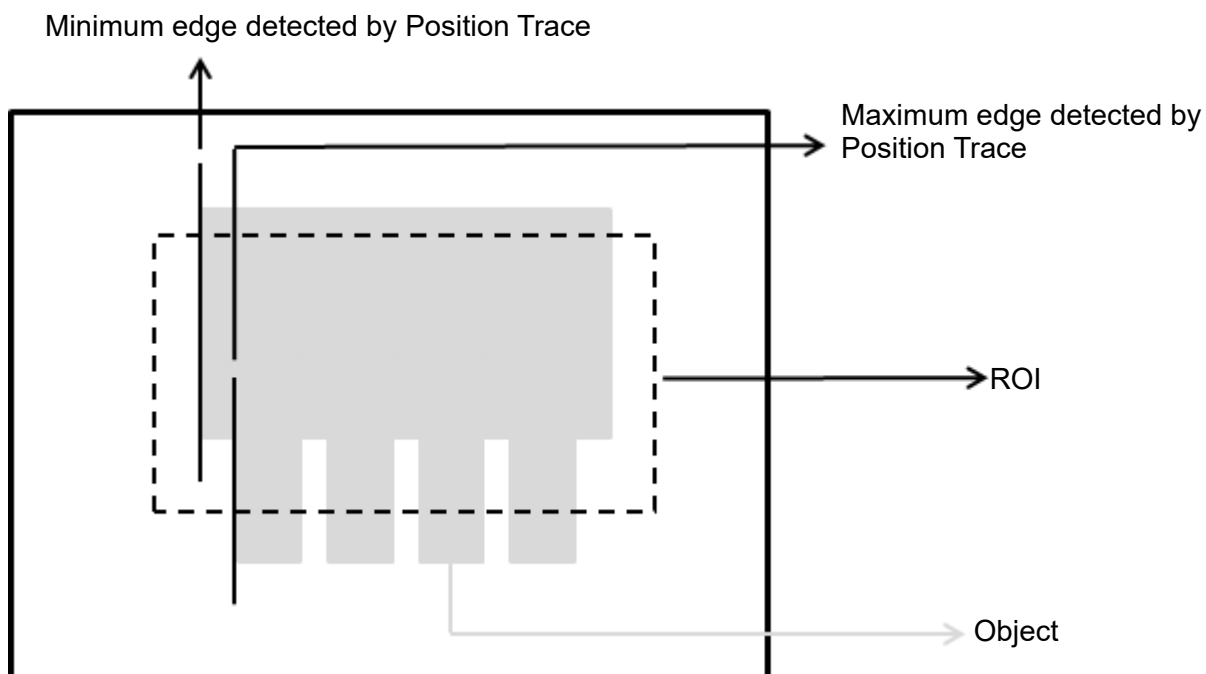
Scanning direction: Downward

Search method: All edges
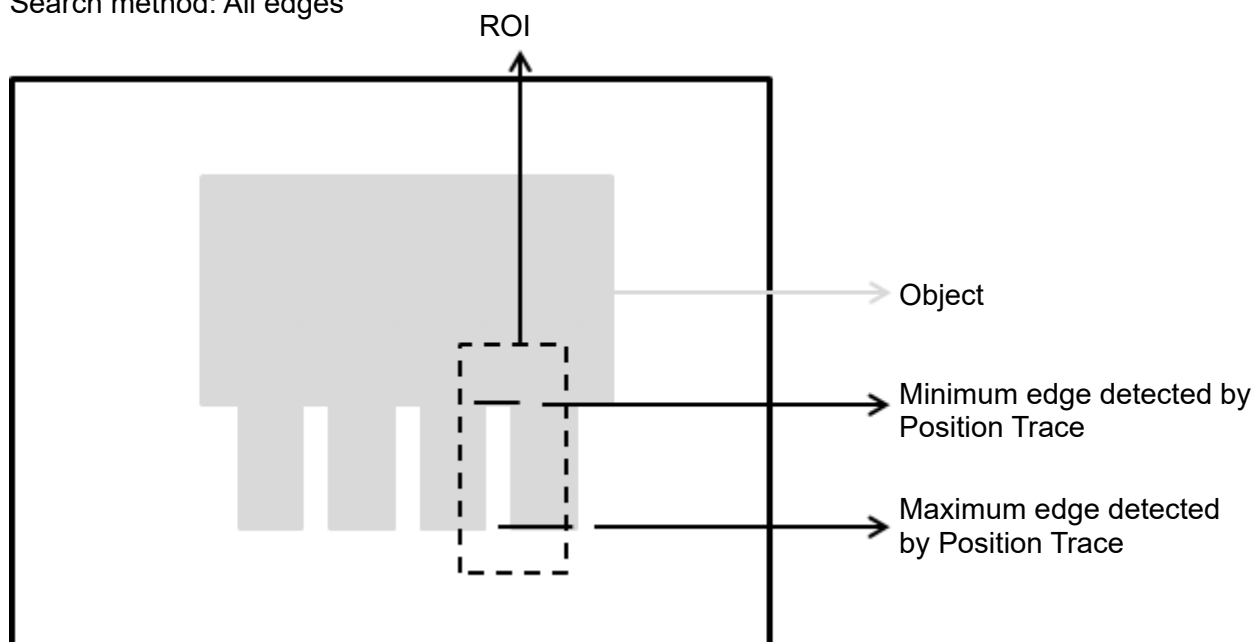
➤ When you select a Ring or Arc ROI, Position Trace calculates the furthest and the nearest edges relative to the origin (the center of the circle regressed from all positions detected on the object) and marks the two edges. This includes the two common conditions shown as follows.

Scanning direction: Outside➔Center

Search method: Bright to dark
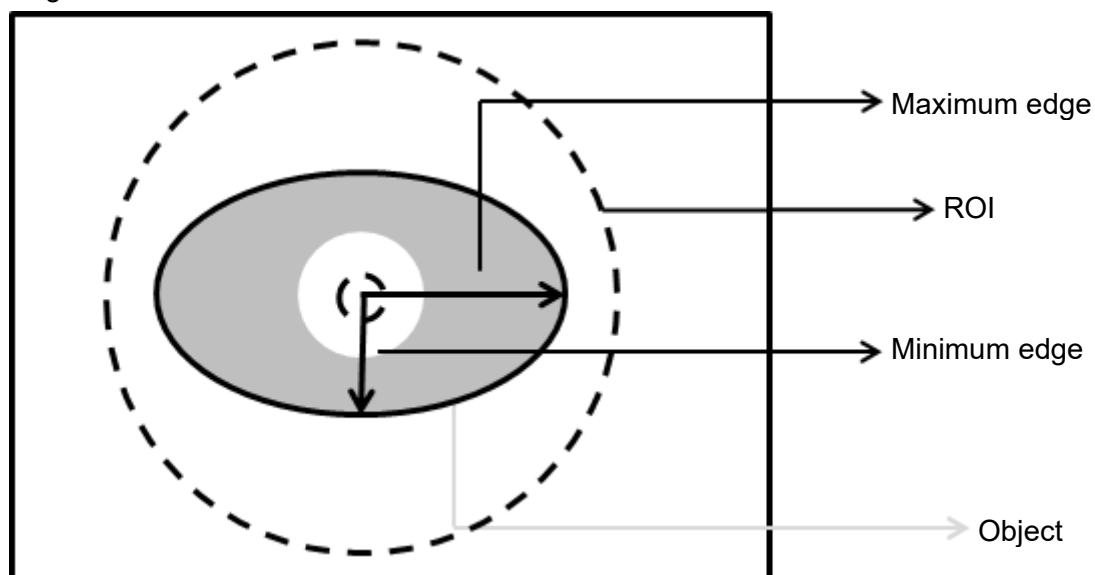
Angle: 0

Scanning direction: Inside-Out

Search method: All edges

Angle: 0
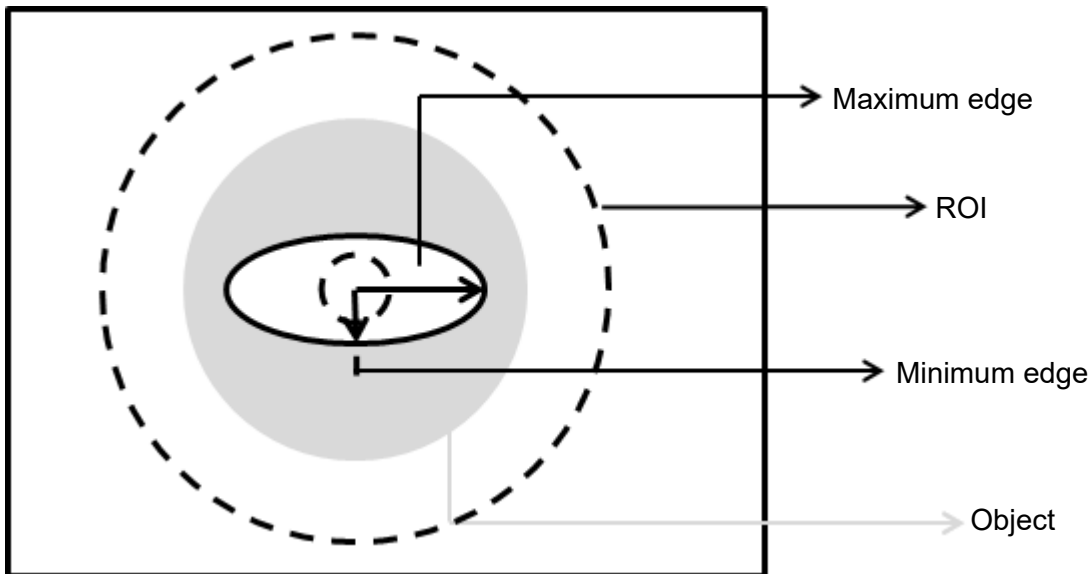
> ➤ **Procedural Results**

The Position Trace inspection tool returns the following inspection results.

➤ Number of Segments: outputs the total number of edges found by the Position Trace tool.

➤ Maximum Edge Position X: outputs the X coordinate of the maximum edge position detected in the scanned region by the Position Trace tool.

➤ Minimum Edge Position X: outputs the X coordinate of the minimum edge position detected in the scanned region by the Position Trace tool.

➤ Maximum Edge Position Y: outputs the Y coordinate of the maximum edge position detected in the scanned region by the Position Trace tool.

➤ Minimum Edge Position Y: outputs the Y coordinate of the minimum edge position detected in the scanned region by the Position Trace tool.

➤ Average Edge Position X: outputs the X coordinate of the average edge position detected in the scanned region by the Position Trace tool.

➤ Average Edge Position Y: outputs the Y coordinate of the average edge position detected in the scanned region by the Position Trace tool.

➤ Roundness: when you select Ring or Arc for the ROI, the system detects all edge positions on the object and regresses the roundness data.

➤ Circle Center Position X: when you select Ring or Arc for the ROI, the system detects all edge positions on the object and regresses the X coordinate of the center of the circle.

➤ Circle Center Position Y: when you select Ring or Arc for the ROI, the system detects all edge positions on the object and regresses the Y coordinate of the center of the circle.

➤ Circle Radius: outputs all radius values for circles fitting all edge positions found by the Position Trace tool.

➤ Maximum Vertex Pitch: outputs the widest pitch among vertexes found by the Position Trace tool.

➤ Minimum Vertex Pitch: outputs the shortest pitch among vertexes found by the Position Trace tool.

➤ Edge Position X: outputs the X coordinate of the assigned edge position selected in the parameters configured in the Position Trace tool.

➤ Edge Position Y: outputs the Y coordinate of the assigned edge position selected in the parameters configured in the Position Trace tool.

➤ Edge Distance: outputs the distance between the assigned edge position selected in the parameters configured in the Position Trace tool and the edge of the fitting line/circle.

➤ Vertex Position X: outputs the X coordinate of the assigned vertex among vertexes found by the Position Trace tool.

➤ Vertex Position Y: outputs the Y coordinate of the assigned vertex among vertexes found by the Position Trace tool.

➤ Vertex Pitch: outputs the assigned pitch data among vertexes found by the Position Trace tool.

➤ **Example**

➤ For ROIs other than Ring and Arc:

Scanning direction: Left to Right

Search method: Bright to dark

Inspection result: the coordinates of the maximum edge position is (200, 310) and the coordinates of the minimum edge position is (170, 200). The tool can identify gaps on the surface based on these data.
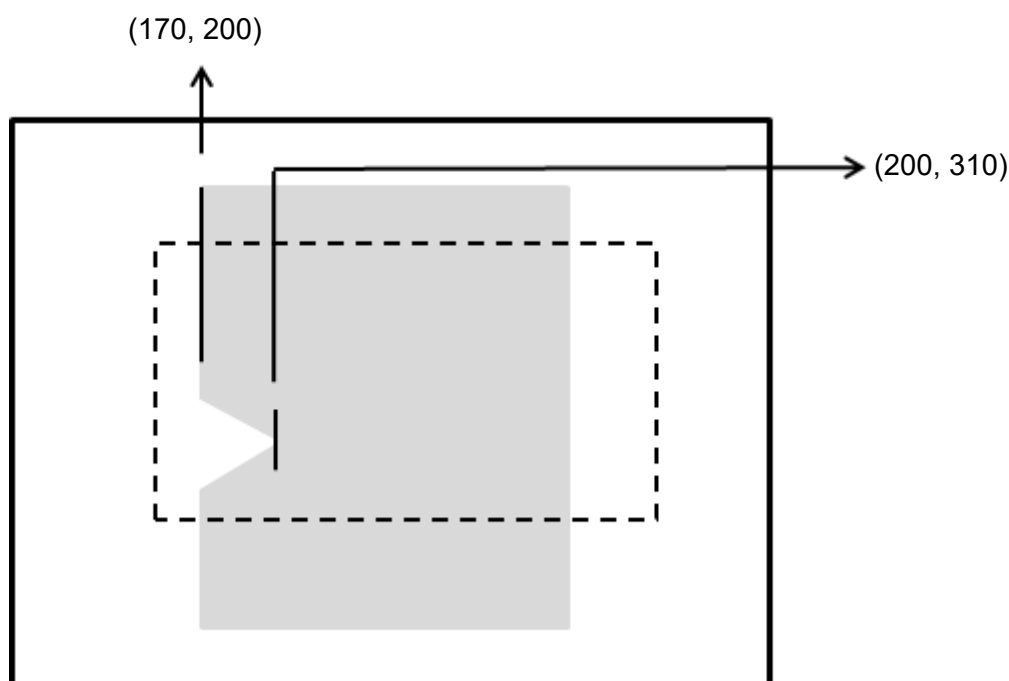
➤ For Ring and Arc ROIs:

Scanning direction: Outside→Center

Search method: Bright to dark

Angle: 0

Inspection result: Maximum radius is 160 (480-320) and minimum radius is 60 (300-240)
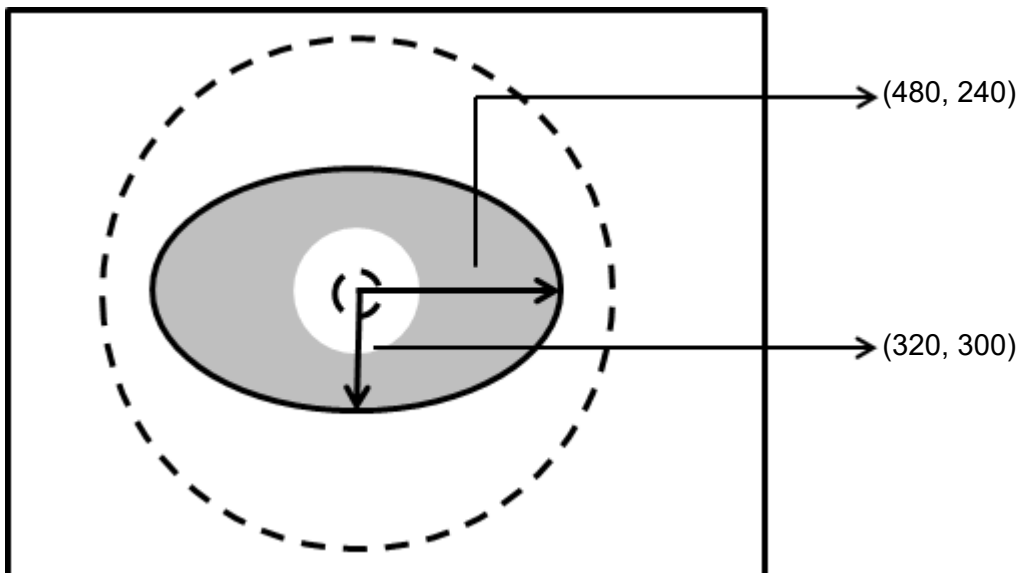
5.11.1 Position Trace inspection tool dialog box

The following picture shows the Position Trace inspection tool dialog box.

◎　**Image Select** (select Register Image)

Selects the image to be inspected from the register gallery. You can configure source cameras and inspect the image display source. When you select a different camera, the image table also switches to show the registered images acquired from that camera.

◎　**ROI** (configure detection region of interest)

Specifies the inspection regions to be used in the inspection. Optional ROI shapes include Rectangle, Circle, Arc, Ellipse, Ring, Polygon, and Rotated Rect. The Polygon ROI supports up to 16 points. In addition, there are up to eight mask functions to ignore particular segments.

◎　**Color**

Selects the color processing for images from a color camera: Color to Binary, Color to Grayscale, RGB grayscale, R Grayscale, G Grayscale, and B Grayscale.

◎　**Filter**

Specifies the image processing to apply before inspections to enhance certain aspects of the image. Preprocessing methods include Binary, Dilation, Erosion, Average, Median, Laplacian, Sobel X, Sobel Y, Sobel XY, Brightness, Contrast, Shade, and Custom (filter). You can superimpose up to six methods or create a custom method by clicking Custom.

◎　**Parameter**

Adjusts the Position Trace inspection tool conditions.

Direction

When you specify Ring or Arc for the ROI, you can then select Center→Outside or Outside→Center for the scanning direction. For other ROI shapes, you can select Left to Right, Right to Left, Upward, or Downward for the scanning direction.

Look For

Specifies the search method: All Edges, Light to Dark, and Dark to Light.

Edge Strength

Specifies the threshold for the edge search (**Look For**), and you can fine-tune it between 0–100 based on the waveform displayed in the preview. When the peak is larger than the configured edge strength, **Look For** identifies the segment as an edge. As shown in the lower left picture, the system finds two edges when Edge Strength is set to 50. As shown in the lower right diagram, the system finds only one edge that is greater than the configured Edge Strength threshold of 70.

Lower

Use the Lower (limit) to filter small noise signals on the image, and the range is between 0–255. Peaks lower than the Lower value are filtered from the waveform. As shown in the lower left diagram, some noise appears when Lower is set to 0, but the noise is filtered out when Lower is set to 20.

Smoothing

Sets the RGB Grayscale for edge calculations between 1–30. When you increase Smoothing, the slope of waveform changes, attenuating the effect caused by noise signals.

Angle

When the ROI is Ring or Arc, this sets the starting angle for the edge scan. The following pictures show starting angles of 0 and 45 degrees, respectively.

Segment Width

When you specify an ROI other than Ring or Arc, the range is between 1–128. When you specify Ring or Arc for the ROI, the range is between 0.1–45.0. Segment Width is the width of the horizontal pixel in each system scan.

Segment Offset

When you set Segment Width to 4 and Segment Offset to 1, the system horizontally offsets one pixel after completing each edge scan of a width of four pixels before proceeding to another four-pixel edge scan. The range is between 0.1–45.

Vertex Inspection

➤ **Vertex Function**

Enable Vertex Inspection.

➤ **Vertex Search Mode**

Specifies whether to search the top or bottom vertex.

➤ **Vertex Exclusivity Width**

Determines the number of vertexes to keep; a larger value corresponds to fewer vertexes kept. The range is between 0–128.

Vertex Exclusivity Width = 0   Vertex Exclusivity Width = 2
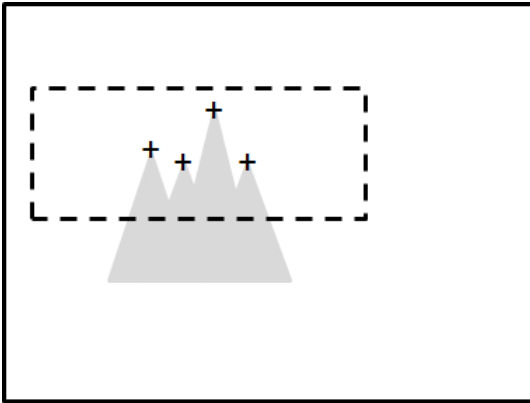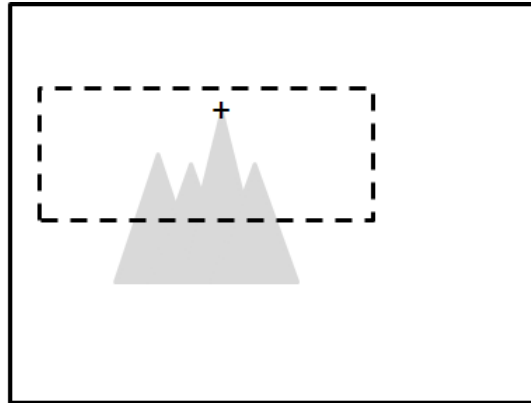
Regression Function

Specifies that the system generates a parabolic fitting curve for the detected vertexes and outputs the coordinates based on the vertex of the generated parabola.

◎   **Limit**

After you complete the configurations, you can view the inspection results using register images through **Test Mode**. You can then configure the upper and lower limits in the Limit dialog box. The following items can be configured for the Position Trace function.

➤   **Maximum Edge Position X**: specifies the upper and lower limits of the X coordinates of the maximum edge positions found by the system.

➤   **Maximum Edge Position Y**: specifies the upper and lower limits of the Y coordinates of the maximum edge positions found by the system.

➤   **Minimum Edge Position X**: specifies the upper and lower limits of the X coordinates of the minimum edge positions found by the system.

➤   **Minimum Edge Position Y**: specifies the upper and lower limits of the Y coordinates of the minimum edge positions found by the system.

➤   **Roundness**: when you enable Roundness, the system inspects the roundness of circular objects. The value specifies the upper and lower limits.

◎   **Locate**

Specifies whether the inspection region follows an inspection result by adjusting its coordinates (X, Y) and Angles (Theta). The inspection tools you can use as a reference includes Shape, Blob, Edge Position and Edge Angle. As shown in the following diagram, specific marks (such as the cross on the object) can be used for the Locate function.

ROI

Object

Locate Off   Locate On

Corrected inspection region after using Locate

Target

Manual mode and quick mode are available for this project.

➤   Manual mode: Manually click【Ref. X】、【Ref. Y】and【Ref. Angle】, separately set the source of the

   reference positioning.

➤   Quick mode: Click【⊖Ref. Nearest Shape Locate Win】, the system will directly bring in the closest

   【Shape】as the【Ref. X】、【Ref. Y】and【Ref. Angle】setting.

➤   🔲 Reference Please refer to Section 9.1 for detailed Locate configurations.

◎　**Execution**

Specifies whether to execute the inspection function in the inspection flow.

➢　**Always Execution**

Always execute the inspection function in Run mode.

➢　**Never Execution**

Never execute the inspection function in Run mode.

➢　**Reference Execution**

This test will be executed when the [Reference Detection] item meets the [OK/NG] condition.

◎　**Output Item**

◎　**Window**

Selects the output window for the total Judge result for the Position Trace tool on the designated interface.

◎　**Item**

1)　**Number of Segments (N)**: outputs the total number of edges found by the Position Trace tool.

2)　**Edge Position X (X)**: outputs the X coordinate of the assigned edge position selected in the parameters configured in the Position Trace tool.

3)　**Edge Position (Y)**: outputs the Y coordinate of the assigned edge position selected in the parameters configured in the Position Trace tool.

4)　**Edge Distance (D)**: outputs the distance between the assigned edge position selected in the parameters configured in the Position Trace and the edge of the fitting line/circle.

5)　**Maximum Edge Position X (XH)**: outputs the X coordinate of the maximum edge position detected in the scanned region by the Position Trace tool.

6)　**Minimum Edge Position X (XL)**: outputs the X coordinate of the minimum edge position detected in the scanned region by the Position Trace tool.

7)　**Average Edge Position X (XA)**: outputs the X coordinate of the average edge position detected in the scanned region by the Position Trace tool.
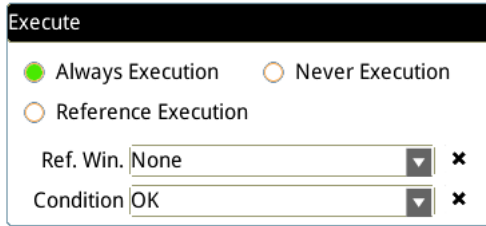
8)　**Maximum Edge Position Y (YH)**: outputs the Y coordinate of the maximum edge position detected in the scanned region by the Position Trace tool.

9)　**Minimum Edge Position Y (YL)**: outputs the Y coordinate of the minimum edge position detected in the scanned region by the Position Trace tool.

10)　**Average Edge Position Y (YA)**: outputs the Y coordinate of the average edge position detected in the scanned region by the Position Trace tool.

11)　**Maximum Edge Distance (DH)**: outputs the distance between the maximum edge position found by the Position Trace tool and the edge of the fitting line/circle.

12) **Minimum Edge Distance (DL)**: outputs the distance between the minimum edge position found by the Position Trace tool and the edge of the fitting line/circle.

13) **Average Edge Distance (DA)**: outputs the distance between the average edge position found by the Position Trace tool and the edge of the fitting line/circle.

14) **Roundness (RD)**: when you select Ring or Arc for ROI, the system detects all edge positions on the object and regresses the roundness data.

15) **Circle Center Position X (CX)**: when you select Ring or Arc for ROI, the system detects all edge positions on the object and regresses the X coordinate of the center of the circle.

16) **Circle Center Position Y (CY)**: when you select Ring or Arc for ROI, the system detects all edge positions on the object and regresses the Y coordinate of the center of the circle.

17) **Circle Radius (CRU)**: outputs all radius values for circles fitting all edge positions found by the Position Trace tool.

18) **Vertex Position X (VTX)**: outputs the X coordinate of the assigned vertex among vertexes found by the Position Trace tool.

19) **Vertex Position Y (VTY)**: outputs the Y coordinate of the assigned vertex among vertexes found by the Position Trace tool.

20) **Vertex Pitch (VP)**: outputs the assigned pitch data among vertexes found by the Position Trace tool.

21) **Maximum Vertex Pitch (VPH)**: outputs the widest pitch among vertexes found by the Position Trace tool.

22) **Minimum Vertex Pitch (VPL)**: outputs the shortest pitch among vertexes found by the Position Trace tool.

23) **Position Trace ID**: outputs the ID of the inspection tool.

24) **Maximum Edge Position X (J) (XH)**: outputs the X coordinate of the maximum edge position found by the Position Trace tool and the results judged based on the standard configured values.

25) **Minimum Edge Position X (J) (XL)**: outputs the X coordinate of the minimum edge position found by the Position Trace tool and the results judged based on the standard configured values.

26) **Maximum Edge Position Y (J) (YH)**: outputs the Y coordinate of the maximum edge position found by the Position Trace tool and the results judged based on the standard configured values.

27) **Minimum Edge Position Y (J) (YL)**: outputs the Y coordinate of the minimum edge position found by the Position Trace tool and the results judged based on the standard configured values.

28) **Roundness (J) (RD)**: outputs the roundness data regressed using the Position Trace tool and the results judged based on the standard configured values.

5.12 Width Trace

The Width Trace tool is an advanced function of the Edge Width tool and uses identical search methods. Using ROI as an example, you can configure the search range to find multiple edges through horizontal or vertical scanning. When a segment of increased contrast is detected on the image, the tool identifies the region as an ROI. You can configure various measurement methods to inspect the maximum, minimum, and average widths of the inner and outer edges of the object.

◎ **Algorithmic Processing**

➤ Width Trace Scan Methods

Selects the ROI. The ROI options provide differing edge scanning methods.

◆ The following example is for ROIs other than Ring and Arc.

Scanning direction: Horizontal

Search method: All edges

Measure method: Outside-in
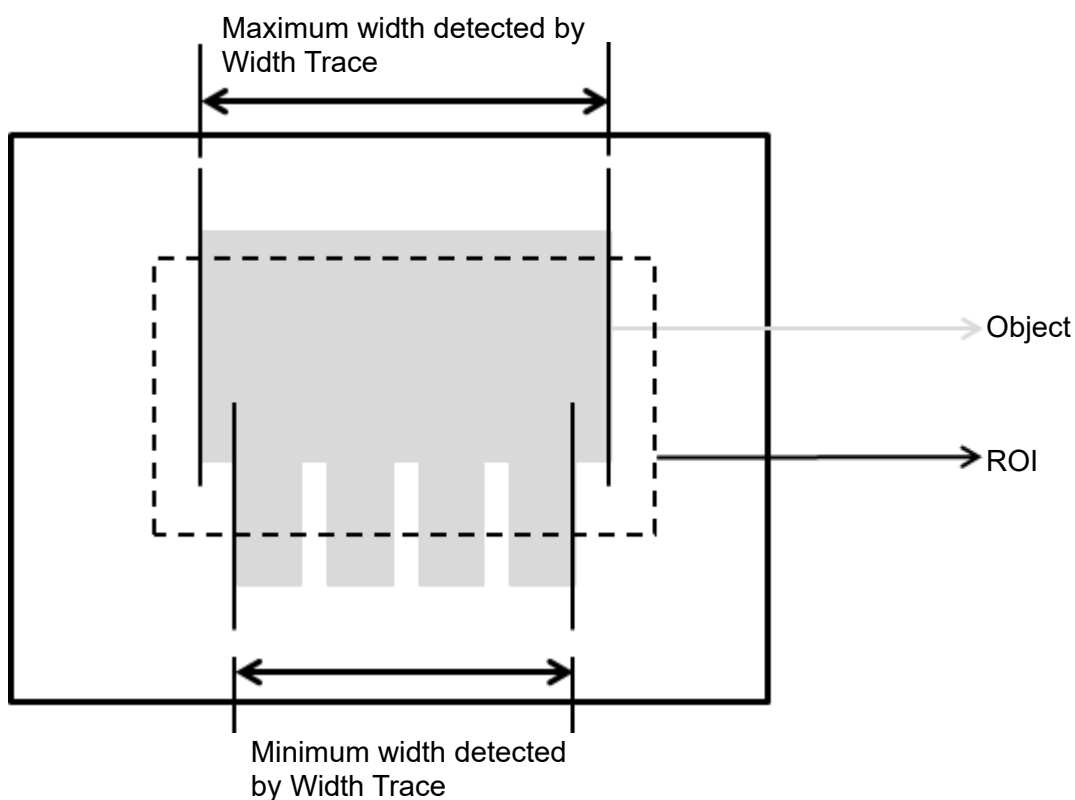
◆   The following example is for the Ring and Arc ROI.

Scanning direction: Outside→Center
Search method: All edges
Measure method: Outside-in
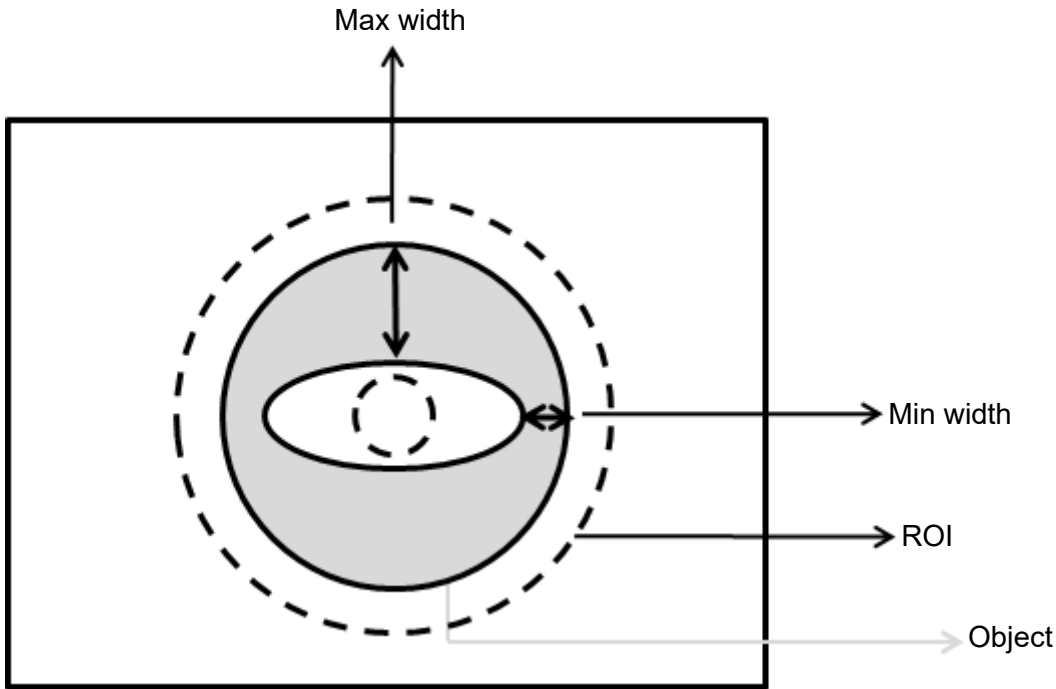
◎   **Procedural Results**

The Width Trace inspection tool returns the following inspection results.

➤   Number of Segments: outputs the total number of widths found by the Width Trace tool (unit in pixels).

➤   Maximum Edge Distance: outputs the maximum edge distance among all widths found by the Width Trace tool.

➤   Minimum Edge Distance: outputs the minimum edge distance among all widths found by the Width Trace tool.

➤   Average Edge Distance: outputs the average edge distance among all widths found by the Width Trace tool.

➤   Roundness 1: when you select Ring or Arc for the ROI, the system detects all edge positions on the inner edge of the object and 1 the Inner Circle Roundness.

➤   Inner Circle Position X: when you select Ring or Arc for the ROI, the system detects all edge positions on the inner edge of the object and regresses Inner Circle Position X.

➤   Inner Circle Position Y: when you select Ring or Arc for the ROI, the system detects all edge positions on the inner edge of the object and regresses Inner Circle Position Y.

➤   Inner Circle Radius: outputs all Inner Circle Radius values for circles fitting all edge positions found by the Width Trace tool on the inner circle.

➤   Roundness 2: when you select Ring or Arc for the ROI, the system detects all edge positions on the outer edge of the object and regresses Outer Circle Roundness.

➤ Outer Circle Position X: when you select Ring or Arc for the ROI, the system detects all edge positions on the outer edge of the object and regresses Outer Circle Position X.

➤ Outer Circle Position Y: when you select Ring or Arc for the ROI, the system detects all edge positions on the outer edge of the object and regresses Outer Circle Position Y.

➤ Outer Circle Radius: outputs all Outer Circle Radius values for circles fitting all edge positions found by the Width Trace tool on the outer circle.

◎ **Example**

◆ For ROIs other than Ring and Arc

Scanning direction: Vertical

Search method: All edges

Measure method: Outside-in

Inspection result: Maximum Width is 150 pixels, Minimum Width is 100 pixels, and Average Width is 125 pixels
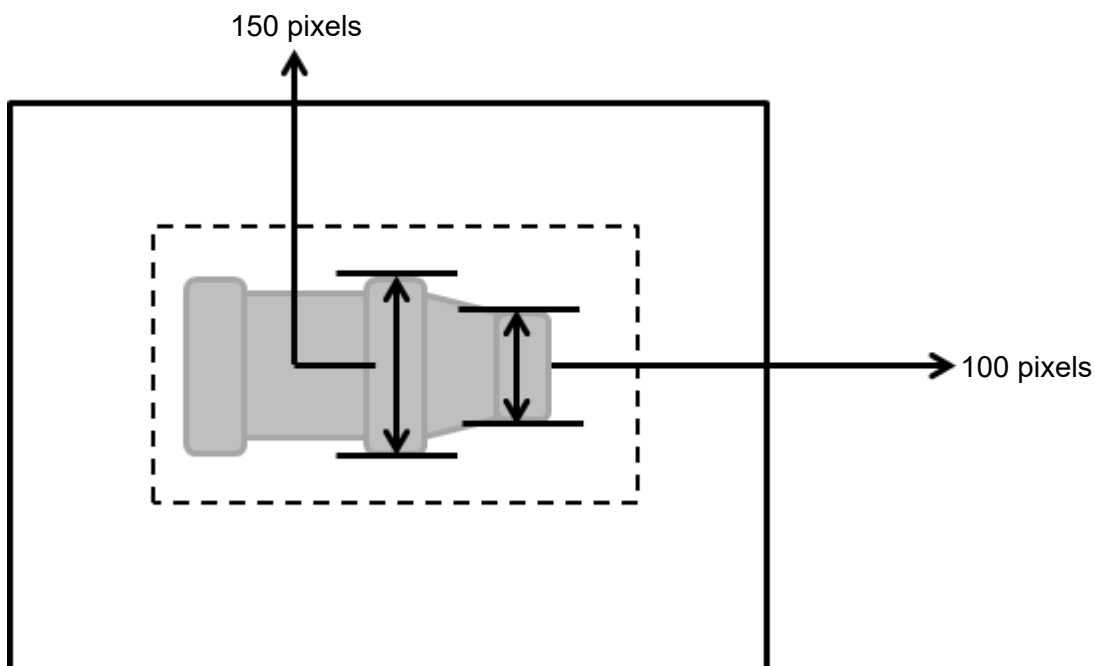
◆   For Ring and Arc ROIs

Scanning direction: Outside→Center

Search method: All edges

Measure method: Outside-in

Inspection result: Maximum Width is 100 pixels, Minimum Width is 40 pixels, and Average Width is 70 pixels
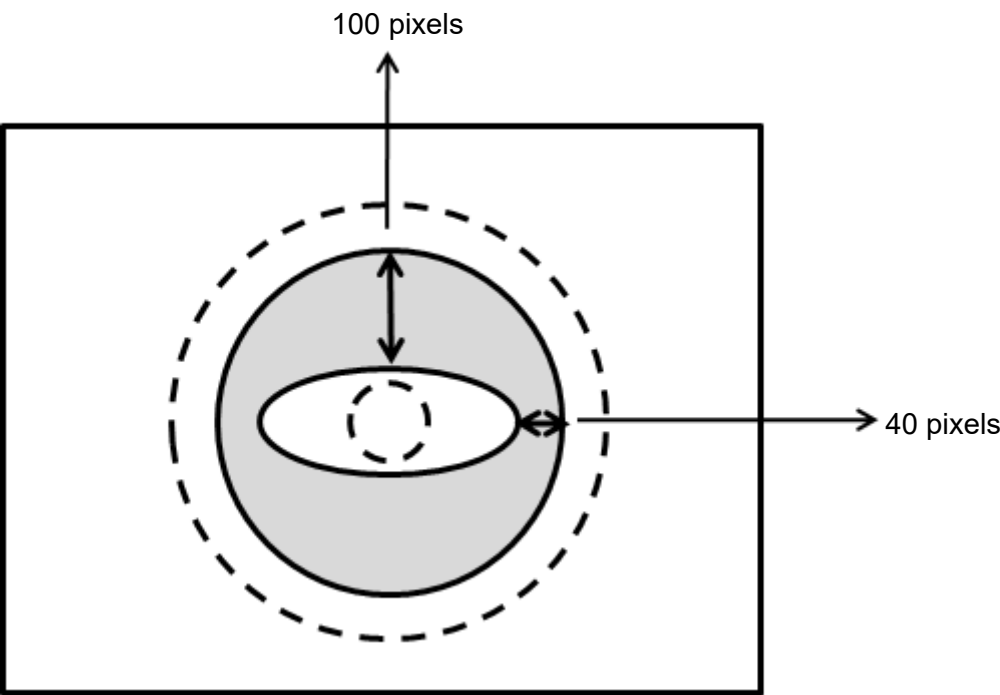
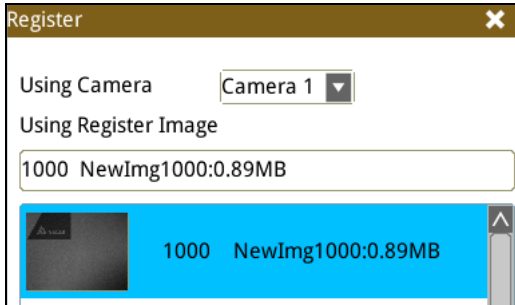## 5.12.1 Width Trace dialog box

The following picture shows the Width Trace inspection tool dialog box.

◎ **Image Select** (select Register Image)

Selects the image to be inspected from the register gallery. You can configure source cameras and inspect the image display source. When you select a different camera, the image table also switches to show the registered images acquired from that camera.

◎ **ROI** (configure detection region of interest)

Specifies the inspection regions to be used in the inspection. Optional ROI shapes include Rectangle, Circle, Arc, Ellipse, Ring, Polygon, and Rotated Rect. The Polygon ROI supports up to 16 points. In addition, there are up to eight mask functions to ignore particular segments.

◎ **Color**

Selects the color processing for images from a color camera: Color to Binary, Color to Grayscale, RGB grayscale, R Grayscale, G Grayscale, and B Grayscale.

◎ **Filter**

Specifies the image processing to apply before inspections to enhance certain aspects of the image. Preprocessing methods include Binary, Dilation, Erosion, Average, Median, Laplacian, Sobel X, Sobel Y, Sobel XY, Brightness, Contrast, Shade, and Custom (filter). You can superimpose up to six methods or create a custom method by clicking Custom.

◎ **Parameter**

Adjusts the Width Trace inspection tool conditions.

Direction
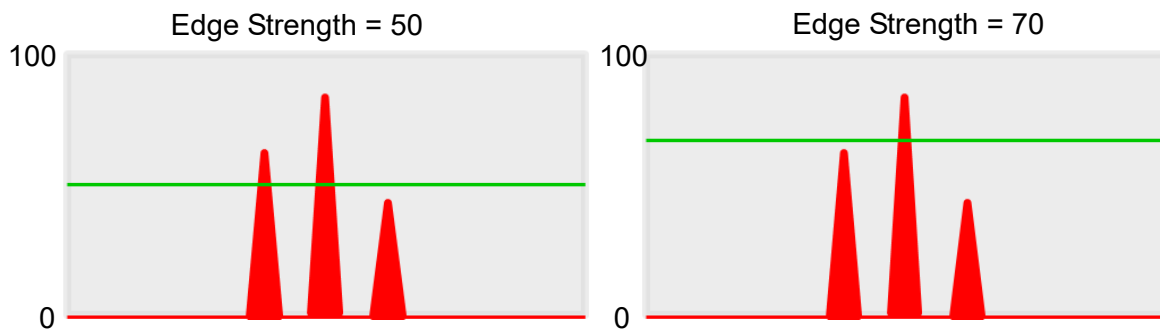
When you specify Ring or Arc for the ROI, you can select Center→Outside and Outside→Center for the scanning direction. For other ROI shapes, you can select Horizontal or Vertical for the scanning direction.

◎ **Look For**

Specifies the search method: All Edges, Light to Dark, and Dark to Light.

◎ **Measure**

Specifies the measuring method: Outside-In and Inside-Out.

Edge Strength

Specifies the threshold for the edge search (**Look For**), and you can fine-tune it between 0–100 based on the waveform displayed in the preview. When the peak is larger than the configured edge strength, **Look For** identifies the segment as an edge. As shown in the lower left picture, the system finds two edges when Edge Strength is set to 50. As shown in the lower right diagram, the system finds only one edge that is greater than the configured Edge Strength threshold of 70.
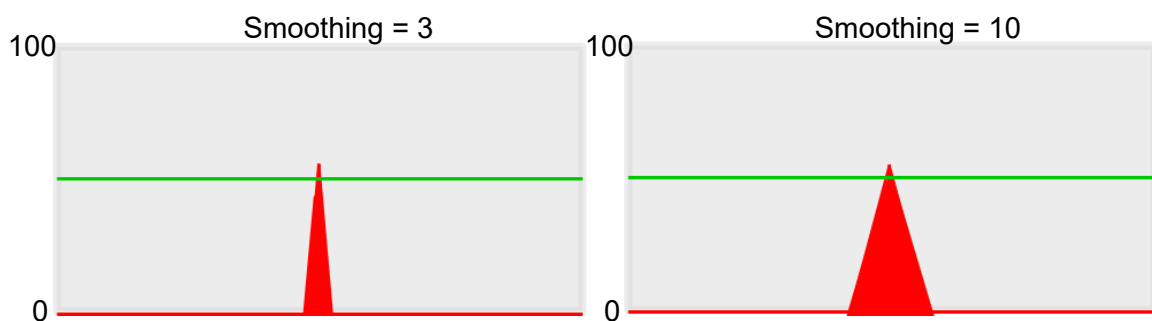

Lower

Use the Lower (limit) to filter small noise signals on the image, and the range is between 0–255. Peaks lower than the Lower value are filtered from the waveform. As shown in the lower left diagram, some noise appears when Lower is set to 0, but the noise is filtered out when Lower is set to 20.
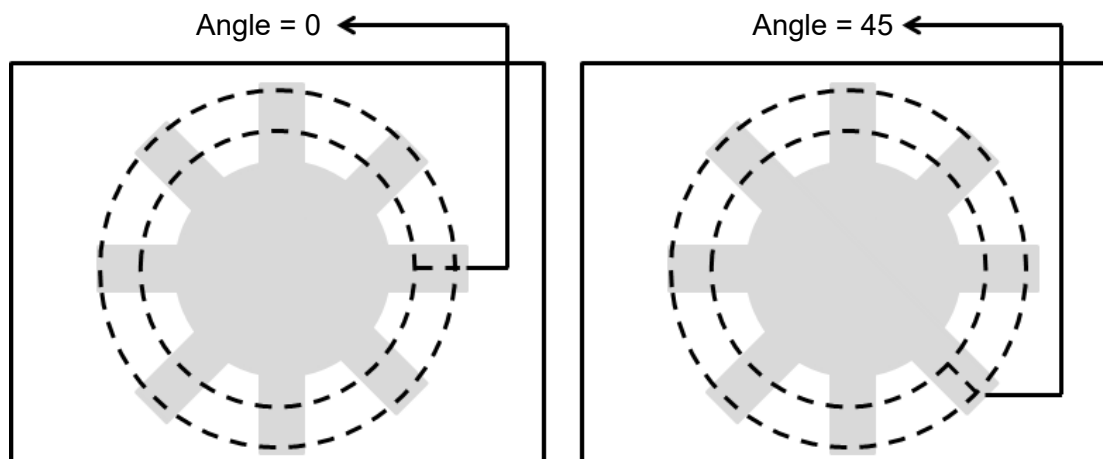

Smoothing

Sets the RGB Grayscale for edge calculations between 1–30. When you increase Smoothing, the slope of waveform changes, attenuating the effect caused by noise signals.

Angle

When the ROI is Ring or Arc, this sets the starting angle for the edge scan. The following pictures show starting angles of 0 and 45 degrees, respectively.

Segment Width

When you select an ROI other than Ring or Arc, the range is between 1–128. When you select Ring or Arc for the ROI, the range is between 0.1–45.0. Segment Width is the width of the horizontal pixel in each system scan.

Segment Offset

When you set Segment Width to 4 and Segment Offset to 1, the system horizontally offsets one pixel after completing each edge scan of a width of four pixels before proceeding to another four-pixel edge scan. The range is between 0.1–45.

Circle Check

➤ **Circle Inspect**

When you select Ring or Arc ROIs, if the object is a circle, the system constructs a fitting circle and outputs its Roundness, Inner/Outer Circle Position X, Inner/Outer Circle Position Y, and Inner/Outer Circle Radius.

➤ **Origin**

The position of the origin (0, 0) in System Setting is displayed on the upper left corner of the screen. You can enter new coordinates to move the origin to the new coordinates.

➤ **Select**

When Width Trace finds multiple widths, the system can output information for the assigned widths.
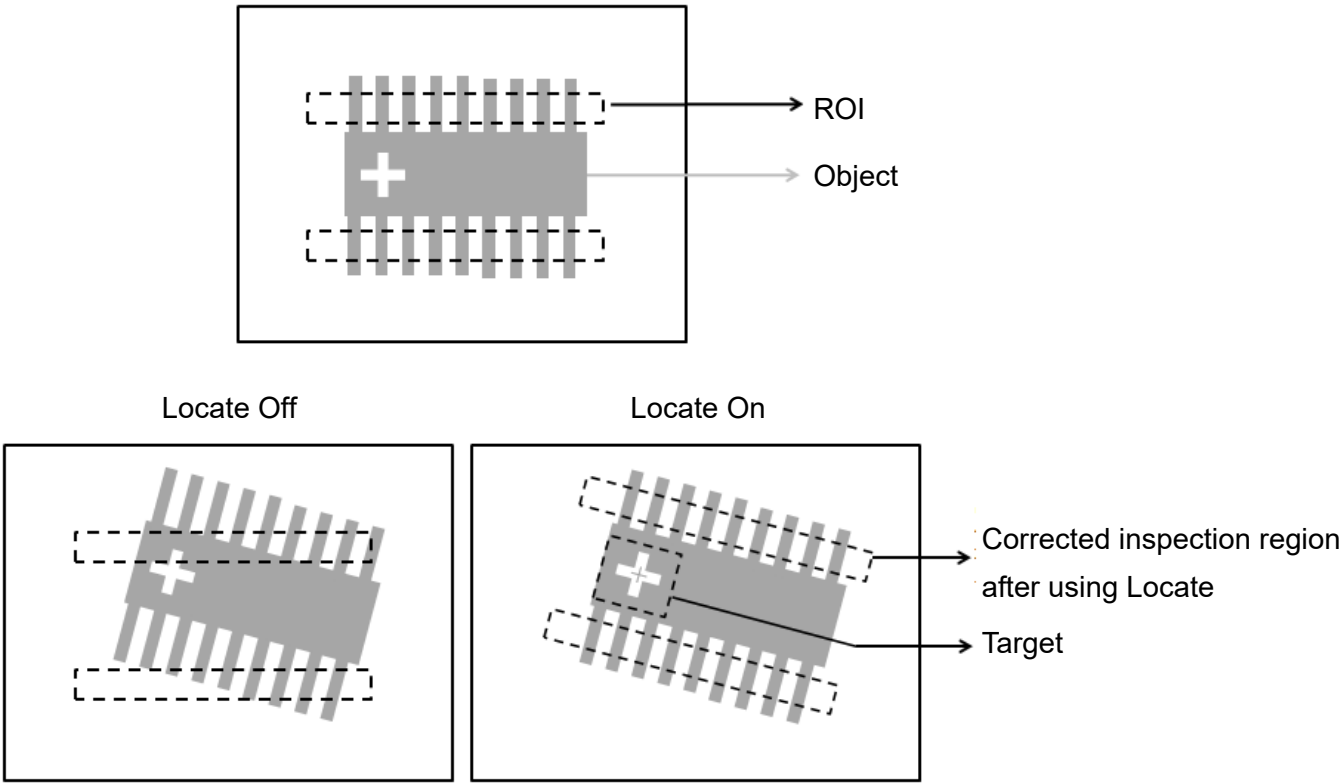
◎ **Limit**

After you complete the configurations, you can view the inspection results using register images through **Test Mode**. You can then configure the upper and lower limits in the Limit dialog box. The following items can be configured for the Width Trace tool.

➤ **Maximum Edge Distance**: specifies the upper and lower width limits identified by the tool.

➤ **Minimum Edge Distance**: specifies the upper and lower width limits identified by the tool.

➤ **Average Edge Distance**: specifies the upper and lower width limits identified by the tool.

➤ **Roundness 1**: when enabled, the system inspects the roundness of circular objects. This specifies the upper and lower limits of Inner Circle Roundness.

➤ **Roundness 2**: when enabled, the system inspects the roundness of circular objects. This specifies the upper and lower limits of Inner Circle Roundness.

◎ **Locate**

Specifies whether the inspection region follows an inspection result by adjusting its coordinates (X, Y) and Angles (Theta). The inspection tools you can use as a reference includes Shape, Blob, Edge Position and Edge Angle. As shown in the following diagram, specific marks (such as the cross on the object) can be used for the Locate function.

Manual mode and quick mode are available for this project.

Locate

☐ Ref. Nearest Shape Locate Win

Ref. X None ✖
Ref. Y None ✖
Ref. Angle None ✖

➤ Manual mode: Manually click【Ref. X】、【Ref. Y】and【Ref. Angle】, separately set the source of the

reference positioning.

➤ Quick mode: Click【☐Ref. Nearest Shape Locate Win】, the system will directly bring in the closest

【Shape】as the【Ref. X】、【Ref. Y】and【Ref. Angle】setting.

➤ 🗐 Reference Please refer to Section 9.1 for detailed Locate configurations.

◎ **Execution**

Specifies whether to execute the inspection function in the inspection flow.

Execute

🟢 Always Execution   ⚪ Never Execution
⚪ Reference Execution

Ref. Win. None ▼ ✖
Condition OK ▼ ✖

➤ **Always Execution**

Always execute the inspection function in Run mode.

➤ **Never Execution**

Never execute the inspection function in Run mode.

➤ **Reference Execution**

This test will be executed when the [Reference Detection] item meets the [OK/NG] condition.

◎ **Output Item**

◎ **Window**

Selects the total Judge result for the Width Trace tool on the designated interface.

◎ **Item**

1) **Number of Segments (N)**: outputs the total number of widths found by the Width Trace tool.

2) **Maximum Edge Distance (WH)**: outputs the maximum edge distance among all widths found by the Width Trace tool.

3) **Minimum Edge Distance (WL)**: outputs the minimum edge distance among all widths found by the Width Trace tool.

4) **Average Edge Distance (WA)**: outputs the average edge distance among all widths found by the Width Trace tool.

5) **Edge Width (W)**: outputs the designated width data of the plural widths identified by the Width Trace tool

6) **Maximum Edge Width Position X1 (HX1)**: outputs the X coordinate of the first edge of the maximum width found by the Width Trace tool.

7) **Maximum Edge Width Position Y1 (HY1)**: outputs the Y coordinate of the first edge of the maximum width found by the Width Trace tool.

8) **Maximum Edge Width Position X2 (HX2)**: outputs the X coordinate of the second edge of the maximum width found by the Width Trace tool.

9) **Maximum Edge Width Position Y2 (HY2)**: outputs the Y coordinate of the second edge of the maximum width found by the Width Trace tool.

10) **Minimum Edge Width Position X1 (LX1)**: outputs the X coordinate of the first edge of the minimum width found by the Width Trace tool.

11) **Minimum Edge Width Position Y1 (LY1)**: outputs the Y coordinate of the first edge of the minimum width found by the Width Trace tool.

12) **Minimum Edge Width Position X2 (LX2)**: outputs the X coordinate of the second edge of the minimum width found by the Width Trace tool.

13) **Minimum Edge Width Position Y2 (LY2)**: outputs the Y coordinate of the second edge of the minimum width found by the Width Trace tool.

14) **Edge Width Position X1 (XS)**: outputs the X coordinate of the first edge from the designated widths in the identified plural widths using the Width Trace tool.

15) **Edge Width Position Y1 (YS)**: outputs the Y coordinate of the first edge from the designated widths in the identified plural widths using the Width Trace tool.

16) **Edge Width Position X2 (XE)**: outputs the X coordinate of the second edge from the designated widths in the identified plural widths using the Width Trace tool.

17) **Edge Width Position Y2 (YE)**: outputs the Y coordinate of the second edge from the designated widths in the identified plural widths using the Width Trace tool.

18) **Roundness 1 (RD1)**: when you select Ring or Arc for the ROI, the system detects all edge positions on the inner edge of the object and regresses the Inner Circle Roundness.

19) **Inner Circle Position X (CX1)**: when you select Ring or Arc for the ROI, the system detects all edge positions on the inner edge of the object and regresses the Inner Circle Position X.

20) **Inner Circle Position Y (CY1)**: when you select Ring or Arc for the ROI, the system detects all edge positions on the inner edge of the object and regresses the Inner Circle Position Y.

21) **Inner Circle Radius (CR1)**: outputs all Inner Circle Radius values for circles fitting all edge positions found by the Width Trace tool on the inner circle.

22) **Roundness 2 (RD2)**: when you select Ring or Arc for the ROI, the system detects all edge positions on the outer edge of the object and regresses the Outer Circle Roundness.

23) **Outer Circle Position X (CX2)**: when you select Ring or Arc for the ROI, the system detects all edge positions on the outer edge of the object and regresses the Outer Circle Position X.

24) **Outer Circle Position Y (CY2)**: when you select Ring or Arc for the ROI, the system detects all edge positions on the outer edge of the object and regresses the Outer Circle Position Y.

25) **Outer Circle Radius (CR2)**: outputs all Outer Circle Radius values for circles fitting all edge positions found by the Width Trace tool on the outer circle.

26) **Width Trace ID**: outputs the ID of the inspection tool.

27) **Maximum Edge Distance (J) (WH)**: outputs the maximum edge distance determined (Judge result) among all widths found by the Width Trace tool.

28) **Minimum Edge Distance (J) (WL)**: outputs the minimum edge distance determined (Judge result) among all widths found by the Width Trace tool.

29) **Average Edge Distance (J) (WA)**: outputs the average edge distance determined (Judge result) among all widths found by the Width Trace tool.

30) **Roundness 1 (J) (RD1)**: outputs the Inner Circle Roundness data regressed using the Width Trace tool and the results judged based on the standard configured values.

31) **Roundness 2 (J) (RD2)**: outputs the Outer Circle Roundness data regressed using the Width Trace tool and the results judged based on the standard configured values.

5.13 Bar Code

The Bar Code inspection tool reads 1D bar codes by searching for valid 1D bar codes in the ROI. It then decodes and outputs the result. This tool supports Code 39, Code 93, Code 128, I25, EAN8, UPCE, ISBN 10, UPCA, EAN13, ISBN 13, and Delta's custom DAH Code.

◎ **Algorithmic Processing**

➤ Bar Code Scanning Methods

The Bar Code tool supports only one type of ROI: Rectangular.

Type: Auto Detect

123456789

ROI

Bar code to be inspected
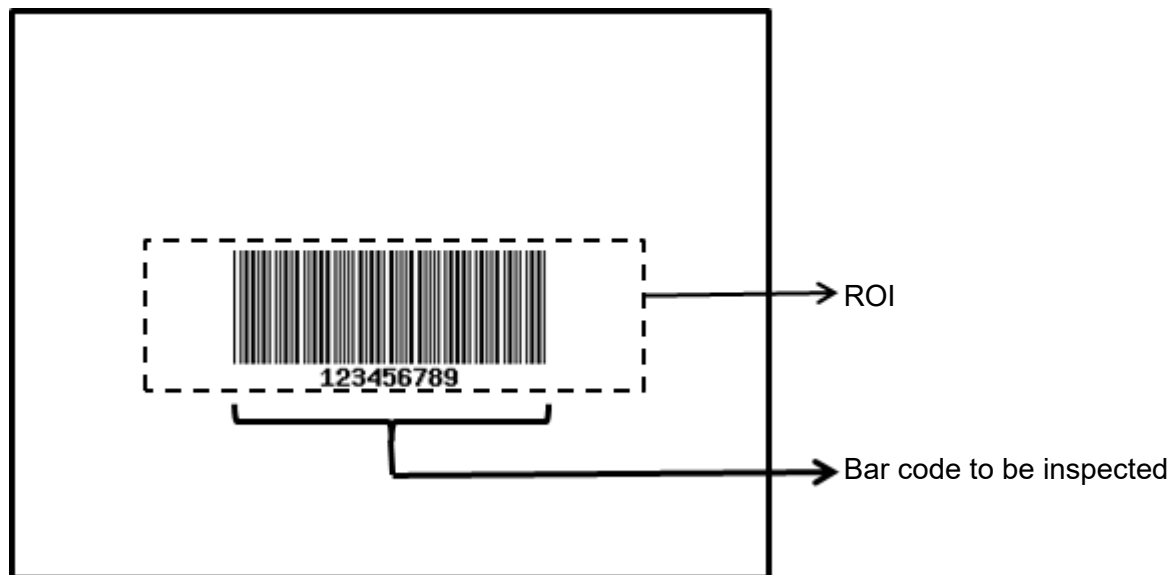
◎ **Procedural Results**

The Bar Code tool returns the following inspection results.

➤ Type: after completing inspections, outputs the type ID to this field. The following table lists the type IDs.

Serial No.	Barcode Type
0	No barcode
1	CODE39
2	CODE93
3	CODE128
4	I25
5	EAN8
6	UPCE
7	ISBN10
8	UPCA
9	EAN13
10	ISBN13
11	DAH CODE

◎ **Example**

Select the bar code to be inspected using the Rectangular ROI and the tool displays the inspection result above the bar code.

Type: Auto Detect
Inspection result: 123456789
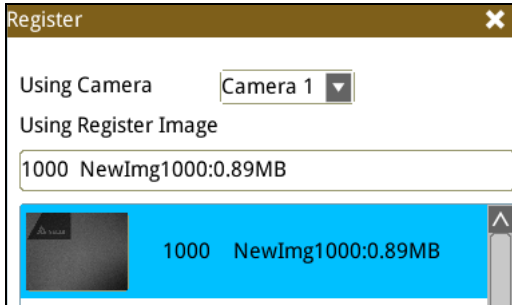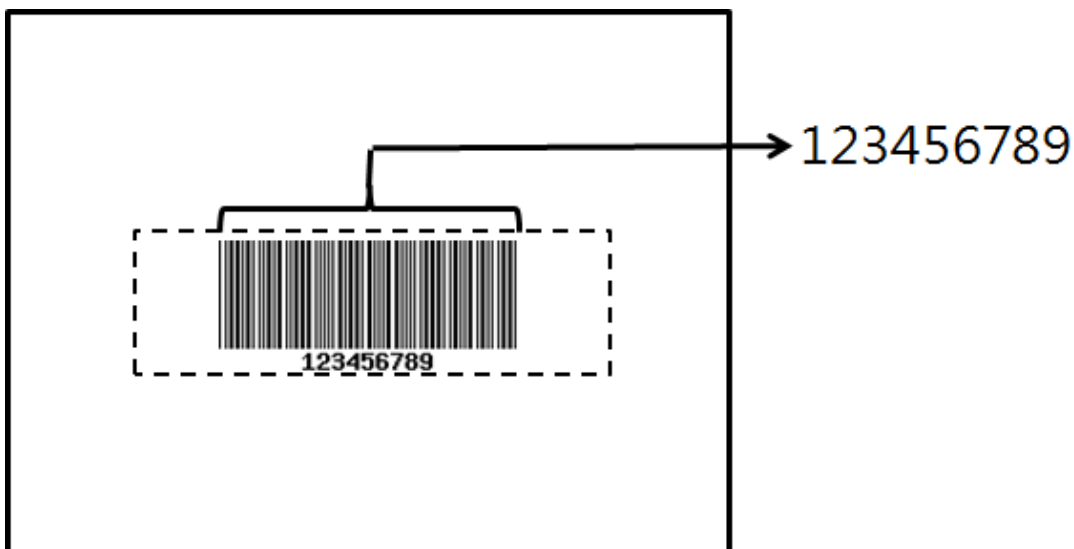
5.13.1 Bar Code dialog box

The following picture shows the Bar Code inspection tool dialog box.

◎ **Image Select** (select Register Image)

Selects the image to be inspected from the register gallery. You can configure source cameras and inspect the image display source. When you select a different camera, the image table also switches to show the registered images acquired from that camera.

◎ **ROI** (configure detection region of interest)

Specifies the inspection regions to be used in the inspection. Optional ROI shapes include Rectangle, Circle, Arc, Ellipse, Ring, Polygon, and Rotated Rect. The Polygon ROI supports up to 16 points. In addition, there are up to eight mask functions to ignore particular segments.

◎ **Color**

Selects the color processing for images from a color camera: Color to Binary, Color to Grayscale, RGB grayscale, R Grayscale, G Grayscale, and B Grayscale.

◎ **Filter**

Specifies the image processing to apply before inspections to enhance certain aspects of the image. Preprocessing methods include Binary, Dilation, Erosion, Average, Median, Laplacian, Sobel X, Sobel Y, Sobel XY, Brightness, Contrast, Shade, and Custom (filter). You can superimpose up to six methods or create a custom method by clicking Custom.

◎ **Parameter**

Adjusts the Bar Code inspection tool conditions.

Type

Specifies the type of Bar Code to read. Options include Code 39, Code 93, Code 128, I25, EAN8, UPCE, ISBN 10, UPCA, EAN13, ISBN 13, and Delta's custom DAH Code. You can also select Auto Detect for automatic bar code type determination.

Origin

The position of the origin (0, 0) in System Setting is displayed on the upper left corner of the screen. You can enter new coordinates to move the origin to the new coordinates.

Restrictions

After acquiring inspection results, you can view the inspection results and configure the correct bar code contents to determine whether the result qualifies.

◎ **Locate**

Specifies whether the inspection region follows an inspection result by adjusting its coordinates (X, Y) and Angles (Theta). The inspection tools you can use as a reference includes Shape, Blob, Edge Position and Edge Angle. As shown in the following diagram, specific marks (such as the cross on the object) can be used for the Locate function.

Manual mode and quick mode are available for this project.

```
Locate
  ⊖ Ref. Nearest Shape Locate Win
      Ref. X  None                        ✖
      Ref. Y  None                        ✖
   Ref. Angle  None                       ✖
```

➤ Manual mode: Manually click【Ref. X】、【Ref. Y】and【Ref. Angle】, separately set the source of the

reference positioning.

➤ Quick mode: Click【⊖Ref. Nearest Shape Locate Win】, the system will directly bring in the closest

【Shape】as the【Ref. X】、【Ref. Y】and【Ref. Angle】setting.

➤ 　Reference　Please refer to Section 9.1 for detailed Locate configurations.

◎ **Execution**

Specifies whether to execute the inspection function in the inspection flow.

```
Execute
  ● Always Execution      ○ Never Execution
  ○ Reference Execution
    Ref. Win.  None              ▼   ✖
    Condition  OK                ▼   ✖
```

➤ **Always Execution**

Always execute the inspection function in Run mode.

➤ **Never Execution**

Never execute the inspection function in Run mode.

➤ **Reference Execution**

This test will be executed when the [Reference Detection] item meets the [OK/NG] condition.

◎ **Output Item**

➤ **Window**

Selects the output window for the total Judge result for the Bar Code inspection tool on the designated

interface.

➤ **Item**

1) **Barcode Type**: outputs the type ID (Serial No.) of the 1D bar code found. The following table lists the type IDs.

Serial No.	Barcode Type
0	No barcode
1	CODE39
2	CODE93
3	CODE128
4	I25
5	EAN8
6	UPCE
7	ISBN10
8	UPCA
9	EAN13
10	ISBN13
11	DAH CODE

2) **Barcode Character**: outputs the designated character contents from a string.

3) **Barcode Character Count**: outputs the number of characters from the bar code.

4) **Bar Code.ID**: outputs the ID of the inspection tool.

5) **String Content**: outputs the content of strings from the bar code.

6) **String Content (J)**: determines whether the bar code content found is consistent with the configuration and outputs OK when the contents are identical.

5.14 2D Bar Code

The 2D Bar Code tool reads two-dimensional bar codes by searching for valid 2D bar codes in the ROI, decoding the bar code upon detection, and outputting the result. This tool supports QR Code and Data Matrix.

◎ **Algorithmic Processing**

➢ 2D Bar Code Scanning Methods

The 2D Bar Code tool supports only one type of ROI: Rectangular.

Type: Auto Detect
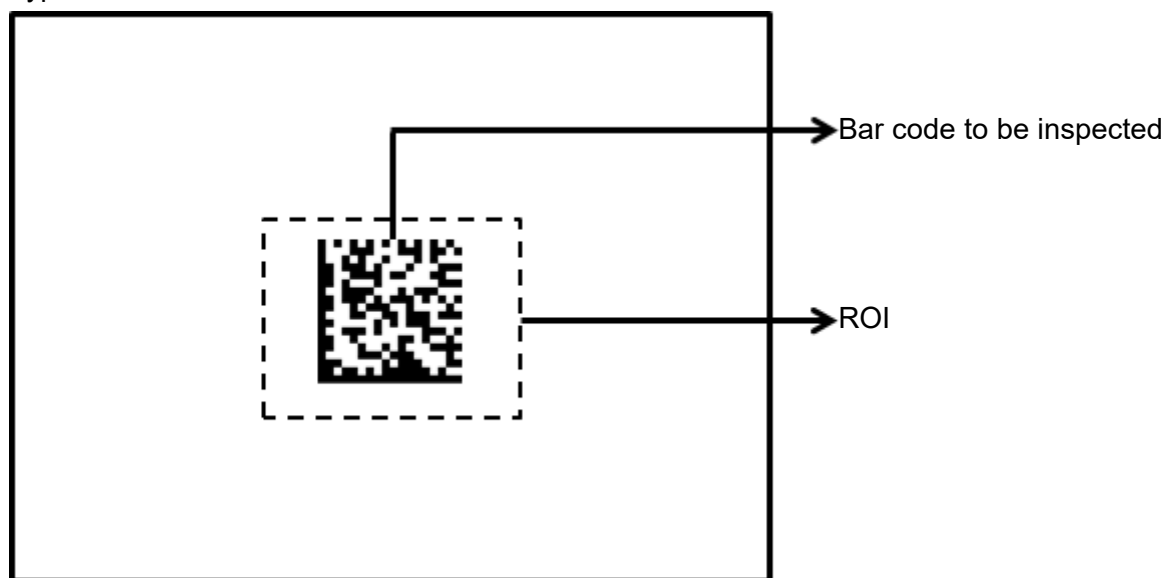
◎ **Procedural Results**

The 2D Bar Code tool returns the following inspection results.

➢ Type: outputs the type ID (Serial No.) of the 2D bar code found. The following table lists the type IDs.

Serial No.	Barcode Type
0	No barcode
1	QR CODE
2	DATA MATRIX

◎ **Example**

Select the bar code to be inspected using the Rectangular ROI and the 2D Bar Code tool displays the inspection result above the bar code.

Type: Auto Detect

Inspection result: Delta Electronics
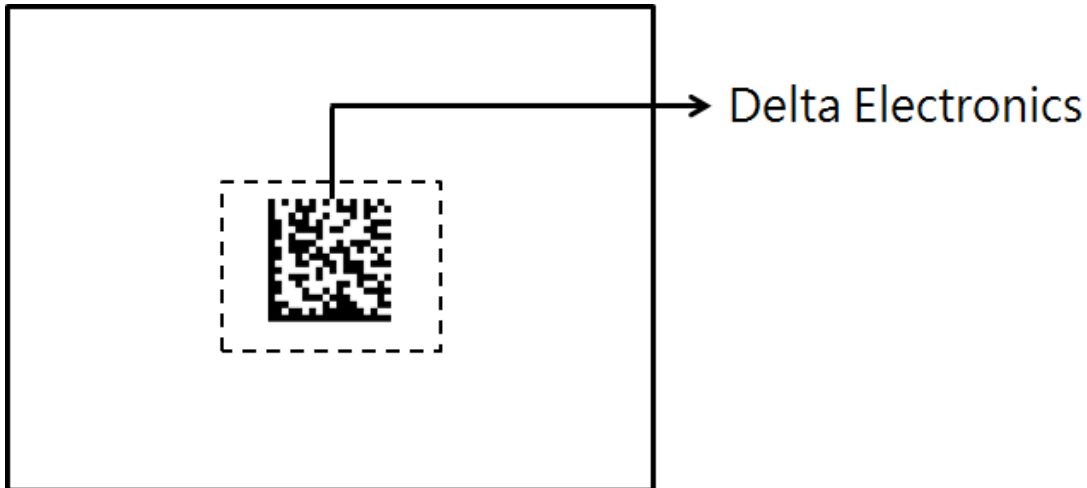
5.14.1 2D Bar Code dialog box

The following picture shows the 2D Bar Code inspection tool dialog box.

◎ **Image Select** (select Register Image)

Selects the image to be inspected from the register gallery. You can configure source cameras and inspect the image display source. When you select a different camera, the image table also switches to show the registered images acquired from that camera.

◎ **ROI** (configure detection region of interest)

Specifies the inspection regions to be used in the inspection. Optional ROI shapes include Rectangle, Circle, Arc, Ellipse, Ring, Polygon, and Rotated Rect. The Polygon ROI supports up to 16 points. In addition, there are up to eight mask functions to ignore particular segments.

◎ **Color**

Selects the color processing for images from a color camera: Color to Binary, Color to Grayscale, RGB grayscale, R Grayscale, G Grayscale, and B Grayscale.

◎ **Filter**

Specifies the image processing to apply before inspections to enhance certain aspects of the image. Preprocessing methods include Binary, Dilation, Erosion, Average, Median, Laplacian, Sobel X, Sobel Y, Sobel XY, Brightness, Contrast, Shade, and Custom (filter). You can superimpose up to six methods or create a custom method by clicking Custom.

◎ **Parameter**

Adjusts the 2D Bar Code inspection tool conditions.

Type

Specifies the type of 2D Bar Code to read. Options include QR Code and Data Matrix. You can also select Auto Detect for automatic bar code type determination.

Origin

The position of the origin (0, 0) in System Setting is displayed on the upper left corner of the screen. You can enter new coordinates to move the origin to the new coordinates.

➤ **Restrictions**

After acquiring inspection results, you can view the inspection results and configure the correct bar code contents to determine whether the result qualifies.

◎ **Locate**

Specifies whether the inspection region follows an inspection result by adjusting its coordinates (X, Y) and Angles (Theta). The inspection tools you can use as a reference includes Shape, Blob, Edge Position and Edge Angle. As shown in the following diagram, specific marks (such as the cross on the object) can be used for the Locate function.

ROI

Object

Locate Off   Locate On

Corrected inspection region after using Locate

Target

Manual mode and quick mode are available for this project.

➤ Manual mode: Manually click【Ref. X】、【Ref. Y】and【Ref. Angle】, separately set the source of the reference positioning.

➤ Quick mode: Click【⊖Ref. Nearest Shape Locate Win】, the system will directly bring in the closest 【Shape】as the【Ref. X】、【Ref. Y】and【Ref. Angle】setting.

➤ 📖 Reference Please refer to Section 9.1 for detailed Locate configurations.

◎ **Execution**

Specifies whether to execute the inspection function in the inspection flow.

Execute
- ● Always Execution ○ Never Execution
- ○ Reference Execution
- Ref. Win. None ▼ ✖
- Condition OK ▼ ✖

➤ **Always Execution**

Always execute the inspection function in Run mode.

➤ **Never Execution**

Never execute the inspection function in Run mode.

➤ **Reference Execution**

This test will be executed when the [Reference Detection] item meets the [OK/NG] condition.

◎ **Output Item**

➤ **Window**

Selects the output window for the total Judge result for the 2D Bar Code inspection tool on the designated interface.

2) Item

1) **Barcode Type**: outputs the type ID (Serial No.) of the 2D bar code found. The following table lists the type IDs.

Serial No.	Barcode Type
0	No barcode
1	QR CODE
2	DATA MATRIX

2) **Barcode Character**: outputs the designated character contents from a string.

3) **Barcode Character Count**: outputs the number of characters from the barcode.

4) **2D Bar Code. ID**: outputs the ID of the inspection tool.

5) **String Content**: outputs the content of strings from the barcode.

6) **String Content (J)**: determines whether the bar code content found is consistent with the configuration and outputs OK when the contents are identical.

5.15 OCV

The OCV tool uses Optical Character Verification to compare characters and search the ROI using font outlines to detect characters. Each character is then automatically or manually divided and added to the dictionary. All subsequent objects in the ROI that are potentially characters are compared to the characters in the dictionary. The tool then recognizes characters matching the characters in the dictionary when there is a high degree of similarity.

A character inspection window can only recognize a line of characters. If there are multiple lines of characters that need to be recognized, multiple character inspection windows need to be added.

➢ **Algorithmic Processing**

◎ OCV Scanning Methods

The OCV tool supports only one type of ROI: Rectangular.

Word color: Black object

Word direction: From left to right
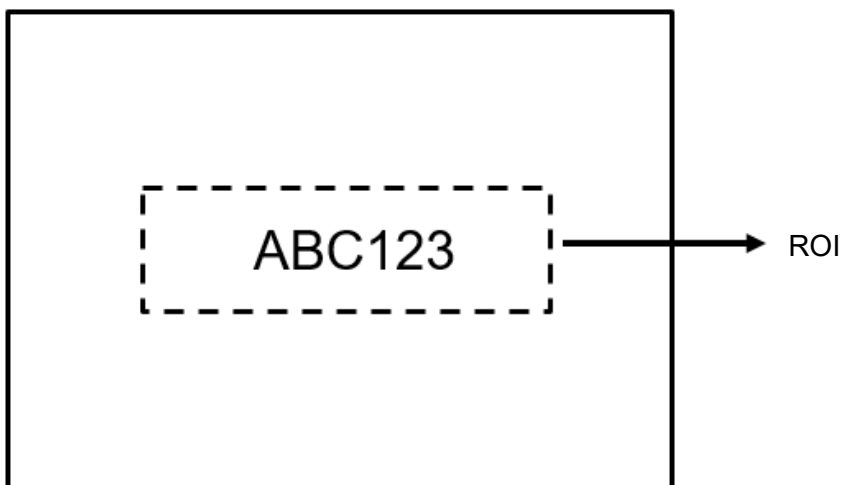
Word color: White object

Word direction: From left to right

◎ **Procedural Results**

The OCV tool returns the following inspection results.

➤ Single character result: the content of the specified character.

➤ Number of characters: The number of characters found and recognized by the OCV in the ROI.

➤ String content: all the string content of the identification result.

➤ Maximum X: outputs the largest X coordinate in all characters found by the OCV in the strings.

➤ Maximum Y: outputs the largest Y coordinate in all characters found by the OCV in the strings.

➤ Minimum X: outputs the smallest X coordinate in all characters found by the OCV in the strings.

➤ Minimum Y: outputs the smallest Y coordinate in all characters found by the OCV in the strings.

➤ Tilt angle: The tilt angle of the character. (Displayed when [Character Tilt Correction] is checked)

➤ Maximum Similarity: outputs the value of the highest degree of character similarity among all characters found by the OCV in the strings.

➤ Minimum Similarity: outputs the value of the lowest degree of character similarity among all characters found by the OCV in the strings.

➤ Single character similarity: Specify the character similarity degree.
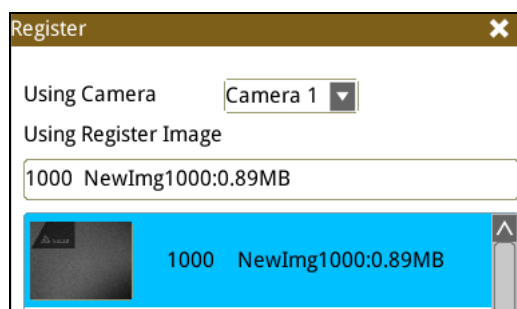
5.15.1 OCV Dialog Box

The following picture shows the OCV inspection tool dialog box.
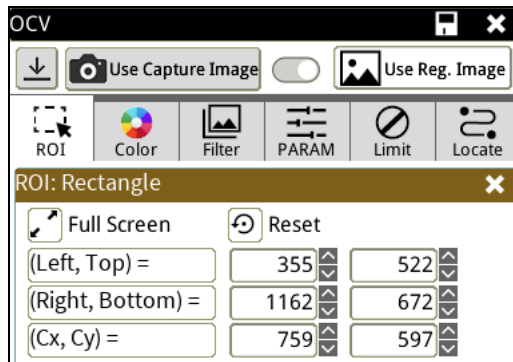
1)   Image Select (select Register Image)

Selects the image to be inspected from the register gallery. You can configure source cameras and inspect the image display source. When you select a different camera, the image table also switches to show the registered images acquired from that camera.

Click the ![icon] first to open the currently saved registration map and select it as a reference for subsequent settings.
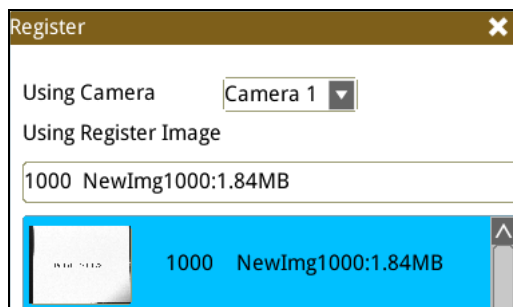
2)   ROI (configure detection region of interest)

Specifies the ROI. The only ROI available for OCV is Rectangle. Up to 8 mask functions are also provided for ignoring unwanted segments.

3)   Color Condition

Specifies the color processing for images from a color camera: Color to Binary, Color to Grayscale, RGB grayscale, R Grayscale, G Grayscale, and B Grayscale.

4)   Preprocess

Specifies the image processing to apply before inspections to enhance certain aspects of the image. Preprocessing methods include Binary, Dilation, Erosion, Average, Median, Laplacian, Sobel X, Sobel Y, Sobel XY, Brightness, Contrast, Shade, and Custom (filter). You can superimpose up to six methods or create a custom method by clicking **Custom**.

5) Parameters

Adjusts the OCV inspection tool conditions.

6) Restrictions

After completing configurations, inspection results using register images can be obtained through Test Mode. Upper and lower limits can also be configured on the Limit page.

7) Locate

When this function is required to perform position and angle compensations along with the assigned coordinates, the specific locating tool can be selected on this page to achieve the "follow" effect.

➤ **Execute**

The option can be selected on this page to execute the inspection tool.

◎ **Image Select** (select Register Image)

In this item, source cameras can be configured and image display source can be inspected. When selecting a different camera, the image table below will also switch to the register image acquired from that camera.

◎ **ROI** (configure detection region of interest)

Rectangle is the only type of ROI available. Up to 8 mask functions are also provided for ignoring unwanted segments.

◎ **Color Condition**

Specifies the color processing for images from a color camera: Color to Binary, Color to Grayscale, RGB grayscale, R Grayscale, G Grayscale, and B Grayscale.

◎ **Preprocess**

Specifies the image processing to apply before inspections to enhance certain aspects of the image. Preprocessing methods include Binary, Dilation, Erosion, Average, Median, Laplacian, Sobel X, Sobel Y, Sobel XY, Difference, Custom (filter), Contrast, Shade and Brightness. You can superimpose up to six methods or create a custom method by clicking **Custom**.

◎ **Parameters (General)**

1) Word Color

   Select the word color to be inspected. The grayscale image processed by [Color]/ [Filter] will be selected in two states: [black object] or [white object].

2) Word Direction

   Four character search directions are supported, including [Left to Right], [Right to Left], [Up to Down], and [Down to Up]. When the direction is different, the output order of the character result is also different.

3) Rotate Adjust

   When disabled, only allow the string to tilt +/-10 degrees, after checking, you can search for a larger tilt angle, but the search time will be longer.

4) Tilt Correction

   Check it when there are italics to increase the stability of recognition.

5) Aspect Ratio

   Generally, the value is preset at 0.8 for standard thin and long fonts. However, when there is a W or M wide font, the aspect ratio value should be set a bit larger, so that the system will not divide the characters into 2 characters.

◎ The aspect ratio in the figure below is 0.8. At this time, the W character is wider, so it is divided into 4 Vs.
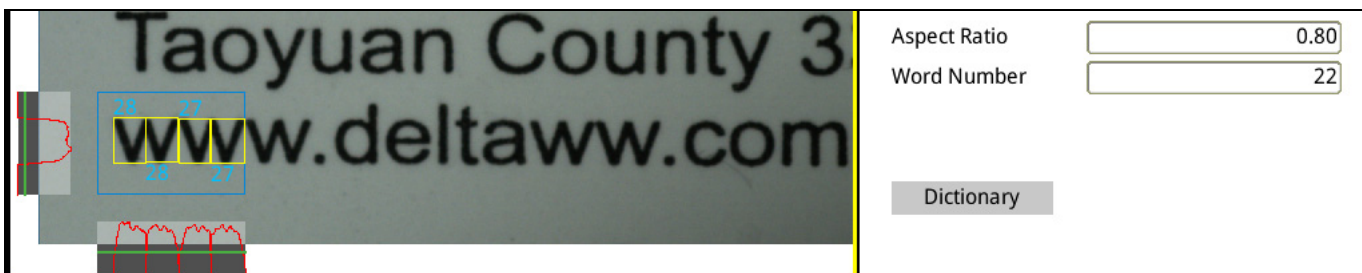
◎ The aspect ratio in the figure below is 1.5. At this time, the W character is divided correctly, so it is divided into 2 Ws.
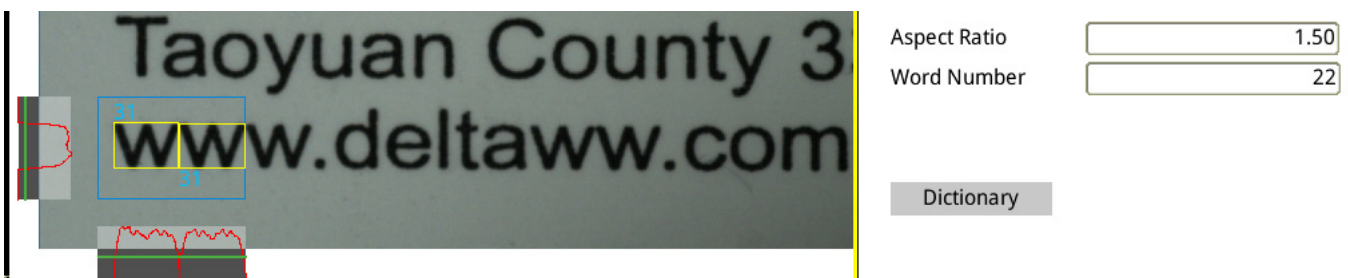
6) Word Number

Set the number of characters to search in the ROI. Only this number of characters will be recognized during the setting and RUN inspection. (Maximum 60 characters)

Word Direction	Left->Right	▼
Rotate Adjust	☐ Enable	
Tilt Correction	☐ Enable	
Aspect Ratio	0.80	
Word Number	5	
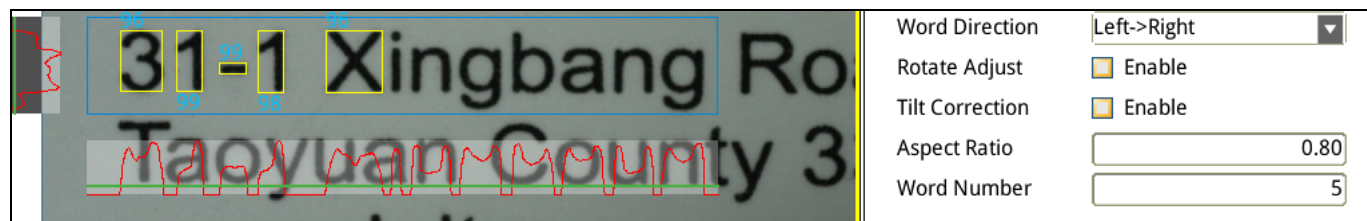
7) Dictionary

7-1) Click the [Dictionary] to enter the setting.

The dictionary is stored in the internal memory, there are a total of 10 characters #0 ~ #9. Select the number of the charater to be registered and run in [Dictionary Index].
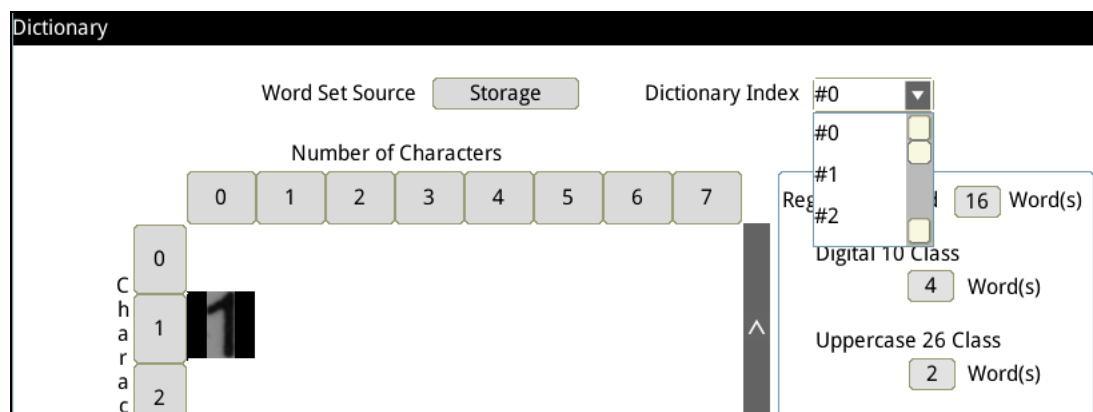
7-2) A dictionary can register 200 characters. Including [Digital], [Uppercase], [Lowercase], [Symbol], almost all visible characters in the keyboard can be registered.

After clicking [Registering], an input box will pop up, allowing continuous input of multiple characters.
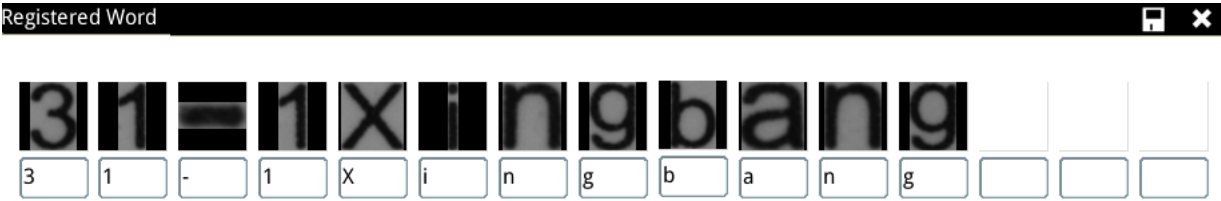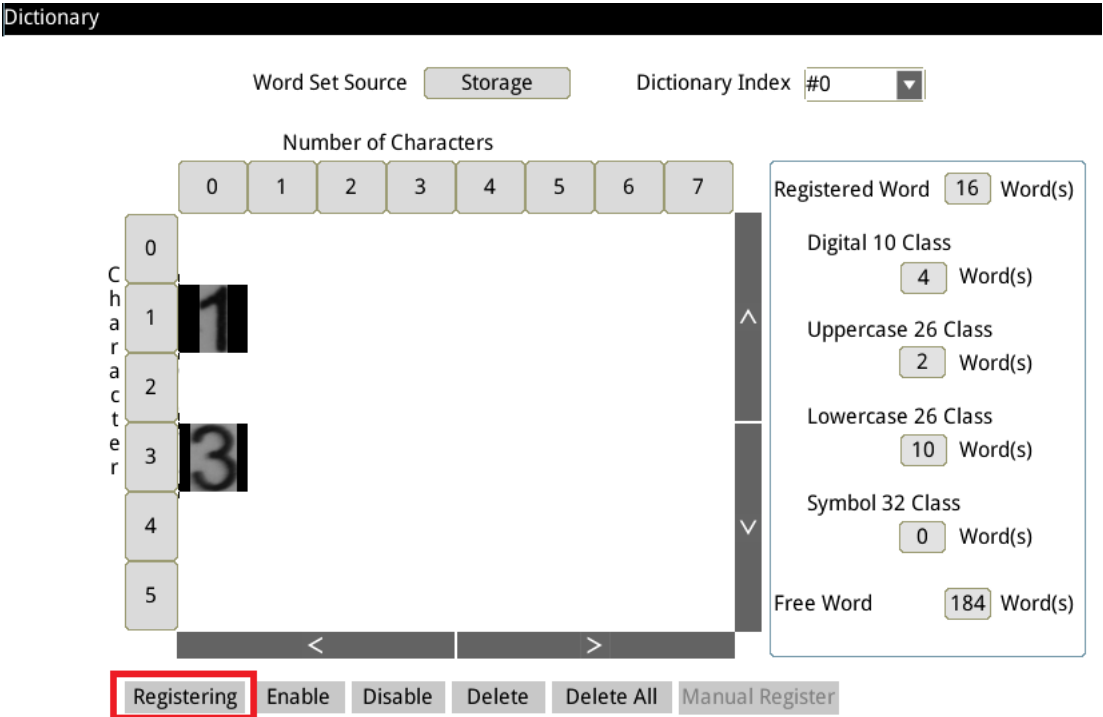
7-3) Click the [Enable] or [Disable] to enable and disable the registered characters, so that the characters can be quickly disabled without deleting the characters during the test.
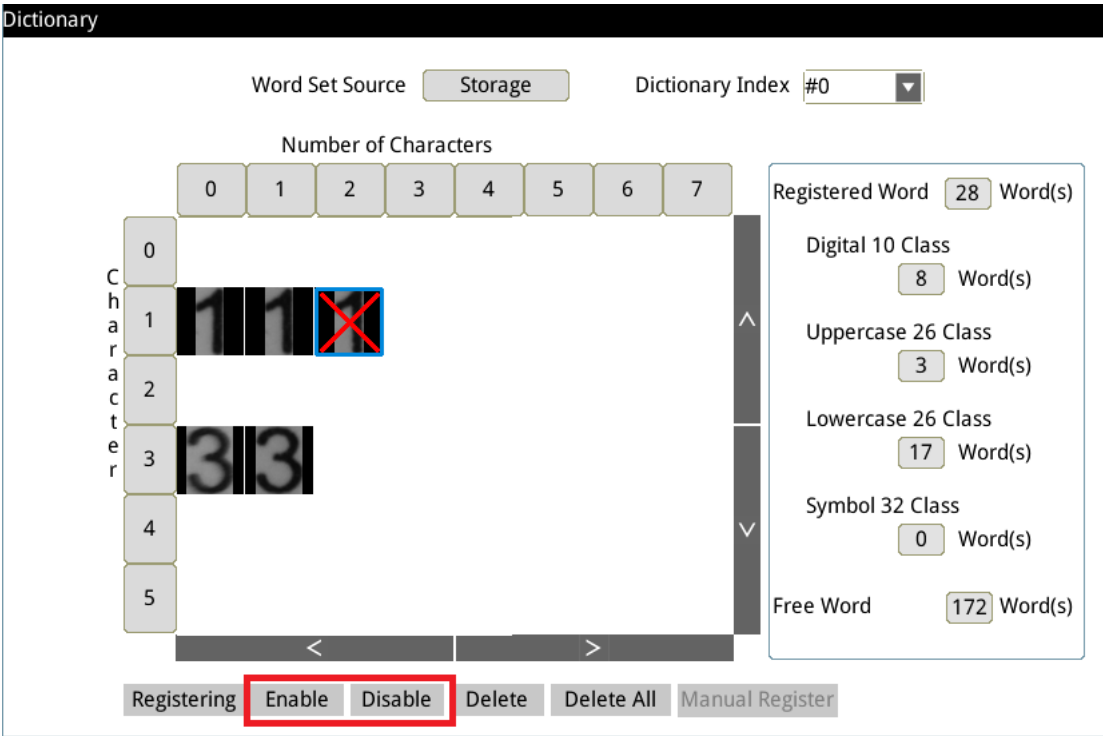
7-4) If you want to copy the dictionary of the DMV host (store in the internal register) to other hosts, it can be copied to the SD card in [Tool]> [Environment]> [Update], and then copied to other hosts through the SD card.
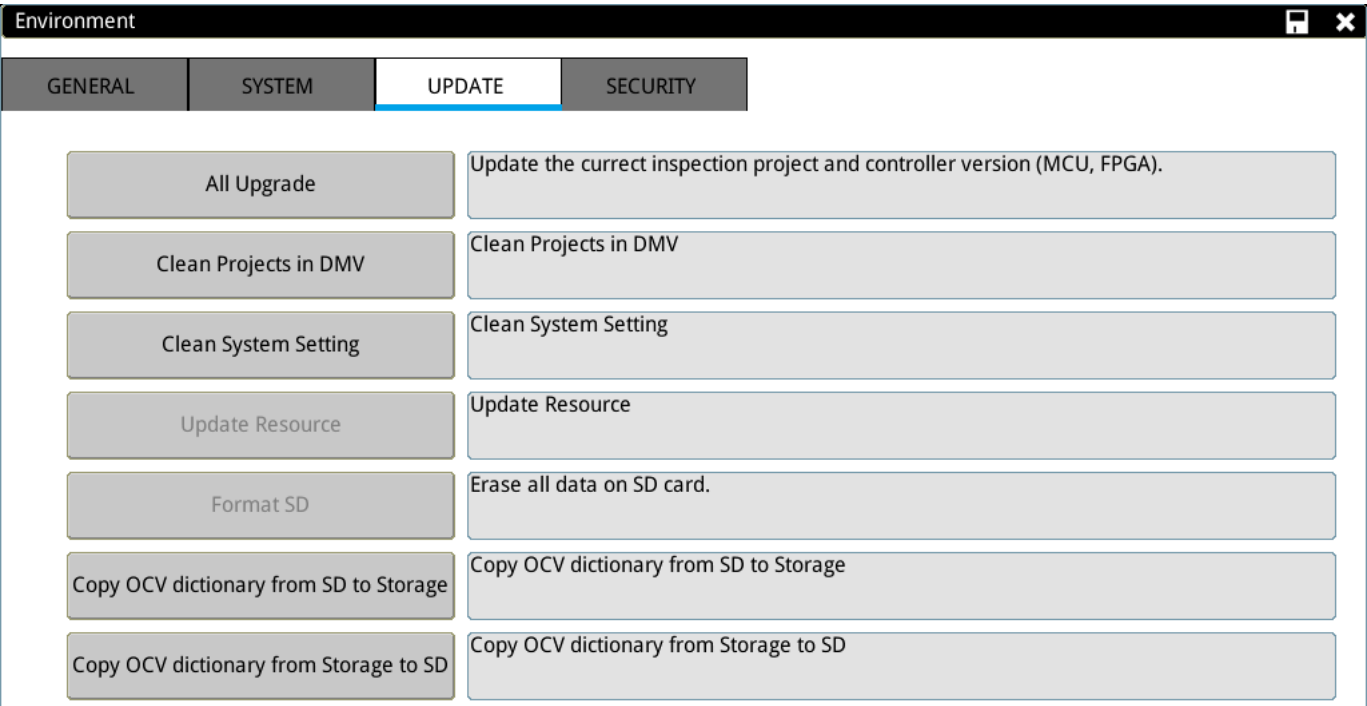
◎ **Parameters (Critical Value)**

1) Binarize Ratio

Click [Auto Adjust] and the system will calculate the appropriate range of 0~100%.

2) Standard Deviation

The ability of the system to filter out noise. The larger the setting value, the stronger the filtering ability At this time, small features are easily overlooked.

3) String Projection

Set the threshold value for the establishment of the string. The waveform on the left and the threshold value determine the maximum value of the string height. When the threshold value is too large, the string height will be insufficiently cut.

◎ The threshold value of the string projection in the figure is 15, and the position where the green line on the left passes through the waveform is the string height. Because the height is almost the maximum, the height of all characters are completely cut.
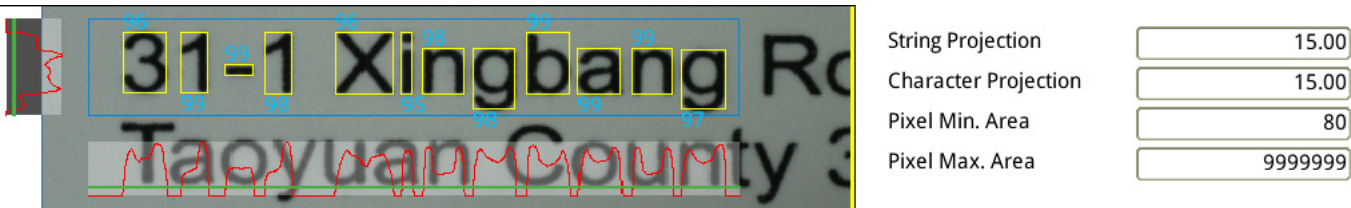
◎ The threshold value of the string projection in the figure below is 50. The green line on the left passes through the waveform at a higher position, so the height is smaller. Therefore, the lower half of the g character is ignored when cutting because it is not in the wave width.

String Projection	50.00
Character Projection	15.00
Pixel Min. Area	80
Pixel Max. Area	9999999
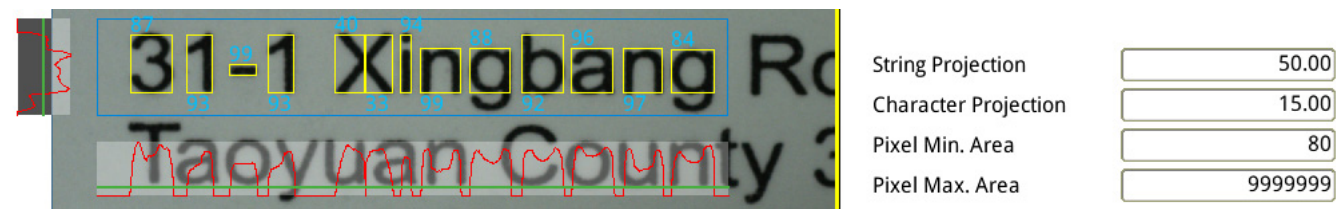
4) Character Projection

Set the value at which the character is established. The waveform and threshold below determine the maximum width of a single character. When the threshold is too large, the character cutting width will be insufficient.

◎ The threshold value of the character projection in the figure below is 15, and the position where the green line below passes through the waveform is the independent cutting width of each character. Because the width is almost the maximum, the width of all characters are completely cut.

String Projection	15.00
Character Projection	15.00
Pixel Min. Area	80
Pixel Max. Area	9999999
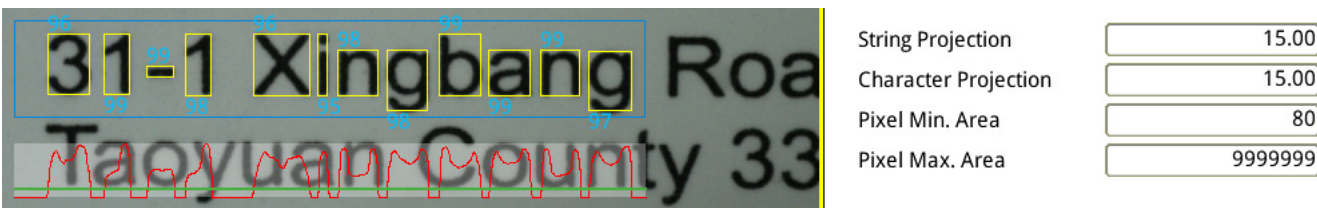
◎ The threshold value of the character projection in the figure below is 60, and the position where the green line below passes through the waveform is the independent cutting width of each character.

String Projection	15.00
Character Projection	60.00
Pixel Min. Area	80
Pixel Max. Area	9999999
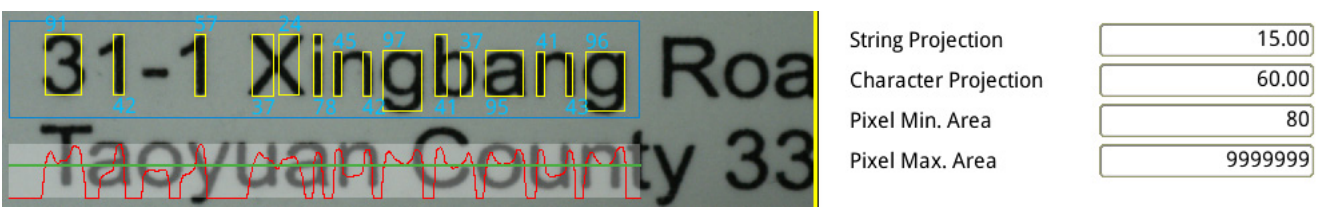
5) Minimum Pixel Aea

Set characters to meet minimum pixel threshold.

For example, when the minimum pixel area is set to 1200, images smaller than 1200 pixels will be filtered. (For example, the 3rd character [–] will be filtered)

String Projection	11.00
Character Projection	15.50
Pixel Min. Area	1200
Pixel Max. Area	9999999
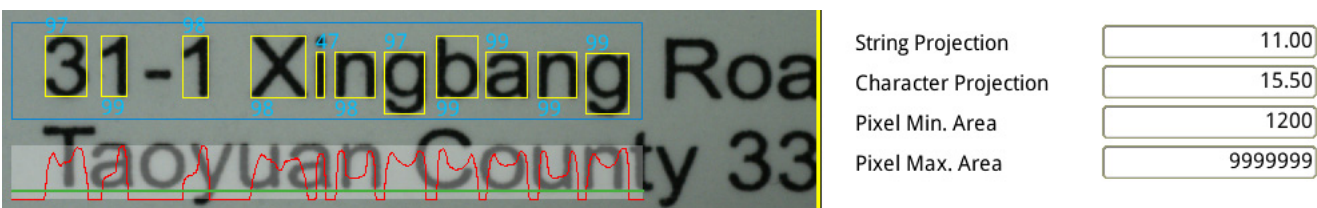
6) Maximum Pixel Aea

Set characters to meet the maximum pixel threshold.

For example, when the maximum pixel area is set to 4000, images larger than 4000 pixels will be filtered.

String Projection	11.00
Character Projection	15.50
Pixel Min. Area	80
Pixel Max. Area	4000
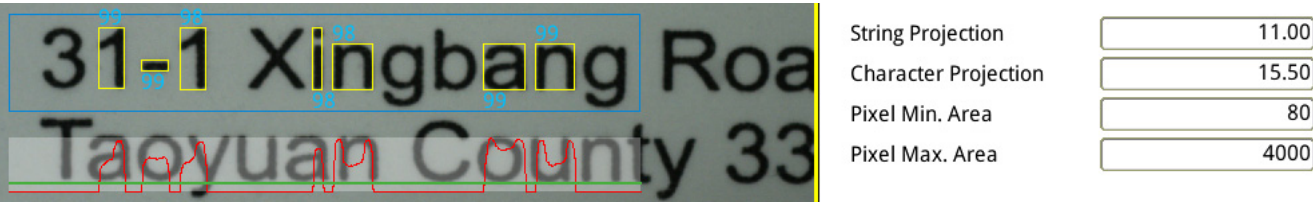
7) Automatic adjustment

After clicking, the system will calculate the best values of all the above parameters by itself.

◎ **Parameters (character setting)**

1) Minimum string projection width

Set the minimum width threshold of the string waveform.

When the string waveform width is less than this value, the string does not exist.

2) Maximum string projection width

Set the maximum width threshold of the string waveform.

When the string waveform width is greater than this value, the string does not exist.

3) Minimum character projection width

Set the minimum width threshold of the character waveform.

When the character wave width is less than this value, the character does not exist.

For example, if the value is increased to 40, the sixth character [i] will be ignored by the filter because the width is lower than 40.

Character Projection Min. Length	40
Character Projection Max. Length	2048
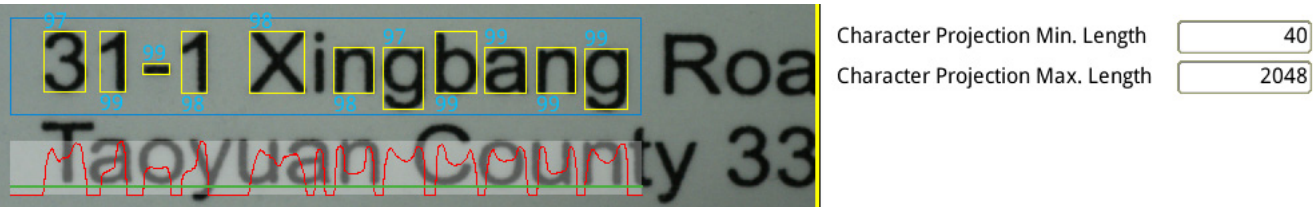
4) Maximum character projection width

Set the maximum width threshold of the character waveform.

When the character wave width is greater than this value, the character does not exist.

◎ **Parameters (Advanced)**

1) Character Expansion

The smaller the value, the sharper (not smooth); the larger the value, the smoother.

◎ The character expansion in the figure below is 0, the red waveform below is sharper and the cutting character frame is closer to the actual character state.
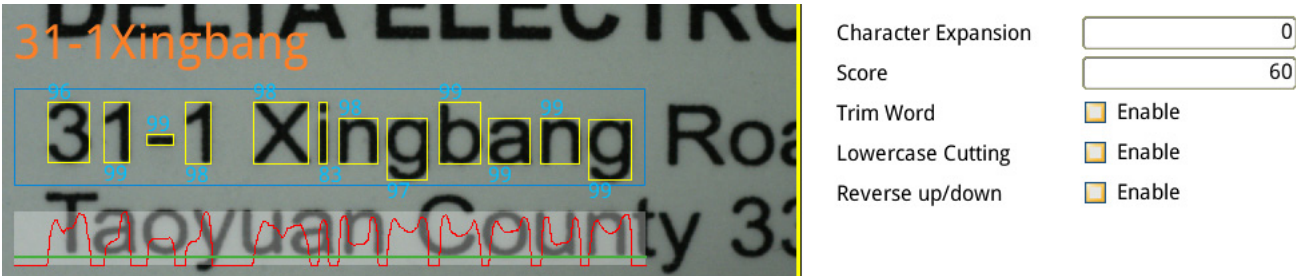
◎ The character expansion in the figure below is 8, the red waveform below is relatively smooth and the cut character frame will be slightly larger than the actual character state.
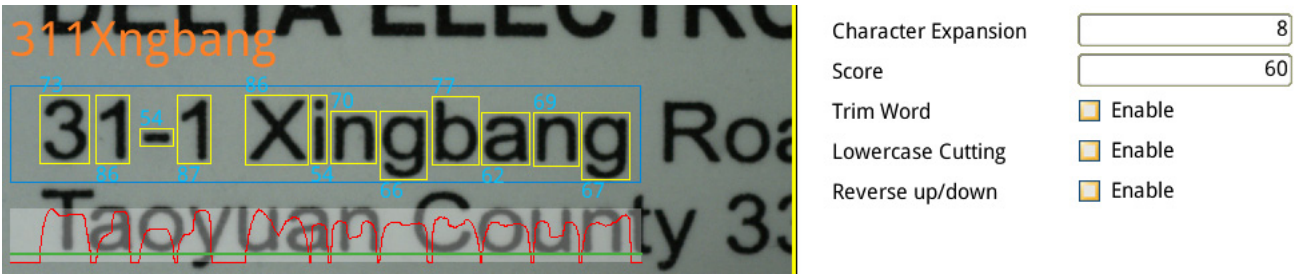
2) Score

Set the score threshold at which the character discrimination is established.

3) Trim Word

The cutting situation of the string will be equal in height after checking.
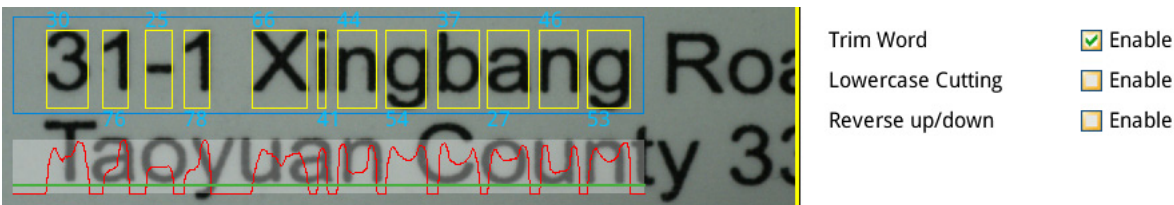
4)   Lowercase Cutting

When the string waveform cannot completely cut the height of the lowercase characters, the lowercase cutting can automatically make up the height.

◎   When it is not checked, the cutting height of the lower half of the lower character g is insufficient.
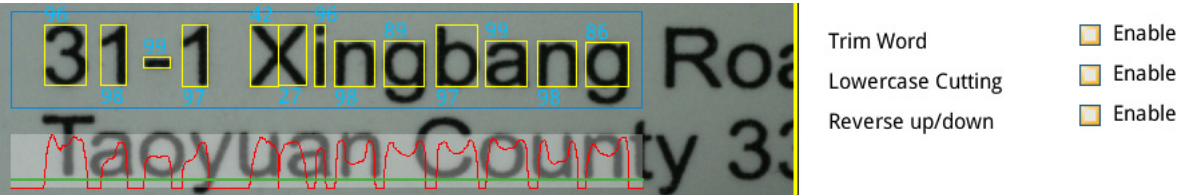
◎   The lower part of the lower character g will automatically make up the cutting height after checking.
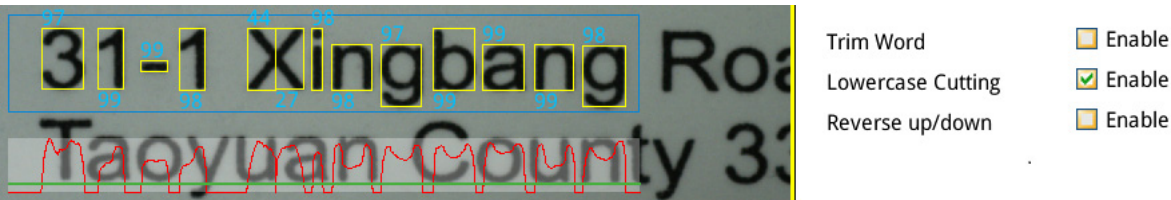
5)   Reverse up/ down

The characters to be recognized will be reverse processing first and then compare with the dictionary. Generally used as a mirroring environment.
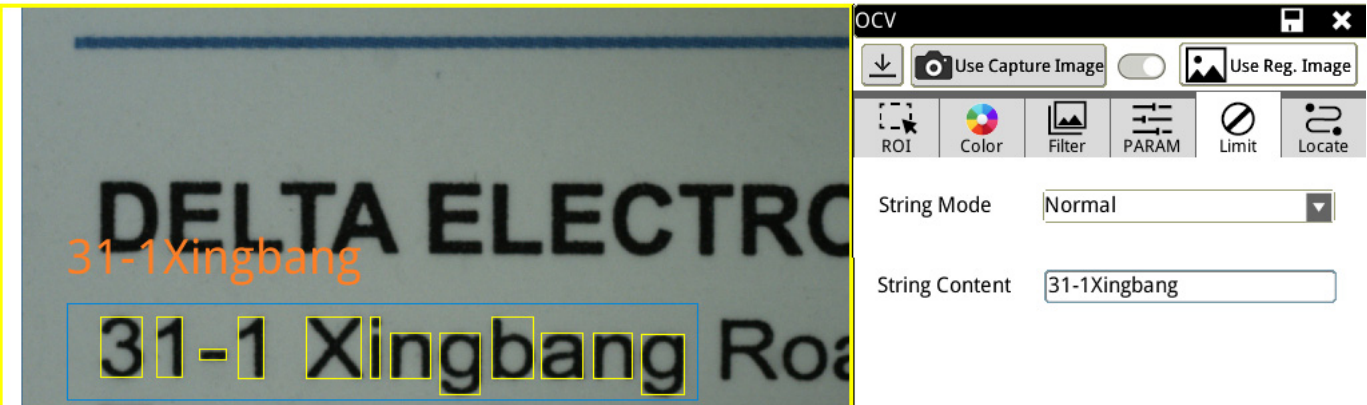
◎ **Limit**

After obtaining the inspection result, you need to know whether the result is qualified or not, that is, you need to set the correct character content in **Limit**.

◎ When [General] is selected in [String Mode]

When the setting of [String Content] is the same as the inspection result, the result is OK.
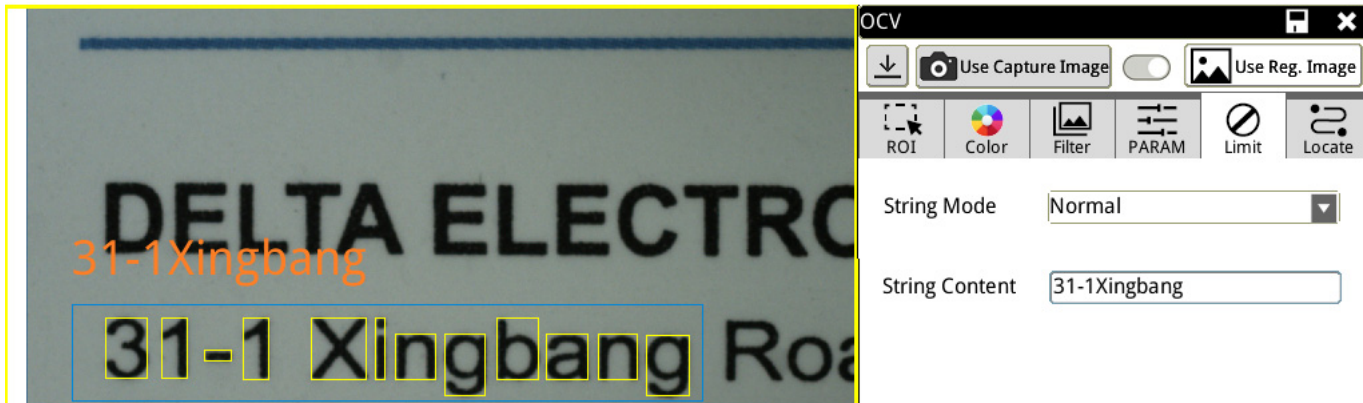
◎ When [Date/ Time] is selected in [String Mode]

Judge the result of the change date/time.

1) [TODAY MOME] is unchecked. Need to set the range of [Date Begin] and [Date End].

When the recognized year/month/day/hour/minute/second result is within the setting range, the result is OK, otherwise, it is NG.

2) [TODAY MOME] is checked. No need to set the range of [Date Begin] and [Date End].
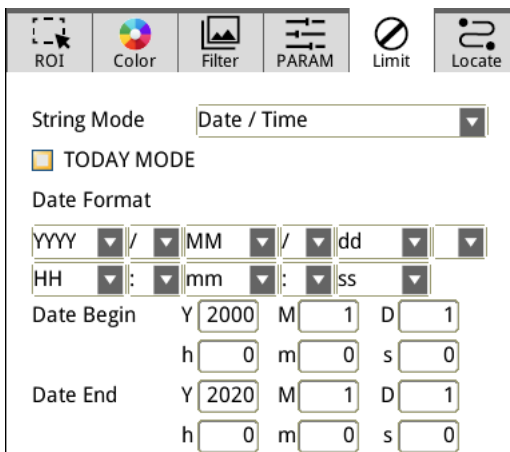
The system will automatically compare the recognized year/month/day results with the perpetual calendar year/month/day in the DMV. When the values are the same, the result is OK, otherwise, it is NG.

3) Free definition of date and time format

Because the actual date/time format is diverse (for example, YYYY/MM/DD, MM/DD/YY, YY.MM.DD, etc...), therefore, free definitions are provided in the [Date Format] which can be selected by the user.

◎ **Locate**

Specifies whether the inspection region follows an inspection result by adjusting its coordinates (X, Y) and Angles (Theta). The inspection tools you can use as a reference includes Shape, Blob, Edge Position and Edge Angle. As shown in the following diagram, specific marks (such as the cross on the object) can be used for the Locate function.

Locate Off   Locate On

Corrected inspection region after using Locate

Target
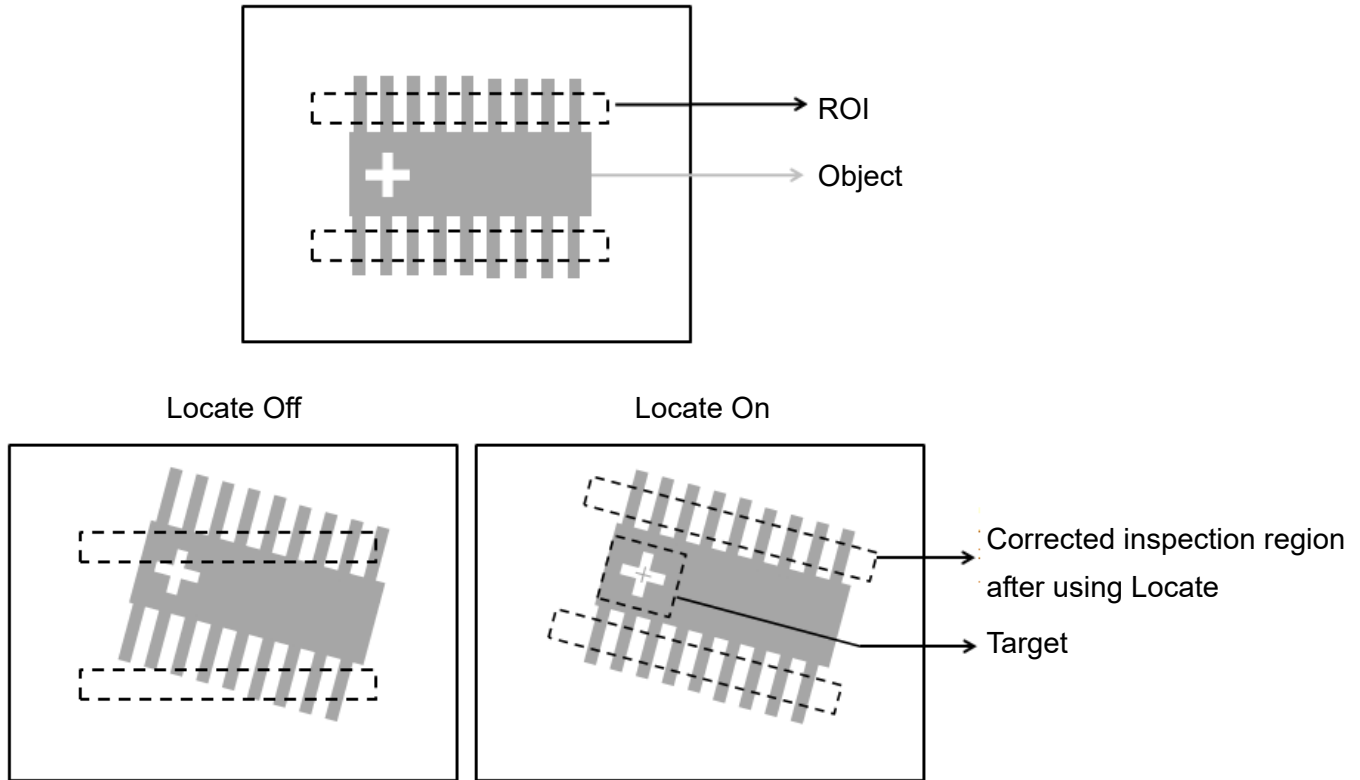
Manual mode and quick mode are available for this project.

➤ Manual mode: Manually click【Ref. X】、【Ref. Y】and【Ref. Angle】, separately set the source of the reference positioning.

➤ Quick mode: Click【⊖Ref. Nearest Shape Locate Win】, the system will directly bring in the closest 【Shape】as the【Ref. X】、【Ref. Y】and【Ref. Angle】setting.

➤ **Reference** Refer to Section 9.1 for detailed Locate configurations.

Chapter 6

Calculator

Enter numeric [Inspection window] or [Calculator] data for arithmetic or function computations to obtain new values. The new values will be provided for subsequent configurations in the [Numerical Output] option. In addition, this new data can be used to configure the upper/lower limits in calculator functions to obtain the calculator ID-specific logic flag, and the result can be used as reference for I/O output and determination.

6.1 What is a Calculator?

The Calculator function provides for a way to use mathematic operations to compute numeric data from Inspection results (such as numbers, coordinates, angles) and generate the required new results. For example, a calculator can add two counters with results 2 and 3 to get the final result, 5, which can then be used in a subsequent Output program (such as sending the numeric result 5 to the superior PC through RS232).

In addition to simple arithmetic, the Calculator also provides trigonometry functions, and functions for calculating the distance between coordinates.

Each inspection project independently supports up to 999 calculators, and you can configure upper and lower limits for each Calculator ID according to compare to the results to get the logic flag for the specific calculator. The system passes these results to subsequent logical Output options. For example, if an arithmetic computation produces a standard value of 100 (with +/-1 tolerance) pixels for a size measurement, the upper/lower limits of the calculator can be set to 101 and 99, respectively. Results between 99–101 are OK, and results not between 99–100 are NG.

6.2 Calculator Category

During the inspection process, click on the [Calculator] icon to enter the calculator function edit screen.

1) Total calculation: Includes all calculation functions and has a relatively complex operating interface.

2) Logic operation, mathematical function, comparison function, trigonometric function, geometric function, lookup function, statistic function: Separates the function to make a cleaner operating interface, but cannot be used for complex compound functions.
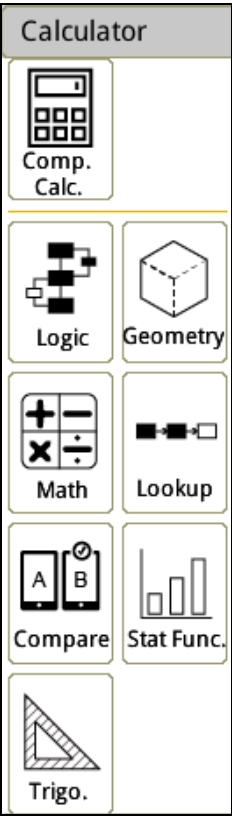
6.3 Description of the Comprehensive Calculation Function

6.3.1 Comprehensive Calculation Operating Interface

The figure below shows the total calculation edit screen. The function in each region is explained as follows.
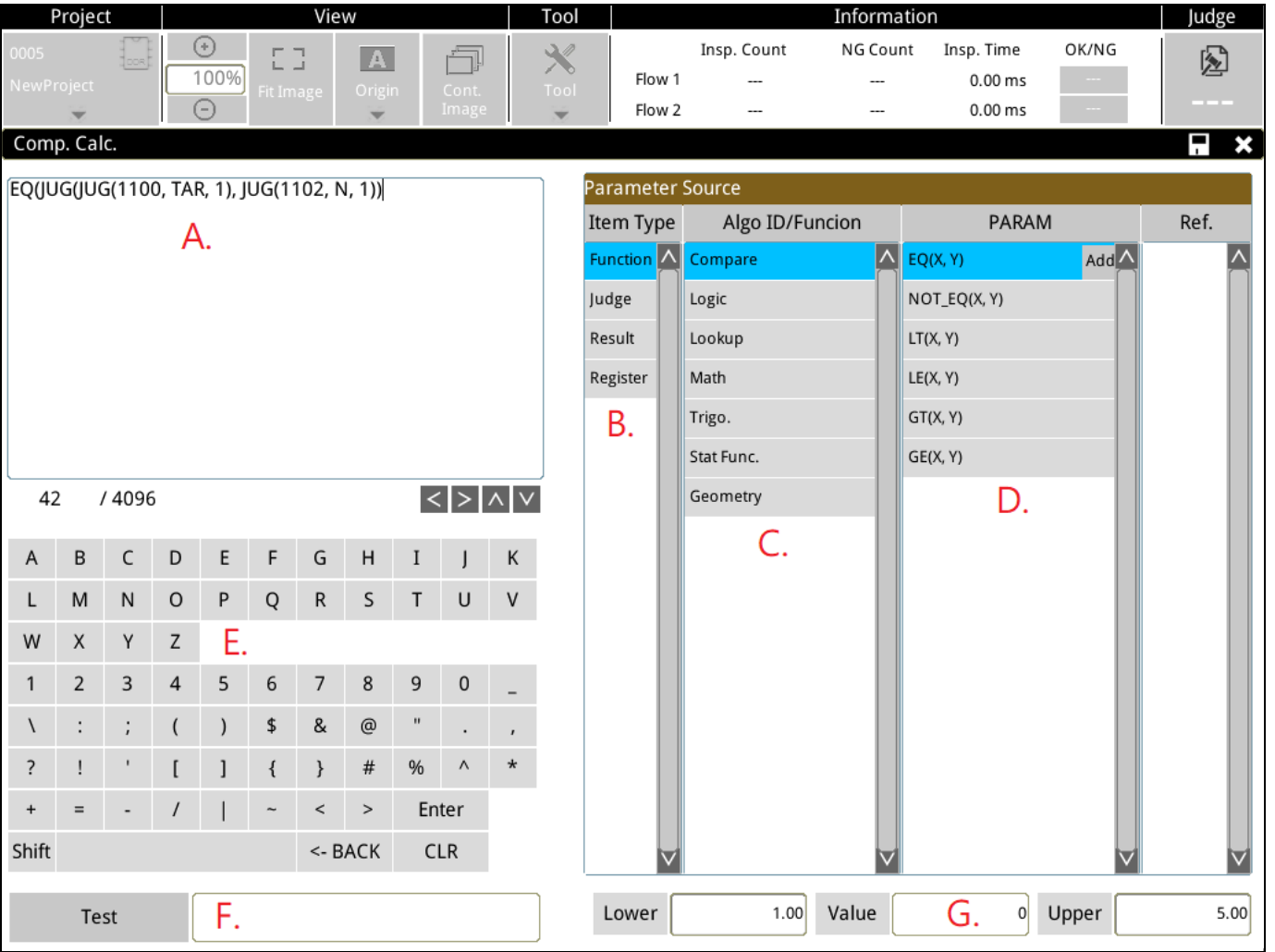
A. Function display area

Area where the functions and equations created are displayed.

B. Item Type

Select the mathematic function or inspection result to create the required equation.

C. Inspection ID/Function

Option is opened after selecting the previously mentioned [Item Type].

For example: After selecting [Function], multiple sublevel options, such as [Compare], [Logic], and [Lookup] will be opened in the [Algo ID/Function] menu.

D. Parameters

After selecting the previously mentioned [Function] and [AlgoID/Function], a variety of functions will be displayed in [Parameter] for users to choose from.

E. Keyboard Operation

When editing functions, the required text or numeric inputs must be entered through this keyboard.

F. Calculator Test and Results Display

When finished creating the function, Calculator Test can first be performed to confirm whether the function is configured correctly. There are the following 3 display methods.

1) Display numerical results: When the inspection function was manually operated and the result can be calculated using the calculator.

2) Display [Syntax Correct]: When the function's syntax is correct but results from the inspection function cannot be obtained.

3) Display [Error...]: When the function's syntax is incomplete or incorrect.

G. Upper/lower limit settings

Configures the range of logical (Judge) conditions for this calculator.

As shown in the following diagram, the [Upper] and [Lower] range values for this calculator can be configured. For example, the calculated result is 3. If Upper and Lower are configured to 5 and 1, the logical (Judge) result for this calculator is OK (=1). Contrarily, if the calculated result exceeds the upper/lower limits, the logical (Judge) result for the calculator is NG (=0). The OK or NG results of this calculator can serve as a basis for logical (Judge) decisions in subsequent processes.

Lower	1.00	Value	3.00	Upper	5.00

6.3.2 Item type > Description of Function

[Item Type] > [Function]

➤ As shown in the figure below, [Function] provides many different [Algo ID/Function], in which the function to be used can be selected in [Parameter].

➤ The figure below uses the [Compare] as an example. After adding EQ (X, Y) in [Parameter], the element is created in the Function Display Area, and the values and inspection results are subsequently substituted into the function for calculations.
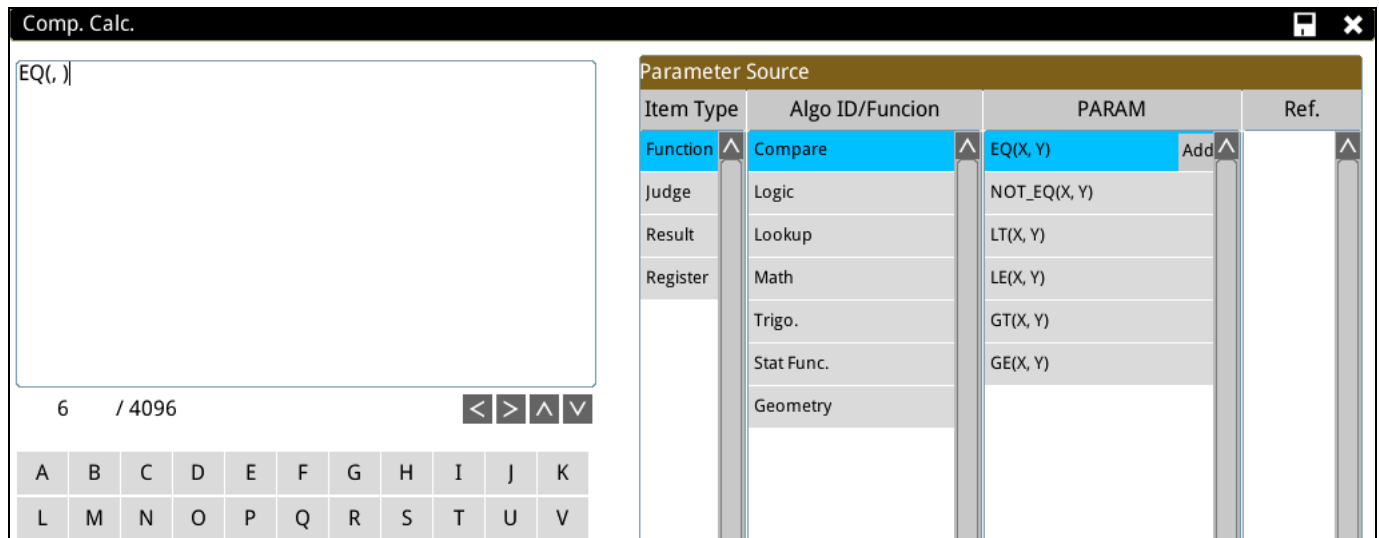
The 7 types of functions include Comparison Operator, Logic Operator, Lookup Function, Mathematical Function, Trigonometric Function, Statistic Function, and Geometric Function.

The Comparison Operator functions: EQ, NOT_EQ, LT, LE, GT, GE

The Logic Operator functions: AND, BIT_AND, OR, BIT_OR, XOR, BIT_XOR, NOT, BIT_NOT

The Lookup Function functions: INRANGE, CHOOSE, MAXN, MINN, MAXthN, MINthN

The Mathematical Function functions: ABS, POW, MOD, LOG10, LN, EXP, SQR, SQRT, SUM, TRUNC, ROUND, CEIL, FLOOR

The Trigonometric Function functions: SIN, SINH, COS, COSH, TAN, TANH, ASIN, ACOS, ATAN, ATAN2, RAD, EDG, PI

The Statistic Function functions: MAX, AVG, AVG_RANGE, MIN, SDEV, MEDIAN

The Geometric Function functions: LINE_DIST, LINE_ISECT_X,LINE_ISECT_Y,CIRCLE_CX, CIRCLE_CY, CIRCLE_CR,ANGLE_H_POS,ANGLE_H_LINE,ANGLE_LINE,LINE_FITM, LINE_FITC,CIRCLE_FITD,CIRCLE_FITE,CIRCLE_FITF,POS_LINE_DIST, POS_LINE_DIST_X,POST_LIINE_DIST_Y,POS_CIRCLE_DIST, ISEC_LINE_CIRCLE_CNT,ISEC_LINE_CIRCLE_X0,ISEC_LINE_CIRCLE_Y0, ISEC_LINE_CIRCLE_X1, ISEC_LINE_CIRCLE_Y1, ISEC_CIRCLE_CIRCLE_CNT, ISEC_CIRCLE_CIRCLE_X0,ISEC_CIRCLE_CIRCLE_Y0, ISEC_CIRCLE_CIRCLE_X1, ISEC_CIRCLE_CIRCLE_Y1

Comparison Operator			
Function	Description	Example	Note
EQ	Compares whether X and Y are equal	EQ(5,5) = 1	Outputs 1 if X and Y are equal; outputs 0 if X and Y differ
NOT_EQ	Compares whether X and Y differ	NOT_EQ(5,5) = 0	Outputs 1 if X and Y differ; outputs 0 if X and Y are equal
LT	Compares whether X<Y	LT(1,5) = 1	X<Y = 1; else 0
LE	Compares whether X<=Y	LE(1,1) = 1	X<=Y = 1; else 0
GT	Compares whether X>Y	GT(5,1) = 1	X>Y = 1; else 0
GE	Compares whether X>=Y	GE(1,1) = 1	X>=Y = 1; else 0
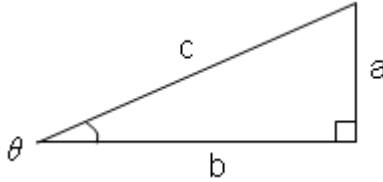
Logic Operator			
Function	Description	Example	Note
AND	AND gate	AND(1,1) = 1	The result will only be 1 when both are 1
BIT_AND	Numerical AND gate	BIT_AND(2,6) = 2	Performs AND after converting numerical value to bits 2 = 0010; 6 = 0110 BIT_AND = 0010
OR	OR gate	OR(1,0) = 1	Outputs 1 if any input is 1
BIT_OR	Numerical OR gate	BIT_OR(2,6) = 6	Performs OR after converting numerical value to bits 2 = 0010; 6 = 0110 BIT_OR = 0110
XOR	XOR gate	XOR(0,0) = 0 XOR(1,1) = 0 XOR(0,1) = 1 XOR(1,0) = 1	Output 0 if inputs match; output 1 if inputs differ.
BIT_XOR	Numerical XOR gate	BIT_XOR(2,6) = 4	Performs OR after converting numerical value to bits 2 = 0010; 6 = 0110 BIT_OR = 0100
NOT	NOT gate	NOT(0) = 1	0 gives an output of 1; 1 gives an output of 0.
BIT_NOT	Numerical NOT gate	BIT_NOT(6) = -7	The output is negative because bit 15 is 1.

Lookup Function			
Function	Description	Example	Note
INRANGE	(X,LL,UL) determines whether X is between LL and UL.	INRANGE(20,5,88) = 1	20 is between 5–88 and outputs a result of 1; else the function outputs 0.
CHOOSE	(M,X0…Xn) finds the value of M in the array	CHOOSE(4,88,56,100,2,25) = 25	4 means to acquire the 5th data
MAXN	(X0…Xn) finds the maximum value sorting index	MAXN(88,56,100,2,25) = 2	The 3rd data index is 2.
MINN	(X0…Xn) finds the minimum value sorting index	MINN(88,56,100,2,25) = 3	The 4th data index is 3.
MAXthN	(M,X0…Xn) finds the maximum value sorting index for the Mth value	MAXthN(2,88,56,100,2,25) = 0	The maximum value sorting index for 100 is 0.
MINthN	(M,X0…Xn) finds the minimum value sorting index for the Mth value	MINthN(2,88,56,100,2,25) = 4	The minimum value sorting index for 100 is 4.

Mathematical Function-			
Function	Description	Example	Note
ABS	Absolute value	ABS(-10) = 10	
POW	Raised to the power N	POW(2,3) = 8 POW(3,4) = 81	3 * 3 * 3 * 3 = 81
MOD	Finds the remainder	MOD(5,2) = 1 MOD(8,3) = 2	8 / 3 = 2 remainder 2
LOG10	Calculates the logarithmic value	LOG10(10) = 1	
LN	Calculates the natural logarithmic value	LN(1) = 0	
EXP	Returns the exponential value	EXP(1) = 2.718281828…	
SQR	Square	SQR(2) = 4 SQR(-2) = 4	
SQRT	Square root	SQRT(9) = 3	
SUM	Calculates the sum of (X0… Xn)	SUM(1,2,3,4,5,) = 15	
TRUNC	Truncates	TRUNC(3.14) = 3	
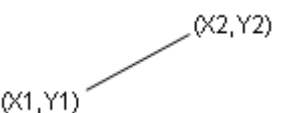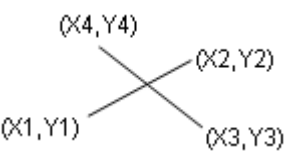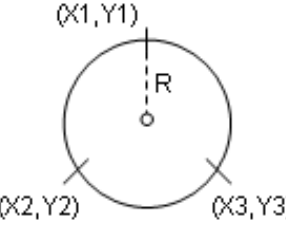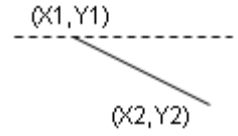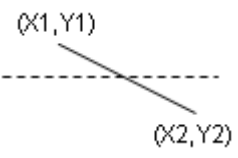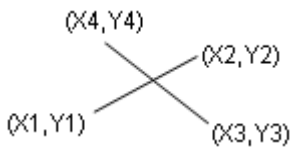
ROUND	Rounds to integer	Round(1.55) = 2	
CEIL	Finds the nearest integer greater than X	CEIL(3.5) = 4 CEIL(-3.5) = -3	
FLOOR	Finds the nearest integer lesser than X	FLOOR(3.5) = 3 FLOOR(-3.5) = -4	
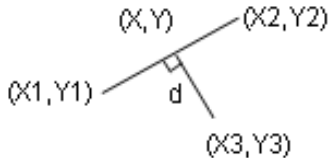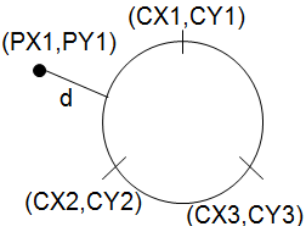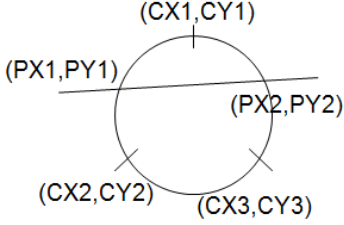
Trigonometric Function			
Function	Description	Example	Note
SIN	Sine	SIN(30) = 0.5	$SIN(\theta) = a / c$
COS	Cosine	COS(30) = 0.866	$COS(\theta) = b / c$
TAN	Tangent	TAN(30) = 0.577	$TAN(\theta) = a / b$
ASIN	Arcsine function	ASIN(1) = 90	$ASIN(a/c) = \theta$
ACOS	Arccosine function	ACOS(1) = 0	$ACOS(b/c) = \theta$
ATAN	Arctangent function	ATAN(1) = 45	$ATAN(a/b) = \theta$
SINH	Hyperbolic sine function	SINH(1) = 1.1752011….	
COSH	Hyperbolic cosine function	COSH(1) = 1.5430806….	
TANH	Hyperbolic tangent function	TANH(1) = 0.7615941….	
ATAN2	(X,Y) arctangent trigonometric function (X/Y)	ATAN2(1,1) = 45	
RAD	Converts to radians	RAD(180) = 3.14	
DEG	Converts to degrees	DEG(3.14) = 179.90	
PI	π constant	3.14159	

Statistic Function			
Function	Description	Example	Note
MAX	Finds the maximum in (X0…Xn)	MAX(88,56,100,2,25) = 100	
AVG	Finds the average in (X0…Xn)	AVG(88,56,100,2,25) = 54.199...	
AVG_RANGE	(LL,UL,X0…Xn) Calculates the average between LL and UL	AVG_RGANGE(50,90,88,56,100,2,25) = 72	
MIN	Finds the minimum in	MIN(88,56,100,2,25) =	

	(X0…Xn)	2	
SDEV	Calculates the standard deviation of (X0...Xn)	SDEV(5,6,8,9) = 1.5811388…	
MEDIAN	Calculates the median of (X0...Xn)	MEDIAN(88,56,100,2,25) = 56	Take the smaller value when there are 2 medians

Geometric Function			
Function	Description	Example	Note
LINE_DIST	(X1,Y1,X2,Y2) Distance between two points	DIST(20,20,30,20) = 10 DIST(20,20,30,30) = 14.14	
LINE_ISECT_X	(X1,Y1,X2,Y2,X3,Y3,X4,Y4) X coordinates of intersection between two lines	ISECT_X(0,0,4,4,0,4,4,0) = 2	
LINE_ISECT_Y	(X1,Y1,X2,Y2,X3,Y3,X4,Y4) Y coordinates of intersection between two lines	ISECT_Y(0,0,4,4,0,4,4,0) = 2	
CIRCLE_CX	(X1,Y1,X2,Y2,X3,Y3) X coordinates of circle formed by three points	CIRCLE_X(-14.6,8.94,-11.64,4.15,-15.61,3.47) = -14	
CIRCLE_CY	(X1,Y1,X2,Y2,X3,Y3) Y coordinates of circle formed by three points	CIRCLE_Y(-14.6,8.94,-11.64,4.15,-15.61,3.47) = 6	
CIRCLE_CR	(X1,Y1,X2,Y2,X3,Y3) Radius (R) of circle formed by three points	CIRCLE_R(-14.6,8.94,-11.64,4.15,-15.61,3.47) = 3	
ANGLE_H_POS	(X1,Y1,X2,Y2) Angle between a line formed by two coordinates and	ANGLE(0,0,5,5) = 45 ANGLE(5,5,0,0) = -135	

	the horizontal surface (connected at X1,Y1) In clockwise direction (range +/-180°)		
ANGLE_H_LINE	(X1,Y1,X2,Y2) Incident angle of line to horizontal axis In clockwise direction (range +/-90°)	LINE_ANGLE(5,5,0,0) = 45	
ANGLE_LINE	(X1,Y1,X2,Y2,X3, Y3,X4,Y4) Acute angle of two intersecting lines	D_LINE_ANGLE(0,0,4,4,0,4,4,0) = 90	
LINE_FITM	(X1,Y1,X2,Y2) Linear equation Y=mX+c	LINE_FITM(1,1,3,2) = 0.5	Return result m
LINE_FITC	(X1,Y1,X2,Y2) Linear equation Y=mX+c	LINE_FITC(1,1,3,2) = 0.5	Return result c
CIRCLE_FITD	(X1,Y1,X2,Y2,X3, Y3) Equation of the circle X*X+Y*Y+dX+eY +f=0	CIRCLE_FITD(0,2,2,0,4,2) = -4	Return result c
CIRCLE_FITE	(X1,Y1,X2,Y2,X3, Y3) Equation of the circle X*X+Y*Y+dX+eY +f=0	CIRCLE_FITE(0,2,2,0,4,2) = -4	Return result e
CIRCLE_FITF	(X1,Y1,X2,Y2,X3, Y3) Equation of the circle X*X+Y*Y+dX+eY +f=0	CIRCLE_FITF(0,2,2,0,4,2) = 4	Return result f

POS_LINE_DIST	(X1,Y1,X2,Y2,X3,Y3) Minimum distance (d) between a line and a point	LINE_DIST(0,0,4,4,0,4) = 2	
POS_LINE_DIST_X	(X1,Y1,X2,Y2,X3,Y3) X coordinates on the line with min distance to a point	LINE_DIST_X(0,0,4,4,0,4) = 2	
POS_LINE_DIST_Y	(X1,Y1,X2,Y2,X3,Y3) Y coordinates on the line with min distance to a point	LINE_DIST_Y(0,0,4,4,0,4) = 2	
POS_CIRCLE_DIST	(PX1,PY1,CX1,CY1,CX2,CY2,CX3,CY3) The minimum distance from a coordinate point to the circumference	POS_CIRCLE_DIST(7,2,2,0,0,2,2,4) = 3	
ISEC_LINE_CIRCLE_CNT	(PX1,PY1,PX2,PY2,CX1,CY1,CX2,CY2,CX3,CY3) Number of intersections between a line generated by two points and the circle	ISEC_LINE_CIRCLE_CNT(1,1,6,6,0,3,3,0,6,3) = 2	
ISEC_LINE_CIRCLE_X0	(PX1,PY1,PX2,PY2,CX1,CY1,CX2,CY2,CX3,CY3) The coordinate of the first intersection (X0) between a line generated by two	ISEC_LINE_CIRCLE_X0(1,1,6,6,0,3,3,0,6,3) = 0.8786796…	

	points and the circle		
ISEC_LINE_CIRCLE_Y0	(PX1,PY1,PX2,PY2,CX1,CY1,CX2,CY2,CX3,CY3) The coordinate of the first intersection (Y0) between a line generated by two points and the circle	ISEC_LINE_CIRCLE_Y0(1,1,6,6,0,3,3,0,6,3) = 0.8786796…	
ISEC_LINE_CIRCLE_X1	(PX1,PY1,PX2,PY2,CX1,CY1,CX2,CY2,CX3,CY3) The coordinate of the second intersection (X1) between a line generated by two points and the circle	ISEC_LINE_CIRCLE_X1(1,1,6,6,0,3,3,0,6,3) = 5.1213203…	
ISEC_LINE_CIRCLE_Y1	(PX1,PY1,PX2,PY2,CX1,CY1,CX2,CY2,CX3,CY3) The coordinate of the second intersection (Y1) between a line generated by two points and the circle	ISEC_LINE_CIRCLE_Y1(1,1,6,6,0,3,3,0,6,3) = 5.1213203…	
ISEC_CIRCLE_CIRCLE_CNT	(C1X1,C1Y1,C1X2,C1Y2,C1X3,C1Y3,C2X1,C2Y1,C2X2,C2Y2,C2X3,C2Y3) Number of intersections between two	ISEC_CIRCLE_CIRCLE_CNT(0,2,2,0,4,2,0,2,2,0,-2,0) = 2	(CX1,CY1) (CX2,CY2) (CX3,CY3) (CX1,CY1) (CX2,CY2)

	circles		
ISEC_CIRCLE_CIRCLE_X0	(C1X1,C1Y1,C1X2,C1Y2,C1X3,C1Y3,C2X1,C2Y1,C2X2,C2Y2,C2X3,C2Y3) The coordinate of the first intersection (X0) between two circles	ISEC_CIRCLE_CIRCLE_X0(0,2,2,0,4,2,0,2,2,0,-2,0) = 0	
ISEC_CIRCLE_CIRCLE_Y0	(C1X1,C1Y1,C1X2,C1Y2,C1X3,C1Y3,C2X1,C2Y1,C2X2,C2Y2,C2X3,C2Y3) The coordinate of the first intersection (Y0) between two circles	ISEC_CIRCLE_CIRCLE_Y0(0,2,2,0,4,2,0,2,2,0,-2,0) = 2	
ISEC_CIRCLE_CIRCLE_X1	(C1X1,C1Y1,C1X2,C1Y2,C1X3,C1Y3,C2X1,C2Y1,C2X2,C2Y2,C2X3,C2Y3) The coordinate of the second intersection (X1) between two circles	ISEC_CIRCLE_CIRCLE_X1(0,2,2,0,4,2,0,2,2,0,-2,0)= 2	
ISEC_CIRCCLE_CIRCLE_Y1	(C1X1,C1Y1,C1X2,C1Y2,C1X3,C1Y3,C2X1,C2Y1,C2X2,C2Y2,C2X3,C2Y3) The coordinate of the second intersection (Y1) between two	ISEC_CIRCLE_CIRCLE_Y1(0,2,2,0,4,2,0,2,2,0,-2,0) = 0	

	circles		

ⓘ Remark A comma separates the elements. For example: AVG(2,3,4)

6.3.3 Item Type > Description of Judge

[Item Type] > [Judge]

1) [Judge] generally carries out Boolean operations in coordination with the previously mentioned [Logic] function in previous sections.

● First create an AND (X, Y) function in [Logic]

Parameter Source			
Item Type	Algo ID/Funcion	PARAM	Ref.
Function	Compare	AND(X0, ..., Xn) Add	
Judge	Logic	BIT_AND(X, Y)	
Result	Lookup	OR(X0, ..., Xn)	
Register	Math	BIT_OR(X, Y)	
	Trigo.	XOR(X0, ..., Xn)	
	Stat Func.	BIT_XOR(X, Y)	
	Geometry	NOT(X)	
		BIT_NOT(X)	

● Then select the source parameters to use the logic operation AND in [Logic Flag].

Comp. Calc.

AND(JUG(1100, TAR, 1),)

Parameter Source			
Item Type	Algo ID/Funcion	PARAM	Ref.
Function	1100 Area	TAR Add	
Judge	1102 Blob		
Result	1103 Compare		
Register			

2) Using the following Blob unit as an example, numerous result items will be generated after blob inspection. Therefore, numerous options will be available in [Parameter] (e.g., the OK/NG result when determining the number of Blobs, Blob Centroid Position X, etc.).

Parameter Source			
Item Type	Algo ID/Funcion	PARAM	Ref.
Function	1100 Area	N	
Judge	1102 Blob	X Add	
Result	1103 Compare	Y	
Register		AR	
		PE	

3) In [Logic Flag], besides selecting the Judge result from [Inspection Window ID], the Judge result can also be selected from other [Calculator] and carried out in Boolean operations.

4) The generation of logical results
   ◆ Logical inspection results (OK=1; NG=0) are generated through result comparison after configuring [Limit] for each Inspection function.
   ◆ Logic operation results (OK=1; NG=0) are generated through result comparison after configuring the [Lower Limit, Value, Upper Limit] for each calculator. (shown in the following diagram)

5) The final inspection result is usually generated through several logical (OK/NG) inspections results. Therefore, the logical OK (1)/NG (0) result from [Function] > [Logic Operation] can be used to execute operations to generate the final logical (Judge) result.

   For example, The output result is OK only when all three inspections are OK. The AND command from logic operators can be used here to process the 3 inspection results. Similarly, using the OR command to three OK flags to generate the OK result indicates that at least one inspection item must be OK.

Data format

Data format and representation is explained using (Edge Position - X coordinate) JUG(□□□□,X,△△) as an example.

□□□□: Represents the nth function unit. For example: 1005 represents the 5th function unit in Flow Process 1.

[△△]: Represents using the nth result as the output. For example, WIN1005 detected 3 edge positions. If [△△] is configured to 2, the result from the second edge is used as the calculation (output) content.

X: Represents the results that are the contents of the X coordinate; please refer to the following table for the result codes for each inspection function.

Inspection Function	Syntax	Description	Reference	Calculator data format
Area	TAR	Total area	--	JUG (□□□□,TAR,0)
	X	X coordinate	[△△]	JUG (□□□□,X,△△)
	Y	Y coordinate	[△△]	JUG (□□□□,Y,△△)

	AG	Absolute Angle (0° in the horizontal direction) of ring and arc	[△△]	JUG (□□□□,AG,△△)
Edge Count	N	Number of edges	--	JUG (□□□□,N,0)
Edge Width	W	Width (unit: pixels or degrees)	--	JUG (□□□□,L,0)
	X	X coordinates of first edge	--	JUG (□□□□,X1,0)
	Y	Y coordinates of first edge	--	JUG (□□□□,Y1,0)
	AG	Absolute angle 1 of circle and arc	--	JUG (□□□□,AG1,0)
Edge Pitch	N	Quantity	--	JUG (□□□□,N,0)
	W	Pitch (unit: pixels or degrees)	[△△]	JUG (□□□□,W,△△)
	WH	Maximum pitch (unit: pixels or degrees)	--	JUG (□□□□,WH,0)
	WL	Minimum pitch (unit: pixels or degrees)	--	JUG (□□□□,WL,0)
	WA	Average pitch (unit: pixels or degrees)	--	JUG (□□□□,WA,0)
Edge Angle	EAG	Angle (0° in the horizontal direction)	--	JUG (□□□□,EAG,0)
Intensity	IA	Average brightness	--	JUG (□□□□,IA,0)
	ID	Standard brightness deviation	--	JUG (□□□□,ID,0)
	IH	Maximum brightness	--	JUG (□□□□,IH,0)
	IL	Minimum brightness	--	JUG (□□□□,IL,0)
Shape	N	Quantity	--	JUG (□□□□,N,0)
	S	Similarity	[△△]	JUG (□□□□,S,△△)
	X	X coordinates of found object	[△△]	JUG (□□□□,X,△△)
	Y	Y coordinates of found object	[△△]	JUG (□□□□,Y,△△)
	AG	Object angle found	[△△]	JUG (□□□□,AG,△△)
Blob	N	Quantity	--	JUG (□□□□,N,0)
	X	Center X coordinates	[△△]	JUG (□□□□,X,△△)
	Y	Center Y coordinates	[△△]	JUG (□□□□,X,△△)
	AR	Blob area	[△△]	JUG (□□□□,AR,△△)
	PE	Circumference	[△△]	JUG (□□□□,PE,△△)
Stain	TAR	Total defective area	--	JUG (□□□□,N,0)
	N	Cluster	--	JUG (□□□□,N,0)
	AR	Defective area	[△△]	JUG (□□□□,AR,△△)
	X	Center X coordinates of all defects	[△△]	JUG (□□□□,X,△△)
	Y	Center Y coordinates of all defects	[△△]	JUG (□□□□,Y,△△)
Position Trace	XH	X coordinates of maximum outline	--	JUG (□□□□,XH,0)
	XL	X coordinates of minimum outline	--	JUG (□□□□,XL,0)
	YH	Y coordinates of maximum outline	--	JUG (□□□□,YH,0)
	YL	Y coordinates of minimum outline	--	JUG (□□□□,YL,0)
	RD	Roundness	--	JUG (□□□□,RD,0)

	WH	Maximum width	--	JUG (□□□□,WH,0)
	WL	Minimum width	--	JUG (□□□□,WL,0)
Width Trace	WA	Average width	--	JUG (□□□□,WA,0)
	RD1	Roundness 1 (inner)	--	JUG (□□□□,RD1,0)
	RD2	Roundness 2 (outer)	--	JUG (□□□□,RD2,0)

6.3.4 Item Type > Description of Result

[Item Type] > [Result]

1) [Result] is used to input numerical data and can be used with all functions.

First create a comparison function EQ (X, Y) (compares if the two values are equal), as shown below.

The numerical values to be compared must be selected from [Result].
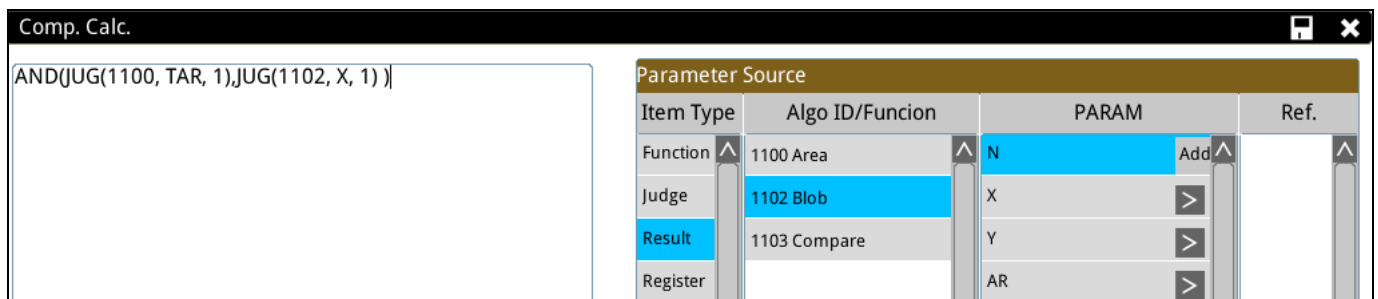
2) Using the following Blob unit as an example, numerous numerical results will be generated after blob inspection. Therefore, numerous options will be available in [Parameter] (e.g., Number of Blobs, Blob Centroid Position X).

3) In [Parameter] options, the attached ▶ symbol means additional [Reference] option is required. (i.e., Blob Centroid Position X provides the ▶ symbol because the sorting function configured during blob inspection can identify the sequence of multiple blobs (meaning multiple centroid X coordinates). Therefore, the resulting value must be selected based on the configurations.)

4) In [Result], besides selecting numerical results from [Window ID], other calculation results can be selected from [Calculator] for operations.

Data format

Data format and representation is explained using (Edge Position - X coordinate) WIN(□□□□,X,△△) as an example.

□□□□: Represents the nth function unit. For example: 1005 represents the 5th function unit in Flow Process 1.

[△△]: Represents using the nth result as the output. For example, WIN1005 detected 3 edge positions. If [△△] is configured to 2, the result from the second edge is used as the calculation (output) content.

X: Represents the results that are the contents of the X coordinate; please refer to the following table for the result codes for each inspection function.

Inspection Function	Syntax	Description	Reference	Calculator data format
Area	TAR	Total area	--	WIN(□□□□,TAR,0)
Edge Position	N	Quantity	--	WIN(□□□□,N,0)
	X	X coordinate	[△△]	WIN(□□□□,X,△△)
	Y	Y coordinate	[△△]	WIN(□□□□,Y,△△)
	AG	Absolute Angle (0° in the horizontal direction) of ring and arc	[△△]	WIN(□□□□,AG,△△)
	RA	Relative edge angle (to initial inspection angle) of ring and arc	[△△]	WIN(□□□□,RA,△△)
Edge Count	N	Number of edges	--	WIN(□□□□,N,0)
Edge Width	L	Width (unit: pixels or degrees)	--	WIN(□□□□,L,0)
	X1	X coordinates of first edge	--	WIN(□□□□,X1,0)
	Y1	Y coordinates of first edge	--	WIN(□□□□,Y1,0)
	AG1	Absolute angle 1 of circle and arc	--	WIN(□□□□,AG1,0)
	RA1	Relative angle 1 of circle and arc	--	WIN(□□□□,RA1,0)
	X2	X coordinates of second edge	--	WIN(□□□□,X2,0)
	Y2	Y coordinates of second edge	--	WIN(□□□□,Y2,0)
	AG2	Absolute angle 2 of circle and arc	--	WIN(□□□□,AG2,0)
	RA2	Relative angle 2 of circle and arc	--	WIN(□□□□,RA2,0)

	N	Quantity	--	WIN(□□□□,N,0)
Edge Pitch	W	Pitch (unit: pixels or degrees)	[△△]	WIN(□□□□,W,△△)
	WH	Maximum pitch (unit: pixels or degrees)	--	WIN(□□□□,WH,0)
	WL	Minimum pitch (unit: pixels or degrees)	--	WIN(□□□□,WL,0)
	WA	Average pitch (unit: pixels or degrees)	--	WIN(□□□□,WA,0)
	XS	X coordinates of first edge	[△△]	WIN(□□□□,XS,△△)
	YS	Y coordinates of first edge	[△△]	WIN(□□□□,YS,△△)
	AGS	Absolute angle 1 of circle and arc	[△△]	WIN(□□□□,AGS,△△)
	RAS	Relative angle 1 of circle and arc	[△△]	WIN(□□□□,RGS,△△)
	XE	X coordinates of second edge	[△△]	WIN(□□□□,XE,△△)
	YE	Y coordinates of second edge	[△△]	WIN(□□□□,YE,△△)
	AGE	Absolute angle 2 of circle and arc	[△△]	WIN(□□□□,AGE,△△)
	RAE	Relative angle 2 of circle and arc	[△△]	WIN(□□□□,RAE,△△)
	X	X coordinates of pitch center	[△△]	WIN(□□□□,X,△△)
	Y	Y coordinates of pitch center	[△△]	WIN(□□□□,Y,△△)
	AG	Absolute angle of edge center of circle and arc	[△△]	WIN(□□□□,AG,△△)
Edge Angle	EAG	Angle (0° in the horizontal direction)	--	WIN(□□□□,EAG,0)
	X1	X coordinates of top angle	--	WIN(□□□□,X1,0)
	Y1	Y coordinates of top angle	--	WIN(□□□□,Y1,0)
	X2	X coordinates of bottom angle	--	WIN(□□□□,X2,0)
	Y2	Y coordinates of bottom angle	--	WIN(□□□□,Y2,0)
Intensity	IA	Average brightness	--	WIN(□□□□,IA,0)
	ID	Standard brightness deviation	--	WIN(□□□□,ID,0)
	IH	Maximum brightness	--	WIN(□□□□,IH,0)
	IL	Minimum brightness	--	WIN(□□□□,IL,0)
Shape	N	Quantity	--	WIN(□□□□,N,0)
	S	Similarity	[△△]	WIN(□□□□,S,△△)
	X	X coordinates of found object	[△△]	WIN(□□□□,X,△△)
	Y	Y coordinates of found object	[△△]	WIN(□□□□,Y,△△)
	XH	Maximum X coordinates from all objects	--	WIN(□□□□,XH,0)
	XL	Minimum X coordinates from all objects	--	WIN(□□□□,XL,0)
	YH	Maximum Y coordinates from all objects	--	WIN(□□□□,YH,0)
	YL	Minimum Y coordinates from all objects	--	WIN(□□□□,YL,0)
	AG	Object angle found	[△△]	WIN(□□□□,AG,△△)
Blob	N	Quantity	--	WIN(□□□□,N,0)

	X	Center X coordinates	[△△]	WIN(□□□□,X,△△)
	Y	Center Y coordinates	[△△]	WIN(□□□□,X,△△)
	XH	Maximum X coordinates of all spot centers	--	WIN(□□□□,XH,0)
	XL	Minimum X coordinates of all spot centers	--	WIN(□□□□,XL,0)
	YH	Maximum Y coordinates of all spot centers	--	WIN(□□□□,YH,0)
	YL	Minimum Y coordinates of all spot centers	--	WIN(□□□□,YL,0)
	AR	Blob area	[△△]	WIN(□□□□,AR,△△)
	ARH	Maximum blob area	--	WIN(□□□□,ARH,0)
	ARL	Minimum blob area	--	WIN(□□□□,ARL,0)
	RD	Roundness	[△△]	WIN(□□□□,RD,△△)
	RDH	Maximum roundness	--	WIN(□□□□,RDH,0)
	RDL	Minimum roundness	--	WIN(□□□□,RDL,0)
	AG	Incident clockwise angle of main axis to horizontal axis	[△△]	WIN(□□□□,AG,△△)
	AGH	Maximum incident clockwise angle of all main axis to horizontal axis	--	WIN(□□□□,AGH,0)
	AGL	Minimum incident clockwise angle of all main axis to horizontal axis	--	WIN(□□□□,AGL,0)
	PE	Circumference	[△△]	WIN(□□□□,PE,△△)
	PEH	Maximum circumference	--	WIN(□□□□,PEH,0)
	PEL	Minimum circumference	--	WIN(□□□□,PEL,0)
	EX	X (horizontal direction) Feret diameter	[△△]	WIN(□□□□,EX,△△)
	EY	Y (vertical direction) Feret diameter	[△△]	WIN(□□□□,EY,△△)
	EXH	Maximum X (horizontal) Feret diameter	--	WIN(□□□□,EXH,0)
	EXL	Minimum X (horizontal) Feret diameter	--	WIN(□□□□,EXL,0)
	EYH	Maximum Y (vertical) Feret diameter	--	WIN(□□□□,EYH,0)
	EYL	Minimum Y (vertical) Feret diameter	--	WIN(□□□□,EYL,0)
	TLX	Top left X coordinates of extension rectangle	[△△]	WIN(□□□□,TLX,△△)
	TLY	Top left Y coordinates of extension rectangle	[△△]	WIN(□□□□,TLY,△△)
	MA	Major axis length	[△△]	WIN(□□□□,MA,△△)
	MAH	Maximum major axis length	--	WIN(□□□□,MAH,0)
	MAL	Minimum major axis length	--	WIN(□□□□,MAL,0)
	TAR	Total defective area	--	WIN(□□□□,N,0)
	N	Cluster	--	WIN(□□□□,N,0)
Stain	AR	Defective area	[△△]	WIN(□□□□,AR,△△)
	ARH	Maximum defective area	--	WIN(□□□□,ARH,0)
	ARL	Minimum defective area	--	WIN(□□□□,ARL,0)

	X	Center X coordinates of all defects	[△△]	WIN(□□□□,X,△△)
	Y	Center Y coordinates of all defects	[△△]	WIN(□□□□,Y,△△)
	XH	Maximum X coordinates from all defect centers	--	WIN(□□□□,XH,0)
	XL	Minimum X coordinates from all defect centers	--	WIN(□□□□,XL,0)
	YH	Maximum Y coordinates from all defect centers	--	WIN(□□□□,YH,0)
	YL	Minimum Y coordinates from all defect centers	--	WIN(□□□□,YL,0)
Position Trace	N	Total	--	WIN(□□□□,N,0)
	X	X coordinates of all edges	[△△]	WIN(□□□□,X,△△)
	Y	Y coordinates of all edges	[△△]	WIN(□□□□,Y,△△)
	XH	X coordinates of maximum outline	--	WIN(□□□□,XH,0)
	XL	X coordinates of minimum outline	--	WIN(□□□□,XL,0)
	YH	Y coordinates of maximum outline	--	WIN(□□□□,YH,0)
	YL	Y coordinates of minimum outline	--	WIN(□□□□,YL,0)
	XA	Average X coordinates of all outlines	--	WIN(□□□□,XA,0)
	YA	Average Y coordinates of all outlines	--	WIN(□□□□,YA,0)
	D	Distances of all outlines	[△△]	WIN(□□□□,D,△△)
	DH	Maximum distance from all outlines	--	WIN(□□□□,DH,0)
	DL	Minimum distance from all outlines	--	WIN(□□□□,DL,0)
	DA	Average distance from all outlines	--	WIN(□□□□,DA,0)
	RD	Roundness	--	WIN(□□□□,RD,0)
	CX	Circle center position X	--	WIN(□□□□,CX,0)
	CY	Circle center position Y	--	WIN(□□□□,CY,0)
	CRU	Circle radius	--	WIN(□□□□,CRU,0)
Width Trace	N	Total	--	WIN(□□□□,N,0)
	WH	Maximum width	--	WIN(□□□□,WH,0)
	WL	Minimum width	--	WIN(□□□□,WL,0)
	WA	Average width	--	WIN(□□□□,WA,0)
	W	All widths	[△△]	WIN(□□□□,W,△△)
	HX1	X1 coordinates of maximum width	--	WIN(□□□□,HX1,0)
	HY1	Y1 coordinates of maximum width	--	WIN(□□□□,HY1,0)
	HX2	X2 coordinates of maximum width	--	WIN(□□□□,HX2,0)
	HY2	Y2 coordinates of maximum width	--	WIN(□□□□,HY2,0)
	LX1	X1 coordinates of minimum width	--	WIN(□□□□,LX1,0)
	LY1	Y1 coordinates of minimum width	--	WIN(□□□□,LY1,0)
	LX2	X2 coordinates of minimum width	--	WIN(□□□□,LX2,0)

	LY2	Y2 coordinates of minimum width	--	WIN(□□□□,LY2,0)
	XS	X1 coordinates of width across all edges	[△△]	WIN(□□□□,XS,△△)
	YS	Y1 coordinates of width across all edges	[△△]	WIN(□□□□,YS,△△)
	XE	X2 coordinates of width across all edges	[△△]	WIN(□□□□,XE,△△)
	YE	Y2 coordinates of width across all edges	[△△]	WIN(□□□□,YE,△△)
	RD1	Roundness 1 (inner)	--	WIN(□□□□,RD1,0)
	CX1	Roundness center position X1	--	WIN(□□□□,CX1,0)
	CY1	Roundness center position Y1	--	WIN(□□□□,CY1,0)
	CR1	Roundness radius 1	--	WIN(□□□□,CR1,0)
	RD2	Roundness 2 (outer)	--	WIN(□□□□,RD2,0)
	CX2	Centre X coordinates of circle 2	--	WIN(□□□□,CX2,0)
	CY2	Centre Y coordinates of circle 2	--	WIN(□□□□,CY2,0)
	CR2	Circle 2 radius	--	WIN(□□□□,CR2,0)

6.3.5 Item Type > Description of Register

[Register]

1) The system provides 128 internal variable registers, from REG (0) to REG (127). The registers adopt global variables, which are shared in all projects in the system.

2) The user can also write/read variable registers through communication methods and substitute variable registers into calculator functions for relevant operations.

For example: In the following diagram, variable register can be substituted into EQ (a function that compares whether two values are equal) as the comparative value.
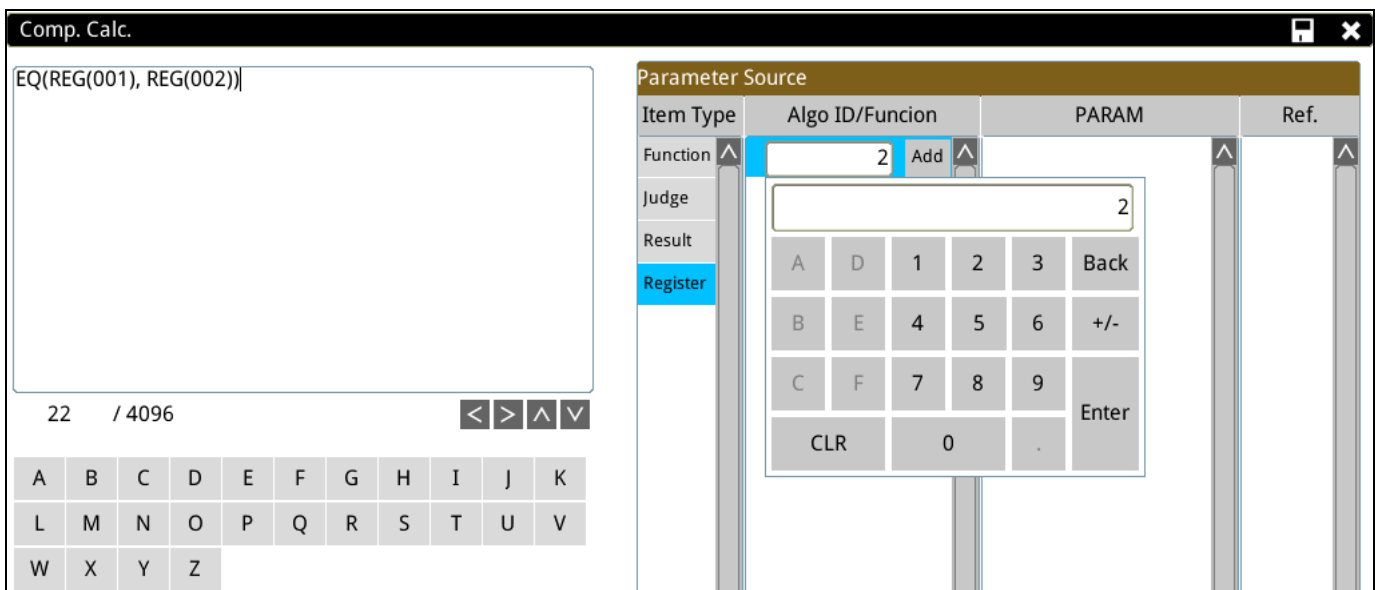
6.4 Description of Single Calculation

Most applications are simple calculator functions, so the system makes each calculator function independent for users to directly click on, and provides a simple operating interface to avoid complex calculations in Total Calculation.

6.4.1 Description of Logic Operation functions

First select the function icon in [Logic] on the right, and add it to the process. Click on parameters needed to enter start settings.
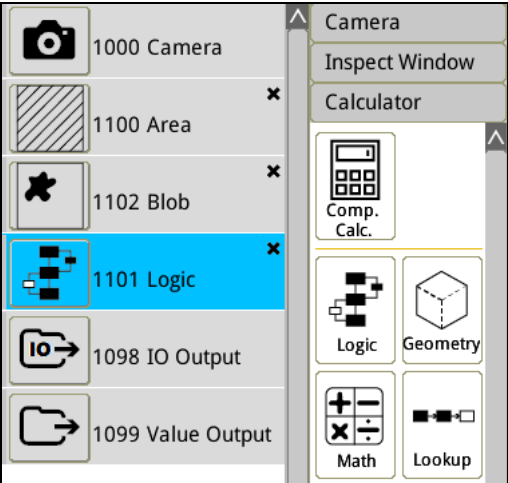
There are 8 functions in logic for users to choose from.
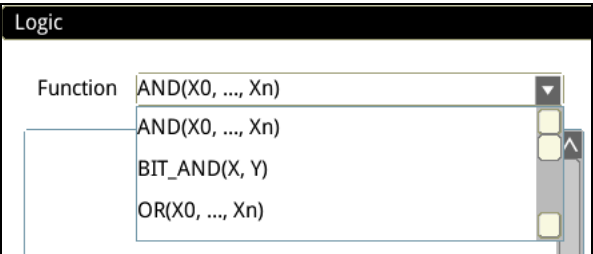
📖 Reference   Please refer to Section 6.3.2 for a detailed description of functions.

Sequentially import parameters for calculation. (Up to 128 parameters may be entered)

6.4.2 Description of Mathematics functions

First select the function icon in [Math] on the right, and add it to the process. Click on parameters needed to enter start settings.

There are 13 functions in math functions for users to choose from.
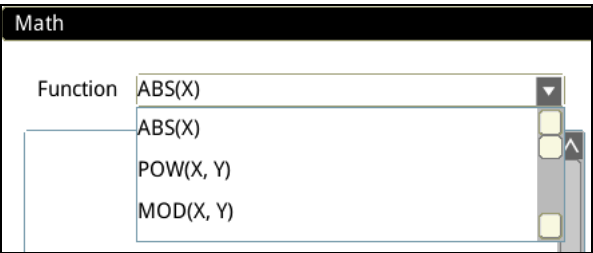
Reference Please refer to Section 6.3.2 for a detailed description of functions.

Sequentially import parameters for calculation. (Up to 128 parameters may be entered)
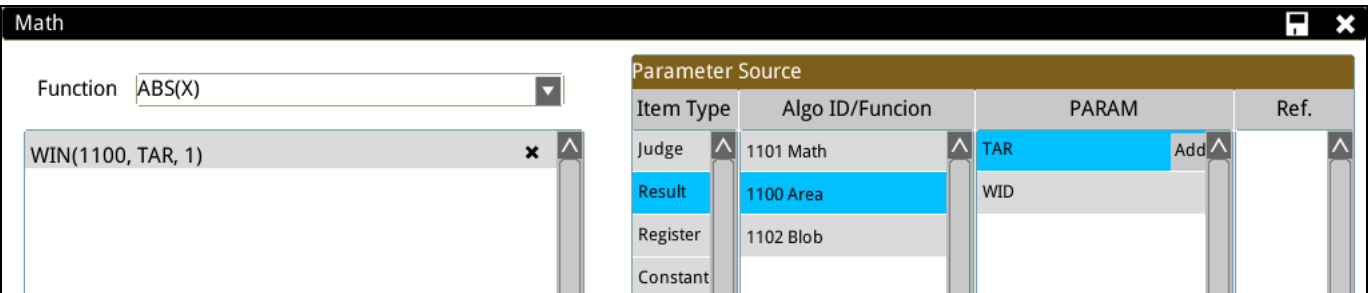
6.4.3 Description of Comparison Operation functions

First select the function icon in [Compare] on the right, and add it to the process. Click on parameters needed to enter start settings.
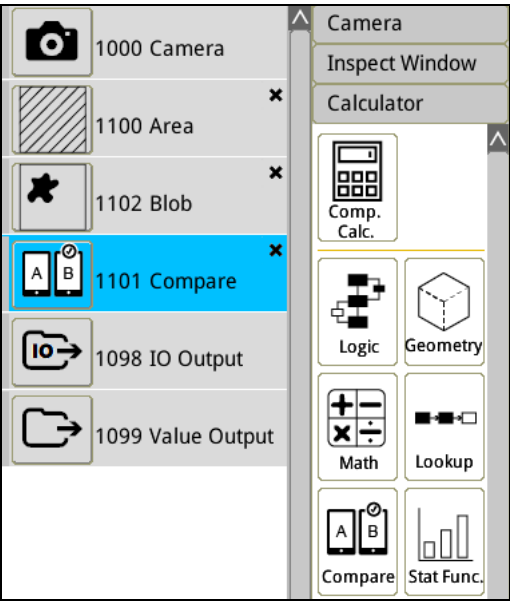
There are 6 functions in compare functions for users to choose from.
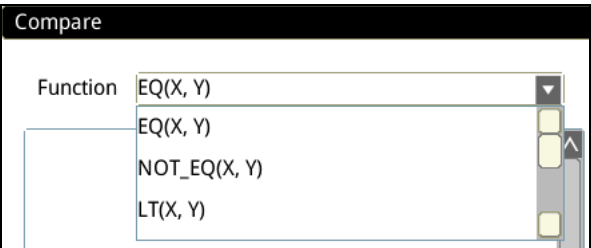
Reference Please refer to Section 6.3.2 for a detailed description of functions.

Sequentially import parameters for calculation. (Up to 128 parameters may be entered)
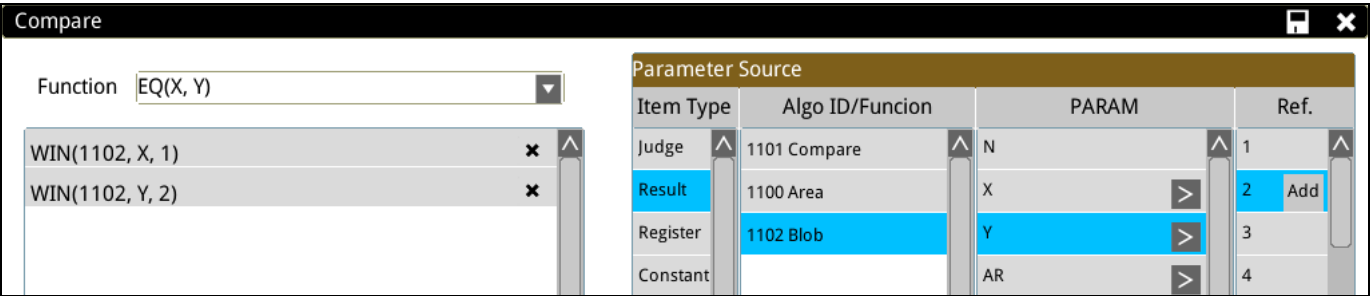
6.4.4 Description of Trigonometric Operation functions

First select the function icon in [Trigo] on the right, and add it to the process. Click on parameters needed to enter start settings.
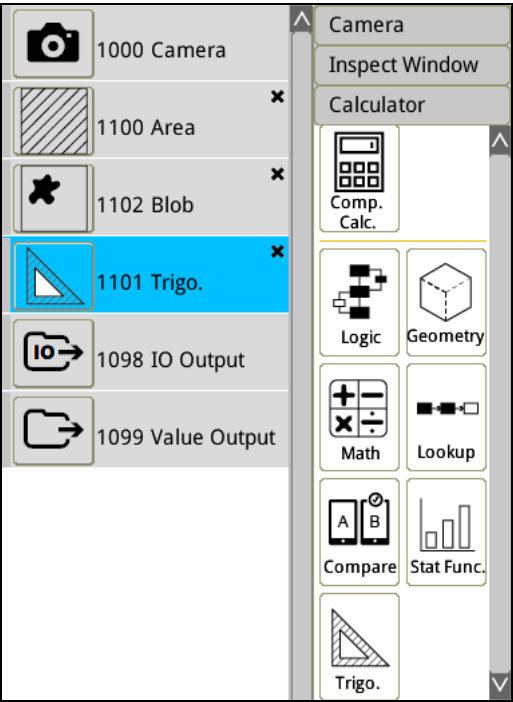
There are 13 functions in compare functions for users to choose from.
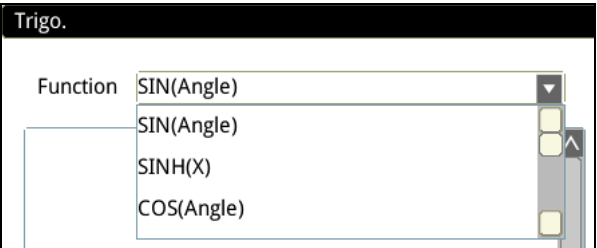
Reference Please refer to Section 6.3.2 for a detailed description of functions.

Sequentially import parameters for calculation. (Up to 128 parameters may be entered)
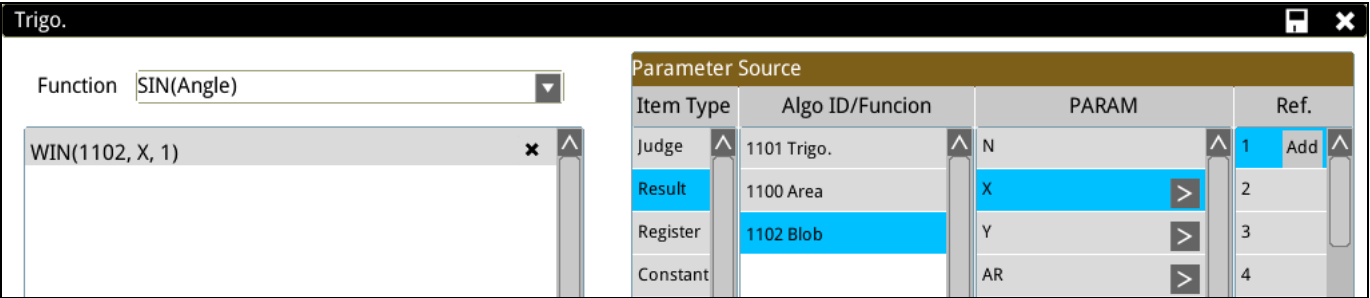
6.4.5 Description of Geometric Operation functions

First select the function icon in [Geometry] on the right, and add it to the process. Click on parameters needed to enter start settings.
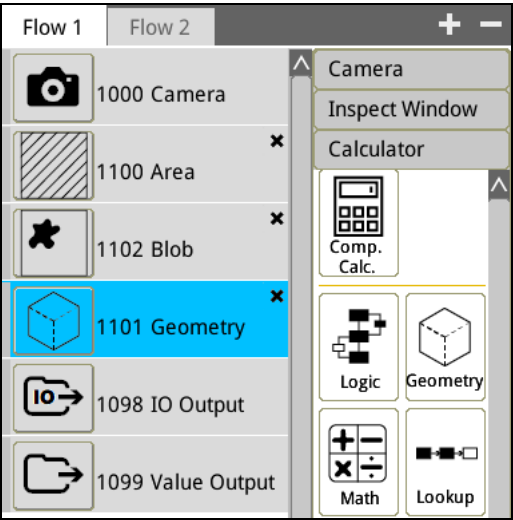
There are 34 functions in compare functions for users to choose from.
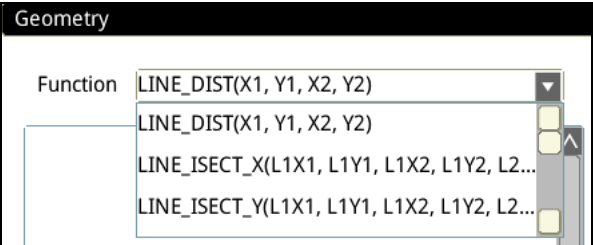
Reference Please refer to Section 6.3.2 for a detailed description of functions.

Sequentially import parameters for calculation. (Up to 128 parameters may be entered)

6.4.6 Description of Lookup Operation functions

First select the function icon in [Lookup] on the right, and add it to the process. Click on parameters needed to enter start settings.

There are 6 functions in compare functions for users to choose from.

Reference Please refer to Section 6.3.2 for a detailed description of functions.

Sequentially import parameters for calculation. (Up to 128 parameters may be entered)
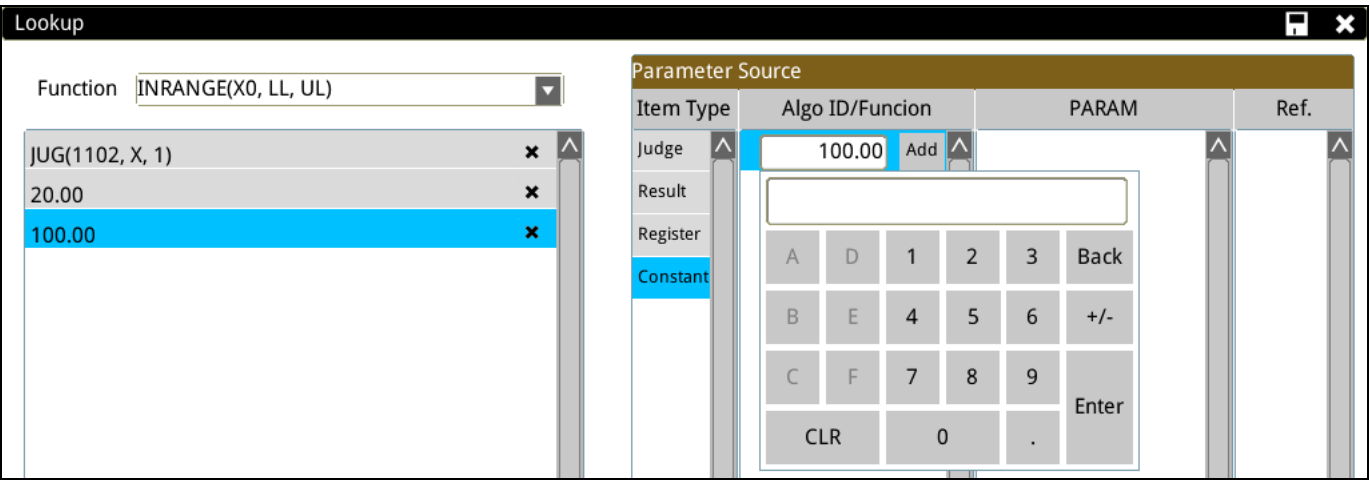
6.4.7 Description of Statistical functions

First select the function icon in [Stat Func.] on the right, and add it to the process. Click on parameters needed to enter start settings.
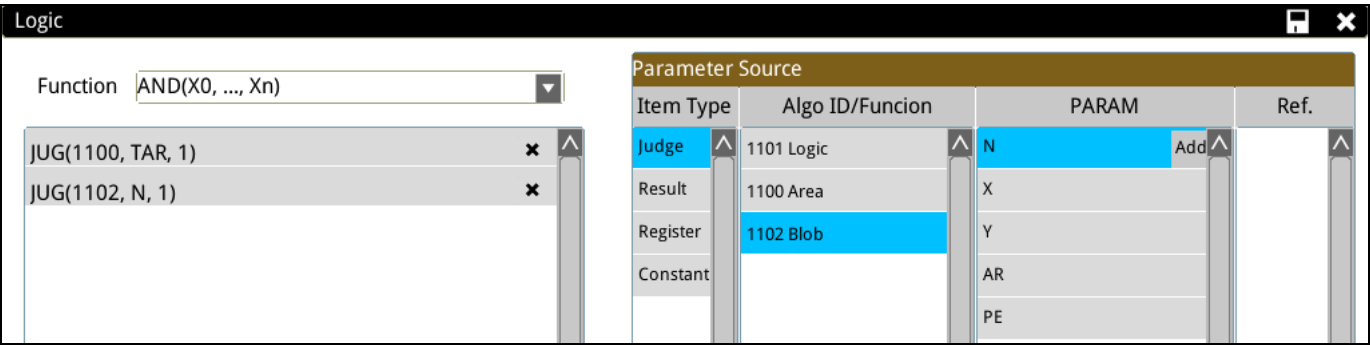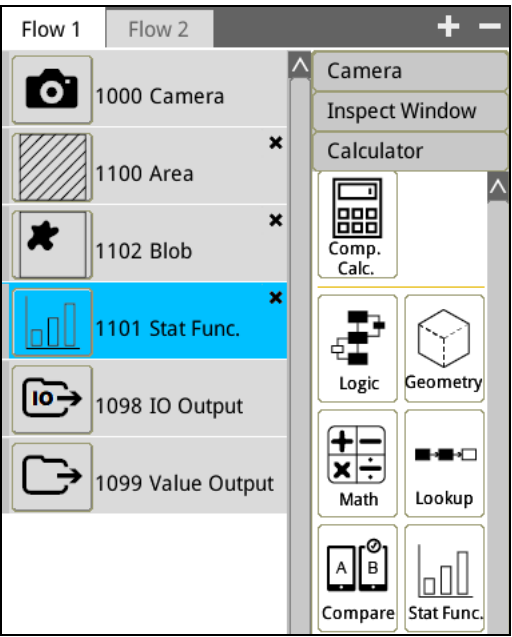

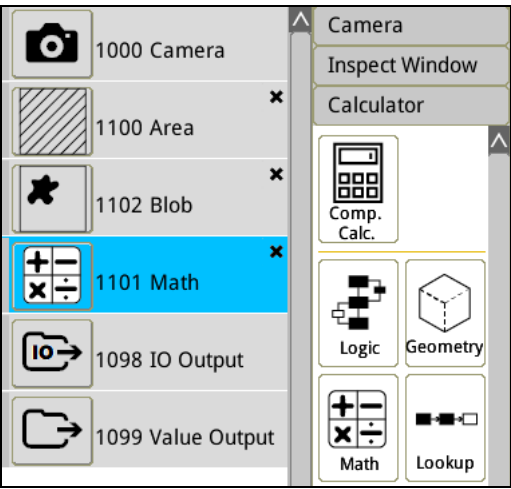There are 6 functions in compare functions for users to choose from.
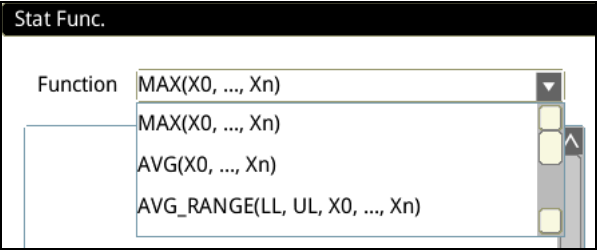
Reference Please refer to Section 6.3.2 for a detailed description of functions.

Sequentially import parameters for calculation. (Up to 128 parameters may be entered)
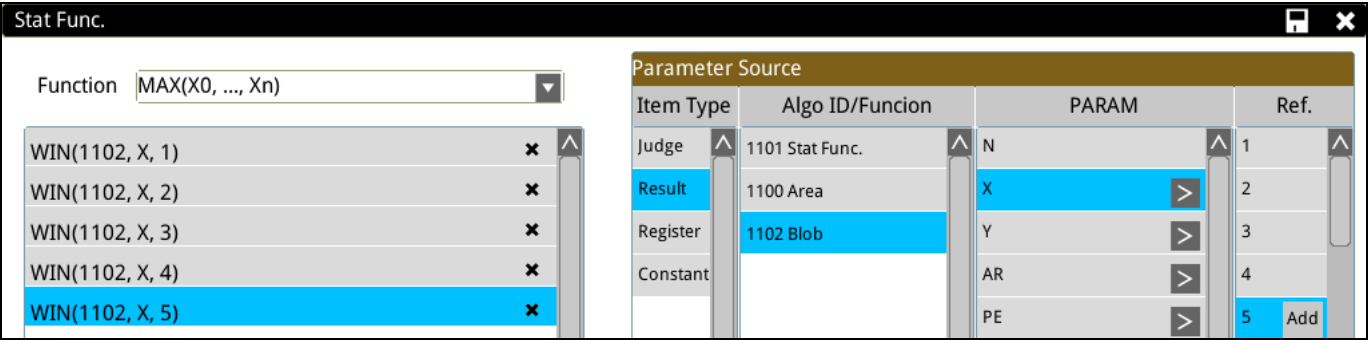
Chapter 7

Input and Output I/O Terminal

The I/O interface provides the main communication method between the DMV3000G and the superior controller and features the following functions.

◎ **Current system state indicator**
For example: Ready, Run, Error and so on

◎ **Camera imaging trigger capture**
You can also issue this trigger issued through the RS232 or Ethernet ports; however the I/O channel is more responsive than the communication channels.

◎ **Flash output**
The system parameters coordinate the light flash output with the camera shutter action (must use with the light controller).

◎ **Output results**
After each inspection, the DMV2000 can transmit the logical OK(1) / NG(0) and numerical results through the I/O channel. These values can also be transmitted through the RS232 or Ethernet ports. In general, if the output consists of only OK(1) / NG(0) data, the I/O channel is more responsive and the string does not need to be processed.

◎ **I/O Contact**
The 8-point input and 11-point output removable I/O terminals are provided on the left side of the system (shown in the following diagram).

1-COMIN	1-OUT1
2-IN1	2-OUT2
3-IN2	3-OUT3
4-IN3	4-OUT4
5-IN4	5-OUT5
6-IN5	6-OUT6
7-IN6	7-OUT7
8-IN7	8-OUT8
9-IN8	9-OUT9
	10-OUT10
	11-OUT11
	12-COMOUT
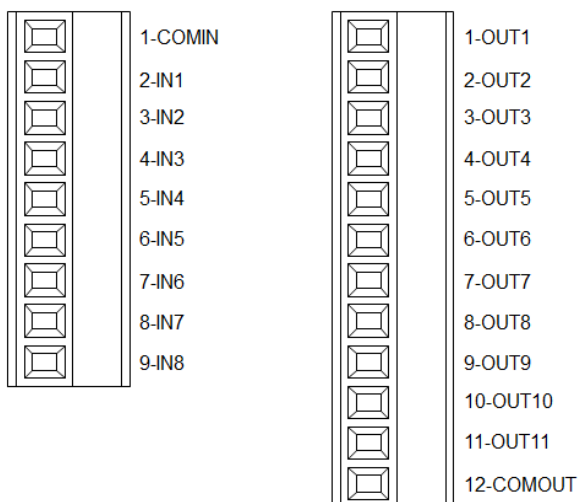
7.1 Definition of the I/O Functions

DMV3000G can support up to 2 cameras, i.e., two independent processes can be executed at the same time, so 2 independent TRIG signals can be provided.

The signal of each I/O point in the system can be defined by the user. During operation, select [Tools] > [Communication] to view the I/O setting table in [I/O].

◎ **Input terminal**

📠 Reference Please refer to Section 2.1.3 for the definition of I/O terminal functions.

1) Enable Input Terminal

 At [Enable], check the terminal that will be used.

2) Change Input Function

At [Signal], select the input point function from the pull-down menu.

Input	Output	EMIO / Input	EMIO / Output	
Enable	I/O	Signal Phase	Signal	Signal Test
☑	IN1	---	TRIG1 ▼ TRIG1 TRIG2 TROFF	◉
☐	IN2	---		○
☐	IN3	---		○

3) Signal Testing

When the circle indicator is green, it means that the input point is currently ON. Verify if the input point is correctly connected when beginning use. This makes it convenient to view the status of input points.

Input	Output	EMIO / Input	EMIO / Output	
Enable	I/O	Signal Phase	Signal	Signal Test
☑	IN1	---	TRIG1 ▼	🟢
☐	IN2	---	TRIG2 ▼	○
☐	IN3	---	TROFF ▼	○

4) NPN/ PNP input method selection

The NPN/PNP of input points is not selected in the software interface and is determined through external wiring.

🔲 Reference Please refer to Section 2.1.1 for the NPN/PNP wiring method.

◎ **Output terminal**

🗐 Reference Please refer to Section 2.1.3 for the definition of I/O terminal functions.

1) Enable Output Terminal

At [Enable], check the terminal that will be used.

2) Forward/Reverse Signal

The default is [NormalOutput], i.e., the state is NO (open circuit). When the signal is output, the state is NC (short-circuit). If [Inverse Output] is selected, i.e., the state is NC (short-circuit), when the signal is output, the state is NO (open circuit).

Input	Output	EMIO / Input	EMIO / Output	
Enable	I/O	Signal Phase	Signal	Signal Test
☑	OUT1	Normal Output	READY1	○
☑	OUT2	Inverse Output	READY2	○
☑	OUT3	Normal Output	RUN	○

3) Change Output Function

At [Signal], select the output point function from the pull-down menu.

Input	Output	EMIO / Input	EMIO / Output	
Enable	I/O	Signal Phase	Signal	Signal Test
☑	OUT1	Normal Output	READY1	○
☑	OUT2	Normal Output	READY1 / READY2	○
☑	OUT3	Normal Output	RUN	○

4) Signal Testing

Directly click on the circle indicator in the figure below, the status alternates (turns ON when clicked once and turns OFF when clicked again). When the circle indicator is green, it means that the output point is currently ON.

Input	Output	EMIO / Input	EMIO / Output	
Enable	I/O	Signal Phase	Signal	Signal Test
☑	OUT1	Normal Output	READY1	●
☑	OUT2	Normal Output	READY2	○
☑	OUT3	Normal Output	RUN	○

5) NPN/PNP output method selection

Besides selecting NPN/PNP through the wiring method, it must also be selected in [Output Type].

Output Type
● NPN ○ PNP

Reference Please refer to Section2.1.2 for NPN/PNP wiring method.

6) TOUT1-TOUT8 advanced settings

The system simultaneously provides eight independent output signals (TOUT1 to TOUT8) to be flexibly configured by the user.

Multiple output timing settings are provided to meet the signal and action timing requirements of the upper controller.

TOUT			
No.	Output Timing	Output Type	Pulse Width
TOUT1	When OK ▼	Hold signal ▼	30.0
TOUT2	When OK ▼	Hold signal ▼	30.0
TOUT3	When OK ▼	Hold signal ▼	30.0
TOUT4	When OK ▼	Hold signal ▼	30.0
TOUT5	When OK ▼	Hold signal ▼	30.0
TOUT6	When OK ▼	Hold signal ▼	30.0
TOUT7	When OK ▼	Hold signal ▼	30.0
TOUT8	When OK ▼	Hold signal ▼	30.0

➤ Output Timing

Configure whether to output when the result is OK or NG.

TOUT			
No.	Output Timing	Output Type	Pulse Width
TOUT1	When OK ▼	Hold signal ▼	30.0
TOUT2	When NG ▼	Hold signal ▼	30.0

➤ Output Type

When [Pulse Signal] is selected, the aforementioned [Pulse Width] is applied as the output pulse width. When [Hold Signal] is selected, the output signal will only change until after the completion of the next inspection.

TOUT			
No.	Output Timing	Output Type	Pulse Width
TOUT1	When OK ▼	Hold signal ▼	30.0
TOUT2	When OK ▼	Pulse signal ▼	30.0

➤ Pulse Width

Configure the output pulse time width when [Pulse Signal] is selected in [Output Type].

7.2 I/O Activation Timing

7.2.1 TRIG (Trigger) Capture

➤ Depending on the model, the DMV3000G can support up to 2 cameras, and provides up to 2 TRIG trigger signals (TRIG1–TRIG2).

➤ Each camera can independently be paired with a TRIG trigger signal; for example, pair Camera1 with TRIG1, Camera2 with TRIG2.

➤ Multiple cameras can share the same TRIG trigger signal; for example, Camera1 and Camera2 can both use TRIG1.

◎ **Use Single Flow Process**

One camera coupled with one TRIG trigger signal
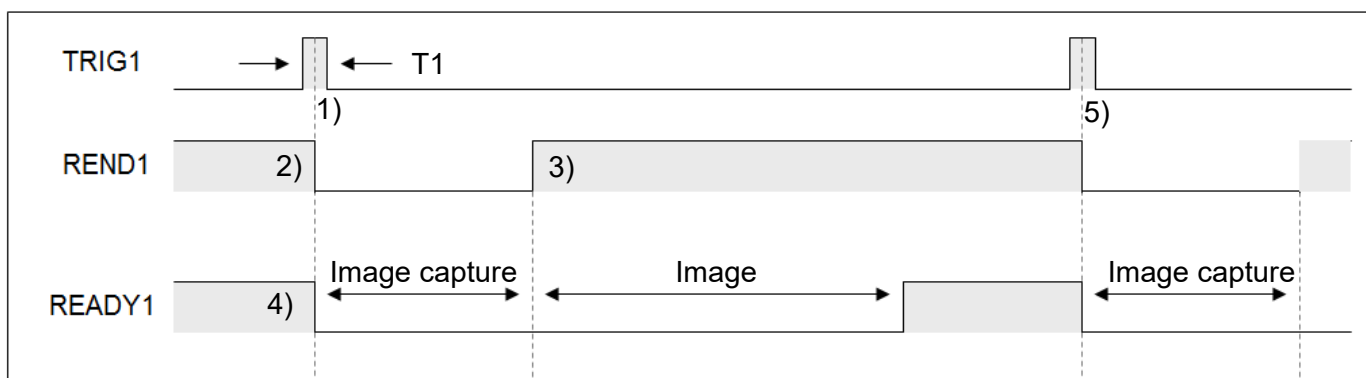
Description:

1) Trigger period T1 must be longer than 0.5ms. If T1 is too short, the trigger may not respond.
2) REND1 signal switches OFF after trigger.
3) When the image is captured (exposure and capture + image transfer), REND1 signal switches ON.
4) READY1 signal switches OFF after capture and switches ON after completing the inspection (image capture + image processing).
5) Steps 1–4 are a complete inspection cycle and the system is ready for the next trigger signal.

Use the READY1 signal as the logical (Judge) condition for the TRIG1 trigger timing.

Total period = image capture time + image processing time

◎ **Use Single Flow Process**

Two cameras coupled with one TRIG trigger signal: Camera1 and Camera2 are both configured as coupled with TRIG1 trigger.

➤ TRIG1 initiates the system to automatically capture Image1 and Image2.
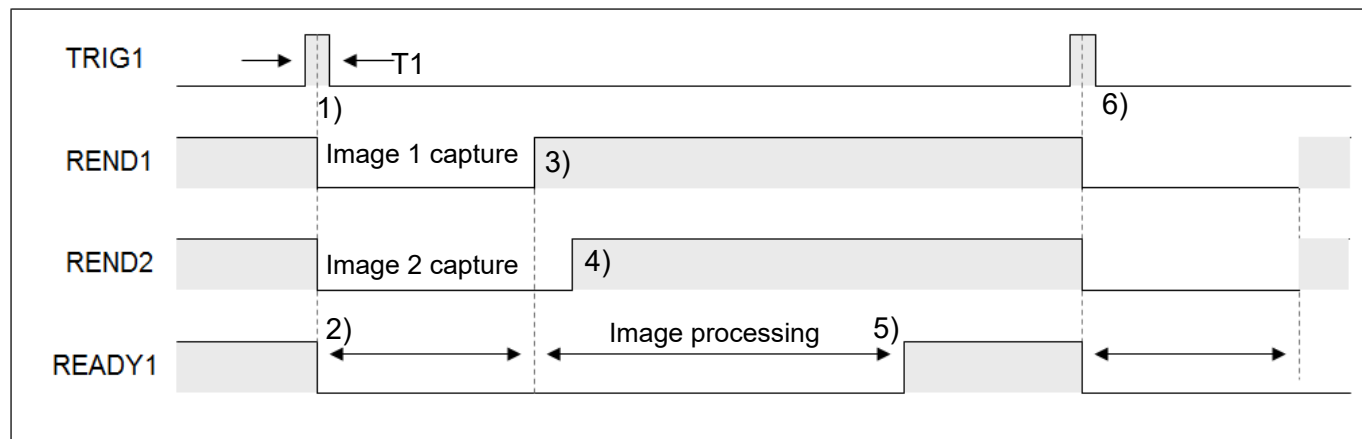
Description:

1) Trigger period T1 must be longer than 0.5ms. If T1 is too short, the trigger may not respond.
2) After Trigger1 is initiated, READY1 and camera REND1 and REND2 switch OFF.
3) REND1 is ON after Image1 is captured.
4) REND2 is ON after Image2 is captured.
5) READY1 is ON after image processing is complete.
6) Steps 1–5 are a complete inspection cycle and the system is ready for the next trigger signal.

Use the READY1 signal as the logical (Judge) condition for the TRIG1 trigger timing.

Total cycle time = (Image1 capture time + Image2 capture time) + image processing time

◎ **Multiplexing Flow Process (Asynchronous Flow)**

Two cameras coupled with two TRIG trigger signals.

➤ Camera1 is coupled with TRIG1, Camera2 is coupled with TRIG2, and the trigger order of TRIG1 and TRIG2 is unrestricted.

Each flow process generates independent outputs, immediately after completing each trigger inspection.

The outputs are irrelevant to the TRIG signals for other flow processes.
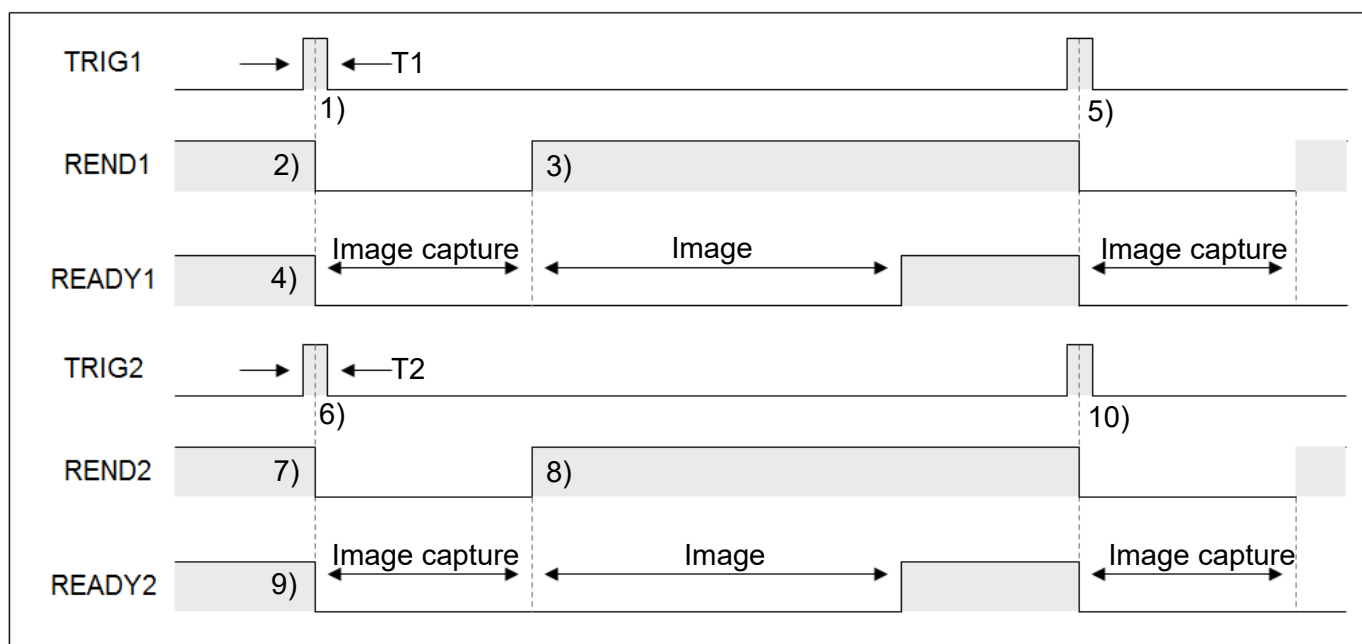
Description:

1) Trigger period T1 must be longer than 0.5ms. If T1 is too short, the trigger may not respond.

2) REND1 signal switches OFF after trigger TRIG1.

3) When the image is captured (exposure and capture + image transfer), REND1 signal switches ON.

4) READY1 signal switches OFF after capture and switches ON after completing the inspection (image capture + image processing).

5) Steps 1–4 are a complete an inspection cycle and the system is ready for the next trigger signal.

6) Trigger period T2 must be longer than 0.5ms. If T2 is too short, the trigger may not respond.

7) REND2 signal switches OFF after trigger.

8) When the image is captured (exposure and capture + image transfer), REND2 signal switches ON.

9) READY2 signal switches OFF after capture and switches ON after completing the inspection (image capture + image processing).

10) Steps 6–9 are a complete inspection cycle and the system is ready for the next trigger signal.

Use the READY signal as the logical (Judge) condition for TRIG trigger timing.

Total period = image capture time + image processing time

7.2.2 Flash Timing

Proper timing of the light source is crucial to the quality of the captured image. The system supports FLASH1–FLASH4 outputs to control the output timing of peripheral light sources.

ⓘRemark The light controller for the light source must have an external trigger input function when using the FLASH signal.

➤ The output of flash activation signal must occur before the activation of camera shutter.
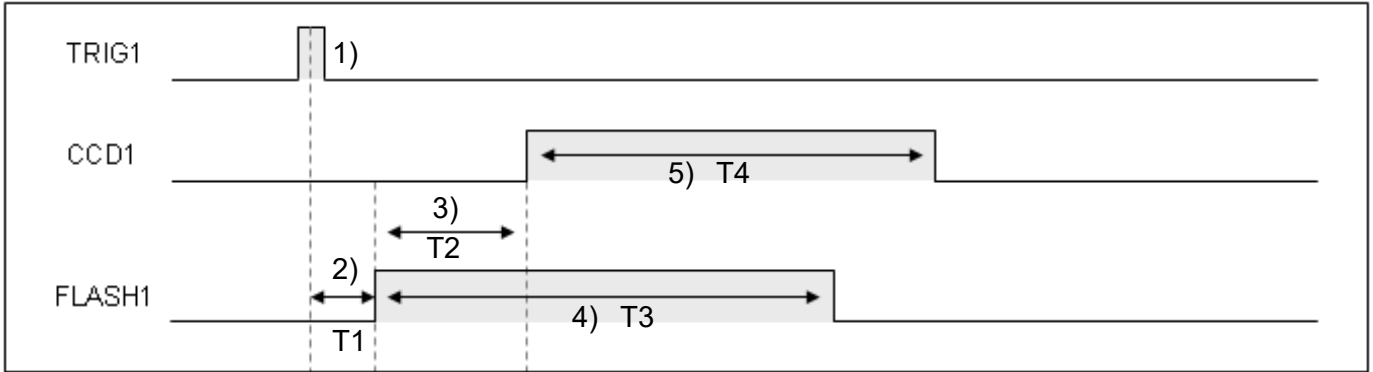
T1: Delay by approximately 2ms (reaction times vary according to differing lights).

T2: Configured in Output Start Time (Unit: ms)

T3: Configured in During Time (Unit: ms)

T4: Configured in Shutter Time for the camera

Description:

1) When TRIG is triggered, timed flash output is enabled.

2) Due to processing delays of the light, the flash output is delayed by approximately 1 ms.

3) The flash output occurs before the camera shutter; therefore, the activation of camera shutter is delayed.

4) Total time of flash output.

5) Shutter duration of the camera.

ⓘRemark The CCD1 (2) signal is controlled internally in the system, unlike typical external terminals.

Therefore, external pins are not provided for CCD1 (2).

The following picture shows the **Flash1** setup in the **Camera 1** dialog box when the flash output is before the shutter output.

7.2.3 Communication Result Output

➤ RS232, USB, ETHERNET, memory card, PLC-Link, and image storage output
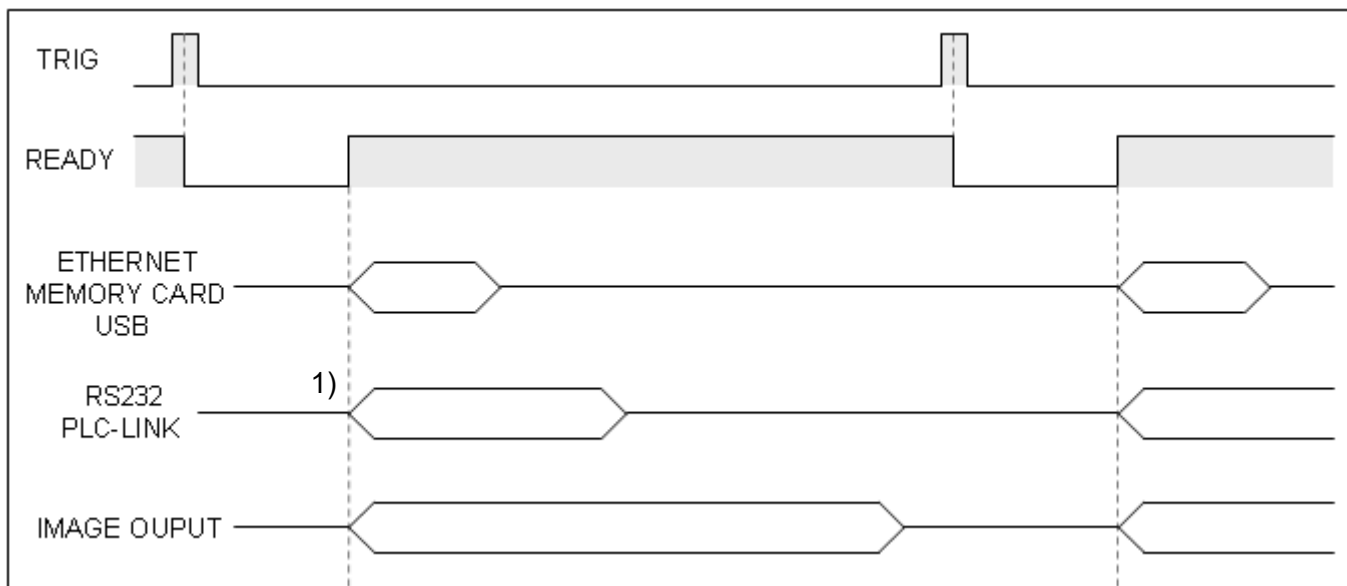
Description:

The outputs are in sync with the READY ON signal.

i Remark To set the communication speed, click **ETHERNET** > **RS232** > **IMAGE OUTPUT**.

7.2.4 Others: TROFF, TEST, RESET

➤ TROFF (trigger disabled)
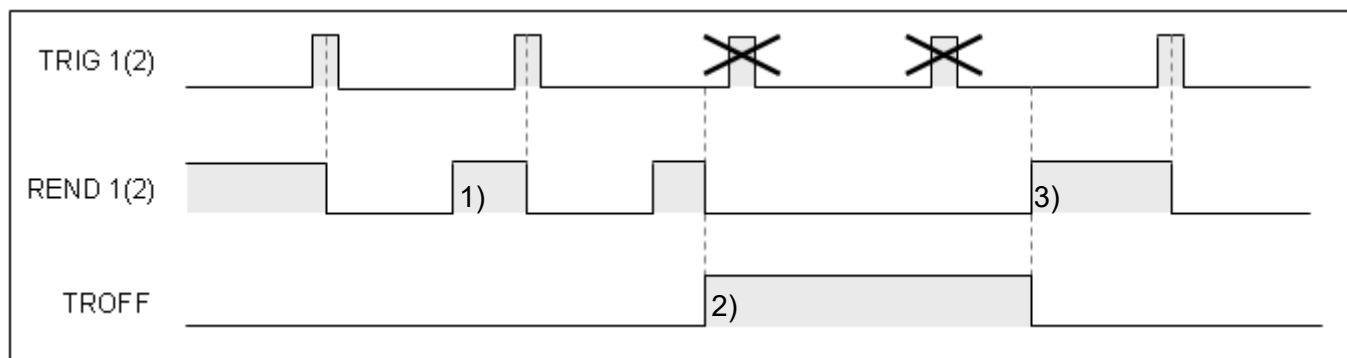
Description:

1) During standard timing sequence, REND is ON after the image is captured to allow the next trigger input.

2) When TROFF input is ON, REND1 and REND2 are disabled at the same time. You can use either the TROFF or REND signals as the trigger point.

3) When TROFF is OFF, REND1 and REND2 signals resume normal operation.

➤ TEST (output disabled)
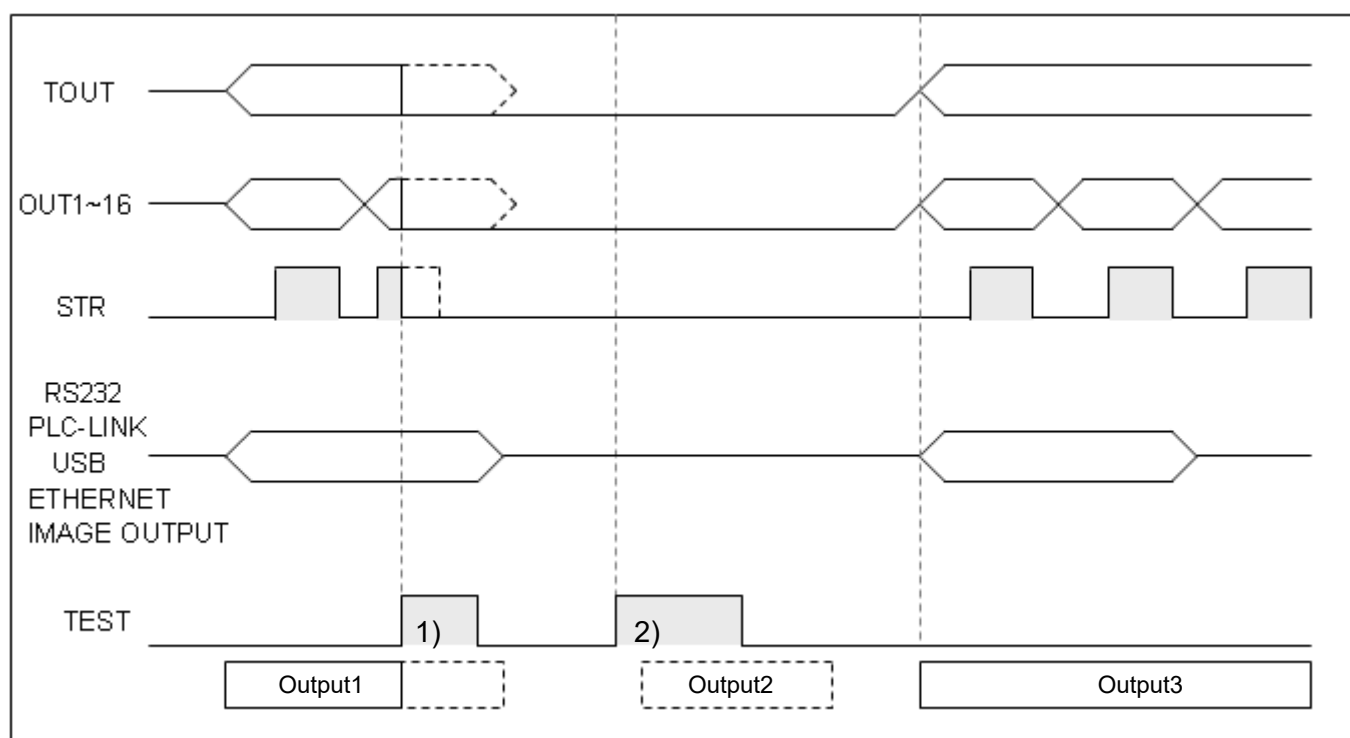
Description:

1) Output1 is valid before TEST input is ON, and all external output terminals are OFF and communication output is uninterrupted until the sequence ends.

2) TEST input occurs before Output2, therefore external output terminals and communication outputs are disabled.

➤ RESET

When RESET signal input is enabled, all outputs are disabled.

Chapter 8

Communication Commands

8.1 RS232/RS485 Serial Communication Mode

The following 3 types of serial communication methods are provided for user selection.

◎ **Modbus Slave Mode: (DMV is in Slave Mode)**
When "Modbus Slave" is selected, the controller will automatically switch to slave mode when it is not outputting data. This enables externally entering MODBUS commands, prompting response from the controller. (Please refer to Section 8.2.1 for more information about the MODBUS Slave Mode command format)
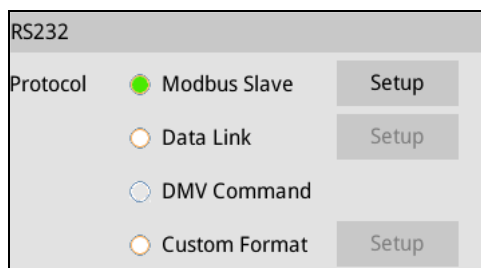
◎ **Data Link Mode: (DMV is in Master Mode)**
After inspection is complete, the system will automatically write output results to the designated register in the upper controller (PLC, HMI, Robot). This eliminates the need to write a communication program and lifts the burden on programmers. The numerical results can be directly obtained from the register of the upper controller.
Data Link functions currently only support Modbus communication protocol.
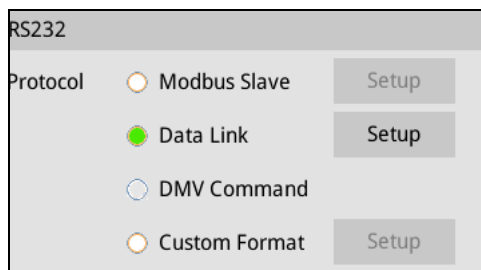
◎ **Custom mode:**

After each inspection, the system will send out the configured output results through the RS232/RS485 communication ports in custom DMV communication protocol. After receiving the communication strings, the user must decode the numerical data according to the DMV defined method.

When results are not output, the system will switch to slave mode and accept DMV custom communication commands.

8.2 RS232/485 MODBUS Slave Mode: (DMV is in Slave Mode)

Configure the communication protocol in [Tools] > [Communications] > [RS232/RS485].

In Modbus Slave Mode, the default communication protocol is 9600, 7, E, 1; DMV station number is set at RS485. RS232/RS485 can communicate independently and supports different communication protocols.

After clicking on the [Settings] button, [Data Format] will be displayed; 16/32 bits and ASCII/RTU data formats are supported.
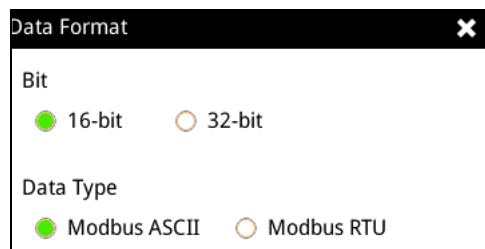
8.2.1 Slave Mode Command Table: (Modbus Communication Format)

Support ASCII and RTU mode. Refer to the ASCII table in Section 8.6 for ASCII to hexadecimal conversions.

R indicates support for Read commands (03H code; maximum64 entries).

W indicates support for Write commands (write single entry: 06H code; write multiple entries: 10H code; maximum 6 entries).

➤ **Read 03 Read Command Description:** (read single or multiple data entries controlled by the **Byte** parameter)

Output format

:	01	03	1010	0002	DA	CR LF
Header	Node ID	Function code (read)	Function address	Data ID	Parity	Suffix

Return format

:	01	03	04	0010	0015	D8	CR LF
Header	Node ID	Function code (read)	Number of entries (Byte)	Result 1	Result 2	Parity	Suffix

➤ **Write 06 Single Entry Write Command Description:** (returns the correctly written data string as is)

Output format

:	01	06	1000	0001	E8	CR LF
Header	Node ID	Function code (write)	Function address	Write data	Parity	Suffix

Return format

:	01	06	1000	0001	E8	CR LF
Header	Node ID	Function code (write)	Function address	Write data	Parity	Suffix

➤ **Write 10 Multiple Entry Write Command Description:** (maximum length of six entries)

Output format

:	01	10	1070	0002	04	0060	0015	F4	CR	LF
Header	Node ID	Function code	Function address	Writes	Byte count	Data 1	Data 2	Parity	Suffix	

Return format

:	01	10	1070	0002	6D	CR	LF
Header	Node ID	Function code	Function address	Writes	Parity	Suffix	

Parity check:

Sum two-by-two, then take the two's complement of the last two digits (add in hexadecimal without the header).

For example: 0110107000020400600015 F4 CR LF

　　　01+10+10+70+00+02+04+00+60+00+15 = 10C (take the last 2 codes 0C)

　　　Calculate the one's complement = FF - 0C = F3 (one's complement is FF minus the value).

　　　Calculate the two's complement = F3 +1 = F4 (two's complement is the sum of one's complement and 1)

◎ **Modbus Communication Address Table**

Position	Function code supported	Name	Description	Permission	
				Run	Edit
1000H(W)	(06H)	Trigger 1 action	Trigger if Data 1 is written	O	
1001H(W)	(06H)	Trigger 2 action	Trigger if Data 1 is written	O	
1010H–104FH(R)	(03H)	Output data (total 64 entries)	(refer to the following for description on output data)	O	
1050H(W)	(06H)	Switch to Run mode	Trigger if Data 1 is written		O
1051H(W)	(06H)	Switch to Edit mode	Trigger if Data 1 is written	O	
1060H(R/W)	(03H,06H)	Read/switch program ID	0–999(0–31 internal memory; 32–999 memory card)	O	O
1062H(R/W)	(03H,06H)	Read/switch window ID	1000 Start	O	
1090H(R/W)	(03H,06H,10H)	Read/set date and time	Date (Year) (00–99)	O	O
1091H(R/W)	(03H,06H,10H)		Date (Month) (01–12)		
1092H(R/W)	(03H,06H,10H)		Date (Day) (01–31)		
1093H(R/W)	(03H,06H,10H)		Time (hour) (00–23)		
1094H(R/W)	(03H,06H,10H)		Time (minute) (00–59)		

1095H(R/W)	(03H,06H,10H)		Time (second) (00–59)		
10B2H(W)	(06H)	Save all program setting	Trigger if Data 1 is written		O
10B3H(W)	(06H)	Capture image	Trigger if Data 1 is written	O	O

Common Error Message Codes

➤ **Error Handling (W):** return string

➤ :01860178 CR LF : function code unsupported

➤ :01860277 CR LF : write address error

➤ :01860673 CR LF : unable to execute (system not Ready)

➤ :01860970 CR LF : parity check failed

➤ :01860C6D CR LF : illegal Modbus command length

➤ :01860D6C CR LF : illegal Modbus command length

➤ :01860E6B CR LF : Modbus command contains illegal character(s)

Error Handling (R): Return string

➤ :0183017B CR LF : function code unsupported

➤ :0183027A CR LF : read address error

➤ :01830676 CR LF : unable to execute (system not Ready)

➤ :01830973 CR LF : parity check failed

➤ :01830C70 CR LF : illegal Modbus command length

➤ :01830D6F CR LF : illegal Modbus command length

➤ :01830E6E CR LF : Modbus command contains illegal character(s)

1) Trigger1 Action 1000H (W) (Run Mode enabled)

Input string: 010610000001 E8 CR LF   Return string: 010610000001 E8 CR LF

➤ **Description:** after writing a "1", the switch is successful if the string returned is identical.

After triggering in Modbus mode, the system does not automatically send results after completing an inspection. The system saves the inspection result in the 1010H–104H register. When Ready turns ON again, send the Read command to get the inspection results.

➤ **Error Handling:** return string

➤ :01860376 CR LF : incorrect content or length of write data (only one entry is allowed).

➤ :01860475 CR LF : unable to execute (system permits incorrect operating status and trigger source interface).

2) Trigger2 Action 1000H (W) (Run Mode enabled)

Input string: 010610010001 E7 [CR] [LF]   Return string: 010610010001 E7 [CR] [LF]

➤ **Description:** after writing a "1", the switch is successful if the string returned is identical.

 After triggering in Modbus mode, the system does not automatically send results after completing an inspection. The system saves the inspection result in the 1010H–104H register. When Ready turns ON again, send the Read command to get the inspection results.

➤ **Error Handling:** return string

➤ :01860376 [CR] [LF] : incorrect content or length of write data (only one entry is allowed).

➤ :01860475 [CR] [LF] : unable to execute (system permits incorrect operating status and trigger source interface).

3) Output Data 1010H–104FH (R) (Run Mode enabled)

Output the previous inspection result if there is no inspection program to run.

16 Bits (Word) Data Mode: if two data entries need to be returned (50,000, 300)

Input string: 010310100002 DA [CR] [LF]   Return string: 010304C350012CB8 [CR] [LF]

➤ **Description:** 50,000 is C350 (hex) and 300 is 12C (hex); B8 is the parity code.

32 Bits (Double Word) Data Mode: if two data entries need to be returned (400,000, 300)

Input string: 010310100004 D8 [CR] [LF]   Return string：01030800061A800000012C27   [CR]
[LF]

➤ **Description:** 400,000 is 61A80 (hex) and 300 is 12C (hex); 27 is the parity code.

➤ If the output value exceeds 65535, set the data format to **32bits** to prevent writing to the wrong register.

Judge (0/1) Data Format: (return bit 2=0, bit 3=1, bit 4=1 when needed)

Input string: 010310100001 DB [CR] [LF]   Return string: 0103020018E2 [CR] [LF]

➤ **Description:** 0018 (hex) is 0000000000011000 (binary)

◎ Judge output format is **16bits** regardless of the setting (16bits or 32bits).
For example: return data is 400,000 and a set of Judge values of bit 2=0, bit 3=1, bit 4=1.
Then read three entries of string length: 010310100003 D9 [CR] [LF] (one entry of DW data and one entry of W Judge content).
System returns: 01030600061A8000183E [CR] [LF]

➤ **Error Handling:** return string

➤ :01830478 [CR] [LF] : unable to execute (system permits incorrect operating status).

4) Switch to Run Mode 1050H (W) (Edit Mode enabled)

　　Input string: 01061050 0001 5A　CR　LF　　Return string: 01061050 0001 5A　CR　LF

➤ **Description:** after writing a "1", the switch is successful if the string returned is identical.

➤ **Error Handling:** return string

➤ :01860376　CR　LF　: incorrect content or length of write data (only one entry is allowed).

➤ :01860475　CR　LF　: unable to execute (system permits incorrect operating status).

➤ :01860B70　CR　LF　: program ID does not exist (or program ID not set).

5) Switch to Edit mode 1051H (W) (Run Mode enabled)

　　Input string: 01061051 0001 97　CR　LF　　Return string: 01061051 0001 97　CR　LF

◎ **Description:** after writing a "1", the switch is successful if the string returned is identical.

◎ **Error Handling: r**eturn string

➤ :01860376　CR　LF　: incorrect content or length of write data (only one entry is allowed).

➤ :01860475　CR　LF　: unable to execute (system permits incorrect operating status).

6) Read/Switch Program ID 1060H (R/W) (Run Mode and Edit Mode enabled)

　　Program ID 0–31 saved on internal memory and 32–999 on SD card.

Read Program ID: (returns the current program ID 10)

　　Input string: 01031060 0001 8B　CR　LF　　Return string 010302 000A F0　CR　LF

◎ **Description:** 10 (dec) is 000A (hex).

Switch Program ID: (switch program ID to 20)

　　Input string: 01061060 0014 75　CR　LF　　Return string: 01061060 0014 75　CR　LF

◎ **Description:** 20 (dec) is 0014 (hex).

　After writing the value, the switch is successful if the string returned is identical.

◎ **Error Handling:** return string

➤ :01830379　CR　LF　: incorrect content or length of read data (only one entry is allowed).

➤ :01860376　CR　LF　: incorrect write data length (only one entry is allowed); program ID does not exist (or not set).

➤ :01860B6E　CR　LF　: unable to execute (current page unsupported).

7) Read/Switch Window ID 1062H (R/W) (Run Mode enabled)

Read Window ID: (returns current window ID 50)

　　Input string: 01031062 0001 89　CR　LF　　Return string: 010302 0032 C8　CR　LF

◎ **Description:** 50 (dec) is 0032 (hex).

Switch Window ID: (switch window ID to 30)

Input string: 01061062001E 69 | CR | | LF | Return string: 01061062001E 69 | CR | | LF |

◎ **Description:** 30 (dec) is 001E (hex).

After writing the value, the switch is successful if the string returned is identical.

◎ **Error Handling:** return string

➤ :01830379 | CR | | LF | : incorrect content or length of read data (only one entry is allowed).

➤ :01830478 | CR | | LF | : unable to execute (system permits incorrect operating status).

➤ :01860376 | CR | | LF | : incorrect content or length of write data (only one entry is allowed); window ID does not exist (or not set).

➤ :01860475 | CR | | LF | : unable to execute (system permits incorrect operating status).

8) Read/Set Date and Time 1090H–1095H (Run Mode and Edit Mode enabled)

1090H (R/W): Date (Year) (00–99; do not need to add the 20 from the yyyy format)

1091H (R/W): Date (Month) (01–12)

1092H (R/W): Date (Day) (01–31)

1093H (R/W): Time (Hour) (00–23)

1094H (R/W): Time (Minute) (00–59)

1095H (R/W): Time (Second) (00–59)

Read Time/Date: (for example, the content to read is 2011/07/22 08:30:58)

Input string: 010310900006 56 | CR | | LF |

Return string: 01030C000B000700160008001E003A 68 | CR | | LF |

◎ **Description:** 11(dec) is 000B (hex).

Decimal 07 is 0007 (hex).

Decimal 22 is 0016 (hex).

Decimal 08 is 0008 (hex).

Decimal 30 is 001E (hex).

Decimal 58 is 003A (hex).

Write Time/Date: (for example, the content to write is 2011/08/25 12:30:40)

First enter string: 0110010900000C000B00080019000C001E0028 BF | CR | | LF |

Return string: 011000900006 59 | CR | | LF |

◎ **Description:** 11 (dec) is 000B (hex).

Decimal 08 is 0008 (hex).

Decimal 25 is 0019 (hex).

Decimal 12 is 000C (hex).

Decimal 30 is 001E (hex).

Decimal 40 is 0028 (hex).

In addition to multi-writes for the date/time, a single write 06 is also supported.

◎ **Error Handling:** return string

➤ :01860376 CR LF : incorrect content or length of write data.

9) Save All Program Setting 10B2H (W) (Edit Mode enabled)

Input string: 010610B20001 36 CR LF   Return string: 010610B20001 36 CR LF

◎ **Description:** after writing the numeric value "1", saving the settings is successful if the string returned is identical.

◎ **Error Handling:** Return string

➤ :01860376 CR LF : incorrect content or length of write data.

➤ :01860475 CR LF : unable to execute (system permits incorrect operating status).

10) Capture Image 10B3H (W) (Run Mode and Edit Mode enabled)

Input string: 010610B30001 35 CR LF   Return string: 010610B30001 35 CR LF

◎ **Description:** after writing the numeric value "1", the image capture is successful if the string returned is identical.

◎ **Error Handling:** return string

➤ :01860376 CR LF : incorrect content or length of write data.

8.3 RS232/485 Data Link Mode: (DMV is in Master Mode)

When inspection of the Data Link communication function is complete, the system will automatically write results through the DMV to the register of the upper controller. Programmers will not need write related programs. The necessary data results can be directly read from the register of the upper controller.

Configure the communication protocol in [Tools] > [Communications] > [RS232/RS485].
In Data Link Mode, the default communication protocol is 9600, 7, E, 1; DMV station number is set at RS485. RS232/RS485 can communicate independently and supports different communication protocols.

After clicking on the [Settings] button, the parameter for automatic connection is displayed.

1) [PLC Manufacturer]: Modbus communication protocol is used because Delta Electronics products (PLC, HMI, Robot) all support Modbus communication protocol, so all of the above products can be used.

2) [PLC Type]: Select [None] if no model is designated.

3) [Bit]: The formats include the 2 options of [16 Bits] and [32 Bits]. When the actual output data exceed -32,767~32,768, please select 32 Bits (Double word) mode to prevent overflow.

4) [Start address]: Configuring to 1000 means to start saving from the D1000 register address.

5) [Complete Flag]: After the DMV writes the data to the PLC's Start Address register, a value of 1 will be written to the Complete Flag register and the PLC can then determine whether the data is written successfully.

   After PLC confirms the data write access (i.e., D1064=1), please manually set the [Complete Flag] register to 0 for the next write access.

6) [Timeout]: This is the time elapsed before communication time-out. After the DMV sends out communication commands and receives no PLC response within the configured time, the system enters the time-out condition.

7) [ID]: Configure the PLC station number to link.

8) The configuration method for RS485 is the same as RS232.

Remark This function currently only supports RS232 and RS485 communication interfaces.

8.4 RS232/485 Custom Mode

In the custom communication function, the system will automatically send out the results from the DMV after completing the inspection. After the upper controller receives the strings, the required results are generated through manual decoding according to the defined format. Besides transmitting inspection results, the custom format also supports multiple written control commands.

The following explains the custom protocol configurations for RS232 and RS485.

Configure the communication protocol in [Tools] > [Communications] > [RS232/RS485].

In Custom Mode, the default communication protocol is 9600, 7, E, 1; DMV station number is set at RS485. RS232/RS485 can communicate independently and supports different communication protocols.

8.4.1 RS232/485 Custom Communication Format Table

	Function	Input string	Return string	Permission	
				Run	Edit
1	Trigger 1 action and output	T1 CR LF	T1 CR LF T0 + Output Data CR	O	
2	Trigger 2 action and output	T2 CR LF	T2 CR LF T0 + Output Data CR	O	
3	Go to Run mode	RN CR LF	RN CR LF		O

4	Go to Edit mode	PG [CR] [LF]	PG [CR] [LF]	O	
5	Repeat data output	DQ [CR] [LF]	DQ + Output Data [CR] [LF]	O	
6	Switch program ID	PCnnnn [CR] [LF]	PC [CR] [LF]	O	O
7	Read program ID	PR [CR] [LF]	PRnnnn [CR] [LF]	O	
8	Switch window ID	WCwnnnn [CR] [LF]	WC [CR] [LF]	O	
9	Read window ID	WR [CR] [LF]	WRwnnnn [CR] [LF]	O	
10	Capture image	CP [CR] [LF]	CP [CR] [LF]	O	O
11	Save all program setting	SV [CR] [LF]	SV [CR] [LF]		O
12	Set time/date	DWyymmddhhmmss [CR] [LF]	DW [CR] [LF]	O	O
13	Read time/date	DR [CR] [LF]	DRyymmddhhmmss [CR] [LF]	O	O

8.4.2 RS232/485 Custom Communication

1) Trigger 1 Action and Output Data (Run Mode enabled)

Input string: T1 [CR] [LF]   Return string: T1 [CR] [LF] T0 +Output Data [CR]

◎ **Description:**

➤ Set string length to 5 for two data (1234, 345) and three judgments (1, 0, 1) in the case of integers.

Return: T1 [CR] [LF] T00123400345101 [CR]

➤ Set string length to 5 for two data (12.3, 34.5) and three judgments (1, 0, 1) in the case of decimals.

Return: T1 [CR] [LF] T01230034500101 [CR]

The system returns T1 [CR] [LF] upon receiving the command, and then returns the result after the inspection completes. Inspection time varies with the inspection item. Increase the controller timeout as required if the inspection time is too long.

◎ **Error Handling:** return string

➤ E01: incorrect permission mode (incorrect Run/Edit mode)

➤ E02: incorrect string data (string length is too long or too short to be recognized)

➤ E03: READY is not ON and cannot execute (confirm the I/O status)

➤ E14: incorrect trigger source interface

➤ E15: inconsistent operating and configured trigger IDs

➤ E17: system busy, cannot respond

2) Trigger 2 Action and Output Data (Run Mode enabled)

Input string: T2 `CR` `LF`　　　Return string: T2 `CR` `LF` T0 + Output Data `CR`

◎　**Description:**

➤ Set string length to 5 for two data (1234, 345) and three judgments (1, 0, 1) in the case of integers.

Return: T2 `CR` `LF` T00123400345101 `CR`

➤ Set string length to 5 for two data (12.3, 34.5) and three judgments (1, 0, 1) in the case of integers.

Return: T2 `CR` `LF` T01230034500101 `CR`

The system returns T2 `CR` `LF` upon receiving the command, and then returns the result after the inspection completes. Inspection time varies with the inspection item. Increase the controller timeout as required if the inspection time is too long.

◎　**Error Handling:** return string

➤ E01: incorrect permission mode (incorrect Run/Edit mode)

➤ E02: incorrect string data (string length is too long or too short to be recognized)

➤ E03: READY is not ON and cannot execute (please confirm the I/O status)

➤ E14: incorrect trigger source interface

➤ E15: inconsistent operating and configured trigger IDs

➤ E17: system busy, cannot respond

3) To Run Mode (Edit Mode enabled)

Input string: RN `CR` `LF`　　　Return string: RN `CR` `LF`

◎　**Error Handling:** return string

➤ E01: incorrect permission mode (incorrect Run/Edit mode)

➤ E02: incorrect string data (string length is too long or too short to be recognized)

➤ E03: FRDY (function ready) is not ON and cannot execute (confirm the I/O status)

➤ E05: program ID does not exist (or program ID not set)

➤ E17: system busy, cannot respond

4) To Setting Mode (Run Mode enabled)

Input string: PG `CR` `LF`　　　Return string: PG `CR` `LF`

◎　**Error Handling:** Return string

➤ E01: incorrect permission mode (incorrect Run/Edit Run/Edit mode)

➤ E02: incorrect string data (string length is too long or too short to be recognized)

➤ E03: FRDY (Function Ready) is not ON and cannot execute (confirm the I/O status)

➤ E17: system busy, cannot respond

5) Repeat Output Data (Run Mode enabled)

Input string: DQ [CR] [LF]   Return string: DQ + Output data [CR] [LF]

◎ **Description:**

Controller returns the latest inspection result.

Error message is returned if there is no inspection result to return; for example: system bootup before an inspection cycle.

◎ **Error Handling:** return string

➤ E01: incorrect permission mode (incorrect Run/Edit Run/Edit mode)

➤ E02: incorrect string data (string length is too long or too short to be recognized)

➤ E17: system busy, cannot respond

6) Switch Program ID (Run Mode and Edit Mode enabled)

Input string: PCnnnn [CR] [LF]   Return string: PC [CR] [LF]

◎ **Description:**

nnnn is program ID (valid internal memory program ID P0000–P9999)

Enter the string to switch the program ID to P0003: PC0003 [CR] [LF]

◎ **Error Handling:** return string

➤ E02: incorrect string data (string length is too long or too short to be recognized)

➤ E03: FRDY (function ready) is not ON and cannot execute (confirm the I/O status)

➤ E05: program ID does not exist (or program ID not set)

➤ E17: system busy, cannot respond

7) Read Program ID (`Run Mode enabled)

Input string: PR [CR] [LF]   Return string: PRnnnn [CR] [LF]

◎ **Description:**

nn is program ID.

If the current program ID is internal memory P0003, then the controller returns the string: PR0003 [CR] [LF]

◎ **Error Handling:** return string

➤ E01: incorrect permission mode (incorrect Run/Edit Run/Edit mode)

➤ E02: incorrect string data (string length is too long or too short to be recognized)

➤ E17: system busy, cannot respond

8) **Switch Window ID** (Run Mode enabled)

Input string: WCwnnnn `CR` `LF`   Return string: WC `CR` `LF`

◎ **Description:**

nnnn is window ID (valid window ID W0000–W0999)

Please enter the string to switch to W0015: WCw0015 `CR` `LF`

◎ **Error Handling:** return string

➢ E01: incorrect permission mode (incorrect Run/Edit mode)

➢ E02: incorrect string data (string length is too long or too short to be recognized)

➢ E03: FRDY (function ready) is not ON and cannot execute (please confirm the I/O status)

➢ E06: window ID does not exist (or window ID not set)

➢ E17: system busy, cannot respond

9) **Read Window ID (**Run Mode enabled)

Input string: WR `CR` `LF`   Return string: WRwnnnn `CR` `LF`

◎ **Description:** nnnn is window ID.

If the current window ID is W0020, the controller returns the string: WRw0020 `CR` `LF`

◎ **Error Handling:** return string

➢ E01: incorrect permission mode (incorrect Run/Edit mode)

➢ E02: incorrect string data (string length is too long or too short to be recognized)

➢ E17: system busy, cannot respond

10) Capture Image (Run Mode and Edit Mode enabled)

Input string: CP `CR` `LF`   Return string: CP `CR` `LF`

◎ **Description:** copy current screen to SD card.

◎ **Error Handling:** return string

➢ E02: incorrect string data (string length is too long or too short to be recognized)

➢ E07: no SD card found

➢ E09: insufficient memory or SD card space

➢ E17: system busy, cannot respond

11) Save All Program Setting (Edit Mode enabled)

Input string: SV ⌶CR⌶ ⌶LF⌶   Return string: SV ⌶CR⌶ ⌶LF⌶

◎ **Error Handling:** return string
➤ E01: incorrect permission mode (incorrect Run/Edit mode)
➤ E02: incorrect string data (string length is too long or too short to be recognized)
➤ E07: no SD card found
➤ E09: insufficient memory or SD card space
➤ E17: system busy, cannot respond

12) Set Date/Time (Run Mode and Edit Mode enabled)

Input string: DWyymmddhhmmss ⌶CR⌶ ⌶LF⌶   Return string: DW ⌶CR⌶ ⌶LF⌶

◎ **Error Handling:** return string
➤ E02: incorrect string data (string length is too long or too short to be recognized)
➤ E10: incorrect calendar format
➤ E17: system busy, cannot respond

13) Read Date/Time (Run Mode and Edit Mode enabled)

Input string: DR ⌶CR⌶ ⌶LF⌶   Return string: DRyymmddhhmmss ⌶CR⌶ ⌶LF⌶

◎ **Error Handling:** return string
➤ E02: incorrect string data (string length is too long or too short to be recognized)
➤ E17: system busy, cannot respond

Return Error Message Table

Error Code	Description
E01	Incorrect mode enabled (incorrect Run/Edit mode)
E02	Incorrect string content (string length is too long or too short to be recognized)
E03	READY is not ON and cannot be executed (please confirm the I/O status)
E03	FRDY (function ready) is not ON and cannot be executed (please confirm the I/O status)
E04	Result does not exist
E05	Program ID does not exist (or program ID not set)
E06	Window ID does not exist (or window ID not set)
E06	Calculator ID does not exist (or calculator ID not set)
E07	No SD card
E08	Upper or lower input error (invalid range or upper is less than lower)
E09	Insufficient memory or SD card space

	Memory address does not exist
E10	Incorrect calendar format
E11	Incorrect camera settings
E14	Incorrect trigger source interface
	Incorrect data ID (not available from current inspection)
E15	Inconsistent operating and configured trigger IDs
E17	System busy, cannot respond
E18	Incorrect numeric content

8.4.3 RS232/485 Custom Output Data Format

Click [Setting], the setting parameters of custom output data format are displayed. If not set (default), the system will output in basic format.

Set the following parameters after choosing【Custom】in【Private Code Format】.

1) 【Data Return T1–T2】: Select to specify that result data is transmitted according to the camera ID.

After T1–T2 [CR] [LF], the system sends the result data.
Clear this check box to specify that the system directly sends the result data according to the method that you select; see the following picture.

Setup
Private Code Form: ○ Default
☑ Data Return To T1~T2
☐ Byte Output(4-Byte float type)

2) 【Byte Output (4-Byte float type)】: The result data will be output in float type.

Setup
Private Code Form: ○ Default
☐ Data Return To T1~T2
☑ Byte Output(4-Byte float type)

3) 【Show plus sign for positive numbers】: Select to specify that a plus sign is added to all positive result data.

When the private code sends negative data, the negative sign is always added before the value, regardless of this option.

☑ Show plus sign for positive numbers
☐ Single Zero

4) 【Single Zero】: When the data result is 0, only 0 will be output, and the value after the decimal place will not be output.

☑ Single Zero
☐ Window is NG, don't output

5) 【Window is NG, don't output】: When the total result of the test is ON, the data is not output.

☐ Single Zero
☑ Window is NG, don't output

6)　【Data Format Fixed】: Select to specify that data is output in fixed decimal places.

For example, the original output value is 123.00; selecting this option outputs the data as 000123.00.

☑ Data Format Fixed

　　9 Digit Number(Including plus-minus sign and decimal point)

7)　【Output value is decimal, whether the decimal point output?　】:

　　7-1)　Select to specify that the output decimal place is based on the number you enter in Digit Place.
　　　For example, the original value on the lower right is 123.000000 and the actual output is 123.000.

☐ Data Format Fixed

　　9 Digit Number(Including plus-minus sign and decimal point)　　　Data Test

☑ Output value is decimal, whether the decimal point output?　　　123.000

　　● Digit Place　　　2　　　Test Result

　　○ Data Type　　　Output integer(Data x 100)　▼　　　123.00

　　7-2)　Select【Data Type】this check box to specify that the output result is generated after multiplying

　　　　　by the value you enter for Data Type.

The original value on the lower right is 123.000000 and you select 【Output Integer (Data x 100)】for Data

Type, then the actual output 12300.

8)　Custom output result string format
　　The output format is 【Start Symbol】 + 【Result 1】 + 【Gap Symbol】+ 【Result 2】 + 【Gap
　　Symbol】…+ 【Stop Symbol】.
　　8-1)　【Start Symbol】: Refer to the ASCII table in Section 8.5 to for the hexadecimal values
　　　　　corresponding to the ASCII characters.

Start Symbol	Byte0								Byte8							Byte15
Length　3	54	30	00	00	00	00	00	00	00	00	00	00	00	00	00	00
	T	0	NUL	NUL	NUL	NUL	NUL	NUL	NUL	NUL	NUL	NUL	NUL	NUL	NUL	NUL

8-2)　【Gap Symbol】: First determine the 　【Gap Symbol Length】.

As shown in the following picture, setting Gap Symbol Length to 1 means that the gap symbol is one character. Refer to the ASCII table in Section 8.5 for the hexadecimal values corresponding to the ASCII characters.

Gap Symbol	Byte0							
Length　1	2C	00	00	00	00	00	00	00
	,	NUL	NUL	NUL	NUL	NUL	NUL	NUL

8-3)　【Stop Symbol】: First decide the 　【Stop Symbol Length】.

As shown in the following picture, configuring Stop Symbol Length to 1 means that the stop symbol is one character. Refer to the ASCII table in Section 8.6 for the hexadecimal values corresponding to the ASCII characters.

Stop Symbol	Byte0								Byte8							Byte15
Length　1	0D	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
	CR	NUL	NUL	NUL	NUL	NUL	NUL	NUL	NUL	NUL	NUL	NUL	NUL	NUL	NUL	NUL

After you complete the above settings, the system outputs data through the RS232 and RS485 serial ports according to these settings when you select custom output.

8.5 ASCII Code Table

The characters in bold are currently used by the DMV (HEX indicates hexadecimal).

HEX	ASCII	HEX	ASCII	HEX	ASCII	HEX	ASCII
0	NUL	20	SPACE	40	@	60	`
1	SOH	21	!	**41**	**A**	61	a
2	STX	22	"	**42**	**B**	62	b
3	ETX	23	#	**43**	**C**	63	c
4	EOT	24	$	**44**	**D**	64	d
5	ENQ	25	%	**45**	**E**	65	e
6	ACK	26	&	**46**	**F**	66	f
7	BEL	27	'	**47**	**G**	67	g
8	BS	28	(	**48**	**H**	68	h
9	TAB	29	)	**49**	**I**	69	i
A	LF	2A	*	**4A**	**J**	6A	j
B	VT	2B	+	**4B**	**K**	6B	k
C	FF	2C	,	**4C**	**L**	6C	l
D	**CR**	2D	-	**4D**	**M**	6D	m
E	SO	2E	.	**4E**	**N**	6E	n
F	SI	2F	/	**4F**	**O**	6F	o
10	DLE	**30**	**0**	50	P	70	p
11	DC1	**31**	**1**	51	Q	71	q
12	DC2	**32**	**2**	52	R	72	r
13	DC3	**33**	**3**	53	S	73	s
14	DC4	**34**	**4**	54	T	74	t
15	NAK	**35**	**5**	55	U	75	u
16	SYN	**36**	**6**	56	V	76	v
17	ETB	**37**	**7**	57	W	77	w
18	CAN	**38**	**8**	58	X	78	s
19	EM	**39**	**9**	59	Y	79	y
1A	SUB	3A	:	**5A**	**Z**	7A	z
1B	ESC	3B	;	5B	[	7B	{
1C	FS	3C	<	5C	\	7C	|
1D	GS	3D	=	5D	]	7D	}
1E	RS	3E	>	5E	^	7E	~
1F	US	3F	?	5F	_	7F	DEL

8.6 Ethernet Communication Method

The following two types of Ethernet communication methods are supported.

◎ **Modbus Slave Mode: (DMV is in Server Mode)**
When "Modbus Slave" is selected, the controller will automatically switch to Server Mode when it is not outputting data. This enables externally entering MODBUS TCP/IP commands, prompting response from the controller. (please refer to Section 8.7.1 for more information about the MODBUS command format)

◎ **Custom mode:**
After each inspection, the system will send out the configured output results through the Ethernet communication ports in custom DMV communication protocol. After receiving the communication strings, the user must decode the result data according to the DMV defined method.
When results are not output, the system will switch to Server Mode and accept DMV custom communication commands.

8.7 Ethernet Modbus Slave (Server) Mode

MODBUS TCP/IP communication protocol, the system is defined as Server Mode.

In the table below, set the IP address of the DMV main unit and remote client.

Local						
IP Version	● IPv4					
IP Address	192	168	1	2		
Subnet Mask	255	255	255	0		
Gateway	192	168	1	1		
Port	502					
MAC Address	B0	D5	CC	A4	45	4C
Remote						
IP Address	192	168	1	3		
Port	503					

8.7.1 Ethernet Server Mode Command Table: (Modbus TCP/IP Communication Format)

R indicates support for Read commands (03H code; maximum64 entries).

W indicates support for Write commands (write single entry: 06H code; write multiple entries: 10H code; maximum 6 entries).

◎ **Read 03 Read Command Description:** (read single or multiple data entries controlled by the **Byte** parameter)

Output format

0000 0000 0006	01	03	1010	0002
	Node ID	Function code (Read)	Function address	Writes

Send format

0000 0000 0007	01	03	04	0010	0015
	Node ID	Function code (Read)	Byte count	Result 1	Result 2

◎ **Write 06 Single Entry Write Command Description:** (sends the correctly written data string as is)

Output format

0000 0000 0006	01	06	1000	0001
	Node ID	Function code(write)	Function address	Writes

Send format

0000 0000 0006	01	06	1000	0001
	Node ID	Function code(write)	Function address	Writes

◎ **Write 10 Multiple Entry Write Command Description:** (maximum length of six entries)

Output format

0000 0000 000B	01	10	1070	0002	04	0060	0015
	Node ID	Function code(writes)	Function address	Writes	Byte count	Data 1	Data2

Send format

0000 0000 0006	01	10	1070	0002
	Node ID	Function code(writes)	Function address	Writes

◎ **Modbus TCP/IP Communication Address Table**

Position	Function code supported	Name	Description	Permission Run	Permission Edit
1000H(W)	(06H)	Trigger 1 action	Trigger if Data 1 is written	O	
1001H(W)	(06H)	Trigger 2 action	Trigger if Data 1 is written	O	
1010H–104FH(R)	(03H)	Output data (total 64 entries)	(refer to the following for description on output data)	O	
1050H(W)	(06H)	Switch to Run mode	Trigger if Data 1 is written		O
1051H(W)	(06H)	Switch to Edit mode	Trigger if Data 1 is written	O	
1060H(R/W)	(03H,06H)	Read/switch program ID	0–999(0–31 internal memory; 32–999 memory card)	O	O
1062H(R/W)	(03H,06H)	Read/switch window ID	1000 Start	O	
1090H(R/W)	(03H,06H,10H)	Read/set date and time	Date (Year) (00–99)	O	O
1091H(R/W)	(03H,06H,10H)		Date (Month) (01–12)		
1092H(R/W)	(03H,06H,10H)		Date (Day) (01–31)		
1093H(R/W)	(03H,06H,10H)		Time (hour) (00–23)		

1094H(R/W)	(03H,06H,10H)		Time (minute) (00–59)		
1095H(R/W)	(03H,06H,10H)		Time (second) (00–59)		
10B2H(W)	(06H)	Save all program setting	Trigger if Data 1 is written		O
10B3H(W)	(06H)	Capture image	Trigger if Data 1 is written	O	O

Common Error Message Codes

◎ **Error Handling (W):** return string

➤ 0000000000040**1860178**: function code unsupported

➤ 0000000000040**1860277**: write address error

Error Handling (R): Return string

➤ 0000000000040**183017B**: function code unsupported

➤ 0000000000040**183027A**: write address error

1) Trigger1 Action 1000H (W) (Run Mode enabled)

Input string: 00000000000**6010610000001** Return string: 00000000000**6010610000001**

◎ **Description:** after writing a "1", the switch is successful if the string returned is identical.

After triggering in Modbus mode, the system does not automatically send results after completing an inspection. The system saves the inspection result in the 1010H–104H register. When Ready turns ON again, send the Read command to get the inspection results.

◎ **Error Handling:** return string

➤ 0000000000040**1860376**: incorrect content or length of write data (only one entry is allowed).

➤ 0000000000040**1860475**: unable to execute (system permits incorrect operating status and trigger source interface).

2) Trigger2 Action 1001H (W) (Run Mode enabled)

Input string: 00000000000**6010610010001** Return string: 00000000000**6010610010001**

◎ **Description:** after writing a "1", the switch is successful if the string returned is identical.
After triggering in Modbus mode, the system does not automatically send results after completing an inspection. The system saves the inspection result in the 1010H–104H register. When Ready turns ON again, send the Read command to get the inspection results.

◎ **Error Handling:** return string

➤ 0000000000040**1860376**: incorrect content or length of write data (only one entry is allowed).

➤ 0000000000040**1860475**: unable to execute (system permits incorrect operating status and trigger source interface).

3) Output Data 1010H–104FH (R) (Run Mode enabled)

   Output the previous inspection result if there is no inspection program to run.

16 Bits (Word) Data Mode: if two data entries need to be returned (50,000, 300)

   Input string: 0000000000060103101000002   Return string: 000000000007010304C350012C

◎ **Description:** 50,000 is C350 (hex) and 300 is 12C (hex); B8 is the parity code.

32 Bits (Double Word) Data Mode: if two data entries need to be returned (400,000, 300)

   Input string: 0000000000060103101000004   Return string: 00000000000B01030800061A800000012C

◎ **Description:** 400,000 is 61A80 (hex) and 300 is 12C (hex).

➤ If the output value exceeds 65535, set the data format to **32bits** to prevent writing to the wrong register.

Judge (0/1) Data Format: (return bit 2=0, bit 3=1, bit 4=1 when needed)

   Input string: 0000000000060103101000001   Return string: 000000000005010302018

➤ **Description:** 0018 (hex) is 0000000000011000 (binary)

◆ Judge output format is **16bits** regardless of the setting (16bits or 32bits).
   For example: return data is 400,000 and a set of Judge values of bit 2=0, bit 3=1, bit 4=1.
   Then read three entries of string length: 0000000000060103101000003 (one entry of DW data and one entry of W Judge content).
   System returns: 00000000000901030600061A800018

◎ **Error Handling:** return string

➤ 0000000000040183 0478: unable to execute (system permits incorrect operating status).

4) Switch to Run Mode 1050H (W) (Edit Mode enabled)

   Input string: 0000000000060106105000001   Return string: 0000000000060106105000001

◎ **Description:** after writing a "1", the switch is successful if the string returned is identical.

◎ **Error Handling:** return string

➤ 0000000000040186 0376: incorrect content or length of write data (only one entry is allowed).

➤ 0000000000040186 0475: unable to execute (system permits incorrect operating status).

5) Switch to Edit mode 1051H (W) (Run Mode enabled)

Input string: 0000000000006010610510001   Return string: 0000000000006010610510001

◎ **Description:** after writing a "1", the switch is successful if the string returned is identical.

◎ **Error Handling: r**eturn string

➤ 0000000000401860376: incorrect content or length of write data (only one entry is allowed).

➤ 0000000000401860475: unable to execute (system permits incorrect operating status).

6) Read/Switch Program ID 1060H (R/W) (Run Mode and Edit Mode enabled)

Read Program ID: (returns the current program ID 10)

Input string: 0000000000006010310600001   Return string: 00000000000005010302000A

◎ **Description:** 10 (dec) is 000A (hex).

Switch Program ID: (switch program ID to 20)

Input string: 0000000000006010610600014   Return string: 0000000000006010610600014

◎ **Description:** 20 (dec) is 0014 (hex).
After writing the value, the switch is successful if the string returned is identical.

◎ **Error Handling:** return string

➤ 0000000000401830379: incorrect content or length of read data (only one entry is allowed).

➤ 0000000000401860376: incorrect write data length (only one entry is allowed); program ID does not exist (or not set).

7) Read/Switch Window ID 1062H (R/W) (Run Mode enabled)

Read Window ID: (returns current window ID 50)

Input string: 0000000000006010310620001   Return string: 000000000050103020032

◎ **Description:** 50 (dec) is 0032 (hex).

Switch Window ID: (switch window ID to 30)

Input string: 00000000000601061062001E   Return string: 00000000000601061062001E

◎ **Description:** 30 (dec) is 001E (hex).
After writing the value, the switch is successful if the string returned is identical.

◎ **Error Handling:** return string

➤ 0000000000401830379: incorrect content or length of read data (only one entry is allowed).

➤ 0000000000401830478: unable to execute (system permits incorrect operating status).

➤ 0000000000401860376: incorrect content or length of write data (only one entry is allowed); window ID does not exist (or not set).

➤ 0000000000401860475: unable to execute (system permits incorrect operating status).

8) Read/Set Date and Time 1090H–1095H (Run Mode and Edit Mode enabled)

1090H (R/W): Date (Year) (00–99; do not need to add the 20 from the yyyy format)

1091H (R/W): Date (Month) (01–12)

1092H (R/W): Date (Day) (01–31)

1093H (R/W): Time (Hour) (00–23)

1094H (R/W): Time (Minute) (00–59)

1095H (R/W): Time (Second) (00–59)

Read Time/Date: (for example, the content to read is 2011/07/22 08:30:58)

Input string: 00000000000006010310900006

Return string: 00000000000F01030C000B000700160008001E003A

◎ **Description:** 11(dec) is 000B (hex).

Decimal 07 is 0007 (hex).

Decimal 22 is 0016 (hex).

Decimal 08 is 0008 (hex).

Decimal 30 is 001E (hex).

Decimal 58 is 003A (hex).

Write Time/Date: (for example, the content to write is 2011/08/25 12:30:40)

First enter string: 0000000000130110109000060C000B00080019000C001E0028

Return string: 00000000000006011000900006

◎ **Description:** 11 (dec) is 000B (hex).

Decimal 08 is 0008 (hex).

Decimal 25 is 0019 (hex).

Decimal 12 is 000C (hex).

Decimal 30 is 001E (hex).

Decimal 40 is 0028 (hex).

In addition to multi-writes for the date/time, a single write 06 is also supported.

◎ **Error Handling:** return string

➤ 0000000000040186 0376: incorrect content or length of write data.

9) Save All Program Setting 10B2H (W) (Edit Mode enabled)

Input string: 00000000000006010610B20001   Return string: 00000000000006010610B20001

◎ **Description:** after writing the numeric value "1", saving the settings is successful if the string returned is identical.

◎ **Error Handling:** Return string

➤ 0000000000040186 0376: incorrect content or length of write data.

➤ 0000000000040186 0475: unable to execute (system permits incorrect operating status).

10) Capture Image 10B3H (W) (Run Mode and Edit Mode enabled)

Input string: 00000000006010610B30001   Return string: 00000000006010610B30001

◎ **Description:** after writing the numeric value "1", the image capture is successful if the string returned is identical.

◎ **Error Handling:** return string
➤ 0000000000401860376: incorrect content or length of write data.

8.8 Ethernet Custom Format

In custom communication, the system automatically sends the results from the DMV3000G after completing the inspection. After receiving the strings, the DMV3000G generates the required results through decoding according to the defined format, and sends them to the superior controller. Besides transmitting inspection results, private code mode also supports multiple written control commands. The following section explains the custom communication format configurations through Ethernet.

In the table below, set the IP address of the DMV local and remote client.

Local					
IP Version	● IPv4				
IP Address	192	168	1	2	
Subnet Mask	255	255	255	0	
Gateway	192	168	1	1	
Port	502				
MAC Address	B0	D5	CC	A4	45	4C
Remote					
IP Address	192	168	1	3	
Port	503				

8.8.1 Ethernet Custom Mode Command Table

	Function	Input string	Return string	Permission	
				Run	Edit
1	Trigger 1 action and output	T1 `CR` `LF`	T1 `CR` `LF` T0 + Output Data `CR`	O	
2	Trigger 2 action and output	T2 `CR` `LF`	T2 `CR` `LF` T0 + Output Data `CR`	O	
3	Go to Run mode	RN `CR` `LF`	RN `CR` `LF`		O
4	Go to Edit mode	PG `CR` `LF`	PG `CR` `LF`	O	
5	Repeat data output	DQ `CR` `LF`	DQ + Output Data `CR` `LF`	O	
6	Switch program ID	PCnnnn `CR` `LF`	PC `CR` `LF`	O	O
7	Read program ID	PR `CR` `LF`	PRnnnn `CR` `LF`	O	
8	Switch window ID	WCwnnnn `CR` `LF`	WC `CR` `LF`	O	
9	Read window ID	WR `CR` `LF`	WRwnnnn `CR` `LF`	O	
10	Capture image	CP `CR` `LF`	CP `CR` `LF`	O	O
11	Save all program setting	SV `CR` `LF`	SV `CR` `LF`		O
12	Set time/date	DWyymmddhhmmss `CR` `LF`	DW `CR` `LF`	O	O
13	Read time/date	DR `CR` `LF`	DRyymmddhhmmss `CR` `LF`	O	O

8.8.2 Ethernet Custom Communication

1) Trigger 1 Action and Output Data (Run Mode enabled)

Input string: T1 ⸢CR⸣ ⸢LF⸣   Return string: T1 ⸢CR⸣ ⸢LF⸣ T0 +Output Data ⸢CR⸣

◎ **Description:**

➤ Set string length to 5 for two data (1234, 345) and three judgments (1, 0, 1) in the case of integers.

Return: T1 ⸢CR⸣ ⸢LF⸣ T00123400345101 ⸢CR⸣

➤ Set string length to 5 for two data (12.3, 34.5) and three judgments (1, 0, 1) in the case of decimals.

Return: T1 ⸢CR⸣ ⸢LF⸣ T01230034500101 ⸢CR⸣

The system returns T1 ⸢CR⸣ ⸢LF⸣ upon receiving the command, and then returns the result after the inspection completes. Inspection time varies with the inspection item. Increase the controller timeout as required if the inspection time is too long.

◎ **Error Handling:** return string

➤ E01: incorrect permission mode (incorrect Run/Edit mode)

➤ E02: incorrect string data (string length is too long or too short to be recognized)

➤ E03: READY is not ON and cannot execute (confirm the I/O status)

➤ E14: incorrect trigger source interface

➤ E15: inconsistent operating and configured trigger IDs

➤ E17: system busy, cannot respond

2) Trigger 2 Action and Output Data (Run Mode enabled)

Input string: T2 ⸢CR⸣ ⸢LF⸣   Return string: T2 ⸢CR⸣ ⸢LF⸣ T0 + Output Data ⸢CR⸣

◎ **Description:**

➤ Set string length to 5 for two data (1234, 345) and three judgments (1, 0, 1) in the case of integers.

Return: T2 ⸢CR⸣ ⸢LF⸣ T00123400345101 ⸢CR⸣

➤ Set string length to 5 for two data (12.3, 34.5) and three judgments (1, 0, 1) in the case of integers.

Return: T2 ⸢CR⸣ ⸢LF⸣ T01230034500101 ⸢CR⸣

The system returns T2 ⸢CR⸣ ⸢LF⸣ upon receiving the command, and then returns the result after the inspection completes. Inspection time varies with the inspection item. Increase the controller timeout as required if the inspection time is too long.

◎ **Error Handling:** return string

➤ E01: incorrect permission mode (incorrect Run/Edit mode)

➤ E02: incorrect string data (string length is too long or too short to be recognized)

➤ E03: READY is not ON and cannot execute (please confirm the I/O status)

➤ E14: incorrect trigger source interface

➤ E15: inconsistent operating and configured trigger IDs

➤ E17: system busy, cannot respond

---

3) To Run Mode (Edit Mode enabled)

Input string: RN $\boxed{CR}$ $\boxed{LF}$ Return string: RN $\boxed{CR}$ $\boxed{LF}$

◎ **Error Handling:** return string
➤ E01: incorrect permission mode (incorrect Run/Edit mode)
➤ E02: incorrect string data (string length is too long or too short to be recognized)
➤ E03: FRDY (function ready) is not ON and cannot execute (confirm the I/O status)
➤ E05: program ID does not exist (or program ID not set)
➤ E17: system busy, cannot respond

---

4) To Setting Mode (Run Mode enabled)

Input string: PG $\boxed{CR}$ $\boxed{LF}$ Return string: PG $\boxed{CR}$ $\boxed{LF}$

◎ **Error Handling:** Return string
➤ E01: incorrect permission mode (incorrect Run/Edit Run/Edit mode)
➤ E02: incorrect string data (string length is too long or too short to be recognized)
➤ E03: FRDY (Function Ready) is not ON and cannot execute (confirm the I/O status)
➤ E17: system busy, cannot respond

---

5) Repeat Output Data (Run Mode enabled)

Input string: DQ $\boxed{CR}$ $\boxed{LF}$ Return string: DQ + Output data $\boxed{CR}$ $\boxed{LF}$

◎ **Description:**
Controller returns the latest inspection result.
Error message is returned if there is no inspection result to return; for example: system bootup before an inspection cycle.

◎ **Error Handling:** return string
➤ E01: incorrect permission mode (incorrect Run/Edit Run/Edit mode)
➤ E02: incorrect string data (string length is too long or too short to be recognized)
➤ E17: system busy, cannot respond

6) Switch Program ID (Run Mode and Edit Mode enabled)

Input string: PCnnnn `CR` `LF`   Return string: PC `CR` `LF`

◎   **Description:**

nnnn is program ID (valid internal memory program ID P0000–P9999)

Enter the string to switch the program ID to P0003: PC0003 `CR` `LF`

◎   **Error Handling:** return string

➤ E02: incorrect string data (string length is too long or too short to be recognized)

➤ E03: FRDY (function ready) is not ON and cannot execute (confirm the I/O status)

➤ E05: program ID does not exist (or program ID not set)

➤ E17: system busy, cannot respond

7) Read Program ID (`Run Mode enabled)

Input string: PR `CR` `LF`   Return string: PRnnnn `CR` `LF`

◎   **Description:**

nn is program ID.

If the current program ID is internal memory P0003, then the controller returns the string: PR0003 `CR` `LF`

◎   **Error Handling:** return string

➤ E01: incorrect permission mode (incorrect Run/Edit Run/Edit mode)

➤ E02: incorrect string data (string length is too long or too short to be recognized)

➤ E17: system busy, cannot respond

8) Switch Window ID (Run Mode enabled)

Input string: WCwnnnn `CR` `LF`   Return string: WC `CR` `LF`

◎   **Description:**

nnnn is window ID (valid window ID W0000–W0999)

Please enter the string to switch to W0015: WCw0015 `CR` `LF`

◎   **Error Handling:** return string

➤ E01: incorrect permission mode (incorrect Run/Edit mode)

➤ E02: incorrect string data (string length is too long or too short to be recognized)

➤ E03: FRDY (function ready) is not ON and cannot execute (please confirm the I/O status)

➤ E06: window ID does not exist (or window ID not set)

➤ E17: system busy, cannot respond

9) Read Window ID (Run Mode enabled)

Input string: WR CR   LF   Return string: WRwnnnn CR   LF

◎ **Description:** nnnn is window ID.

If the current window ID is W0020, the controller returns the string: WRw0020 CR   LF

◎ **Error Handling:** return string
➤ E01: incorrect permission mode (incorrect Run/Edit mode)
➤ E02: incorrect string data (string length is too long or too short to be recognized)
➤ E17: system busy, cannot respond

10) Capture Image (Run Mode and Edit Mode enabled)

Input string: CP CR   LF   Return string: CP CR   LF

◎ **Description:** copy current screen to SD card.

◎ **Error Handling:** return string
➤ E02: incorrect string data (string length is too long or too short to be recognized)
➤ E07: no SD card found
➤ E09: insufficient memory or SD card space
➤ E17: system busy, cannot respond

11) Save All Program Setting (Edit Mode enabled)

Input string: SV CR   LF   Return string: SV CR   LF

◎ **Error Handling:** return string
➤ E01: incorrect permission mode (incorrect Run/Edit mode)
➤ E02: incorrect string data (string length is too long or too short to be recognized)
➤ E07: no SD card found
➤ E09: insufficient memory or SD card space
➤ E17: system busy, cannot respond

12) Set Date/Time (Run Mode and Edit Mode enabled)

Input string: DWyymmddhhmmss CR   LF   Return string: DW CR   LF

◎ **Error Handling:** return string
➤ E02: incorrect string data (string length is too long or too short to be recognized)
➤ E10: incorrect calendar format
➤ E17: system busy, cannot respond

13) Read Date/Time (Run Mode and Edit Mode enabled)

Input string: DR [CR] [LF]   Return string: DRyymmddhhmmss [CR] [LF]

◎ **Error Handling:** return string

➤ E02: incorrect string data (string length is too long or too short to be recognized)

➤ E17: system busy, cannot respond

Return Error Message Table

Error Code	Description
E01	Incorrect mode enabled (incorrect Run/Edit mode)
E02	Incorrect string content (string length is too long or too short to be recognized)
E03	READY is not ON and cannot be executed (please confirm the I/O status)
E03	FRDY (function ready) is not ON and cannot be executed (please confirm the I/O status)
E04	Result does not exist
E05	Program ID does not exist (or program ID not set)
E06	Window ID does not exist (or window ID not set)
E06	Calculator ID does not exist (or calculator ID not set)
E07	No SD card
E08	Upper or lower input error (invalid range or upper is less than lower)
E09	Insufficient memory or SD card space
E09	Memory address does not exist
E10	Incorrect calendar format
E11	Incorrect camera settings
E14	Incorrect trigger source interface
E14	Incorrect data ID (not available from current inspection)
E15	Inconsistent operating and configured trigger IDs
E17	System busy, cannot respond
E18	Incorrect numeric content

8.8.3 Ethernet Custom Output Data Format

Click [Setting], the setting parameters of custom output data format are displayed. If not set (default), the system will output in basic format.

➢ Set the following parameters after choosing【Custom】in【Private Code Format】.

1) 【Data Return T1–T2】: select to specify that result data is transmitted according to the camera ID.

After T1–T2 ☐CR☐ ☐LF☐, the system sends the result data.

Clear this check box to specify that the system directly sends the result data according to the method that you select; see the following picture.

2)　【Byte Output (4-Byte float type)】: The result data will be output in float type.

> Private Code Form: ○ Default
> ☐ Data Return To T1~T2
> ☑ Byte Output(4-Byte float type)

3)　【Show plus sign for positive numbers】: Select to specify that a plus sign is added to all positive result

data.
When the private code sends negative data, the negative sign is always added before the value,
regardless of this option.

> ☑ Show plus sign for positive numbers
> ☐ Single Zero

4)　【Single Zero】: When the data result is 0, only 0 will be output, and the value after the decimal place

will not be output.

> ☑ Single Zero
> ☐ Window is NG, don't output

5)　【Window is NG, don't output】: When the total result of the test is ON, the data is not output.

> ☐ Single Zero
> ☑ Window is NG, don't output

6)　【Data Format Fixed】: Select to specify that data is output in fixed decimal places.

For example, the original output value is 123.00; selecting this option outputs the data as 000123.00.

> ☑ Data Format Fixed
> 　　9 Digit Number(Including plus-minus sign and decimal point)

7)　【Output value is decimal, whether the decimal point output? 】:

　　7-1)　Select to specify that the output decimal place is based on the number you enter in Digit Place. For example, the original value on the lower right is 123.000000 and the actual output is 123.000.

Data Format Fixed		
9 Digit Number(Including plus-minus sign and decimal point)	Data Test	
☑ Output value is decimal, whether the decimal point output?		123.000
🔘 Digit Place 2	Test Result	
⚪ Data Type Output integer(Data x 100) ▼	123.00	

　　7-2)　Select【Data Type】this check box to specify that the output result is generated after multiplying

　　　　　by the value you enter for Data Type.

The original value on the lower right is 123.000000 and you select 【Output Integer (Data x 100)】for Data

Type, then the actual output 12300.

8)　Custom output result string format

The output format is 【Start Symbol】 + 【Result 1】 + 【Gap Symbol】+ 【Result 2】 + 【Gap Symbol】…+ 【Stop Symbol】.

　　8-1)　【Start Symbol】: Refer to the ASCII table in Section 8.5 to for the hexadecimal values corresponding to the ASCII characters.

Start Symbol	Byte0								Byte8							Byte15
Length 3	54	30	00	00	00	00	00	00	00	00	00	00	00	00	00	00
	T	0	NUL	NUL	NUL	NUL	NUL	NUL	NUL	NUL	NUL	NUL	NUL	NUL	NUL	NUL

　　8-2)　【Gap Symbol】: First determine the 【Gap Symbol Length】.

　　　　　As shown in the following picture, setting Gap Symbol Length to 1 means that the gap symbol is one character. Refer to the ASCII table in Section 8.5 for the hexadecimal values corresponding to the ASCII characters.

Gap Symbol	Byte0							
Length 1	2C	00	00	00	00	00	00	00
	,	NUL	NUL	NUL	NUL	NUL	NUL	NUL

8-3) 【Stop Symbol】: First decide the 【Stop Symbol Length】.

As shown in the following picture, configuring Stop Symbol Length to 1 means that the stop symbol is one character. Refer to the ASCII table in Section 8.6 for the hexadecimal values corresponding to the ASCII characters.

Stop Symbol		Byte0								Byte8							Byte15
Length	1	0D	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
		CR	NUL	NUL	NUL	NUL	NUL	NUL	NUL	NUL	NUL	NUL	NUL	NUL	NUL	NUL	NUL

After you complete the above settings, the system outputs data through the RS232 and RS485 serial ports according to these settings when you select custom output.

Chapter 9

Appendix

9.1 Locate

The Locate tool makes ROI inspections possible when the orientation of the target object changes as shown in the following diagram. Before using the Locate tool, inspections can only be performed at fixed positions. When the position of the target object deviates, a fixed ROI cannot be used due to the deviation in the position of the target object.

ROI

Object to be tested

Fixed ROI

Deviated target object
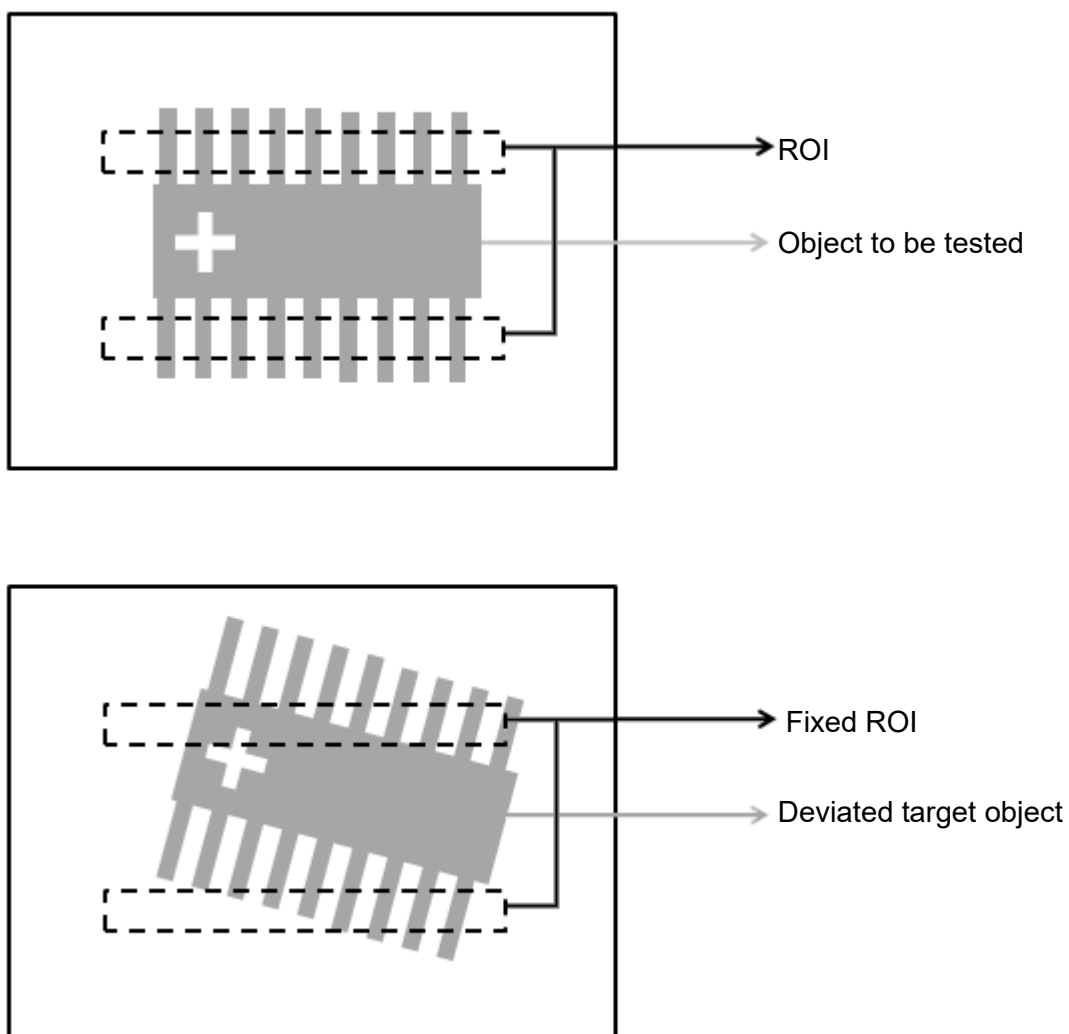
The Locate tool can identify a feature on the target object to confirm the object position before correcting the position of the ROI. As shown in the following diagram, Locate can use the crosshair on the target object to confirm the object position. Locate can then correct the position the ROI.
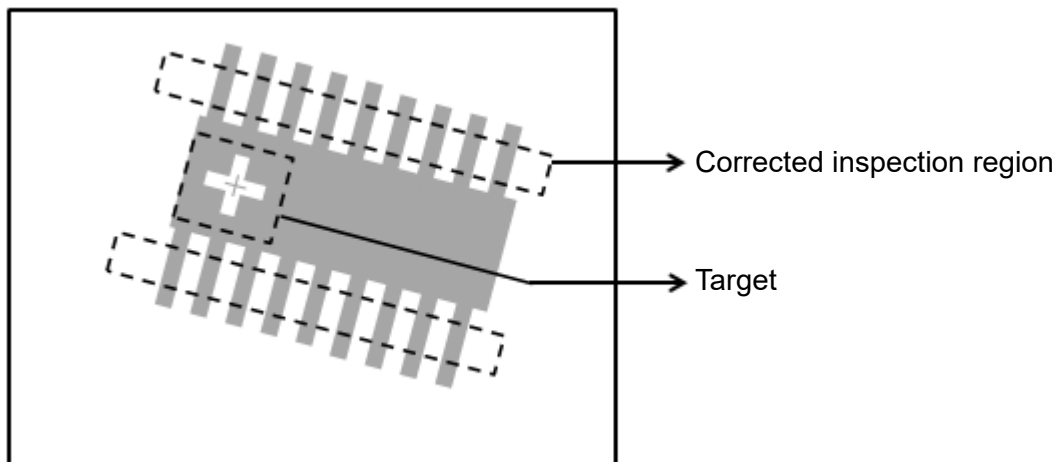
9.1.1 Locate Parameters

You can select the Ref. X, Ref. Y, and Ref. Angle in the Locate options for all inspection tools.

➤ **Ref. X**: Configure the ROI's reference X coordinate of the inspection tool
➤ **Ref Y**: Configure the ROI's reference Y coordinate of the inspection tool
➤ **Ref. Angle**: Configure the ROI's reference angle coordinate of the inspection tool

9.1.2 Reference Tools that Use Locate

You can use the output results of the following types of inspection tools for reference locations.

◎ **Shape (The most commonly used positioning reference tool)**
1) Ref. X:
Shape Position X [N]

2) Ref Y:
Shape Position Y [N]

3) Ref. Angle:
Shape Angle [N]

◎ **Blob**

1) Ref. X:

Blob Centroid Position X [N]

Blob Bounding Rectangle Upper Left Position X [N]

2) Ref Y:

Blob Centroid Position Y [N]

Blob Bounding Rectangle Upper Left Position Y [N]

3) Ref. Angle:

Blob Major Axis Angle [N]

◎ **Stain**

1) Ref. X:

Stain Centroid Position X [N]

2) Ref Y:

Stain Centroid Position Y [N]

◎ **Edge Angle**

1) Ref. Angle:

Edge Angle

◎ **Edge Pitch**

1) Ref. X:

Edge Pitch Center Position X

Edge Pitch First Edge Position X [N]

Edge Pitch Second Edge Position X [N]

2) Ref Y:

Edge Pitch Center Position Y

Edge Pitch First Edge Position Y [N]

Edge Pitch Second Edge Position Y [N]

3) Ref. Angle:

Pitch Center Absolute Angle [N]

Edge Pitch First Edge Absolute Angle [N]

Edge Pitch First Edge Relative Angle [N]

Edge Pitch Second Edge Absolute Angle [N]

Edge Pitch Second Edge Relative Angle [N]

◎ **Edge Position**

1) Ref. X:

Edge Position X [N]

2) Ref Y:

Edge Position Y [N]

3) Ref. Angle:

Edge Position Edge Absolute Angle [N]

Edge Position Edge Relative Angle [N]

◎ **Position Trace**

1) Ref. X:

Position Trace Edge Position X [N]

Position Trace Vertex Position X [N]

2) Ref Y:

Position Trace Edge Position Y [N]

Position Trace Vertex Position Y [N]

◎ **Width Trace**

1) Ref. X:

Width Trace Edge Width Position X1 [N]

Width Trace Edge Width Position X2 [N]

2) Ref Y:

Width Trace Edge Width Position Y1 [N]

Width Trace Edge Width Position Y2 [N]

9.1.3 Locate Configuration Process

The following examples explain the configuration of Locate flow processes.

A register image is shown in the following picture. The Blob bool is used to inspect the number of pins on the communication terminal and the Shape tool is used for positioning.
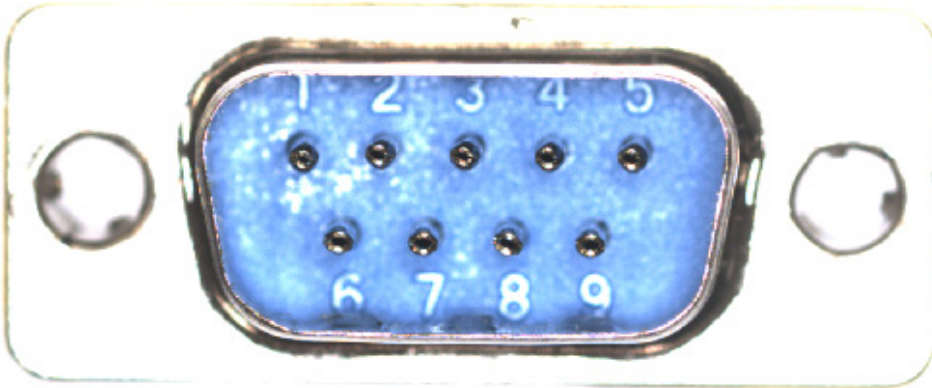
◎ **Flow Configuration**

1) Create one Shape tool function for positioning and one Blob function to count the number of pins.

2) Use the same register image for both the Shape and Blob functions.

3) Use the shape feature of the communication terminal as the target pattern in the Shape function.
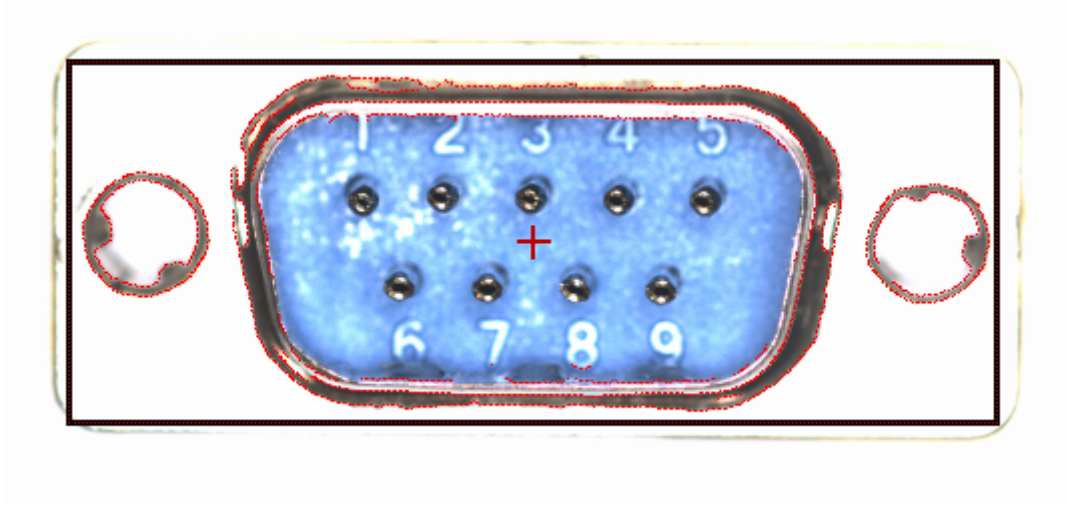
4) Configure the ROI as a Rectangle for the Blob function.

5) Locate is configured as shown in the following **Blob** tool dialog box. Configure **Ref. X**, **Ref. Y**, and **Ref. Angle** to **Shape Position X**, **Shape Position Y**, and **Shape Angle**, respectively.
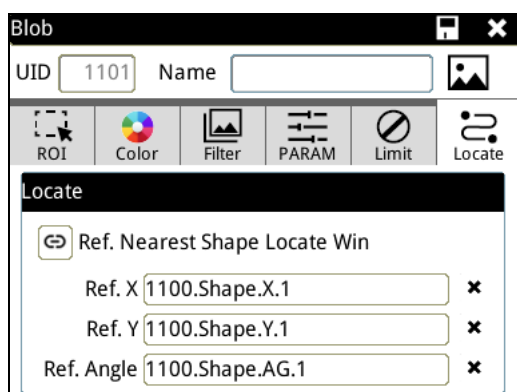
6) When the target object does not have an offset, the number of pins can be correctly counted as shown in the following operation screen.

Number of Blobs = 9

When the position of the target object deviates, the Blob function follows the Shape function, using Locate to correctly count the number of pins as long as the Shape function can correctly identify the shape

Number of Blobs = 9
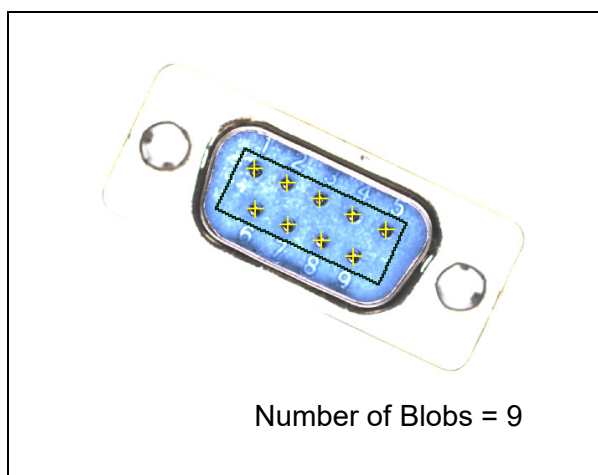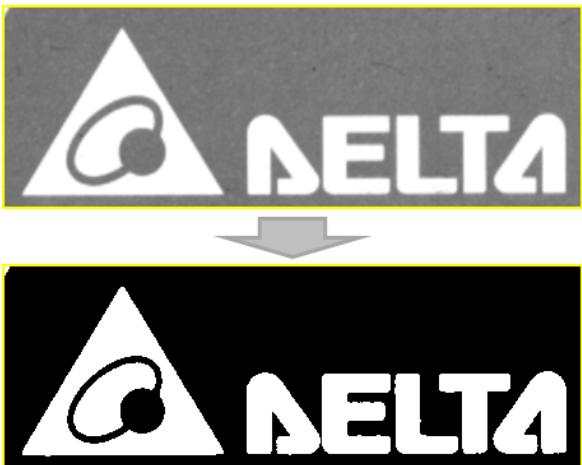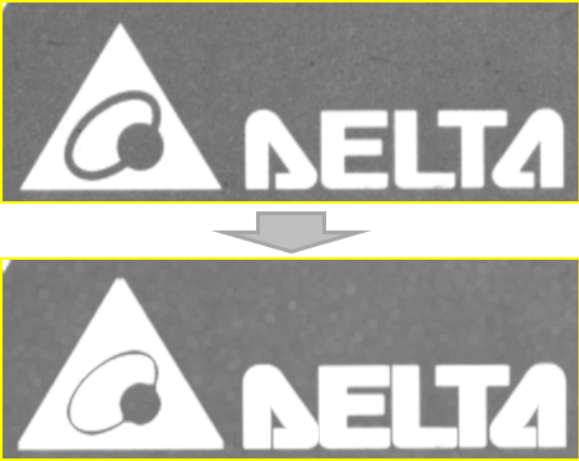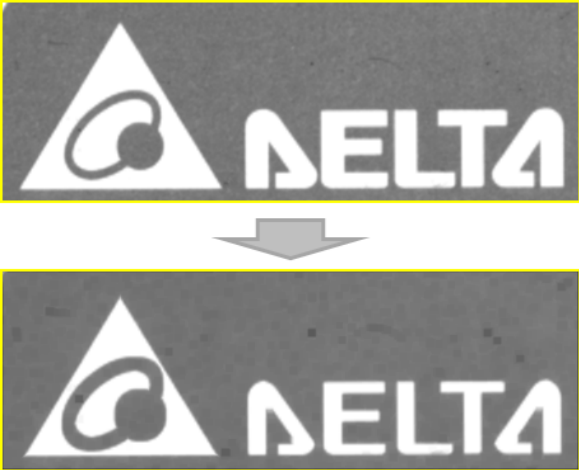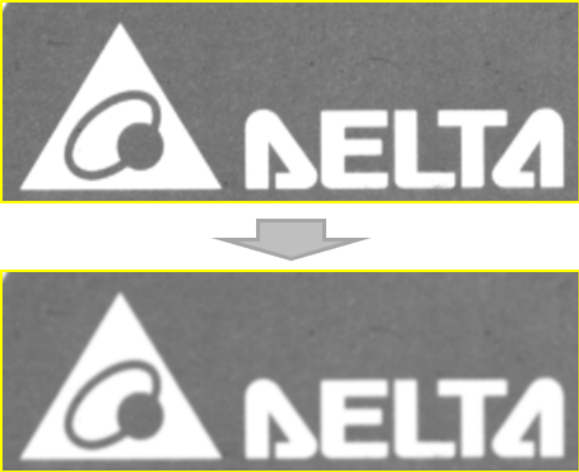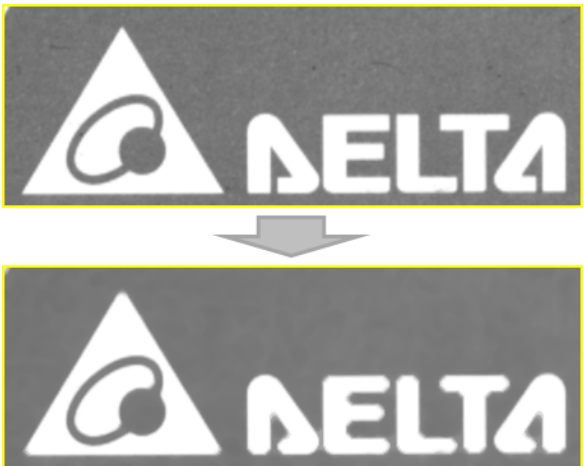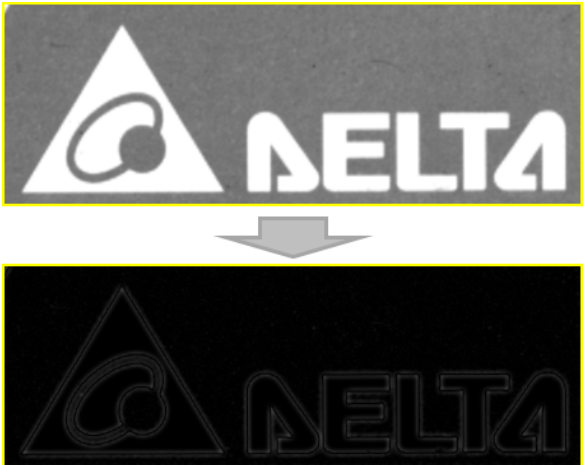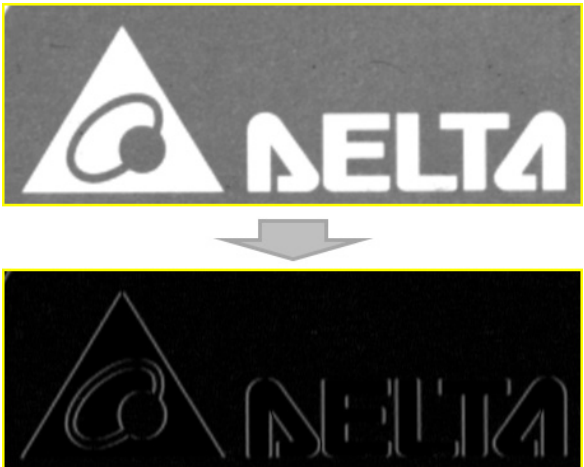
9.2 Preprocess

In the visual inspection application environment, inspections can misjudge or fail due to unclear target features in the images captured by the camera. Preprocessing the image before image processing may be required enhance features to increase the accuracy and success rate of inspections.
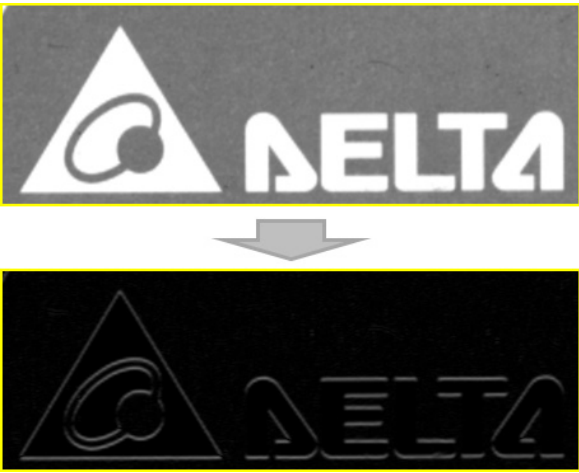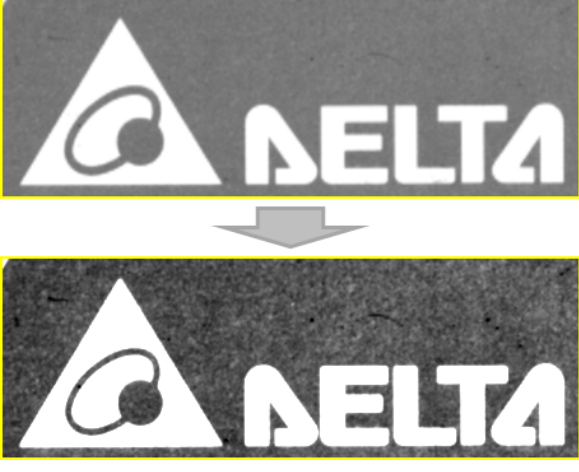
9.2.1 Preprocess Types
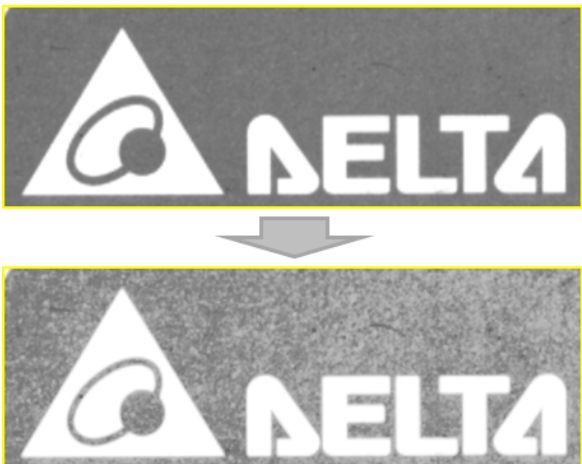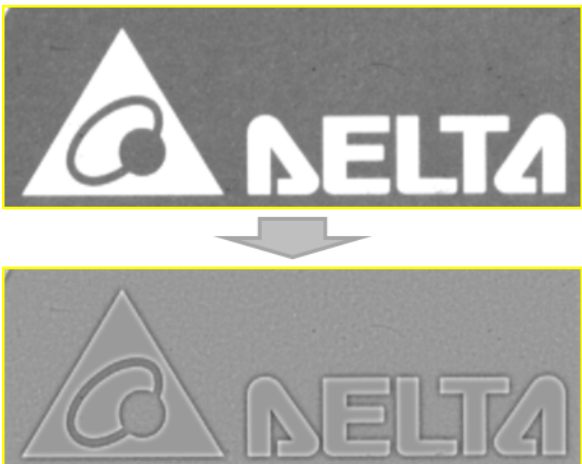
You can apply and overlay up to six sets of preprocesses to each inspection unit. You can create various effects through overlaying different preprocesses to enhance image features. The system currently supports 13 preprocess effects, including Binary, Dilate, Erosion, Average, Median, Laplacian, SobelX, SobelY, SobelXY, Intensity Adj., Contrast, Shade, and Custom.

No.	Preprocess	Description	Configuration Parameter
1	No preprocess	Select **None** in preprocess options; the preview shows the original image captured by the camera.	Without any preprocess function
2	Binarization	The system converts gray-scale image regions into black or white pixels.	ON/OFF: ON Color Condition: White Histogram: Upper 255/Lower 149

3	Dilation	The system dilates (expands) the white pixels. 	ON/OFF: ON Filter Size: 3x3 Filter Direction: XY Frequency: 2
4	Erosion	The system reduces (shrinks) the white pixels. 	ON/OFF: ON Filter Size: 3x3 Filter Direction: XY Frequency: 2
5	Average	The system averages the surrounding pixels to blur the image and reduce noise. 	ON/OFF: ON Filter Size: 3x3 Filter Direction: XY Frequency: 2

6	Median	The system takes the median after comparing surrounding pixels to reduce noise without blurring the image. 	ON/OFF: ON Filter Size: 5x5 Filter Direction: XY Frequency: 5
7	Laplacian	The system performs edge extraction in the XY direction with similar effects as Sobel, but the lines are thinner with stronger results at high contrasting edges 	ON/OFF: ON Filter Size: 9x9 Frequency: 1
8	SobelX	The system extracts edges in the X direction. 	ON/OFF: ON Filter Size: 3x3 Frequency: 1

9	SobelY	The system extracts edges in the Y direction. 	ON/OFF: ON Filter Size: 3x3 Frequency: 1
10	SobelXY	The system simultaneously extracts edges in the X and Y directions. 	ON/OFF: ON Filter Size: 3x3 Frequency: 1
11	Intensity Adj.	The system adjusts the overall brightness of the grayscale in the original image based on variations in slope and offset. 	ON/OFF: ON Offset: -423 Slope: 4.2

12	Contrast	The system increases the contrast in the image.	ON/OFF: ON
13	Shade	The system makes adjustments to emphasize the Stain effect when the gray scale on the surface of the target object is uneven.	ON/OFF: ON Filter Size: 5

9.3 Lighting

9.3.1 Lighting Method

Lighting covers the light source as well as the relative position with the camera. The most common light sources and imaging results are described below.

◎ **Dark Field Lighting:** Smooth surfaces appear darker.

The camera and the lens are coaxial and the angle is not perpendicular. Light hitting the smooth surface on the object reflects at a right angle away from the image sensor and light bouncing off non-smooth areas scatter into the CCD. As a result, the smooth surfaces appear darker and the rough areas appear brighter.
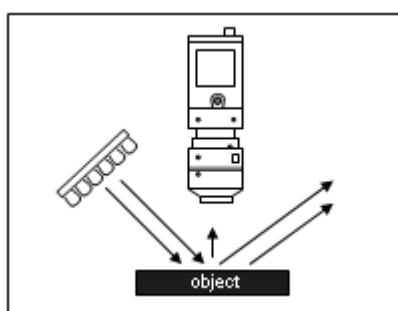
Raised text on black plastic

DELTA — Target object

DELTA — Dark field

◎ **Bright Field Lighting:** Smooth surfaces appear brighter.

The camera and lens are coaxial and the angle is perpendicular. Light is directly reflected off the smooth surface on the object into the image sensor. As a result, the smooth surfaces appear brighter and the rough areas scatter light away from the CCD and thus appear darker. Therefore, bright field and dark field lighting are inversely related in image brightness/darkness. However, you should prevent glare due to bright reflections in bright field lighting.
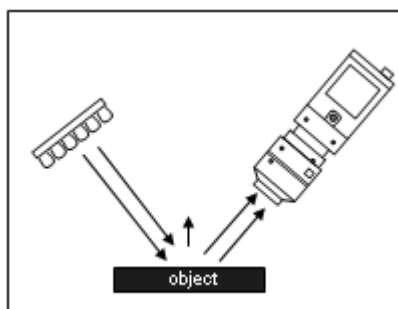

Raised text on black plastic

DELTA — Target object

DELTA — Dark field

◎ **Front Lighting**

Front lighting is a common technique, with ring or strip light source, and is suitable for acquiring surface images of general objects. If you install the circle light at a different angle, it casts a different shadow effect. For highly reflective objects, you can use the diffuser or diffuse softening series to clarify images.
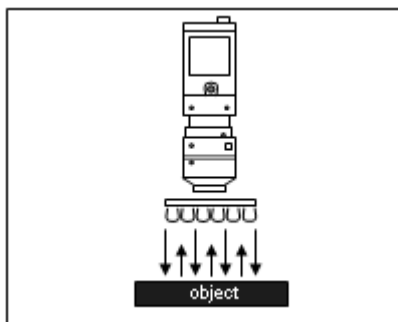
Lighting on flat

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Taoyuan Count
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◎ **Oblique Lighting**

Oblique lighting creates side shadows when projected from the side of raised objects. The resulting image has a 2.5D effect. Among the different angles of 0°, 30°, 60°, and 90° used for general ring lighting, you can use 0° and 30° for oblique lighting.

To reduce errors in edge position caused by the shadowing, avoid using oblique lighting in edge detection.
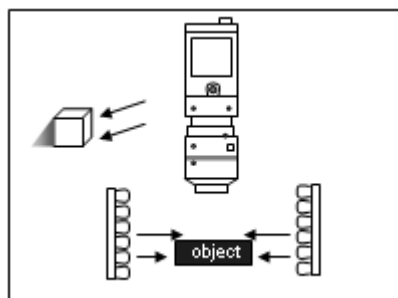
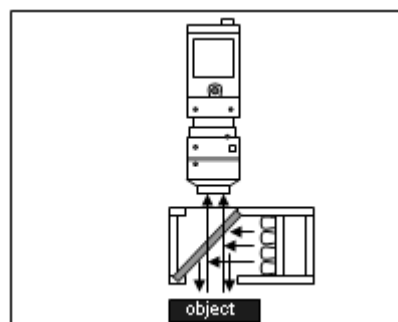Printed text on a fuse

Target object

General Circle lighting
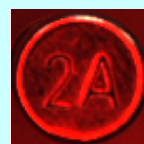
Low angle Circle lighting

◎ **Coaxial Lighting**

The light source can be either inside or outside the lens (inner/outer coaxial). You can also use a beam splitter to create a soft light field that can reduce reflections or glare, suitable for objects with high reflectivity, such as glass or metallic material.
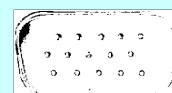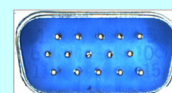
Measuring a pin connector
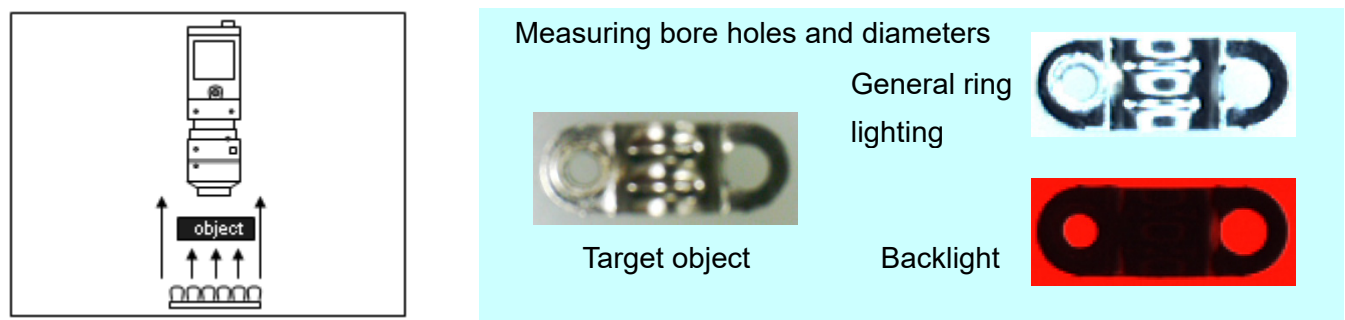
Target object

General

Coaxial

◎ **Back Lighting**

The camera can capture the object outline by shielding the light source, but the surface characteristics are lost. This is generally used for measuring an object's size, positioning, or for defect detection.


Measuring bore holes and diameters

General ring lighting

Target object   Backlight

9.4 Color

When using a color camera, every inspection tool can use the Color Condition function to extract and convert the specific colors of a color image into a binary or gray-scale image.

### 9.4.1 Color Condition Configuration

The following picture shows the **Color Extraction Method Setting** dialog box for color conditioning. It includes the Extraction Method Setting, Color Extraction Tool, and Color Range Setting.
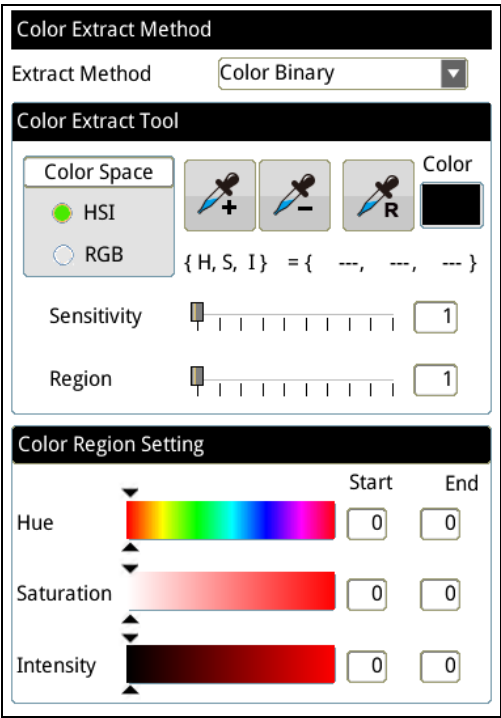
◎ **Extraction Method**

➤ **Color to Binary**

The Color Extraction Tool extracts specific colors and converts color images to binary images. You select the color to be extracted. After processing, the extracted color is white and the remaining colors are black, as shown in the following picture.
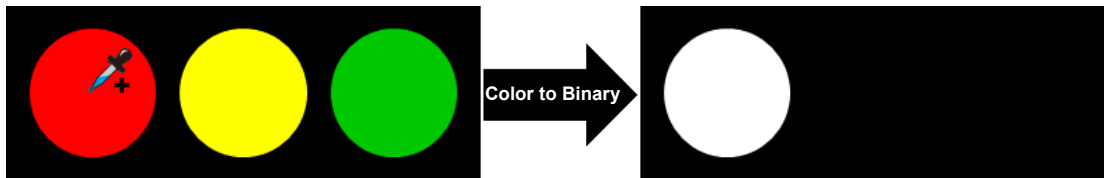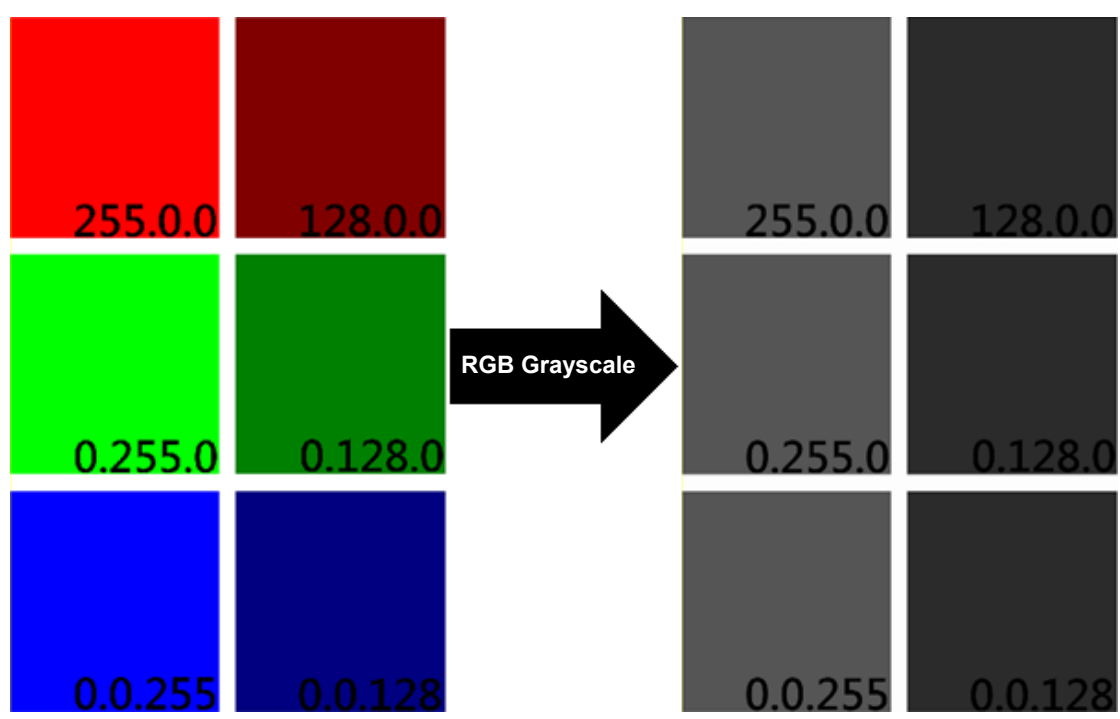

➤ **Color to Grayscale**

The Color Extraction Tool extracts specific colors and converts color images to gray-scale images. You select the color to be extracted. After processing, the extracted color is the brightest (a grayscale of value 255), as shown in the following picture.
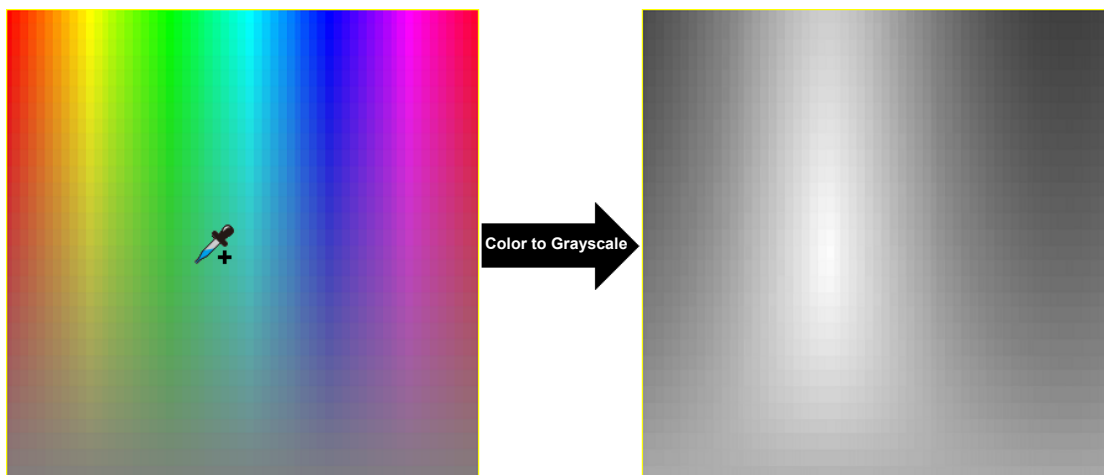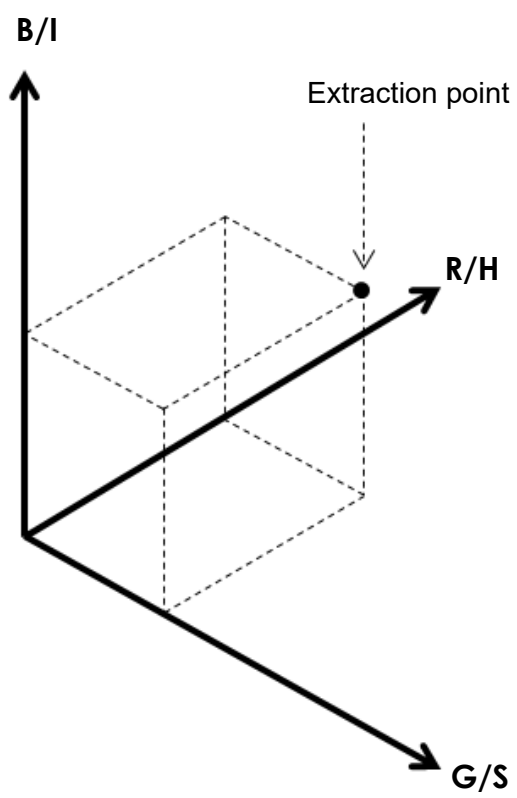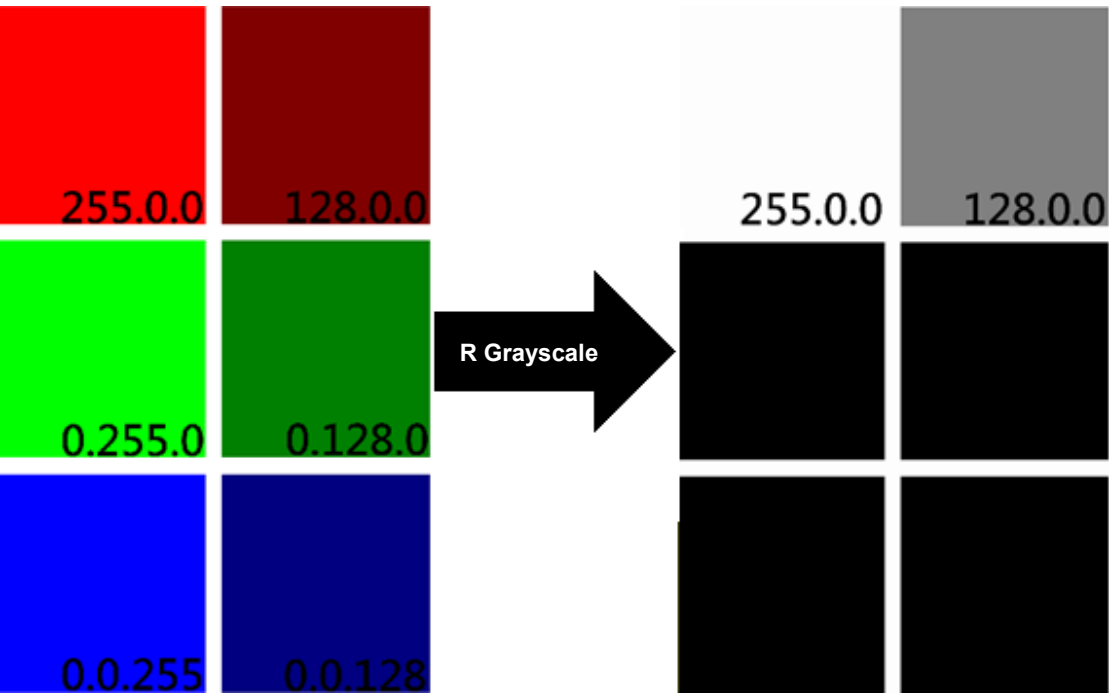
➤ **RGB Grayscale**

This selection averages the R, G, and B grayscales for each pixel, and converts the color image to a gray-scale image.
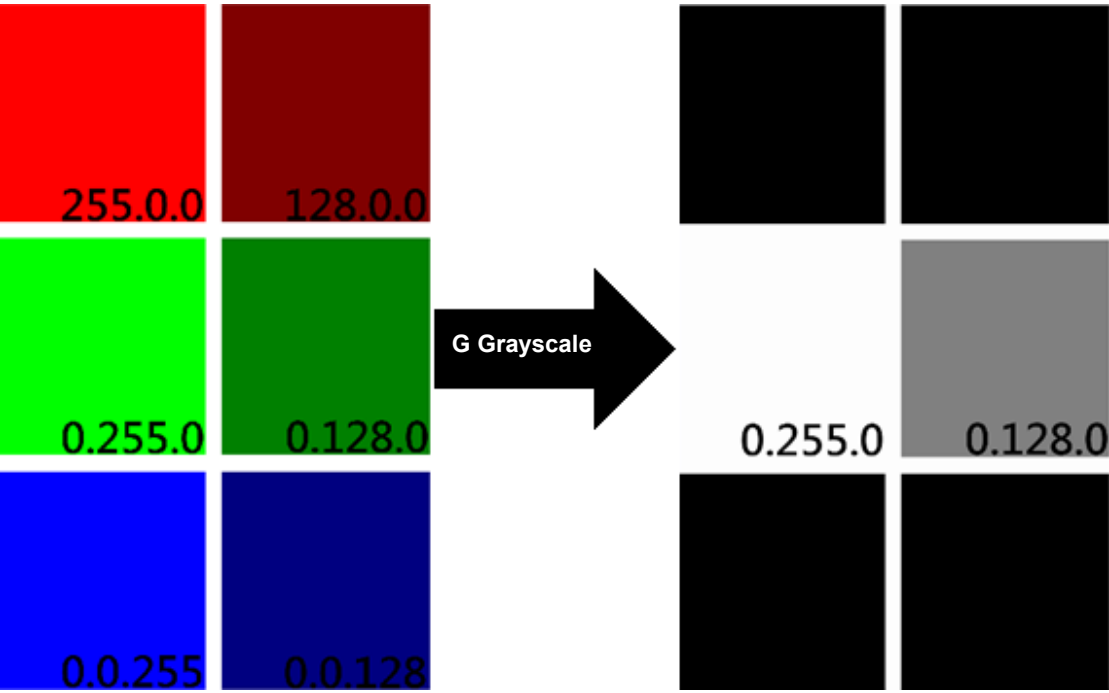
➤ **R Grayscale**

This selection extracts the R grayscale value for each pixel, and converts the color image to a gray-scale image according to the intensity of the R grayscale.

➤ **G Grayscale**

This selection extracts the G grayscale value for each pixel, and converts the color image is to a gray-scale image according to the intensity of the G grayscale.

➤ **B Grayscale**

This selection extracts the B grayscale value for each pixel, and converts the color image to a gray-scale image according to the intensity of the B grayscale.
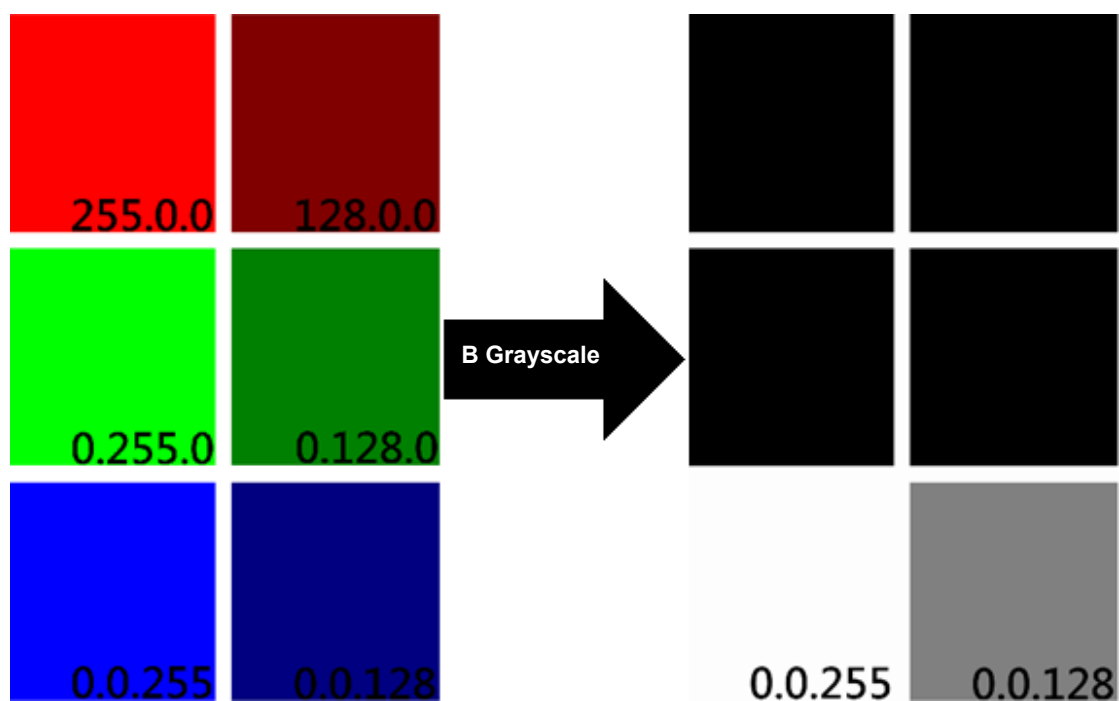

➤ **B Grayscale**

◎ **RGB VS HSI**

A color can be presented using the intensities of the three primary color R, G, and B components. For example, dark red can is R = 50, G = 0, B = 0 and bright red is R = 255, G = 0, B = 0. Dark yellow is R = 50, G = 50, B = 0 and bright yellow is R = 255, G = 255, B = 0. Therefore, you must adjust at least 2 color parameters to change color intensity and saturation when colors are defined using RGB. In addition, the adjustments are non-intuitive.

HSI is often used because it is more intuitive when using color extraction tools. Similar to RGB, HSI also uses 3 color components to represent 1 color. However, HSI uses the three components of hue (H), saturation (S), and intensity (I) instead of the red, green, and blue components of RGB (as shown in the following picture). Therefore, in HSI, the H component determines the color, the S component determines the saturation of the color, and the I component determines the intensity of the color.
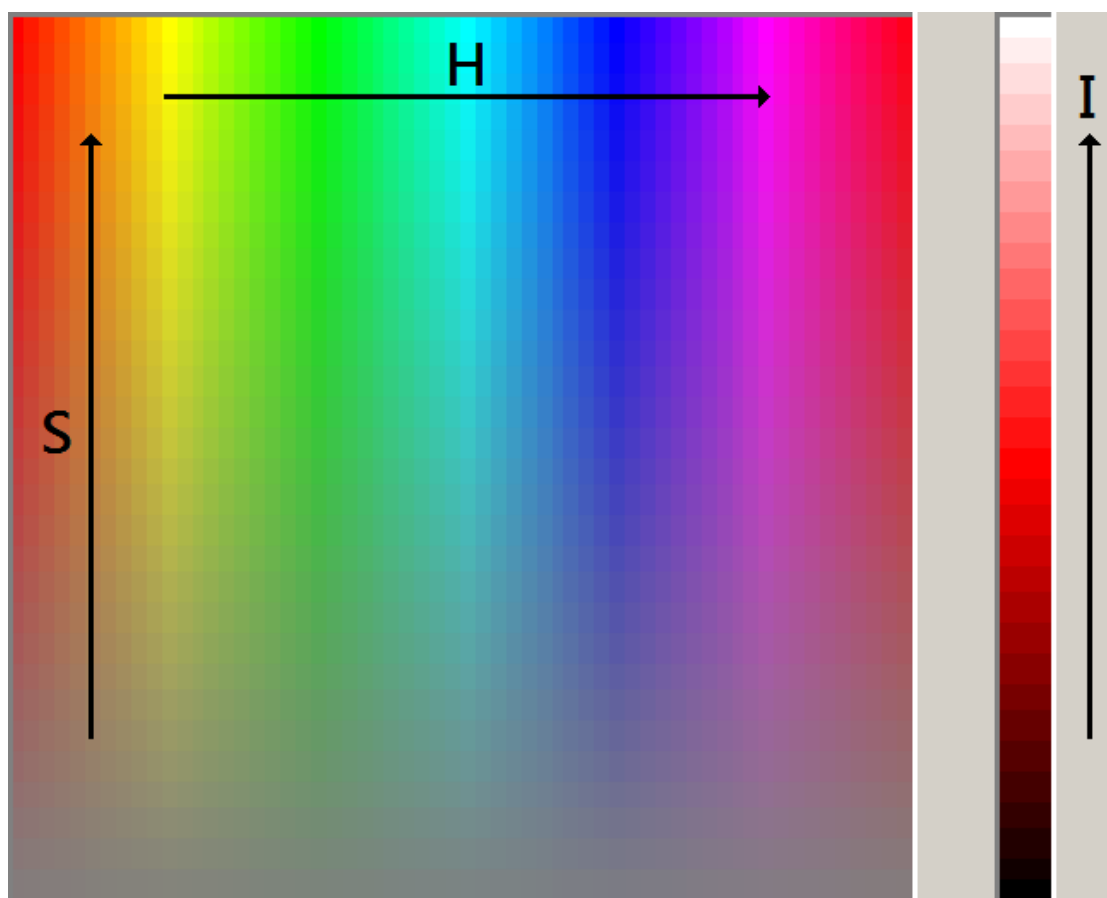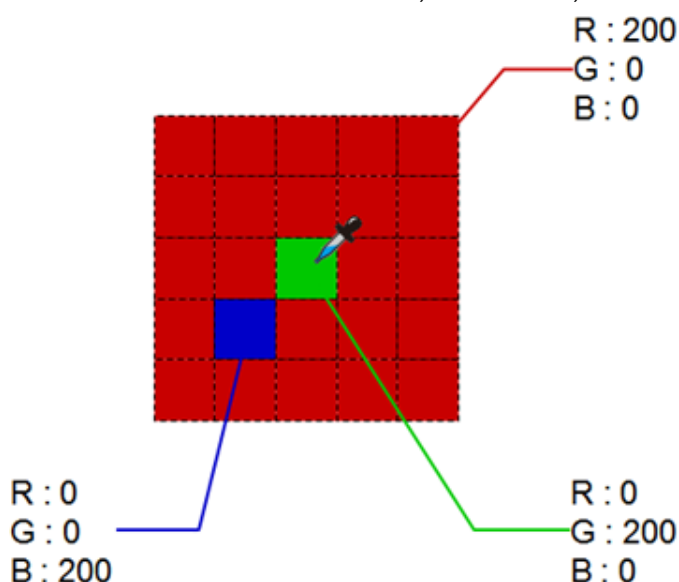

◎ **Color Extraction Tool**

Use the dropper tool to extract the target color from an image in the Color Extraction Tool.

➤ The Color Extraction Tool for the Color to Binary function appears in the following picture. Color to Binary requires extracting a color range. Therefore, when extracting colors, you use **Dropper+** and **Dropper-** repeatedly to increase or decrease the color range; Click **DropperR** to reset the extracted color range.
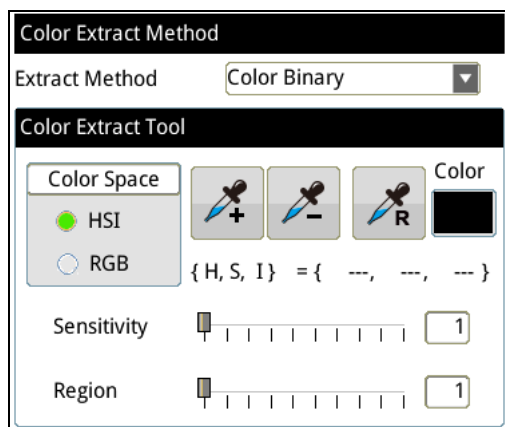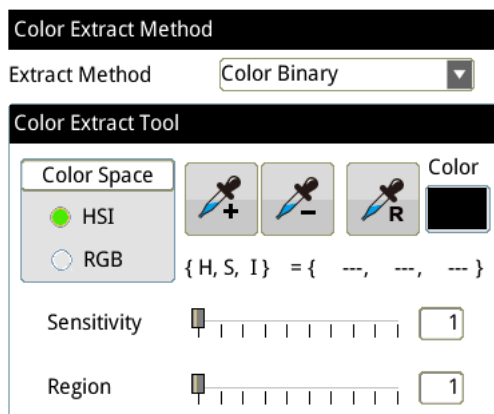

◆ The **Sensitivity** and **Region** settings influence the color range for each extraction. For example: the extraction position is shown in the following picture. Set **Region** and **Sensitivity** to 1 and 5, respectively.

Set **Region** to 1; the selected pixel region is extended by +/-1 pixel in the X and Y directions. The selected region becomes 3x3 which is then averaged using the RGB components. As a result, the extracted values are R = 200*7/9, G = 200*1/9, and B = 200*1/9; R = 156, G = 22, and B = 22. When you set **Sensitivity** is set to 5, the extracted RGB range is extended by +/-5. The final extraction result is R = 151–161, G = 17–27, and B = 17–27.

➤ The Color Extraction Tool for the Color to Grayscale function appears in the following picture.

Color to Grayscale only extracts one specific color. Therefore, when extracting colors, you use only the **Dropper+** to extract of a single color. Use **DropperR** to reset the range of the extracted color.
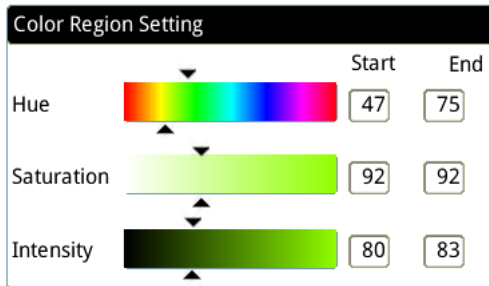
Color Extract Method	
Extract Method	Color Binary ▼

Color Extract Tool

Color Space			Color
○ HSI			■
○ RGB	{ H, S, I } = { ---, ---, --- }		
Sensitivity	▯‖‖‖‖‖‖‖‖	1	
Region	▯‖‖‖‖‖‖‖‖	1	

◆ The **Region** setting influences the extracted color, as shown in the following example.

The extraction position is shown in the following picture. Set **Region** to 1;

the selected pixel region is extended by +/-1 pixel in the X and Y directions. The selected region becomes 3*3 which is then averaged using the RGB components. As a result, the extracted values are R = 200*7/9, G = 200*1/9, and B = 200*1/9, thus R = 156, G = 22, and B = 22.

R : 200
G : 0
B : 0

R : 0
G : 0
B : 200

R : 0
G : 200
B : 0
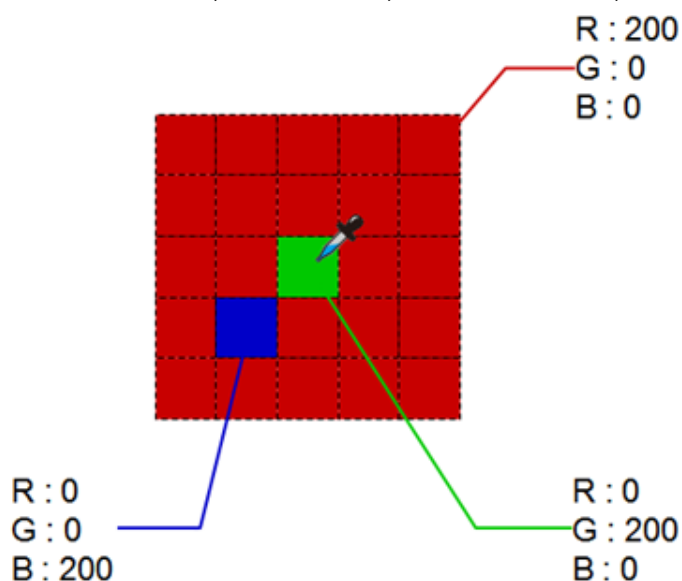
◎ **Color Range Setting**

Adjusts the extracted color range.

➤ The Color Range Settings for Color to Binary appears in the following picture. Drag the bars on the color picker to adjust the extracted color range. You can also enter the **Lower** and **Upper** numeric values to adjust the extracted color range.

HSI color picker interface