DMV2000 Technical Manual V2.0

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Thank you for selecting the high-performance Digital Machine Vision System DMV2000 series from Delta Electronics Inc. This operating manual contains descriptions of all components and provides information on product-related issues including installation, operation (process configuration), troubleshooting, peripherals, and maintenance.

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. To prevent damage due to an incorrect voltage input level, please check to ensure that all signal connections, such as input voltage and polarity, are correct before powering on any component.
2. 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.
3. Please do not attempt to disassemble or modify the internal components of the controller.
4. 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 external impact.
5. Keep away from scrap metal, which could interfere with operation or even cause damage to the components.
6. During installation, keep away from sources of interference such as high voltage and/or high frequency noise. Avoid system operation under the following situations:
   (a) Excessive dust and/or corrosive gasses; (b) high temperature, high humidity, and high levels of radiation; (c) shock and impact; (d) exposure to direct sunlight
7. Please clean the system with a dry cloth. Do not use cleaning solutions containing acidic or alkaline chemicals.
8. Check to ensure a proper connection is established between the ground terminal and the power source. Check to ensure that all terminals are securely connected.
9. Only use a blower cleaner 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.
10. 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.
11. Restart must be performed at least 10 s after power off.

DMV2000 Technical Manual V2.0

Revision History

Version	Revision	Date
V1.0	The first version was published.	2016/07/15
V2.0	1. The Codes for camera shutter speed setting in chapter 8 are amended. 2. Modbus master mode communication method for RS232, RS485 and Ethernet are added in chapter 8.	2016/12/30

Chapter 1

Components and Specifications

1.1 Packaging and Optional Parts

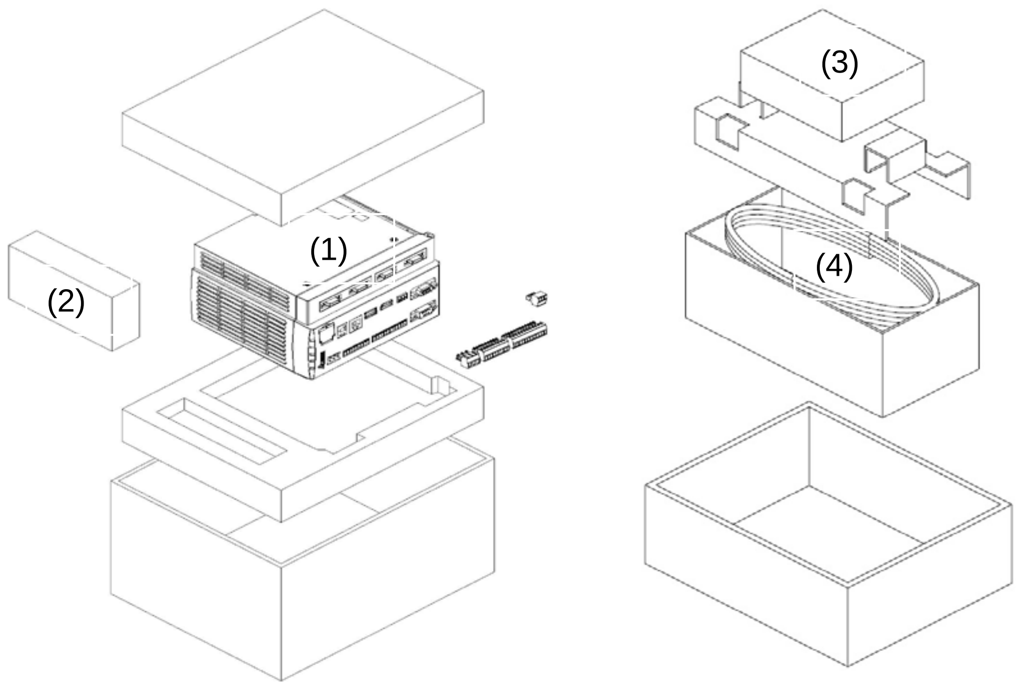
A complete DMV system comprises the following basic components:

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) DMV2000-CL2-HS (DMV2000-CL4-HS) controller unit
2) Mouse
3) Camera
4) Camera transmission cable



1.1.2 Camera (Optional: 2nd–4th Camera Expansion)

The camera adopts the Camera Link transmission interface and is equipped with standard CH1 and CH2 transmission ports. When using one transmission cable, please connect to CH1. When increased camera transmission speeds are required (increased frame rate), please connect both CH1 and CH2 ports through two transmission cables to the DMV2000 main unit (i.e., simultaneously connect to both Camera-1 and Camera-2 ports on DMV2000).

◎ **0.3 MP Camera**

Specifications: 1/3" COMS chip, C mount port, 480 fps, 7.4 µm chip size

- 0.3 MP (640*480) color camera: DMV-CM30CCL
- 0.3 MP (640*480) gray-scale camera: DMV-CM30GCL

◎ **2 MP Camera**

Specifications: 2/3" COMS chip, C mount port, 295 fps, 5.5 µm chip size

- 2 MP (2048*1088) color camera: DMV-CM2MCCL
- 2 MP (2048*1088) gray-scale camera: DMV-CM2MGCL

◎ **4 MP Camera**

Specifications: 1" COMS chip, C mount port, 159 fps, 5.5 µm chip size

- 4 MP (2048*2048) color camera: DMV-CM4MCCL
- 4 MP (2048*2048) gray-scale camera: DMV-CM4MGCL

◎ **5 MP Camera**

Specifications: 2/3" CCD chip, C mount port, 16 fps, 3.45 µm chip size

- 5 MP (2448*2058) color camera: DMV-CD5MCCL
- 5 MP (2448*2058) gray-scale camera: DMV-CD5MGCL

◎ **12 MP Camera**

Specifications: 1.76" COMS chip, F mount port, 50 fps, 5.5 µm chip size

- 12 MP (4096*3072) color camera: DMV-CM12MCCL
- 12 MP (4096*3072) gray-scale camera: DMV-CM12MGCL

1.1.3 Lens (Optional)

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

- 6 mm focal length lens: DMV-LN06W40
- 8mm focal length lens: DMV-LN08W40
- 12mm focal length lens: DMV-LN12W40
- 16mm focal length lens: DMV-LN16W40
- 25mm focal length lens: DMV-LN25W40
- 35mm focal length lens: DMV-LN35W40
- 50mm focal length lens: DMV-LN50W40
- 75mm focal length lens: DMV-LN75W40
- 100mm focal length lens: DMV-LN100W40

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

- 5mm focal length lens: DMV-LN05M
- 8mm focal length lens: DMV-LN08M
- 12mm focal length lens: DMV-LN12M
- 16mm focal length lens: DMV-LN16M
- 25mm focal length lens: DMV-LN25M
- 35mm focal length lens: DMV-LN35M
- 50mm focal length lens: DMV-LN50M

◎ **1" Megapixel Lens (Smaller Distortion):** 1" image size, C-mount port
Applicable for 4 and 5 MP cameras

- 12mm focal length lens: DMV-LN12M06 (high resolution series)
- 16mm focal length lens: DMV-LN16M06 (high resolution series)
- 25mm focal length lens: DMV-LN25M06 (high resolution series)
- 35mm focal length lens: DMV-LN35M06 (high resolution series)
- 50mm focal length lens: DMV-LN50M06 (high resolution series)
- 12mm focal length lens: DMV-LN12M05 (normal resolution series)
- 35mm focal length lens: DMV-LN35M05 (normal resolution series)
- 50mm focal length lens: DMV-LN50M05 (normal resolution series)

◎ **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: DMV-PS12C1
- Two channel output: DMV-PS12C2
- Power extension cord: DMV-CA30P

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

1.2 Controller Unit

1.2.1 Specifications

◆ **General Specifications**

Input power	DC 24 V
Operation voltage	90%~110% of rated voltage
Current consumption	Two cameras: <3.4 A Four cameras: <4 A
Vibration resistance	No error (normal operation): 3-axis; 10~55 Hz; 10 m/s (1.0 G); 10 min. No damage: 3-axis; 10~55 Hz; 20 m/s (2.0 G); 10 min.
Shock resistance	No error (normal operation): 200 m/s (20 G); 3 drops; 3 edges, 6 surfaces, and 1 corner No damage: 300m/s (30 G); 3 drops; 3 edges, 6 surfaces, and 1 corner
Operating temperature	0°C~+45°C
Storage temperature	-20°C ~+65°C
Operating humidity	35%~65% RH (no condensation)
Operating altitude	Lower than 2,000 m
Battery lifespan	More than 5 years

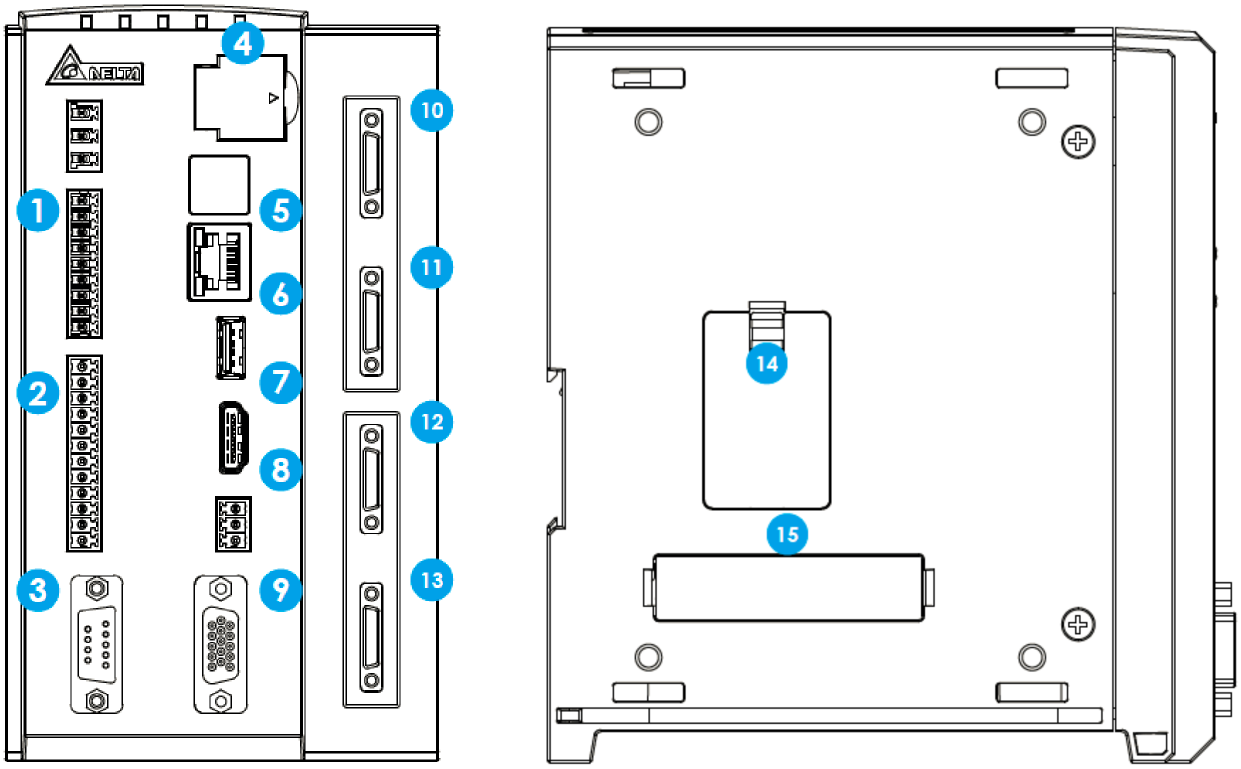
◆ **Functional Specifications**

Camera	Type	Camera Link digital color/gray-scale camera
	Resolution	0.3 MP Camera: 642 (H) * 484 (V), Base: 480 fps
		2 MP Camera: 2048 (H) * 1088 (V), Base: 74 fps, Full: 295 fps
		4 MP Camera: 2048 (H) * 2048 (V), Base: 40 fps, Full: 159 fps
		5 MP Camera: 2448 (H) * 2058 (V), Base: 16 fps
		12 MP Camera: 4096 (H) * 3072 (V), Base: 13 fps, Full: 50 fps
	Connected systems	DMV2000-CL2-HS maximum 2 units DMV2000-CL4-HS maximum 4 units
	Shutter speed	0.3 MP: 20 µs~16.777 s 2 MP: 22 µs~45 s 4 MP: 22 µs~45 s 5 MP: 4.8 µs~0.125 s 12 MP: 42 µs~1 s
	Lens mount	C mount (F mount for 12 MP)
	Operating temperature	0°C~+45°C
	Storage temperature	-20°C ~+65°C

Project quantity		Internal memory: 1000 Memory card: Pending space; upper limit at 9999 May switch through I/O and communication ports (RS232/485, Ethernet)
Inspection window	Quantity	Maximum 1000 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 1P Position, 1P Location
	ROI type	Rectangle, circle, polygon, ellipse, circle, arc, rotation rectangle
	Number of ROIs	1
	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, custom, brightness, contrast, shade
Run mode		Always execute, never execute
Calculation processing	Quantity	Maximum 1000 sets (each project)
	Arithmetic	Add, subtract, multiply, divide
	Function (71 types)	EQ；NOT_EQ；LT；LE；GT；GE；AND；BIT_AND；OR；BIT_OR；XOR；BIT_XOR；NOT；BIT_NOT；INRANGE；CHOOSE；IF；MAX_INDEX；MIN_INDEX；MAXth_INDEX；MINth_INDEX；ABS；POW；MOD；LOG10；LN；EXP；SQR；SQRT；SUM；TRUNC；ROUND；CEIL；FLOOR；SIN；COS；TAN；ASIN；ACOS；ATAN；ATAN2；RAD；DEG；PI；MAX；AVG；AVG_RANGE；MIN；SDEV；MEDIAN；MODE；LINE_FIT；CIRCLE_FIT；POINT_TO_POINT；POINT_TO_LINE；POINT_TO_CIRCLE；POINT_TO_POINT_DIST；POINT_TO_POINT_ANGLE；LINE_ANGLE；LINE_MIN_ANGLE；LINE_TO_LINE；LINE_TO_CIRCLE；CIRCLE_TO_CIRCLE；BLOB_TO_POINT；BLOB_TO_LINE；BLOB_TO_BLOB；BLOB_TO_POINT_ANGLE；STAIN_TO_POINT；STAIN_TO_LINE；STAIN_TO STAIN；STAIN_TO_STAIN_ANGLE
Communication port		Programmable input pins: 8 (high speed); 24 (normal) Programmable output pins: 11 (high speed); 38 (normal) RS232 (maximum 115,200 bps), RS485 (maximum 230,400 bps), Ethernet (10/100/1000BASE-T), Delta PLC-Link
Display	Monitor Display	FHD 1920*1080 output, XGA 1024*768 output (currently unsupported)

	Display ratio	Adjustable 5~1000%
	Operating language	Traditional Chinese, English
	Output interface	VGA, HDMI
Operating interface	Mouse	Standard 3-button
Flash control		DMV2000-CL2-HS: Setup output control through I/O contact, supporting a maximum of 2 sets DMV2000-CL4-HS: Setup output control through I/O contact, supporting a maximum of 4 sets
Type of memory card		MicroSD card (supports maximum 32GB); Class 10

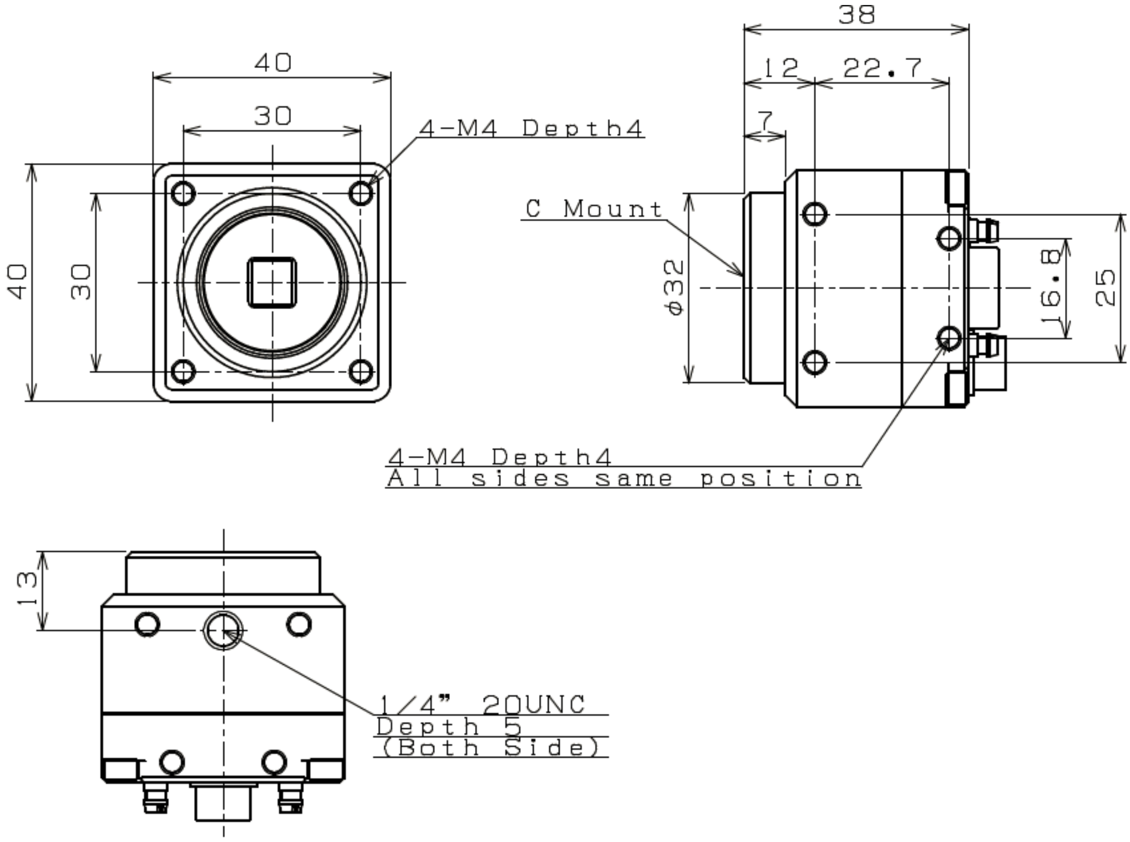
1.2.2 Name of Controller Components



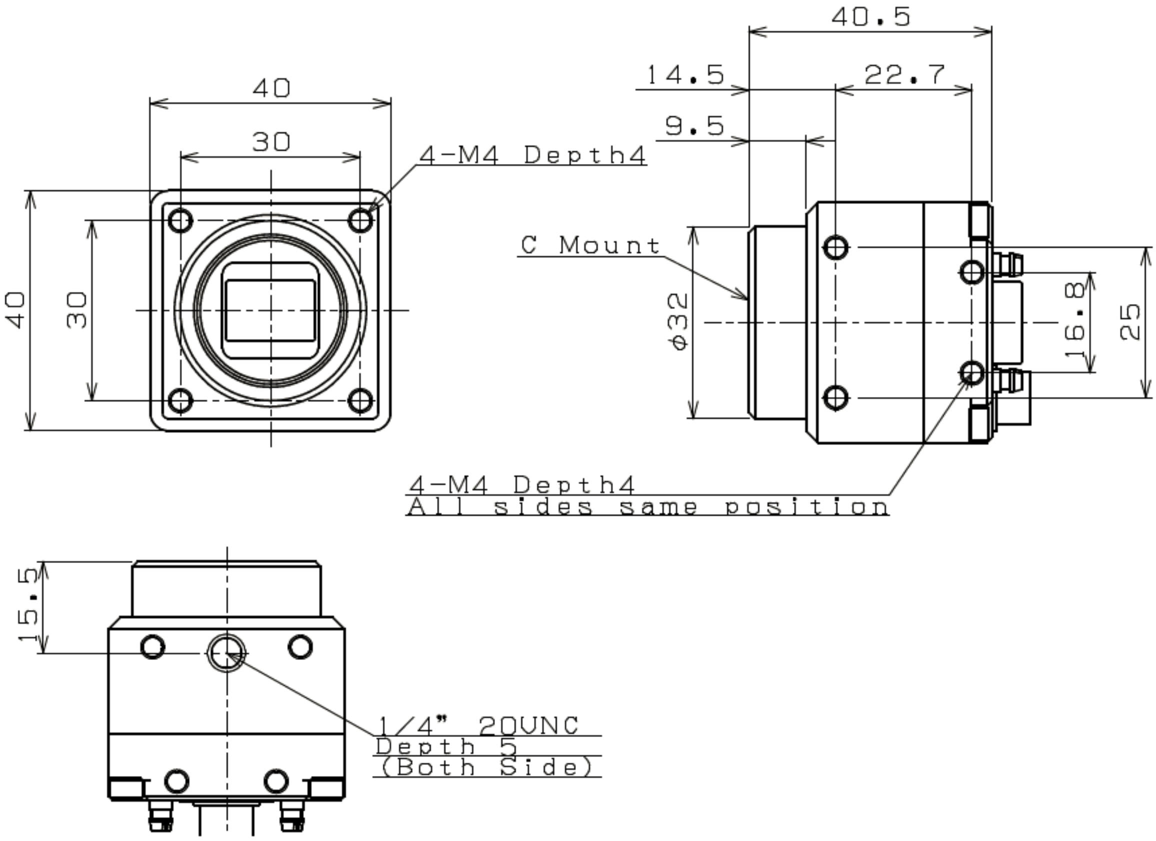
Serial No.	Name	Description
1	Input I/O terminal block	Input terminal (8 pin)
2	Output I/O terminal block	Output terminal (11 pin)
3	RS-232 serial port	Supports master/slave serial communication
4	SD card	Saves project configuration and image backup
5	Ethernet port	10/100 BASE-T communication
6	USB 2.0 port	Mouse interface
7	HDMI output port	Connects to commercial HDMI interfaced displays
8	RS-485 serial port	Supports master/slave serial communication
9	VGA output port	Connects to commercial VGA interfaced displays
10	Camera 1 port	Ports for 0.3, 2, 4, 5, and 12 MP cameras
11	Camera 2 port	Ports for 0.3, 2, 4, 5, and 12 MP cameras
12	Camera 3 port	Ports for 0.3, 2, 4, 5, and 12 MP cameras
13	Camera 4 port	Ports for 0.3, 2, 4, 5, and 12 MP cameras
14	Button cell port	Maintain system clock operation
15	Expansion port	Light source control, I/O extension

1.2.3 Camera Installation and Dimensions

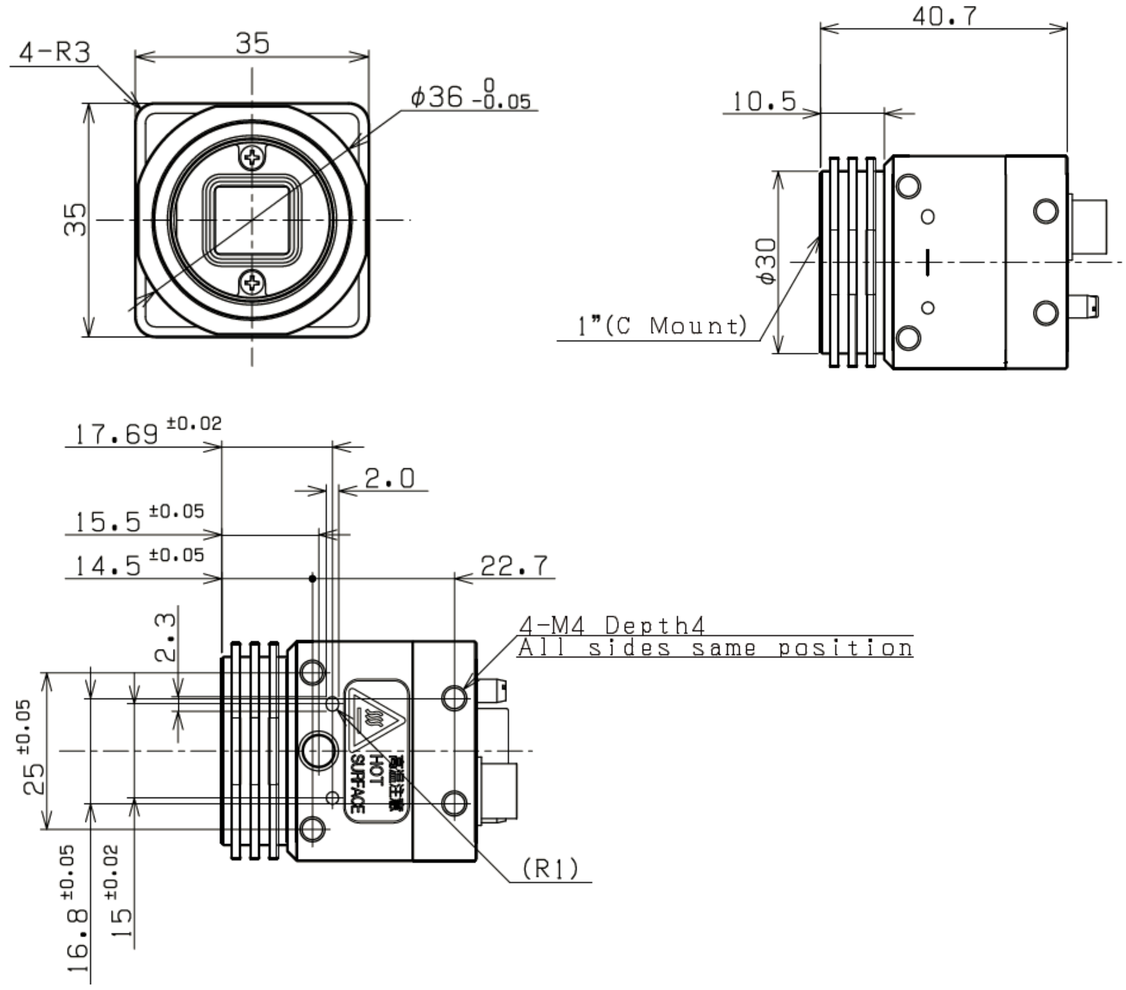
◎ **0.3 MP Camera**



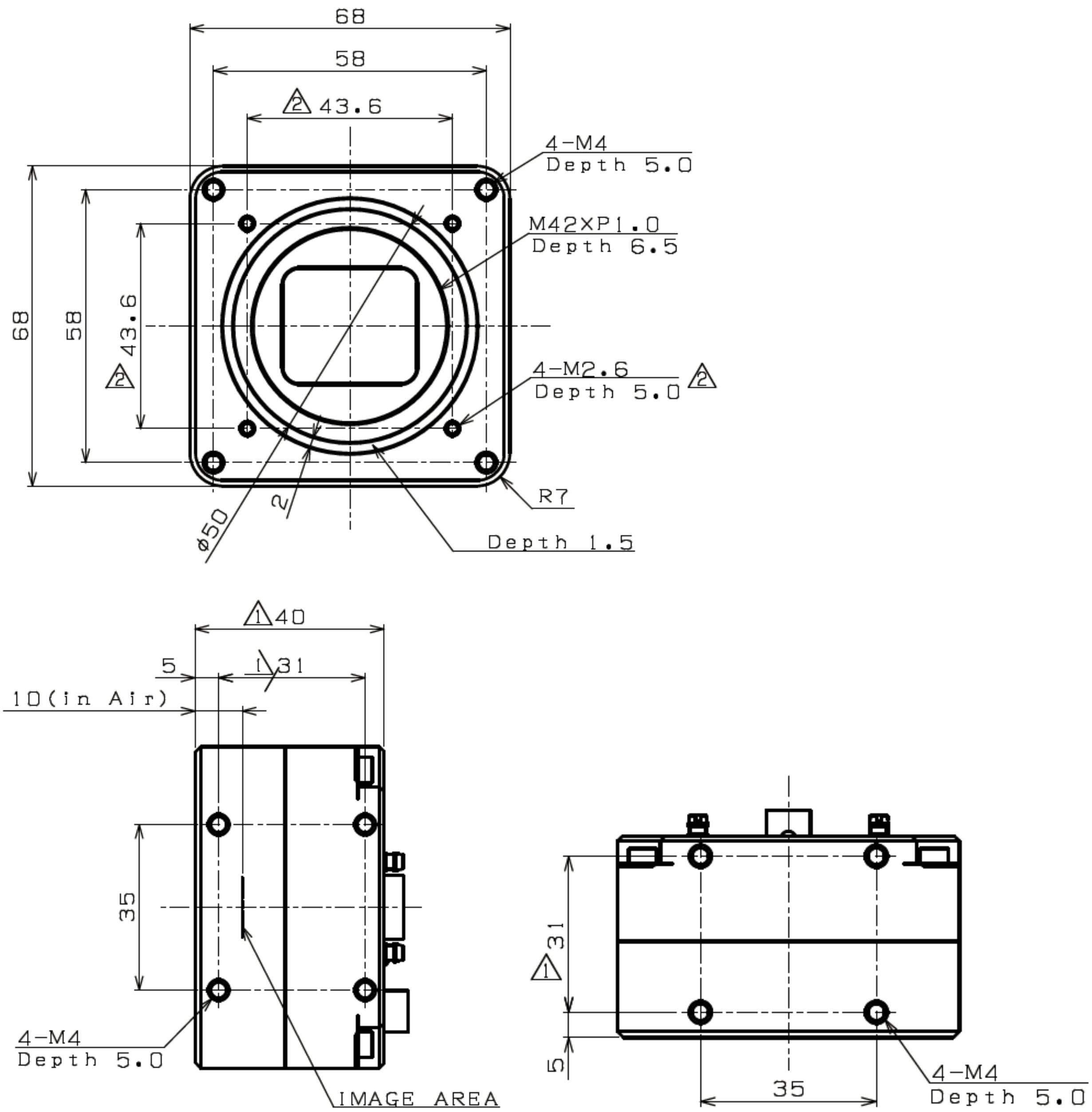
◎ **4 MP Camera**


40.5
14.5
22.7
9.5
40
30
4-M4 Depth4
C Mount
40
30
φ32
16.8
25
4-M4 Depth4
All sides same position
15.5
1/4" 20UNC
Depth 5
(Both Side)

◎ **5 MP Camera**


4-R3
35
φ36 0 -0.05
35
40.7
10.5
φ30
1"(C Mount)
17.69 ±0.02
2.0
15.5 ±0.05
14.5 ±0.05
22.7
2.3
4-M4 Depth4
All sides same position
25 ±0.05
HOT SURFACE
(R1)
16.8 ±0.05
15 ±0.02

◎ **12 MP Camera**


68
58
43.6
4-M4
Depth 5.0
M42XP1.0
Depth 6.5
4-M2.6
Depth 5.0
R7
Depth 1.5
φ50
2
40
5
31
10(in Air)
35
4-M4
Depth 5.0
IMAGE AREA
31
5
35
4-M4
Depth 5.0

1.3 Camera and Lens Selections

The camera paired with the DMV2000 controller is Camera-Link compatible. 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.

Field of view (mm) Horizontal (H) * Vertical (V)	**Focal length 6 mm**		**Focal length 8 mm**		**Focal length 12mm**		**Focal length 16mm**		**Focal length 25mm**		**Resolution μm/pixel**
	DMV-LN06~100W40 lens (applicable for 0.3 MP camera)										
	Dis.	R	Dis.	R	Dis.	R	Dis.	R	Dis.	R	640 * 480
1000(H)*750(V)	1265	0	1667	0							1562
800(H)*600(V)	1010	0	1333	0	2013	0					1250
600(H)*450(V)	755	0	1000	0	1513	0	2015	0			938
500(H)*375(V)	630	0	833	0	1263	0	1683	0			781
400(H)*300(V)	505	0	667	0	1013	0	1348	0	2181	0	625
350(H)*263(V)	428	0	583	0	888	0	1181	0	1906	0	547
300(H)*225(V)	380	0	500	0	763	0	1014	0	1631	0	469
250(H)*188(V)	310	0	417	0	638	0	847	0	1356	0	391
225(H)*169(V)	278	0	375	0	575	0	764	0	1218	0	352
200(H)*150(V)	248	0	333	0	513	0	681	0	1081	0	313
175(H)*131(V)	210	0	292	0	450	0	597	0	943	0	273
150(H)*113(V)	180	0	244	0	389	0	514	0	806	0	234
140(H)*105(V)	170	0	228	0	362	0	480	0	751	0	219
130(H)*98(V)	155	0	210	0	334	0	444	0	696	0	203
120(H)*90(V)	144	0	193	0	307	0	407	0	641	0	188
110(H)*83(V)	132	0	175	0	280	0	371	0	586	0	172
100(H)*75(V)	116	0	158	0	253	0	336	0	532	0	156
90(H)*68(V)	106	0	142	0	227	0	300	0	477	0	141
80(H)*60(V)	95	0.5	124	0	200	0	265	0	423	0	125
75(H)*56(V)	90	0.5	115	0	183	0	247	0	397	0	117
70(H)*53(V)	84	0.5	107	0	176	0	230	0	370	0	109
65(H)*49(V)	77	0.5	98	0	160	0	212	0	344	0	102
60(H)*45(V)	70	0.5	90	0	147	0	193	1	316	0	94
55(H)*41(V)	64	0.5	81	0.5	133	0	175	1	290	0	86
50(H)*38(V)	58	0.5	72	1	120	0	158	1	262	0	78
45(H)*34(V)	50	0.5	63	1	106	0	142	1.5	235	0	70
40(H)*30(V)	45	0.5	55	1	93	0	123	1.5	208	0	63

Field of view (mm) Horizontal (H) * Vertical (V)	**Focal length 6 mm**		**Focal length 8 mm**		**Focal length 12mm**		**Focal length 16mm**		**Focal length 25mm**		**Resolution μm/pixel**
	DMV-LN06~100W40 lens (applicable for 0.3 MP camera)										
	Dis.	R	Dis.	R	Dis.	R	Dis.	R	Dis.	R	640 * 480
35(H)*26(V)	39	0.5	47	1	79	1	108	1.5	183	1	55
32.5(H)*24.4(V)	36	0.5	42	1	72	1	99	2	168	2	51
30.0(H)*22.5(V)	31	0.5	37	1.5	66	1.5	89	2	153	2	46.9
27.5(H)*20.6(V)			33	1.5	58	1.5	80	2	139	2	43.0
25.0(H)*18.8(V)			28	1.5	53	2	72	2	126	2	39.1
22.5(H)*16.9(V)			23	2	45	2			111	5	35.2
20.0(H)*15.0(V)			19	2	40	2			94	5	31.3
18.0(H)*13.5(V)			16	2	33	2			87	5	28.1
17.0(H)*12.8(V)			14	2					81	5	26.6
16.0(H)*12.0(V)							40	5	76	6	25.0
15.0(H)*11.3(V)							36	5	70	6	23.4
14.0(H)*10.0(V)					23	5	32	5	64	7	21.9
13.0(H)*9.8(V)					21	5	29	6	59	7	20.3
12.0(H)*9.0(V)					18	5	25	6	54	8	18.8
11.0(H)*8.3(V)					15	5	23	7	49	9	17.2
10.0(H)*7.5(V)					13	5	19	8	44	10	15.6
9.0(H)*6.75(V)					11	6	16	9	39	11	14.1
8.0(H)*6.00(V)					8	7	13	10	34	13	12.5
7.5(H)*5.63 (V)					8	7	10	10	31	14	11.7
7.0(H)*5.25(V)							7	11	27	16	10.9
6.5(H)*4.88(V)									25	18	10.2
6.0(H)*4.50(V)									23	20	9.38
5.5(H)*4.13(V)									21	22	8.59
5.0*H)*3.75(V)									17	24	7.81
4.5(H)*3.38(V)									14	26	7.03
4.0(H)*3.00(V)									12	30	6.25
3.5(H)*2.63(V)									9	34	5.47

Field of view (mm) Horizontal(H)* Vertical (V)	**Focal length 35mm**		**Focal length 50mm**		**Focal length 75mm**		**Focal length 100mm**		**Resolution μm/pixel**
	DMV-LN06~100W40 lens (applicable for 0.3 MP camera)								
	Dis.	R	Dis.	R	Dis.	R	Dis.	R	640 * 480

Field of view (mm) Horizontal(H)* Vertical (V)	**Focal length 35mm**		**Focal length 50mm**		**Focal length 75mm**		**Focal length 100mm**		**Resolution μm/pixel**
	DMV-LN06~100W40 lens (applicable for 0.3 MP camera)								
	Dis.	R	Dis.	R	Dis.	R	Dis.	R	640 * 480
300(H)*225(V)	2253	0							469
250(H)*188(V)	1878	0							391
225(H)*169(V)	1690	0							352
200(H)*150(V)	1503	0	2241	0					313
175(H)*131(V)	1315	0	1963	0					273
150(H)*113(V)	1128	0	1686	0					234
140(H)*105(V)	1053	0	1575	0					219
130(H)*98(V)	978	0	1464	0					203
120(H)*90(V)	903	0	1353	0					188
110(H)*83(V)	828	0	1242	0					172
100(H)*75(V)	753	0	1131	0					156
90(H)*68(V)	678	0	1020	0					141
80(H)*60(V)	603	0	909	0					125
75(H)*56(V)	565	0	853	0					117
70(H)*53(V)	528	0	798	0					109
65(H)*49(V)	490	0	742	0	1120	5			102
60(H)*45(V)	453	0	687	0	1030	5			94
55(H)*41(V)	417	0	631	0	954	5			86
50(H)*38(V)	378	0	576	0	868	5	1158	5	78
45(H)*34(V)	341	1	520	0	794	5	1050	10	70
40(H)*30(V)	304	1	465	2	715	5	933	10	63
35(H)*26(V)	268	2	409	2	620	5	828	10	55
32.5(H)*24.4(V)	247	2	382	5	595	10	780	10	51
30.0(H)*22.5(V)	229	2	354	5	536	10	725	15	46.9
27.5(H)*20.6(V)	211	2	325	5	508	10	667	15	43.0
25.0(H)*18.8(V)	189	5	298	5	470	10	620	15	39.1
22.5(H)*16.9(V)	170	5	272	5	427	10	558	20	35.2
20.0(H)*15.0(V)	153	5	243	10	384	15	515	20	31.3
18.0(H)*13.5(V)	137	5	221	10	353	15	465	25	28.1
17.0(H)*12.8(V)	130	5	210	10	338	20	450	25	26.6
16.0(H)*12.0(V)	122	5	199	10	324	20	422	25	25.0
15.0(H)*11.3(V)	116	5	189	10	309	20	405	30	23.4
14.0(H)*10.0(V)	106	10	177	15	289	20	380	30	21.9

Field of view (mm) Horizontal(H)* Vertical (V)	**Focal length 35mm**		**Focal length 50mm**		**Focal length 75mm**		**Focal length 100mm**		**Resolution μm/pixel**
	DMV-LN06~100W40 lens (applicable for 0.3 MP camera)								
	Dis.	R	Dis.	R	Dis.	R	Dis.	R	640 * 480
13.0(H)*9.8(V)	99	10	166	15	276	25	362	35	20.3
12.0(H)*9.0(V)	92	10	153	15	260	25	335	35	18.8
11.0(H)*8.3(V)	85	15	145	15	240	30	320	40	17.2
10.0(H)*7.5(V)	77	**15**	133	20	228	35	300	45	15.6
9.0(H)*6.75(V)	68	15	122	20	210	35			14.1
8.0(H)*6.00(V)	63	20	111	25					12.5
7.5(H)*5.63 (V)	58	20	104	25					11.7
7.0(H)*5.25(V)	53	20	99	30					10.9
6.5(H)*4.88(V)	51	25	92	30					10.2
6.0(H)*4.50(V)	46	25	88	35					9.38
5.5(H)*4.13(V)	44	30	84	40					8.59
5.0*H)*3.75(V)	39	30	76	45					7.81
4.5(H)*3.38(V)	35	35	72	50					7.03
4.0(H)*3.00(V)	33	40	66	55					6.25
3.5(H)*2.63(V)	27	45	60	65					5.47

Field of view (mm) Horizontal(H)* Vertical (V)	**Focal length 5mm**		**Focal length 8 mm**		**Focal length 12mm**		**Focal length 16mm**		**Focal length 25mm**		**Resolution μm/pixel**
	DMV-LN06~50M lens (applicable for 2 MP camera)										
	Dis.	R	Dis.	R	Dis.	R	Dis.	R	Dis.	R	2000*1000
1000(H)*500(V)	415	0	715	0	1120	0					500
800(H)*400(V)	325	0	555	0	900	0	1175	0			400
600(H)*300(V)	240	0	410	0	630	0	880	0			300
500(H)*250(V)	198	0	335	0	525	0	730	0	1150	0	250
400(H)*200(V)	158	0	265	0	416	0	545	0	920	0	200
350(H)*175(V)	135	0	232	0	360	0	476	0	800	0	175
300(H)*150(V)	116	0	200	0	310	0	408	0	646	0	150
250(H)*125(V)	92	0	166	0	254	0	340	0	535	0	125
225(H)*112(V)	84	0	145	0	227	0	304	0	480	0	112
200(H)*100(V)	74	0	130	0	202	0	270	0	426	0	100
175(H)*82.5(V)	58	0	105	0.5	164	0	215	0	350	0	82.5
150(H)*75(V)	51	0	91	0.5	150	0	200	0	320	0	75

Field of view (mm) Horizontal(H)* Vertical (V)	**Focal length 5mm**		**Focal length 8 mm**		**Focal length 12mm**		**Focal length 16mm**		**Focal length 25mm**		**Resolution μm/pixel**
	DMV-LN06~50M lens (applicable for 2 MP camera)										
	Dis.	R	Dis.	R	Dis.	R	Dis.	R	Dis.	R	2000*1000
140(H)*70(V)	47	0	85	0.5	138	0	187	0.5	298	0	70
130(H)*65(V)	43	0	78	0.5	127	0.5	170	0.5	277	0	65
120(H)*60(V)	38	0	71	0.5	115	0.5	156	1	255	0	60
110(H)*55(V)	34	0	62	1	107	0.5	144	1	235	0	55
100(H)*50(V)			57	1	95	1	130	1.5	214	0	50
90(H)*45(V)			50	1	86	1	115	1.5	189	1	45
80(H)*40(V)			44	1	72	1	100	2	166	1	40
75(H)*37.5(V)			39	1	66	2	92	2	153	2	37.5
70(H)*35(V)			35	1	61	2	85	2	145	2	35
65(H)*32.5(V)					56	2			135	2	32.5
60(H)*30(V)					51	2			123	2	30
55(H)*27.5(V)					45	2			110	5	27.5
50(H)*25(V)									100	5	25
45(H)*22.5(V)							47	5	87	5	22.5
40(H)*20(V)							43	5	78	5	20
35(H)*17.5(V)							34	5	66	7	17.5
32.5(H)*16.2(V)									62	7	16.25
30.0(H)*15.0(V)									57	10	15
27.5(H)*13.7(V)									49	10	13.75
25.0(H)*12.5(V)									45	10	12.5

Field of view (mm) Horizontal(H)* Vertical (V)	**Focal length 35mm**		**Focal length 50mm**		**Resolution μm/pixel**
	DMV-LN06~50M lens (applicable for 2 MP camera)				
	Dis.	R	Dis.	R	2000*1000
350(H)*175(V)	1120	0			175
300(H)*150(V)	938	0			150
250(H)*125(V)	788	0	1200	0	125
225(H)*112(V)	715	0	1070	0	112
200(H)*100(V)	602	0	964	0	100
175(H)*82.5(V)	500	0	855	0	82.5
150(H)*75(V)	458	0	735	0	75

Field of view (mm) Horizontal(H)* Vertical (V)	**Focal length 35mm**		**Focal length 50mm**		**Resolution µm/pixel**
	DMV-LN06~50M lens (applicable for 2 MP camera)				
	Dis.	R	Dis.	R	2000*1000
140(H)*70(V)	427	0	660	0	70
130(H)*65(V)	400	0	600	0	65
120(H)*60(V)	368	0	555	0	60
110(H)*55(V)	342	0	510	0	55
100(H)*50(V)	312	0	468	0	50
90(H)*45(V)	280	0	425	0	45
80(H)*40(V)	246	0	378	0	40
75(H)*37.5(V)	230	0	355	0	37.5
70(H)*35(V)	218	0	338	0	35
65(H)*32.5(V)	204	0	318	0	32.5
60(H)*30(V)	190	1	294	0	30
55(H)*27.5(V)	172	2	270	0	27.5
50(H)*25(V)	156	5	250	0	25
45(H)*22.5(V)	138	5	225	0	22.5
40(H)*20(V)	125	5	203	0	20
35(H)*17.5(V)	111	10	180	5	17.5
32.5(H)*16.2(V)	104	10	174	5	16.25
30.0(H)*15.0(V)	95	10	160	5	15
27.5(H)*13.7(V)	88	15	150	10	13.75
25.0(H)*12.5(V)	82	15	138	10	12.5
22.5(H)*11.2(V)	74	15	131	15	11.25
20.0(H)*10.0(V)	68	15	117	20	10
18.0(H)*9.0(V)			105	30	9
17.0(H)*8.5(V)			100	30	8.5
16.0(H)*8.0(V)			95	30	8
15.0(H)*7.5(V)			90	30	7.5

Field of view (mm) Horizontal (H) * Vertical (V)	**Focal length 12mm**		**Focal length 16mm**		**Focal length 25mm**		**Focal length 35mm**		**Focal length 50mm**		**Resolution µm/pixel**
	DMV-LN12~50M06 lens (applicable for 4 MP camera)										
	Dis.	R	Dis.	R	Dis.	R	Dis.	R	Dis.	R	2000*2000
1000(H)*1000(V)	1120	0									500

Field of view (mm) Horizontal (H) * Vertical (V)	**Focal length 12mm**		**Focal length 16mm**		**Focal length 25mm**		**Focal length 35mm**		**Focal length 50mm**		**Resolution µm/pixel**
	DMV-LN12~50M06 lens (applicable for 4 MP camera)										
	Dis.	R	Dis.	R	Dis.	R	Dis.	R	Dis.	R	2000*2000
800(H)*800(V)	900	0	1175	0							400
600(H)*600(V)	630	0	880	0							300
500(H)*500(V)	525	0	730	0	1150	0					250
400(H)*400(V)	416	0	545	0	920	0					200
350(H)*350(V)	360	0	476	0	800	0	1125	0			175
300(H)*300(V)	310	0	408	0	646	0	950	0			150
250(H)*250(V)	254	0	340	0	535	0	790	0	1146	0	125
225(H)*225(V)	227	0	304	0	478	0	706	0	1038	0	112
200(H)*200(V)	202	0	270	0	424	0	635	0	933	0	100
175(H)*175(V)	164	0	215	0	348	0	560	0	820	0	82.5
150(H)*150(V)	150	0	200	0	318	0	480	0	735	0	75
140(H)*140(V)	138	0	187	0.5	295	0	444	0	655	0	70
130(H)*130(V)	127	0.5	170	0.5	274	0	408	0	610	0	65
120(H)*120(V)	115	0.5	156	1	253	0	375	0	565	0	60
110(H)*110(V)	107	0.5	144	1	233	0	342	0	515	0	55
100(H)*100(V)	95	1	130	1.5	212	0	312	0	478	0	50
90(H)*90(V)	86	1	115	1.5	186	1	280	0	428	0	45
80(H)*80(V)	72	1	100	2	162	1	246	0	380	0	40
75(H)*75(V)	66	2	92	2	149	2	230	0	357	0	37.5
70(H)*70(V)	61	2	85	2	140	2	218	0	339	0	35
65(H)*65(V)	56	2			128	2	204	0	319	0	32.5
60(H)*60(V)	51	2			118	2	190	1	294	0	30
55(H)*55(V)	45	2			105	5	172	2	270	1	27.5
50(H)*50(V)					95	5	158	5	253	5	25
45(H)*45(V)			47	5	82	5	145	5	225	5	22.5
40(H)*40(V)			43	5	72	5	130	5	203	5	20
35(H)*35(V)			34	5	61	7	114	10	184	10	17.5
32.5(H)*32.5(V)					57	7	104	10	172	10	16.25
30.0(H)*30.0(V)					51	10	95	10	160	15	15
27.5(H)*27.5(V)					43	10	88	15	150	20	13.75
25.0(H)*25.0(V)					39	10	82	15	138	20	12.5
22.5(H)*22.5(V)							74	15	127	25	11.25
20.0(H)*20.0(V)							68	15	116	25	10.0

Field of view (mm) Horizontal (H) * Vertical (V)	Focal length 12mm		Focal length 16mm		Focal length 25mm		Focal length 35mm		Focal length 50mm		Resolution µm/pixel
	DMV-LN12~50M06 lens (applicable for 4 MP camera)										
	Dis.	R	Dis.	R	Dis.	R	Dis.	R	Dis.	R	2000*2000
18.0(H)*18.0(V)									105	30	9.0
17.0(H)*17.0(V)									100	30	8.5
16.0(H)*16.0(V)									95	30	8.0
15.0(H)*15.0(V)									90	30	7.5
14.0(H)*14.0(V)									85	40	7.0

Field of view (mm) Horizontal (H) * Vertical (V)	Focal length 12mm		Focal length 35mm		Focal length 50mm		Resolution µm/pixel
	DMV-LN12~50M05 lens (applicable for 4 MP camera)						
	Dis.	R	Dis.	R	Dis.	R	2000*2000
1000(H)*1000(V)	1050	0					500
800(H)*800(V)	835	0					400
600(H)*600(V)	625	0					300
500(H)*500(V)	535	0					250
400(H)*400(V)	422	0					200
350(H)*350(V)	372	0	1105	0			175
300(H)*300(V)	303	0	954	0			150
250(H)*250(V)	246	0	790	0	1108	0	125
225(H)*225(V)	217	0	712	0	992	0	112
200(H)*200(V)	194	0	630	0	888	0	100
175(H)*175(V)	167	0	538	0	773	0	82.5
150(H)*150(V)	138	0	465	0	655	0	75
140(H)*140(V)	128	0	430	0	615	0	70
130(H)*130(V)	119	0	402	0	560	0	65
120(H)*120(V)	108	0	367	0	520	0	60
110(H)*110(V)	98	0	336	0	478	0	55
100(H)*100(V)	86	0	308	0	435	0	50
90(H)*90(V)	79	2	278	0	390	0	45
80(H)*80(V)	68	2	246	0	345	0	40
75(H)*75(V)	61	2	230	0	320	0	37.5
70(H)*70(V)	55	2	216	0	297	0	35
65(H)*65(V)	50	2	198	0	278	0	32.5

Field of view (mm) Horizontal (H) * Vertical (V)	Focal length 12mm		Focal length 35mm		Focal length 50mm		Resolution µm/pixel
	DMV-LN12~50M05 lens (applicable for 4 MP camera)						
	Dis.	R	Dis.	R	Dis.	R	2000*2000
60(H)*60(V)	44	2	178	5	250	5	30
55(H)*55(V)	38	2	164	5	230	5	27.5
50(H)*50(V)			147	5	210	5	25
45(H)*45(V)			134	5	189	5	22.5
40(H)*40(V)			115	5	158	10	20
35(H)*35(V)			100	10	138	10	17.5
32.5(H)*32.5(V)			92	10	129	10	16.25
30.0(H)*30.0(V)			86	10	120	15	15
27.5(H)*27.5(V)			80	10	100	20	13.75
25.0(H)*25.0(V)			66	15	90	20	12.5
22.5(H)*22.5(V)			60	15	84	20	11.25
20.0(H)*20.0(V)			55	15	70	25	10.0
18.0(H)*18.0(V)					60	30	9.0

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.

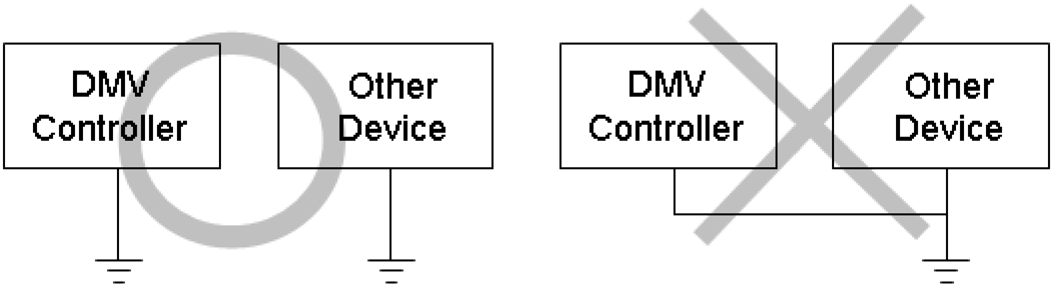
- Longer extension circles results in shallower depths of field; thus the depth of field increases when using shorter extension circles.
- Longer working distance results in a deeper depth of field.
- Smaller aperture results in a deeper depth of field.
- Shorter focal length of the lens results in a deeper depth of field.

1.4 Grounding and Installation

1.4.1 Grounding

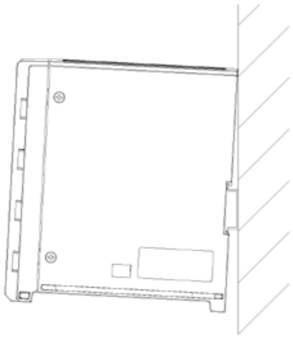
Caution:

1) Do not connect or disconnect the wires while system is powered on.
2) The grounding wire should be at minimum length using the wire gauge specified by relevant laws and regulations. The grounding resistance must be under 100Ω.
3) Please ground the grounding terminal using the third method. Do not directly connect to other power devices.



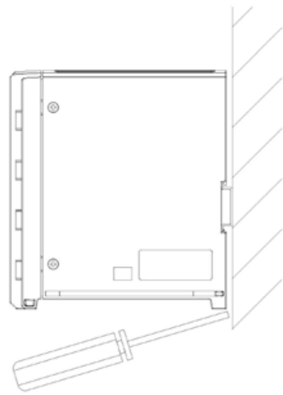
1.4.2 Installation

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 reserve at least 50 mm above and 30 mm left/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 open in front of the wiring panel for ease of access in the future.

Chapter 2

Input and Output Interface

The DMV input and output interfaces consist of

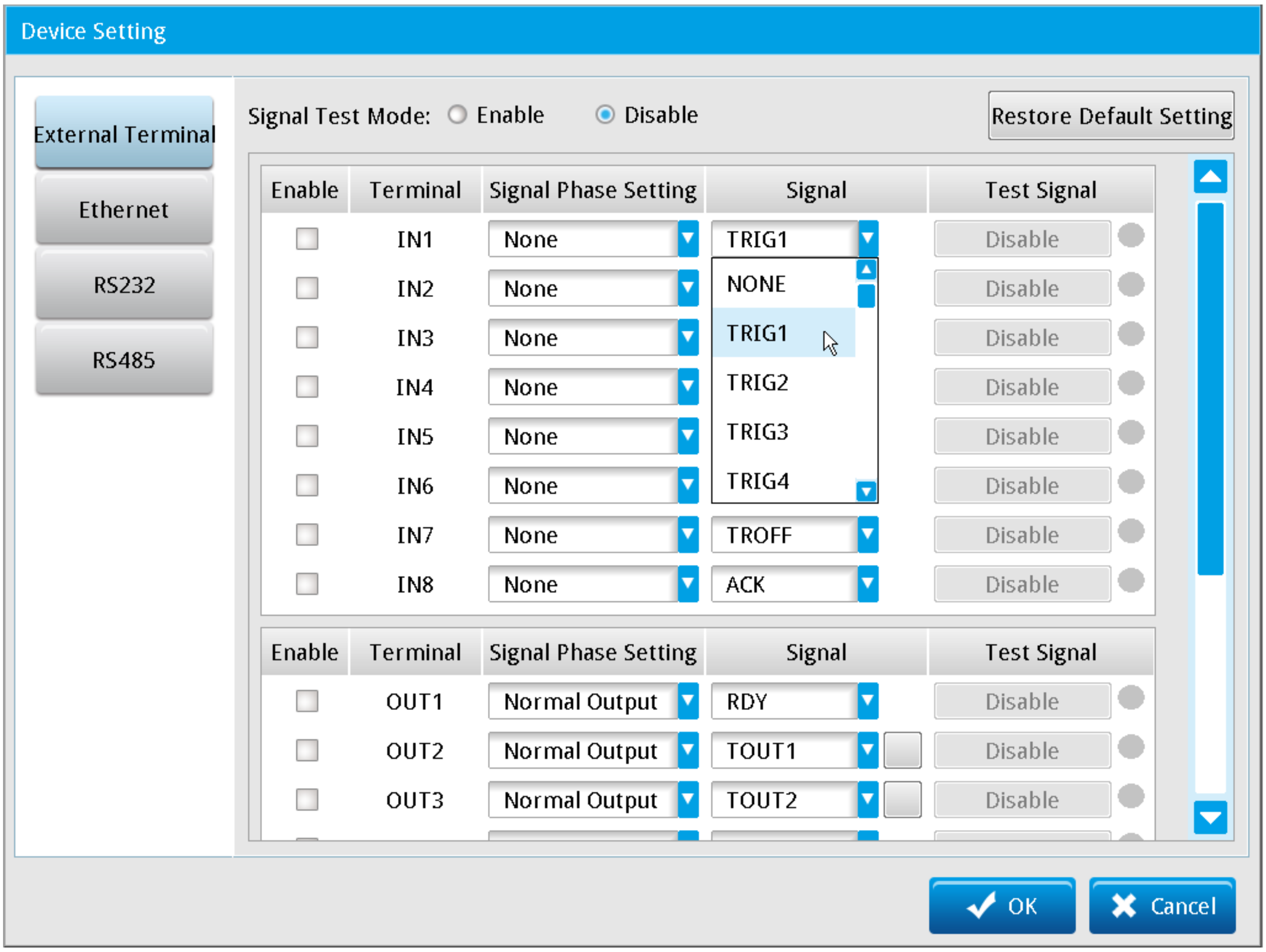
1) I/O terminal
2) RS232
3) RS485
4) Ethernet
5) Micro SD card

The pins and wiring connections are defined and detailed as follows.

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 diagram. Each input/output function can also be freely defined by the user according to needs.

➤ Make selection in [System] > [Communication] > [Device Setting] > [External Terminal]

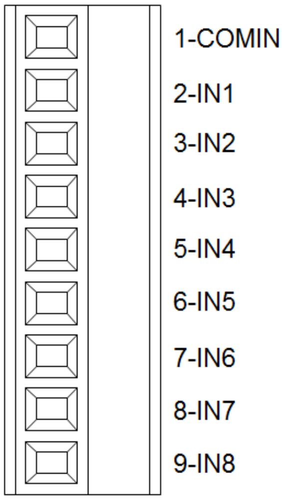


Reference Please refer to Chapter 7 for the purpose and sequence of each terminal.

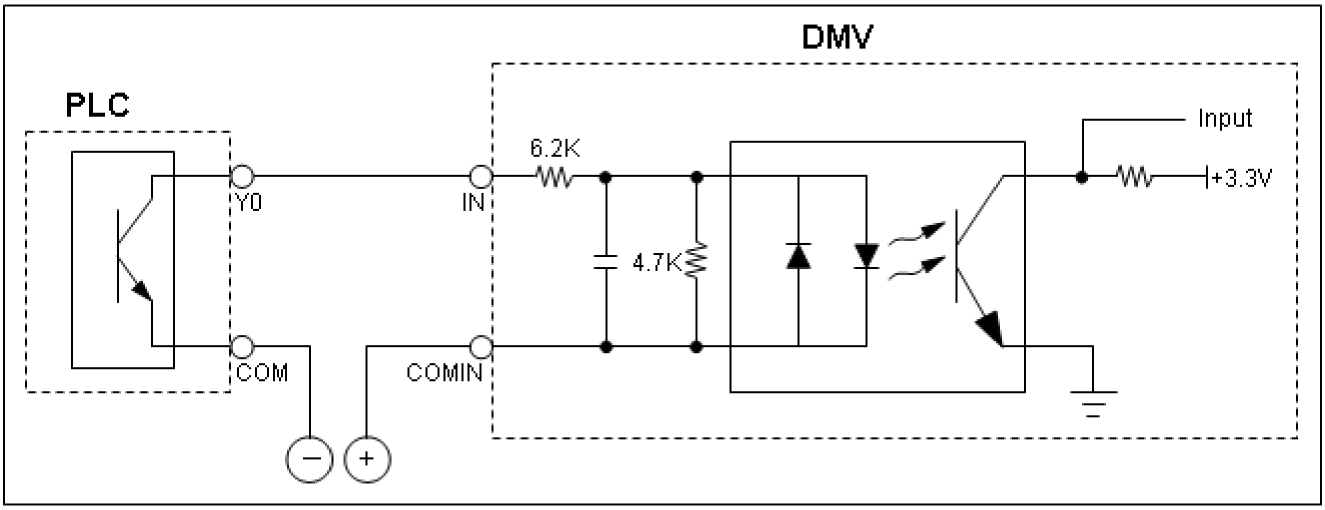
2.1.1 9-Pin Input Terminal

The following input functions are defined as default values and can be selected by user according to needs

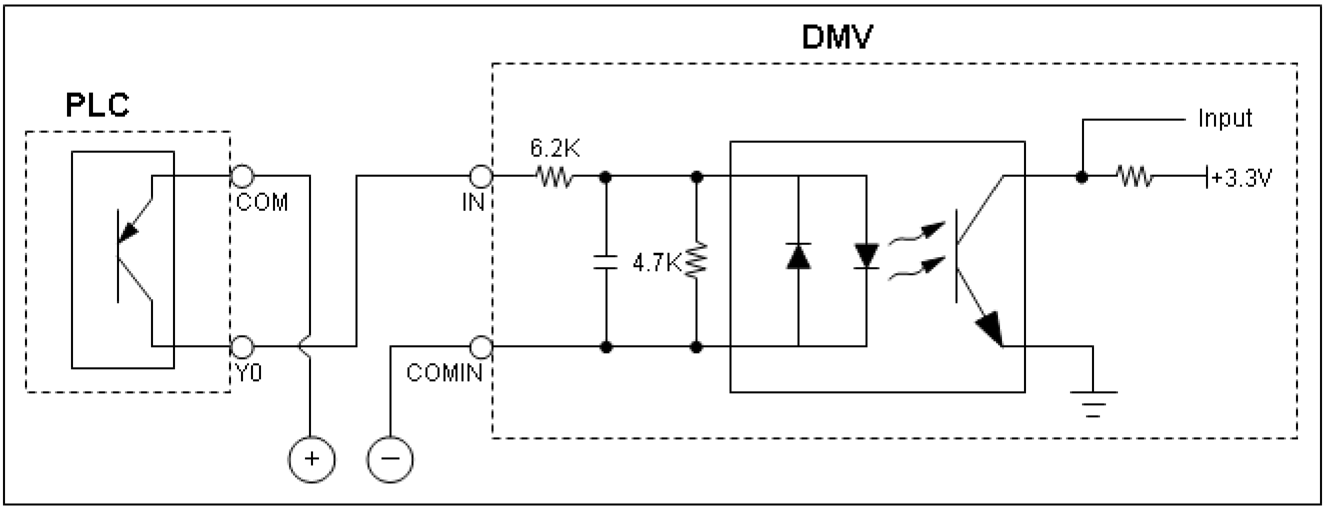
Serial No.	Name	Description
1	COMIN	9-pin input common contact (NPN/PNP selection)
2	IN1	TRIG1: Camera 1 capture trigger
3	IN2	TRIG2: Camera 2 capture trigger
4	IN3	TRIG3: Camera 3 capture trigger
5	IN4	TRIG4: Camera 4 capture trigger
6	IN5	TEST: Test status (no inspection results are generated in output)
7	IN6	PLINK: PLC data link communication startup flag
8	IN7	TROFF: Trigger disabled (inspection disabled)
9	IN8	ACK: Parallel output handshake flag



◆ **Input schematic** (NPN input)



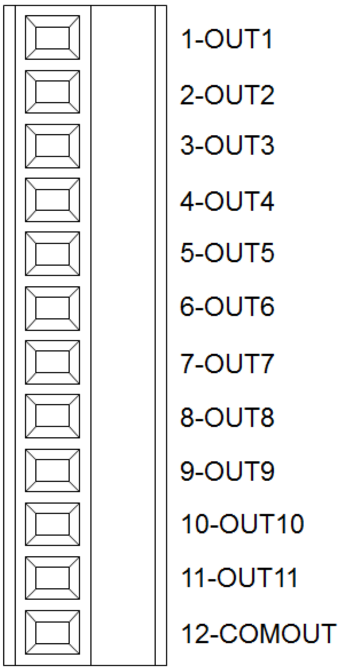
◆ **Input schematic** (PNP input)



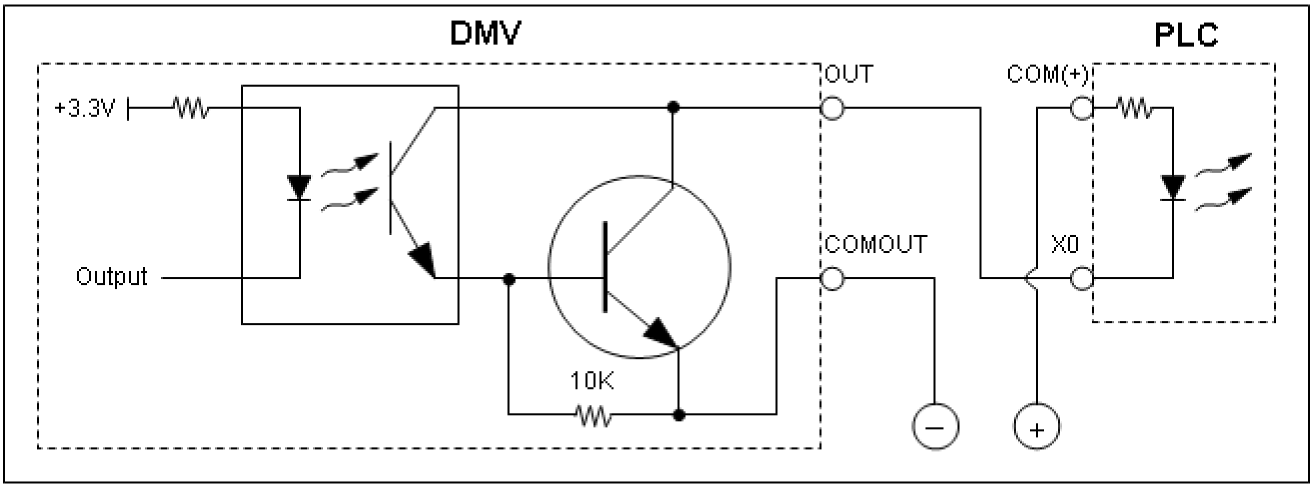
2.1.2 12-Pin Output Terminal

The following output functions are defined as default values and can be selected by user according to needs.

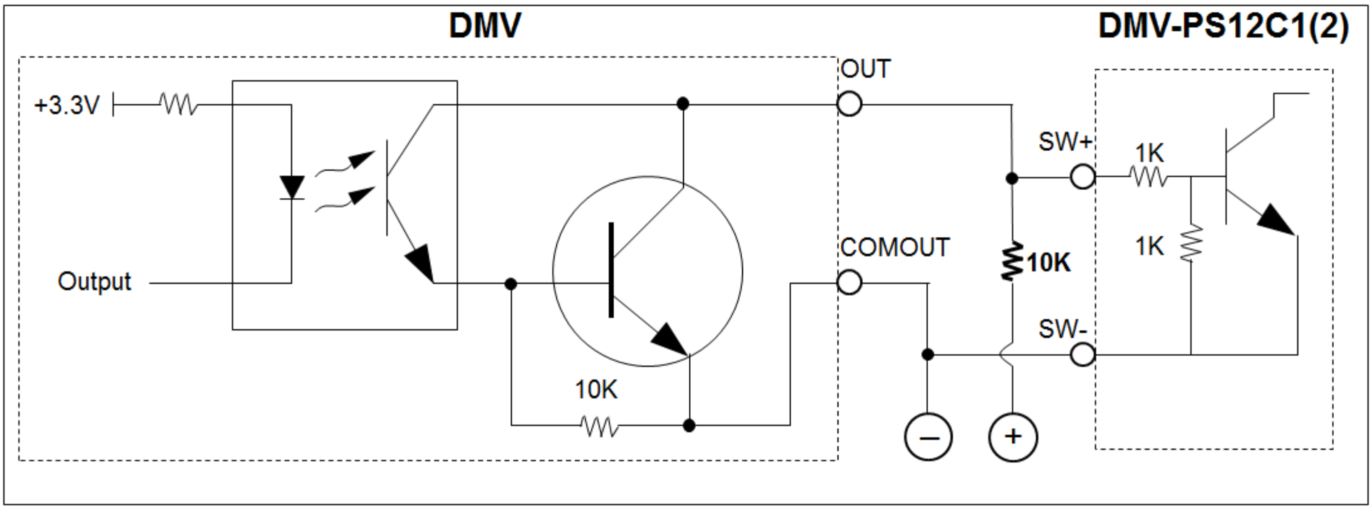
Serial No.	Name	Description
1	OUT1	RDY: Controller in standby waiting for image capture and output inspection
2	OUT2	TOUT1: Total Judge Result Output 1
3	OUT3	TOUT2: Total Judge Result Output 2
4	OUT4	ERR: Error status indicator
5	OUT5	STR: Parallel output handshake flag
6	OUT6	REND1: Camera 1 capture complete
7	OUT7	REND2: Camera 2 capture complete
8	OUT8	REND3: Camera 3 capture complete
9	OUT9	REND4: Camera 4 capture complete
10	OUT10	FLH1: Camera 1 light source strobe control output
11	OUT11	FLH2: Camera 2 light source strobe control output
12	COMOUT	12-pin output common contact (please connect the negative terminal of the power source for NPN output method)



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



- **Light source dimmer strobe control output circuit diagram** (fixed to NPN output)
  10 KΩ resistor must be connected to the 24-V positive terminal of the power supply. Error resistor values will not result in burnt I/O terminals on the DMV system but may cause incorrect strobes of the flash light.



2.1.3 Functions of Input / Output Contacts

Input and output connection as instructed in sections 2.1.1 and 2.1.2

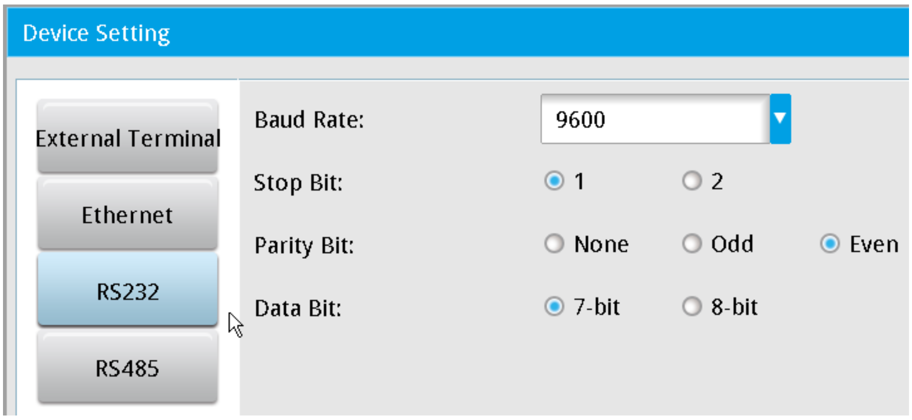
Name	Description	Mode
TRIG1	Camera 1 trigger capture	Input
TRIG2	Camera 2 trigger capture	Input
TRIG3	Camera 3 trigger capture	Input
TRIG4	Camera 4 trigger capture	Input
TEST	Test status (results are not generated in output)	Input
PLINK	PLC data link communication startup flag	Input
TROFF	Trigger disabled (inspection disabled)	Input
ACK	Parallel output handshake flag	Input
IN1	Number input 1	Input
IN2	Number input 2	Input
IN3	Number input 3	Input
IN4	Number input 4	Input
IN5	Number input 5	Input
IN6	Number input 6	Input
IN7	Number input 7	Input
IN8	Number input 8	Input
FNC1	Function Selection 1	Input
FNC2	Function Selection 2	Input
FNC3	Function Selection 3	Input
FNC4	Function Selection 4	Input
FNC5	Function Selection 5	Input
FNC6	Function Selection 6	Input
FNC7	Function Selection 7	Input
FNC8	Function Selection 8	Input
FCH	Function select trigger	Input
IACK	Communication output handshake flag	Input
RST	System reset	Input

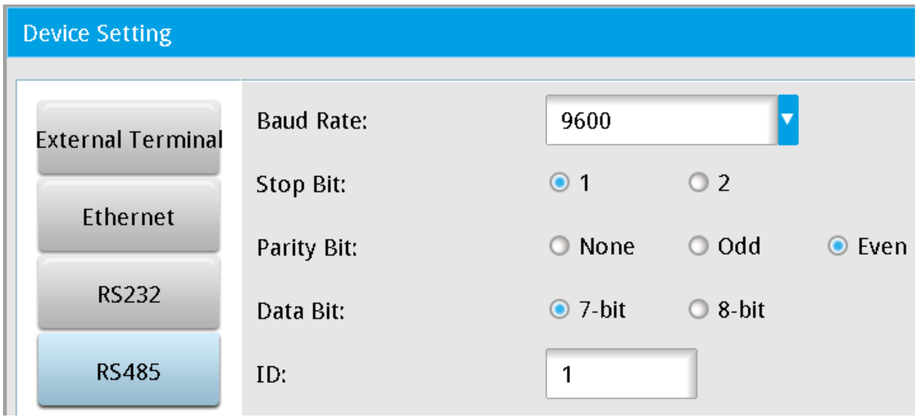
Name	Description	Mode
READY1	Controller ready output indicator 1	Output
READY2	Controller ready output indicator 2	
READY3	Controller ready output indicator 3	
READY4	Controller ready output indicator 4	
TOUT1	Total Judge Result Output 1	Output
TOUT2	Total Judge Result Output 2	Output
ERR	Error status indicator	Output
STR	Parallel output handshake flag	Output
REND1	Camera 1 captured	Output
REND2	Camera 2 captured	Output
REND3	Camera 3 captured	Output
REND4	Camera 4 captured	Output
FLH1	Camera 1 light source strobe control output	Output
FLH2	Camera 2 light source strobe control output	Output
FLH3	Camera 3 light source strobe control output	Output
FLH4	Camera 4 light source strobe control output	Output
SW	Function switching success flag	Output
NSW	Function switching failed flag	Output
FRDY	Allow function switching flag	Output
OUT1	Parallel output 1	Output
OUT2	Parallel output 2	Output
OUT3	Parallel output 3	Output
OUT4	Parallel output 4	Output
OUT5	Parallel output 5	Output
OUT6	Parallel output 6	Output
OUT7	Parallel output 7	Output
OUT8	Parallel output 8	Output
OUT9	Parallel output 9	Output
OUT10	Parallel output 10	Output
OUT11	Parallel output 11	Output
OUT12	Parallel output 12	Output
OUT13	Parallel output 12	Output
OUT14	Parallel output 14	Output
OUT15	Parallel output 15	Output
OUT16	Parallel output 16	Output

2.2 RS232/RS485 Serial Output

RS232 and RS485 serial communication interfaces are both built-in in the equipment. Both interfaces operate independently. Therefore, different baud rates and protocols can be configured.

- Make selection in [System] > [Communication] > [Device Setting] > [RS232] / [RS485] DMV2000's communication station number can be selected in the RS485 settings.



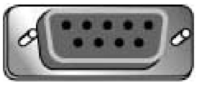


2.2.1 RS232/RS485 Pins

◎ **RS232**

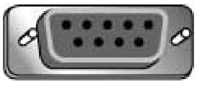
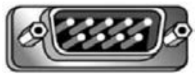
The DMV can directly connect to the PC master when DMV is defined as slave mode.

DMV		PC& DOP-HMI
2 TX		2 RX
3 RX		3 TX
5 GND		5 GND




RX and TX must be reversed when connected to the Delta PLC (using COM3 RS232 expansion card) because DMV and PLC are both configured to slave modes.

DMV		DVP-PLC
2 TX		3 RX
3 RX		2 TX
5 GND		5 GND

◎ **RS485**

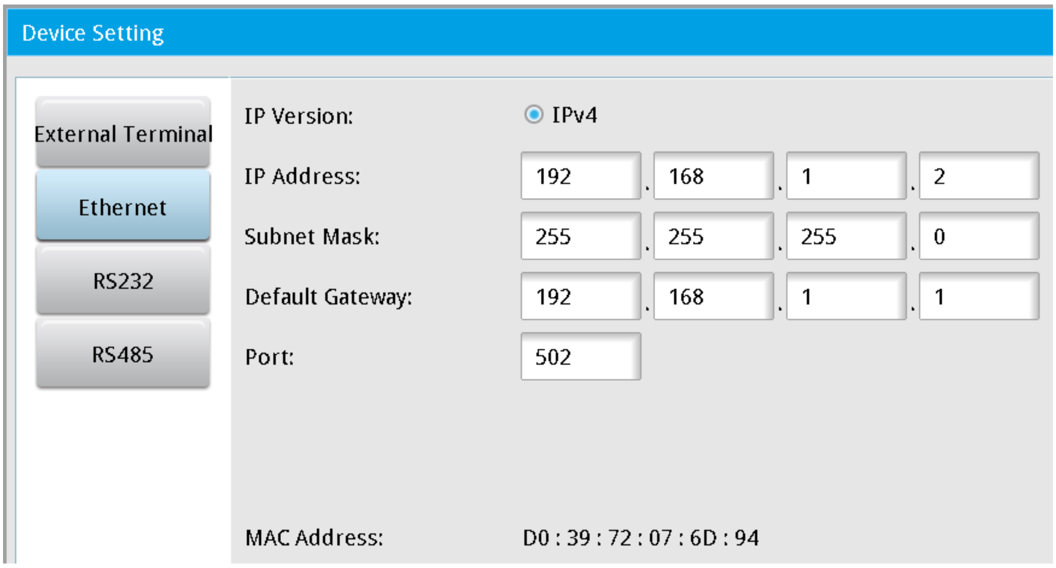
The main unit is built-in with a 3 wire RS485 port, which is capable of executing one-to-many communication architectures.

When making wire connections, D+ and D- can be directly connected to the D+ and D- terminals on the component.

2.3 Ethernet Output

The built-in Ethernet port in the equipment adopts the TCP/IP communication protocol.

➤ Configure the IP location of the unit in [System] > [Communication] > [Device Setting] > [Ethernet]



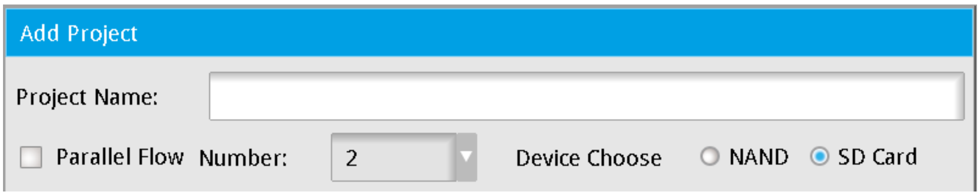
2.4 Micro SD Card

The unit supports up to 32 G capacity for the two following main functions.

◎ **Expansion for the Number of Projects**

The system memory is limited, additional projects can be stored in the Micro SD card to expand the number of projects.

As shown in the following diagram, the user may select whether to store the project in the internal memory (NAND) or the Micro SD card when adding a new project.



◎ **Storage for Inspection Image Files**

During the inspection process, the operating inspection images can be stored according to the configured conditions to facilitate subsequent analysis.

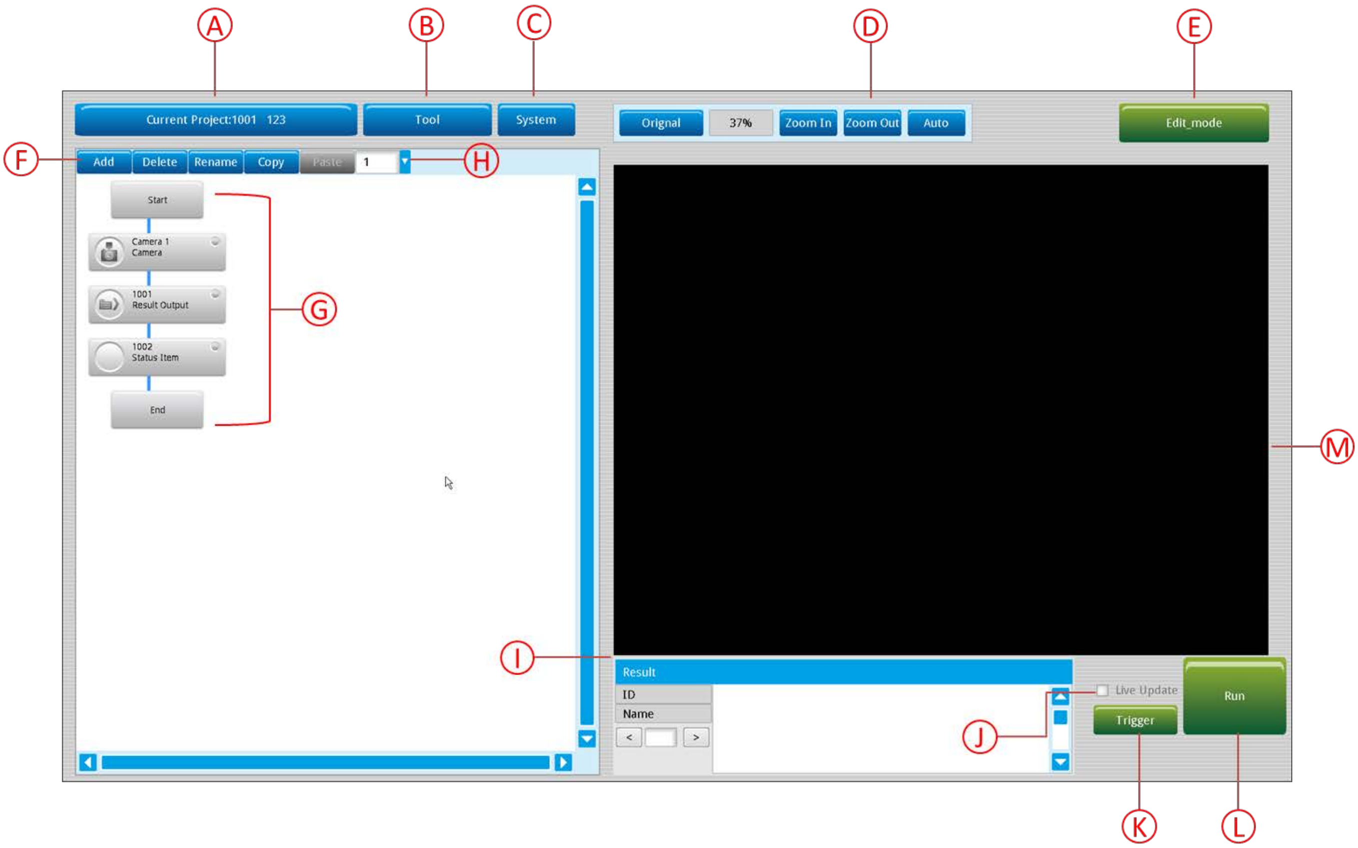
Chapter 3

Basic Operation

DMV2000 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

The following diagram illustrates the main page when activating the DMV2000 controller. Each feature is introduced and explained as follows.



A. Current Project

The project currently being configured.

B. Tool

The mode and basis for executing project inspection. These include register image management, operating mode screen editing, and judge setting.

Reference Please refer to Section 3.3 for detailed tool settings.

C. System

The system consists of several configuration functions, including general setting, camera setting, communication setting, display setting, environment setting, security setting, and software update.

Reference Please refer to Section 3.4 for detailed system settings.

D. Zoom in, zoom out, auto

Zoom in, zoom out, and auto adjust of the camera capture screen.

E. Editing Mode

Displays that the current project settings are editable.

F. Add, delete, rename, copy, paste

A single inspection process may contain several inspections. These commands add, delete, rename, copy, and paste the individual inspections.

G. Inspection (Flow) Process

A complete inspection process includes camera, inspections, result output, and status item.

[Add]: Adds 1 inspection.

[Delete]: Deletes the selected inspection.

[Rename]: Identical inspections can be renamed to make distinction.

[Copy]: Copies the selected inspection.

[Paste]: The selected inspection can be pasted according to the placement order once copied.

H. Parallel Flow Number

A maximum of 8 inspection processes can be configured as needed for a single inspection project. This displays the inspection flow number.

I. Result

The inspection result is displayed here.

J. Live Update

Settings cannot be selected here on the main page and can only be used when the system or flow process cameras are capturing images.

K. Trigger

Press this trigger command when executing project inspection.

L. Execute

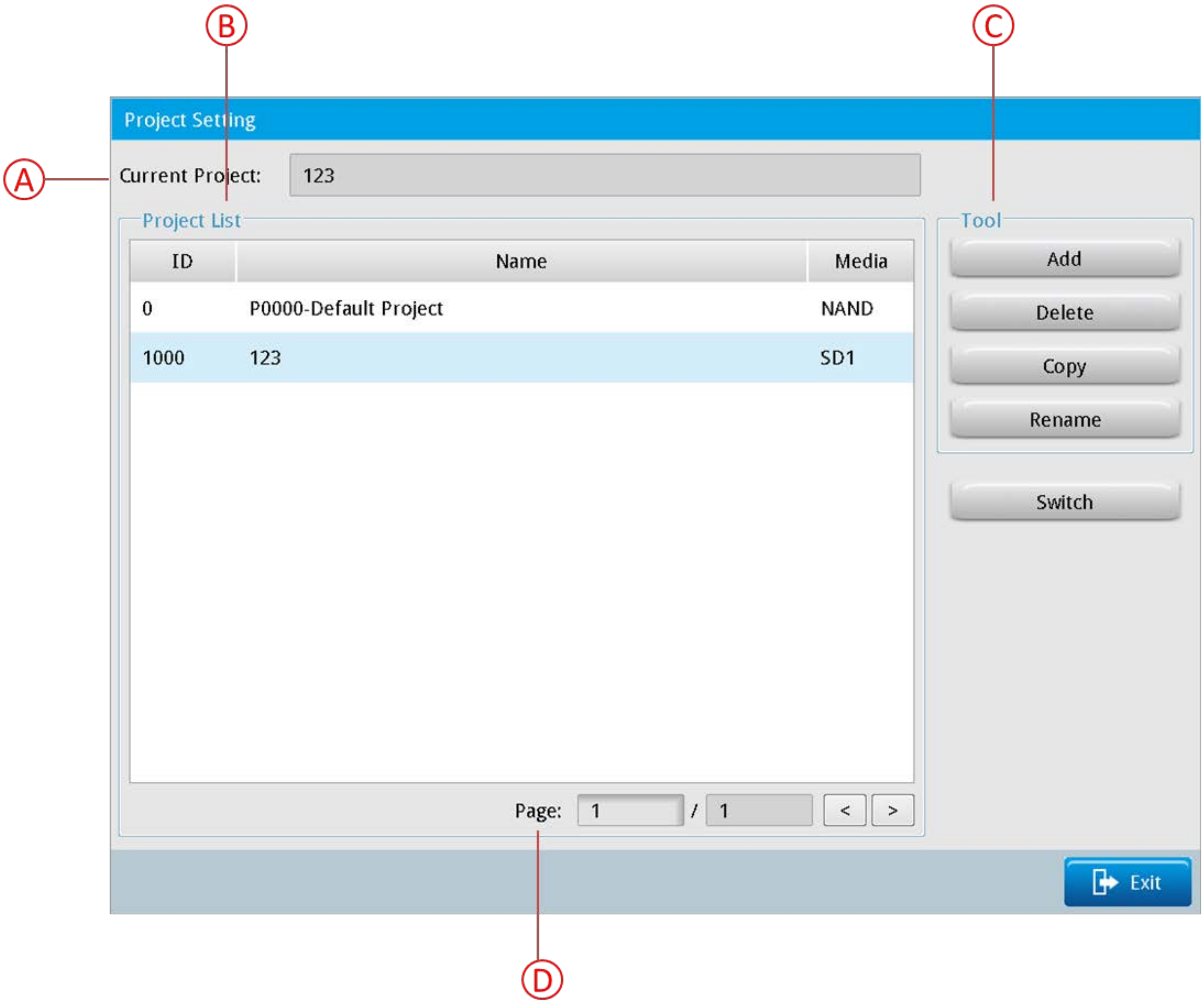
Press this to enter run mode after completing project inspection settings.

M. Camera Capture Screen

Settings cannot be selected here on the main page and can only be used when the system or flow process cameras are capturing images.

3.2 Project Setting

Project setting is the first step when entering the main page. All subsequent inspection settings will be stored according to the selected project.



A. Current Project

Displays the project name currently being configured for operation.

B. Project List

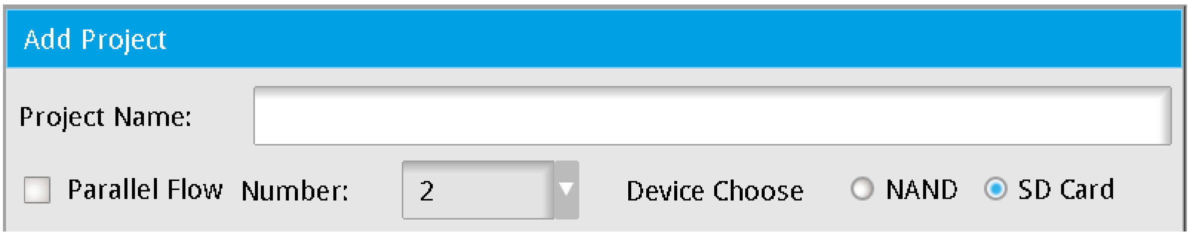
The DMV2000 internal memory can store up to 1000 projects and be expanded to 9999 projects with memory card expansion. Project list displays the projects currently saved in the controller and memory card.

1) ID: Project number Project numbers in the internal memory of the controller are 0~999. Projects numbers in the memory card start at 1000.
2) Name: Name of Each Project:
3) Media: Location of the stored project NAND is the controller internal memory; SD is the memory card.

C. Tools

1) Add: Select to add new project

Parallel Flow: According to varying model numbers, DMV2000 can simultaneously operate 2, 4, and 8 cameras. Therefore, up to 8 parallel processes can be executed for one project. Check the box next to parallel flow when adding new projects if the function is needed. Settings cannot be changed once new project has been added. Each parallel process can simultaneously trigger inspections without conflict.



2) Delete: Select the project to be deleted and click to delete the project
3) Copy: Select the project to be copied and click to copy the project
4) Rename: Select the project to be renamed and click to rename the project
5) Switch: Select the project to be switched and click to switch the project

D. Pages

Displays the current page number; can press left and right arrow keys to switch pages

3.3 Tool Setting

This views the settings of the overall internal functions and relevant parameters of the DMV2000 controller, including image register, inspection screen editing during project execution, and judge settings.

3.3.1 Register Image Management

This is the register image management for the entire controller system and can store, rename, delete, and copy the images captured by the camera. Registered images of individual or all cameras can be processed.
To register images, click on live update to confirm that the camera captured the desired image after adjusting camera settings and then click on [Register Image] to complete the process.

◎ **Display and Capture Setting**

➤ Image Source

Capture source of image register; always capture from the camera.

➤ Camera

DMV2000 can connect 2, 4, and 8 cameras according to the varying model numbers. The number of cameras connected can be selected using [Camera 1]~[Camera 8]. When any camera is selected, only the captured and registered images of the selected camera will be displayed on the image list.

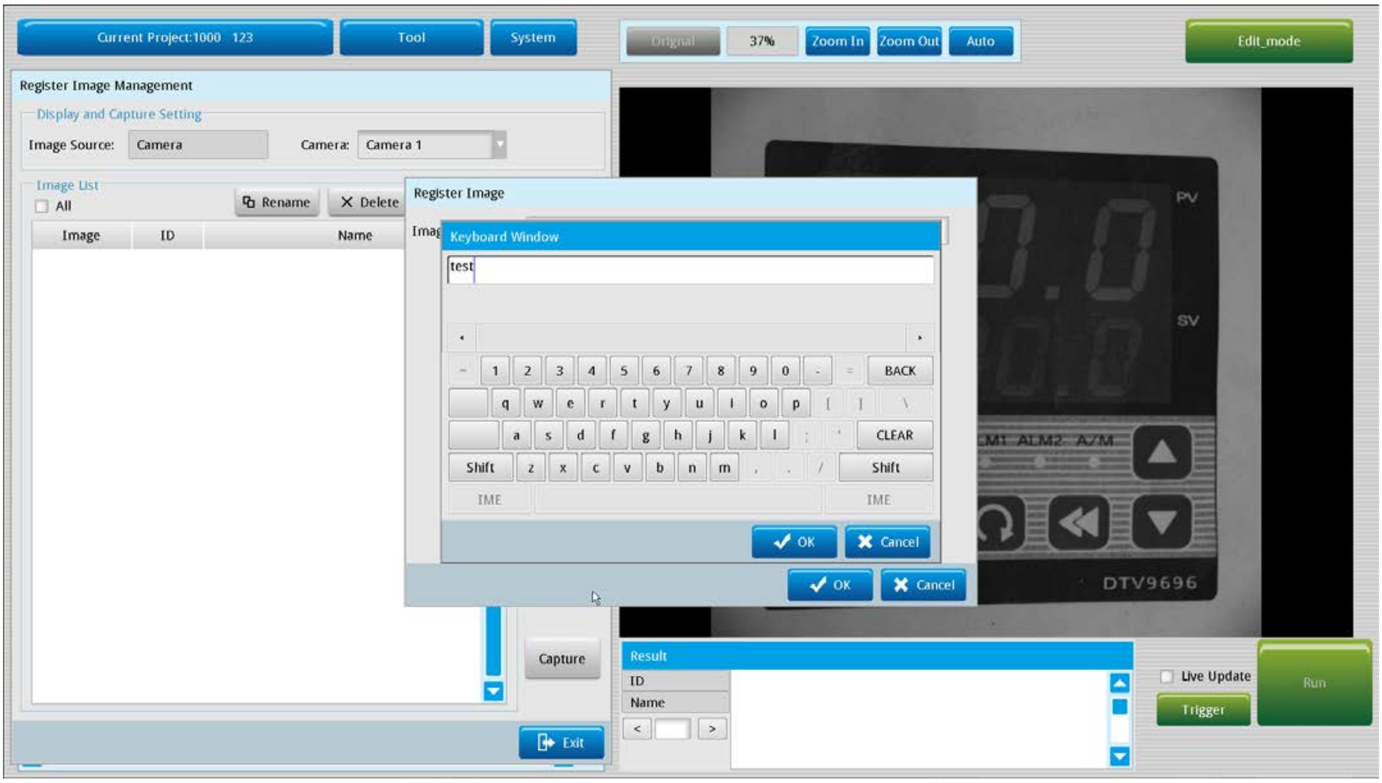
◎ **Image List**

Image list displays the registered images according to [Camera 1]~[Camera 8]. ID numbers start from 1000 to 8000.

➤ [All]: After checking the option, the [Camera] selection in [Display and Capture Setting] becomes disabled and the image list will display the registered images of all cameras connected to the controller.
➤ [Rename]: Select the image to be renamed and click to rename the image.
➤ [Delete]: Select the image to be deleted and click to delete the image.
➤ [Copy]: Select the image to be copied; enter the number of copies desired in the prompt window after clicking the option.

1) If making more than 2 copies, "1" or "-2" will be added to the name of the copies. If the original image name is "ABC", the copied image name is "XXX", and the number of copies is set to 3, the last 3 copied images are named "XXX-1", "XXX-2", and "XXX-3".
2) If making 1 copy, "-1" will not be added. If the original image name is "ABC", the copied image name is "XXX", and the number of copies is set to 1, the last copied image is named "XXX".

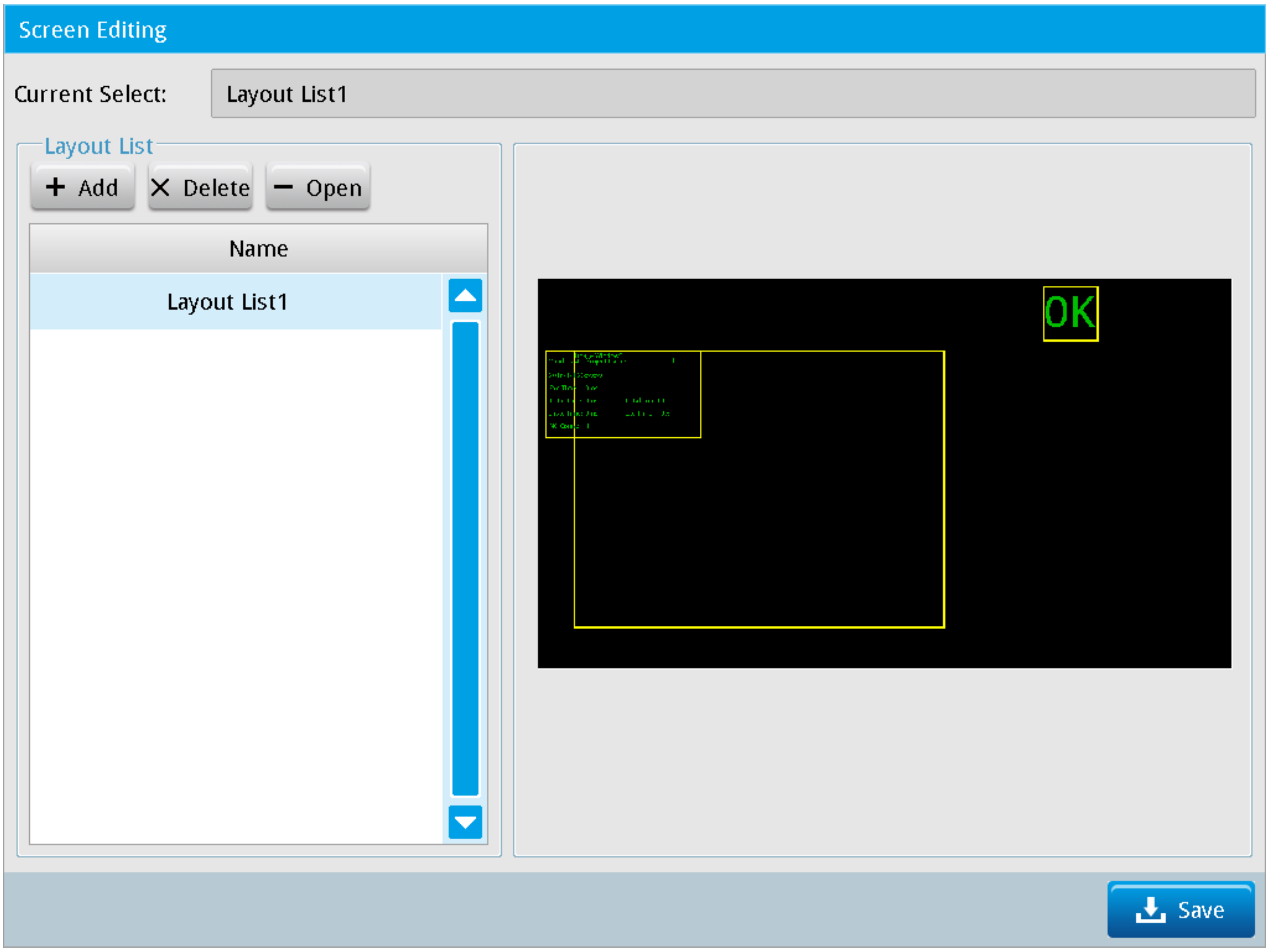
- Register Image



- After completing register image, the screen displays the following image.

3.3.2 Screen Editing

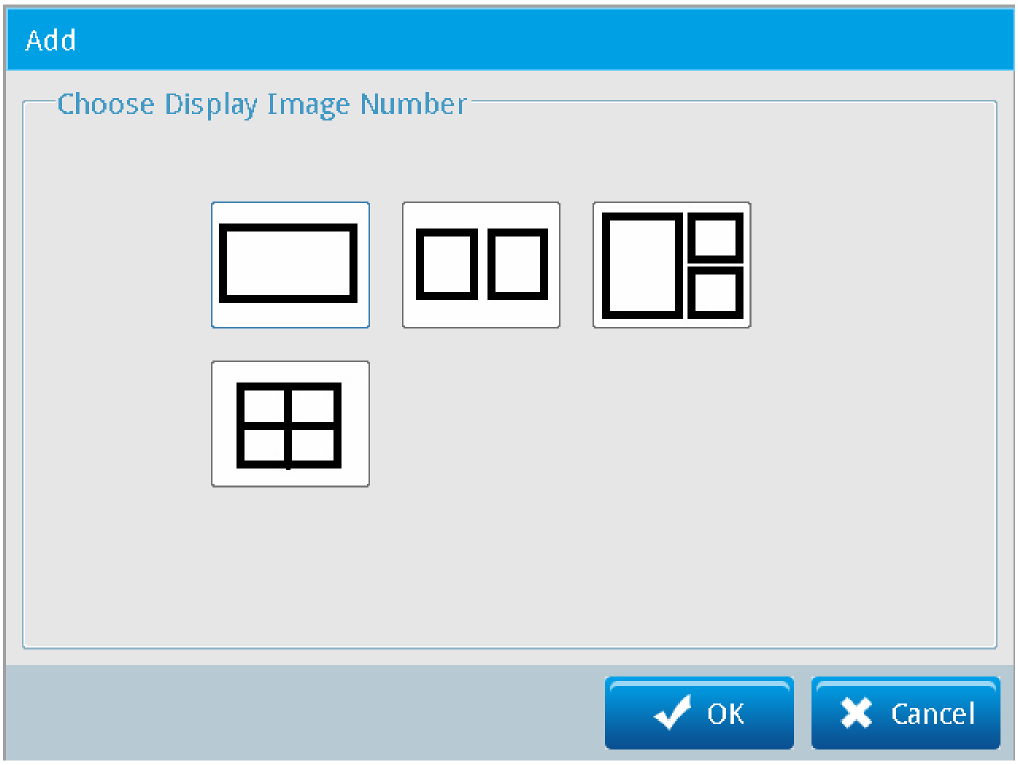
After completing project setting, the system may proceed to project execution. [Screen Editing] refers to the layout method of the inspection window during run mode.



◎ **Layout List**

➤ Add: Click to add new layout list and select the layout method.

1~4 inspection windows can be selected according to inspection requirements in a single flow process. The results from multiple inspections can be switched and displayed in each window.



➤ Delete: Select the layout list to be deleted and click to delete the layout list

➤ Open: Select the layout list to be opened and click to open the layout list

The opening screen will be displayed according to the selected layout method.

◎ **Screen Editing Setting**

The opening screen is shown as follows. Click right mouse button to set [Edit], [Dot ON/Dot OFF], and [Close].

➤ [Edit]

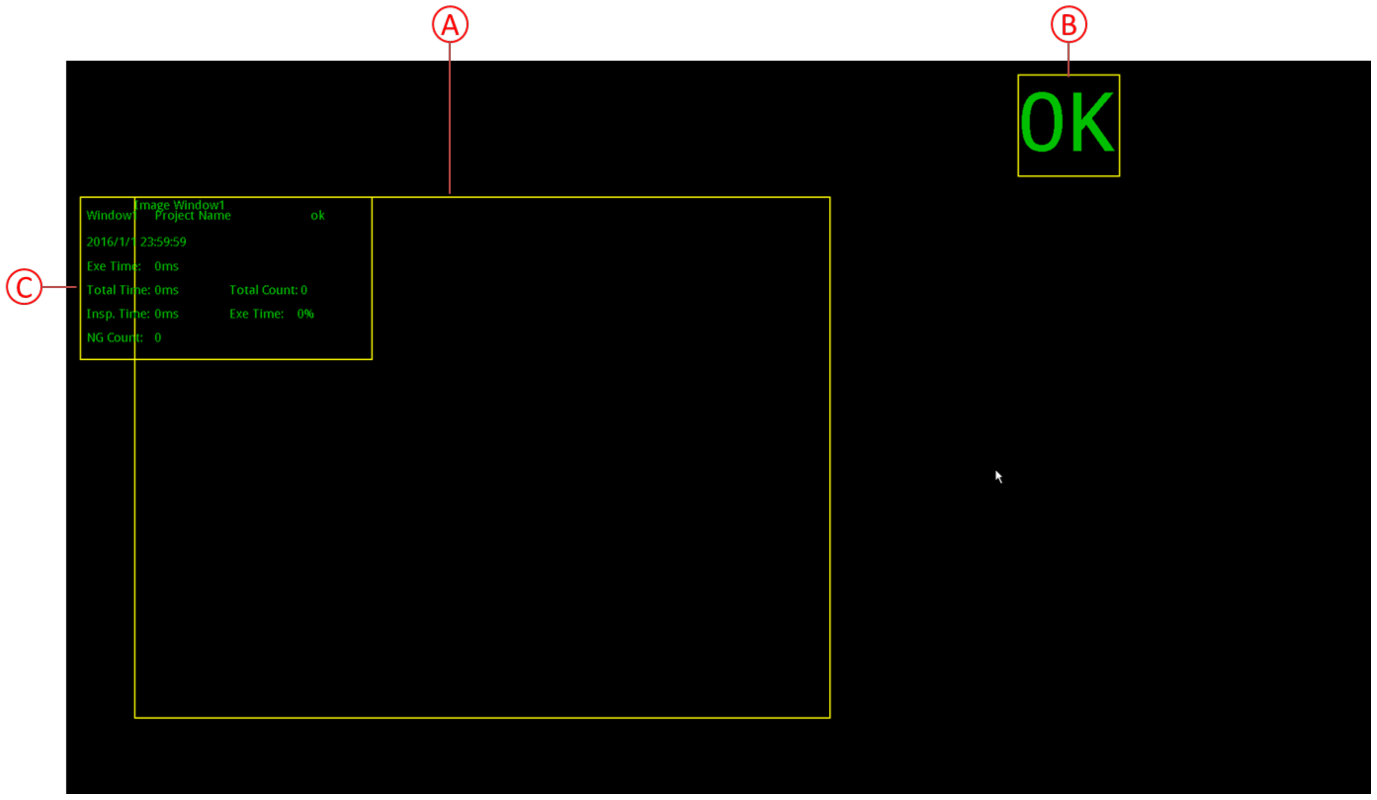
Adjusts the length, width, and font color of the image window.

➤ [Dot ON/Dot OFF]

Turns grid on or off.

➤ [Close]

Click to leave the editing screen.



A. Image Window

Screen display when inspections are triggered.

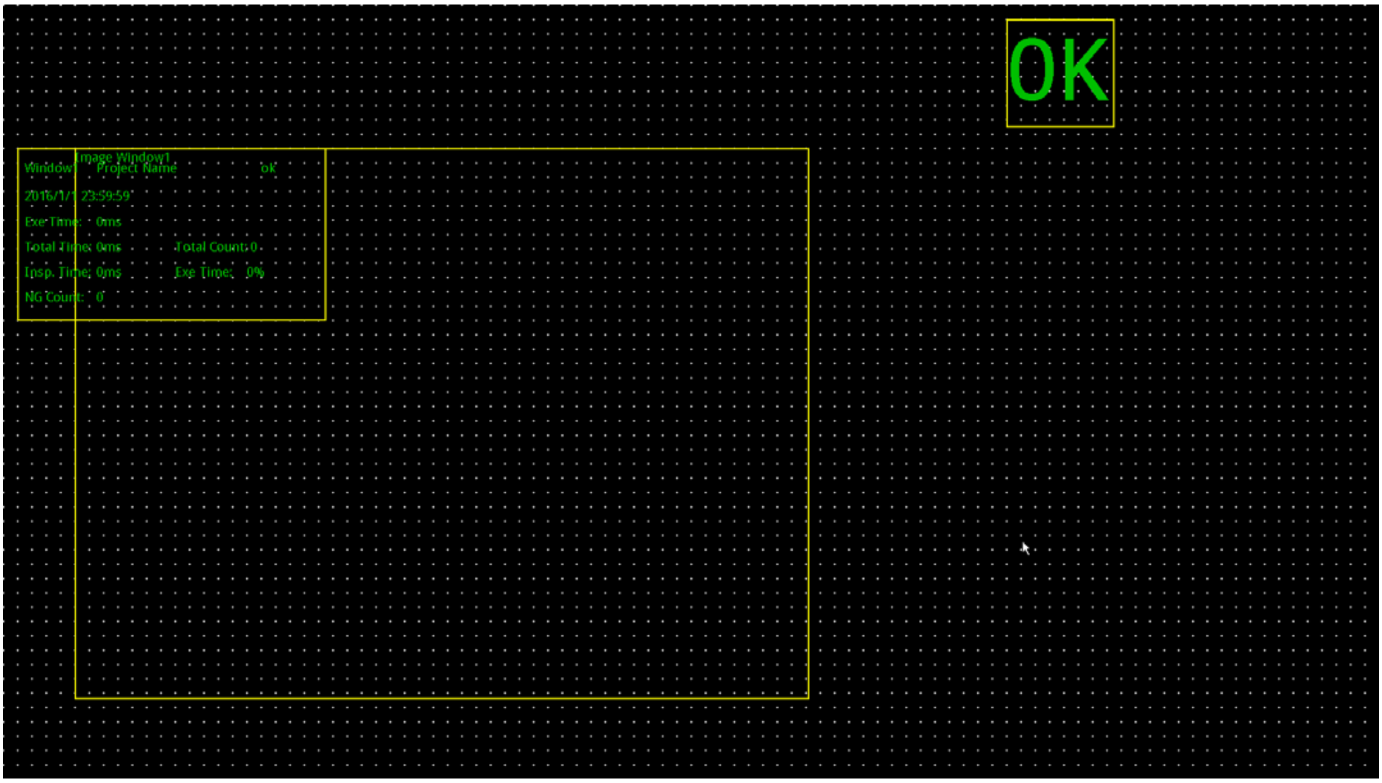
B. Execution Result

Result display (OK/NG) when project execution is triggered.

C. Window

Data from project inspection Includes Project Name, Date and Time, Exe Time, Total Time, Insp. Time, NG Count, Total Count, and NG Rate.

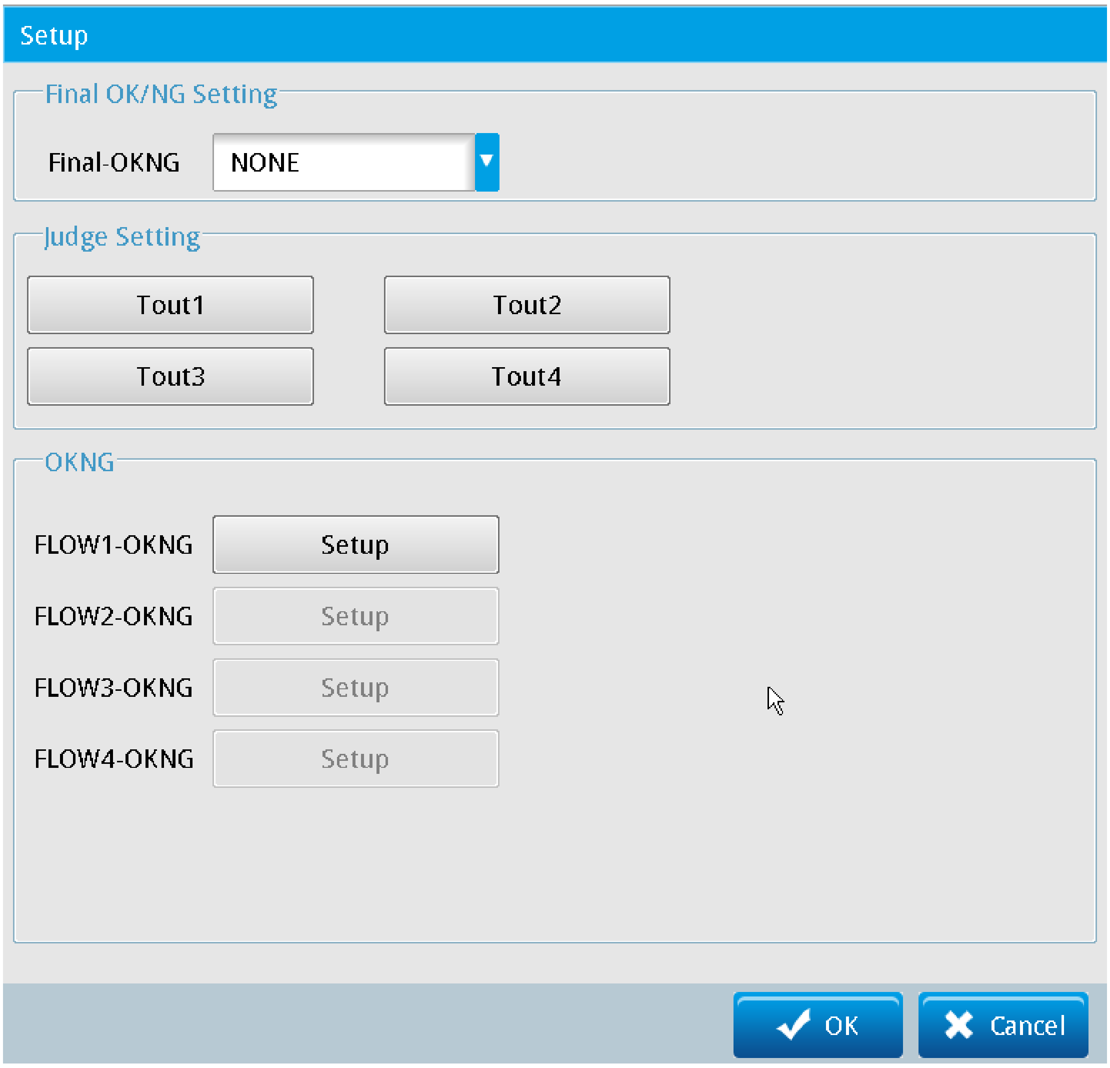
The grid selection screen after clicking the right mouse button is shown as follows. The option aligns the borders of [Image Window] and [Window].



3.3.3 Judge Setting

When executing project inspection, the execution results OK or NG will appear in the window. The judge result is based on the reference data set in the [Judge Setting] by the user.

The setting process from the bottom up: [OKNG]>[Judge Setting]>[Final OK/NG Setting].



◎ **Final OK/NG Setting**

Sets the basis for judging whether the final result is OK or NG.

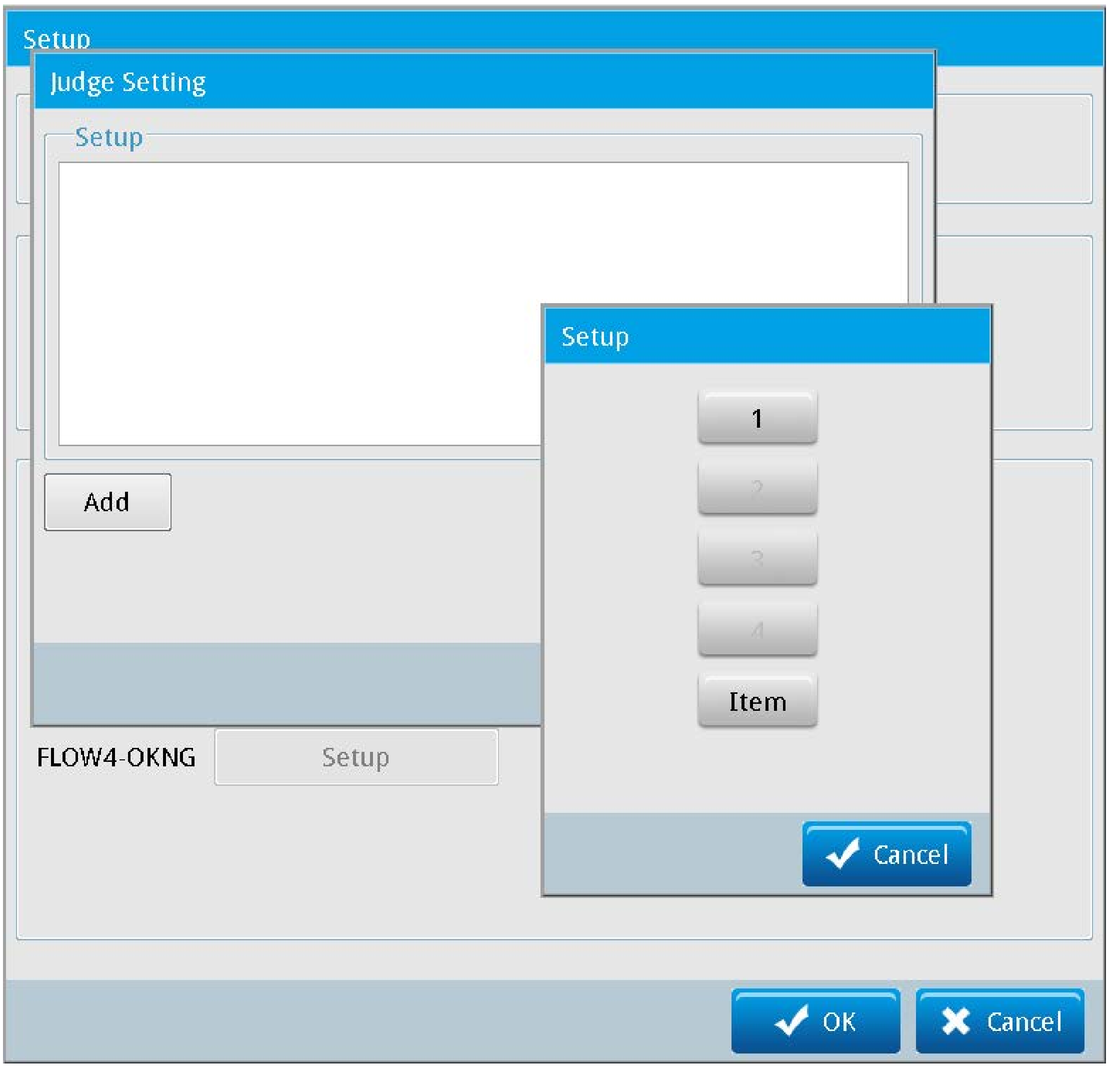
- TOUT1: If the TOUT1 inspection is OK, the final judge result is OK.
- TOUT2: If the TOUT2 inspection is OK, the final judge result is OK.
- TOUT1 AND TOUT2: Both the inspection results of TOUT1 and TOUT2 must be OK so that the final judge result is OK.
- TOUT1 OR TOUT2: Either the inspection result of TOUT1 or TOUT2 must be OK so that the final judge result is OK.

◎ **Judge Setting**

Judges whether the TOUT1 and TOUT2 inspection results are OK or NG.

- Add New Process Judgment

Click [Setting] and select [Add] after entering the screen, the configured number of flow processes and items for the project will appear. The user may select the desired flow process or item to include for inspection and judgment.



➤ Add New Item Judgment

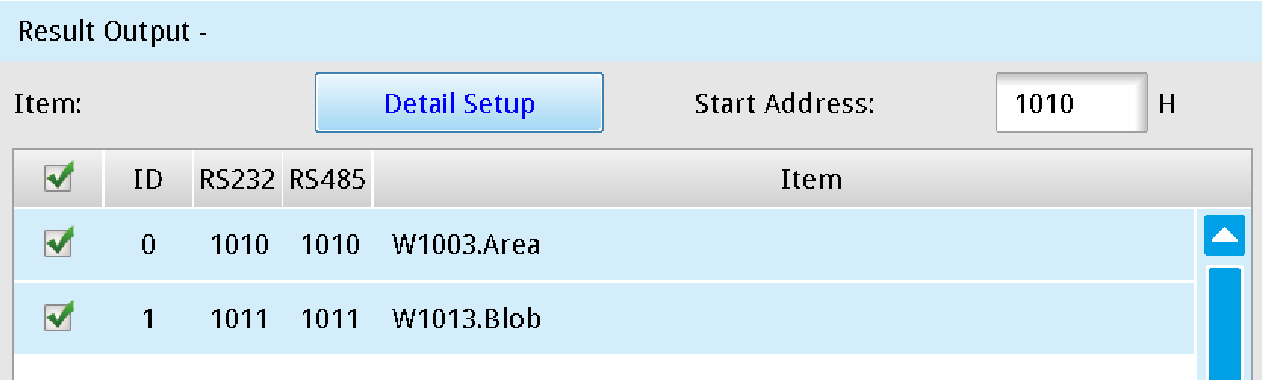
◆ Choose Type: The 2 options of [Item] and [Window] appear after entering.

◆ Inspections: List of inspections

◆ Parameters: Inspections must comprise Coordinate Positions, Areas, Perimeter parameters to be displayed here, and thus include Blob, Stain, Edge Position, Shape, Position Trace, and Width Trace.

◆ Reference: Inspections include Blob, Stain, Edge Position, Shape, Position Trace, and Width Trace.

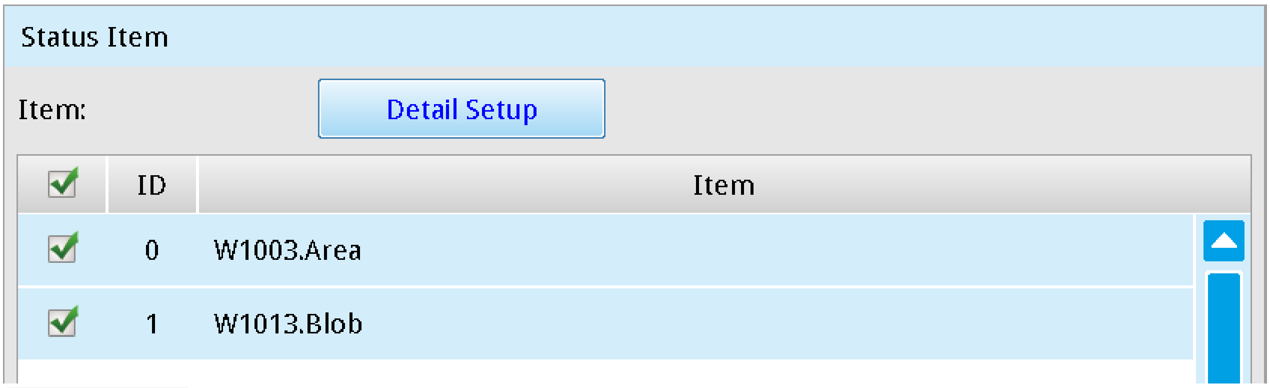
After adding new [Select Item], the inspections to be included in the OK/NG judgment can be reconfirmed in [Result Output].



◎ **OKNG**

- Choose Type: The 2 options of [Item] and [Window] appear after entering.
- Element: List of inspections
- Parameters: Inspections must comprise Coordinate Positions, Areas, Perimeter parameters to be displayed here, and thus include Blob, Stain, Edge Position, Shape, Position Trace, and Width Trace.
- Reference: Inspections include Blob, Stain, Edge Position, Shape, Position Trace, and Width Trace.

After adding new [Select Item], the inspections to be included in the OK/NG judgment can be reconfirmed in [Status Light].



Reference Please refer to Section 6 for detailed judge settings.

3.4 System Setting

In edit mode, the initial display of the controller shows the 3 setting options of [Current Project], [Tool], and [System]. Click the [System] button to enter the internal controller settings. All system settings are applicable for all inspection projects and will not change for varying projects. This chapter explains the system settings.

3.4.1 General Setting

◎ **Device**

Delta DMV2000

◎ **Date & Time**

Enter the date and time for project inspections.

◎ **Language Setting**

"Traditional Chinese" and "English" are built-in in the system. The user can select according to need.

Remark System must restart after changing the language setting.

◎ **Startup Screen**

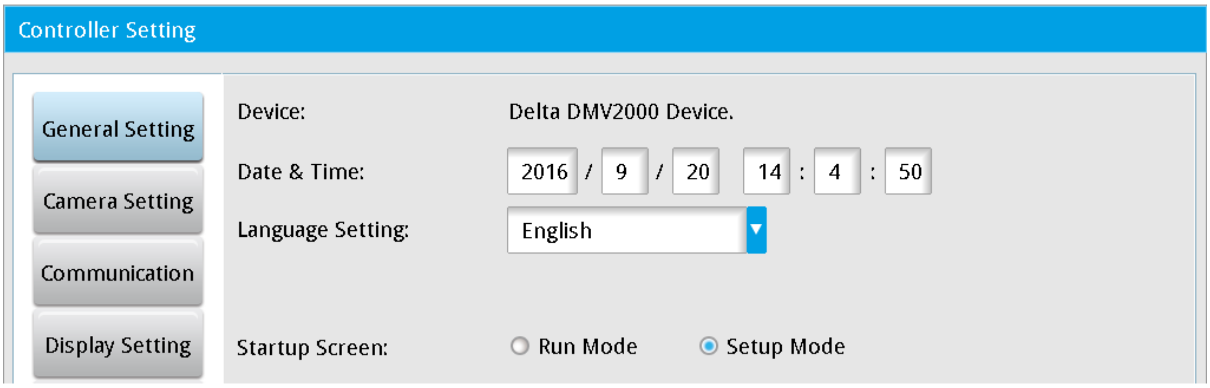
Select and configure to display either run mode or program mode in the initial screen of the controller

➤ Setting Mode

The initial screen of the controller displays project inspection settings in which projects can be changed, adjusted, or added.

➤ Run mode

The initial screen of the controller displays direct project execution. This option requires preconfigured projects, so that project inspection may immediately begin once the controller activates.



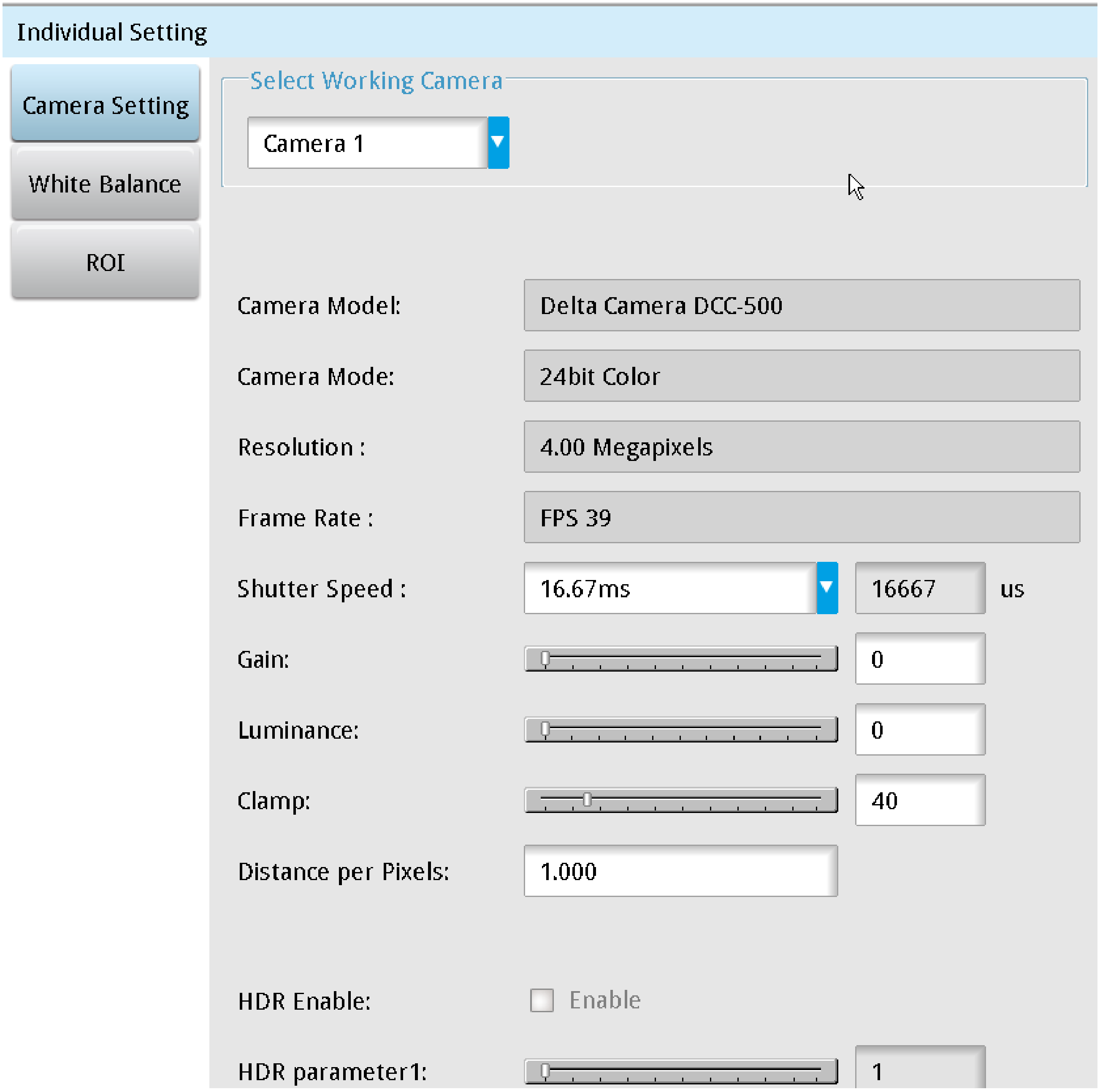
3.4.2 Camera Setting

I. Individual Setting

The main function of individual setting is to setup all relevant parameters of the controller's cameras, including the 3 options of Camera Setting, White Balance, and ROI.

◎ **Camera Setting**

According to varying model numbers, DMV2000 can simultaneously operate 2, 4, and 8 cameras. Therefore, [Camera 1], [Camera 2], [Camera 3], [Camera 4], [Camera 5], [Camera 6], [Camera 7], and [Camera 8] can be selected as the working camera. Each camera can be colored or gray-scaled. After connecting the camera, the controller will prompt whether to automatically detect camera model and specifications, which will automatically be downloaded after clicking the option.



- Camera Model

After connecting the camera, the system automatically detects.

- Camera Mode

After connecting the camera, the system automatically detects.

- Resolution

After connecting the camera, the system automatically detects.

- Frame Rate

After connecting the camera, the system automatically detects.

- Shutter Speed

The desired shutter setting (default is user defined) is selected through a layout list. The user is free to set the required shutter time here. Longer shutter time increases exposure and the amount of light absorbed and is suited for occasions of insufficient lighting.

- Gain

Range: 0~255; higher gain results in a brighter image but is prone to generate noise.

- Luminance

Range: 0~10; higher luminance results in a brighter image but actual luminosity variation is less than gain adjustment.

- Clamp

Range: 0~255; higher Clamp value results in a brighter image but actual luminosity variation is less than luminance adjustment.

- Distance/Pixel

The ratio between on-screen pixels and actual distance; units of pixels are converted to actual units.

- HDR

Range: 0~254; only suitable for gray-scale cameras; low parameter value results in a low exposure and can only develop whitish and overexposed outlines; regions of denser black pixels on the original image become darker.

◎ **White Balance Setting**

Restores the colors of the selected image and calibrates the colors. Drag the white balance region to the white position on-screen and select Auto Setting.

➤ The result of calibrated white balance is shown as follows.

➤ Inspection Region

Displays the X and Y coordinates (X0, Y0) and (X1, Y1) of the white balance region; the image shows the deviation from the color tone corrected based on the white reference of the region.

Remark Click [Reset] to reposition and resize the selected region for white balance.

➤ Average RGB in Region

Calculates the RGB pixels within the selected region for white balance.

➤ White Balance Coefficient

Range: 0~1; larger value results in a larger color density When the three values obtained by multiplying the white balance coefficient with the RGB average within the region are similar; the color within the inspected region is close to white.

Remark Click [Auto Setting] and the system will automatically adjust the white balance coefficient according to the selected region.

◎ **ROI Setting**

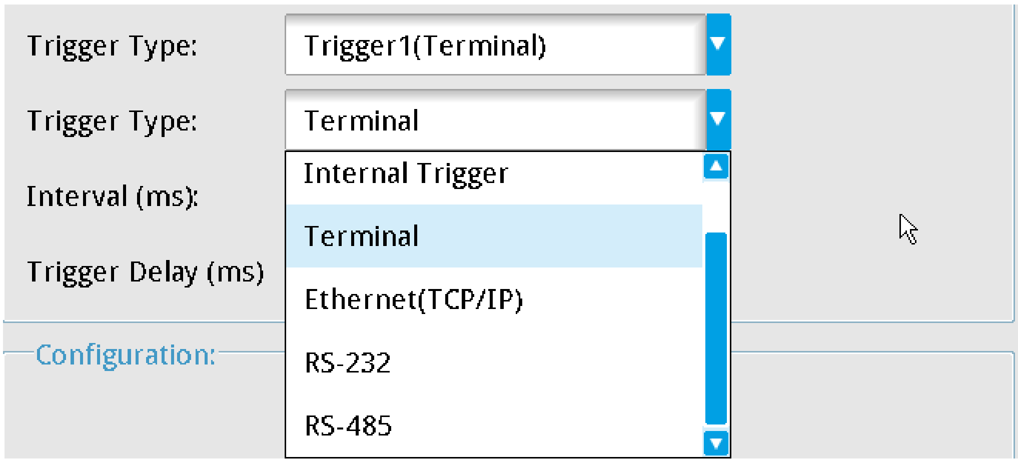
Captures images in the selected range; saves image processing time during inspections and measurements; users can adjust the size of the inspection region according to need.

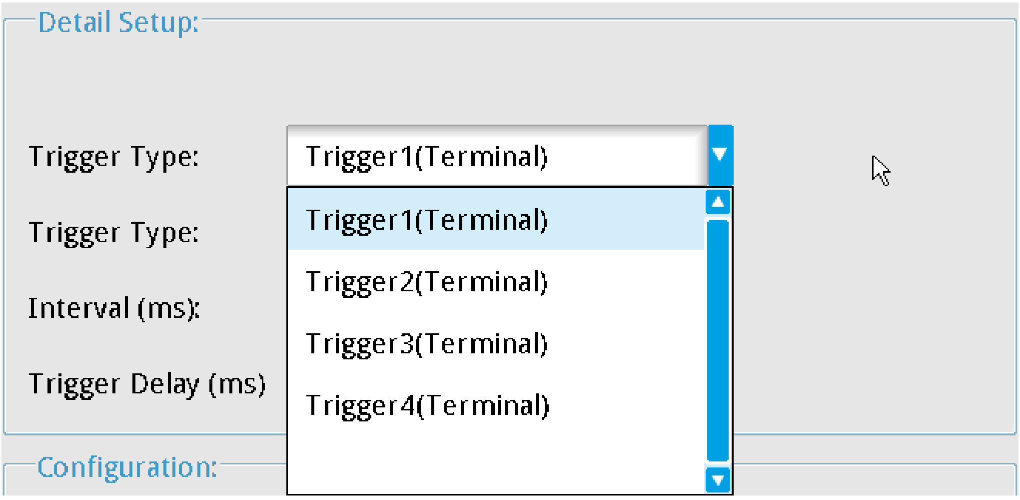
II. Common Setting

Common setting primarily sets the conditions of the trigger inspection process and relevant parameters of the flash light, including the two options of [Trigger Setup] and [Flash Setting].

◎ **Trigger Setup**

The setup of trigger inspection processes is divided into the 5 triggers of external terminal, internal trigger, Ethernet, RS-232, and RS485. A single inspection process can be triggered by up to 4 types of triggers.





- External Trigger

Triggered by external device through varying interfaces, a single inspection process can be configured to be triggered by up to 4 types of triggers.

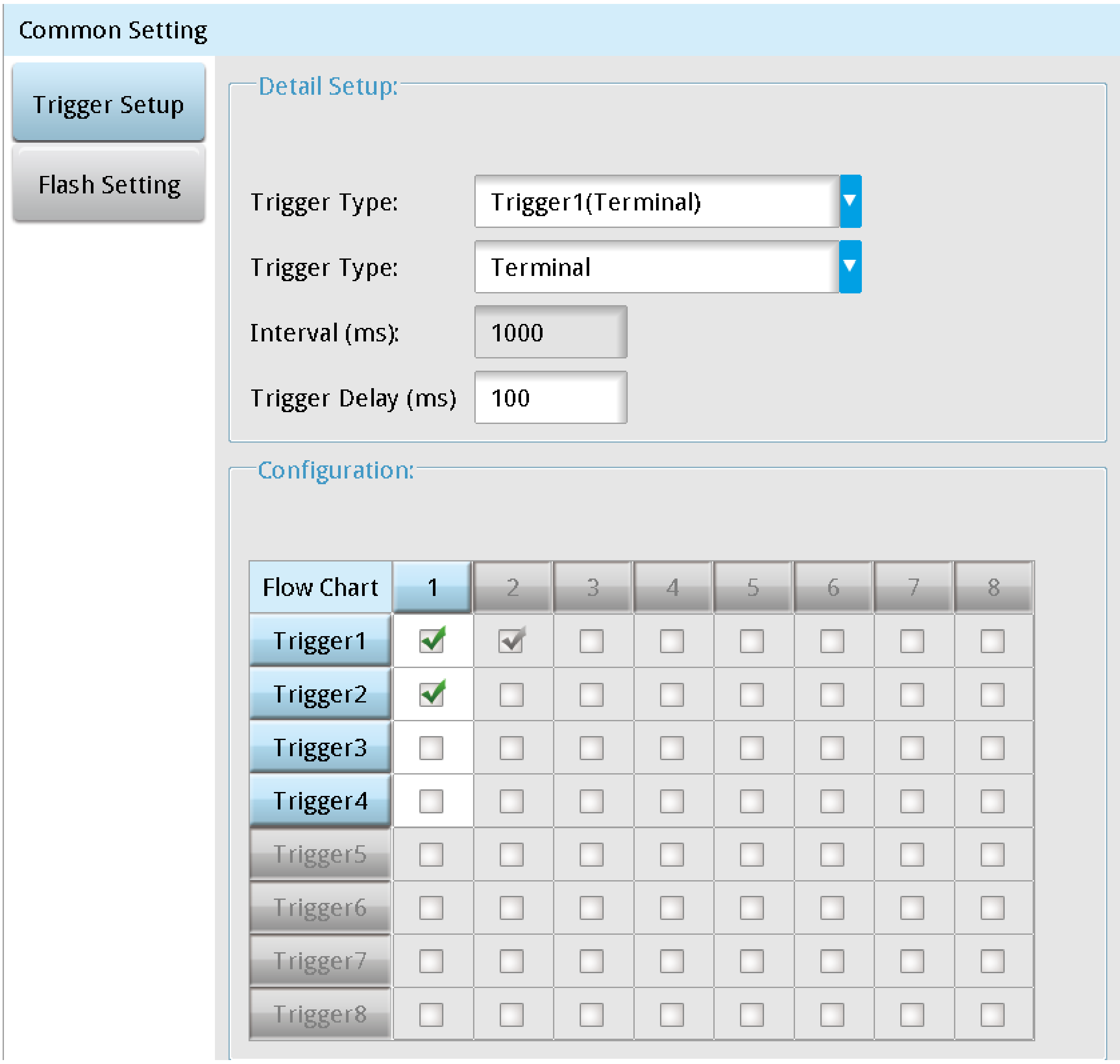
1) External Terminal: Input trigger signal using I/O to execute process inspection.
2) RS232: Input communication command through the serial interface to execute process inspection.
3) RS485: Input communication command through the serial interface to execute process inspection.
4) Ethernet: Input communication command through the Ethernet interface to execute process inspection.

- Internal Trigger

Can only be setup on Trigger 1; automatically triggers according to the configured time; suitable for applications requiring timed inspections.

Interval (ms) and trigger delay (µs) are items for setting timed inspections.

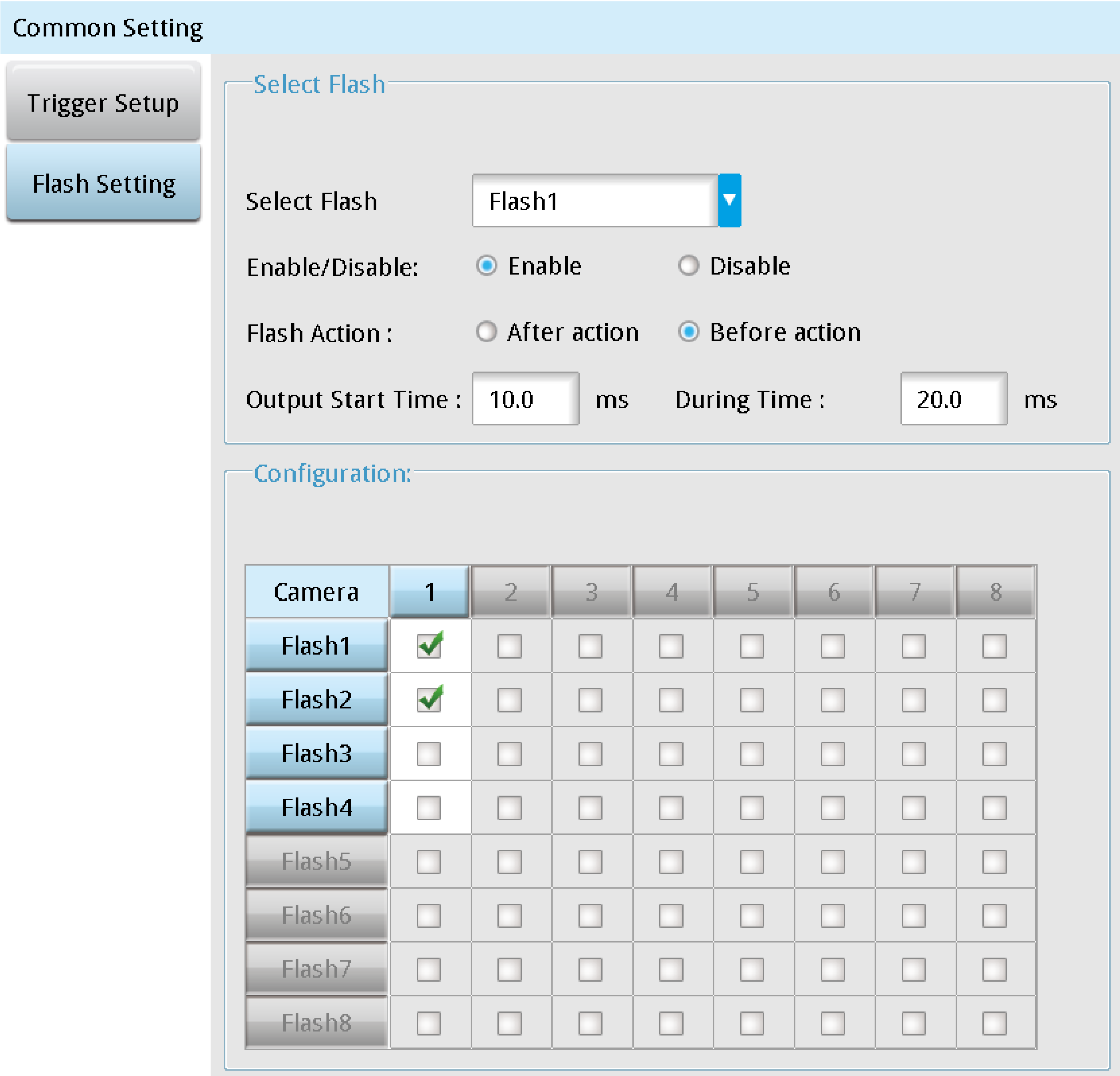
Users can choose to configure the following settings according to inspection requirements.



◎ **Flash Setup**

Flash controls the lighting output in sync with the camera shutter when capturing images. According to varying model numbers, DMV2000 can connect up to 8 cameras. Therefore up to 8 flash can be configured. Multiple flash can be configured for the same process or different processes.

Users can choose to configure the following settings according to inspection requirements.



➤ Enable/Disable

Flash can only be turned on when [Enable] is selected.

➤ Flash Action

[After Action]: Flash activates only after camera shutter engages [Before Action]: Flash activates only before camera shutter engages.

➤ Output Start Time

Sets the delay time between flash and shutter; the timing depends on the [After Action] and [Before Action] settings.

For example: Setting value is [10 ms]

- ◆ When set to [After Action], the shutter first activates to capture image after the input of capture trigger signal; then, the flash activates after 10 ms according to the delay setting.
- ◆ When set to [Before Action], the flash first activates after the input of capture trigger signal; then, the shutter activates after 10 ms according to the delay setting. (generally recommended method)

➤ During Time

Total flash duration.

To ensure that the flash can first activate and hold for a certain duration when shutter activates during image capture, the [During Time] setting must be greater than the sum of [Output On Time] and [Shutter Time].

3.4.3 Communication Setting

The controller can establish communication connection with the upper controller through external (I/O) terminals. The settings include [Device Setting] and [Protocol Setting].

I. Device Setting

◎ **External Terminal**

Sets whether to enable receiving signals from external (I/O) terminals and signal reception methods

INPUT: IN1~IN8

OUTPUT: OUT1~OUT11

➤ Enabling External Terminal

After confirming the [Signal Test Mode] field is on [Disable], select the external terminal to be tested and click on [Enable].

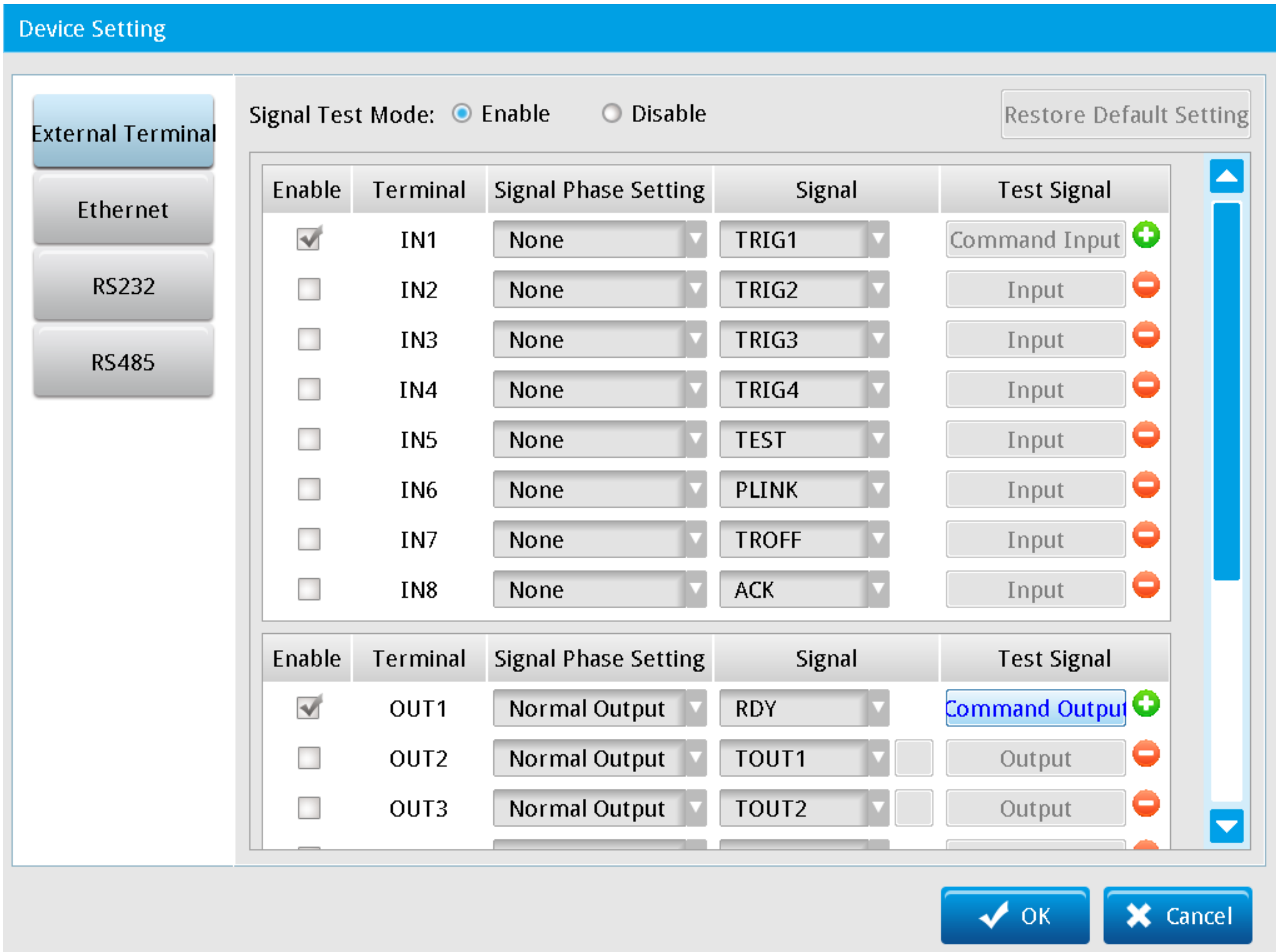
The upper half is the controller signal input and the lower half is the controller signal output.

➤ Test Signal

Click on [Enable] in the [Signal Test Mode] field

When the external (I/O) terminal is connected to the controller and enabled, the test signal is turned on and the dot light signal to the right turns to green.

The upper half is the controller signal input terminal. When external terminal is checked enabled, the light signal to the right appears green. The lower half is the signal output terminal of the controller. When external terminal is checked enabled, the light signal to the right appears green.



Remark Click [Restore Default Setting] to return to initial settings.

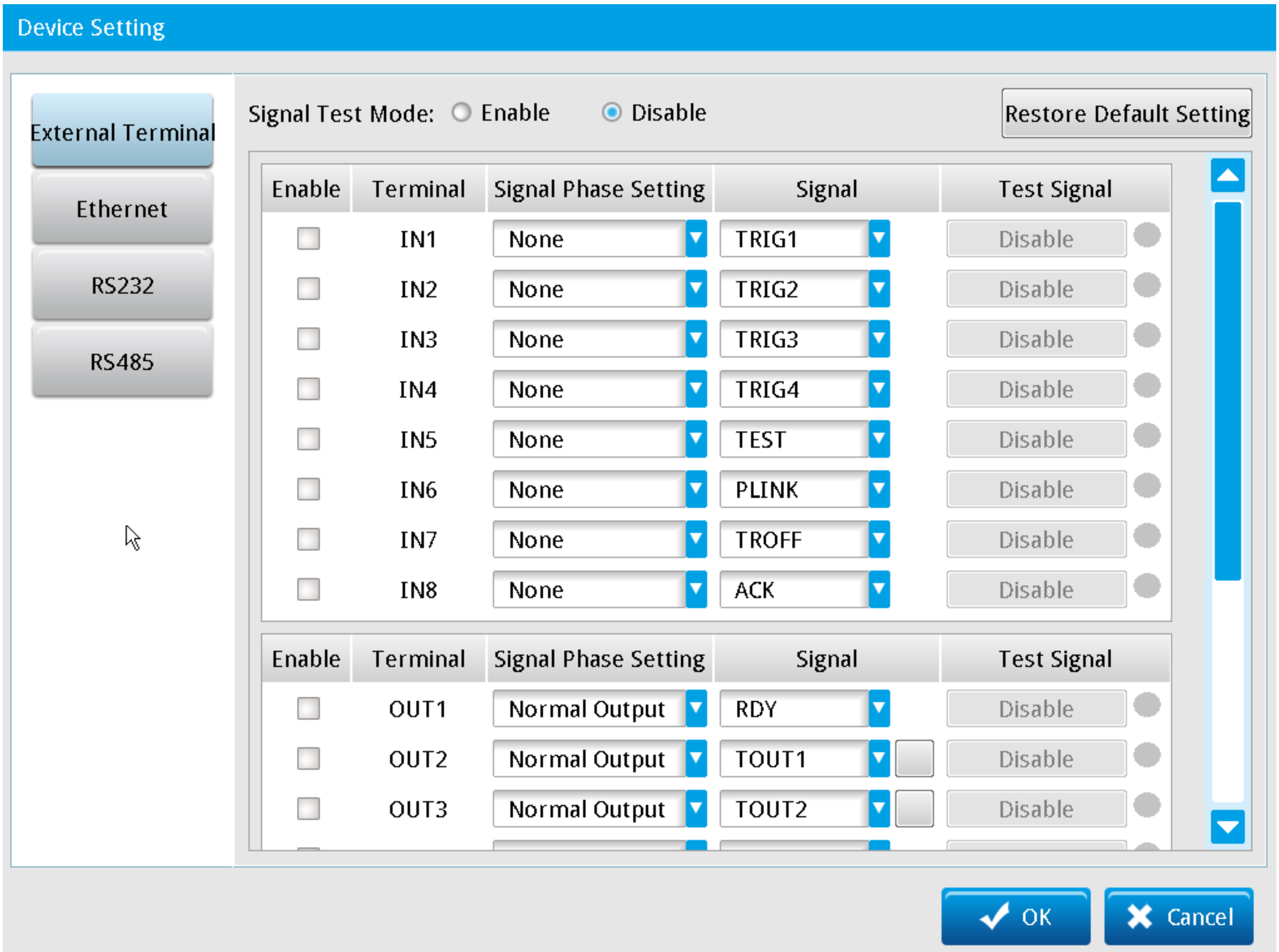
➤ Signal Phase Setting

Can only be configured for the output; signal is output to the external terminal through Contact A in normal output to receive controller transmitted signals; signal is output to the external controller through Contact B in inverse output to receive external terminal transmitted signals.

➤ Signal

Comprise the 64 options of RDY, TOUT1, TOUT2, ERR, STR, REND1, REND2, REND3, REND4, FLH1, FLH2, SW, NSW, FRDY, DO1, DO2, DO3, DO4, DO5, OUT1, OUT2, OUT3, OUT4, OUT5, OUT6, OUT7, OUT8, OUT9, OUT10, OUT11, OUT12, OUT13, OUT14, OUT15, OUT16, REND5, REND6, REND7, REND8, DO6, DO7, DO8, DO9, FLH3, FLH4, FLH5, FLH6, FLH7, FLH8, NA, RDY2, RDY3, RDY4, RDY5, RDY6, RDY7, RDY8, ERR2, ERR3, ERR4, ERR5, ERR6, ERR7, and ERR8

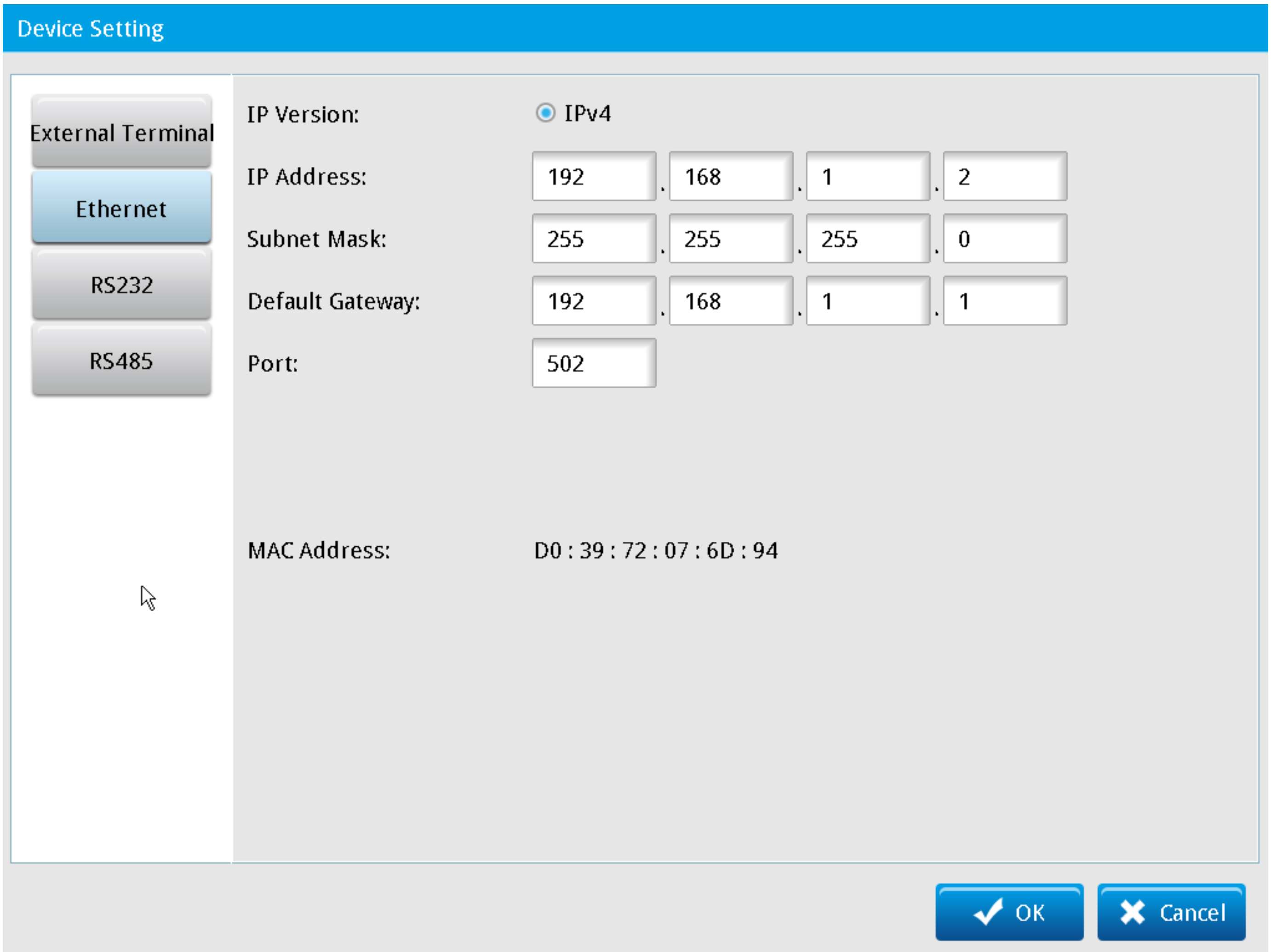
Remark In output configuration signals TOUT1, TOUT2, and STR, the box to the right can be clicked to enter [Protocol Setting].



Reference Please refer to Chapter 7 for detailed communication settings for I/O signals.

◎ **Ethernet**

Set the IP location of the controller when communicating using Ethernet.



◎ **RS232**

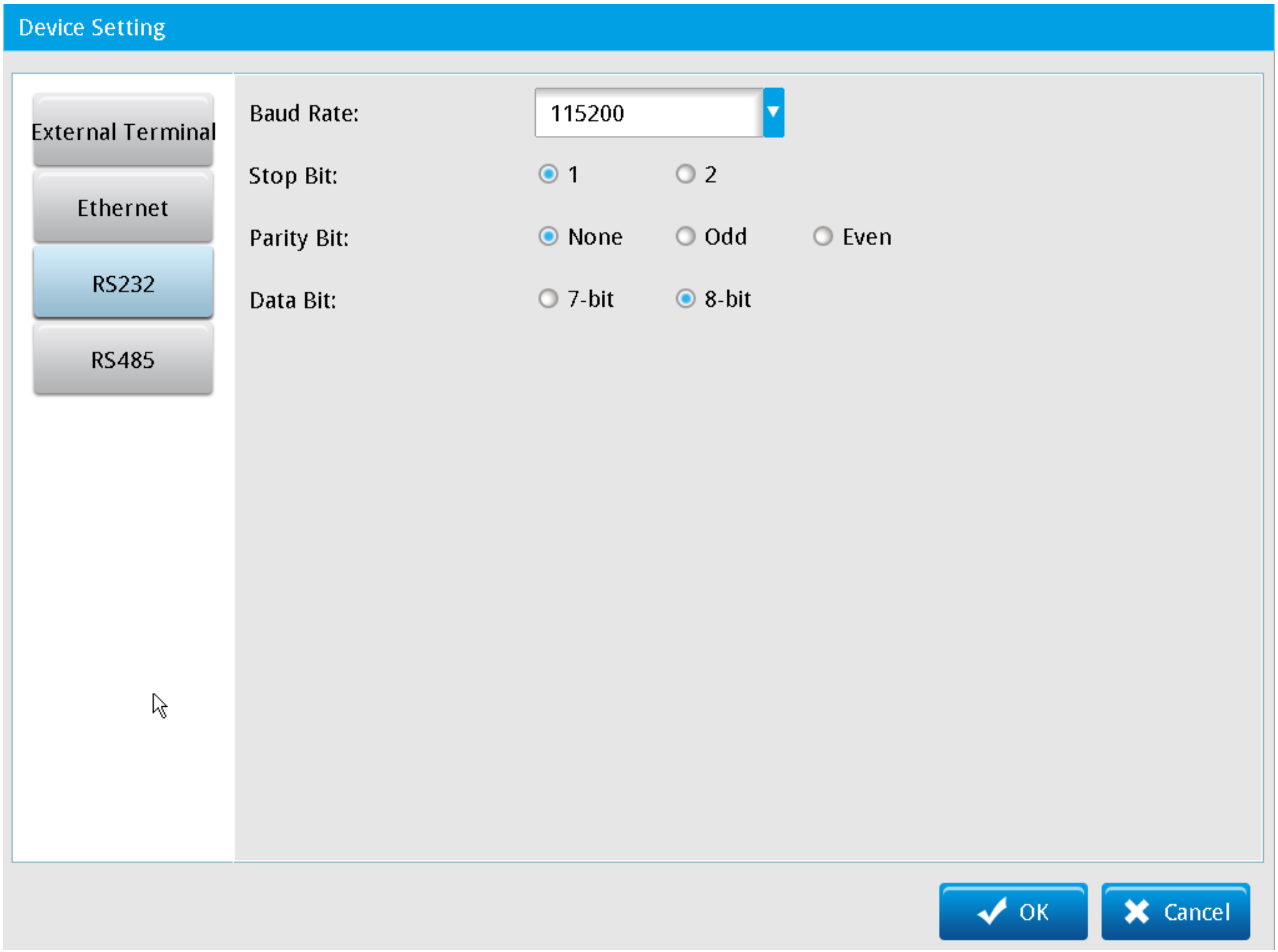
Communication format for RS232 Default values are as follows.

Transmission Speed: 115200 (setting contents: 2400, 4800, 9600, 19200, 38400, 57600, 115200)

Stop Bit: 1 (setting contents: 1, 2)

Parity Bit: None (setting contents: odd, even, none)

Data Bit: 8-bit (setting contents: 7, 8)



◎ **RS485**

Communication format for RS485 Default values are as follows.

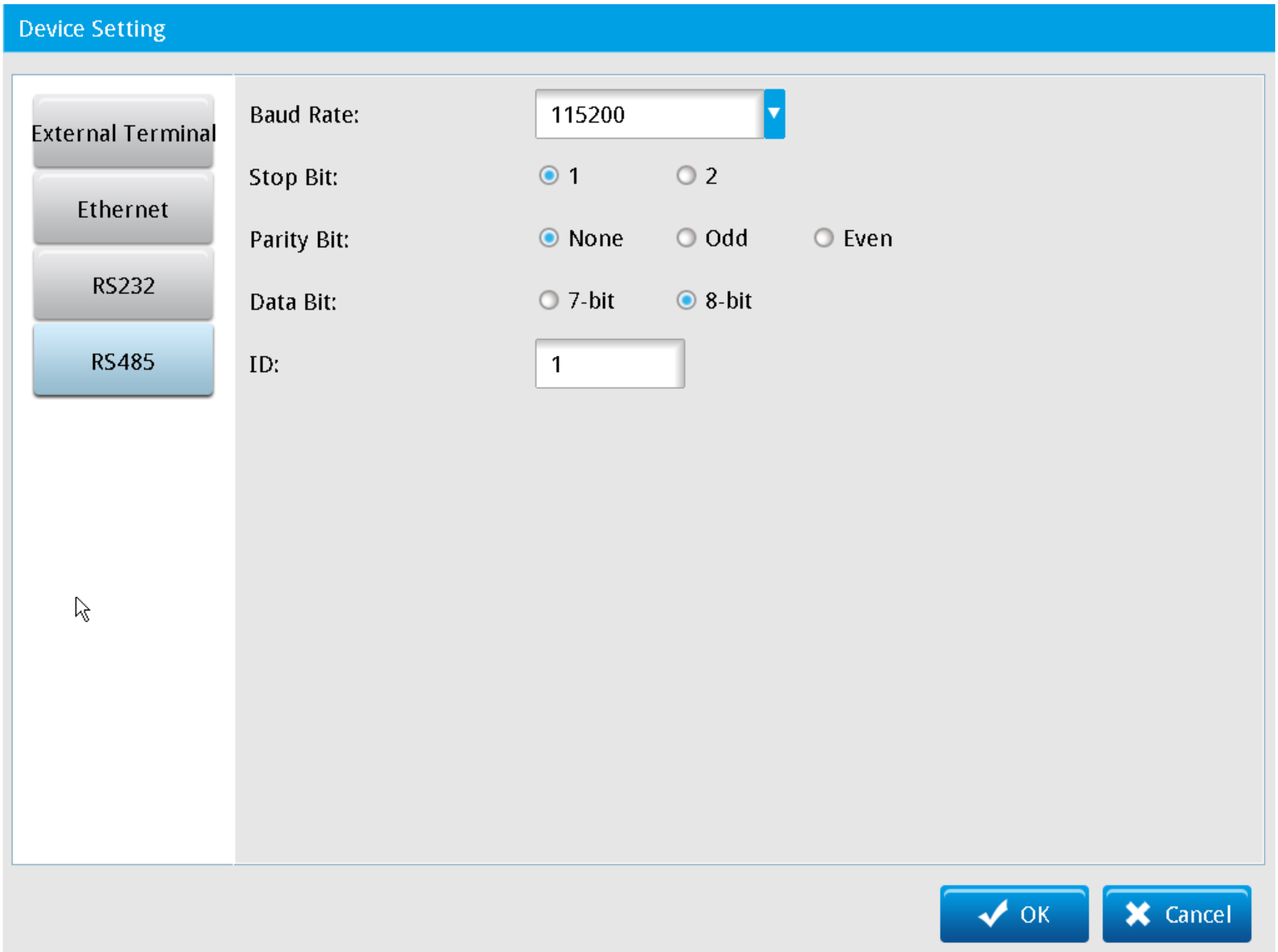
Transmission Speed: 115200 (setting contents: 2400, 4800, 9600, 19200, 38400, 57600, 115200)

Stop bit: 1 (setting contents: 1, 2)

Parity Bit: None (setting contents: odd, even, none)

Data Bit: 8-bit (setting contents: 7, 8)

ID: 1

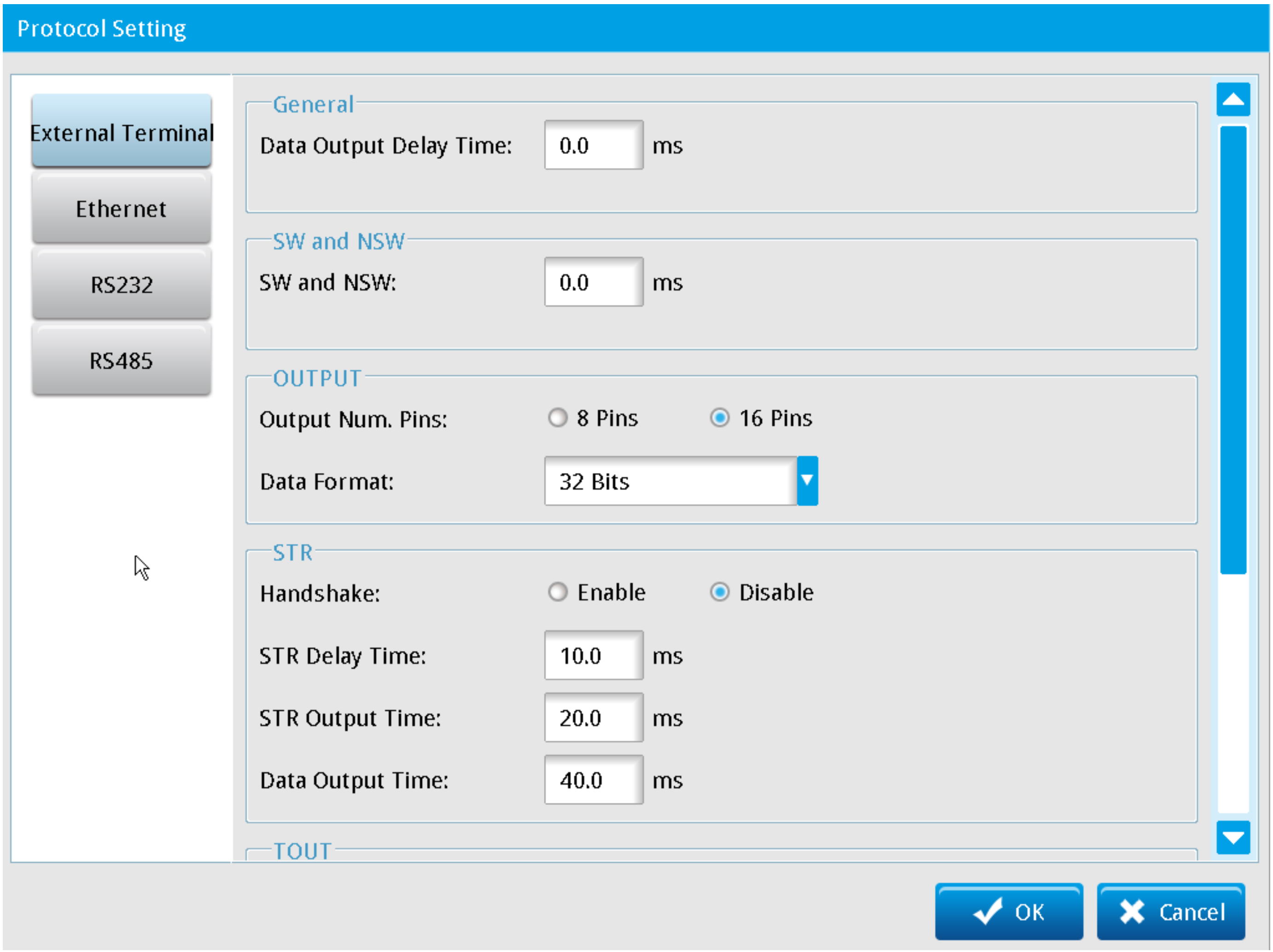


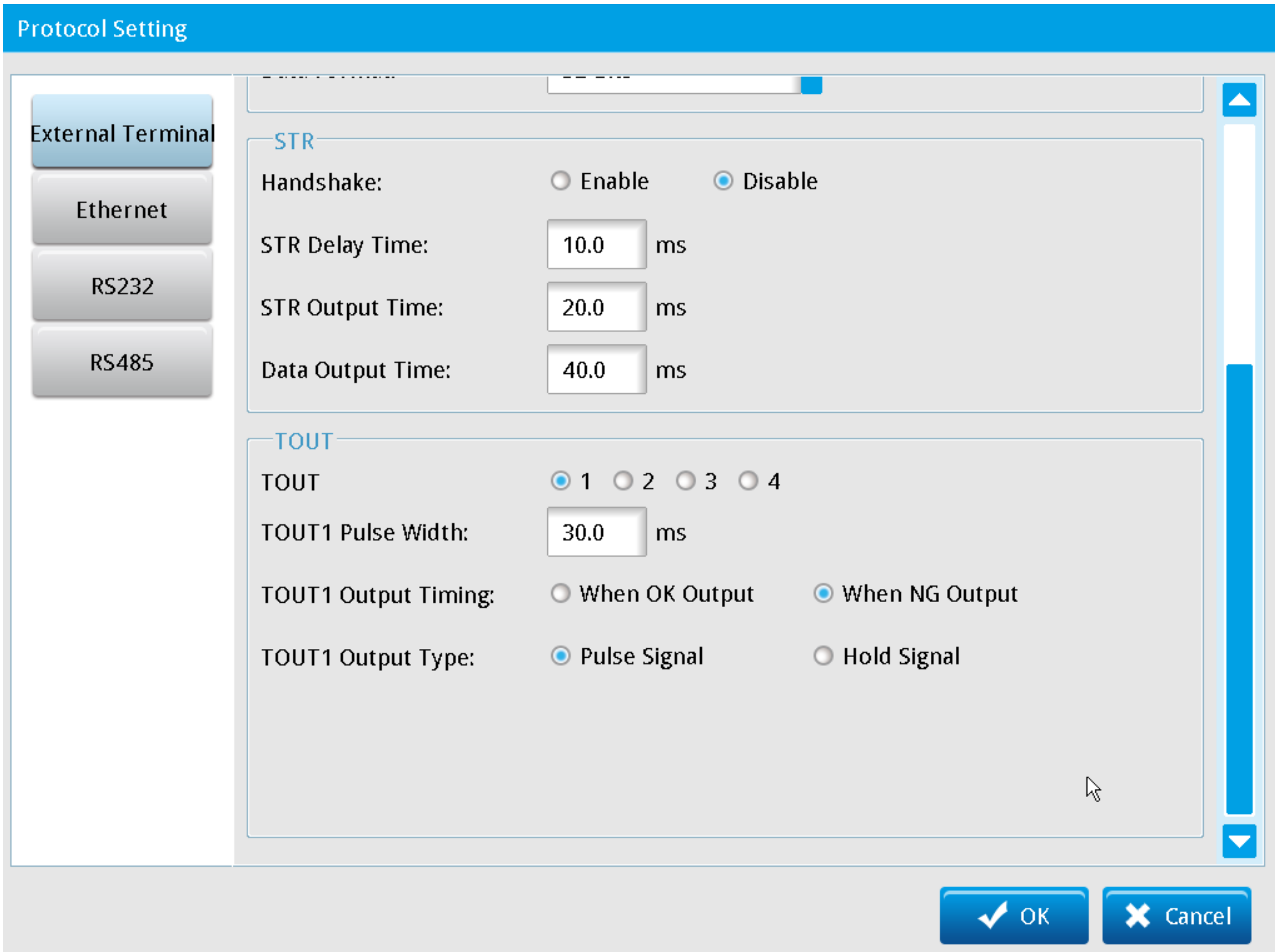
II. Protocol Setting

◎ **External Terminal Settings**

Setup output reception data.

Complete setting General, SW and NSW, OUTPUT, STR, and TOUT in sequence

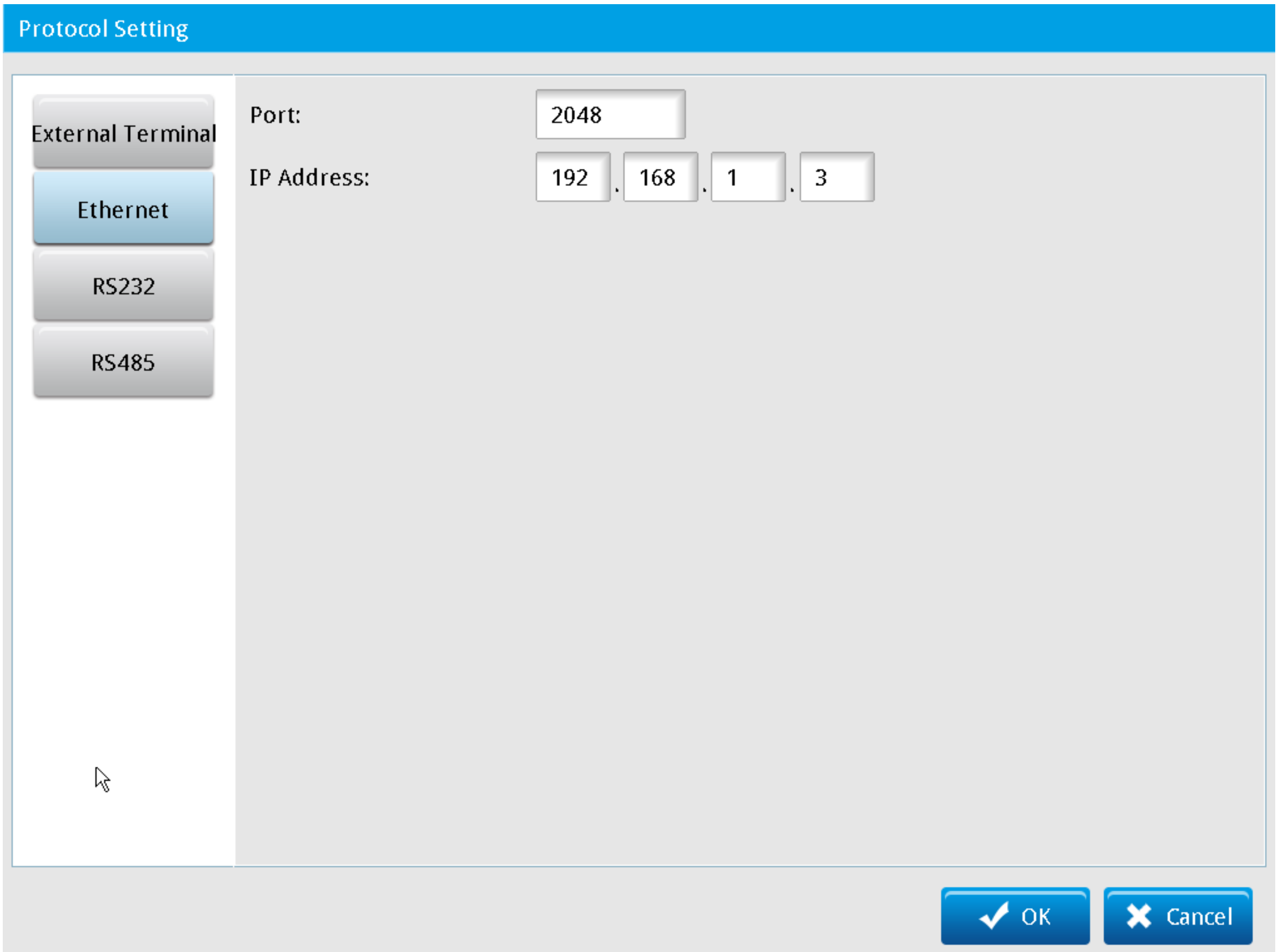




Reference Please refer to Chapter 7 for detailed communication settings for external terminal signals.

◎ **Ethernet**

Configures Ethernet command execution data during communication.



Reference Please refer to Section 8.6 for detailed communication settings for Ethernet signals.

◎ **RS232**

Configures RS232 command execution data during communication

➤ Data Format

Setting Contents: 16 bits/32 bits

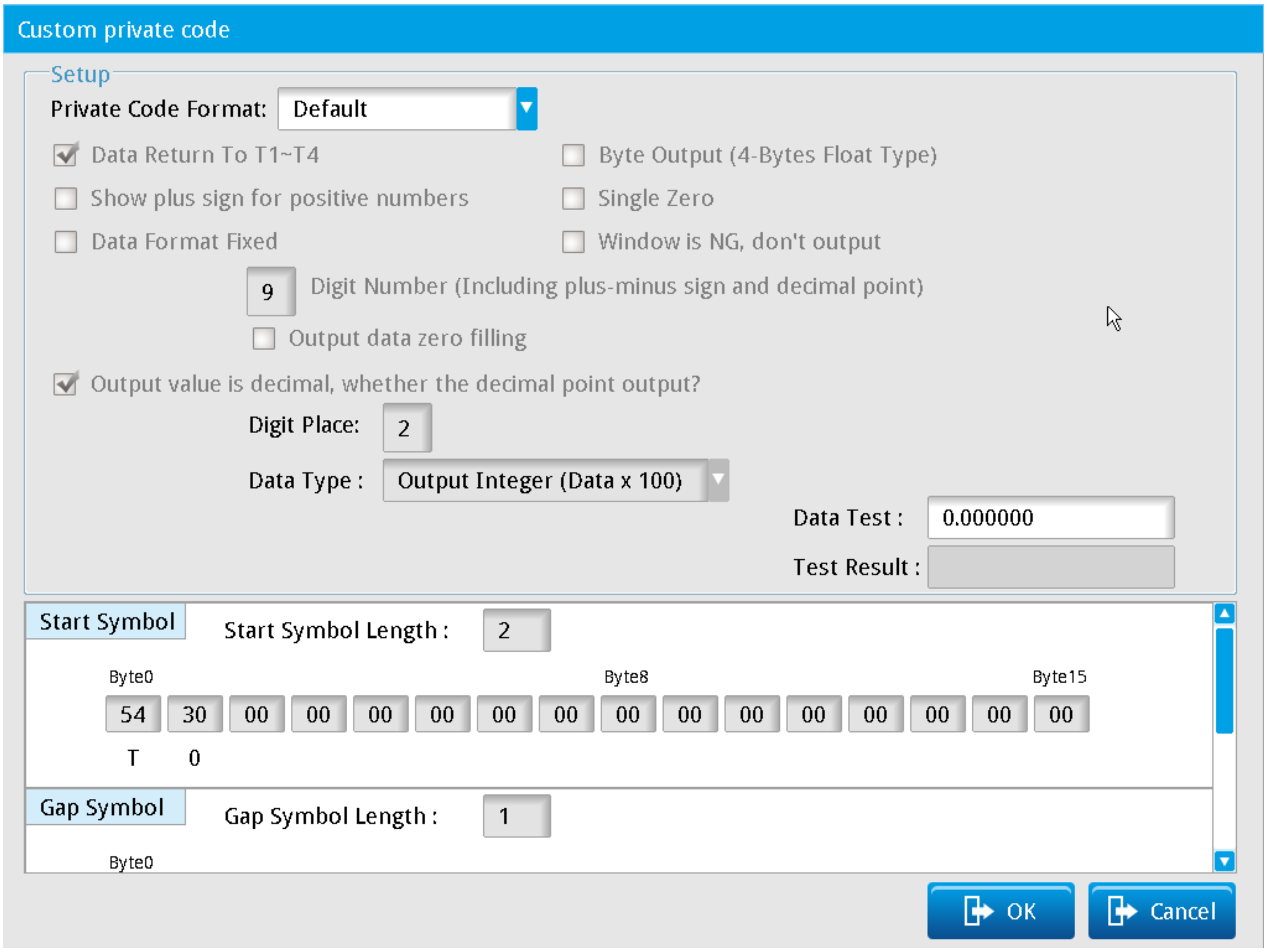
➤ Protocol: Select configure private code/PLC link

◆ Private Code

Click Detail Setup and enter user defined private code

Private Code Format: Default/user defined private codes

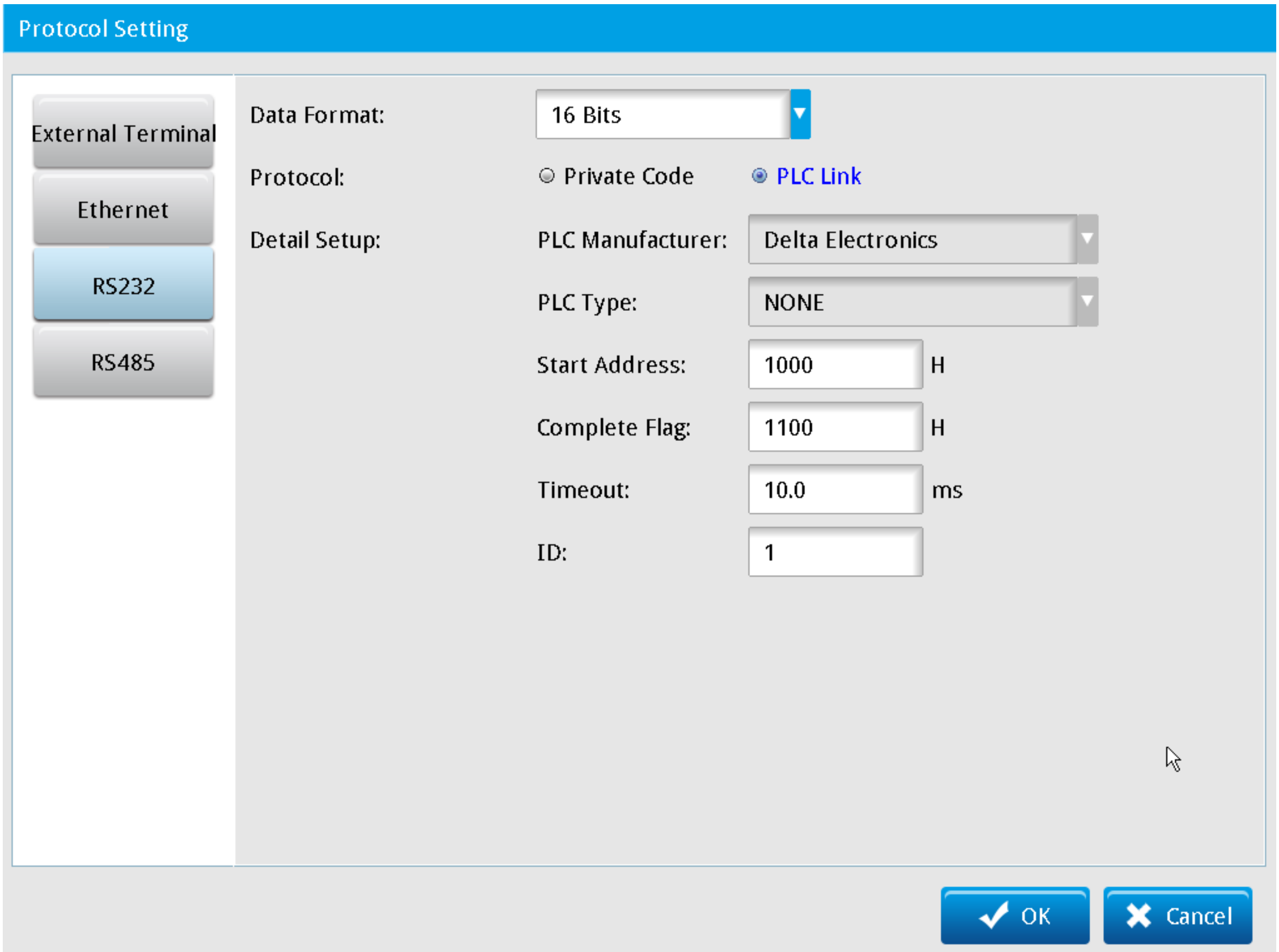
User selects according to need and configures according to the following steps



Reference Please refer to Section 8.2 for the detail setup for the private code of RS232.

◆ PLC Link

Through PLC link, communication can be directly established with the PLC (current version of DMV2000 only supports Delta PLC connection). Start Address, Complete Flag, Timeout, and ID are configured in order to complete the connection setting.



Reference Please refer to Section 8.3 for the detail setup for the PLC link of RS232.

◎ **RS485**

Configures RS485 command execution data during communication

➤ Data Format

Setting Contents: 16 bits/32 bits

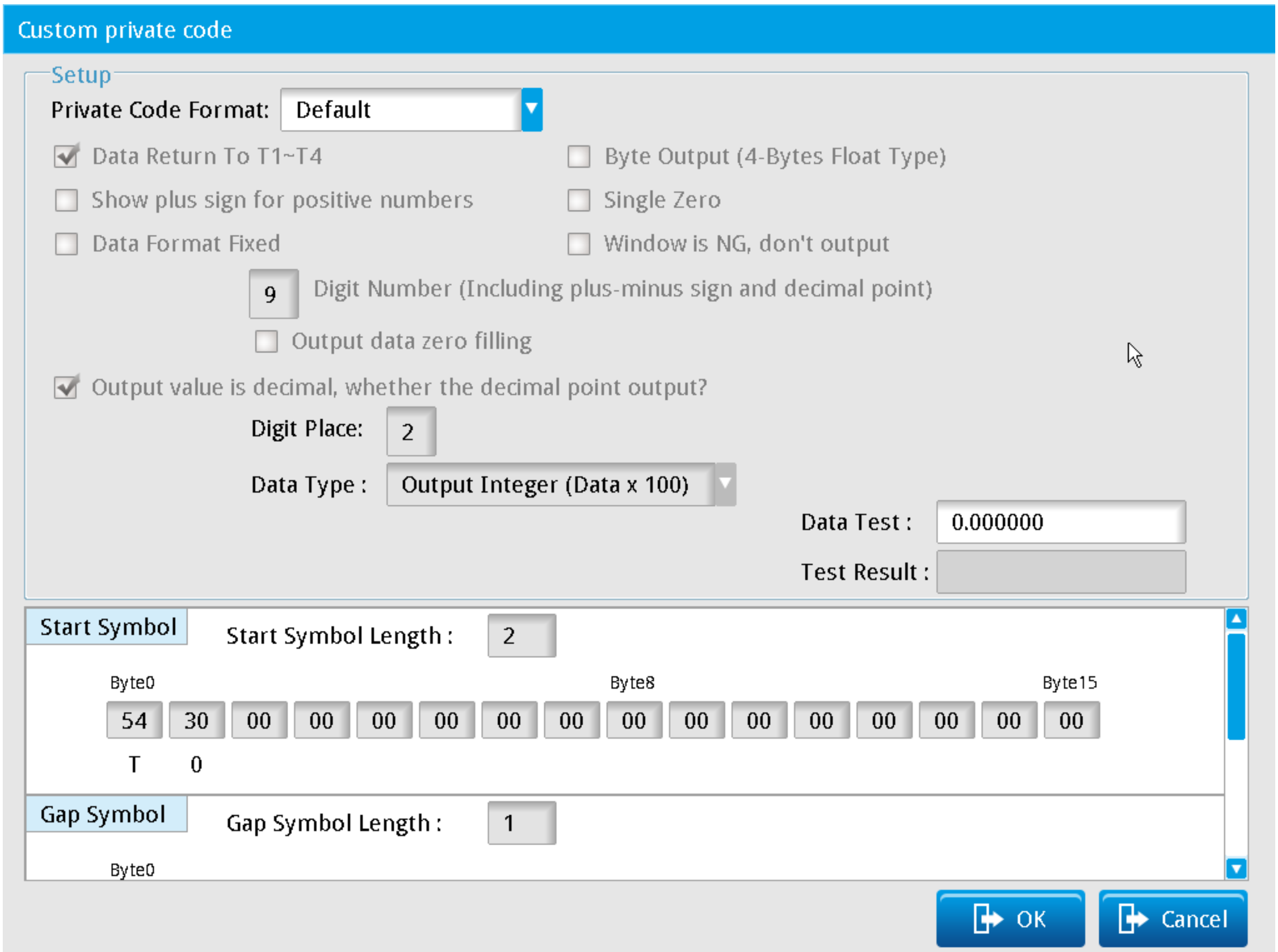
➤ Protocol: Select configure private code/PLC link

◆ Private Code

Click Detail Setup and enter user defined private code

Private Code Format: Default/user defined private codes

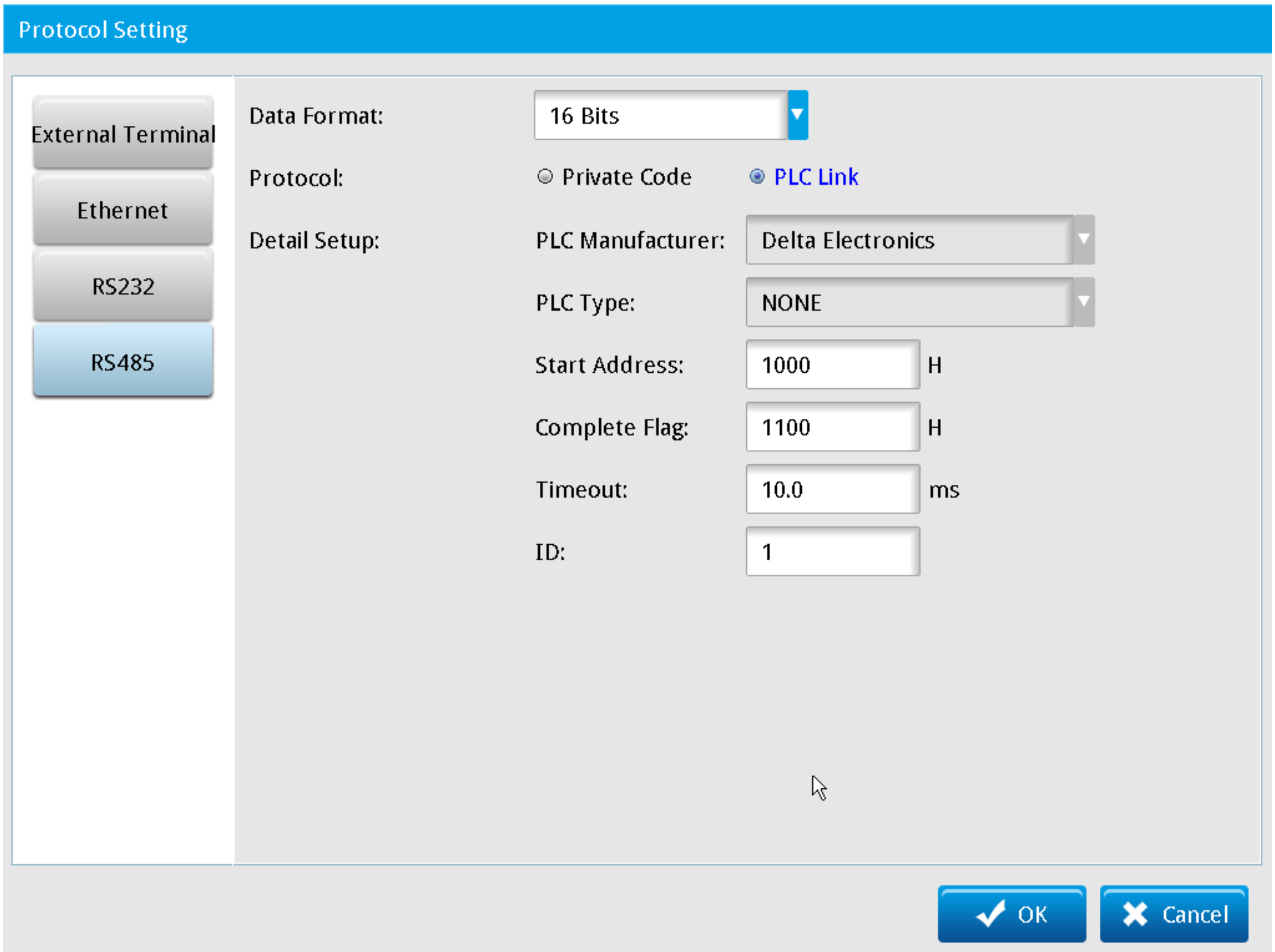
User selects according to need and configures according to the following steps



Reference Please refer to Section 8.2 for the detail setup for the private code of RS485.

◆ PLC Link

Through PLC link, communication can be directly established with the PLC (current version of DMV2000 only supports Delta PLC connection). Start Address, Complete Flag, Timeout, and ID are configured in order to complete the connection setting.



Reference Please refer to Section 8.3 for the detail setup for the PLC link of RS485.

3.4.4 Display Setting

Configure inspection display requirements through the controller end.

◎ **Screen Resolution**

Current controller only supports a screen resolution of 1920*1080; 1024*768 is currently not supported.

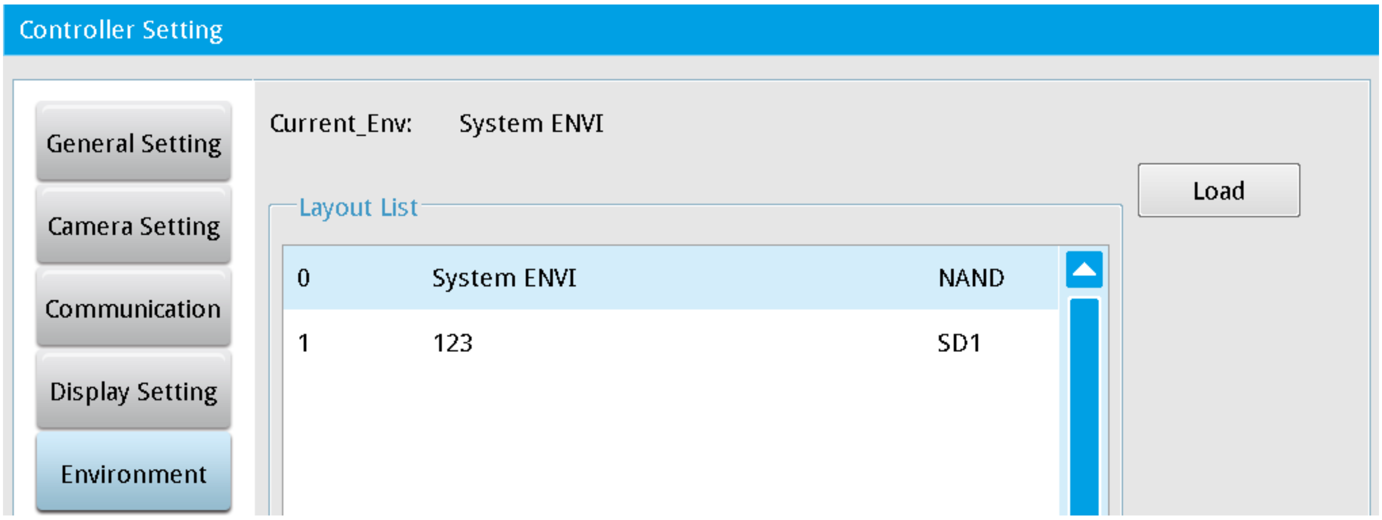
◎ **Show Ruler**

Visual aid displayed on the camera capture screen; the user can switch on or off according to inspection requirements.

3.4.5 Environment Setting

Current environment setting of the controller; always consists of only two storage options: system settings (common system setting for all inspection projects) of either storing in the controller or the inspection project.

Select the controller internal memory or the project to be inspected, press load, and save to complete the setup.



3.4.6 System Info.

This displays the current system data of the controller, including version, number and model of the connected camera(s), and capacities of controller internal memory and SD card memory.

◎ **Controller Version**

To optimize the operating condition of the controller, the following data on software version are displayed.

- MCU Version: Micro Controller Unit
- DSP Version: Digital Signal Processor
- FPGA Version: Field Programmable Gate Arrays

◎ **Camera Information**

According to varying models, DMV2000 can separately support 2, 4, and 8 cameras. This shows the number and models of cameras connected to the controller.

◎ **SD Information**

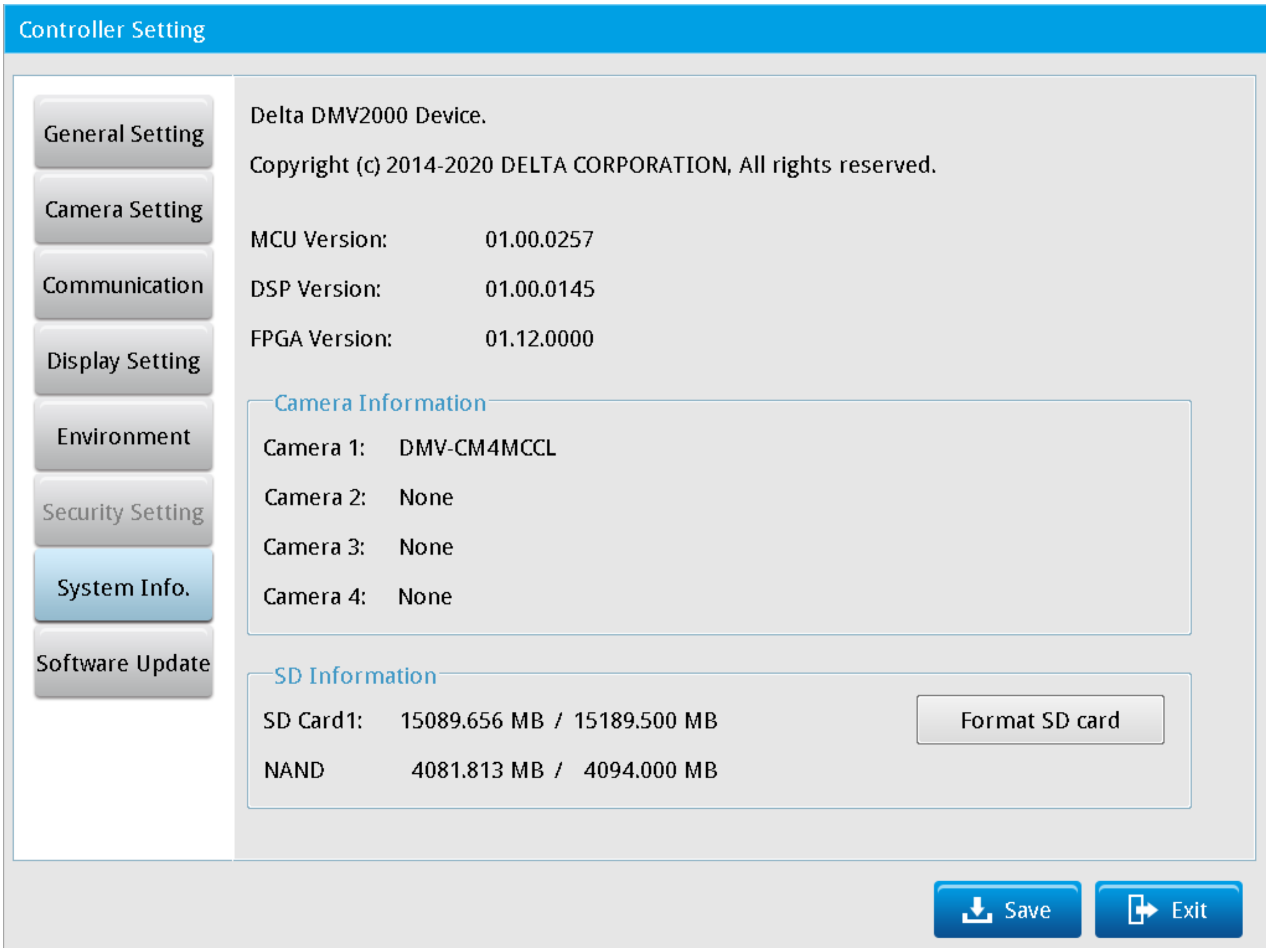
➤ SD Card 1

The left portion displays the remaining capacity of the memory card and the right portion displays the total capacity of the memory card.

[Format] can be selected to erase all data on the SD card.

➤ NAND

The left portion displays the remaining capacity of the controller internal memory and the right portion displays the total capacity of the controller internal memory.



3.4.7 Software Update

◎ **Quick Update**

Determines whether the current inspection project and controller version can be updated. (MCU, DSP, FPGA)

◎ **Full Update**

Directly updates the current inspection project and controller version. (MCU, DSP, FPGA)

◎ **Restore**

Restores the previous configured version before software burning. (MCU, DSP, FPGA)

Chapter 4

Inspection System and Process Settings

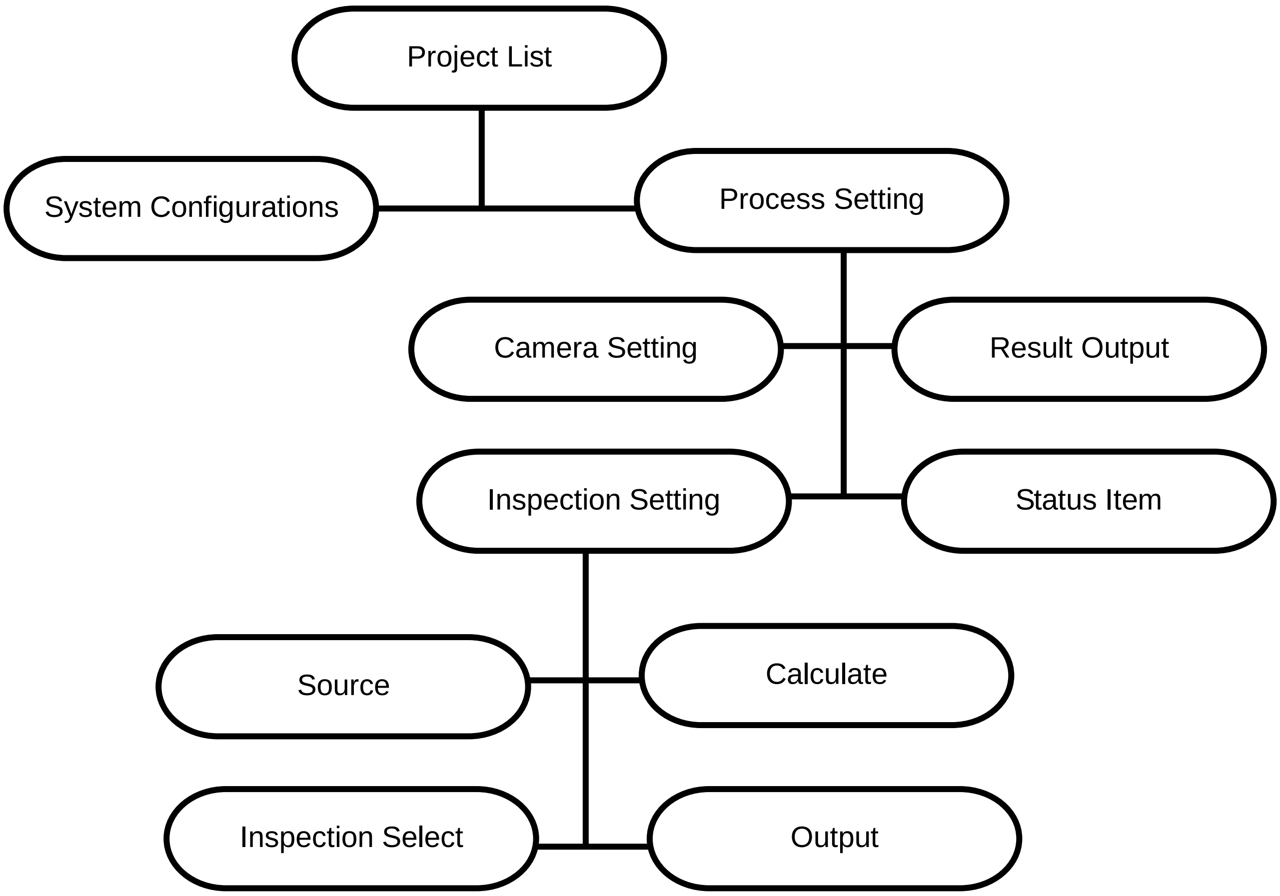
DMV2000 configures the inspection system using the flow scheme. After setting relevant parameters based on each process icon through the processing steps, the required inspection system project can be quickly created.

According to varying models, DMV2000 can separately connect 2, 4, and 8 cameras. Therefore, a single project can execute 8 parallel inspection processes. Additionally, the controller provides 1000 built-in projects in the internal memory and can be expanded to 9999 projects with SD card. Projects can be added, deleted, copied, renamed, and switched after creation.

This chapter explains the editing settings of the inspection process.

4.1 Process Editing and Setting

After adding a new [Project], flow process can be configured according to the number of connected cameras needed for the inspections.



4.1.1 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.

4.1.2 Inspection Process Setting

According to varying inspection requirements, each project can simultaneously execute 1~8 processes. The number of parallel processes must be configured when adding new projects. A single process must include [Camera], [Inspection], [Result Output], and [Status Item] and may contain up to 1000 [Inspection].

I. Flow Process Page

Attention must be paid to [Light Signal to the Right of the Flow Box], [Flow Box], and [Process Icon] when configuring flow processes. These items are explained as follows.

◎ **Light Signal to the Right of the Flow Box**

Orange light indicates setting incomplete; gray light indicates setting complete; red light indicates NG inspection result; blue light indicates OK inspection result.

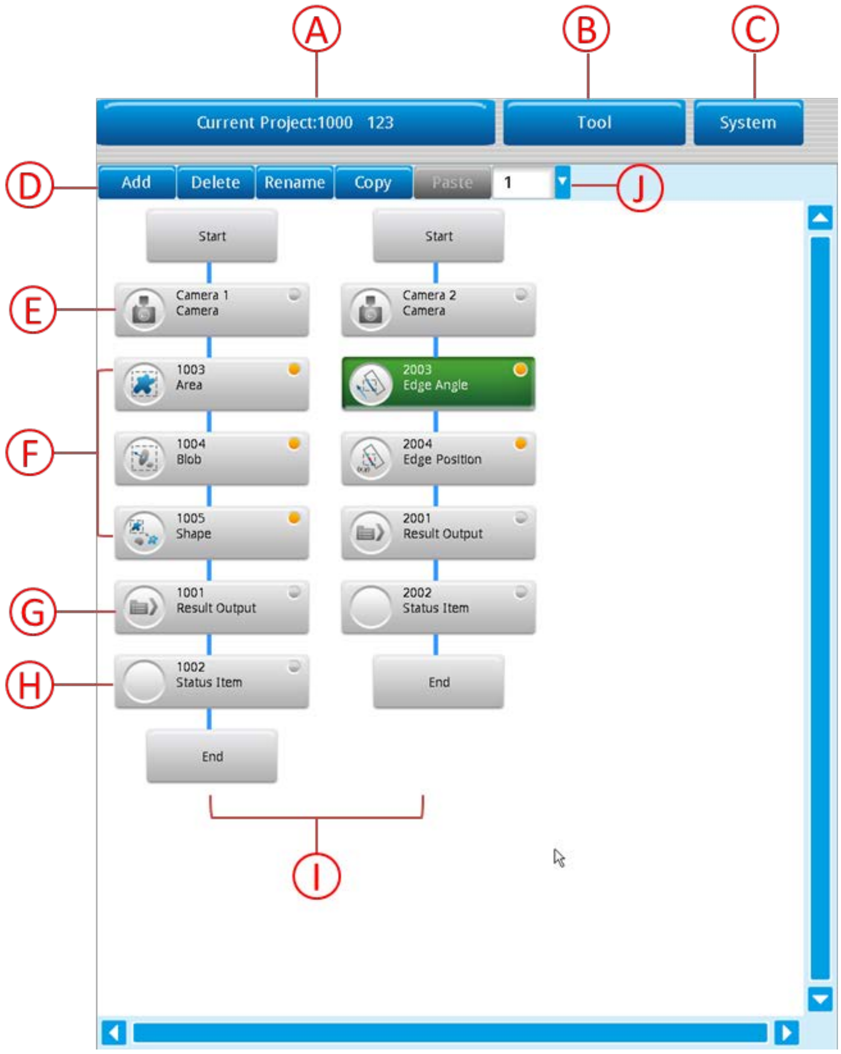
◎ **Flow Box**

Flow box must first be clicked to add, delete, rename, copy, or paste inspections. The order of flow boxes directly relates to the sequence of execution.

◎ **Process Icon**

Process icons must be clicked to enter each individual option setting.

The following illustrates a single project running 2 parallel processes.



A. Current Project

Displays the project name currently being configured for operation.

Reference Please refer to Section 3.2 for detailed project settings.

B. Tool

The mode and basis for executing project inspection; these include Register Image Management, Run Mode Screen Editing, and Judge Setting.

Reference Please refer to Section 3.3 for detailed tool settings.

C. System

The system consists of several configuration functions, including general setting, camera setting, communication setting, display setting, environment setting, security setting, and software update.

Reference Please refer to Section 3.4 for detailed system settings.

D. Add, delete, rename, copy, paste

A single inspection process may contain several inspections. These include Add, Delete, Rename, Copy, and Paste.

[Add]: Adds 1 inspection

[Delete]: Deletes the selected inspection

[Rename]: Identical inspections can be renamed for differentiation

[Copy]: Copies the selected inspection

[Paste]: The selected inspection can be pasted according to the placement order once copied.

E. Camera

Comprises 7 configuration items when entered: [Camera Setting], [White Balance], [ROI], [Trigger Setup], [Flash Setup], [Register Image], and [CCM Status].

Flow camera setting captures images according to the connected cameras. Each camera can be colored or gray-scaled. After connecting the camera, the controller will prompt whether to automatically detect camera model and specifications, which will automatically be downloaded after clicking the option. Flow camera can be configured according to inspection requirements or downloaded by directly checking [Reference System Setting].

Reference Please refer to Section 4.2 for detailed camera settings.

F. Inspection

Inspections can be added here according to project inspection requirements. A single process can contain 1000 inspections. For the order of inspections during project execution, move the mouse to the desired position of inspection order and click [add], [delete], [rename], [copy], and [paste] on the tool bar above, similar to the [add] operation.

Click the icon to the left of the inspection to enter inspection setting and complete configuring, in order, the 8 items of [Image Select], [ROI], [Color Condition], [Preprocess], [Parameter], [Limit], [Locate], and [Execute]. [Color Condition] is not required for gray-scale cameras.

Reference Please refer to Chapter 5 for the detail setup of inspections.

G. Result output

Select the inspection of the desired inspection result output and configure in the order of [Device Choose], [Data Output Priority], and [When No Storage].

Reference Please refer to Section 6.3 for the detail setup of result output.

H. Status Item

Select the inspection to be judged (OK/NG) during run mode.

Reference Please refer to Section 6.4 for the detail setup of status item.

I. Parallel Flow

The project can execute up to 8 parallel processes according to the number of cameras connected to the controller and the inspection requirements.

J. Parallel Flow Number

A maximum of 8 inspection processes can be configured as needed for a single inspection project. This displays the inspection flow number.

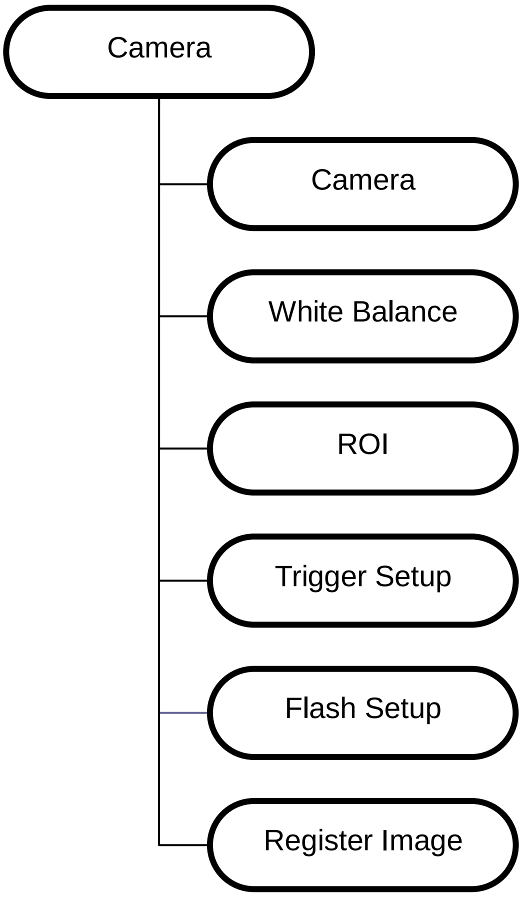
II. Edit Flow

After completing system settings in a project, the inspection flow process can be configured. The inspection flow process is configured based on individual project inspection requirements and can contain 1~8 process(es) for different projects. Flow editing is configured through the connected camera(s).

The following must be completed in order: [Camera] setting>[Inspection] setting>[Result Output]>[Status Light].

◎ **Camera**

Click the icon next to the camera to enter and configure the following settings.



Reference Please refer to Section 3.4.2 for the detail setup of [Camera], [White Balance], [ROI], [Trigger], and [Flash]. Please refer to Section 3.3.1 for the detail setups for [Register Image].

◎ **Add Unit**

➤ Source

Camera source; according to varying models, DMV2000 can contain [Camera 1]~[Camera 8].

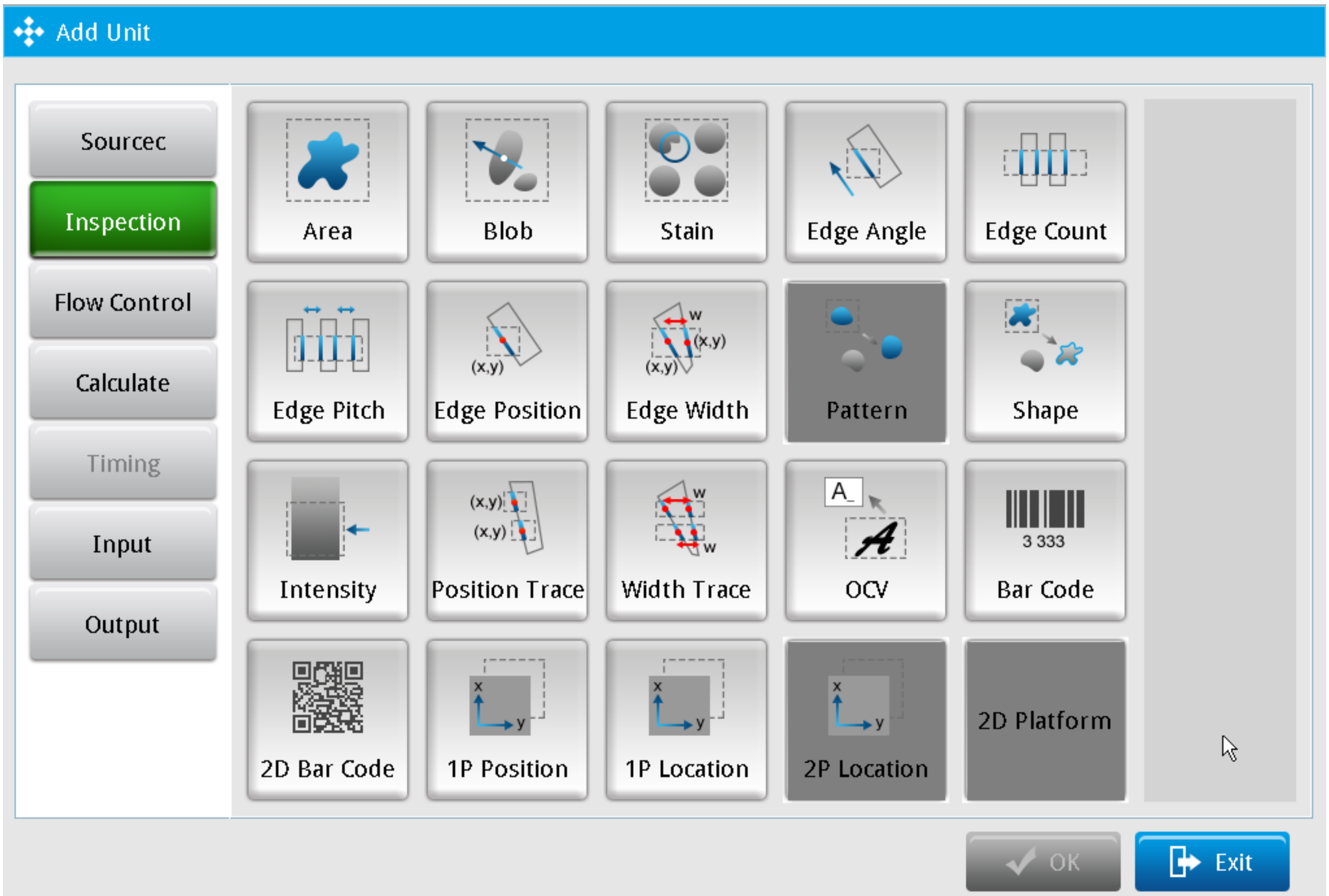
➤ Camera

Core of the project; configured according to inspection requirements; a single process can add up to 1000 inspections; the order of inspections is related to the sequence of project execution; select the subsequent item and click [Add] from above.

DMV2000 contains 20 inspections and the currently supported 17 units are [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], [1P Position], and [1P Location].

To complete adding a new inspection, the icons to the left must be clicked to configure [Image Select], [ROI], [Color Condition], [Preprocess], [Parameter], [Limit], [Locate], and [Execute].

Reference Please refer to Chapter 5 for detailed inspection settings.



➤ Calculate

Apply fundamental arithmetic operations and function calculations on data from [Inspection] to obtain new data, which will be provided for configuring subsequent [Output] options In addition, this new data can be restricted to the upper/lower limits in the calculator to output the calculator-specific logic flag and pass this result to the subsequent [Judge] and [Output] programs.

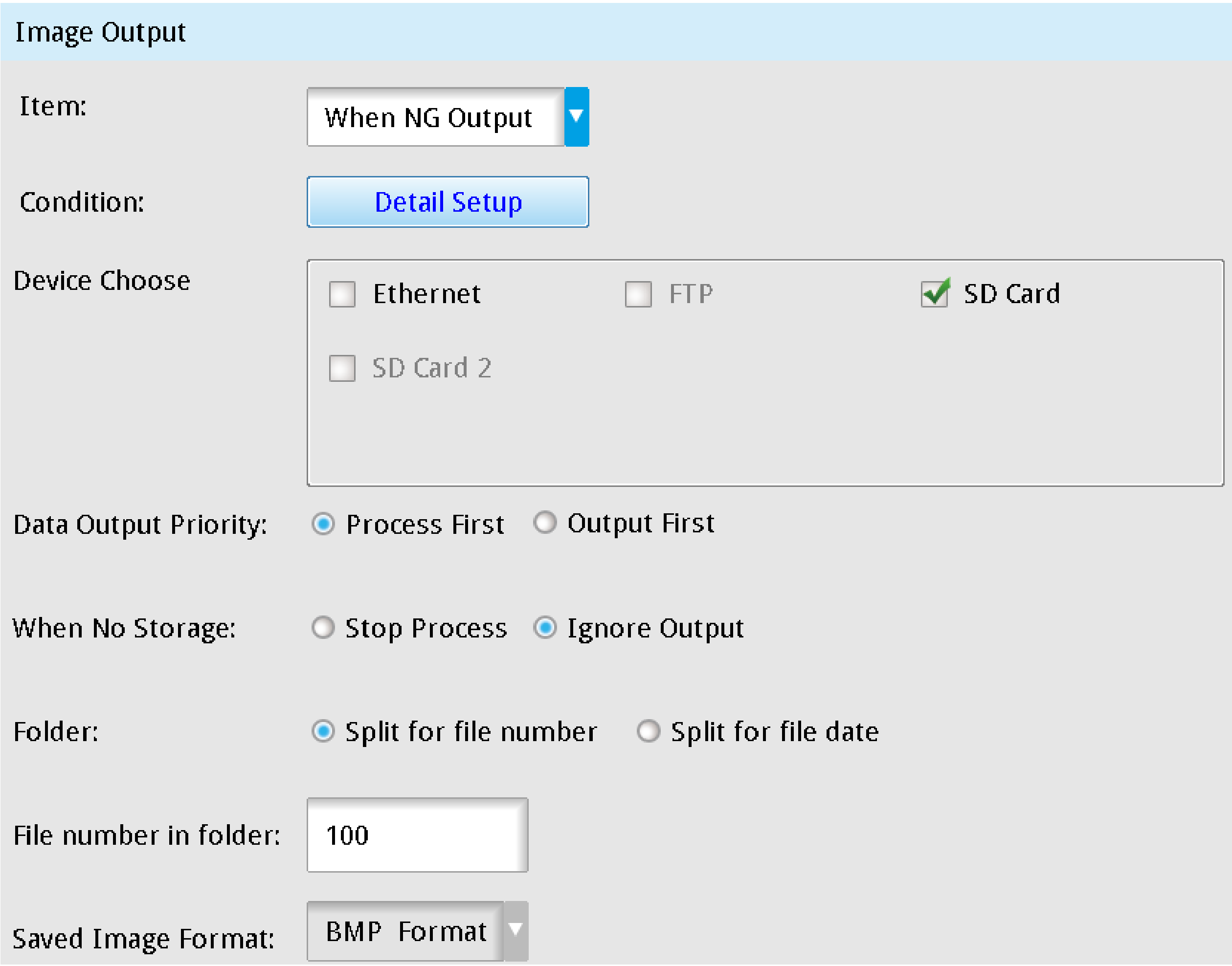
Reference Please refer to Chapter 6 for detailed calculation settings.

➤ Output

The user can choose to output the resulting numeric data of [Inspection] and [Calculate] and the logic flag of [Inspection], [Calculate], and [Judge] through any communication interface.

◆ [Image Output]: Select any hardware interface (Ethernet, SD card) to output the resulting contents Next, click [Detail Setup] and select the desired inspection output (OK/NG) screen during project execution.

The user can choose to configure the following settings.



[Item]

Select whether to output image when OK or NG.

[Condition]
Select the inspection to output image.

[Device Choose]
Select the hardware interface to output image: Ethernet/SD card.

[Data Output Priority]
Select the image output priority: Process First/Output First.
Process First: Directly continue project inspection before completing output to SD card.
Output First: Unable to trigger project inspection before completing output to SD card.

[When No Storage]
Select action when running out of memory for image output: Stop Process/Ignore Output.

[Folder]
Select storage method: Split for File Number/Split for File Date.

[Number of Folders]
Configured Value: 0~99999999.

[Saved Image Format]
Always save in BMP format.

◆ Internal Memory

DMV2000 provides 32 internal registers. The user can choose to configure [Constant], [Judge Value], and [Inspection Result Value], and directly load these configured values in the [Calculate] tool.

[Constant]

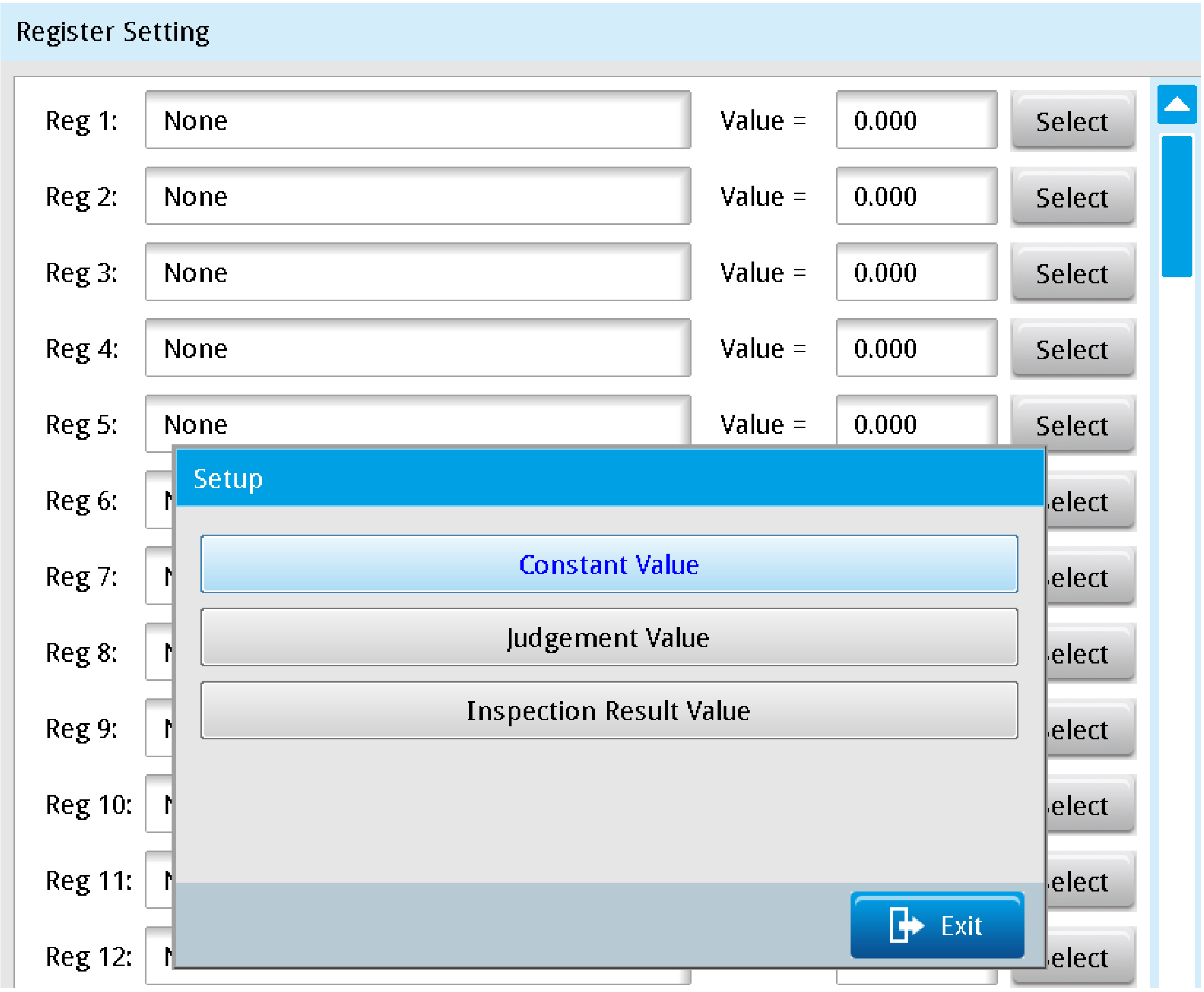
Set a fixed value.

[Judge Value]

Select the item (inspection) judge value: inspection result OK = 1 and NG = 0

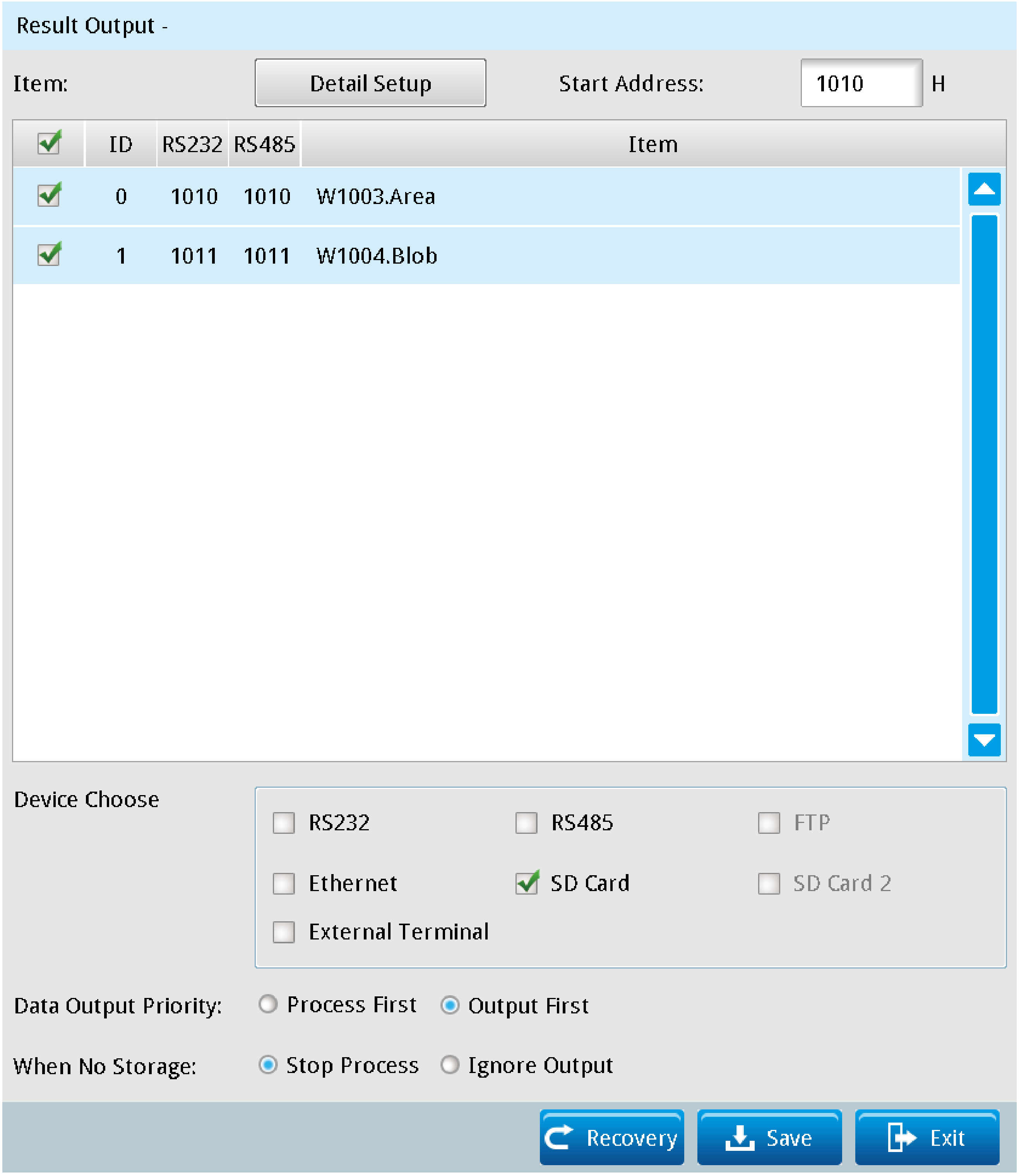
[Inspection Result]

Select the inspection result for numerical basis.



◎ **Result Output**

Click [Detail Setup], select the inspection of the desired inspection result output and configure in the order of [Device Choose], [Data Output Priority], and [When No Storage].



Remark Click [Restore] to restore initial settings. Click [Save] to save all modified parameters and values Click [Exit] to leave the setup page.

- Data Output Priority

When RS232 or RS485 is checked

Process First: Cannot output through RS232, RS485, Ethernet, SD card, and external terminals before SD card completes output

Output First: Stop reception trigger until SD card completes output

- When No Storage

1) When RS232 or RS485 is checked

Stop Process: When register runs out of space during SD card output, warning window appears and process stops.

Ignore Output: When register runs out of space during SD card output, inspection continues but unable to output result.

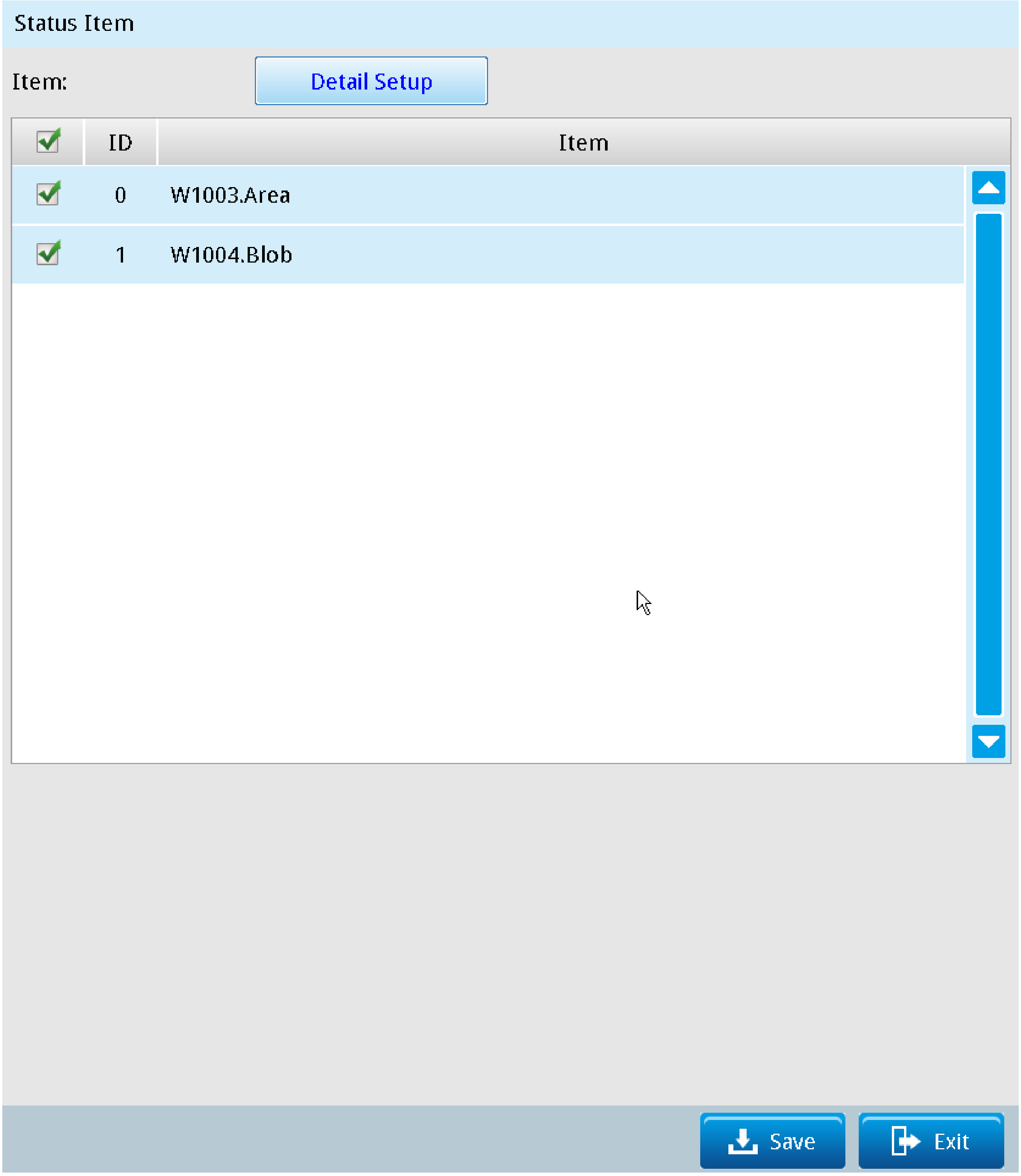
2) When SD Card is checked

Stop Process: When register runs out of space during SD card output, warning window appears and process stops.

Ignore Output: When register runs out of space during SD card output, inspection continues but unable to output result.

◎ **Status Item**

Click [Detail Setup], select the inspection to be judged (OK/NG) during run mode.

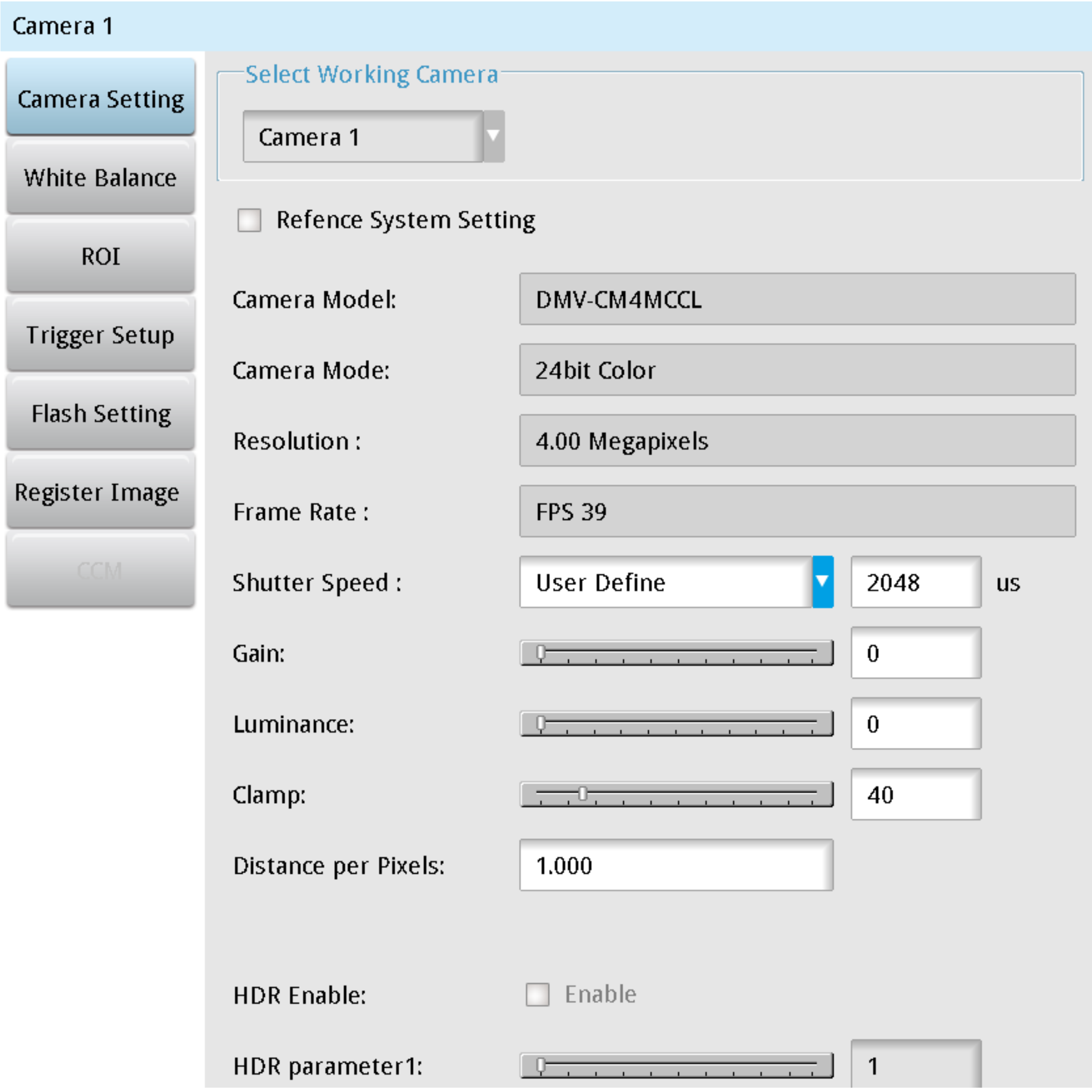


4.2 Flow Process Camera Setting

The flow process camera is configured according to individual inspection project requirements. The system camera is configured specifically for the cameras connected to the entire controller. System camera setting facilitates quick setup of flow process camera when adding new projects. Therefore, in the flow process camera setting, reference system camera setting can be checked to directly load or reset all configured values.

◎ **Camera Setting**

The flow process camera is configured specifically for a single flow process of an individual project. According to varying models, DMV2000 can connect up to 8 cameras, meaning configuring up to 8 flow process cameras. Each camera can be colored or gray-scaled. After connecting the camera, the controller will prompt whether to automatically detect camera model and specifications, which will automatically be downloaded after clicking the option.



- Reference System Setting

After checking the option, all configured values will be automatically loaded with identical system configurations.

- Camera Model

After connecting the camera, the system automatically detects.

- Camera Mode

After connecting the camera, the system automatically detects.

- Resolution

After connecting the camera, the system automatically detects.

- Frame Rate

After connecting the camera, the system automatically detects.

- Shutter speed

The desired shutter setting (default is user defined) is selected through a layout list. The user is free to set the required shutter time here. Longer shutter time increases exposure and the amount of light absorbed and is suited for occasions of insufficient lighting.

- Gain

Range: 0~255; higher gain results in a brighter image but is prone to generate noise.

- Brightness

Range: 0~10; higher brightness results in a brighter image but actual luminosity variation is less than gain adjustment.

- Clamp

Range: 0~255; higher Clamp value results in a brighter image but actual luminosity variation is less than brightness adjustment.

- Distance/Pixel

Actual pixel and screen ratio.

- HDR

Range: 0~254; only suitable for gray-scale cameras; low parameter value results in a low exposure and can only develop whitish and overexposed outlines; regions of denser black pixels on the original image become darker.

◎ **White Balance Setting**

Restores the colors of the selected image and calibrates the colors. Drag the white balance region to the white position on-screen and select Auto Setting.

➤ The result of calibrated white balance is shown as follows.

➤ Inspection Region

Displays the X and Y coordinates (X0, Y0) and (X1, Y1) of the white balance region; the image shows the deviation from the color tone corrected based on the white reference of the region.

Remark Click [Reset] to reposition and resize the selected region for white balance.

➤ Average RGB in Region

Calculates the RGB pixels within the selected region for white balance.

➤ White Balance Coefficient

Range: 0~1; larger value results in a larger color density When the three values obtained by multiplying the white balance coefficient with the RGB average within the region are similar, the color within the inspected region is close to white.

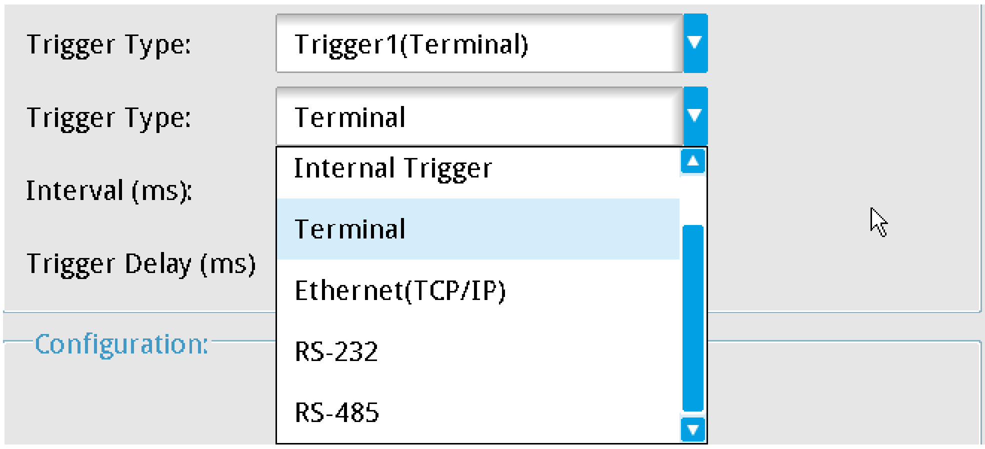
Remark Click [Auto Setting] and the system will automatically adjust the white balance coefficient according to the selected region.

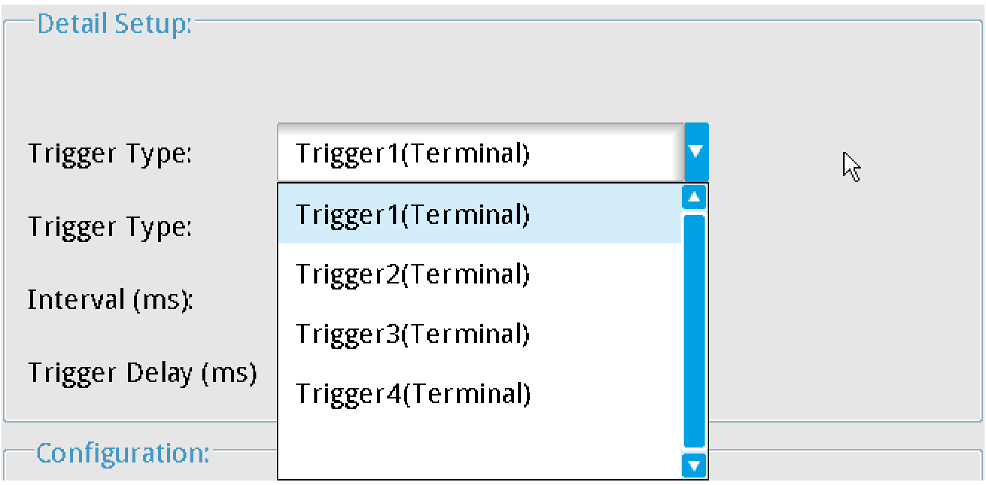
◎ **ROI**

Captures images in the selected range; saves image processing time during inspections and measurements; users can adjust the size of the inspection region according to need.

◎ **Trigger Setup**

The setup of trigger inspection processes is divided into the 5 triggers of external terminal, internal trigger, Ethernet, RS-232, and RS485. A single inspection process can be triggered by up to 4 types of triggers.





➤ Reference System Setting

After checking the option, all configured values will be automatically loaded with identical system configurations.

➤ External Trigger

Triggered by external device through varying interfaces, a single inspection process can be configured to be triggered by up to 4 types of triggers.

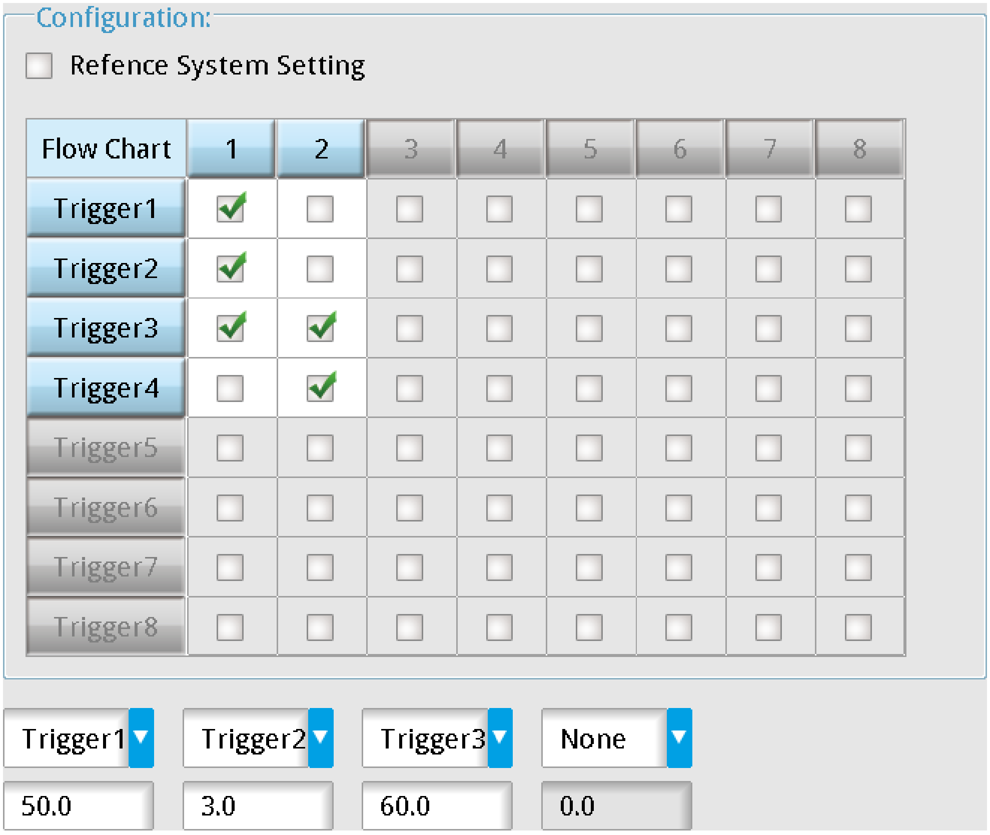
1) External Terminal: Input trigger signal using I/O to execute process inspection.
2) RS232: Input communication command through the serial interface to execute process inspection.
3) RS485: Input communication command through the serial interface to execute process inspection.
4) Ethernet: Input communication command through the Ethernet interface to execute process inspection.

➤ Internal Trigger

Can only be setup on Trigger 1; automatically triggers according to the configured time; suitable for applications requiring timed inspections.

[Interval (ms)] and [Trigger Delay (μs)] are items for setting timed inspections.

The user can choose to configure the following settings.



- Reference System Setting

After checking the option, all configured values will be automatically loaded with identical system configurations.

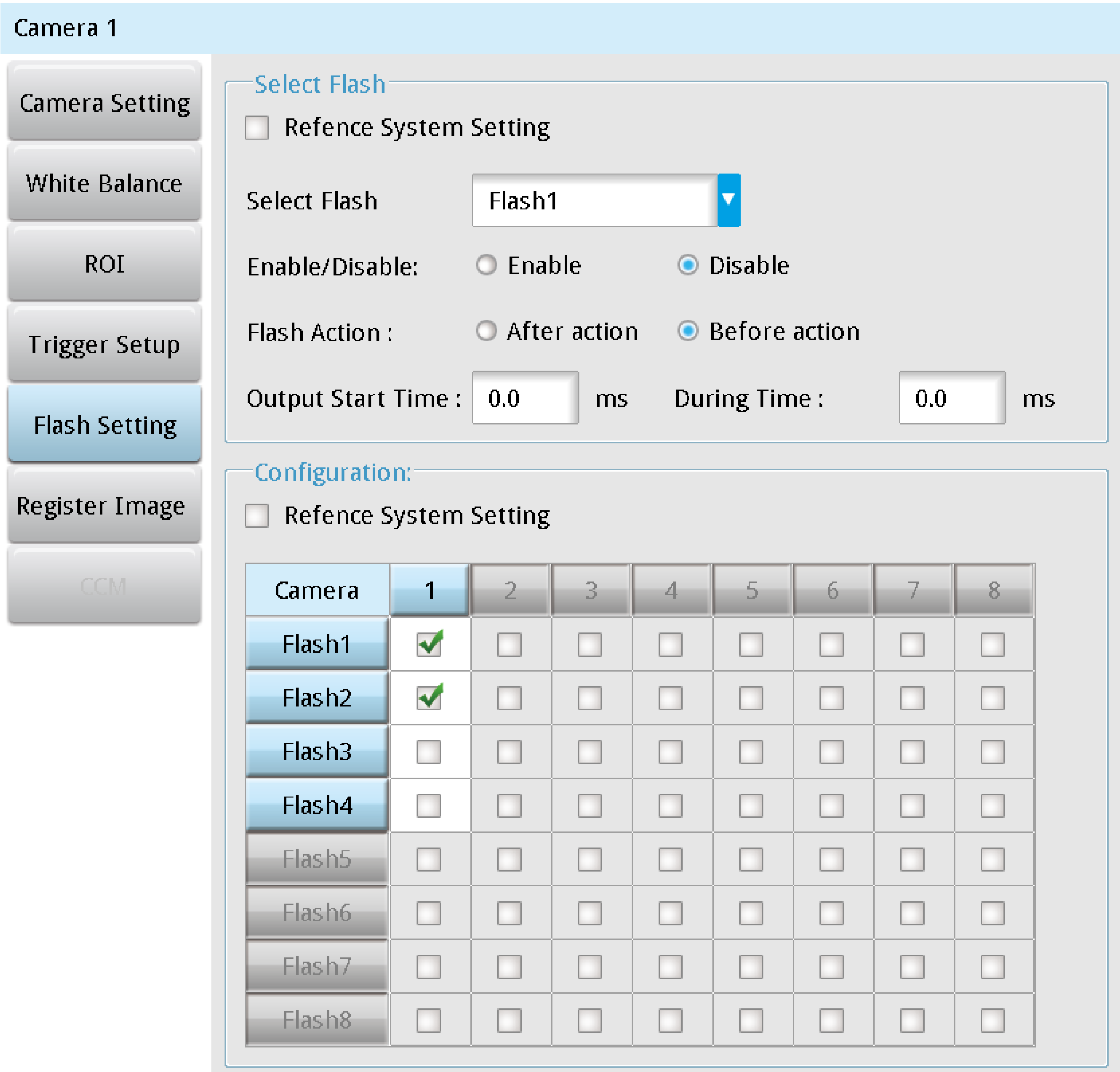
- Lower Combined Field

Range: 0~9999; unit in µs; configures interval for each trigger.

◎ **Flash Setup**

Flash controls the lighting output in sync with the camera shutter when capturing images. According to varying model numbers, DMV2000 can connect up to 8 cameras. Therefore up to 8 flash can be configured. Multiple flash can be configured for the same process or different processes.

Users can choose to configure the following settings according to inspection requirements.



- Enable/Disable

Flash can only be turned on when [Enable] is selected.

- Flash Action

[After Action]: Flash activates only after camera shutter engages [Before Action]: Flash activates only before camera shutter engages.

- Output On Time

Sets the delay time between flash and shutter; the timing depends on the [After Action] and [Before Action] settings.

For example: Setting value is [10 ms]

1) When set to [After Action], the shutter first activates to capture image after the input of capture trigger signal; then, the flash activates after 10 ms according to the delay setting.
2) When set to [Before Action], the flash first activates after the input of capture trigger signal; then, the shutter activates after 10 ms according to the delay setting. (generally recommended method)

- During Time

Total flash duration

To ensure that the flash can first activate and hold for a certain duration when shutter activates during image capture, the [During Time] setting must be greater than the sum of [Output On Time] and [Shutter Time].

Reference

Please refer to Section 7.2.2 for the detail setup of status item.

◎ **Register Image**

When executing inspections, the image of interest must first be registered here, so that the inspected image can match its configurations. Here, [Register Image] is the register image management for a single flow process and can store, rename, delete, and copy the images captured by the connected camera. To register image, complete camera configuration and click on [Register Image]. When clicked on [Live Update], the camera captures live images. The user can confirm whether the camera captured the image that meets inspection requirements.

- Image Source

Capture source of image register; always capture from the camera.

- Camera

No options available here; only the cameras connected to the process is displayed.

➤ Image List

Image list displays the registered images according to [Camera 1]~[Camera 8]. ID numbers start from 1000 to 8000.

[All]: After checking the option, the [Camera] selection in [Display and Capture Setting] becomes disabled and the image list will display the captured and registered images of all cameras connected to the controller.

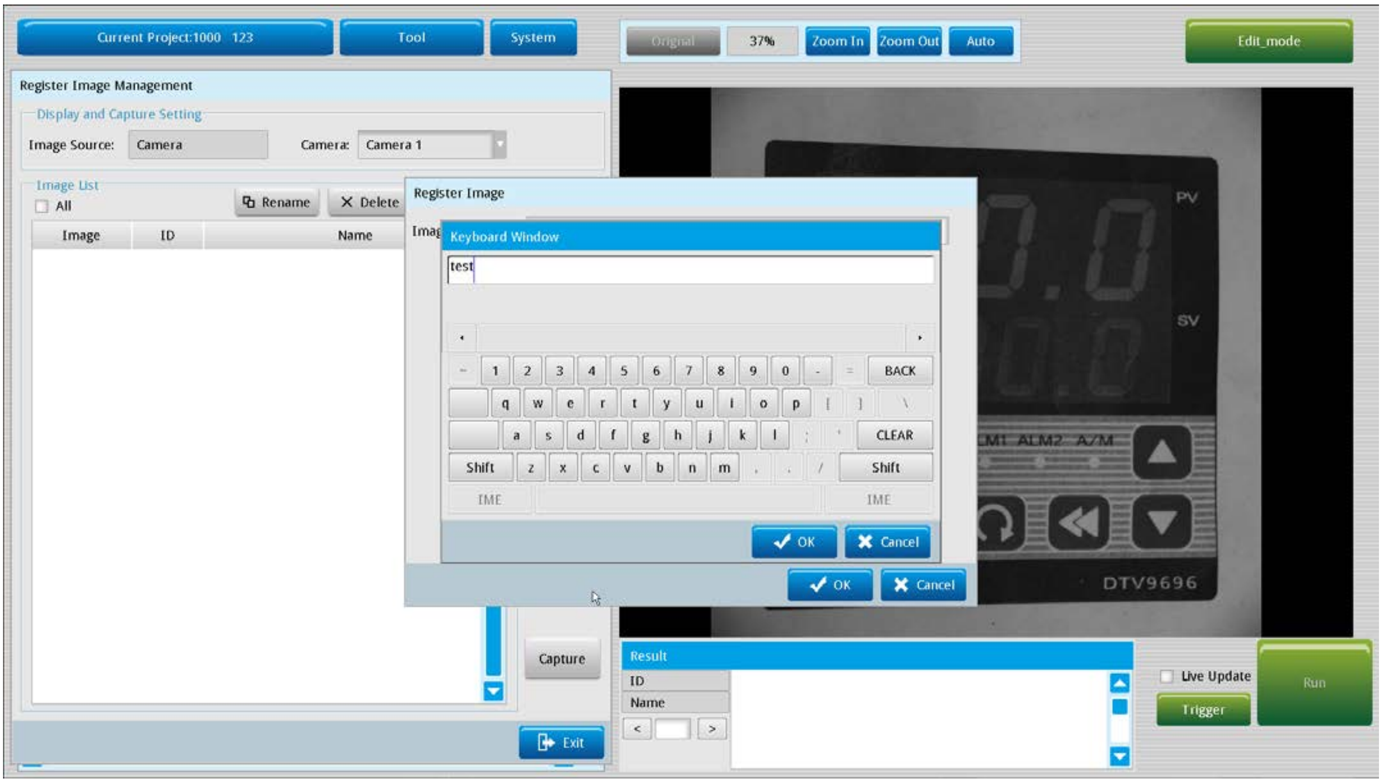
[Rename]: Select the image to be renamed and click to rename the image.

[Delete]: Select the image to be deleted and click to delete the image.

[Copy]: Select the image to be copied; enter the number of copies desired in the prompt window after clicking the option.

1) When making more than 2 copies, "-1" and "-2" (and so on) will be added to the name of the copies. For example, the original image is named "ABC" and the modified name of the copy is "XXX", and the number of copies is set to 3, the last 3 copied images are named "XXX-1", "XXX-2", and "XXX-3".

2) When making a single copy, "-1" will not be generated. If the original image is named "ABC", the modified name of the copy is "XXX", and the number of copies is set to 1, the last copied image is named "XXX".



After completing register image, the screen displays the following image.

4.3 Draw ROI

When creating each new inspection, the user must drag and select the range of image to be inspected, which is commonly referred to as ROI (region of interest). The ROI can be configured as follows.

- Each setting in [Inspection]>[ROI]>[Region]
- Each setting in [Inspection]>[ROI]>[Region Mask]

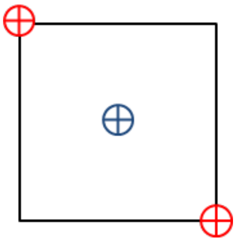
Due to the differing requirements of various selected image regions, the following different shapes of ROI are provided

- Rectangle
- Circle
- Polygon
- Ellipse
- Circle
- Arc
- Rotation rectangle

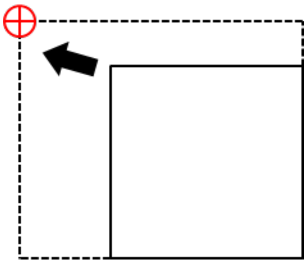
4.3.1 Draw Rectangle

Follow the steps below to draw the rectangle.

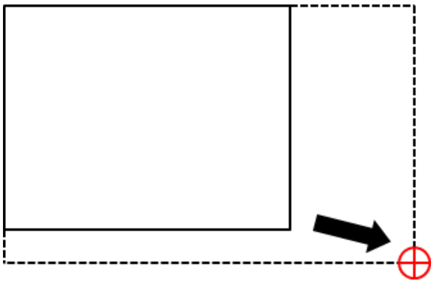
1) Initial status of the rectangle shows the central crosshair and the 2 upper and lower vertices. Click using the left mouse button and drag the central crosshair of the rectangle to move the entire object.

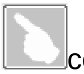


2) Click the left mouse button on the upper left crosshair to adjust the position of the upper vertex and select the inspection region.

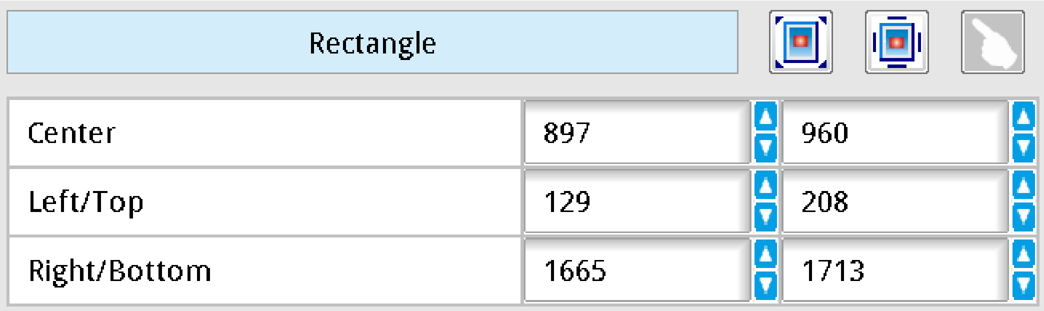


3) Click the left mouse button on the lower right crosshair to adjust the position of the lower vertex and select the inspection region.



4) Lastly, click the central crosshair or  complete setting the coordinate positions of the rectangle.

5) The aforementioned Steps 1) ~ 4) can be applied in coordination with data on the right as reference for adjusting numerical values.

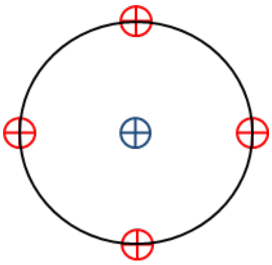


Remark : Represents restore initial configured value. : Represents maximum range ROI.

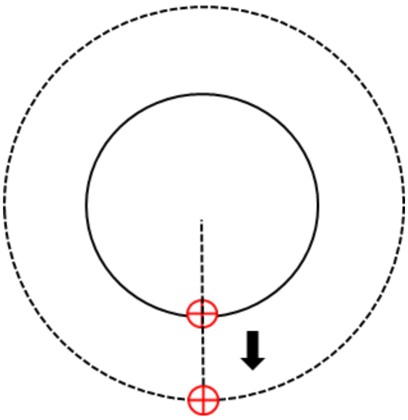
4.3.2 Draw Circle

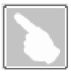
Follow the steps below to draw the circle.

1) Initial status of the circle shows the central crosshair and 4 vertices at the top, bottom, left, and right .Click the crosshair at the center of the circle using the left mouse button to move the entire object.

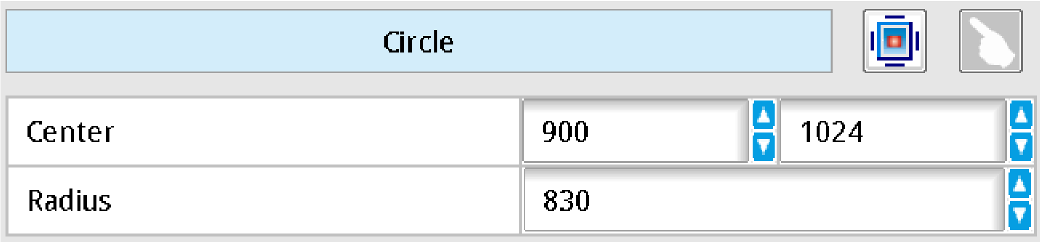


2) Click the left mouse button to select any vertex from the 4 vertices to adjust vertex position and select inspection range.



3) Lastly, click the central crosshair or  to complete setting the coordinate positions of the circle.

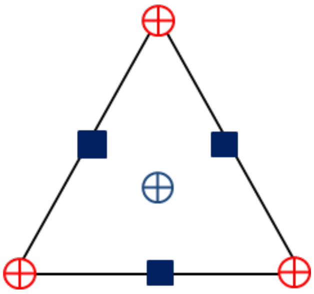
4) The aforementioned Steps 1)~3) can be applied in coordination with data on the right as reference for adjusting numerical values.



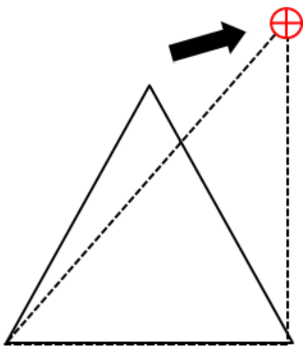
4.3.3 Draw Polygon

Please follow the steps below to draw the polygon. (up to a maximum of 15 sides or a pentadecagon)

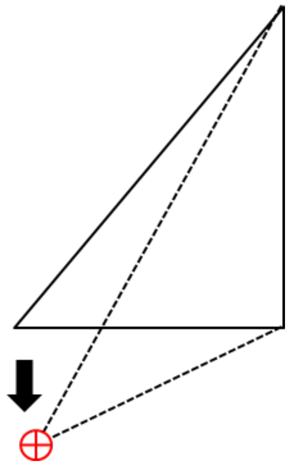
1) Initial status of the polygon shows the central crosshair, 3 vertices, and 3 edges. Click the crosshair at the center of the polygon using the left mouse button to move the entire object.



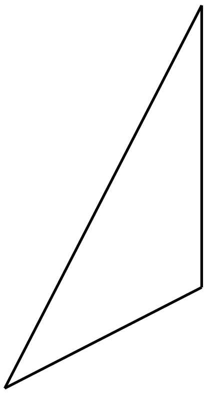
2) Click the left mouse button to select any one vertex (1st vertex) from the 3 vertices, adjust vertex position, drag to the desired range, and then click the left mouse button again to locate.



3) Click the left mouse button to select any one vertex (2nd vertex) from the 3 vertices, adjust vertex position, drag to the desired range, and then click the left mouse button again to locate.

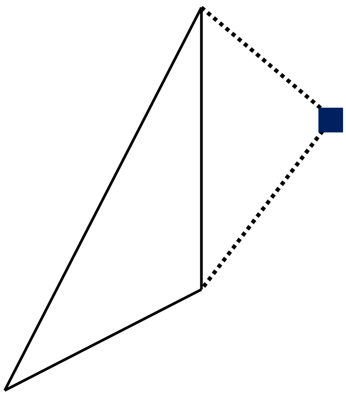


4) After locating all vertices in the desired inspection region, the user can also adjust each vertex position and coordinate display according to the table to the right.

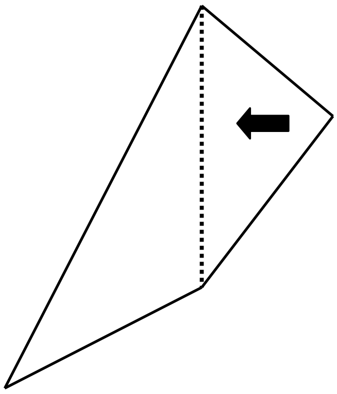


5) Click the " " on any edge to add the 4th vertex in coordination with each vertex position and coordinate display on the right, drag to the desired inspection range, and then click the left mouse button to complete the vertex setting Or, select from each vertex position and coordinate displayed on the right to add vertices.

6) Follow the aforementioned Steps 1)~4) to adjust the required polygon.



7) Same as Step 5); click the vertex to be deleted and click the right mouse button to delete or select from each vertex position and coordinate displayed on the right to delete vertices.



8) Lastly, click the central crosshair or to complete setting the coordinate positions of the polygon.

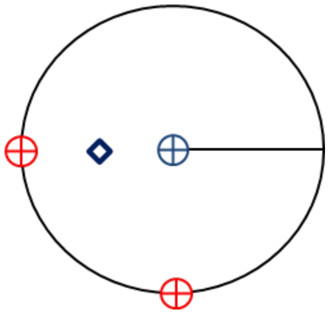
9) The aforementioned Steps 1)~8) can be applied in coordination with data on the right as reference for adjusting numerical values.

Polygon				
Center	967	991		
Pt01	1023	512		
Pt02	1467	1279		
Pt03	580	1280		
Pt04	801	896		

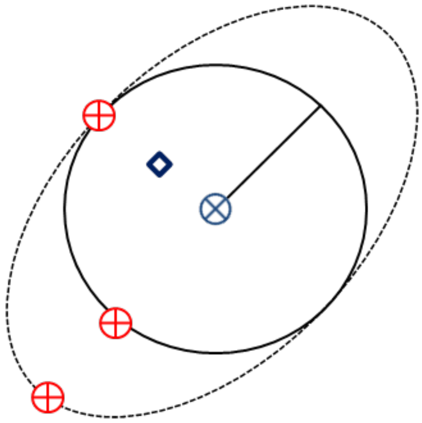
4.3.4 Draw Ellipse

Please follow the steps below to draw the ellipse.

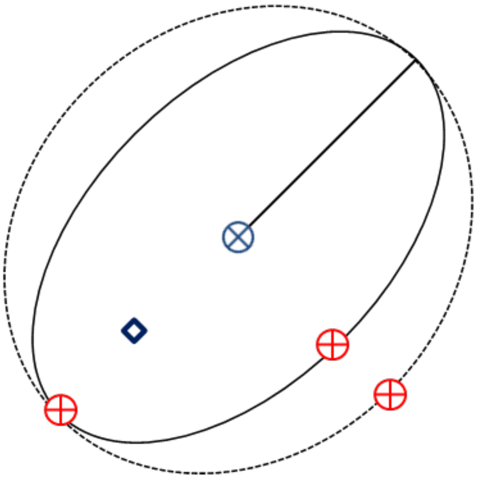
1) Initial status of the ellipse shows the central crosshair, small square in the ellipse, and the straight line and the bottom and left vertices corresponding to the small square. Click the crosshair at the center of the circle using the left mouse button to move the entire object.



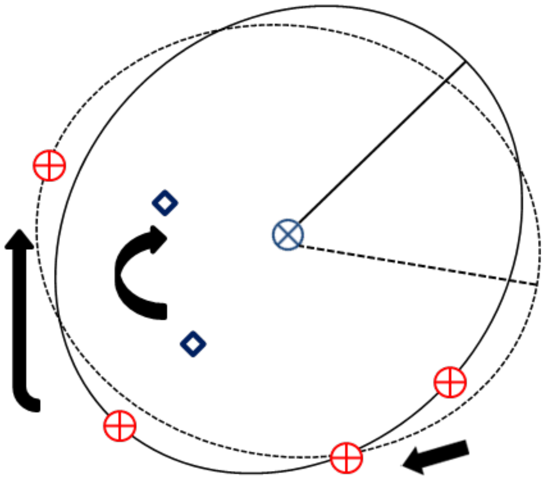
2) Click the left mouse button to select one vertex to adjust the width of the ellipse in the corresponding direction.

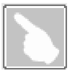


3) As explained in Step 2), click the left mouse button on the other vertex to adjust the width of the ellipse in the other corresponding direction.



4) Click the left mouse button on the small square and drag to rotate the angle of the ellipse.



5) Lastly, click the central crosshair or  to complete setting the coordinate positions of the ellipse.

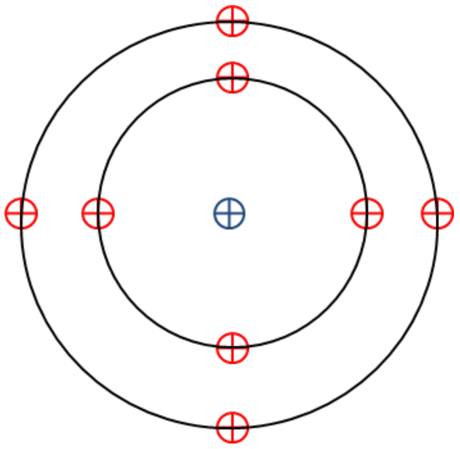
6) The aforementioned Steps 1)~5) can be applied in coordination with data on the right as reference for adjusting numerical values.

Ellipse		
Center	900	912
Horizontal Axis	538	
Vertical Axis	574	
Angle	22	

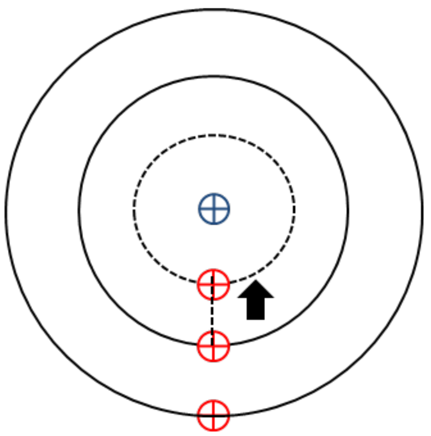
4.3.5 Draw Ring

Please follow the steps below to draw the ring.

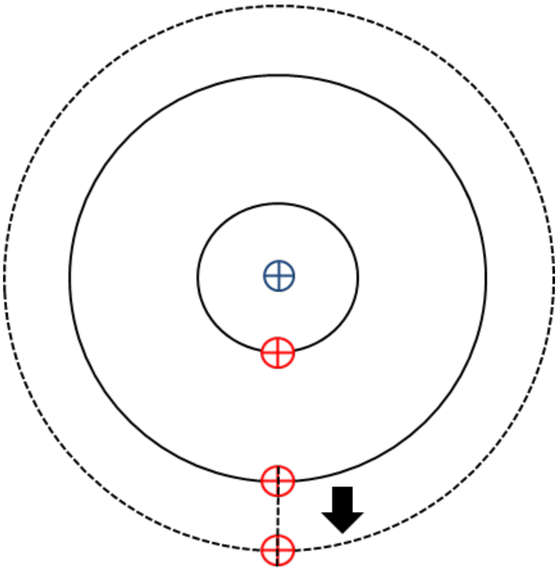
1) Initial status of the ring shows the central crosshair, 4 inner ring vertices, and 4 outer ring vertices. Click the crosshair at the center of the ring using the left mouse button to move the entire object.

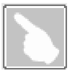


2) Click the left mouse button on the bottom vertex of the inner ring to adjust the inner ring radius.

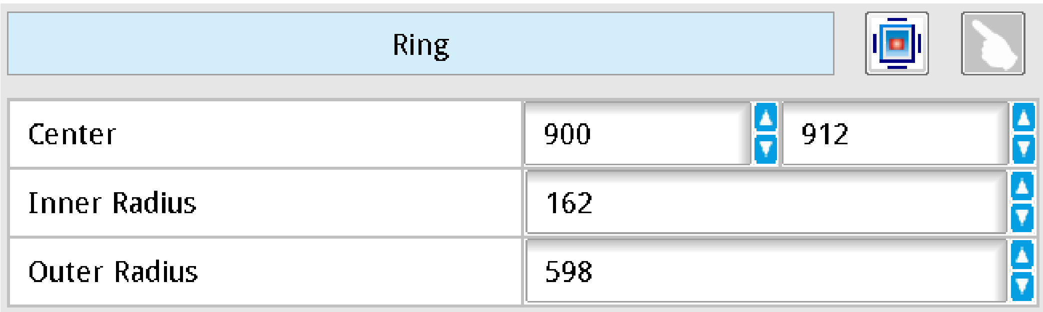


3) Click the left mouse button on the bottom vertex of the outer ring to adjust the outer ring radius.



4) Lastly, click the central crosshair or  to complete setting the coordinate positions of the ring.

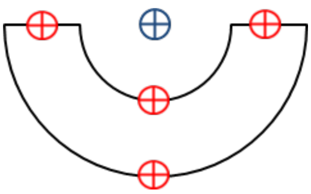
5) The aforementioned Steps 1)~4) can be applied in coordination with data on the right as reference for adjusting numerical values.



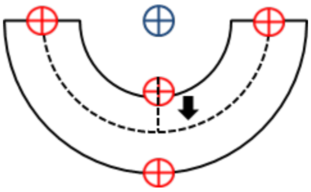
4.3.6 Draw Arc

Please follow the steps below to draw the arc.

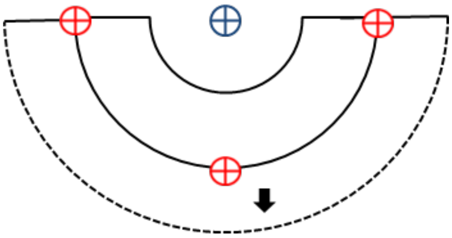
1) Initial status of the arc shows the central crosshair, inner arc vertex, outer arc vertex, and the 2 centroids of the lines connecting the inner and outer arc. Click the crosshair at the center of the ring using the left mouse button to move the entire object.



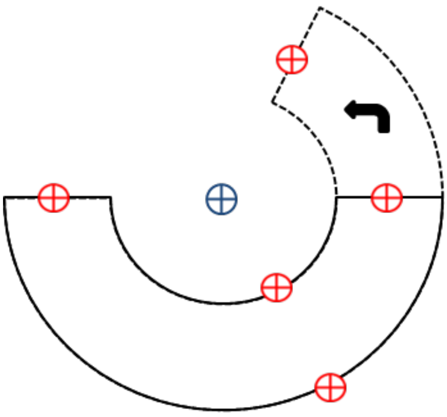
2) Click the left mouse button on the bottom vertex of the inner ring to adjust the inner ring radius.

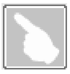


3) Click the left mouse button on the bottom vertex of the outer ring to adjust the outer ring radius.

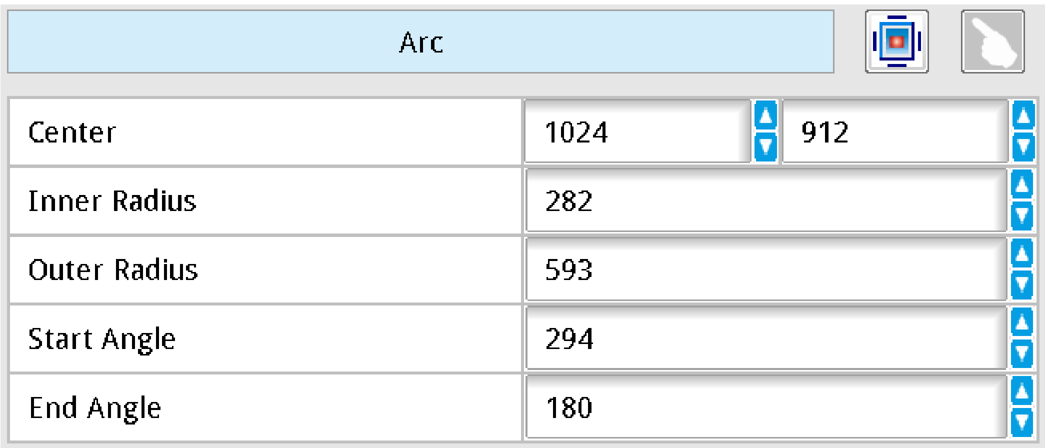


4) Click the left mouse button on one of the 2 centroids of the lines connecting the inner and outer arc to adjust the arc angle.



5) Lastly, click the central crosshair or  to complete setting the coordinate positions of the arc.

6) The aforementioned Steps 1)~5) can be applied in coordination with data on the right as reference for adjusting numerical values.

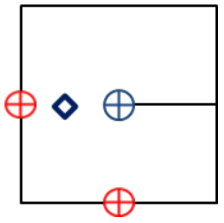


Arc		
Center	1024	912
Inner Radius	282	
Outer Radius	593	
Start Angle	294	
End Angle	180	

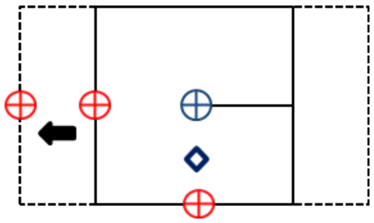
4.3.7 Draw Rotated Rectangle

Please follow the steps below to draw the rotated rectangle.

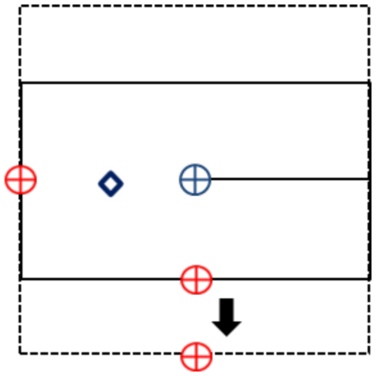
1) Initial status of the rotated rectangle shows the central crosshair, small square in the rectangle, and the straight line and the bottom and left vertices corresponding to the small square. Click using the left mouse button and drag the central cross point of the rectangle to move the entire object.



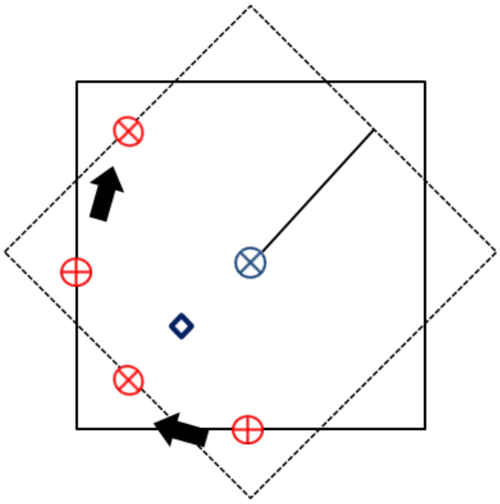
2) Click the left mouse button to select one vertex to adjust the width of the rectangle in the corresponding direction

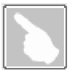


3) As explained in Step 2), click the left mouse button on the other vertex to adjust the width of the rectangle in the other corresponding direction

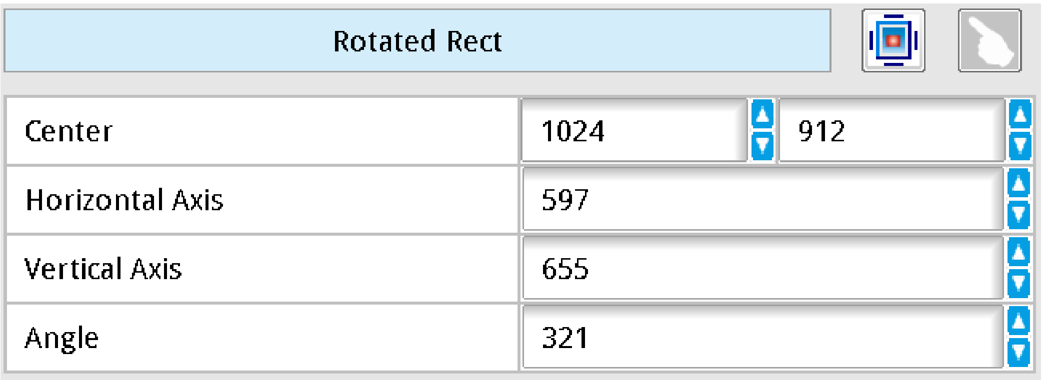


4) Click the left mouse button on the small square and drag to rotate the angle of the rectangle.



5) Lastly, click the central crosshair or  to complete setting the coordinate positions of the rectangle.

6) The aforementioned Steps 1) ~5) can be applied in coordination with data on the right as reference for adjusting numerical values.



Rotated Rect		
Center	1024	912
Horizontal Axis	597	
Vertical Axis	655	
Angle	321	

4.4 Add Inspections and Overview of Functions

According to the number of cameras connected, DMV2000 can execute up to 8 parallel processes. A single process can configure a maximum of 1000 inspections, which can be added, deleted, copied, renamed, and switched according to need.

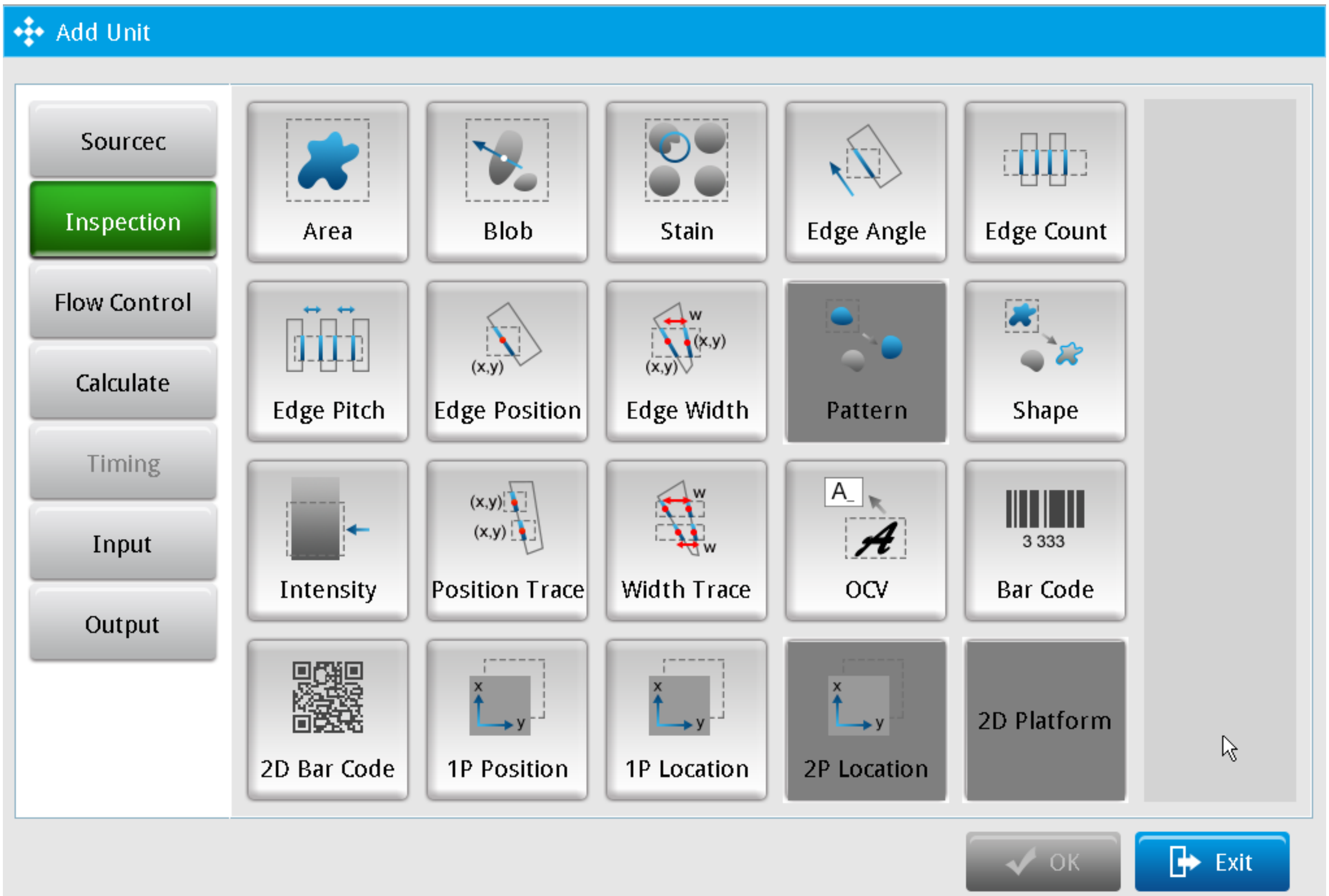
1) [Add]: Adds 1 inspection
2) [Delete]: Deletes the selected inspection
3) [Rename]: Identical inspections can be renamed for differentiation
4) [Copy]: Copies the selected inspection
5) [Paste]: The selected inspection can be pasted according to the placement order once copied.

4.4.1 Inspections

Vision inspection items can be categorized as "counting numbers", "detecting stains", "locating coordinates", and "measuring dimensions" according to the application. Therefore, to satisfy various vision inspection applications, DMV2000 provides diversified inspection tools, so that users can select accordingly to satisfy various inspection requirements. During the application process, stable and complete vision inspections rarely complete through a single inspection in the inspection system but require simultaneous judgment through several inspection tools to complete the process.

For example, when measuring the dimensions of moving objects, the coordinates of locating tools, such as [Edge Position] or [Shape], must first be configured to ensure stability and accuracy of the measurements. This describes the coordinated execution between inspection and locating functions.

However, please first pay attention to the characteristics and targets of the items to be detected before designing the vision inspection system, as the run length of each inspection may vary. Choosing the optimal method and combination will not only improve system stability but also decrease inspection time and improve productivity.



Tool (1) Area

In the configuration region, the function calculates the number of black or white pixels. Through a binary method, the function converts the image so that it consists of only black and white layers for measurements. When the numbers of pixels agree with the configured range, the inspection result is OK. Contrarily, when the number of pixels exceeds the configured range, the inspection result is NG.

Tool (2) Blob

Through a binary method, the function converts the image so that it consists of only black and white layers for measurements, and then calculates groups of black and white pixels. When the configured range is satisfied, the group of pixels is defined as a blob. The number, area, and coordinates of a blob can be detected.

Tool (3) Stain

When the inspected object has stains in a fixed direction, such as scrapes and smears, the stain tool can be used for detection.

Tool (4) Edge Angle

The function finds the 2 edges formed through brightness changes on a gray-scaled image, scans horizontally or vertically to obtain the coordinates of the 2 edges and draw a straight line, and calculates the angle of inclination of the straight line against the horizontal axis.

Tool (5) Edge Count

The function inspects whether image brightness variation agrees with the configured value. If the number of edges agrees with the configured range, the inspection result is determined OK. Contrarily, when the function fails to detect the number of edges that agree with the configured range, the inspection result is determined NG.

Tool (6) Edge Pitch

Edge Pitch is an enhanced function of Edge Width and is capable of measuring multiple widths instead of just between two edges. The individual width, max width, min width, and average width can be calculated.

Tool (7) Edge Position

The function finds edges formed by brightness variations in gray-scale images. Two edges are obtained through horizontal or vertical scanning. When the brightness variation agrees with the configured values and the function obtains the X and Y axes, the inspection result is determined OK. Contrarily, when the function fails to detect brightness variations that agree with the configured values, the inspection result is determined NG.

Tool (8) Edge Width

The function finds the plural edges formed by brightness variations in gray-scale images and calculates the edge widths, which are obtained by finding either the outer or inner edges through horizontal or vertical scanning. When the brightness variation agrees with the configured range limit for width measurements, the inspection result is determined OK. Contrarily, when the measured width disagrees with the configured range limit, the inspection result is determined NG.

Tool (9) Shape

The 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 compares its similarity with the default sample. In general, the shape tool is recommended to be executed 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 (10) Intensity

Intensity measures the "Maximum Intensity", "Minimum Intensity", "Average Intensity", and "Standard Deviation of Intensity" of all gray-scale pixels in the region of inspection.

Tool (11) Position Trace

The function enhances Edge Position, which can only find 2 edges. Position Trace searches edge positions of brightness variations that agree with the measured widths through horizontal or vertical scanning, and can find multiple edge positions on the same surface and output the coordinates.

Tool (12) Width Trace

The function enhances Edge Width and obtains distances between edges by searching outer or inner edges through horizontal or vertical scanning, and can output the maximum and minimum distances measured. Width Trace can measure the maximum, minimum, and average widths and check whether they agree with the range limit.

Tool (13) OCV

A dictionary is established to determine whether the input strings in the region of inspection agree with the configured threshold. When the scanned input string agrees with the configured value, the inspection result is determined OK. Contrarily, when the scanned input string disagrees with the configured value, the inspection result is determined NG. DMV2000 currently supports "Upper and Lower Case English Characters (A~Z)" and "Number 0~9", and "Symbol:"

Tool (14) Bar Code

The function reads 1D bar codes by searching for a valid 1D bar code in the ROI. Once detected, the bar code is decoded and output as the result. When the scanned bar code agrees with the configured value, the inspection result is determined OK. Contrarily, when the scanned bar code disagrees with the configured value, the inspection result is determined NG.

Tool (15) 2D Bar Code

The function reads 2D bar codes by searching for a valid 2D bar code in the ROI. Once detected, the bar code is decoded and output as the result. When the scanned bar code agrees with the configured value, the inspection result is determined OK. Contrarily, when the scanned bar code disagrees with the configured value, the inspection result is determined NG.

Tool (16) 1P Position

The coordinate units of machine vision and devices (i.e., mechanical arms) are in pixels and actual physical units (i.e., mm), respectively. When machine vision is coordinated with these devices, the coordinate conversion matrix (CCM) is configured to convert between the coordinate systems.

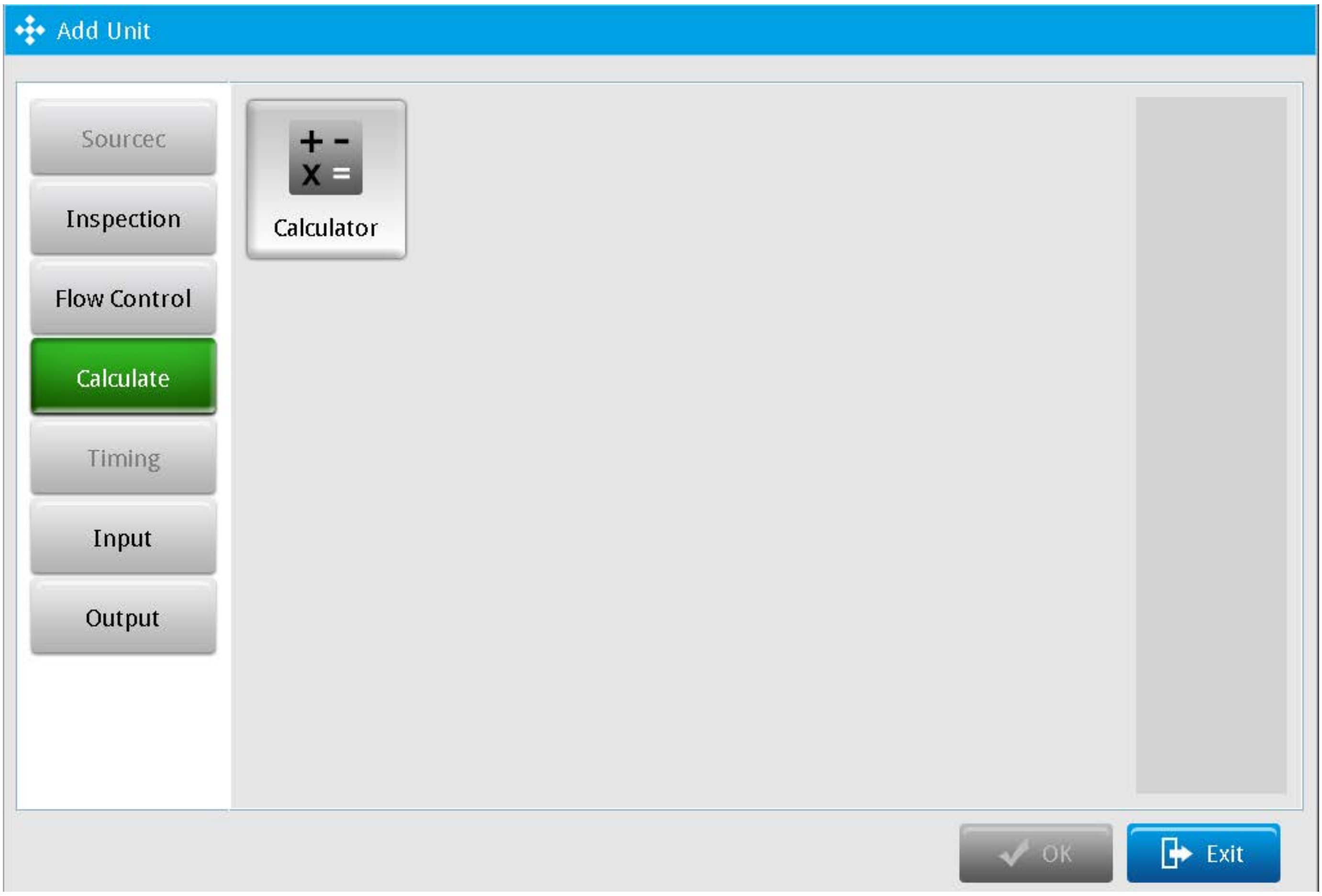
Tool (17) 1P Position

The coordinate units of machine vision and devices (i.e., mechanical arms) are in pixels and actual physical units (i.e., mm), respectively. When machine vision is coordinated with these devices, the CCM is configured to convert between the coordinate systems. Offset is then calculated for positioning.

4.4.2 Calculate, Input, and Output

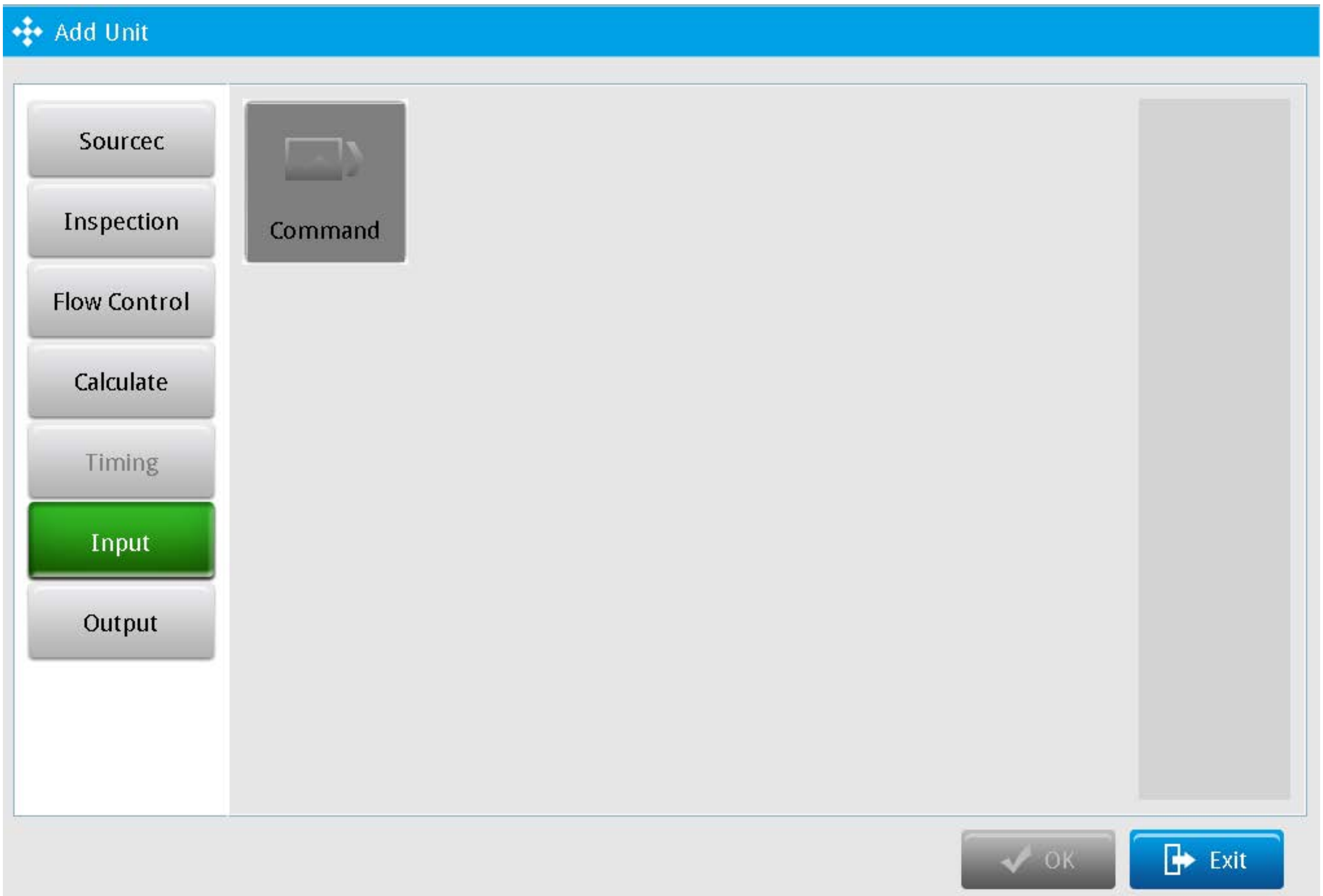
In [Add Unit], [Calculate], [Output], and [Inspection] are configured by clicking on [Add], [Delete], [Rename], and [Copy] during the inspection process.

◎ **Calculate**

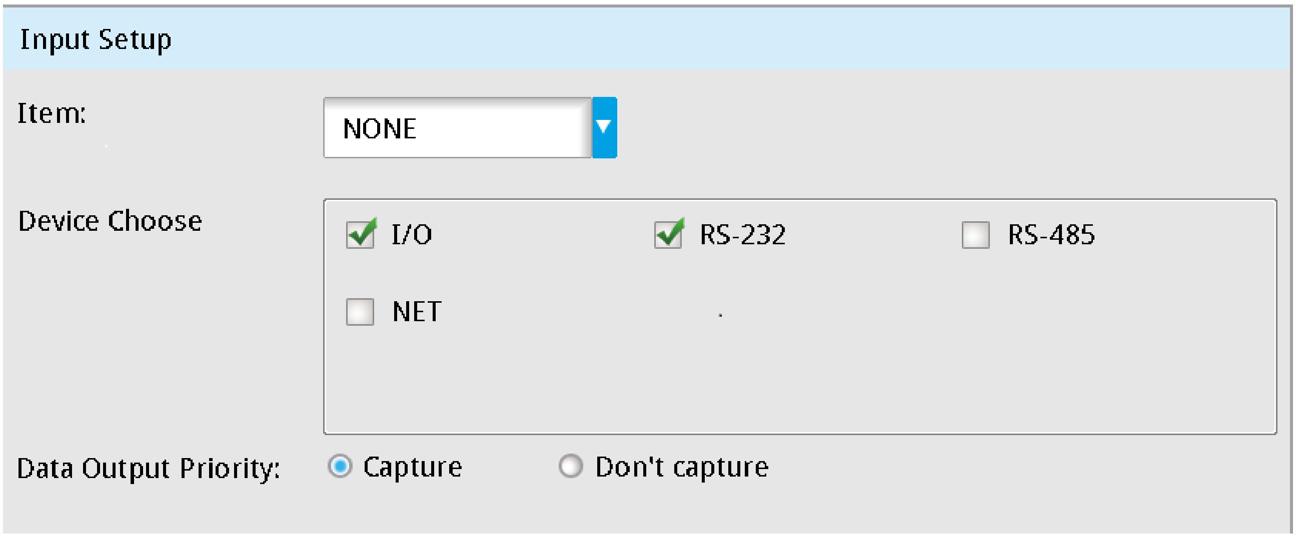


Apply fundamental arithmetic operations and function calculations on data from [Inspection] after completing the inspection process to obtain new data, which will be provided for configuring subsequent [Output] options. In addition, this new data can be restricted to the upper/lower limits in the calculator to output the calculator-specific logic flag and pass this result to the subsequent [Judge] and [Output] programs.

◎ **Input**



Input is the signal controlling process inspections, which can be split through [Command Input] to configure multiple inspection objects in a single flow process. Therefore, the system can execute multiple inspections without connecting multiple cameras.



➤ Item

[NONE] or [WTR1]~[WTR8] The option configures INPUT signal sources in coordination with [External Terminal] from the Device Setting in System Setting.

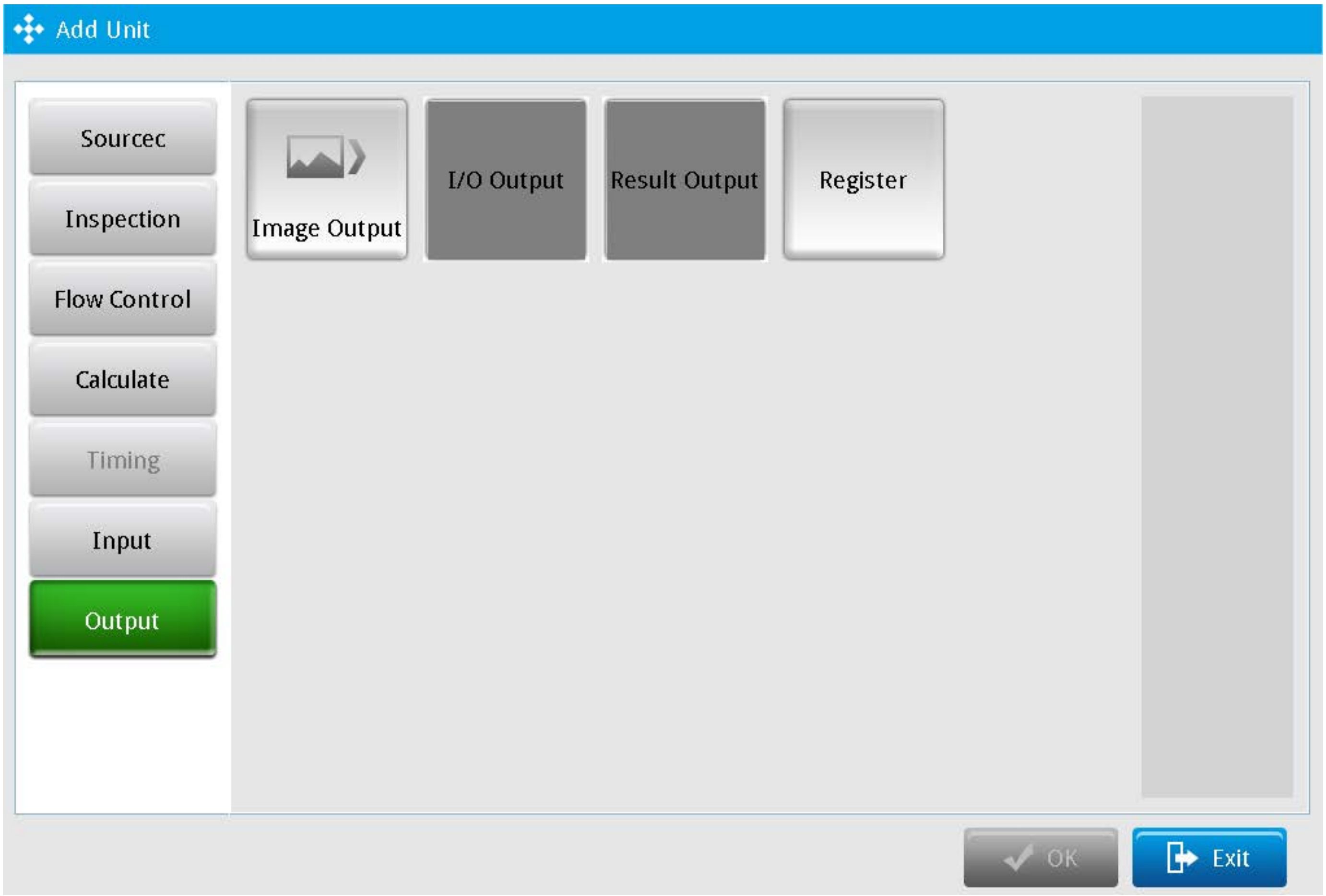
➤ Device Choose

The function provides the option of inputting signal sources from [I/O], [RS232], [RS485], or [NET] communication interfaces.

➤ Data Output Priority

The function prompts whether to recapture image when the flow process receives the continue inspection signal.

◎ **Output**

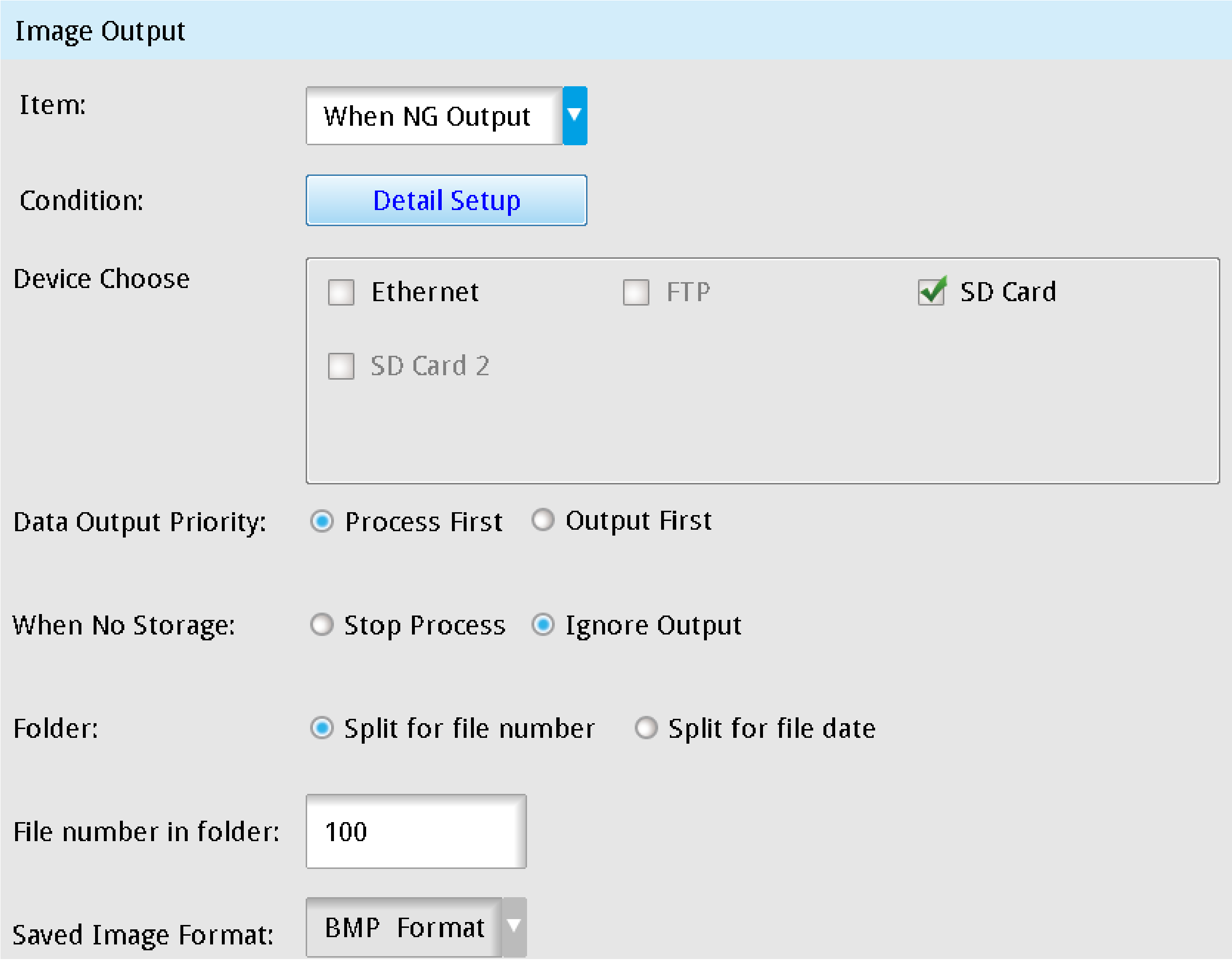


The user can choose to output the resulting numeric data of [Inspection] and [Calculate] and the logic flag of [Inspection] and [Calculate] through any communication interface (i.e., RS232, RS485, I/O, and Ethernet).

➤ Image Output

Select any hardware interface (Ethernet, SD card) to output the resulting contents Next, click [Detail Setup] and select the desired inspection output (OK/NG) screen during project execution

The user can choose to configure the following settings.



◆ [Item]

Select whether to output image when OK or NG

◆ [Condition]

Select the inspection to output image

◆ [Device Choose]

Select the communication output interface to output content

◆ [Data Output Priority]

Select the image output priority: Process First/Output First.

When RS232 or RS485 is checked

Process First: After the inspection is complete but before output to SD card is finished, RS232, RS485, Ethernet, SD card, and external terminal cannot output when TRIG triggers inspection signal input.

Output First After the inspection is complete but before output to SD card is finished, trigger reception is disabled when TRIG triggers inspection signal input until output to SD card is complete.

◆ [When No Storage]

Select action when running out of memory for image output: Stop Process/Ignore Output.

1) When RS232 or RS485 is checked

Stop Process: When data is being output to SD card and the output register space is insufficient, a warning window will appear and all subsequent trigger and inspection processes will stop.

Ignore Output: When data is being output to SD card and the output register space is insufficient, the system continues the inspection processes but will not output the inspection results.

2) When SD Card is checked

Stop Process: When data is being output to SD card and the output register space is insufficient, a warning window will appear and all subsequent trigger and inspection processes will stop.

Ignore Output: When data is being output to SD card and the output register space is insufficient, the system continues the inspection processes but will not output the inspection results.

◆ Folder

Select storage method: Split for File Number/Split for File Date.

◆ [Number of Folders]

Configured Value: 0~99999999

◆ [Saved Image Format]

Always save in BMP format

➤ Register

DMV2000 provides 32 internal registers. The user can choose to configure [Constant], [Judge Value], and [Inspection Result Value], and directly load these configured values in the [Calculate] tool.

◆ [Constant]

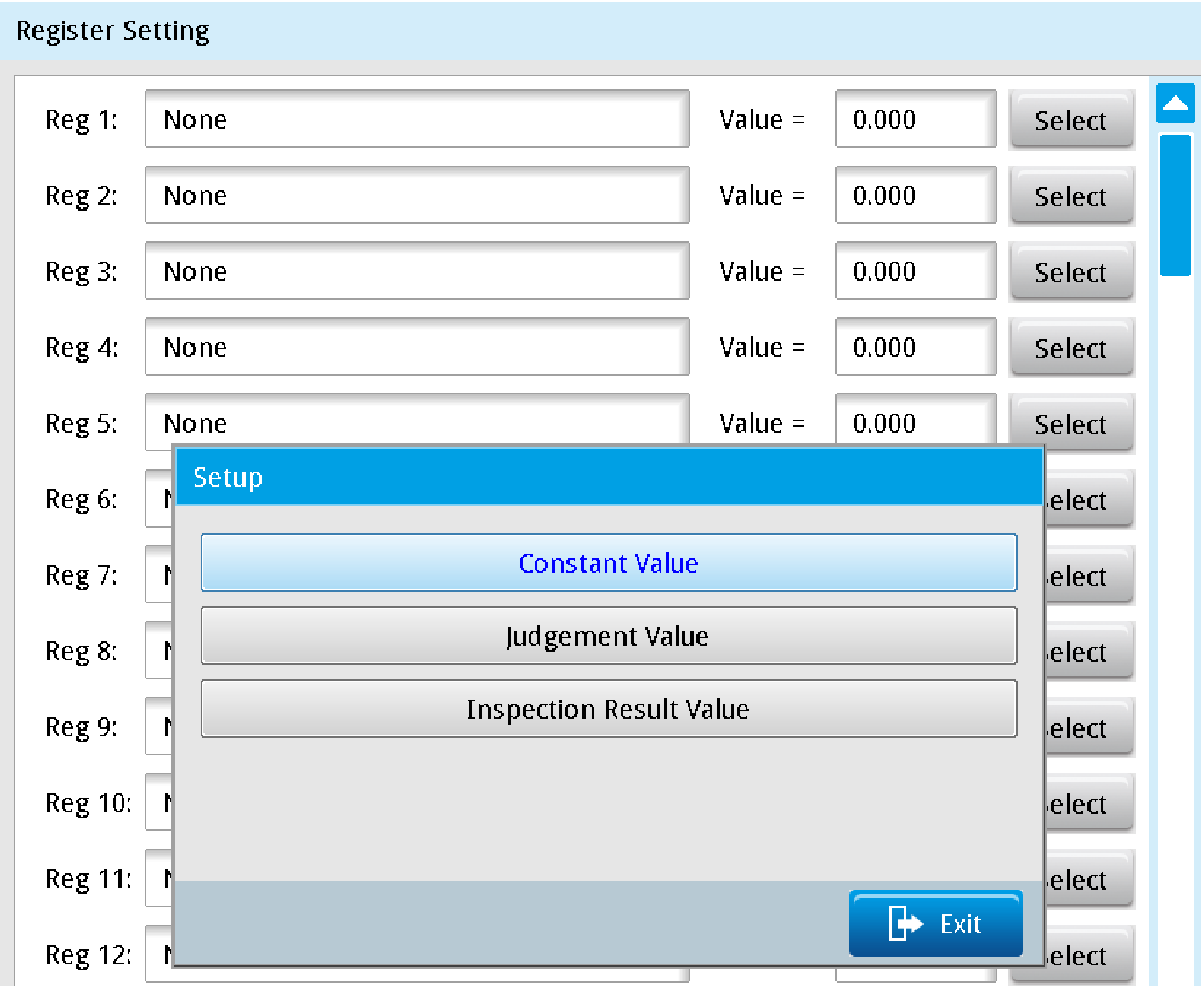
Set a fixed value.

◆ [Judge Value]

Select the item (inspection) judge value: inspection result OK = 1 and NG = 0

◆ [Inspection Result]

Select the inspection result for numerical basis.



4.5 Result Output and Status Light

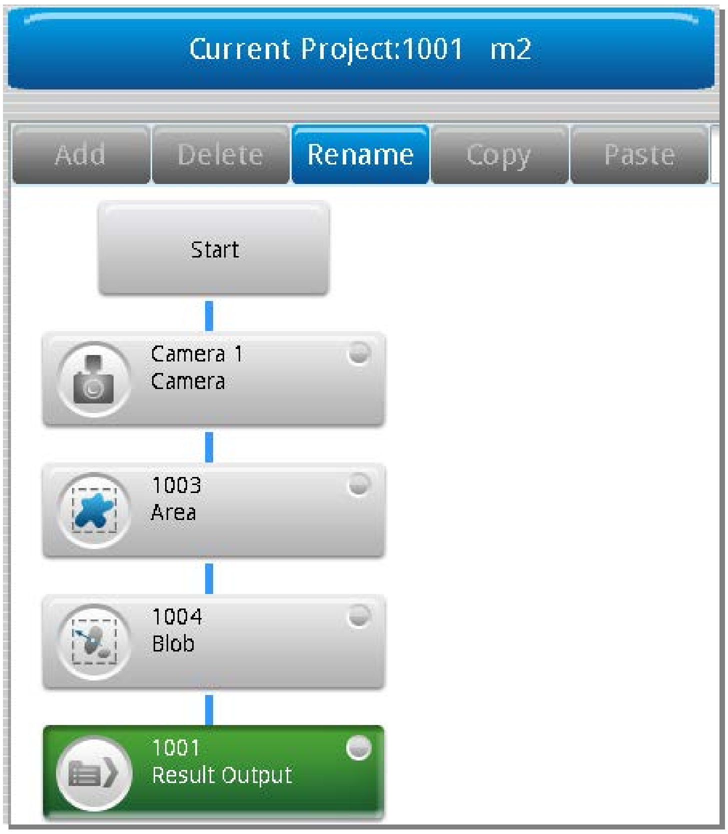
After completing flow inspection configurations according to inspection requirements, the user must configure the judge settings for inspection results during execution mode. [Result Output] and [Status Light] are prerequisite items in the configuration of judge settings. The user must select the inspection result value (OK/NG) in the [Result Output] configuration interface and subsequently configure [Status Light] to observe the inspection results (OK/NG).

Remark [Judge] is the basis of the inspection results. Please refer to Chapter 7 for the detail setup.

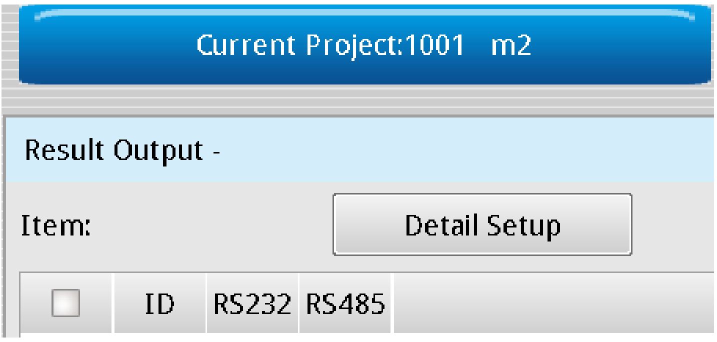
4.5.1 Result Output

The content of each inspection result (including each numerical and logical result from inspection, calculator, and judge) to output to upper PC or PLC can be configured through [Result Output]. The system provides various communication interfaces, such as [External I/O Terminal], [RS232], [RS485], [Ethernet], and [SD Card]. The user can choose according to the varying interfaces of the upper controller.

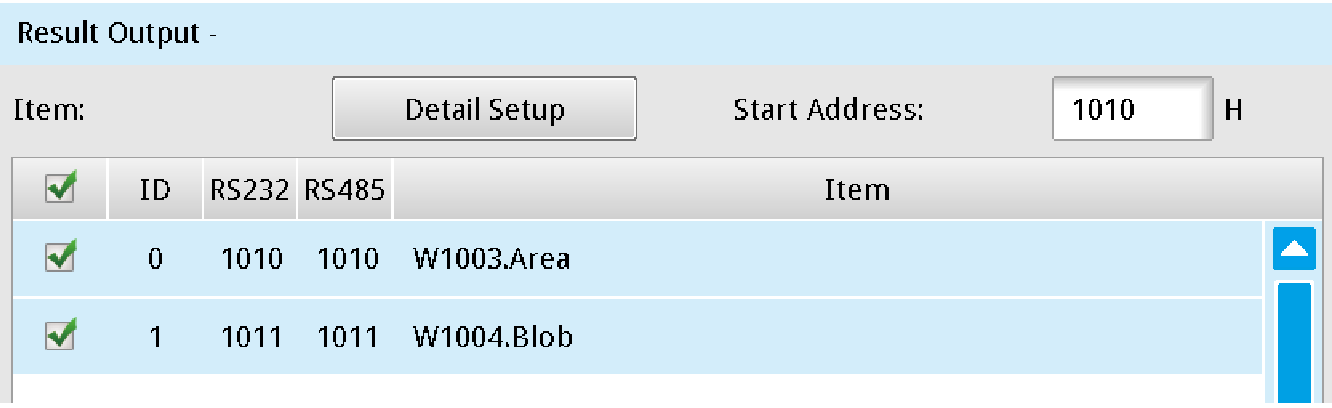
- During the inspection process, click on the [Result Output] icon to enter the output function edit screen.



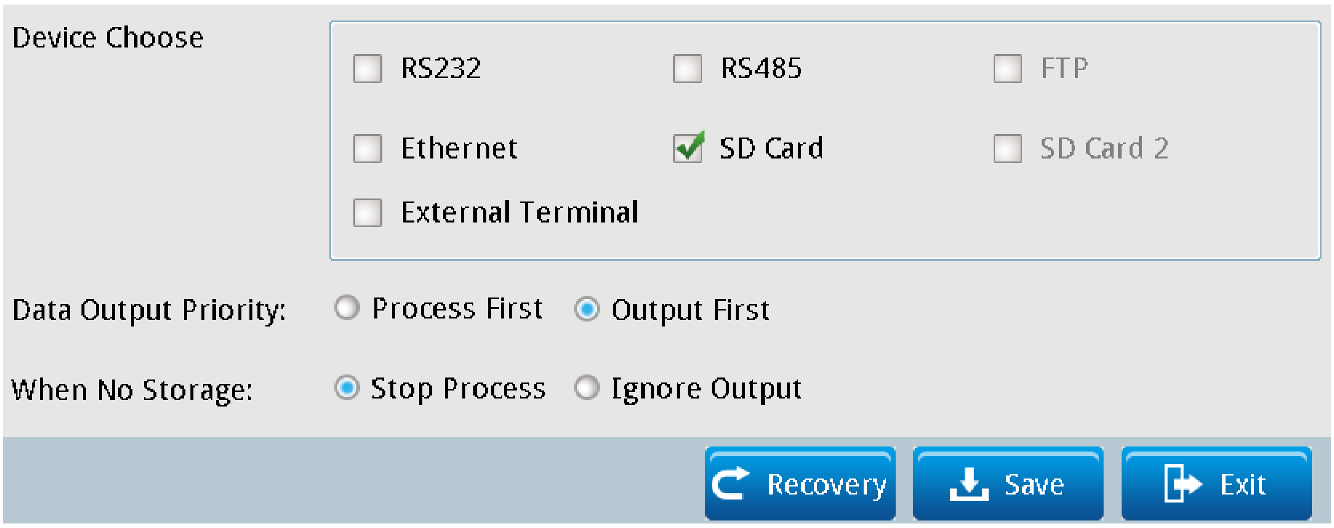
➤ Click [Detail Setting] and the system will display the following dialog box.



➤ Select the inspection result to output



➤ and then configure, step by step, [Device Choose], [Data Output Priority], and [When No Memory]



◆ Device Choose

Select the communication interface to output the contents: [RS232], [RS485], [Ethernet], [SD Card], and [External Terminal]; [FTP] and [SD Card 2] are currently unsupported.

◆ Data Output Priority

When RS232 or RS485 is checked

Process First: After the inspection is complete but before output to SD card is finished, RS232, RS485, Ethernet, SD card, and external terminal cannot output when TRIG triggers inspection signal input.

Output First After the inspection is complete but before output to SD card is finished, trigger reception is disabled when TRIG triggers inspection signal input until output to SD card is complete.

◆ When No Storage

1) When RS232 or RS485 is checked

Stop Process: When data is being output to SD card and the output register space is insufficient, a warning window will appear and all subsequent trigger and inspection processes will stop.

Ignore Output: When data is being output to SD card and the output register space is insufficient, the system continues the inspection processes but will not output the inspection results.

2) When SD Card is checked

Stop Process: When data is being output to SD card and the output register space is insufficient, a warning window will appear and all subsequent trigger and inspection processes will stop.

Ignore Output: When data is being output to SD card and the output register space is insufficient, the system continues the inspection processes but will not output the inspection results.

◆ Restore

Click to restore initial settings

◆ Save

Click to save all modified parameters and values

◆ Exit

Click to leave the setup page

Reference

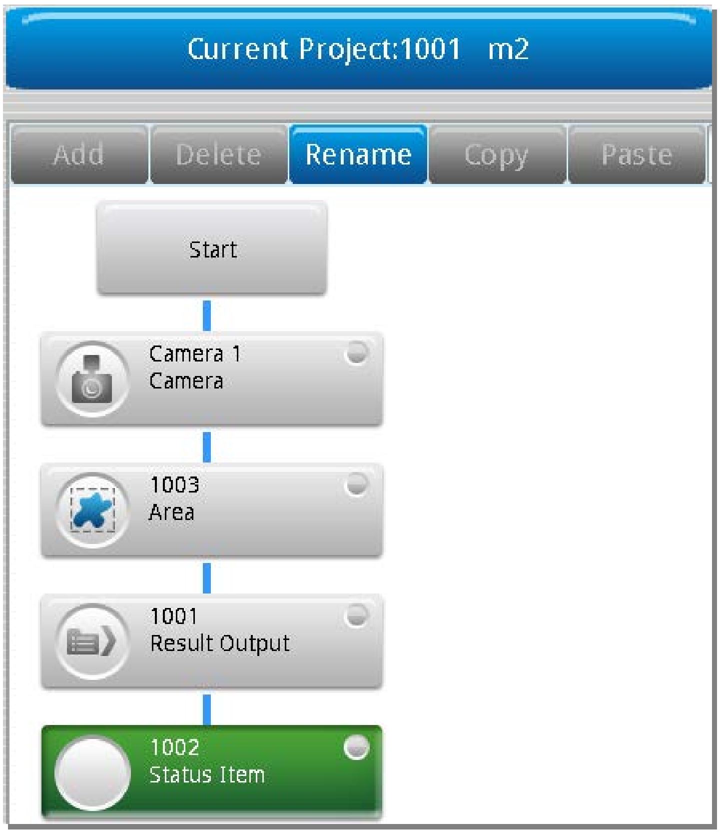
Please refer to Section 6.3 for the detail setup of result output

4.5.2 Status Item

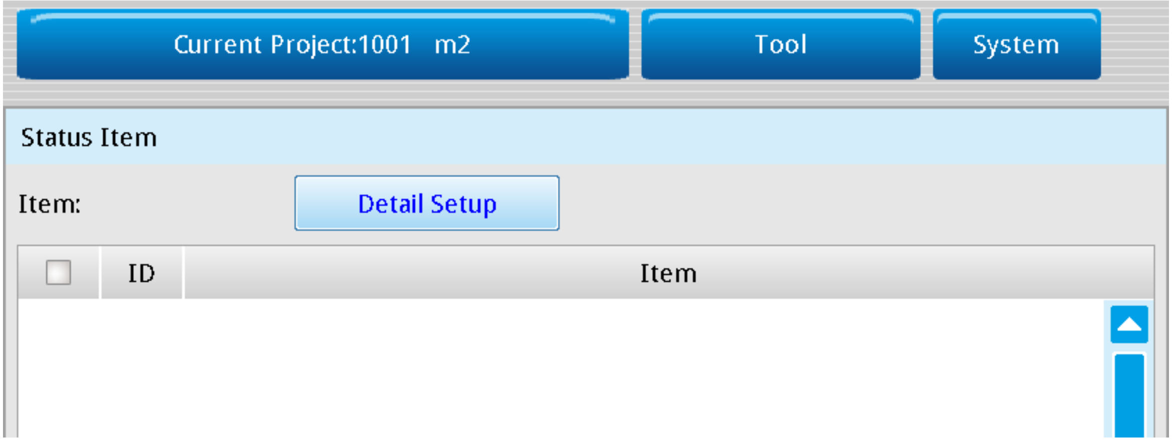
To facilitate on-site operators observe the logical (OK/NG) and numerical inspection results, status item is provided when executing RUN mode to enable the user to choose the specific data to display in the status table.

Click [Detail Setup], select the inspection to be judged (OK/NG) during run mode

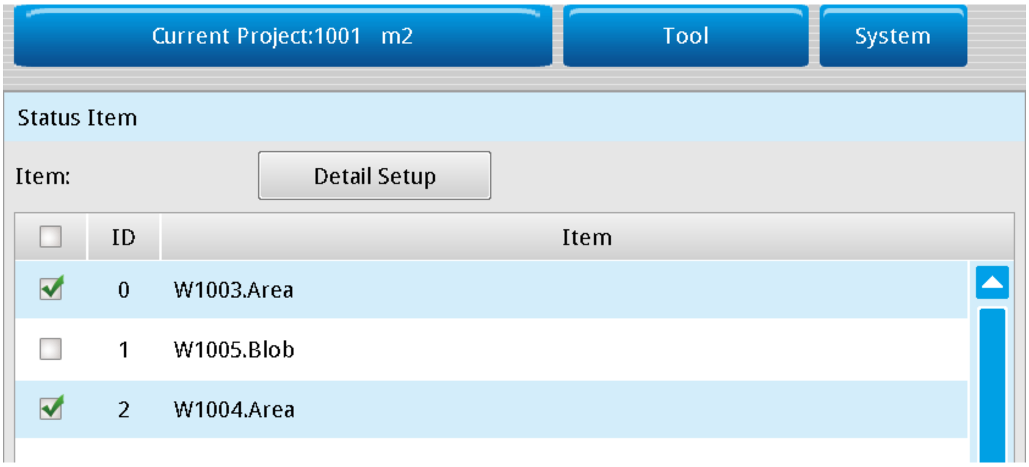
- During the inspection process, click on the [Status Signal] icon to enter the result signal edit screen.



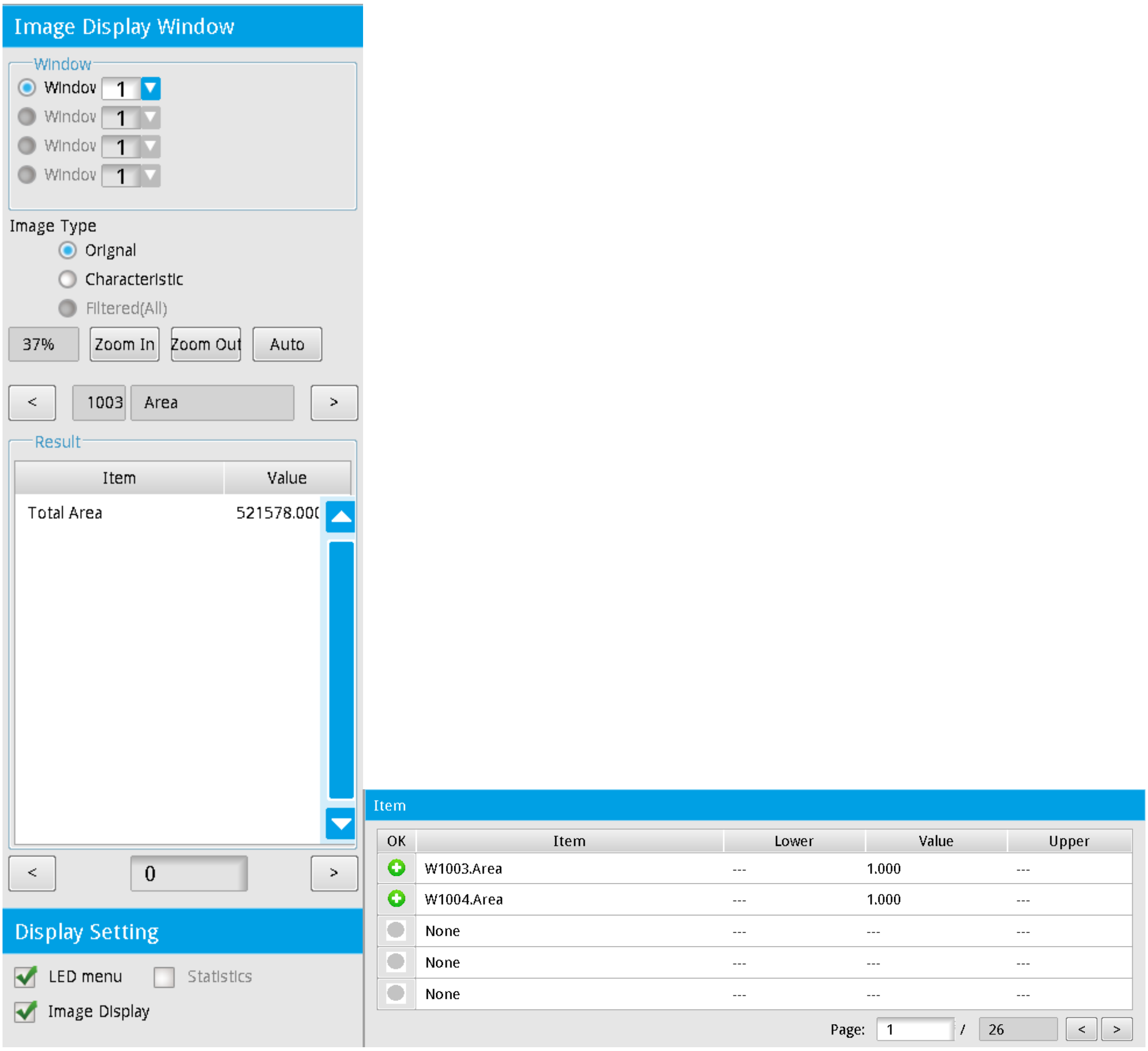
- Click [Detail Setting] shown in the following diagram and the system will display the following dialog box.



- Select the inspection to add the judge result (OK/NG) during RUN mode.



- After completing the aforementioned configurations and switched to execution status, [Image Display Window] will appear on the left side of the screen. Check [LED menu] at the bottom (as shown in the lower left diagram) and the LED data table will open and display the user defined result items. (as shown in the lower right diagram)

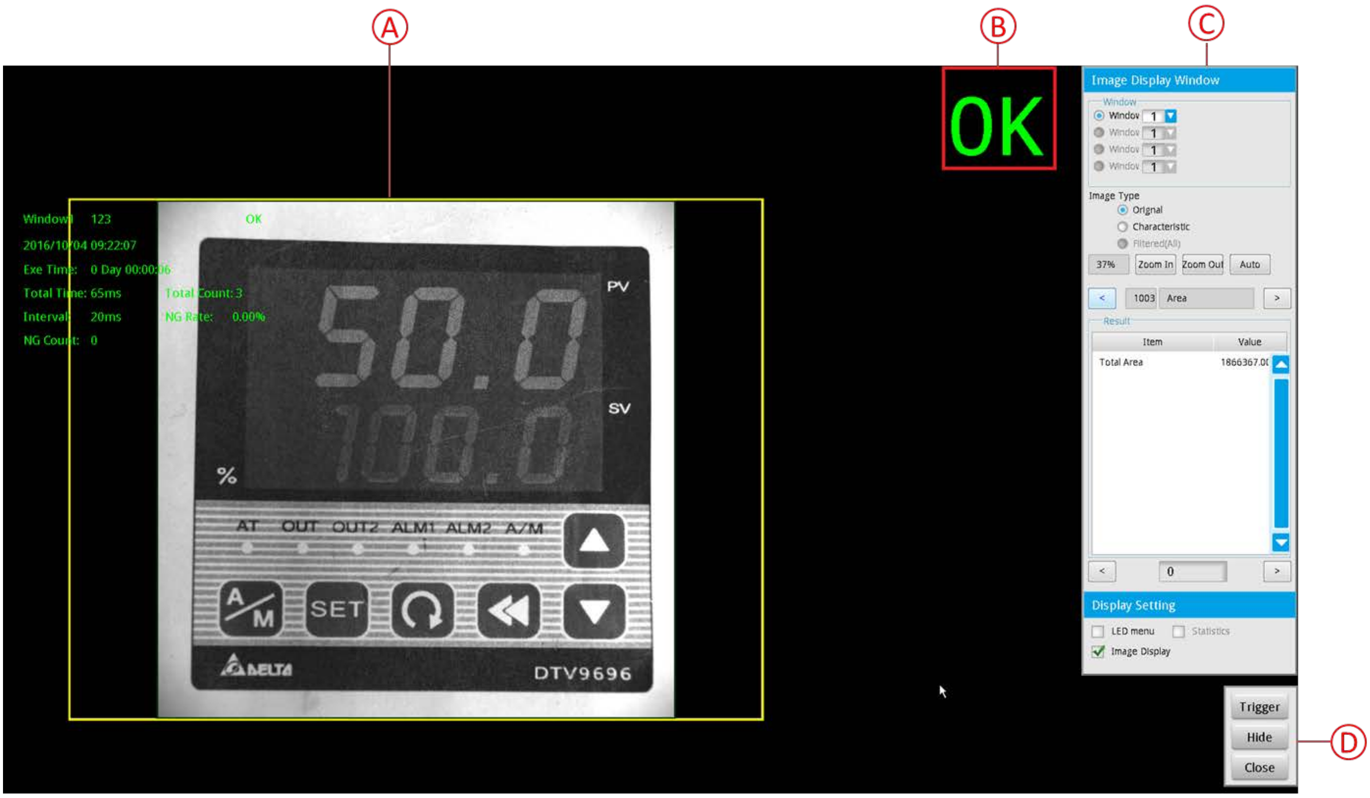


4.6 Run Mode

After configuring, step by step, [Camera], [Inspection], [Result Output], and [Status Light] for each project, click the [Run] button at the lower right corner of the main screen to enter the Run Mode screen. All configured trigger conditions must be met to begin execution. The configured inspections in the project are then successively executed for image inspection. Finally, the actual logical results and status are obtained and displayed on the run mode page.

To edit the run mode screen and logical output and status, first click [Tool] on the main page and then select [Judge Setting] and [Screen Edit] to individually configure the logical basis of inspection results and the display method of the execution screen.

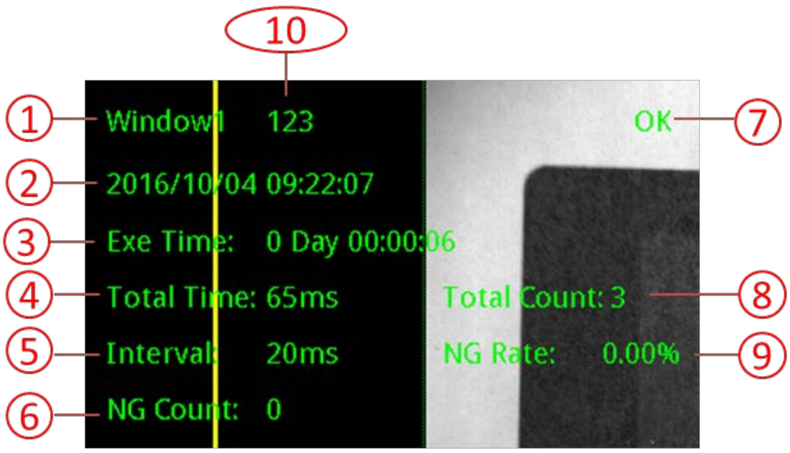
The following diagram illustrates the controller display during Run Mode. The items are numbered and individually explained.



A. Window

This is the inspection result display window. The inspection objects from instant camera capture are displayed here. Regardless of the number of parallel processes, only 4 inspection windows can be configure for a project at a time.

➤ The inspection window displays the 10 following items.



1) Name of window (Window 1~Window 4)
2) Date and time of inspection
3) Duration of currently executing inspection
4) Total time of inspection
5) Interval between each inspection trigger

6) Number of NG inspections
7) Logical result (OK/NG) of the inspection in the window
8) Total number of inspections
9) Ratio of NG inspections
10) Name of the inspection project

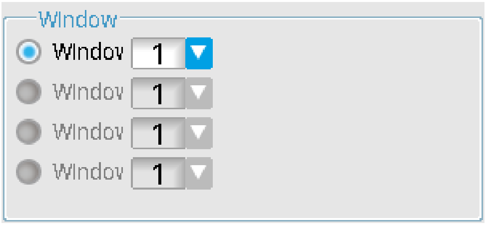
B. Inspection results from all windows included for judgment

The result is displayed here according to the configured [Judge Setting] in tools. For example, 4 windows are set up in 1 project and [Window 1]~[Window 3] are OK and [Window 4] is NG. If [Window 4] in [Judge Setting] is set as one of the final logical results, the inspection result here will display NG.

C. Image Display Window

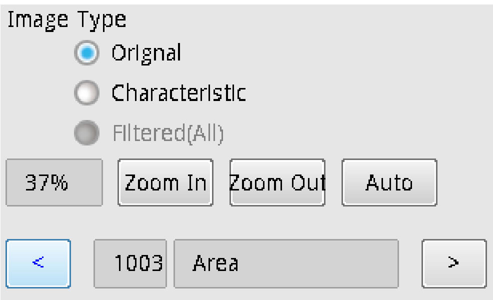
➤ Window

The Run Mode screen can simultaneously display inspection processes in [Window 1]~[Window 4] and the corresponding process numbers on the right side of each window.

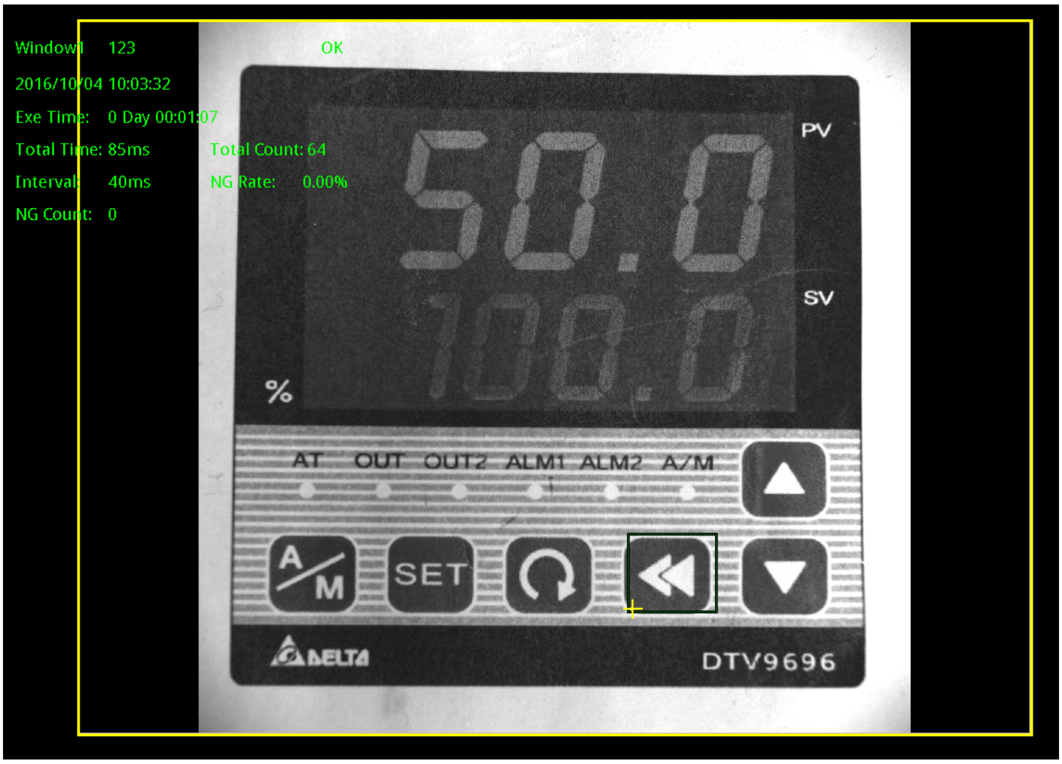


➤ Image Type

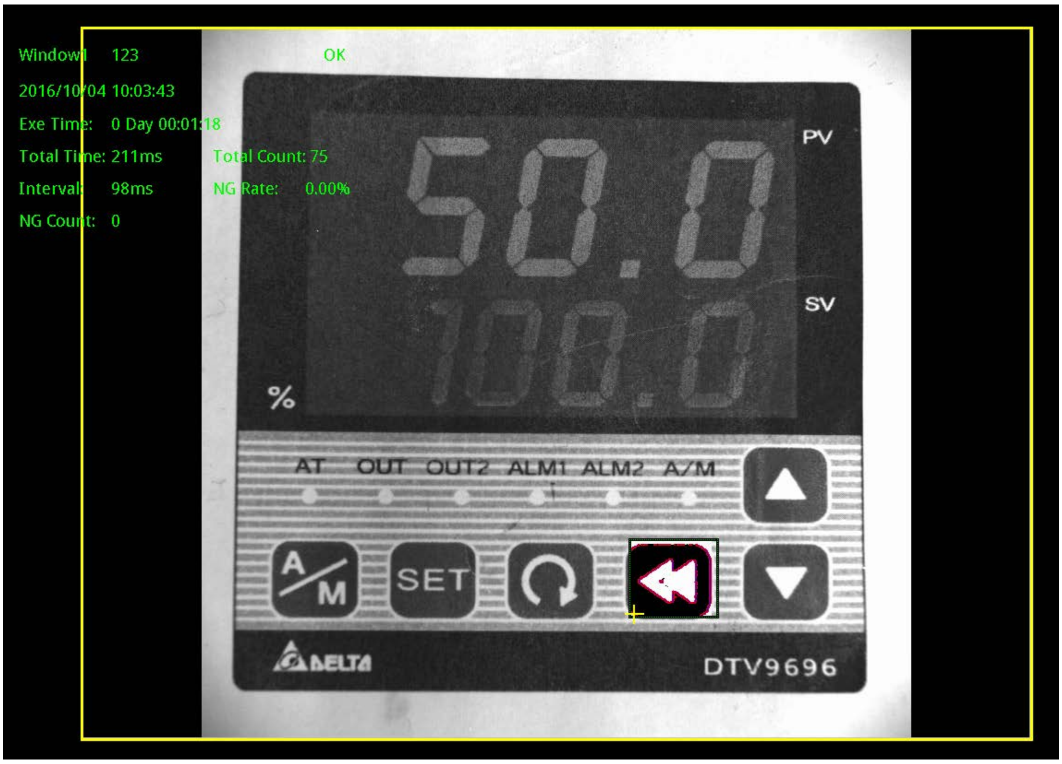
The user can select the display method for the camera captured images: [Original], [Characteristic], and [Filter (All)]. These options are individually described using [Stain] as an example.



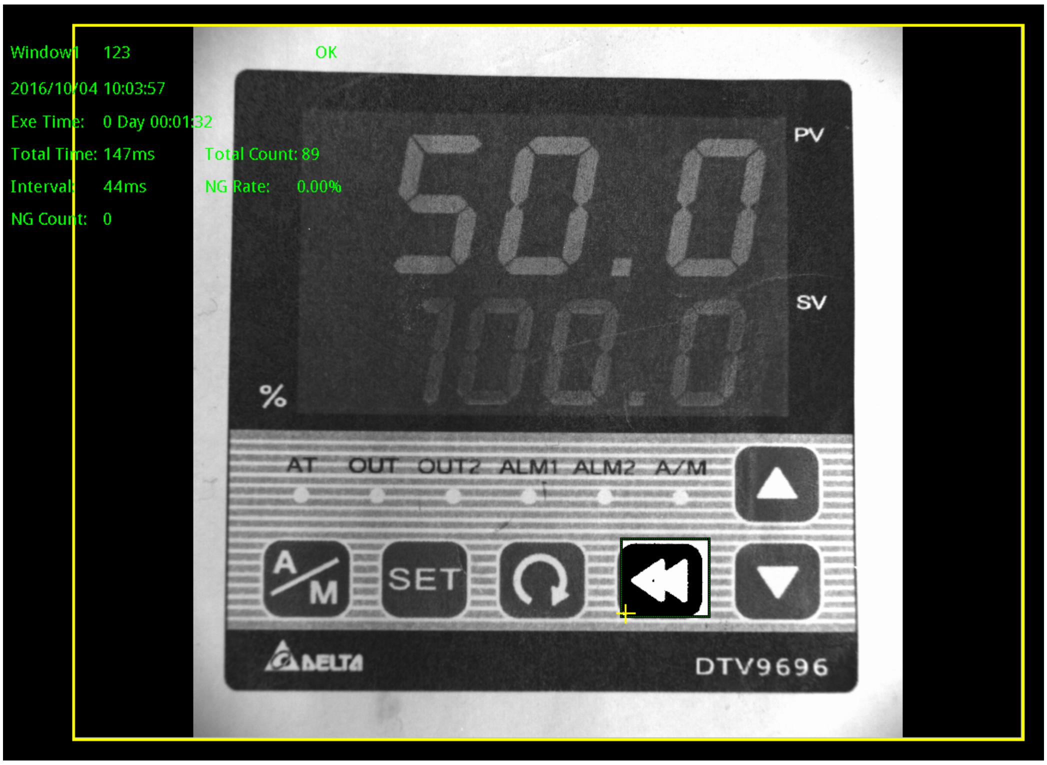
1) Original: Original image screen captured by the camera.



2) Characteristic: This function is only applicable for the inspection units of [Area], [Blob], [Stain], [Shape], [Edge Width], [Edge Pitch], [Edge Count], and [Position Trace]. The purpose of this function is to display more information on the ROI image displayed to emphasize the regional characteristics of the ROI.



3) Filter (All): The ROI image displayed after [Preprocess].



◆ The ration of the captured image can be adjusted using the three functions of [Zoom In], [Zoom Out], and [Auto] by clicking the on the button. The current image size is displayed on the left in percentage.

1) Zoom In: Zooms in on the image displayed instantly captured by the camera.

2) Zoom Out: Zooms out on the image displayed instantly captured by the camera.

3) Auto: The system automatically displays the most suitable image display ratio.

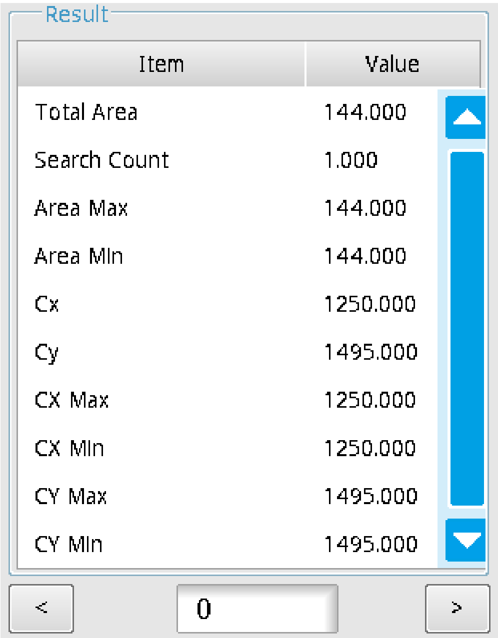
- The user can switch to view the desired inspection by clicking on the left and right arrow keys. The ID and name of the inspection is displayed at the center.

➤ Result

◆ A process can comprise multiple inspections, therefore the left and right arrow keys can be used to look up the result values of each inspection. These include each item and numerical values contained in the inspection.

◆ The user can switch to view the desired coordinate of the inspection by clicking on the left and right arrow keys. The coordinate number of the inspection is displayed at the center.

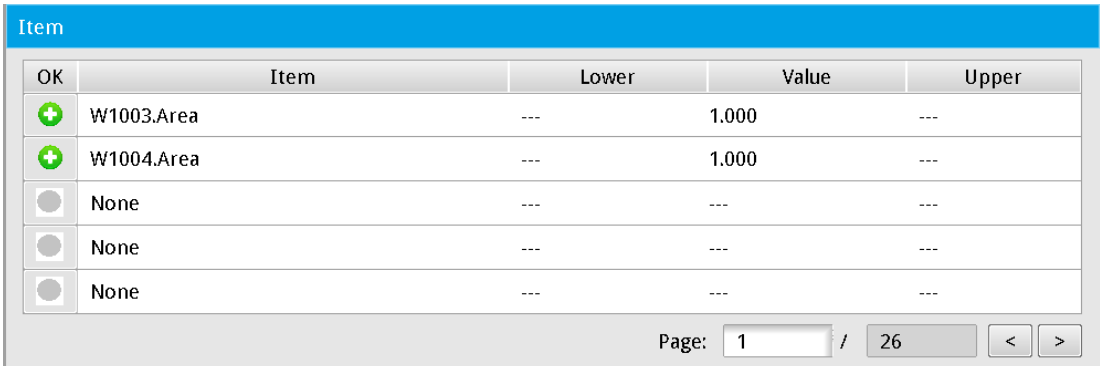
The following illustrates an example using [Stain].



Reference Please refer to Chapter 5 for the numeric output results for each inspection.

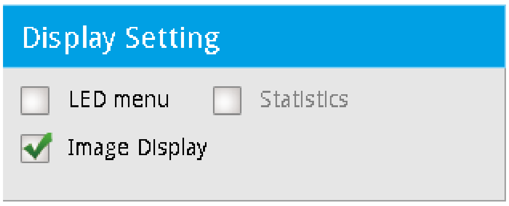
➤ Display settings

◆ LED menu: Status item must first be configured in the process. Checking the option displays the following screen, which shows the user defined result items.



Reference Please refer to Section 6.4 for the detail setup of status item.

- Display Image: By checking this option, the camera continues to update the captured images, or else the image screen stops to update.



D. [Trigger], [Hide], [Close]

Click for the operation controls of the inspection screen

- [Trigger]: When [Internal Trigger] is not selected in [Trigger Setup] for auto trigger, the trigger button must be manually clicked to trigger processes. Therefore, clicking this button triggers flow inspections.
- [Hide]: Click this button can close [Image Display Window], displaying only the inspection window on screen.
- [Close]: Click this button can exit operating mode and return to the controller configuration screen.

Chapter 5

Inspection

5.1 Area

Binary converts the image to black and white and counts the number of black and white pixels.

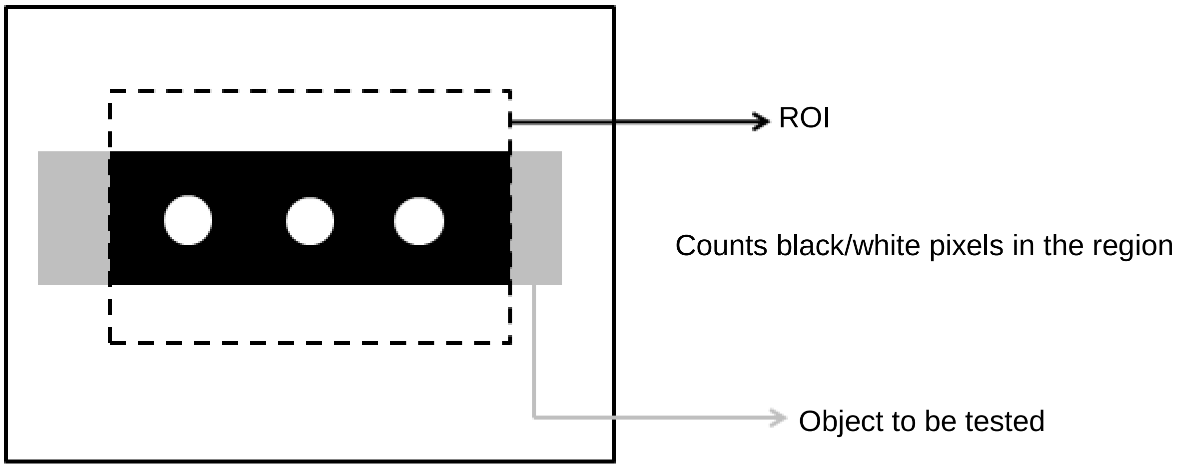
◎ **Algorithmic Processing**

When using Area, Binary must also be used to convert images to black and white before counting the white or black areas.

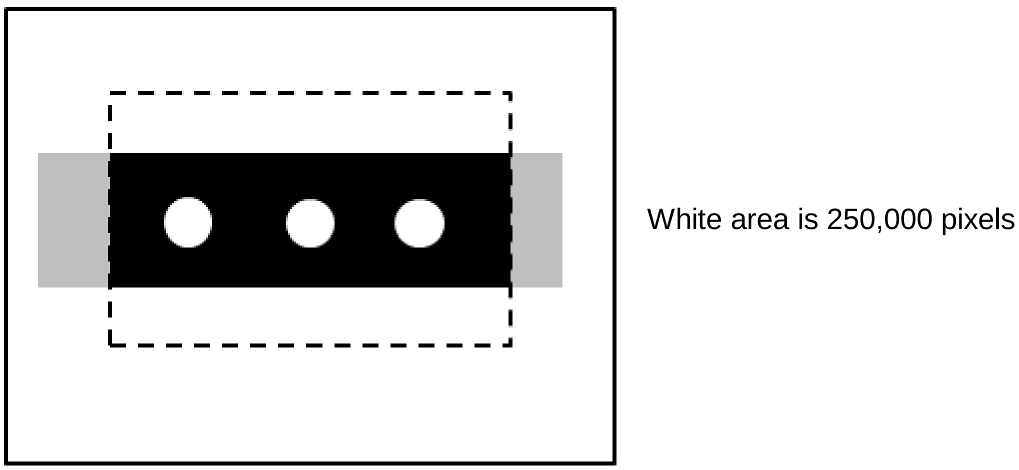
◎ **Procedural Results**

Area returns the following inspection results.

➢ Area: Outputs the counter values of black and white pixels.

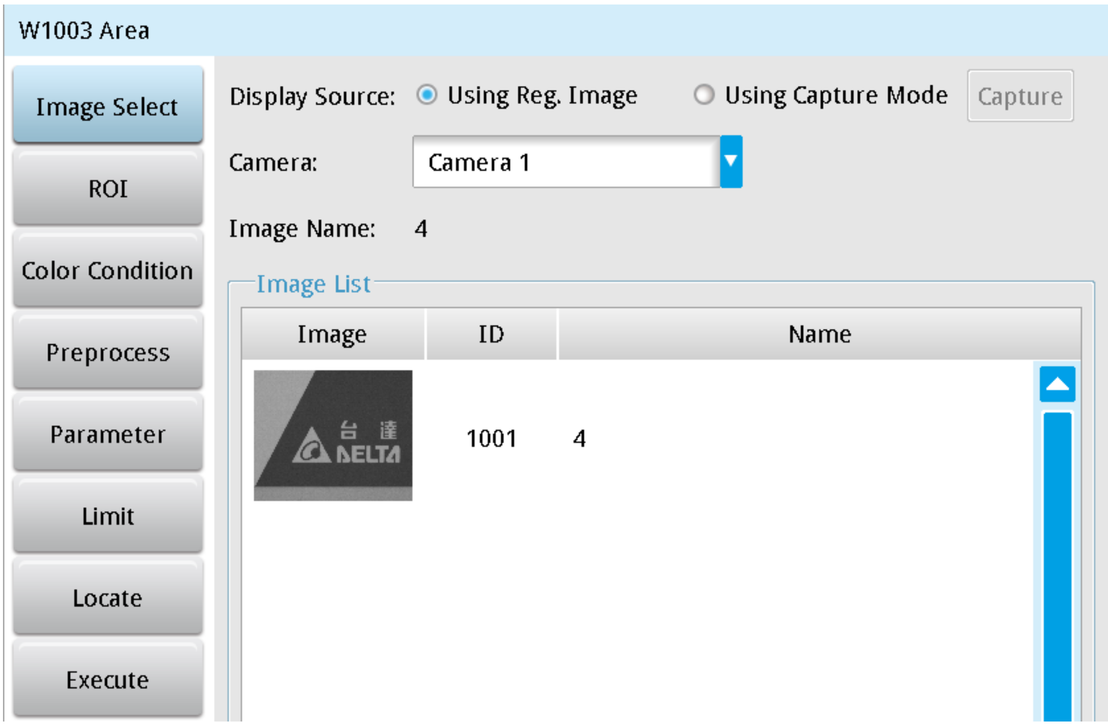


◎ **Example**



◎ **Area Main Menu**

The Area setup page includes the following items.



➤ Image Select (select Register Image)

Before entering inspection configurations, the registered image to be inspected must first be selected from the register gallery.

➤ ROI (configure detection region)

The desired inspection regions can be selected through ROI configurations. Optional ROI shapes include Rectangle, Circle, Arc, Ellipse, Ring, Polygon, and Rotated Rect.

➤ Color Condition

When using color camera, Color to Binary, Color to Grayscale, RGB grayscale, R Grayscale, G Grayscale, and B Grayscale can be configured on this page.

➤ Preprocess

When the camera image cannot perfectly highlight the emphasized effect, feature points can be enhanced through preprocessing.

➤ Parameter

The Area inspection conditions can be adjusted in Parameter Setting.

➤ Limit

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.

➤ 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**

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)**

Optional ROI types include Rectangle, Circle, Ellipse, Ring, Arc, Polygon, and Rotated Rect. Polygon can support up to 16 points according to the requirement. Additionally, up to 8 mask functions are provided to ignore particular segments.

◎ **Color Condition**

Color images can be processed according to need. In Color Condition, images can be converted using the methods of Color to Binary, Color to Grayscale, RGB Grayscale, R grayscale, G grayscale, and B grayscale.

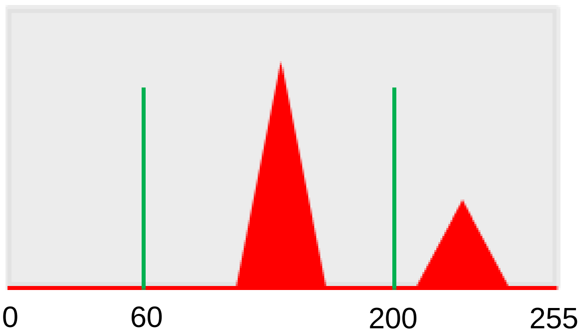
◎ **Preprocess**

Preprocess includes Binary, Dilation, Erosion, Average, Median, Laplacian, Sobel X, Sobel Y, Sobel XY, Brightness, Contrast, Shade, and Custom (filter) and can superimpose up to 6 options or produce custom preprocessed effect through Custom.

◎ **Parameter**

➤ Binary Limit

This function configures the upper and lower limits of Binary and converts pixels within the configured range to white pixels and the remaining pixels to black pixels. As shown in the following diagram, when the lower limit is set to 60 and the upper limit is set to 200, all gray scale values between 60 and 200 will be converted to white and the remaining pixels will be converted to black.



- Object

Configures whether to count the area of white or black objects.

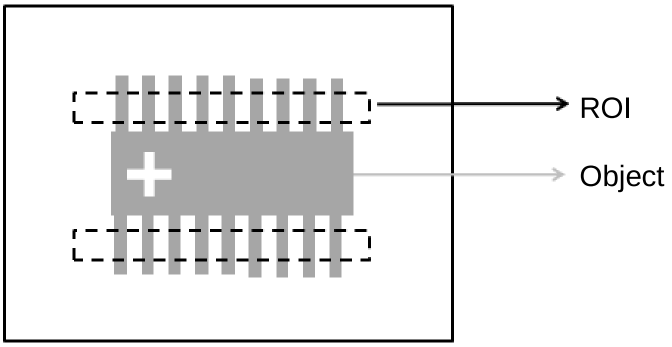
◎ **Limit**

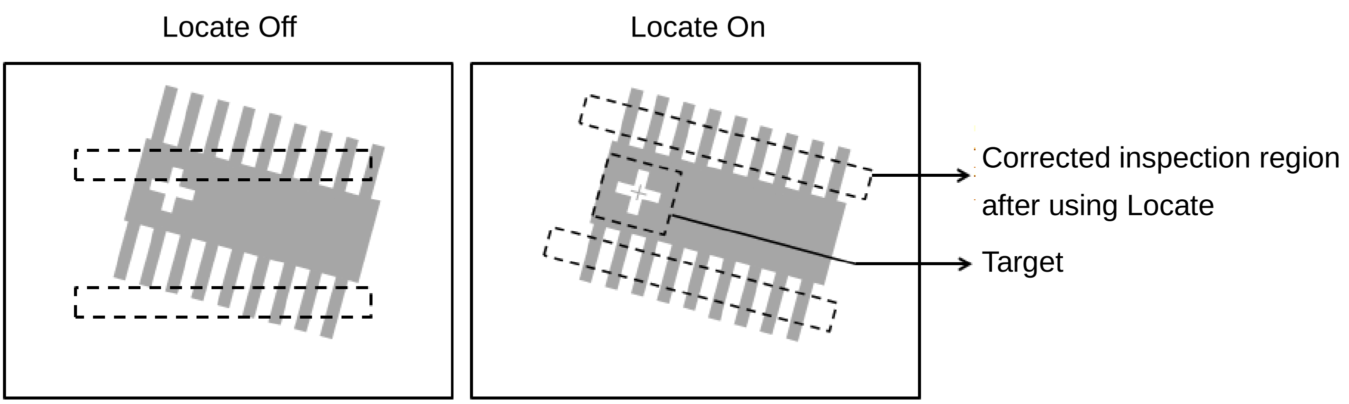
After acquiring the inspection results, Upper and Lower must be configured in this item to determine whether the result is qualified. The following items can be configured in Area.

- Area: Configures the upper and lower limits of Area

◎ **Locate**

This configures whether the inspection region will follow an inspection result for adjusting its coordinates (X, Y) and Angles (Theta). The inspection tools that can be used 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.





➢ Three tools are also provided in this item for quick configuration.

◆ Reference Previous Unit

When clicked, the nearest inspection tool that can provide reference for Locate will be automatically filled in the Ref. X, Ref. Y, and Ref. Angle fields below.

◆ Reference Available Unit

When clicked, the nearest unit with Locate configured will be automatically filled in the Ref. X, Ref. Y, and Ref. Angle fields below.

◆ Reference Unit

The option arbitrarily selects an inspection tool that can provide locating reference and automatically fills in the reference values of the selected unit in the Ref. X, Ref. Y, and Ref. Angle fields below.

Reference Please refer to Section 9.1 for detailed locating configurations.

◎ **Execute**

Configures whether to execute the inspection function in the inspection process.

➢ Always Execute

Always execute the inspection function in run mode.

➢ Never Execute

Never execute the inspection function in run mode.

◎ **Save**

All modified parameters and values can be saved by clicking this button.

◎ **Exit**

Click to leave the setup page.

◎ **Output Item**

➤ Window

By selecting the output window, the total judge result of the Area tool will be output on the designated interface.

➤ Item

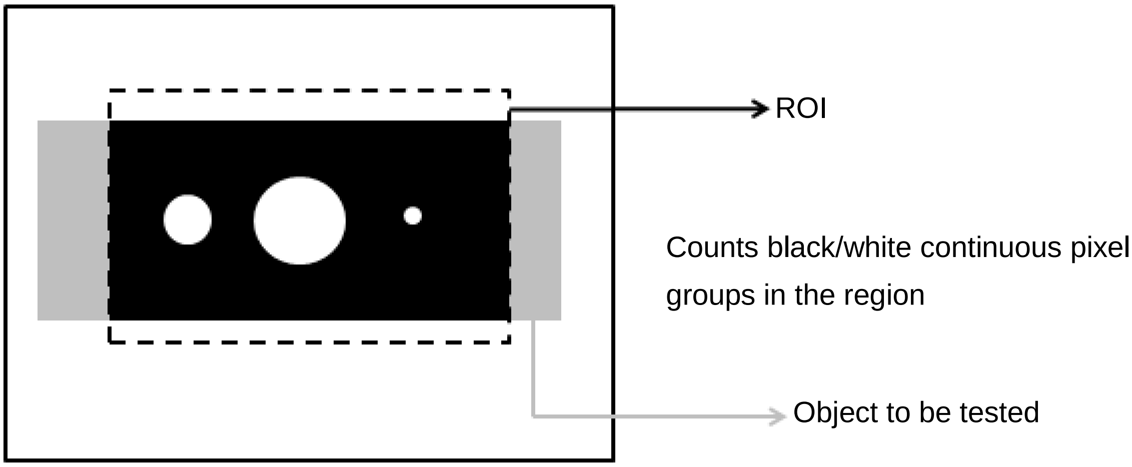
1) Area: Outputs the area count obtained by Area.
2) Area ID: Outputs the ID of the inspection tool.
3) Total Area (J): Outputs the logical (Judge) result of the area count obtained by Area.

5.2 Blob

Converts images to black and white through Binary, counts the number and area of continuous black or white pixel groups, and inspects and calculates the coordinates of each continuous pixel group.

◎ **Algorithmic Processing**

When using Blob, Binary must also be used to convert images to black and white before counting the black or white continuous pixel groups.

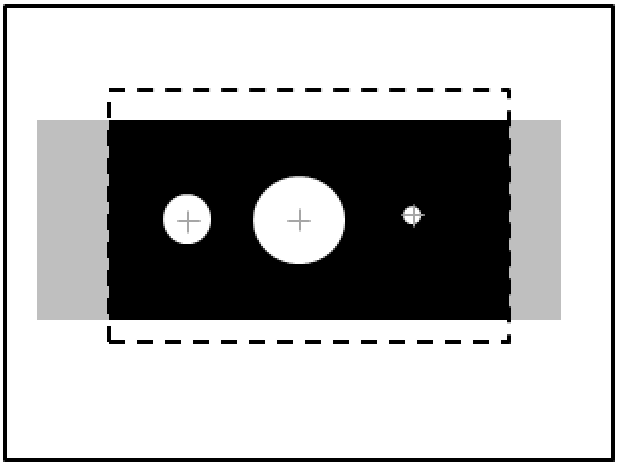


◎ **Procedural Results**

Blob returns the following inspection results.

- Number of Blobs: Outputs the number of black or white continuous pixel groups.
- Blob Centroid Position X [N]: Outputs the centroid's X coordinate of the Nth black or white continuous pixel group.
- Blob Centroid Position Y [N]: Outputs the centroid's Y coordinate of the Nth black or white continuous pixel group.
- Blob Area [N]: Outputs the area of the Nth black or white continuous pixel group.
- Blob Perimeter [N]: Outputs the perimeter of the Nth black or white continuous pixel group.

◎ **Example**



Number of Blobs: 3

Blob Centroid Position X [1]: 1000

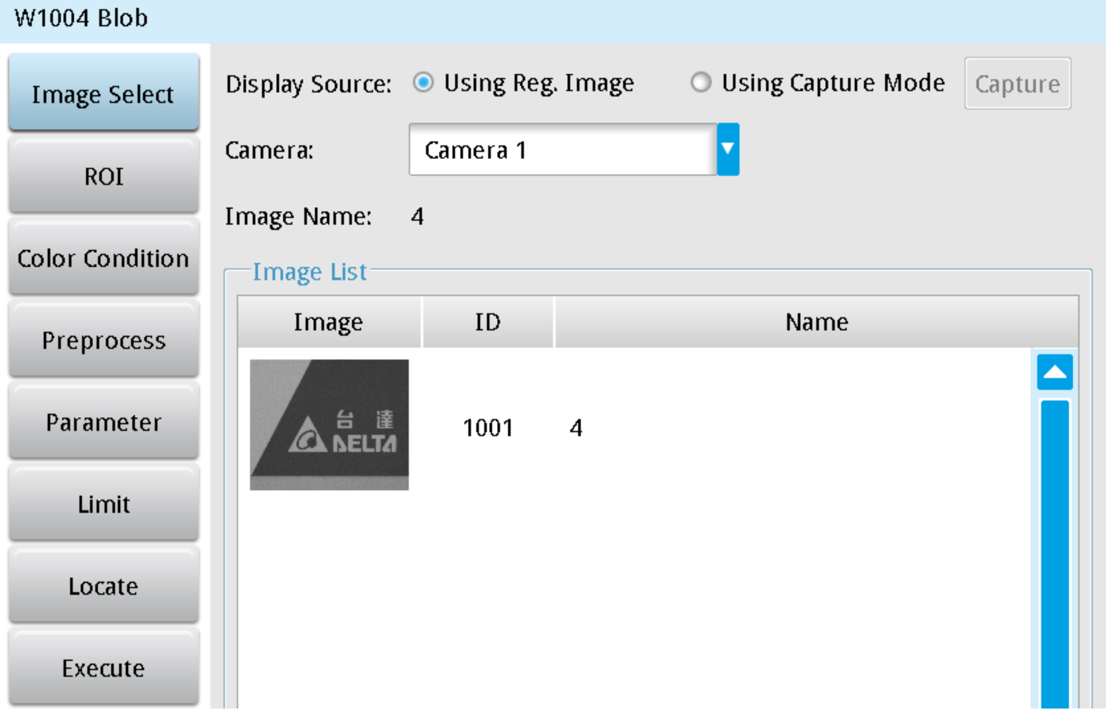
Blob Centroid Position Y [1]: 500

Blob Area [1]: 4000

Blob Perimeter [1]: 1500

◎ **Blob Main Menu**

The Blob setup page includes the following items.



➤ Image Select (select Register Image)

Before entering inspection configurations, the registered image to be inspected must first be selected from the register gallery.

➤ ROI (configure detection region)

The desired inspection regions can be selected through ROI configurations. Optional ROI shapes include Rectangle, Circle, Arc, Ellipse, Ring, Polygon, and Rotated Rect.

➤ Color Condition

When using color camera, Color to Binary, Color to Grayscale, RGB grayscale, R Grayscale, G Grayscale, and B Grayscale can be configured on this page.

➤ Preprocess

When the camera image cannot perfectly highlight the emphasized effect, feature points can be enhanced through preprocessing.

➤ Parameter

The Blob inspection conditions can be adjusted in Parameter Setting.

➤ Limit

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.

➤ 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**

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)**

Optional ROI types include Rectangle, Circle, Ellipse, Ring, Arc, Polygon, and Rotated Rect. Polygon can support up to 16 points according to the requirement. Additionally, up to 8 mask functions are provided to ignore particular segments.

◎ **Color Condition**

Color images can be processed according to need. In Color Condition, images can be converted using the methods of Color to Binary, Color to Grayscale, RGB Grayscale, R grayscale, G grayscale, and B grayscale.

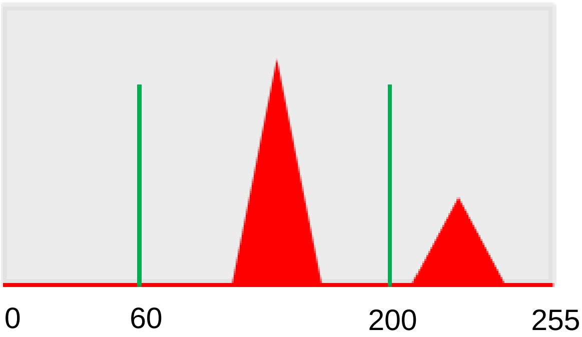
◎ **Preprocess**

Preprocess includes Binary, Dilation, Erosion, Average, Median, Laplacian, Sobel X, Sobel Y, Sobel XY, Brightness, Contrast, Shade, and Custom (filter) and can superimpose up to 6 options or produce custom preprocessed effect through Custom.

◎ **Parameter**

➤ Binarization

This function configures the upper and lower limits of Binary and converts pixels within the configured range to white pixels and the remaining pixels to black pixels. As shown in the following diagram, when the lower limit is set to 60 and the upper limit is set to 200, all gray scale values between 60 and 200 will be converted to white and the remaining pixels will be converted to black.



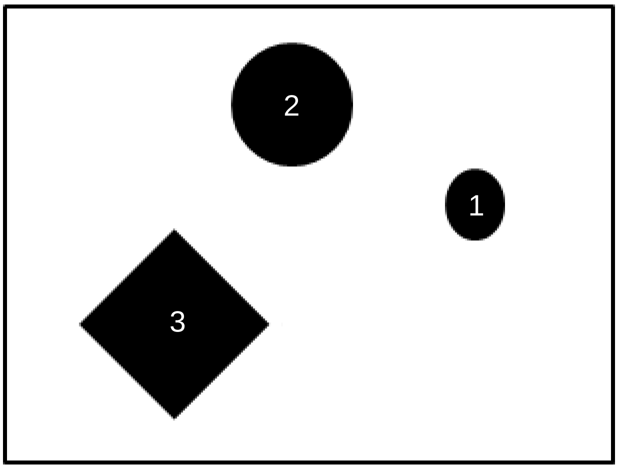
➤ Detect Object

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

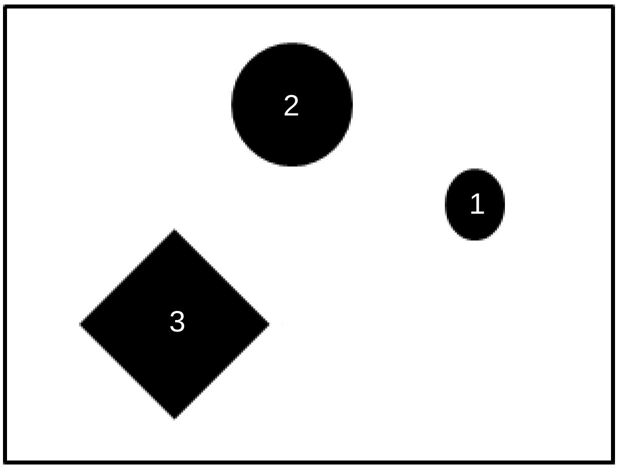
➤ Blob Condition

Sort Rule: When searching multiple blobs, the following blob sorting methods are provided.

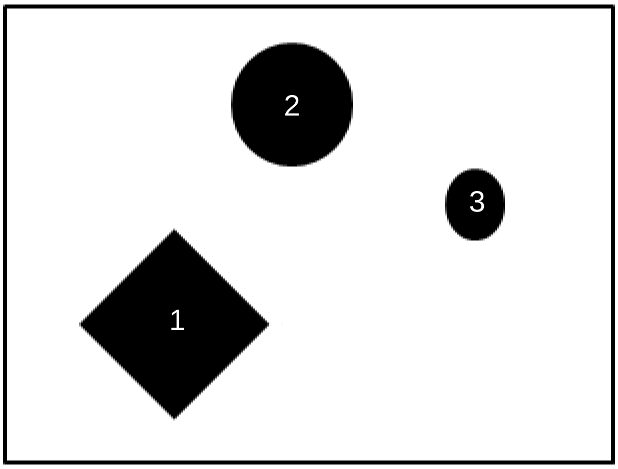
1) Area Ascend/Descend: When Area Ascend is configured, the sorting result is shown as follows. Smaller areas are arranged ahead, and in the opposite direction for Area Descend.



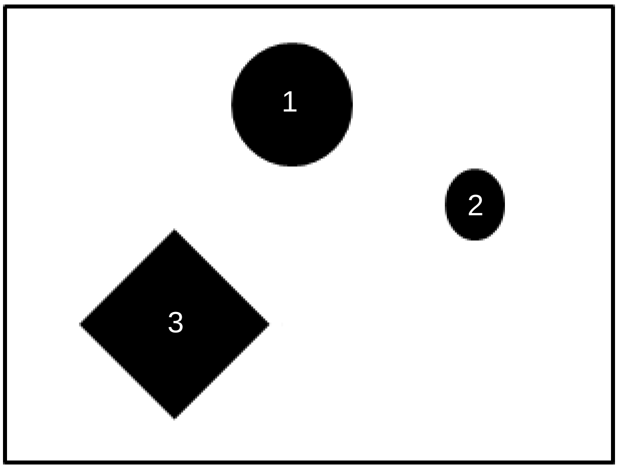
2) Perimeter Ascend/Descend: When Perimeter Ascend is configured, the sorting result is shown as follows. Shorter perimeters are arranged ahead, and in the opposite direction for Perimeter Descend.



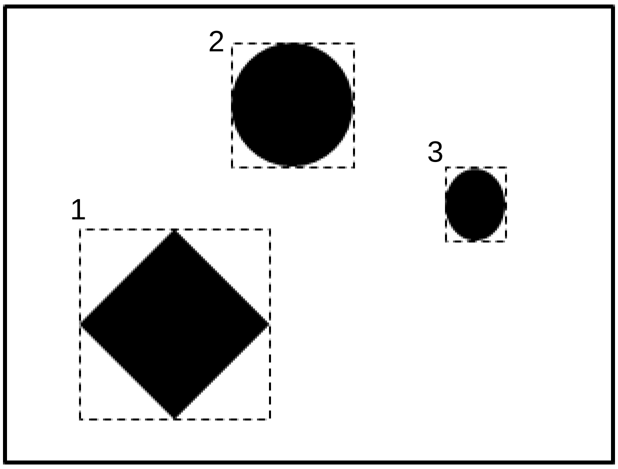
3) Horizontal Center Position Ascend/Descend: When Horizontal Center Position Ascend is configured, the sorting result is shown as follows. Smaller Horizontal Center Position (coordinate values) are arranged ahead, and in the opposite direction for Horizontal Center Position Descend.



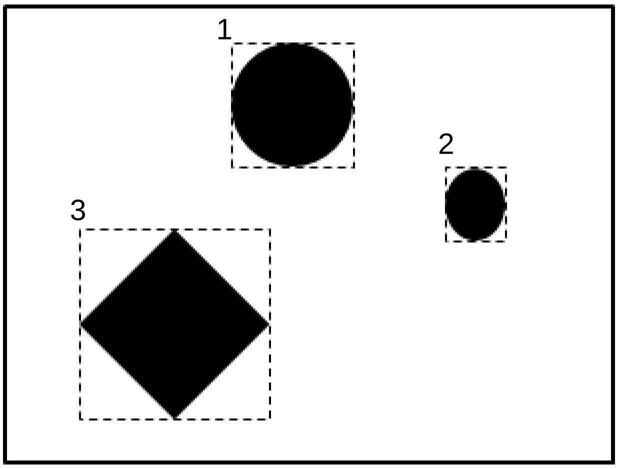
4) Vertical Center Position Ascend/Descend: When Vertical Center Position Ascend is configured, the sorting result is shown as follows. Smaller Vertical Center Position (coordinate values) are arranged ahead, and in the opposite direction for Vertical Center Position Descend.



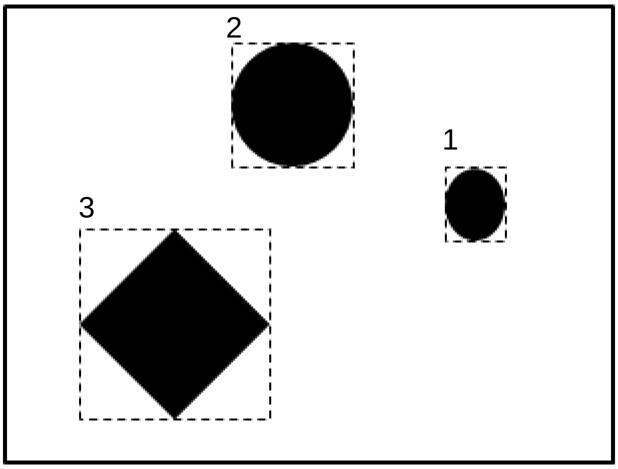
5) Bounding Rectangle Horizontal Position Ascend/Descend: When Bounding Rectangle Horizontal Position Ascend is configured, the sorting result is shown as follows. Smaller Bounding Rectangle Horizontal Position (coordinate values) are arranged ahead, and in the opposite direction for Bounding Rectangle Horizontal Position Descend.



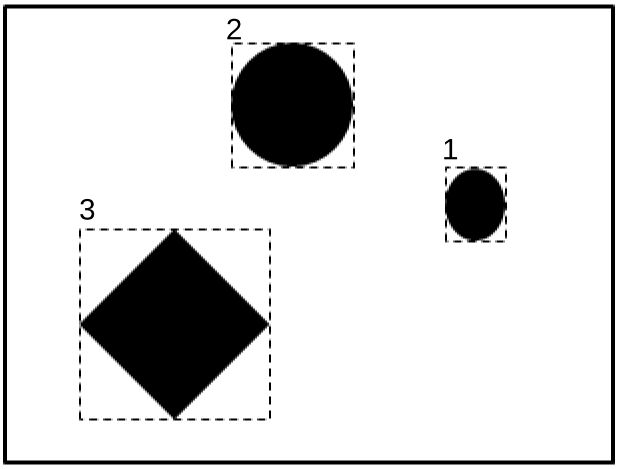
6) Bounding Rectangle Vertical Position Ascend/Descend: When Bounding Rectangle Vertical Position Ascend is configured, the sorting result is shown as follows. Smaller Bounding Rectangle Vertical Position (coordinate values) are arranged ahead, and in the opposite direction for Bounding Rectangle Vertical Position Descend.



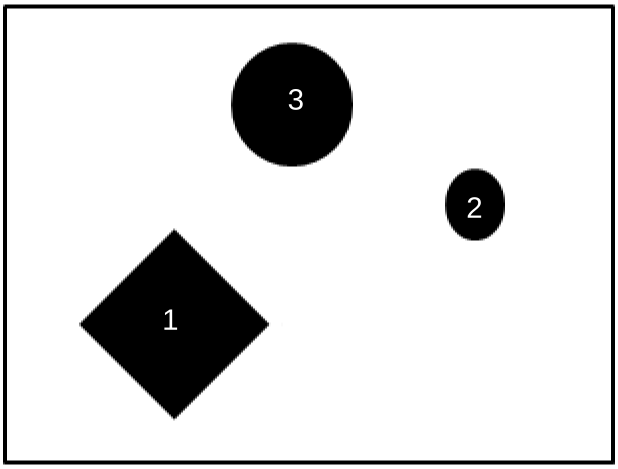
7) Bounding Rectangle Width Ascend/Descend: When Bounding Rectangle Width Ascend is configured, the sorting result is shown as follows. Shorter bounding rectangle widths are arranged ahead, and in the opposite direction for Bounding Rectangle Width Descend.



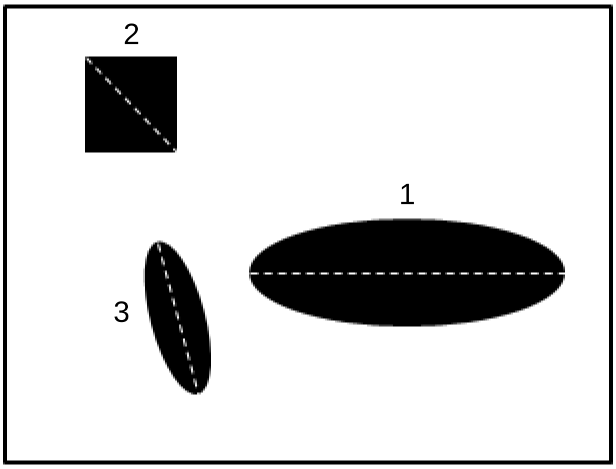
8) Bounding Rectangle Height Ascend/Descend: When Bounding Rectangle Height Ascend is configured, the sorting result is shown as follows. Shorter bounding rectangle heights are arranged ahead, and in the opposite direction for Bounding Rectangle Height Descend.



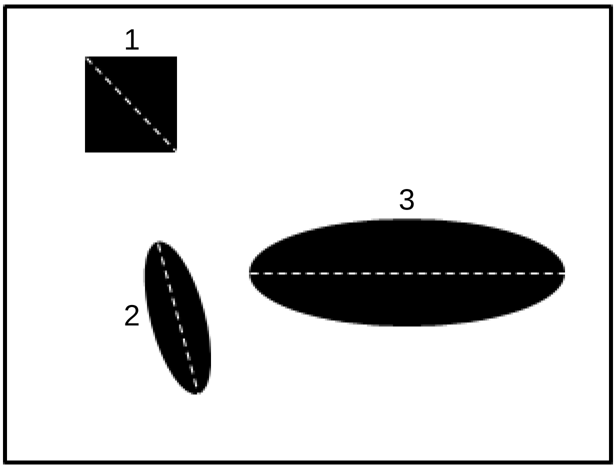
9) Roundness Ascend/Descend: When Roundness Ascend is configured, the sorting result is shown as follows. Lesser roundness results are arranged ahead, and in the opposite direction for Roundness Descend.



10) Major Axis Angle Ascend/Descend: When Major Axis Angle Ascend is configured, the sorting result is shown as follows in which the white dotted line denotes the major axis. Smaller angles between the major axis and the horizontal line are arranged ahead, and in the opposite direction for Major Axis Angle Descend.



11) Major Axis Length Ascend/Descend: When Major Axis Length Ascend is configured, the sorting result is shown as follows in which the white dotted line denotes the major axis. Shorter major axis lengths are arranged ahead, and in the opposite direction for Major Axis Length Descend.



➤ Reference

Output the n-th 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. The desired coordinates can be entered to change and move the origin to the new coordinates.

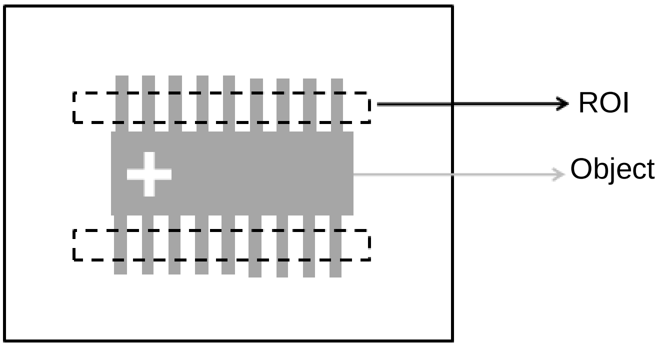
◎ **Limit**

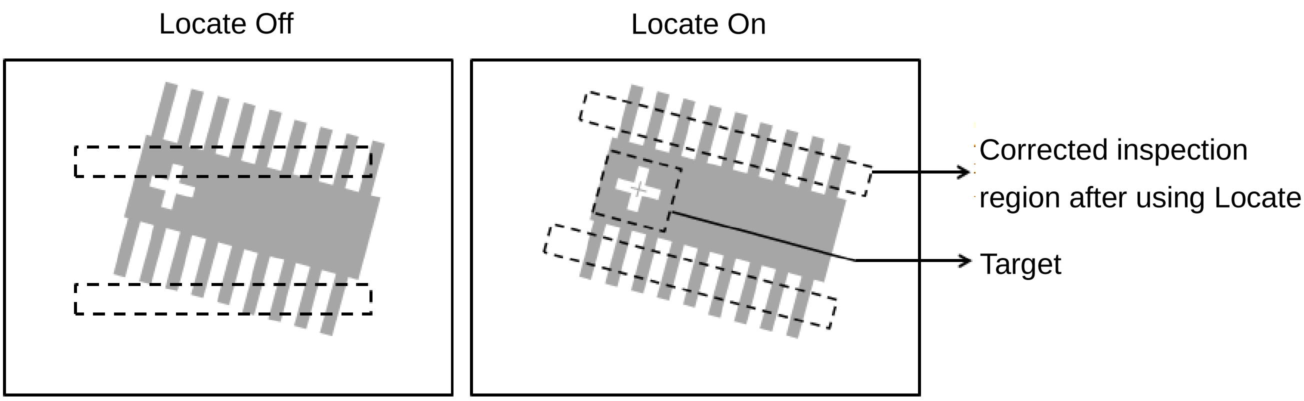
After acquiring the inspection results, Upper and Lower must be configured in this item to determine whether the result is qualified. The following items can be configured in Blob.

- Number of Blobs: Configures the upper and lower limits for the number of blobs.
- Blob Centroid Position X: Configures the upper and lower X coordinate limits of blob centroids.
- Blob Centroid Position Y: Configures the upper and lower Y coordinate limits of blob centroids.
- Blob Area: Configures the upper and lower limits of Blob Area.
- Blob Perimeter: Configures the upper and lower limits of Blob Perimeter.

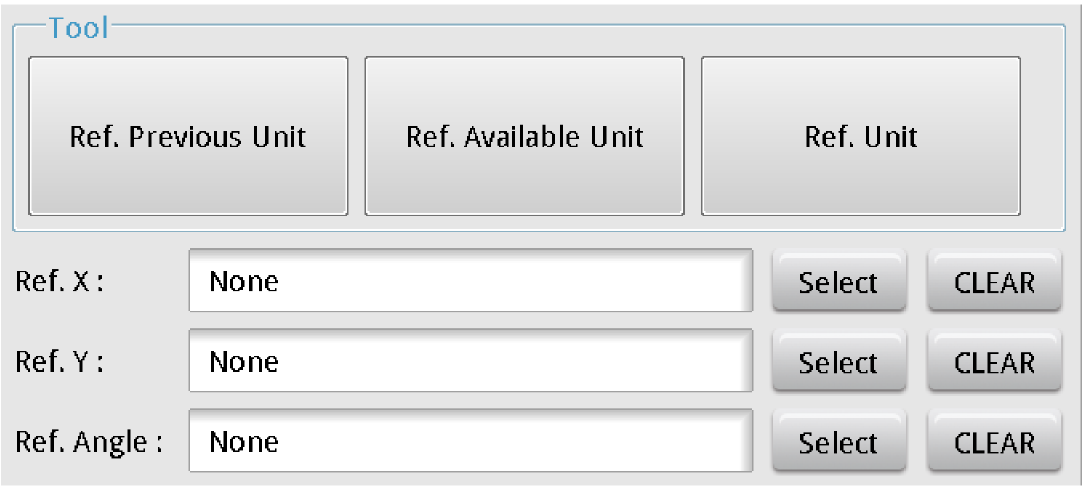
◎ **Locate**

This configures whether the inspection region will follow an inspection result for adjusting its coordinates (X, Y) and Angles (Theta). The inspection tools that can be used as a reference include [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.





➤ Three tools are also provided in this item for quick configuration.



◆ Reference Previous Unit

When clicked, the nearest inspection tool that can provide reference for Locate will be automatically filled in the Ref. X, Ref. Y, and Ref. Angle fields below.

◆ Reference Available Unit

When clicked, the nearest unit with Locate configured will be automatically filled in the Ref. X, Ref. Y, and Ref. Angle fields below.

◆ Reference Unit

The option arbitrarily selects an inspection tool that can provide locating reference and automatically fills in the reference values of the selected unit in the Ref. X, Ref. Y, and Ref. Angle fields below.

Reference Please refer to Section 9.1 for detailed locating configurations.

◎ **Execute**

Configures whether to execute the inspection function in the inspection process.

➤ Always Execute

Always execute the inspection function in run mode.

➤ Never Execute

Never execute the inspection function in run mode.

◎ **Save**

All modified parameters and values can be saved by clicking this button.

◎ **Exit**

Click to leave the setup page.

◎ **Output Item**

➤ Window

By selecting the output window, the total judge result of the Blob tool will be output 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.

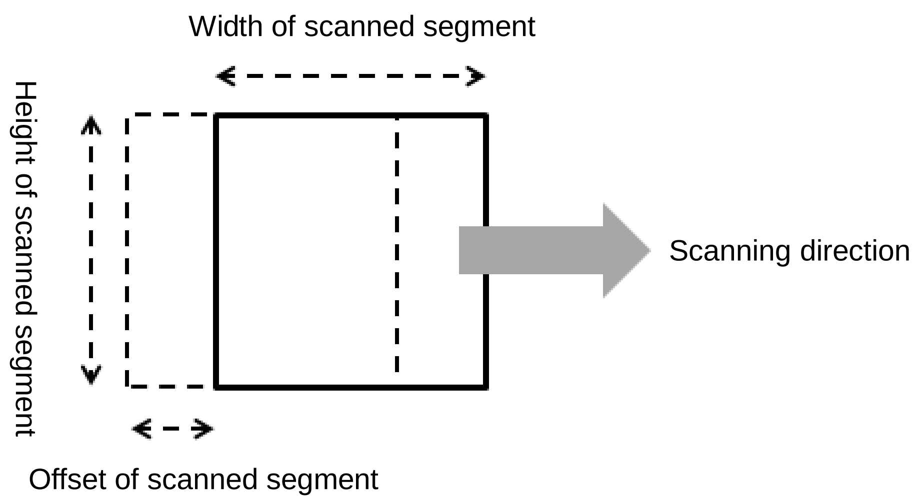
34) Blob Centroid Position Y (J) [N]: Outputs the logical (Judge) result for the centroid's Y coordinate of the Nth blob found by the Blob tool
35) Blob Area (J) [N]: Outputs the logical (Judge) result for the area of the Nth blob found by the Blob tool
36) Blob Perimeter (J) [N]: Outputs the logical (Judge) result for the perimeter of the Nth blob found by the Blob tool

5.3 Stain

When the object has stains in a fixed direction, such as scrapes and smears, the stain tool can be used for detection.

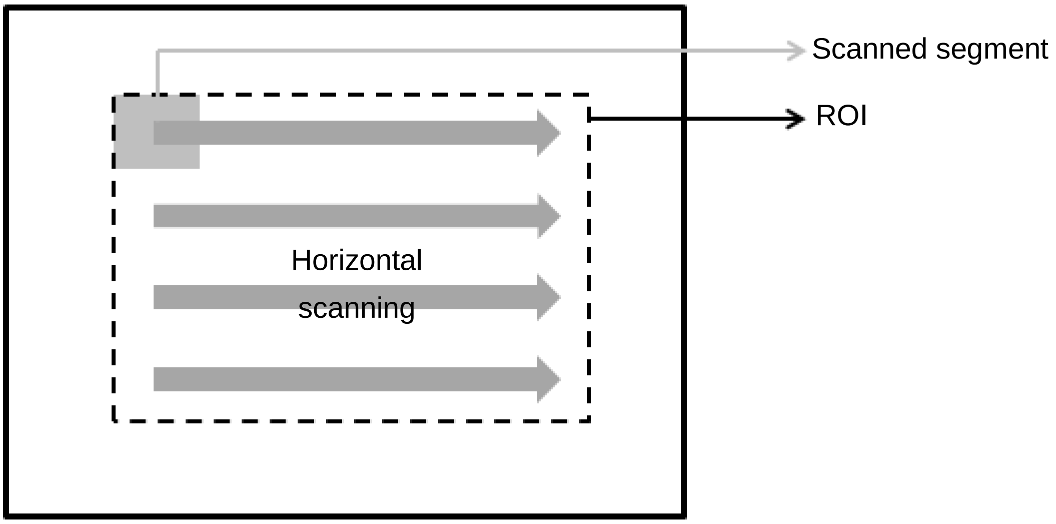
◎ **Algorithmic Processing**

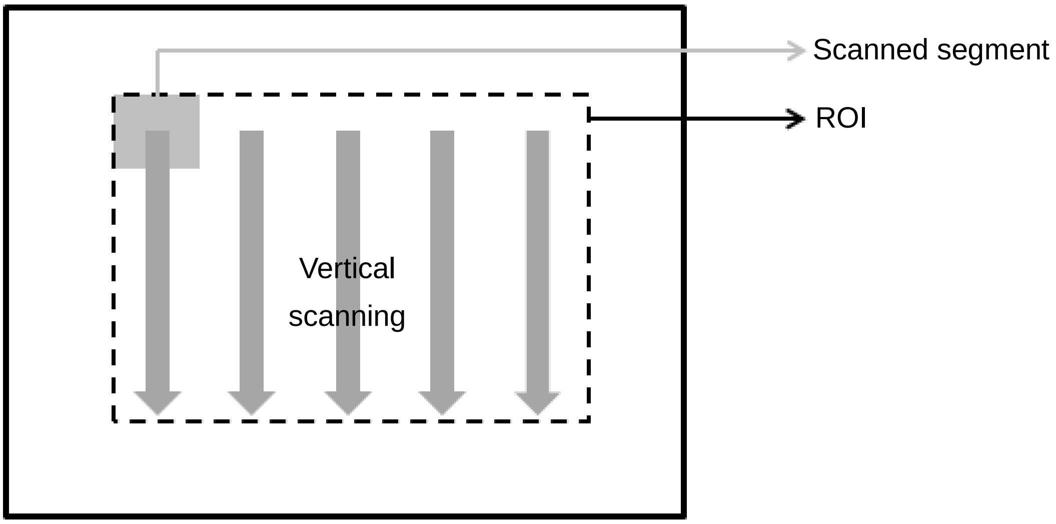
To use this function, the scan direction and the width, height, and offset of the scanned segment must first be defined. During each scan, the controller will calculate the average gray scale value within the scanned segment and compare this value with the previously scanned result. When the difference exceeds Stain Threshold and the area exceeds Stain Area, the system recognizes the segment as a stain.



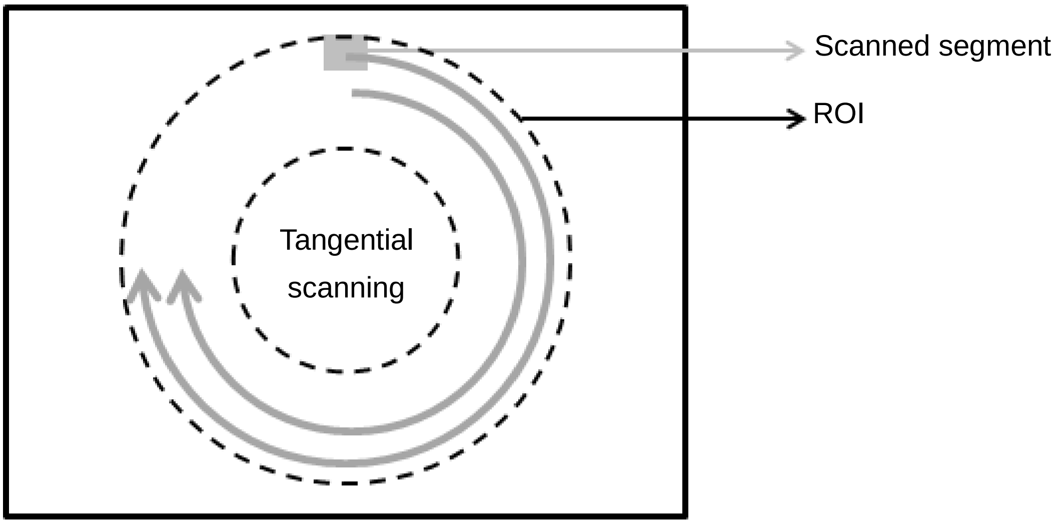
➤ Stain Scanning Methods

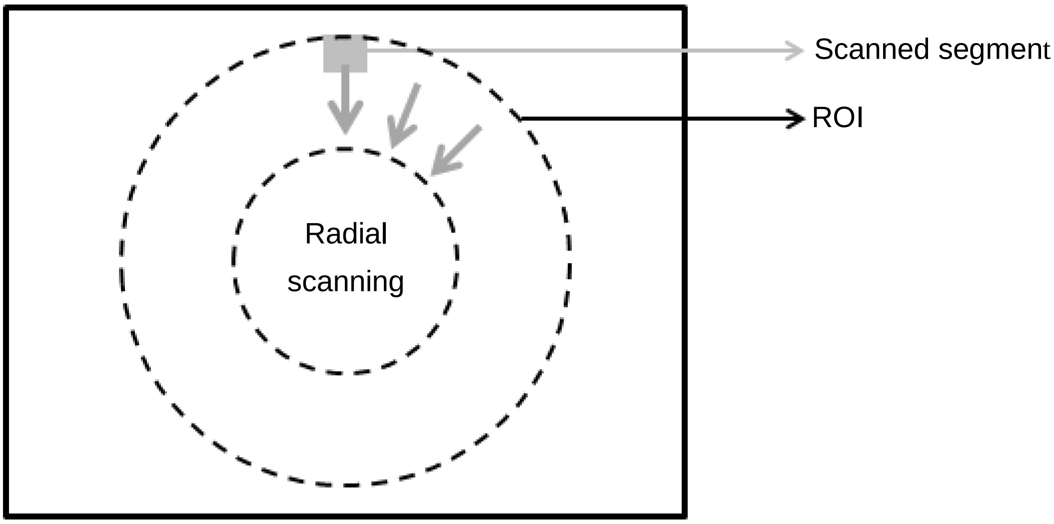
Stain includes diversified ROI options. Varying types of ROI options are available when choosing differing stain scanning methods. All types of ROIs can be scanned in horizontal, vertical, or horizontal–vertical directions. Horizontal and vertical scanning can be used to inspect stains in the vertical and horizontal directions, respectively.





◆ When ROI is [Circle], [Ring], or [Arc], tangential and radial directions can also be selected in addition to horizontal, vertical, and horizontal–vertical scanning. Tangential and radial scanning can be used to inspect stains in the radial and tangential directions, respectively.





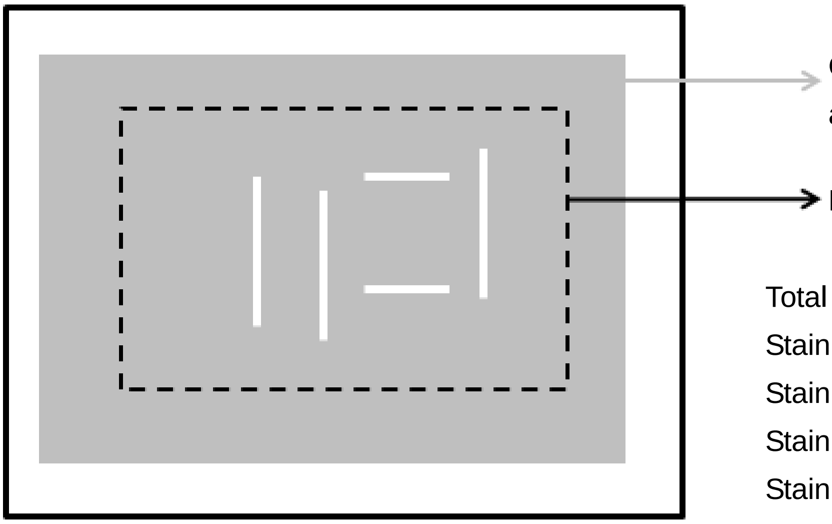
◎ **Procedural Results**

Blob returns the following inspection results.

- Total Area of Stains: Sum of stain area inspected.
- Stain Area [N]: Area of the Nth stain inspected.
- Stain Centroid Position X [N]: The X coordinate of the Nth stain inspected.
- Stain Centroid Position Y [N]: The Y coordinate of the Nth stain inspected.
- Stain Search Count: The number of stains inspected.

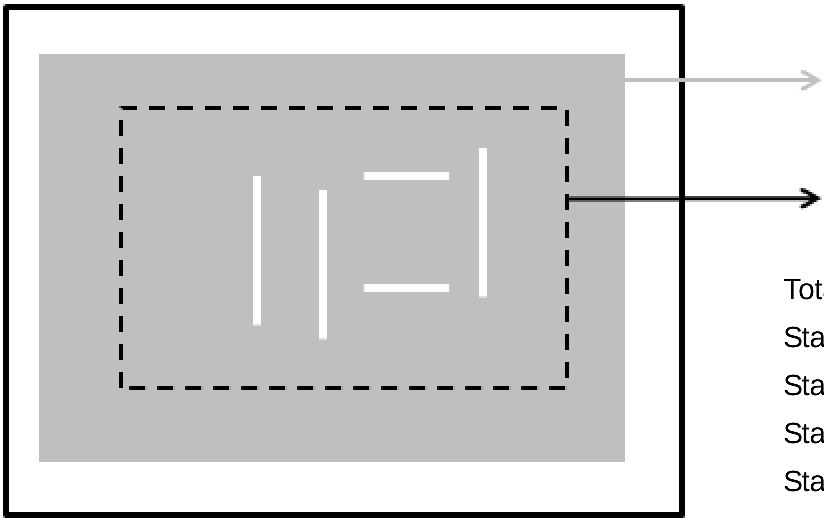
◎ **Example**

As shown in the following diagram, 3 scrapes in the vertical direction can be found using horizontal scanning.



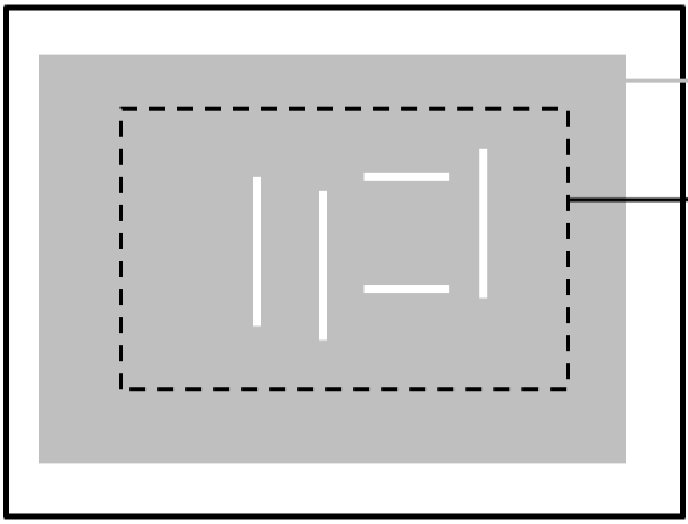
Total Area of Stains: 9000
Stain Area [1]: 3000
Stain Centroid Position X [1]: 200
Stain Centroid Position Y [1]: 300
Stain Search Count: 3

As shown in the following diagram, 2 scrapes in the horizontal direction can be found using vertical scanning.



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, 5 scrapes in the vertical and horizontal directions can be found using horizontal and vertical scanning.

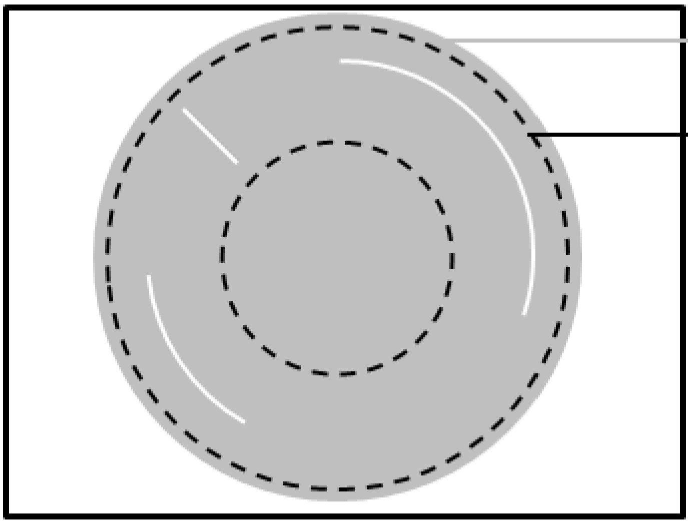


Object to be inspected, with 3 vertical and 2 horizontal scrapes

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, 1 scrape in the radial direction can be found using tangential scanning.

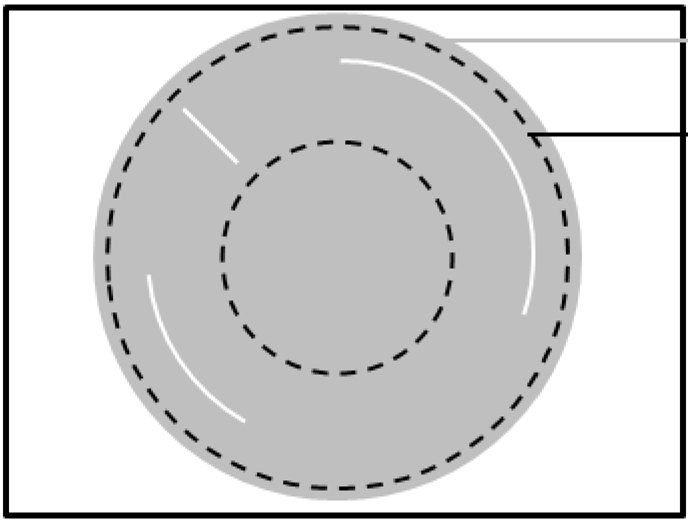


Object to be inspected, with 1 scrape in the radial direction

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, 2 scrape in the tangential direction can be found using radial scanning.



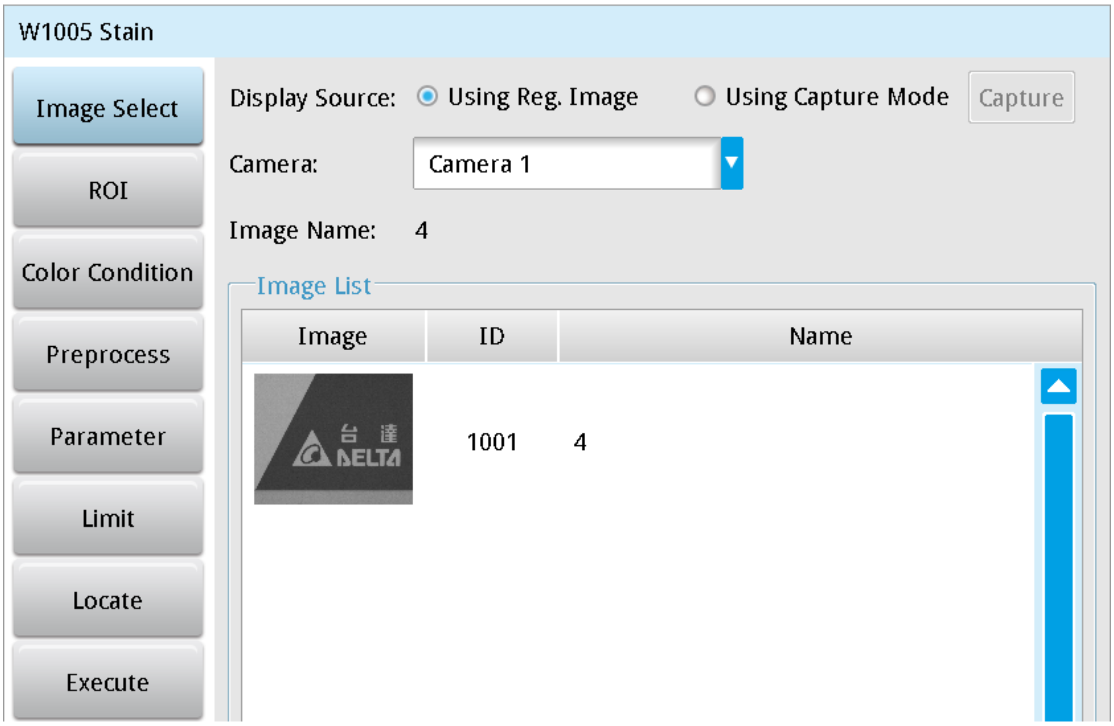
Object to be inspected, with 2 tangential and 1 radial scrapes

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

◎ **Stain Main Menu**

The Stain setup page includes the following items.



➤ Image Select (select Register Image)

Before entering inspection configurations, the registered image to be inspected must first be selected from the register gallery.

➤ ROI (configure detection region)

The desired inspection regions can be selected through ROI configurations. Optional ROI shapes include Rectangle, Circle, Arc, Ellipse, Ring, Polygon, and Rotated Rect.

➤ Color Condition

When using color camera, Color to Binary, Color to Grayscale, RGB grayscale, R Grayscale, G Grayscale, and B Grayscale can be configured on this page.

➤ Preprocess

When the camera image cannot perfectly highlight the emphasized effect, feature points can be enhanced through preprocessing.

➤ Parameter

The Stain inspection conditions can be adjusted in Parameter Setting.

➤ Limit

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.

➤ 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**

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)**

Optional ROI types include Rectangle, Circle, Ellipse, Ring, Arc, Polygon, and Rotated Rect. Polygon can support up to 16 points according to the requirement. Additionally, up to 8 mask functions are provided to ignore particular segments.

◎ **Color Condition**

Color images can be processed according to need. In Color Condition, images can be converted using the methods of Color to Binary, Color to Grayscale, RGB Grayscale, R grayscale, G grayscale, and B grayscale.

◎ **Preprocess**

Preprocess includes Binary, Dilation, Erosion, Average, Median, Laplacian, Sobel X, Sobel Y, Sobel XY, Brightness, Contrast, Shade, and Custom (filter) and can superimpose up to 6 options or produce custom preprocessed effect through Custom.

◎ **Parameter**

➤ Scanning Direction

Configures scanning directions to horizontal/vertical scanning; tangential/radial scanning can be selected for [Circle], [Ring], and [Arc] ROIs.

➤ Sort Rule

Configures 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

Configures the segment size to be scanned.

- Segment Offset

Configures the offset of the segment to be scanned.

- Stain Threshold

The difference between average gray scale values will be obtained during each scan. When this difference exceeds Stain Threshold, the system recognizes the segment as a stain. This parameter can be used as the basis for determining the shade of the stain.

- Stain Area

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

- Reference

Output the n-th result when scanning multiple targets.

- Number

Configures 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. The desired coordinates can be entered to change and move the origin to the new coordinates.

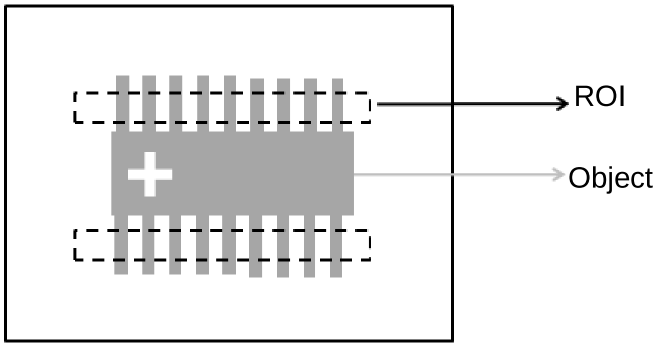
◎ **Limit**

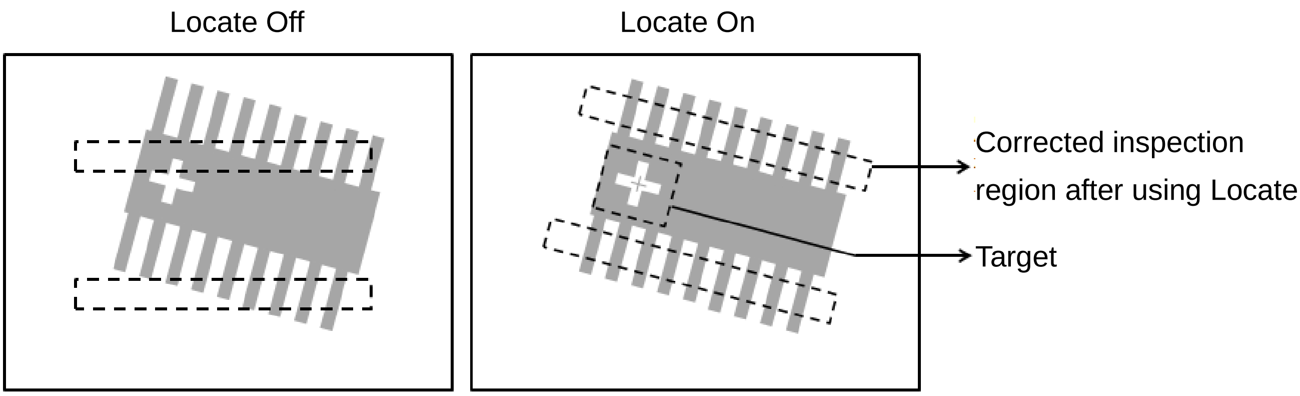
After acquiring the inspection results, Upper and Lower must be configured in this item to determine whether the result is qualified. The following items can be configured in Stain.

- Total Area: Configures the upper and lower limits of Total Area.
- Area: Configures the upper and lower limits of Area.
- Centroid Position X: Configures the upper and lower limits of centroid position in the X direction.
- Centroid Position Y: Configures the upper and lower limits of centroid position in the Y direction.
- Search Count: Configures the upper and lower limits for Search Count.

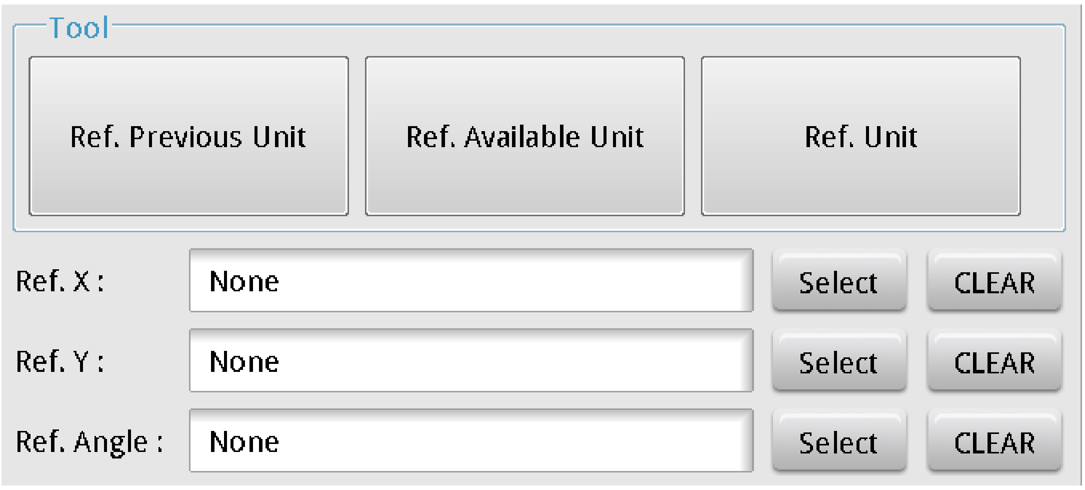
◎ **Locate**

This configures whether the inspection region will follow an inspection result for adjusting its coordinates (X, Y) and Angles (Theta). The inspection tools that can be used as a reference include [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.





➤ Three tools are also provided in this item for quick configuration.



◆ Reference Previous Unit

When clicked, the nearest inspection tool that can provide reference for Locate will be automatically filled in the Ref. X, Ref. Y, and Ref. Angle fields below.

◆ Reference Available Unit

When clicked, the nearest unit with Locate configured will be automatically filled in the Ref. X, Ref. Y, and Ref. Angle fields below.

◆ Reference Unit

The option arbitrarily selects an inspection tool that can provide locating reference and automatically fills in the reference values of the selected unit in the Ref. X, Ref. Y, and Ref. Angle fields below.

Reference Please refer to Section 9.1 for detailed locating configurations.

◎ **Execute**

Configures whether to execute the inspection function in the inspection process.

➤ Always Execute

Always execute the inspection function in run mode.

➤ Never Execute

Never execute the inspection function in run mode.

◎ **Save**

All modified parameters and values can be saved by clicking this button.

◎ **Exit**

Click to leave the setup page.

◎ **Output Item**

➤ Window

By selecting the output window, the total judge result of the Stain tool will be output on the designated interface.

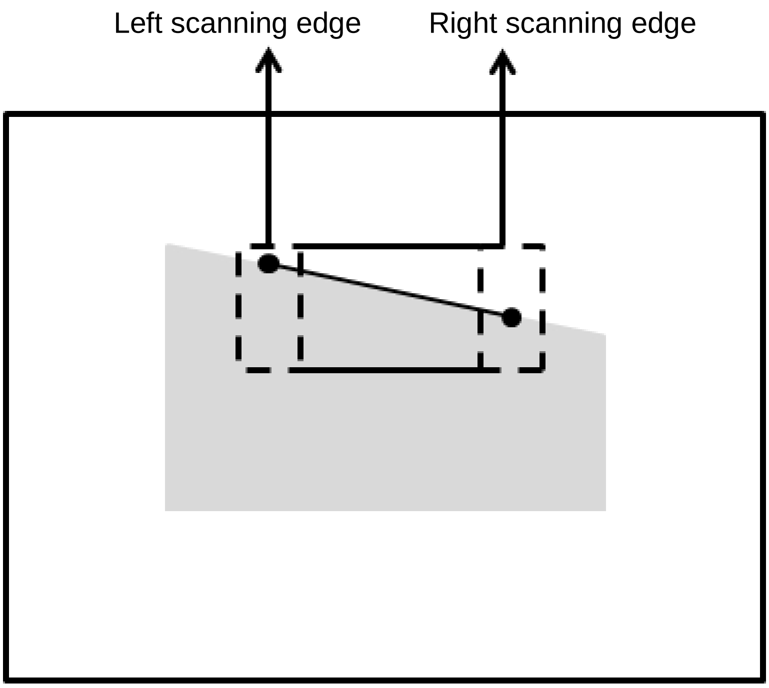
➤ Item

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

The function search for the two edges formed due to brightness difference on the gray scale image and obtains the relative angle created by the average coordinates. The search region can be configured. Two edges can be obtained at the two ends of the search region through horizontal scanning. Next, the function regresses two points through Average to draw a straight line, and calculates the angle of inclination of the straight line against the horizontal axis. The scanning width on the left and right sides can also be manually configured. When scanning wider edges, more points are acquired, leading to more accurate measured angles.



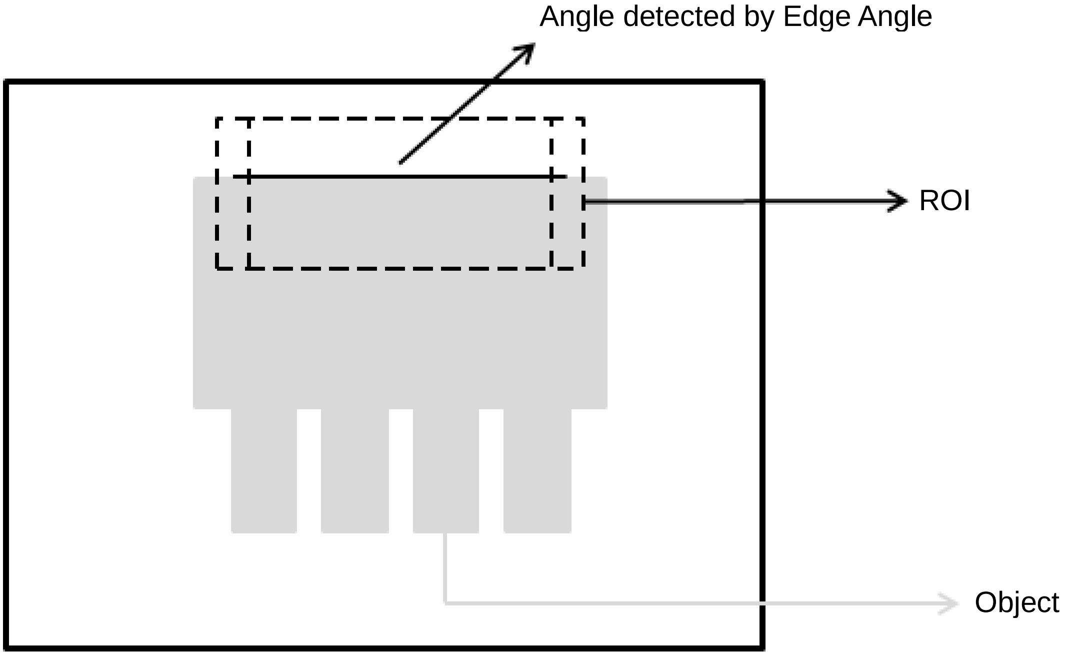
◎ **Algorithmic Processing**

➤ Edge Angle Scan Methods

Provides one type of ROI and can calculate the relative angles according to the four scanning directions.

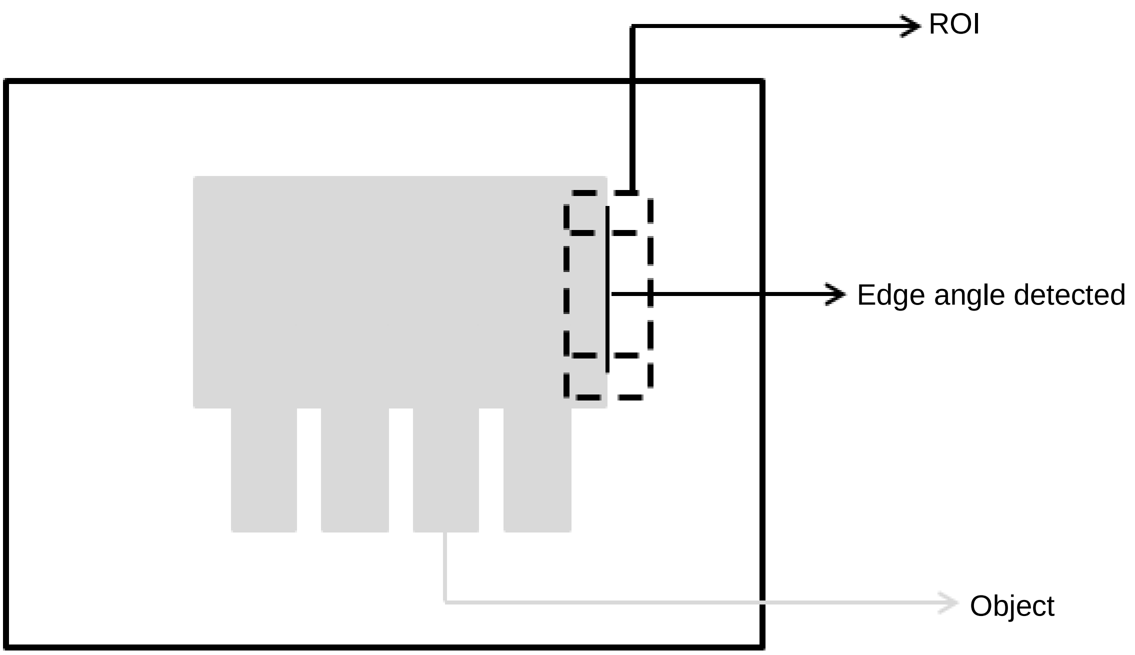
Scanning direction: Downward

Search method: All edges



Scanning direction: Right to left

Search method: Bright to dark



◎ Procedural Results

Edge Angle returns the following inspection results.

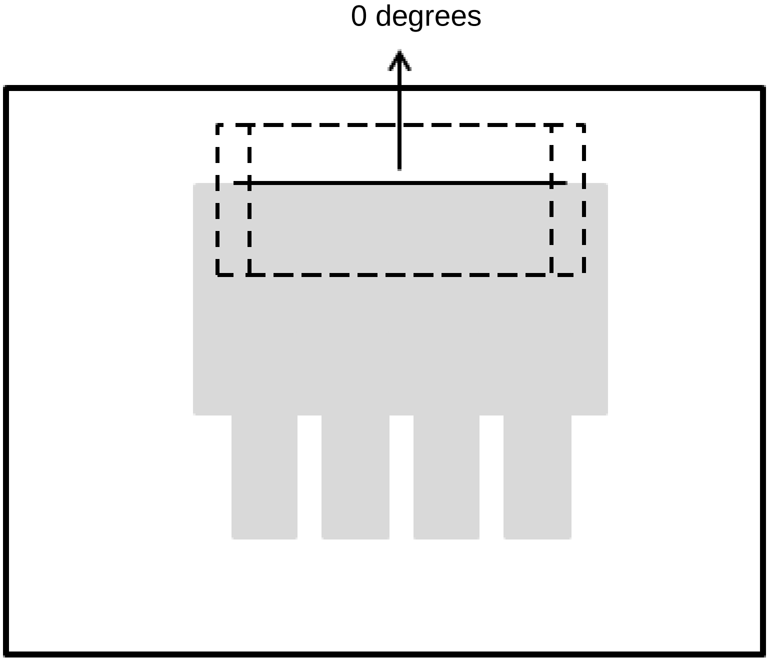
- Edge Angle: Outputs the angle from two points on the edge found by Edge Angle.
- Upper Edge Position X: Outputs the X coordinate of the first edge position encountered in the scanning direction from the two points found by Edge Position.
- Upper Edge Position Y: Outputs the Y coordinate of the first edge position encountered in the scanning direction from the two points found by Edge Position.
- Lower Edge Position X: Outputs the X coordinate of the second edge position encountered in the scanning direction from the two points found by Edge Position.
- Lower Edge Position Y: Outputs the Y coordinate of the second edge position encountered in the scanning direction from the two points found by Edge Position.

◎ Example

Scanning direction: Downward

Search method: All edges

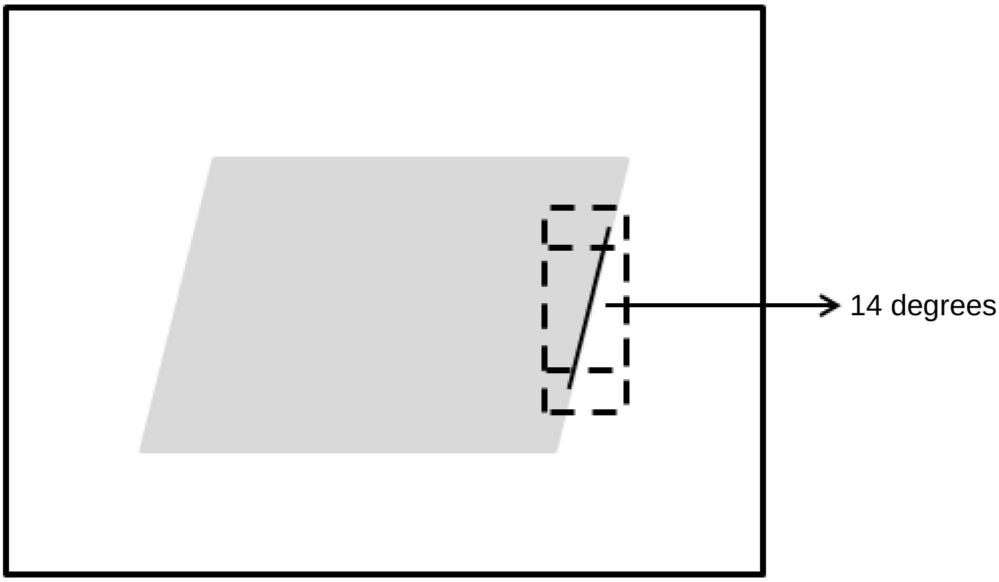
Inspection result: Absolute angle is 0 degrees



Scanning direction: Right to left

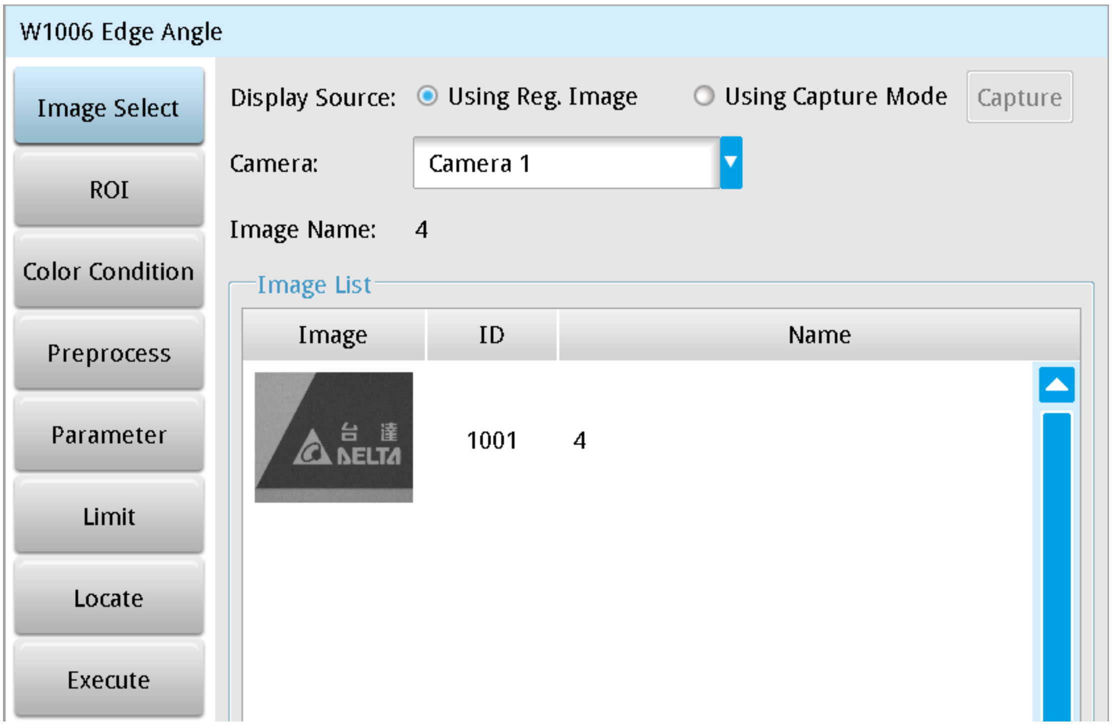
Search method: Bright to dark

Inspection result: Absolute angle is 14 degrees



◎ **Edge Angle Main Menu**

The Edge Angle setup page includes the following items.



➤ Image Select (select Register Image)

Before entering inspection configurations, the registered image to be inspected must first be selected from the register gallery.

➢ ROI (configure detection region)

The desired inspection regions can be selected through ROI configurations. The shape of the ROI in Edge Angle is only available in rectangles.

➢ Color Condition

When using color camera, Color to Binary, Color to Grayscale, RGB grayscale, R Grayscale, G Grayscale, and B Grayscale can be configured on this page.

➢ Preprocess

When the camera image cannot perfectly highlight the emphasized effect, feature points can be enhanced through preprocessing.

➢ Parameter

The search conditions can be adjusted in Parameter Setting.

➢ Limit

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.

➢ 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**

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)**

Only rectangles can be selected as the shape of the ROI in Edge Angle. The unique part is that the reference edge width for the two ends in the rectangle is configurable.

◎ **Color Condition**

Color images can be processed according to need. In Color Condition, images can be converted using the methods of Color to Binary, Color to Grayscale, RGB Grayscale, R grayscale, G grayscale, and B grayscale.

◎ **Preprocess**

Preprocess includes Binary, Dilation, Erosion, Average, Median, Laplacian, Sobel X, Sobel Y, Sobel XY, Brightness, Contrast, Shade, and Custom (filter) and can superimpose up to 6 options or produce custom preprocessed effect through Custom.

◎ **Parameter**

Edge Filter

➤ Direction

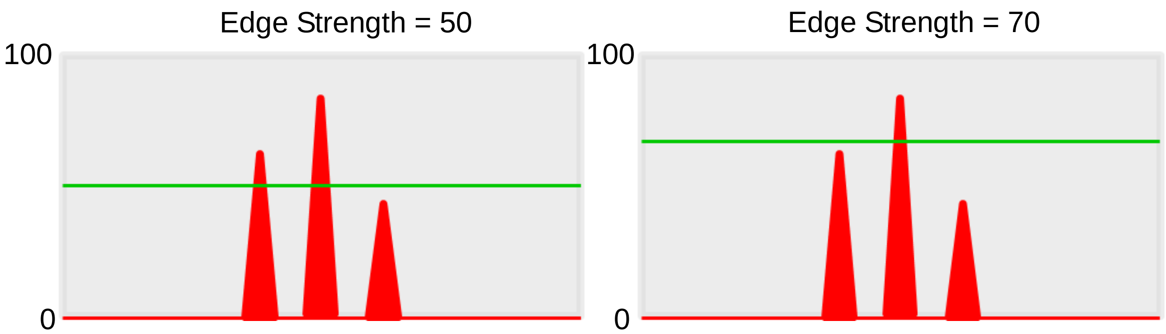
Rectangle is the only option in Edge Angle; which can be scanned using the four modes of [Left to Right], [Right to Left], [Downward], and [Upward].

➤ Look For

The search method can be configured according to need and can be divided into the three modes of [All Edges], [Light to Dark], and [Dark to Light].

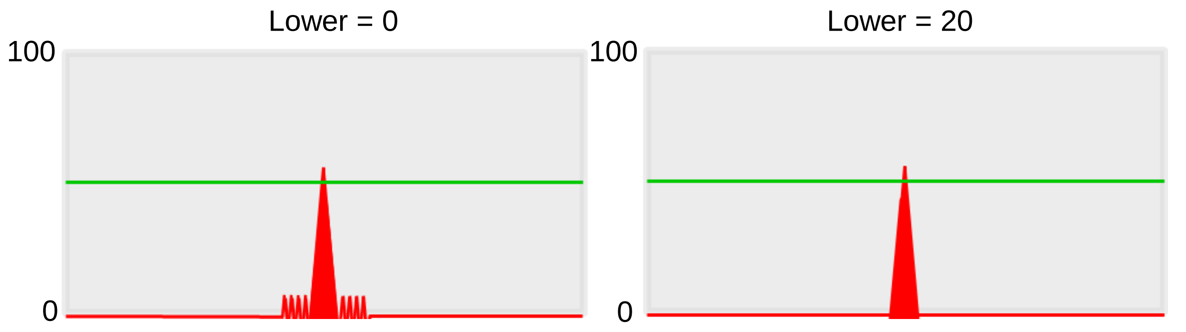
➤ Edge Strength

Edge Strength is the threshold of edge search (Look For) and can be fine-tuned between 0 and 100 based on the waveform displayed in the preview. When the wave is larger than the configured edge strength, Look For will identify the segment as an edge. As shown in the lower left diagram, the system will find two edges when Edge Strength is set to 50. As shown in the lower right diagram, only one edge, which is greater than the configured Edge Strength threshold of 70, remains.



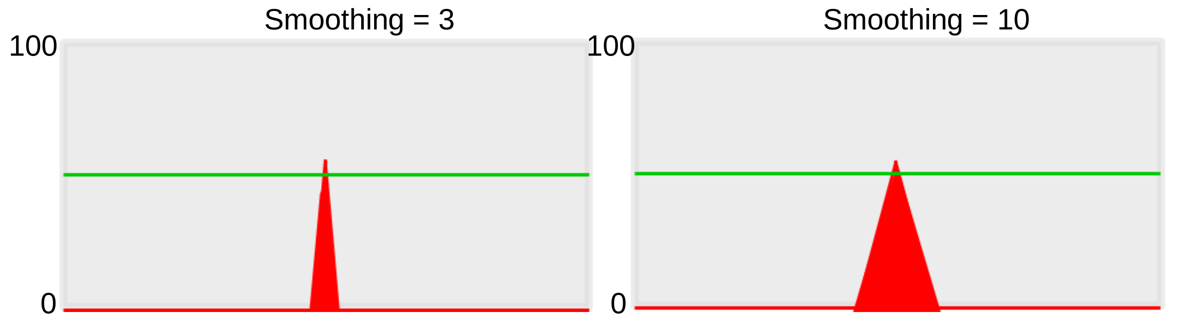
➤ Lower

Lower (limit) is used to filter small noise signals on the image and the parameter can be adjusted between 0 and 255. Waves less than the Lower configured value will disappear in the waveform. As shown in the lower left diagram, some noise appears when Lower is set to 0 and the noise will be filtered when Lower is set to 20.



➤ Smoothing

RGB Grayscale of edges can be set between 1 and 30 for calculations. When Smoothing is increased, Slope of waveform changes, thereby attenuating the effect caused by noise signals.



◎ **Limit**

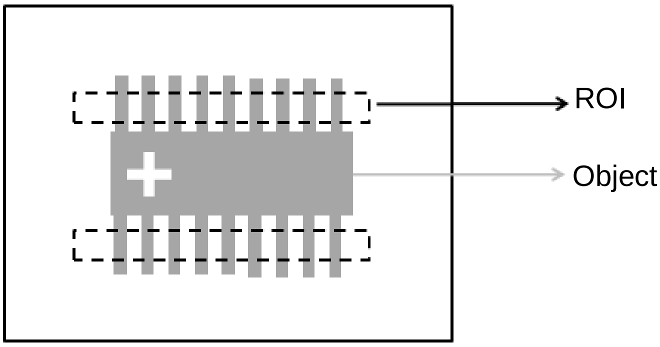
After acquiring the inspection results, Upper and Lower must be configured in this item to determine whether the result is qualified. The following item can be configured in Edge Angle.

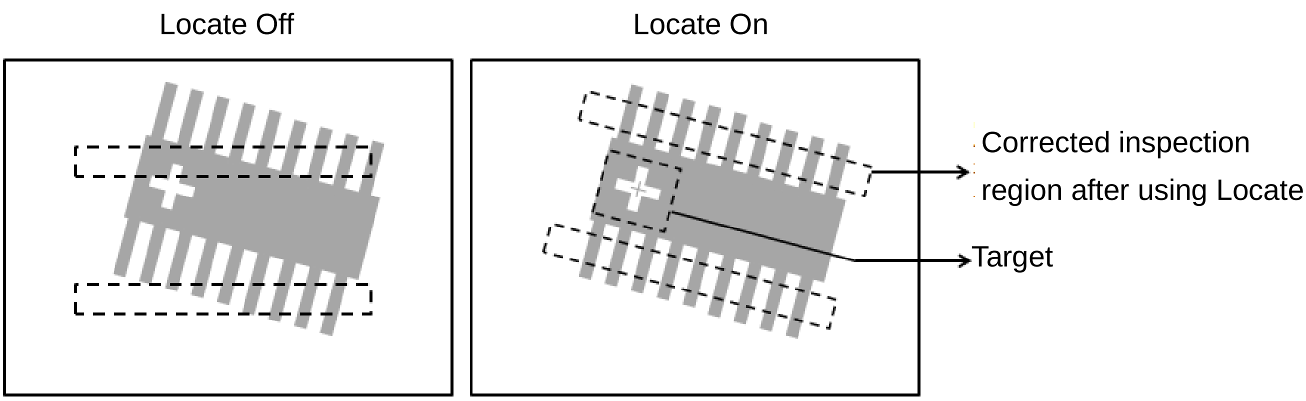
➤ Angle

Can configure the Upper and Lower limits of the angles detected by Edge Angle

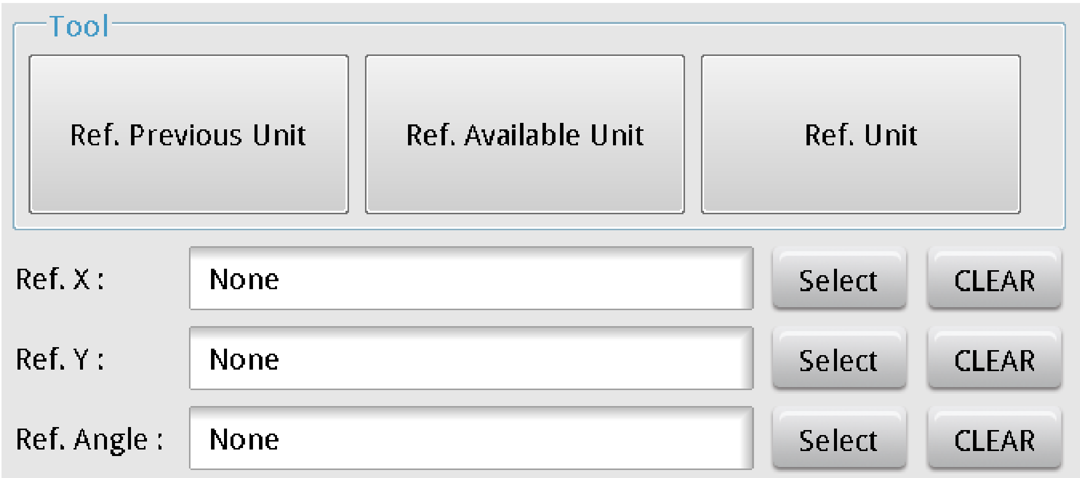
◎ **Locate**

This configures whether the inspection region will follow an inspection result for adjusting its coordinates (X, Y) and Angles (Theta). The inspection tools that can be used as a reference include [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.





➤ Three tools are also provided in this item for quick configuration.



◆ Reference Previous Unit

When clicked, the nearest inspection tool that can provide reference for Locate will be automatically filled in the Ref. X, Ref. Y, and Ref. Angle fields below.

◆ Reference Available Unit

When clicked, the nearest unit with Locate configured will be automatically filled in the Ref. X, Ref. Y, and Ref. Angle fields below.

◆ Reference Unit

The option arbitrarily selects an inspection tool that can provide locating reference and automatically fills in the reference values of the selected unit in the Ref. X, Ref. Y, and Ref. Angle fields below.

Reference Please refer to Section 9.1 for detailed locating configurations.

◎ **Execute**

Configures whether to execute the inspection function in the inspection process.

➤ Always Execute

Always execute the inspection function in run mode.

➤ Never Execute

Never execute the inspection function in run mode.

◎ **Save**

All modified parameters and values can be saved by clicking this button.

◎ **Exit**

Click to leave the setup page.

◎ **Output Item**

➤ Window

By selecting the output window, the total judge result of the Edge Angle tool will be output on the designated interface.

➤ Item

1) Edge Angle (EAG): Outputs the angle from two points on the edge found by Edge Angle.
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 Edge Position.
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 Edge Position.
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 Edge Position.
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 Edge Position.
6) Edge Angle ID: Outputs the ID of the inspection tool.
7) Edge Angle (J) (EAG): Outputs the configured standard judge result found by Edge Angle.

5.5 Edge Count

The function configures a fixed scanning path on the gray scale image and defines the types of edges. Any edge the system comes across in the scanning path that satisfies the edge type and demonstrates excess difference in gray scale is recognized as 1 edge. The total number of edges is acquired after completing the scan, providing the counter function.

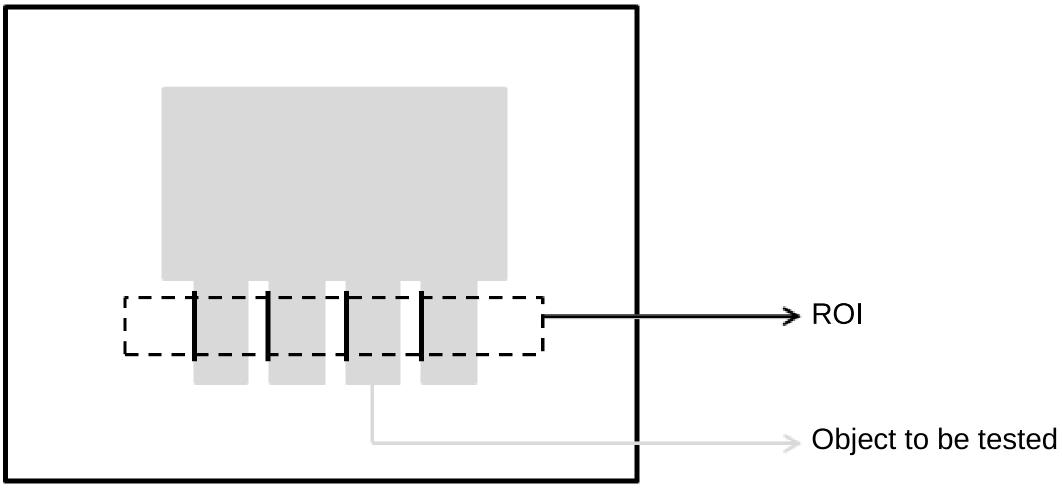
◎ **Algorithmic Processing**

➤ Edge Position Scan Methods

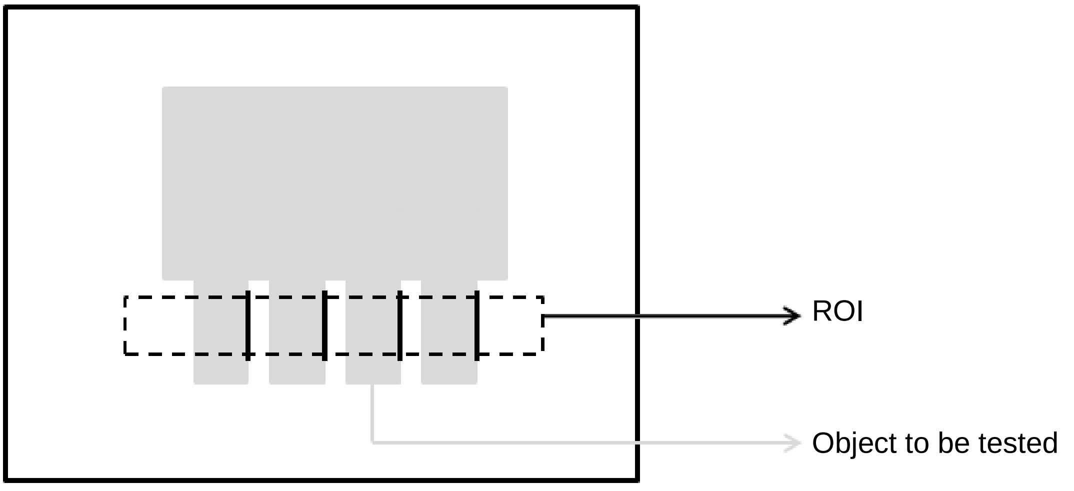
Edge Count includes diversified ROI options. Varying types of ROI options provide differing edge scanning methods.

◆ When the ROI is [Rectangle], [Circle], [Polygon], [Ellipse], and [Rotated Rect], the scanning direction can be defined as the four modes of left to right, right to left, downward, and upward.

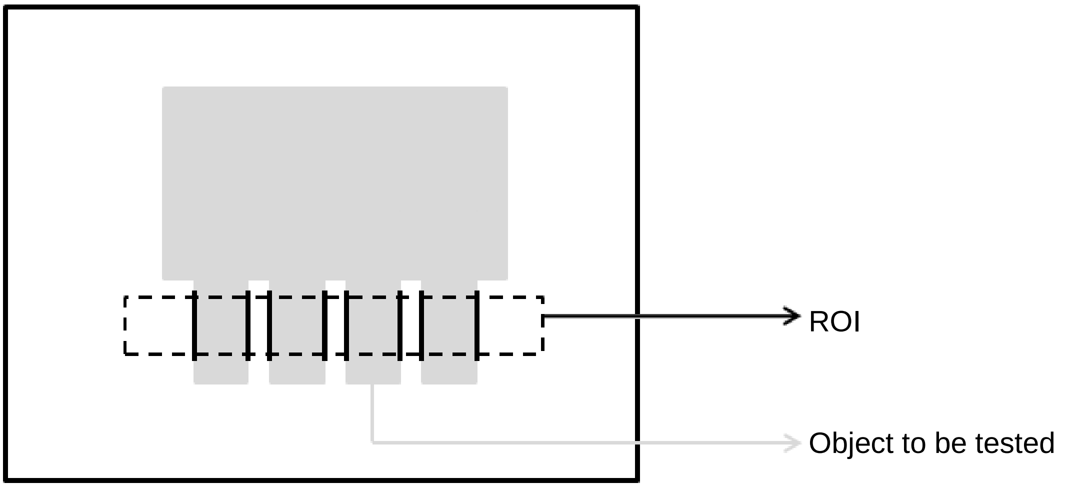
1) When the scanning direction is configured to left to right, and the edge type is light to dark, 4 edges are found in the result shown as follows:



2) When the scanning direction is configured to left to right, and the edge type is dark to light, 4 edges are found in the result shown as follows:

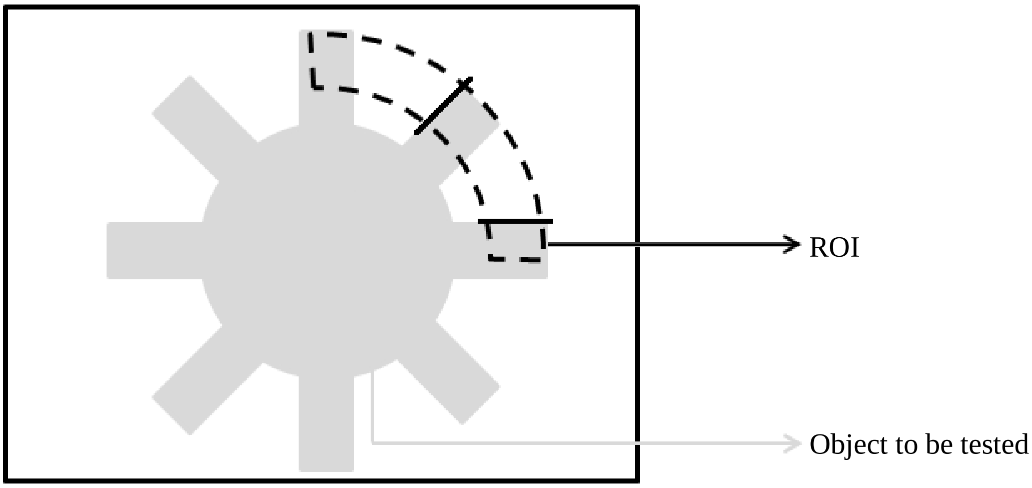


3) When the scanning direction is configured to left to right with all edge types included, 8 edges are found in the result shown as follows:

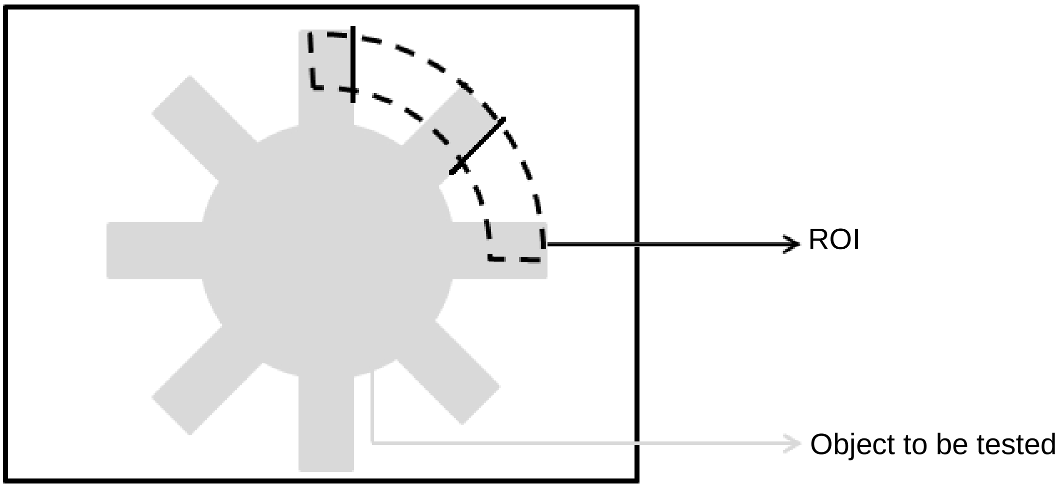


◆ When the ROI is [Ring] and [Arc], the scanning direction can be configured to the tow scanning methods of clockwise and counterclockwise.

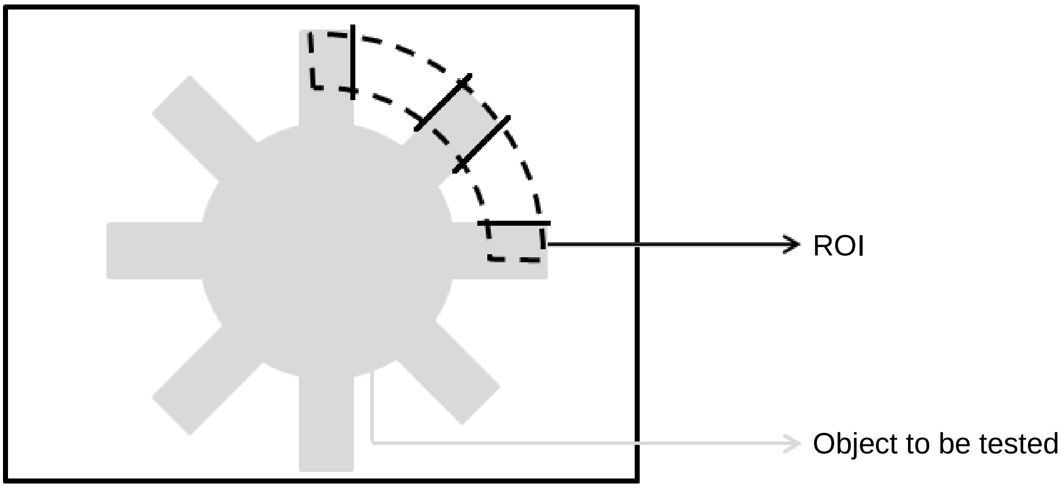
1) When the scanning direction is configured to clockwise, and the edge type is light to dark, 2 edges are found in the result shown as follows:



2) When the scanning direction is configured to clockwise, and the edge type is dark to light, 2 edges are found in the result shown as follows:



3) When the scanning direction is configured to clockwise with all edge types included, 5 edges are found in the result shown as follows:



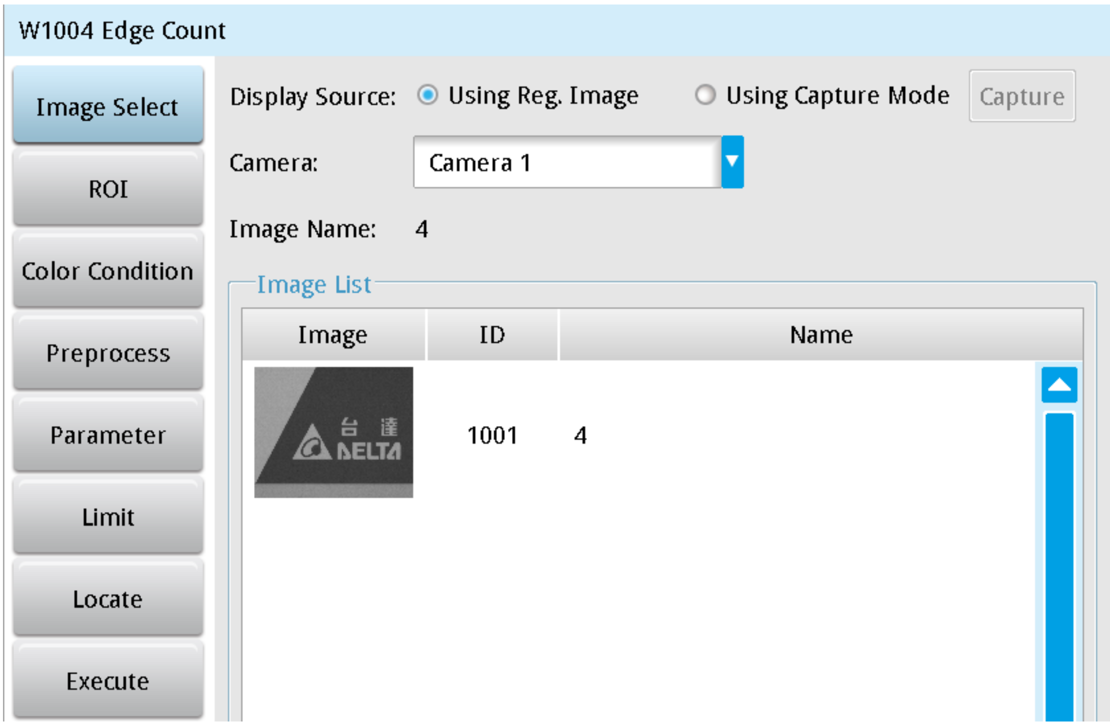
◎ **Procedural Results**

Edge Count returns the following inspection results.

➤ Edge Count Number of Edges: Total Number of Edges

◎ **Edge Count Main Menu**

The Edge Count setup page includes the following items.



➤ Image Select (select Register Image)

Before entering inspection configurations, the registered image to be inspected must first be selected from the register gallery.

➢ ROI (configure detection region)

The desired inspection regions can be selected through ROI configurations. Optional ROI shapes include Rectangle, Circle, Arc, Ellipse, Ring, Polygon, and Rotated Rect.

➢ Color Condition

When using color camera, Color to Binary, Color to Grayscale, RGB grayscale, R Grayscale, G Grayscale, and B Grayscale can be configured on this page.

➢ Preprocess

When the camera image cannot perfectly highlight the emphasized effect, feature points can be enhanced through preprocessing.

➢ Parameter

The Edge Position inspection conditions can be adjusted in Parameter Setting.

➢ Limit

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.

➢ 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**

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)**

Optional ROI types include Rectangle, Circle, Ellipse, Ring, Arc, Polygon, and Rotated Rect. Polygon can support up to 16 points according to the requirement. Additionally, up to 8 mask functions are provided to ignore particular segments.

◎ **Color Condition**

Color images can be processed according to need. In Color Condition, images can be converted using the methods of Color to Binary, Color to Grayscale, RGB Grayscale, R grayscale, G grayscale, and B grayscale.

◎ **Preprocess**

Preprocess includes Binary, Dilation, Erosion, Average, Median, Laplacian, Sobel X, Sobel Y, Sobel XY, Brightness, Contrast, Shade, and Custom (filter) and can superimpose up to 6 options or produce custom preprocessed effect through Custom.

◎ **Parameter**

Edge filter

➤ Direction

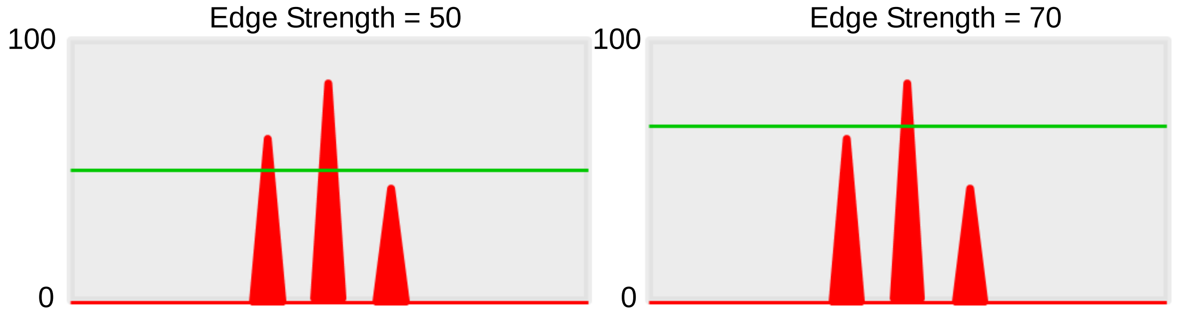
When ROI is configured as ring or arc, [Clockwise] and [Counterclockwise] can be selected as the two modes of scanning directions. When other shapes of ROIs are selected, [Left to Right], [Right to Left], [Upward], and [Downward] can be selected as the four modes of scanning directions.

➤ Look For

The search method can be configured according to need and can be divided into the three modes of [All Edges], [Light to Dark], and [Dark to Light].

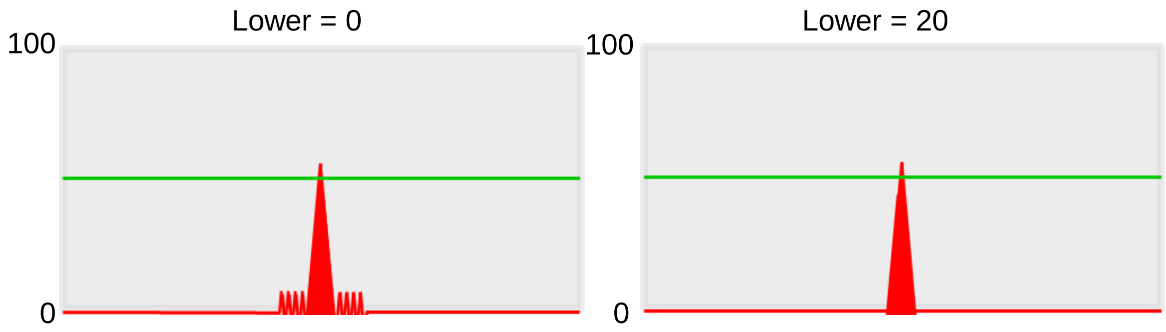
➤ Edge Strength

Edge Strength is the threshold of edge search (Look For) and can be fine-tuned between 0 and 100 based on the waveform displayed in the preview. When the wave is larger than the configured edge strength, Look For will identify the segment as an edge. As shown in the lower left diagram, the system will find two edges when Edge Strength is set to 50. As shown in the lower right diagram, only one edge, which is greater than the configured Edge Strength threshold of 70, remains.



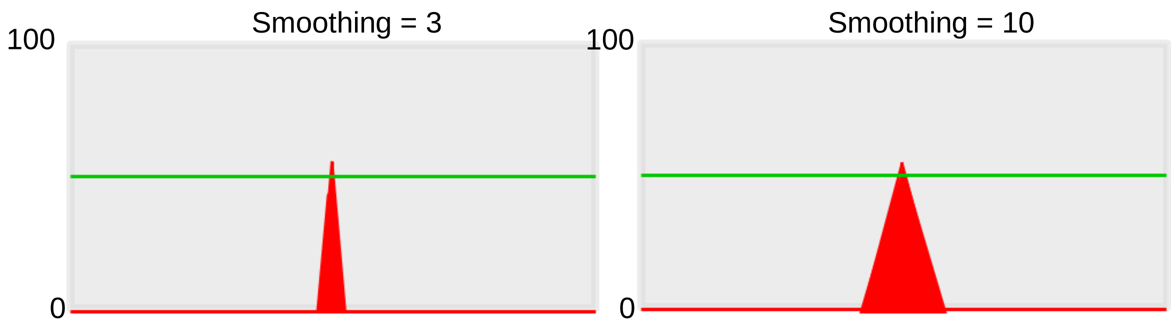
➤ Lower

Lower (limit) is used to filter small noise signals on the image and the parameter can be adjusted between 0 and 255. Waves less than the Lower configured value will disappear in the waveform. As shown in the lower left diagram, some noise appears when Lower is set to 0 and the noise will be filtered when Lower is set to 20.



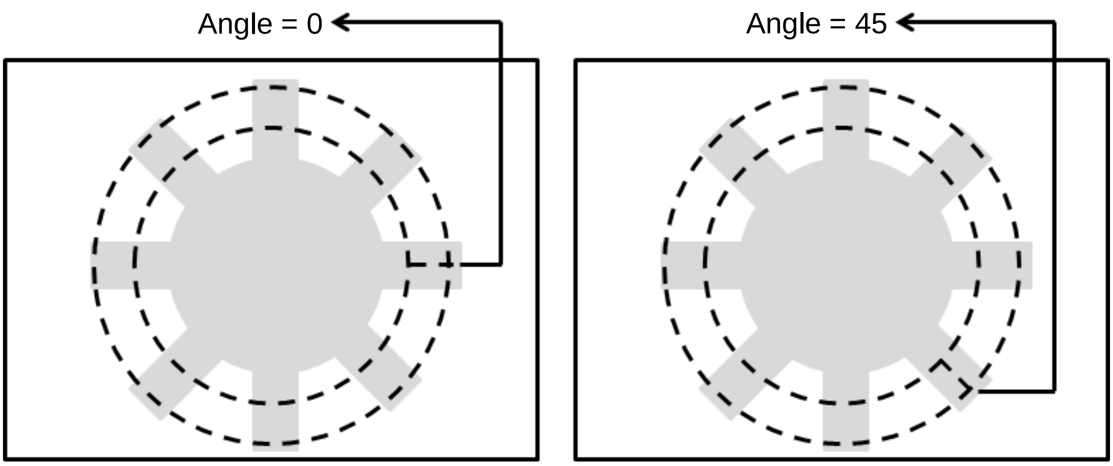
➤ Smoothing

RGB Grayscale of edges can be set between 1 and 30 for calculations. When Smoothing is increased, Slope of waveform changes, thereby attenuating the effect caused by noise signals.



➤ Angle

When ROI is set to [Ring] or [Arc], the starting angle for edge scans can be configured in this item. As shown in the lower left and right diagrams, the starting angles are 0 and 45 degrees, respectively.



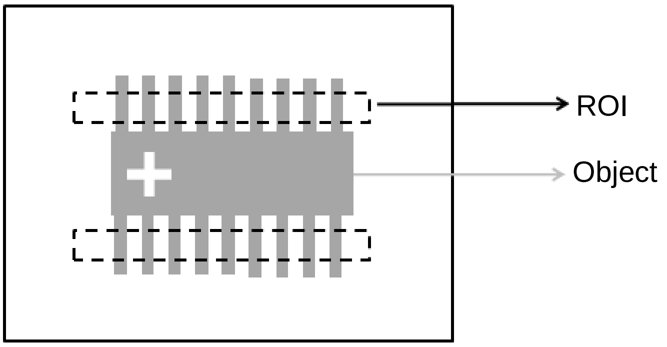
◎ **Limit**

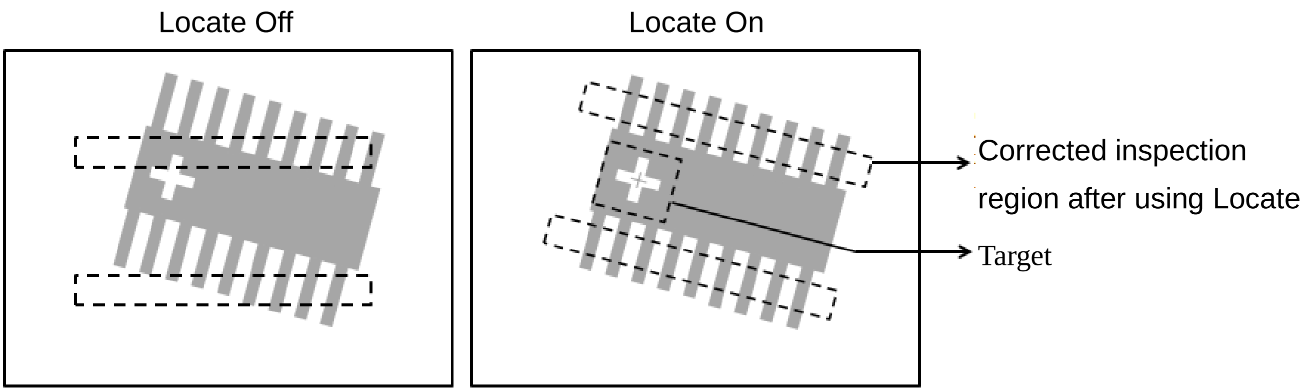
After acquiring the inspection results, Upper and Lower must be configured in this item to determine whether the result is qualified. The following item can be configured in Edge Position.

➤ Number of Edges: Can configure the upper and lower limits for the number of edges

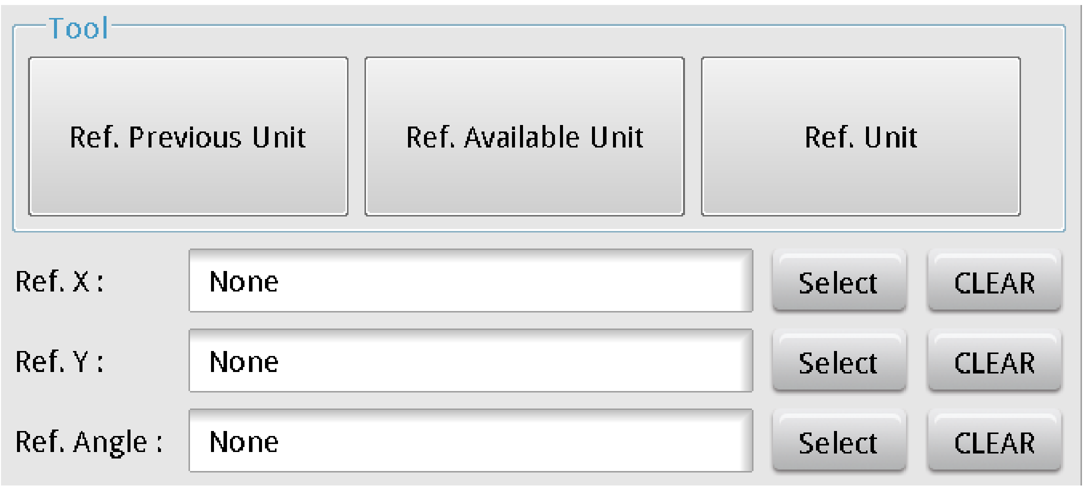
◎ **Locate**

This configures whether the inspection region will follow an inspection result for adjusting its coordinates (X, Y) and Angles (Theta). The inspection tools that can be used as a reference include [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.





➤ Three tools are also provided in this item for quick configuration.



◆ Reference Previous Unit

When clicked, the nearest inspection tool that can provide reference for Locate will be automatically filled in the Ref. X, Ref. Y, and Ref. Angle fields below.

◆ Reference Available Unit

When clicked, the nearest unit with Locate configured will be automatically filled in the Ref. X, Ref. Y, and Ref. Angle fields below.

◆ Reference Unit

The option arbitrarily selects an inspection tool that can provide locating reference and automatically fills in the reference values of the selected unit in the Ref. X, Ref. Y, and Ref. Angle fields below.

Reference Please refer to Section 9.1 for detailed locating configurations

◎ **Execute**

Configures whether to execute the inspection function in the inspection process.

➤ Always Execute

Always execute the inspection function in run mode.

➤ Never Execute

Never execute the inspection function in run mode.

◎ **Save**

All modified parameters and values can be saved by clicking this button.

◎ **Exit**

Click to leave the setup page.

◎ **Output Item**

➤ Window

By selecting the output window, the total judge result of the Edge Count tool will be output on the designated interface.

➤ Item

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

5.6 Edge Pitch

Edge Pitch is an enhanced function of Edge Width and is capable of measuring multiple widths instead of just between two edges (as in Edge Width). The individual width, max width, min width, and average width can be calculated.

◎ **Algorithmic Processing**

➤ Edge Pitch Scan Methods

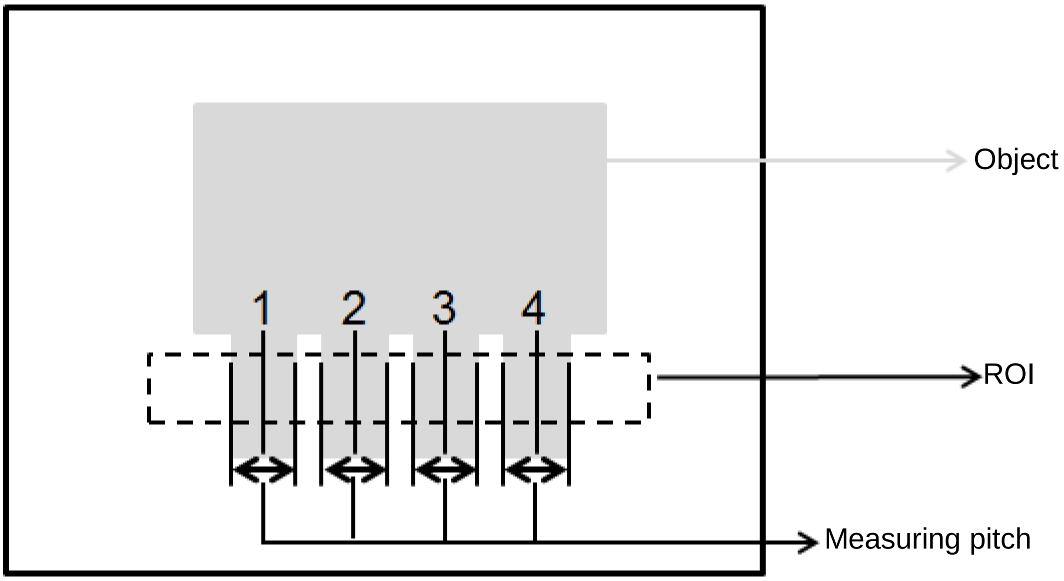
Edge Pitch includes diversified ROI options. Varying types of ROI options provide differing edge scanning methods.

◆ The two following conditions usually occur for ROIs other than [Ring] and [Arc].

Scanning direction: Left to Right

Search method: All edges

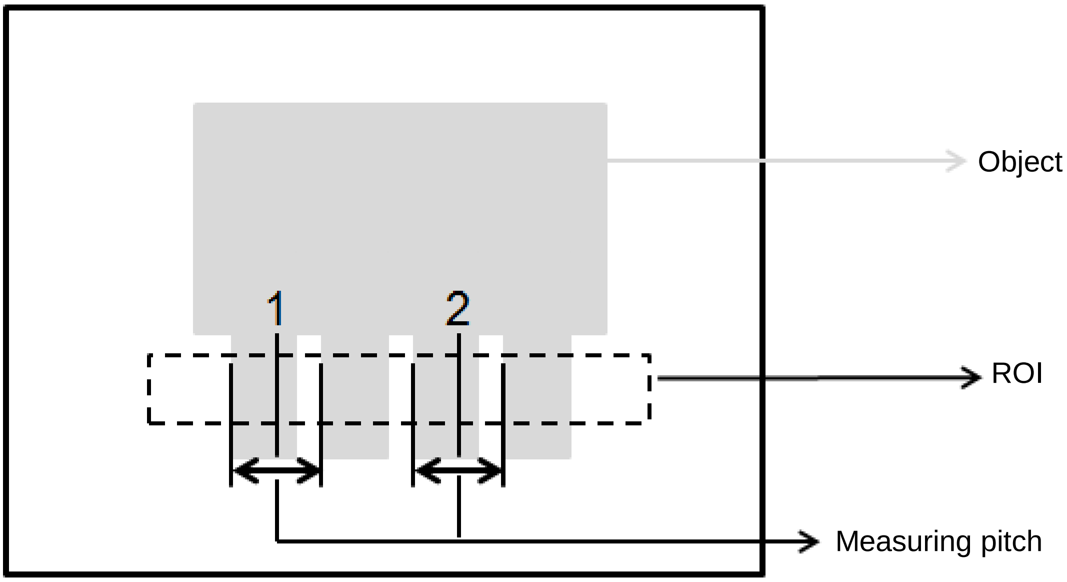
Reference: 1



Scanning direction: Left to Right

Search method: Bright to dark

Reference: 1



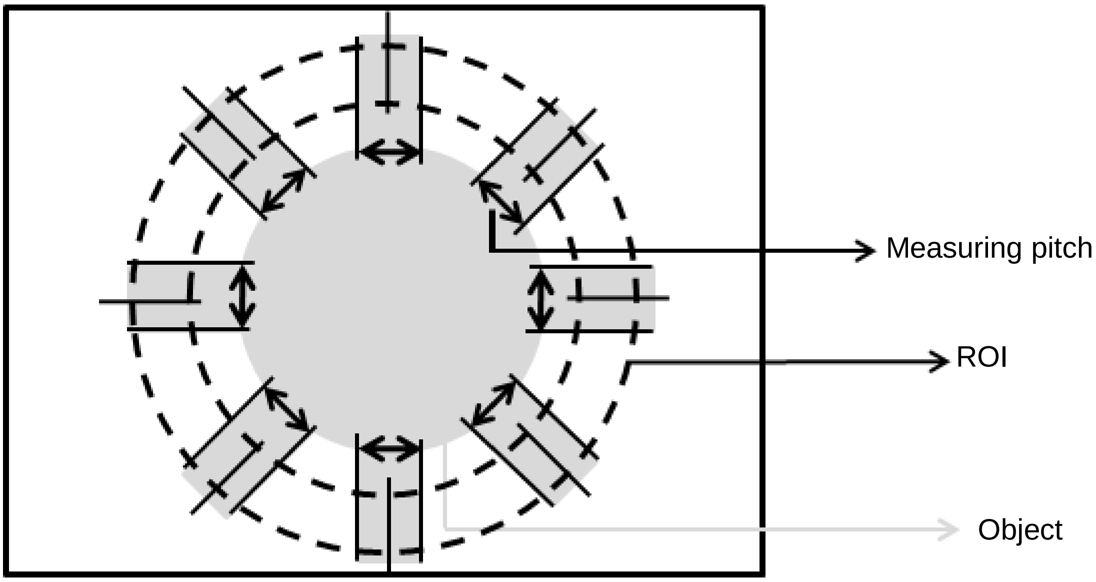
◆ The two following conditions usually occur for ROIs other than [Ring] and [Arc].

Scanning direction: Clockwise

Search method: All edges

Angle: -45

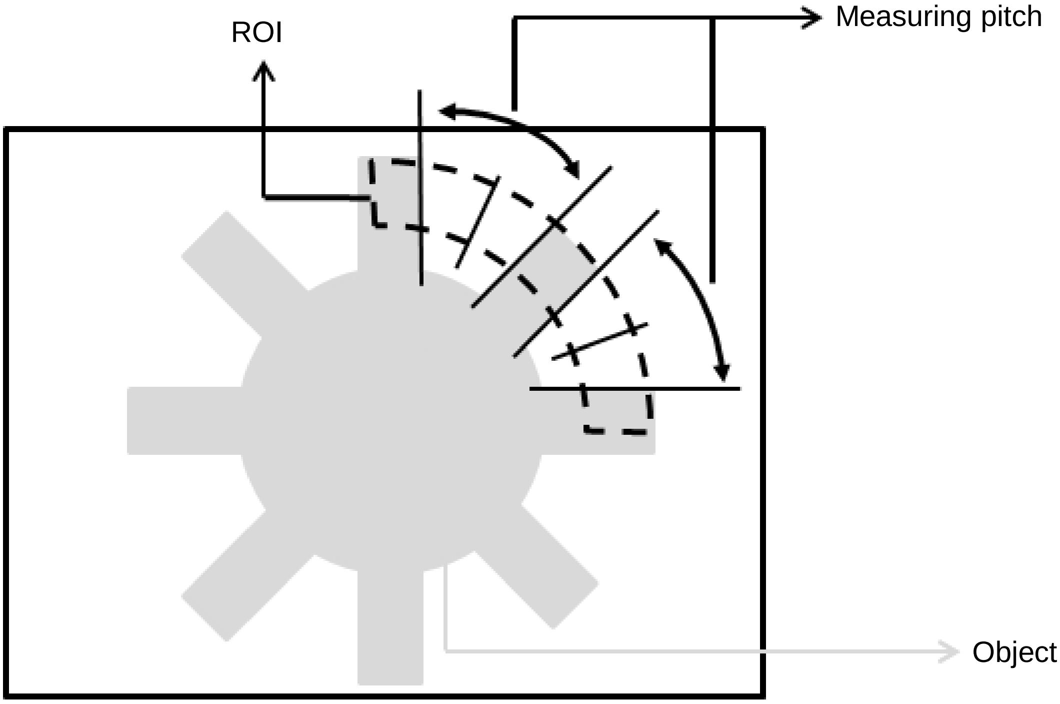
Reference: 1



Scanning direction: Clockwise

Search method: All edges

Reference: 1



◎ **Procedural Results**

Edge Pitch returns the following inspection results.

- Pitch Count: Outputs the total number of pitches found by Edge Pitch.
- Maximum Pitch: Outputs the width data of the maximum pitch found among all pitch data by Edge Pitch.
- Minimum Pitch: Outputs the width data of the minimum pitch found among all pitch data by Edge Pitch.
- Average Pitch: Outputs the total average of all pitch data found by Edge Pitch.

◎ **Example**

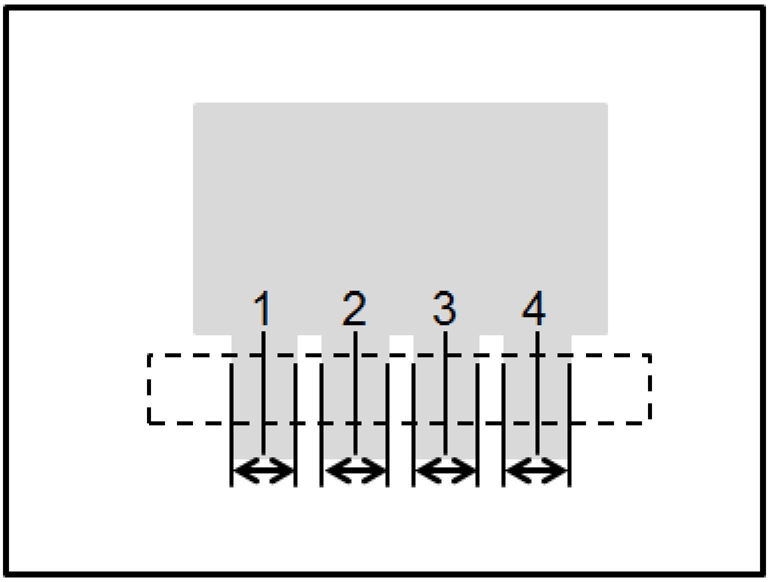
◆ For ROIs other than [Ring] and [Arc]

Scanning direction: Left to Right

Search method: All edges

Reference: 1

Inspection result: Pitch1 = 90, Pitch2 = 91, Pitch3 = 94, Pitch4 = 91

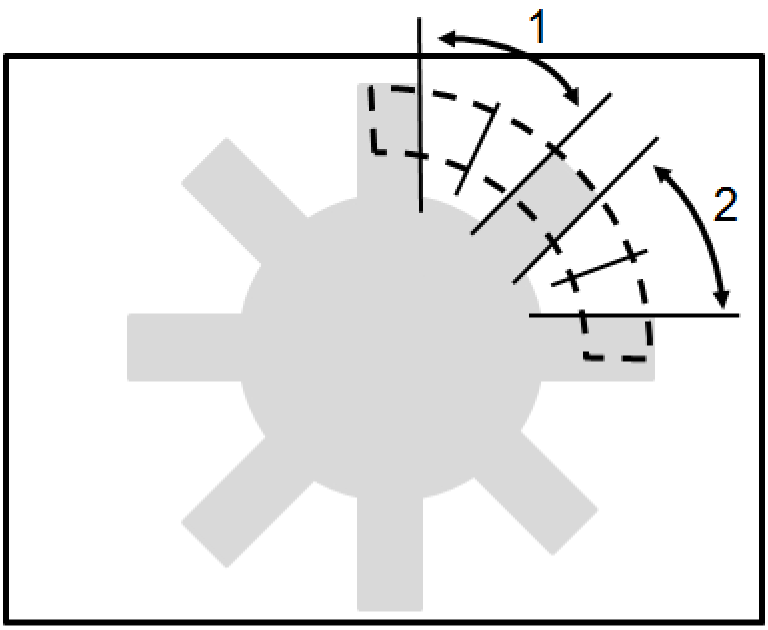


Scanning direction: Left to Right

Search method: All edges

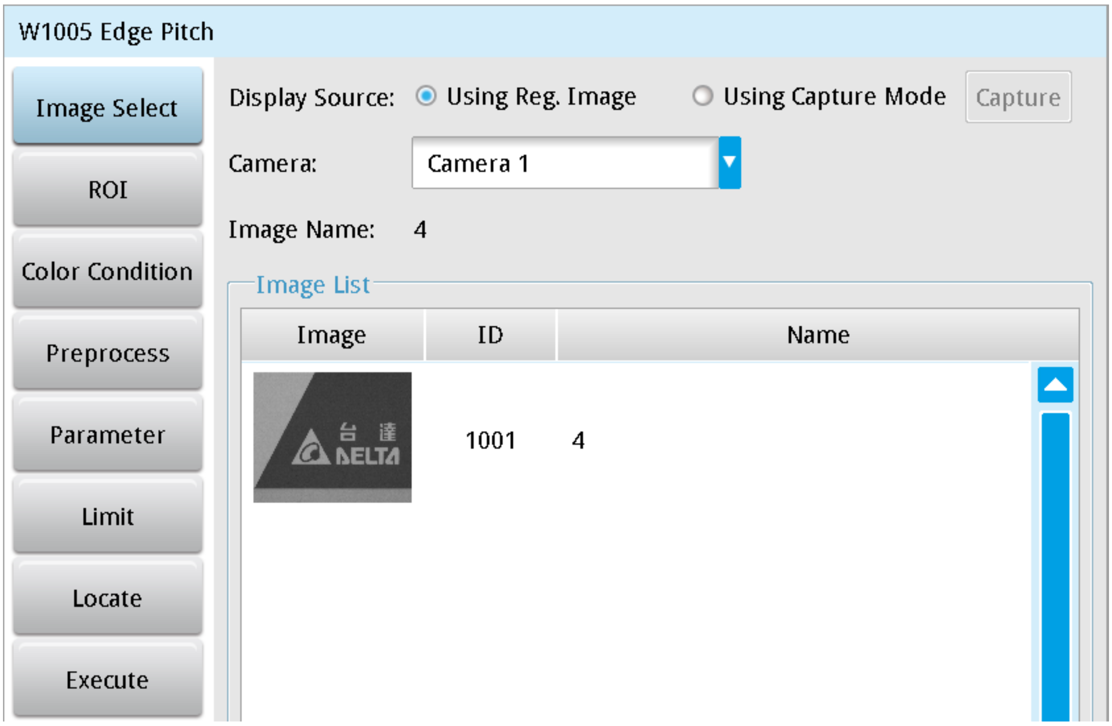
Reference: 1

Inspection result: Pitch1 = 201, Pitch2 = 200



◎ **Edge Pitch Main Menu**

The Edge Pitch setup page includes the following items.



➤ Image Select (select Register Image)

Before entering inspection configurations, the registered image to be inspected must first be selected from the register gallery.

➤ ROI (configure detection region)

The desired inspection regions can be selected through ROI configurations. Optional ROI shapes include Rectangle, Circle, Ellipse, Ring, Polygon, and Rotated Rect.

➤ Color Condition

When using color camera, Color to Binary, Color to Grayscale, RGB grayscale, R Grayscale, G Grayscale, and B Grayscale can be configured on this page.

➤ Preprocess

When the camera image cannot perfectly highlight the emphasized effect, feature points can be enhanced through preprocessing.

➤ Parameter

The Edge Pitch inspection conditions can be adjusted in Parameter Setting.

➤ Limit

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.

- 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**

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)**

Optional ROI types include Rectangle, Circle, Ellipse, Ring, Arc, Polygon, and Rotated Rect. Polygon can support up to 16 points according to the requirement. Additionally, up to 8 mask functions are provided to ignore particular segments.

◎ **Color Condition**

Color images can be processed according to need. In Color Condition, images can be converted using the methods of Color to Binary, Color to Grayscale, RGB Grayscale, R grayscale, G grayscale, and B grayscale.

◎ **Preprocess**

Preprocess includes Binary, Dilation, Erosion, Average, Median, Laplacian, Sobel X, Sobel Y, Sobel XY, Brightness, Contrast, Shade, and Custom (filter) and can superimpose up to 6 options or produce custom preprocessed effect through Custom.

◎ **Parameter**

Edge filter

- Direction

When ROI is configured as ring or arc, [Clockwise] and [Counterclockwise] can be selected as the two modes of scanning directions. When other shapes of ROIs are selected, [Left to Right], [Right to Left], [Upward], and [Downward] can be selected as the four modes of scanning directions.

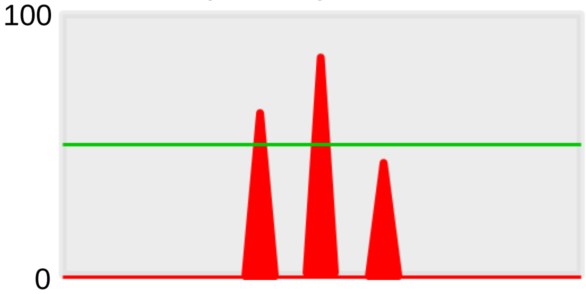
- Look For

The search method can be configured according to need and can be divided into the three modes of [All Edges], [Light to Dark], and [Dark to Light].

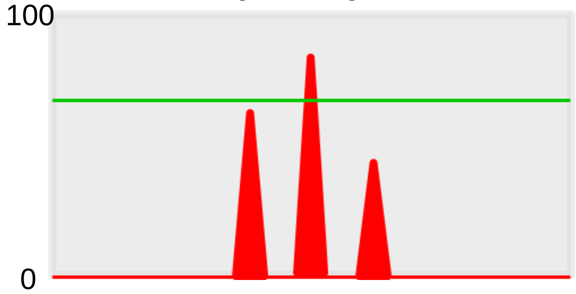
- Edge Strength

Edge Strength is the threshold of edge search (Look For) and can be fine-tuned between 0 and 100 based on the waveform displayed in the preview. When the wave is larger than the configured edge strength, Look For will identify the segment as an edge. As shown in the lower left diagram, the system will find two edges when Edge Strength is set to 50. As shown in the lower right diagram, only one edge, which is greater than the configured Edge Strength threshold of 70, remains.

Edge Strength = 50



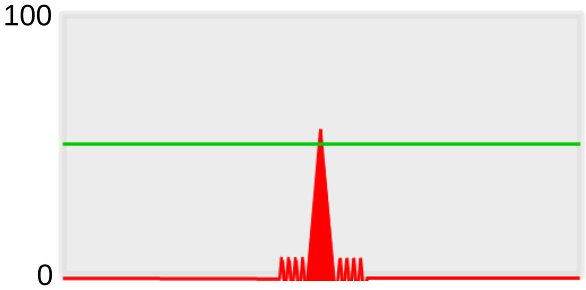
Edge Strength = 70



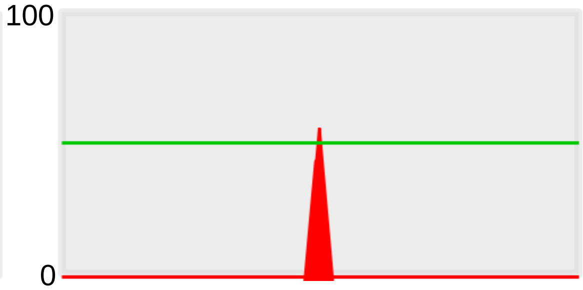
- Lower

Lower (limit) is used to filter small noise signals on the image and the parameter can be adjusted between 0 and 255. Waves less than the Lower configured value will disappear in the waveform. As shown in the lower left diagram, some noise appears when Lower is set to 0 and the noise will be filtered when Lower is set to 20.

Lower = 0



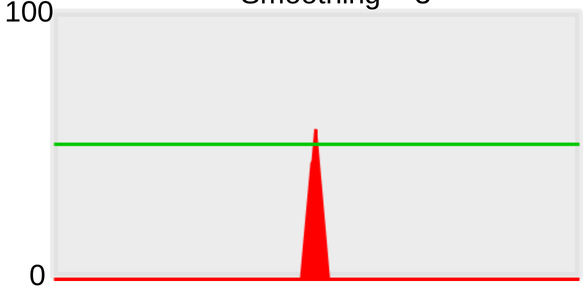
Lower = 20



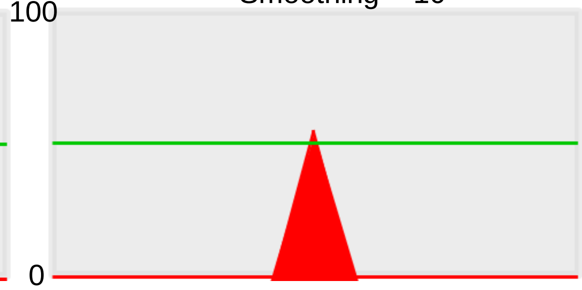
- Smoothing

RGB Grayscale of edges can be set between 1 and 30 for calculations. When Smoothing is increased, Slope of waveform changes, thereby attenuating the effect caused by noise signals.

Smoothing = 3

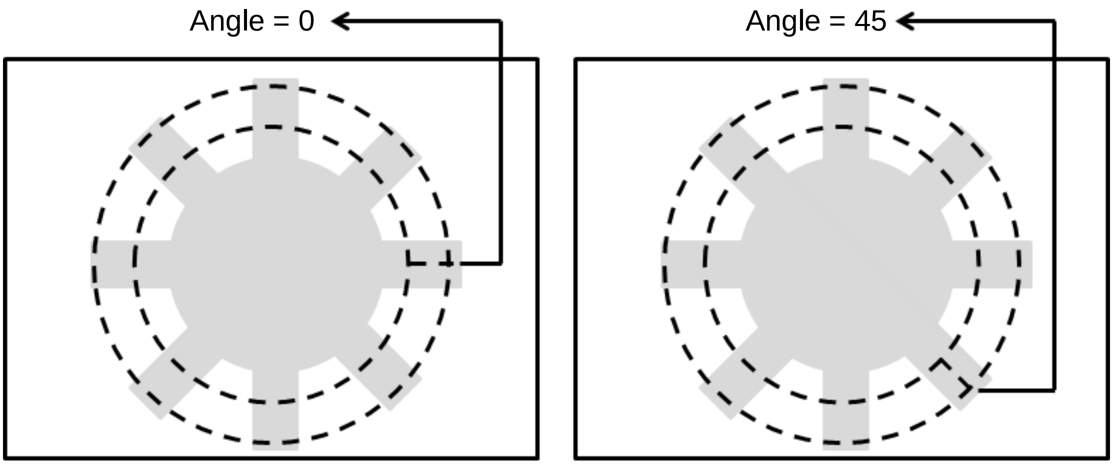


Smoothing = 10



- Angle

When ROI is set to [Ring] or [Arc], the starting angle for edge scans can be configured in this item. As shown in the lower left and right diagrams, the starting angles are 0 and 45 degrees, respectively.



- Reference

Output the n-th result when scanning multiple targets.

- Pitch Upper

Pitch Upper is the threshold for retaining edge pitch. The edge pitch will be kept if measured within the upper pitch limit. Values exceeding the configured range will be discarded. The maximum number can be set to 999.

- Pitch Lower

Pitch Lower is the threshold for retaining edge pitch. The edge pitch will be kept if measured within the upper pitch limit. Values exceeding the configured range will be discarded. The minimum number can be set to 0.

- Origin

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

◎ **Limit**

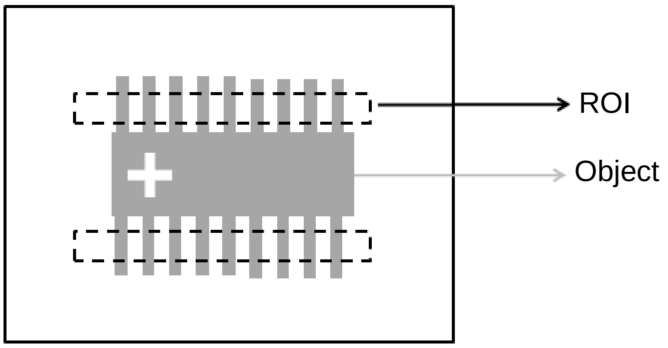
After acquiring the inspection results, Upper and Lower must be configured in this item to determine whether the result is qualified. The following 5 items can be configured in Edge Pitch.

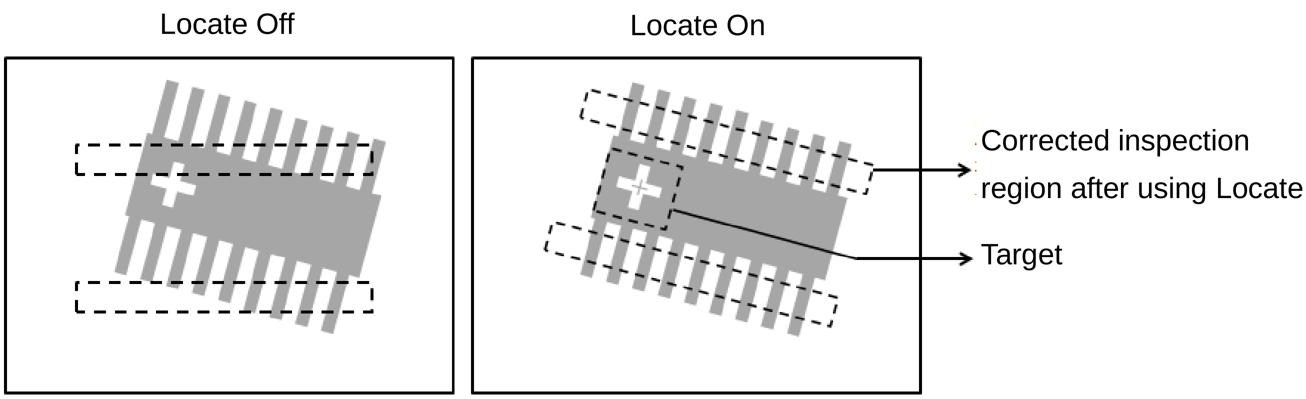
- Pitch Count: Can configure the upper and lower limits of the number of pitch values to look for.
- Pitch: Can configure the upper and lower width limits of the assigned pitch for system reference.
- Maximum Pitch: Obtain the maximum pitch among all pitch data found; Upper and Lower can also be configured in this item.

- Minimum Pitch: Obtain the minimum pitch among all pitch data found; Upper and Lower can also be configured in this item.
- Average Pitch: Obtain the average pitch among all pitch data found; Upper and Lower can also be configured in this item.

◎ **Locate**

This configures whether the inspection region will follow an inspection result for adjusting its coordinates (X, Y) and Angles (Theta). The inspection tools that can be used as a reference include [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.





➤ Three tools are also provided in this item for quick configuration.

◆ Reference Previous Unit

When clicked, the nearest inspection tool that can provide reference for Locate will be automatically filled in the Ref. X, Ref. Y, and Ref. Angle fields below.

◆ Reference Available Unit

When clicked, the nearest unit with Locate configured will be automatically filled in the Ref. X, Ref. Y, and Ref. Angle fields below.

◆ Reference Unit

The option arbitrarily selects an inspection tool that can provide locating reference and automatically fills in the reference values of the selected unit in the Ref. X, Ref. Y, and Ref. Angle fields below.

Reference Please refer to Section 9.1 for detailed locating configurations.

◎ **Execute**

Configures whether to execute the inspection function in the inspection process

➤ Always Execute

Always execute the inspection function in run mode.

➤ Never Execute

Never execute the inspection function in run mode.

◎ **Save**

All modified parameters and values can be saved by clicking this button.

◎ **Exit**

Click to leave the setup page.

◎ **Output Item**

➤ Window

By selecting the output window, the total judge result of the Edge Pitch tool will be output on the designated interface.

- Item

1) Pitch Count (N): Outputs the total number of pitches found by Edge Pitch.
2) Pitch (W): Outputs the width data of the assigned pitch found among all pitch data by Edge Pitch.
3) Maximum Pitch (WH): Outputs the width data of the maximum pitch found among all pitch data by Edge Pitch.
4) Minimum Pitch (WL): Outputs the width data of the minimum pitch found among all pitch data by Edge Pitch.
5) Average Pitch (WA): Outputs the total average of all pitch data found by Edge Pitch.
6) Pitch Center Position X (X): Outputs the center position X coordinate of the assigned reference pitch found among all pitch data by Edge Pitch.
7) Pitch Center Position Y (Y): Outputs the center position Y coordinate of the assigned reference pitch found among all pitch data by Edge Pitch.
8) Pitch Center Absolute Angle (AG): When Ring and Arc ROIs are selected, Pitch Center Absolute Angle outputs the absolute angle of the assigned reference pitch found by Edge Pitch.
9) First Edge Position X (XS): Outputs the first edge position X coordinate of the assigned reference pitch found among all pitch data by Edge Pitch.
10) First Edge Position Y (YS): Outputs the first edge position Y coordinate of the assigned reference pitch found among all pitch data by Edge Pitch.
11) First Edge Absolute Angle (AGS): When Ring and Arc ROIs are selected, First Edge Absolute Angle outputs the absolute angle of the first edge encountered from the assigned reference pitch found by Edge Pitch.
12) First Edge Relative Angle (RAS): When Ring and Arc ROIs are selected, First Edge Relative Angle outputs the relative angle of the first edge encountered from the assigned reference pitch found by Edge Pitch.
13) Second Edge Position X (XE): Outputs the second edge position X coordinate of the assigned reference pitch found among all pitch data by Edge Pitch.
14) Second Edge Position Y (YE): Outputs the second edge position Y coordinate of the assigned reference pitch found among all pitch data by Edge Pitch.
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 Edge Pitch.
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 Edge Pitch.
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 Edge Pitch.
19) Pitch (J) (W): Outputs the logical (Judge) result of the assigned reference pitch widths obtained by Edge Pitch.

20) Maximum Pitch (J) (WH): Outputs the logical (Judge) result of the maximum assigned reference pitch width obtained by Edge Pitch.
21) Minimum Pitch (J) (WL): Outputs the logical (Judge) result of the minimum assigned reference pitch width obtained by Edge Pitch.
22) Average Pitch (J) (WA): Outputs the logical (Judge) result of the average assigned reference pitch width obtained by Edge Pitch.

5.7 Edge Position

The function searches for edges formed by brightness differences differences on gray scale images. The search region can be configured along with horizontal/vertical scanning methods. When image segments of larger brightness differences are detected, the tool recognizes the region as the edge to look for. Contrarily, effective edges are unlikely to be detected in regions of smaller brightness differences.

◎ **Algorithmic Processing**

➤ Edge Position Scan Methods

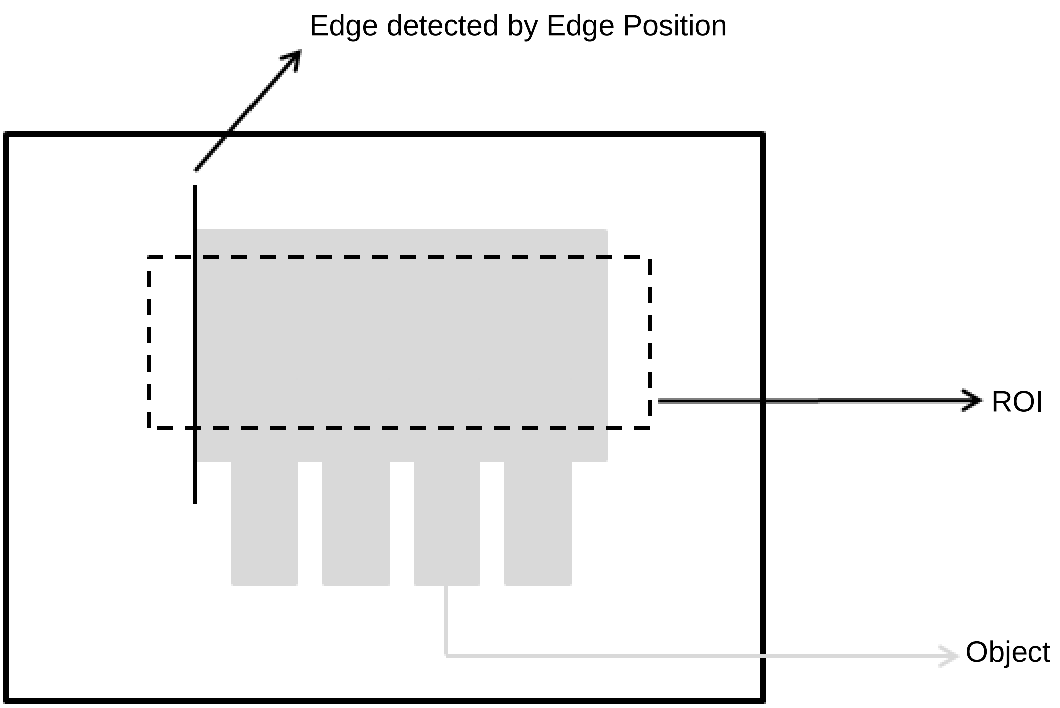
Edge Position includes diversified ROI options. Varying types of ROI options provide differing edge scanning methods.

◆ The two following conditions usually occur for ROIs other than [Ring] and [Arc].

Scanning direction: Left to Right

Search method: Bright to dark

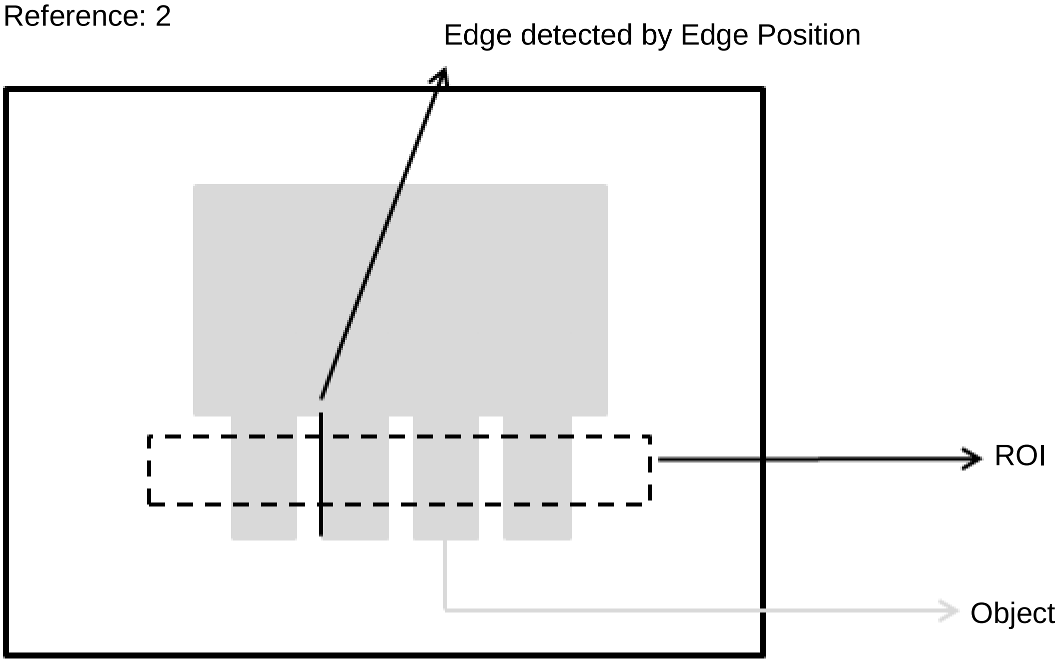
Reference: 1



Scanning direction: Left to Right

Search method: Bright to dark

Reference: 2



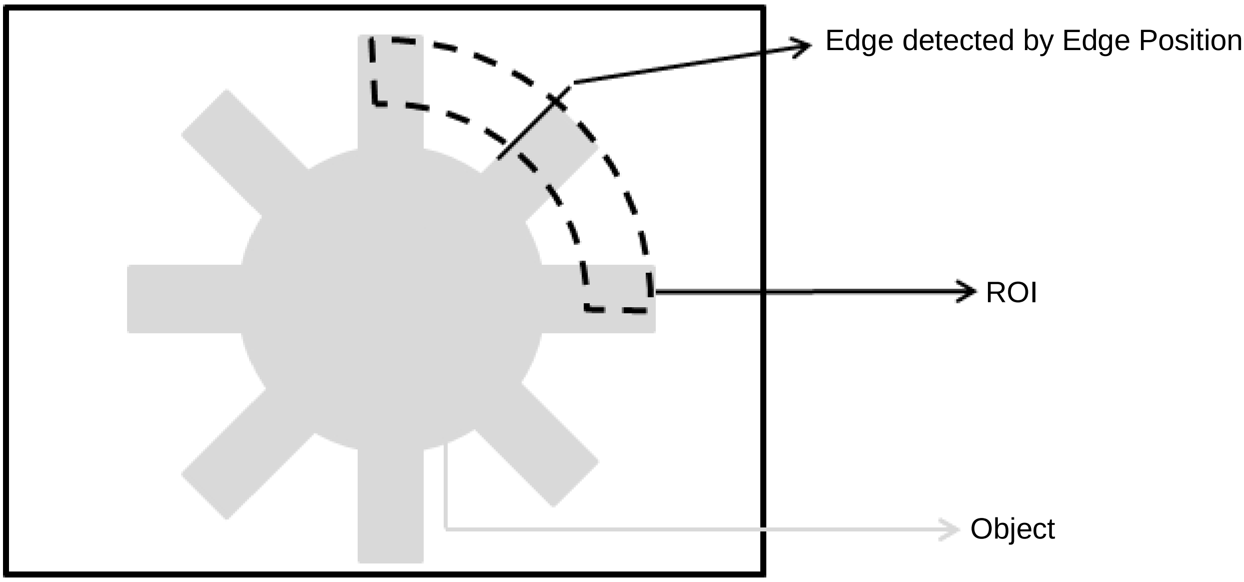
◆ The two following conditions usually occur for ROIs other than [Ring] and [Arc].

Scanning direction: Clockwise

Search method: Bright to dark

Angle: 0

Reference: 1

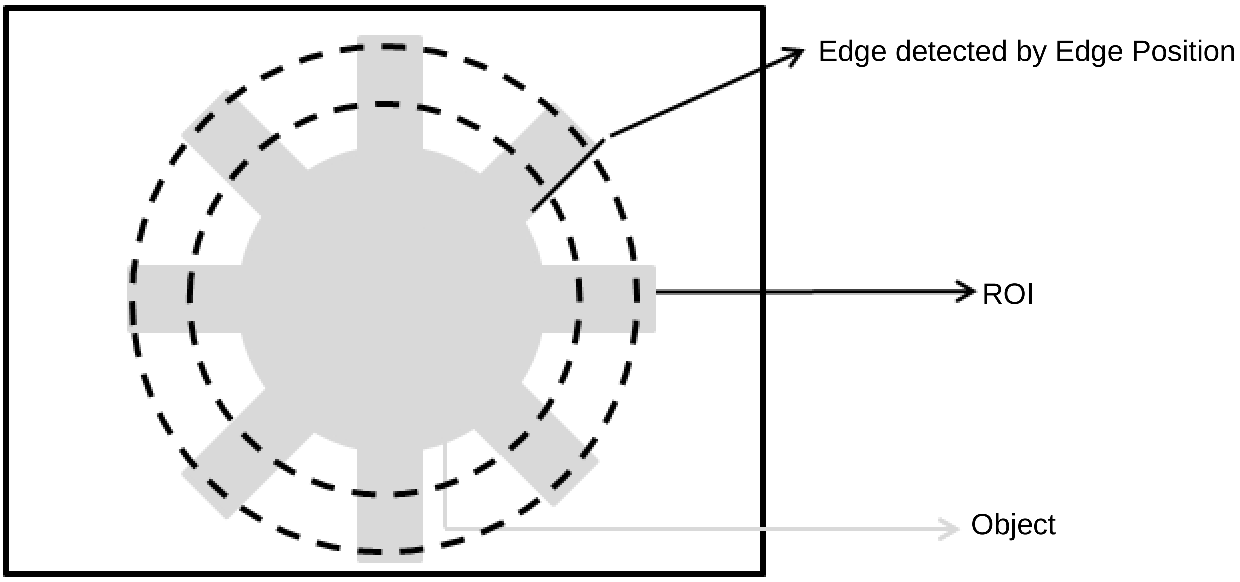


Scanning direction: Counterclockwise

Search method: Bright to dark

Angle: 0

Reference: 1



◎ **Procedural Results**

Edge Position returns the following inspection results.

- Edge Position X: Outputs the X coordinate of the edge found by Edge Position.
- Edge Position Y: Outputs the Y coordinate of the edge found by Edge Position.
- Edge Absolute Angle: When Ring and Arc ROIs are selected, Edge Absolute Angle outputs the absolute angle of the edge found by Edge Pitch.
- Edge Relative Angle: When Ring and Arc ROIs are selected, Edge Relative Angle outputs the relative angle of the edge found by Edge Pitch.

◎ **Example**

◆ For ROIs other than [Ring] and [Arc]

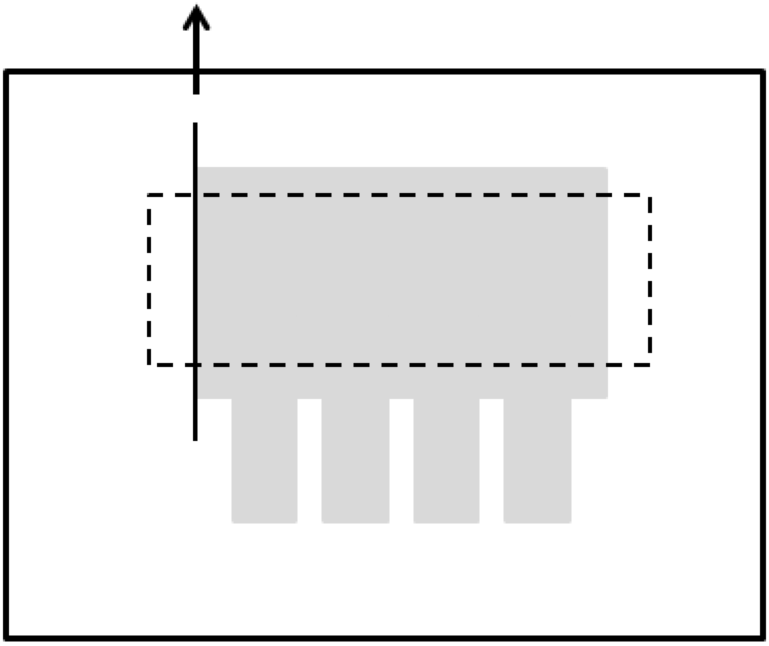
Scanning direction: Left to Right

Search method: Bright to dark

Reference: 1

Inspection result: X coordinate is 200

X coordinate: 200



◆ For [Ring] and [Arc] ROIs

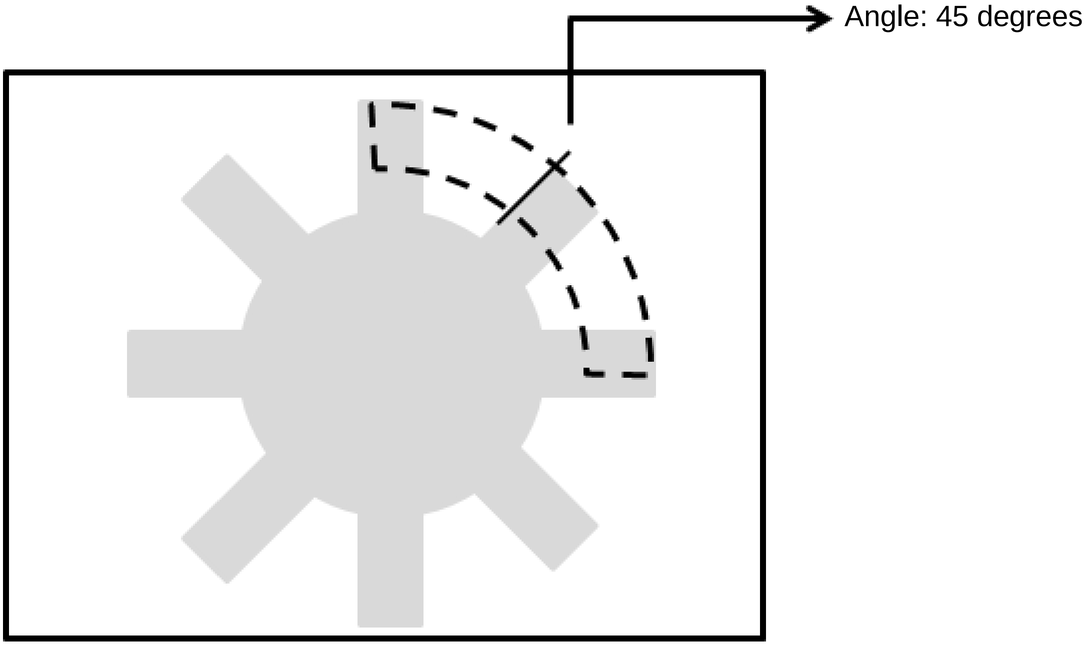
Scanning direction: Clockwise

Search method: Bright to dark

Angle: 0

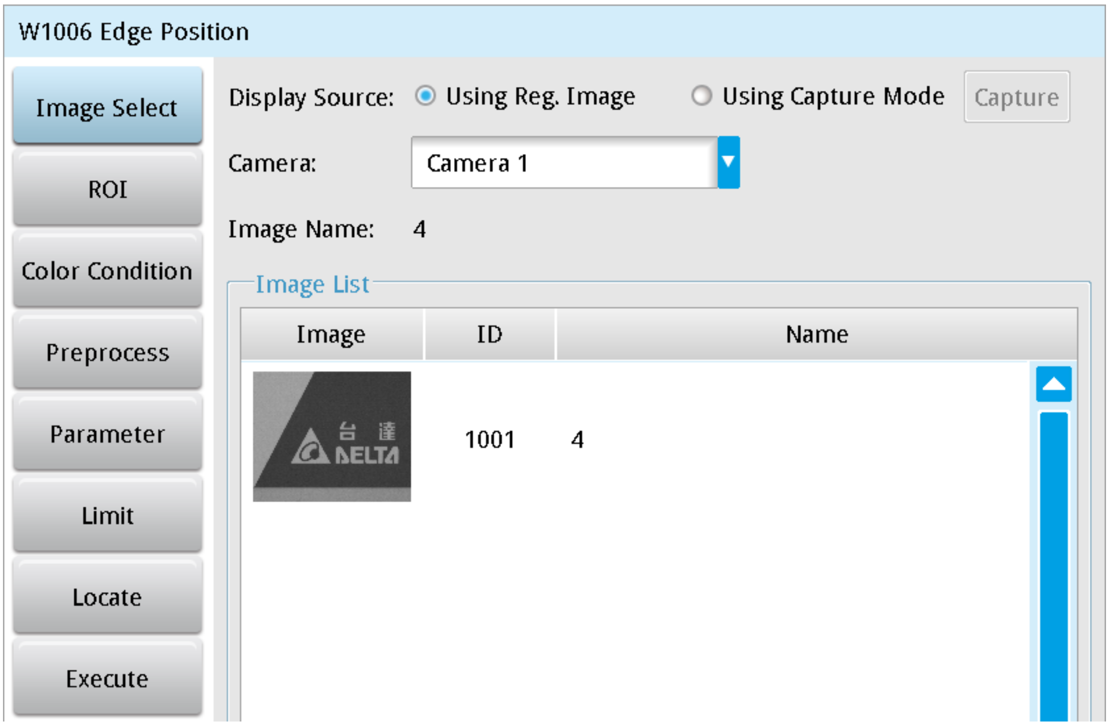
Reference: 1

Inspection result: The absolute angle of the edge is 45 degrees.



◎ **Edge Position Main Menu**

The Edge Position setup page includes the following items.



- Image Select (select Register Image)

Before entering inspection configurations, the registered image to be inspected must first be selected from the register gallery.

- ROI (configure detection region)

The desired inspection regions can be selected through ROI configurations. Optional ROI shapes include Rectangle, Circle, Arc, Ellipse, Ring, Polygon, and Rotated Rect.

- Color Condition

When using color camera, Color to Binary, Color to Grayscale, RGB grayscale, R Grayscale, G Grayscale, and B Grayscale can be configured on this page.

- Preprocess

When the camera image cannot perfectly highlight the emphasized effect, feature points can be enhanced through preprocessing.

- Parameters

The Edge Position inspection conditions can be adjusted in Parameter Setting.

- Limit

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.

- 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**

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)**

Optional ROI types include Rectangle, Circle, Ellipse, Ring, Arc, Polygon, and Rotated Rect. Polygon can support up to 16 points according to the requirement. Additionally, up to 8 mask functions are provided to ignore particular segments.

◎ **Color Condition**

Color images can be processed according to need. In Color Condition, images can be converted using the methods of Color to Binary, Color to Grayscale, RGB Grayscale, R grayscale, G grayscale, and B grayscale.

◎ **Preprocess**

Preprocess includes Binary, Dilation, Erosion, Average, Median, Laplacian, Sobel X, Sobel Y, Sobel XY, Intensity, Contrast, Shade, and Custom (filter) and can superimpose up to 6 options or produce custom preprocessed effect through Custom.

◎ **Parameters**

Edge Filter

➤ Direction

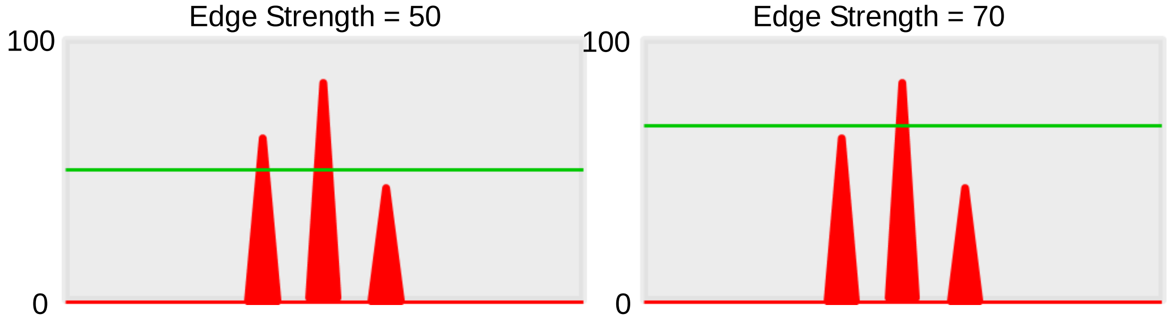
When ROI is configured as ring or arc, [Clockwise] and [Counterclockwise] can be selected as the two modes of scanning directions. When other shapes of ROIs are selected, [Left to Right], [Right to Left], [Upward], and [Downward] can be selected as the four modes of scanning directions.

➤ Look For

The search method can be configured according to need and can be divided into the three modes of [All Edges], [Light to Dark], and [Dark to Light].

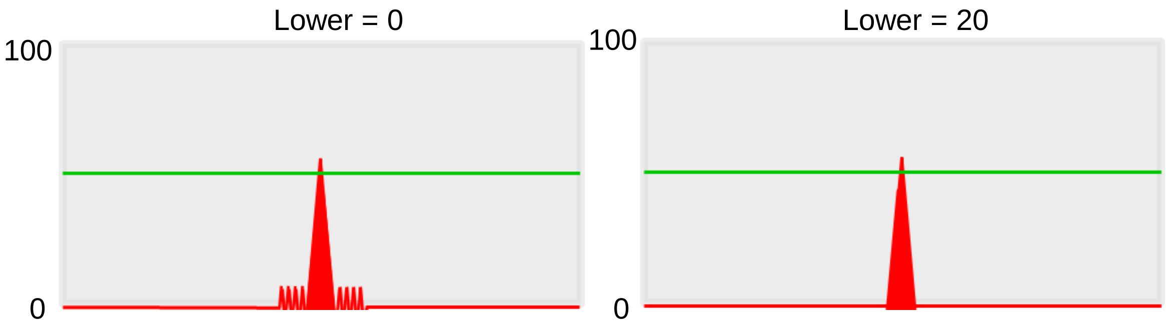
➤ Edge Strength

Edge Strength is the threshold of edge search (Look For) and can be fine-tuned between 0 and 100 based on the waveform displayed in the preview. When the wave is larger than the configured edge strength, Look For will identify the segment as an edge. As shown in the lower left diagram, the system will find two edges when Edge Strength is set to 50. As shown in the lower right diagram, only one edge, which is greater than the configured Edge Strength threshold of 70, remains.



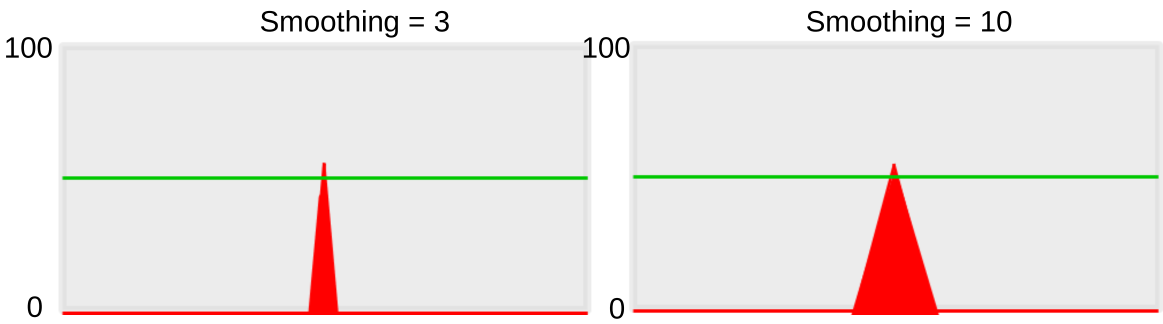
- Lower

Lower (limit) is used to filter small noise signals on the image and the parameter can be adjusted between 0 and 255. Waves less than the Lower configured value will disappear in the waveform. As shown in the lower left diagram, some noise appears when Lower is set to 0 and the noise will be filtered when Lower is set to 20.



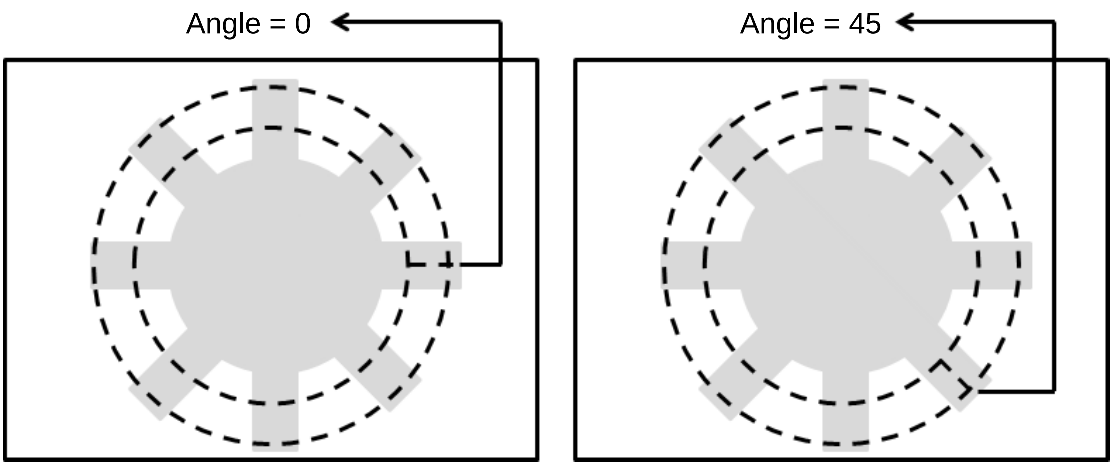
- Smoothing

RGB Grayscale of edges can be set between 1 and 30 for calculations. When Smoothing is increased, Slope of waveform changes, thereby attenuating the effect caused by noise signals.



- Angle

When ROI is set to [Ring] or [Arc], the starting angle for edge scans can be configured in this item. As shown in the lower left and right diagrams, the starting angles are 0 and 45 degrees, respectively.



➤ Reference

Output the n-th 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. The desired coordinates can be entered to change and move the origin to the new coordinates.

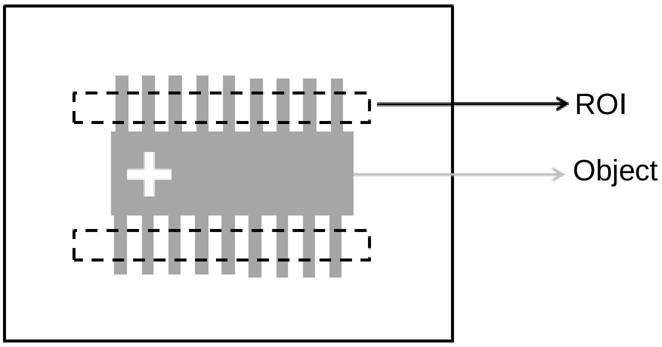
◎ **Limit**

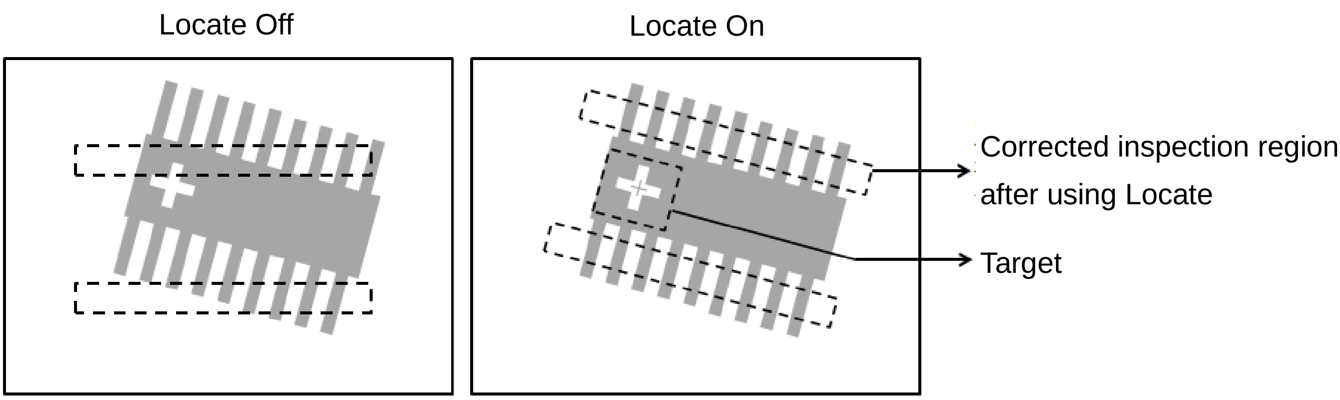
After acquiring the inspection results, Upper and Lower must be configured in this item to determine whether the result is qualified. The following 3 items can be configured in Edge Position.

- ➤ Edge Position X: Can configure the upper and lower X coordinate limits of edges
- ➤ Edge Position Y: Can configure the upper and lower Y coordinate limits of edges
- ➤ Edge Absolute Angle: When ROI is configured to [Ring] or [Arc], there will be an effective absolute edge angle. The upper and lower limits can be configured in this setting.

◎ **Locate**

This configures whether the inspection region will follow an inspection result for adjusting its coordinates (X, Y) and Angles (Theta). The inspection tools that can be used as a reference include [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.





➤ Three tools are also provided in this item for quick configuration.

◆ Reference Previous Unit

When clicked, the nearest inspection tool that can provide reference for Locate will be automatically filled in the Ref. X, Ref. Y, and Ref. Angle fields below.

◆ Reference Available Unit

When clicked, the nearest unit with Locate configured will be automatically filled in the Ref. X, Ref. Y, and Ref. Angle fields below.

◆ Reference Unit

The option arbitrarily selects an inspection tool that can provide locating reference and automatically fills in the reference values of the selected unit in the Ref. X, Ref. Y, and Ref. Angle fields below.

Reference Please refer to Section 9.1 for detailed locating configurations.

◎ **Execute**

Configures whether to execute the inspection function in the inspection process.

➤ Always Execute

Always execute the inspection function in run mode.

➤ Never Execute

Never execute the inspection function in run mode.

◎ **Save**

All modified parameters and values can be saved by clicking this button.

◎ **Exit**

Click to leave the setup page.

◎ **Output Item**

➤ Window

By selecting the output window, the total judge result of the Edge Position tool will be output on the designated interface.

➤ Item

1) Number of Edges (N): Outputs the total number of edges found by Edge Position
2) Edge Position X (X): Outputs the X coordinate of the edge found by Edge Position
3) Edge Position Y (Y): Outputs the Y coordinate of the edge found by Edge Position
4) Edge Absolute Angle (AG): When Ring and Arc ROIs are selected, Edge Absolute Angle outputs the absolute angle of the edge found by Edge Pitch.
5) Edge Relative Angle (RA): When Ring and Arc ROIs are selected, Edge Relative Angle outputs the relative angle of the edge found by Edge Pitch.
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 Edge Position
8) Edge Position Y (J) (Y): Outputs the logical (Judge) result of the Y coordinates of the edges found by Edge Position
9) Edge Absolute Angle (J) (AG): When Ring and Arc ROIs are selected, Edge Absolute Angle (J) outputs the logical (Judge) result of the absolute edge angle found by Edge Position.

5.8 Edge Width

The function searches for plural edges formed by brightness differences on gray scale images calculate the edge widths. The search region can be configured. The widths can be obtained through horizontal/vertical scanning methods or outer or inner edge detection. When image segments of larger brightness differences are detected, the tool recognizes the region as the edge with the pitch to look for. Contrarily, effective widths are unlikely to be detected in regions of smaller brightness differences or in regions consisting of only one edge.

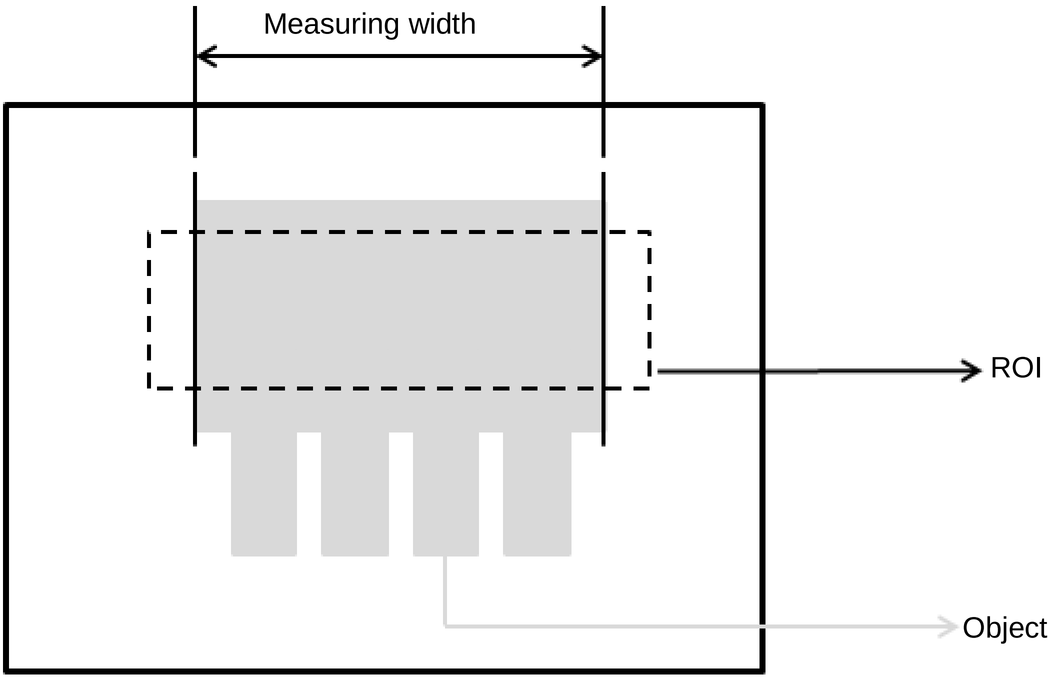
◎ **Algorithmic Processing**

➤ Edge Width Scan Methods

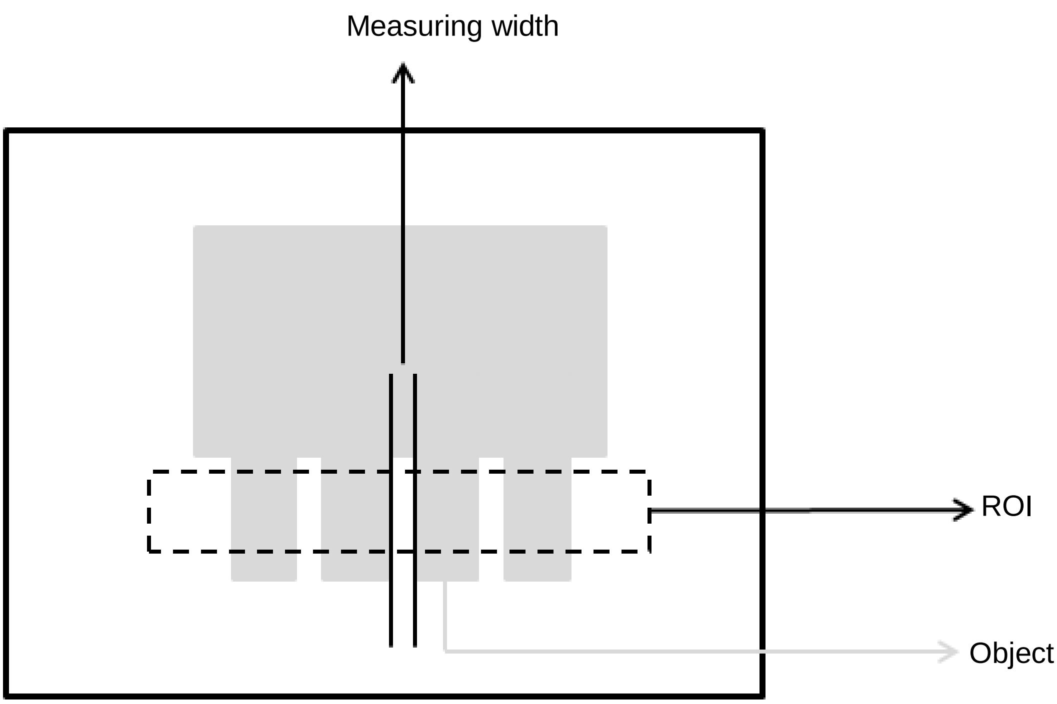
Edge Width includes diversified ROI options. Varying types of ROI options provide differing edge scanning methods.

◆ The three following conditions usually occur for ROIs other than [Ring] and [Arc].

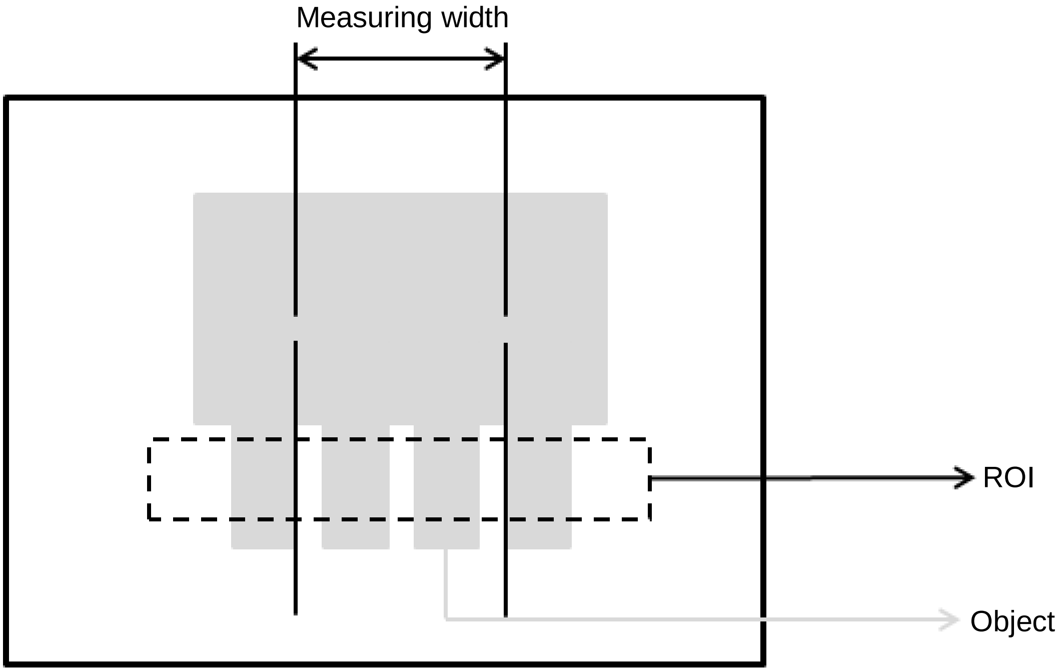
Scanning direction: Horizontal
Search method: All edges
Measure method: Out to in



Scanning direction: Horizontal
Search method: All edges
Measure method: Inside-out

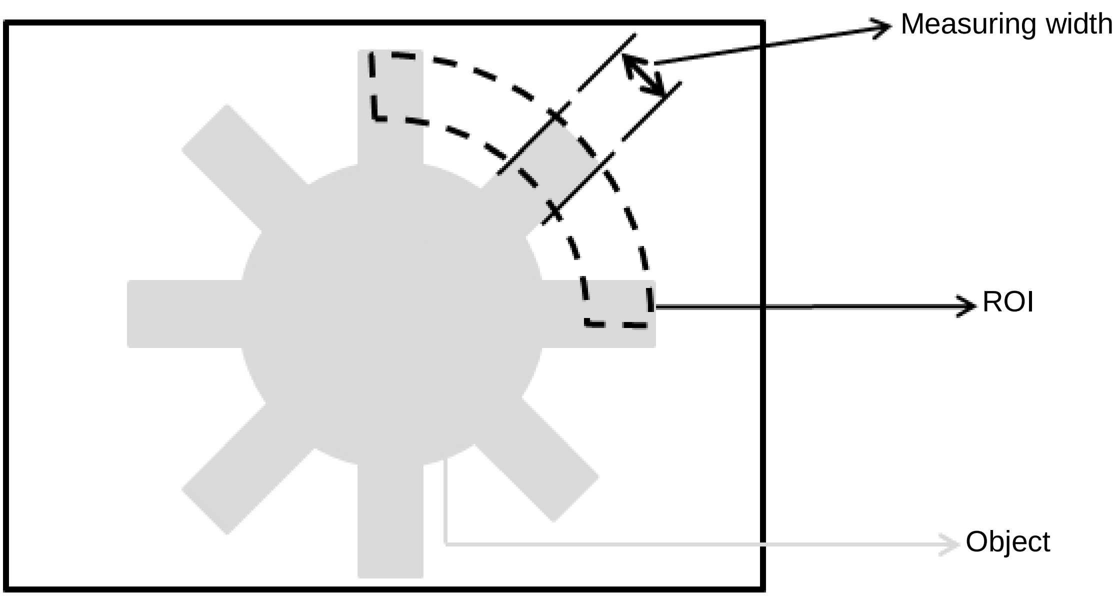


Scanning direction: Horizontal
Search method: Dark to bright
Measure method: Outside-in



◆ The two following conditions usually occur for ROIs other than [Ring] and [Arc].

Scanning direction: Clockwise
Search method: All edges
Measure method: Inside-out

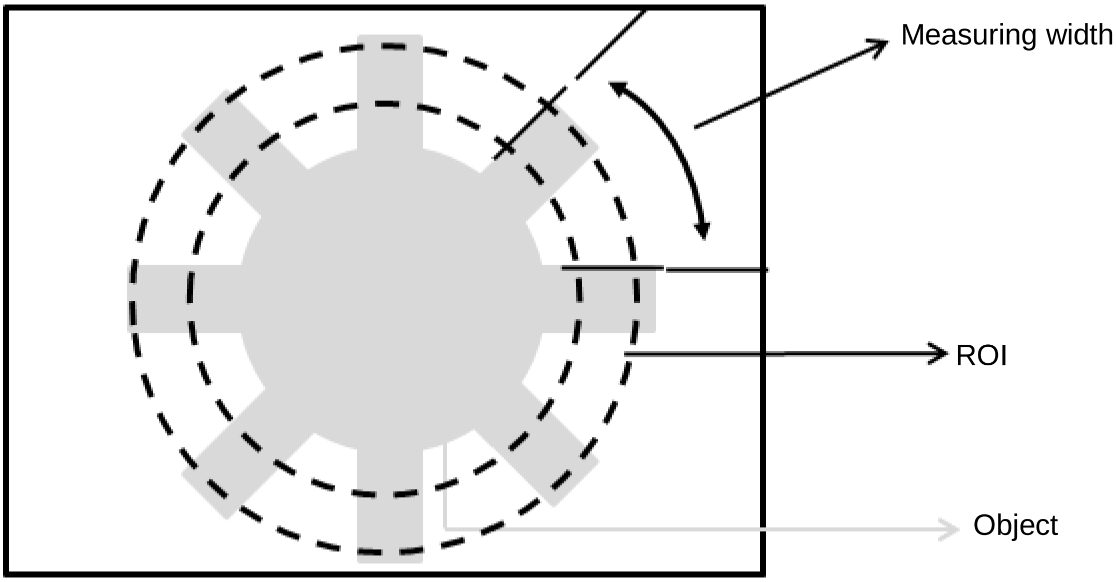


Scanning direction: Clockwise

Search method: Bright to dark

Angle: -15

Measure method: Out to in



◎ **Procedural Results**

Edge Width returns the following inspection results.

- Edge Width: Outputs the width data found by Edge Width (unit in pixels)
- First Edge Position X: Outputs the X coordinate of the first edge position found by Edge Width
- First Edge Position Y: Outputs the Y coordinate of the first edge position found by Edge Width
- First Edge Absolute Angle: When Ring and Arc ROIs are selected, First Edge Absolute Angle outputs the absolute angle of the first edge found by Edge Width.
- First Edge Relative Angle: When Ring and Arc ROIs are selected, First Edge Relative Angle outputs the relative angle of the first edge found by Edge Width.
- Second Edge Position X: Outputs the X coordinate of the second edge position found by Edge Width
- Second Edge Position Y: Outputs the Y coordinate of the second edge position found by Edge Width
- Second Edge Absolute Angle: When Ring and Arc ROIs are selected, First Edge Absolute Angle outputs the absolute angle of the second edge found by Edge Width.
- Second Edge Relative Angle: When Ring and Arc ROIs are selected, Second Edge Relative Angle outputs the relative angle of the second edge found by Edge Width.

◎ **Example**

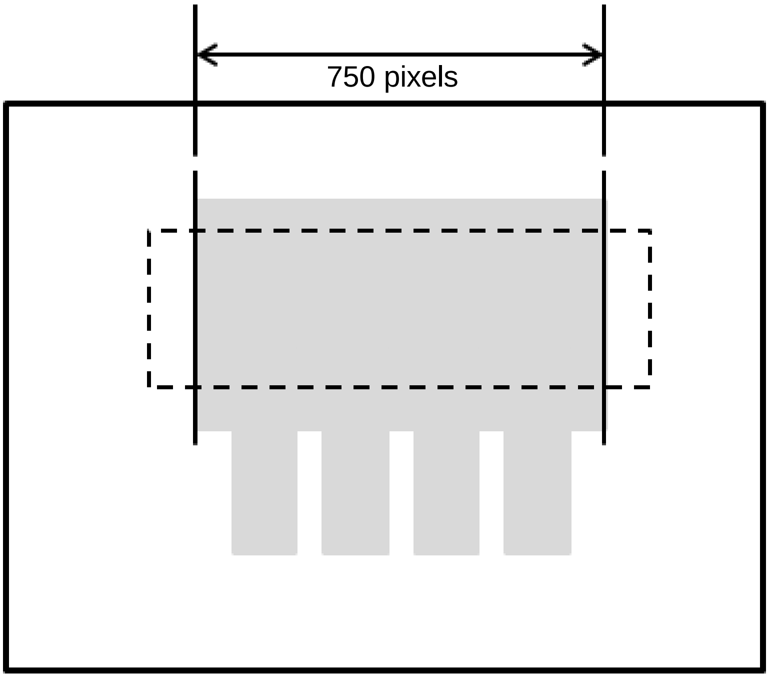
◆ For ROIs other than [Ring] and [Arc]

Scanning direction: Horizontal

Search method: All edges

Measure method: Out to in

Inspection result: Edge width is 750 pixels

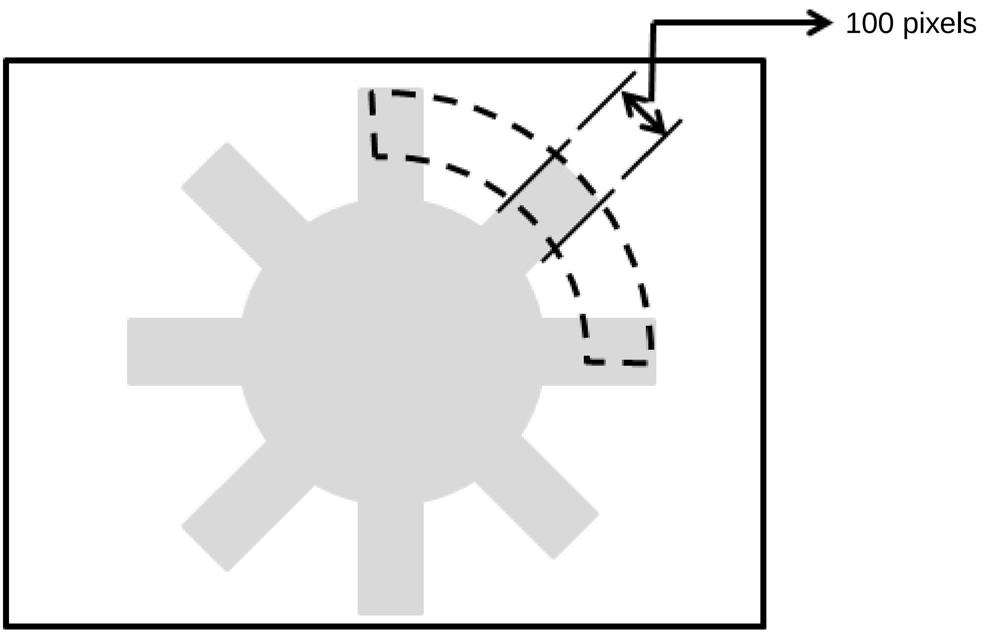


Scanning direction: Clockwise

Search method: All edges

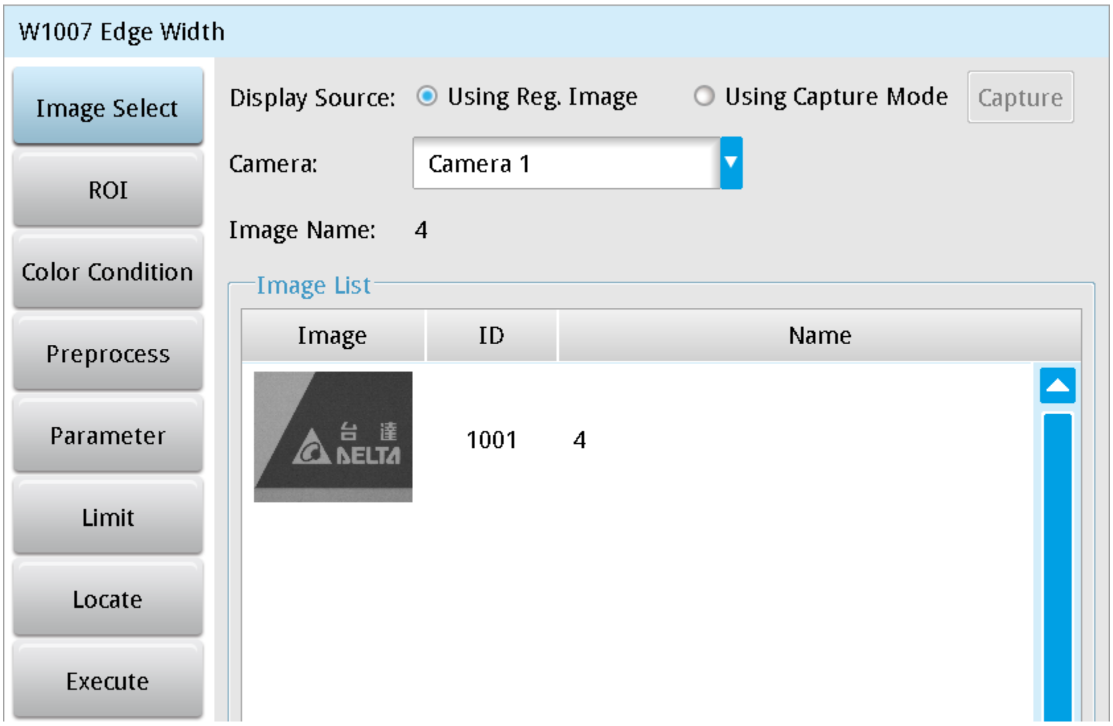
Measure method: Inside-out

Inspection result: Edge width is 100 pixels



◎ **Edge Width Main Menu**

The Edge Width setup page includes the following items.



➤ Image Select (select Register Image)

Before entering inspection configurations, the registered image to be inspected must first be selected from the register gallery.

➤ ROI (configure detection region)

The desired inspection regions can be selected through ROI configurations. Optional ROI shapes include Rectangle, Circle, Ellipse, Ring, Polygon, and Rotated Rect.

➤ Color Condition

When using color camera, Color to Binary, Color to Grayscale, RGB grayscale, R Grayscale, G Grayscale, and B Grayscale can be configured on this page.

➤ Preprocess

When the camera image cannot perfectly highlight the emphasized effect, feature points can be enhanced through preprocessing.

➤ Parameters

The Edge Width inspection conditions can be adjusted in Parameter Setting.

➤ Limit

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.

➤ 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**

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)**

Optional ROI types include Rectangle, Circle, Ellipse, Ring, Arc, Polygon, and Rotated Rect. Polygon can support up to 16 points according to the requirement. Additionally, up to 8 mask functions are provided to ignore particular segments.

◎ **Color Condition**

Color images can be processed according to need. In Color Condition, images can be converted using the methods of Color to Binary, Color to Grayscale, RGB Grayscale, R grayscale, G grayscale, and B grayscale.

◎ **Preprocess**

Preprocess includes Binary, Dilation, Erosion, Average, Median, Laplacian, Sobel X, Sobel Y, Sobel XY, Intensity, Contrast, Shade, and Custom (filter) and can superimpose up to 6 options or produce custom preprocessed effect through Custom.

◎ **Parameters**

Edge Filter

➤ Direction

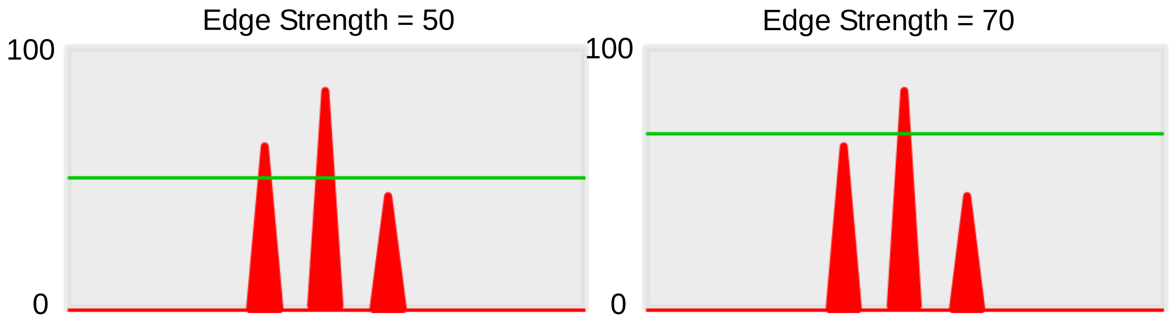
When ROI is configured as ring or arc, [Clockwise] and [Counterclockwise] can be selected as the two modes of scanning directions. When other shapes of ROIs are selected, [Vertical] and [Horizontal] can be selected as the two modes of scanning directions.

➤ Look For

The search method can be configured according to need and can be divided into the three modes of [All Edges], [Light to Dark], and [Dark to Light].

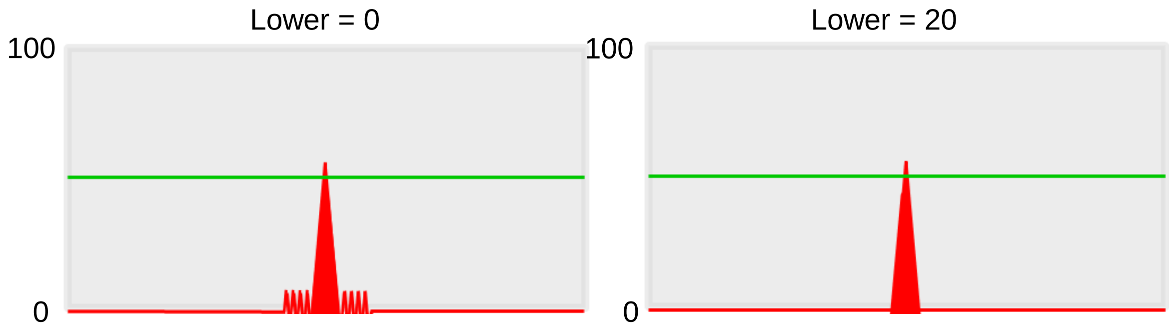
➤ Edge Strength

Edge Strength is the threshold of edge search (Look For) and can be fine-tuned between 0 and 100 based on the waveform displayed in the preview. When the wave is larger than the configured edge strength, Look For will identify the segment as an edge. As shown in the lower left diagram, the system will find two edges when Edge Strength is set to 50. As shown in the lower right diagram, only one edge, which is greater than the configured Edge Strength threshold of 70, remains.



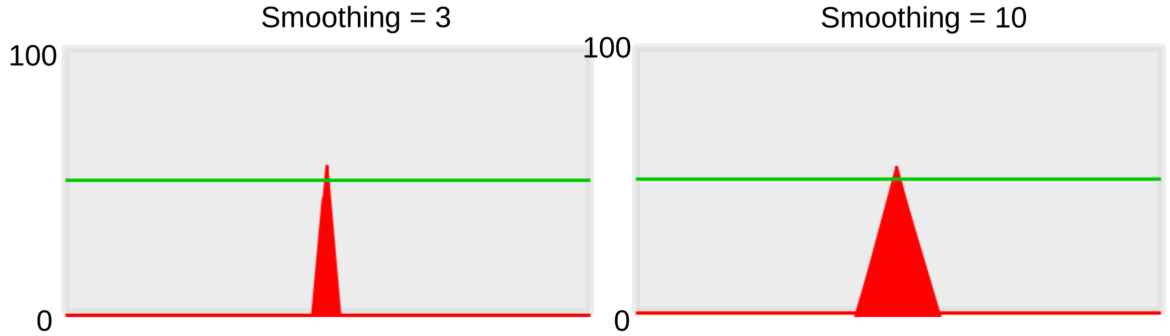
➤ Lower

Lower (limit) is used to filter small noise signals on the image and the parameter can be adjusted between 0 and 255. Waves less than the Lower configured value will disappear in the waveform. As shown in the lower left diagram, some noise appears when Lower is set to 0 and the noise will be filtered when Lower is set to 20.



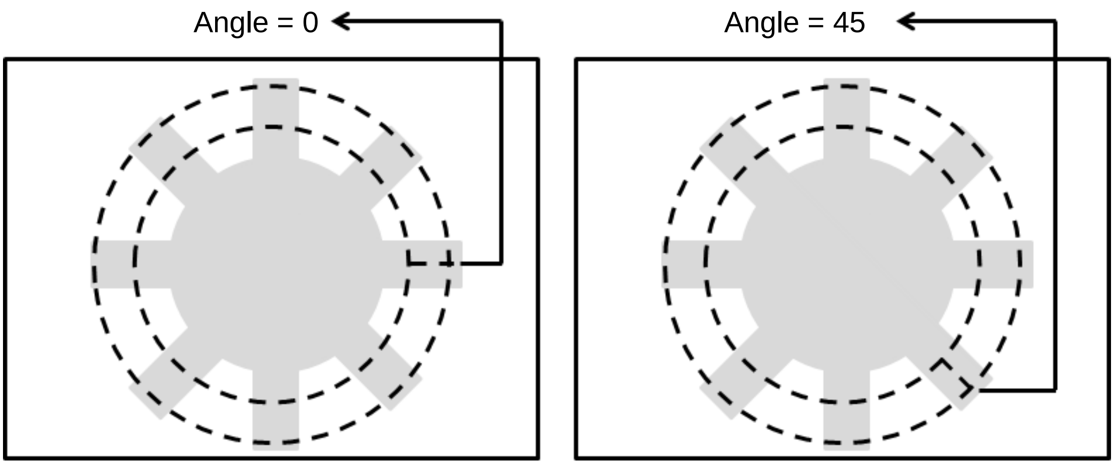
➤ Smoothing

RGB Grayscale of edges can be set between 1 and 30 for calculations. When Smoothing is increased, Slope of waveform changes, thereby attenuating the effect caused by noise signals.



➤ Angle

When ROI is set to [Ring] or [Arc], the starting angle for edge scans can be configured in this item. As shown in the lower left and right diagrams, the starting angles are 0 and 45 degrees, respectively.



➤ Reference

Output the n-th 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. The desired coordinates can be entered to change and move the origin to the new coordinates.

◎ **Limit**

After acquiring the inspection results, Upper and Lower must be configured in this item to determine whether the result is qualified. The following 7 items can be configured in Edge Width.

➤ Edge Width: Can configure the Upper and Lower limits of the angles detected by Edge Width

➤ First Edge Position X : Can configure the upper and lower X coordinate limits of the first edge

➤ First Edge Position Y: Can configure the upper and lower Y coordinate limits of the first edge

➤ Second Edge Position X: Can configure the upper and lower X coordinate limits of the second edge

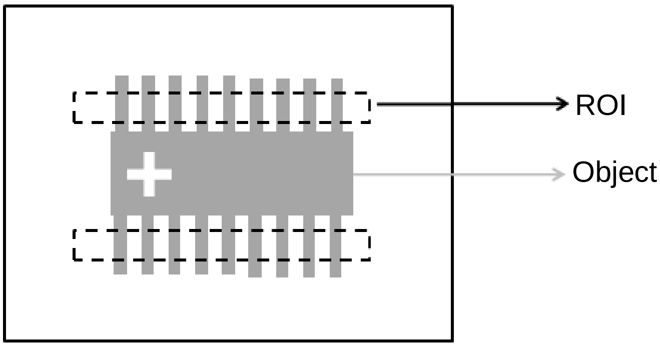
➤ Second Edge Position Y: Can configure the upper and lower Y coordinate limits of the second edge

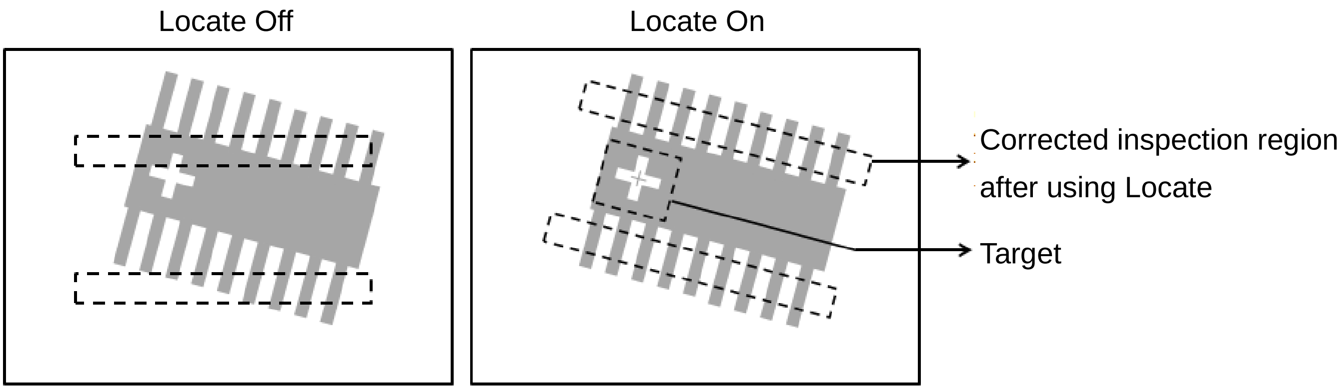
➤ First Edge Absolute Angle: When ROI is configured to [Ring] or [Arc], there will be an effective absolute angle for the first edge. The upper and lower limits can be configured in this setting.

➤ Second Edge Absolute Angle: When ROI is configured to [Ring] or [Arc], there will be an effective absolute angle for the second edge. The upper and lower limits can be configured in this setting.

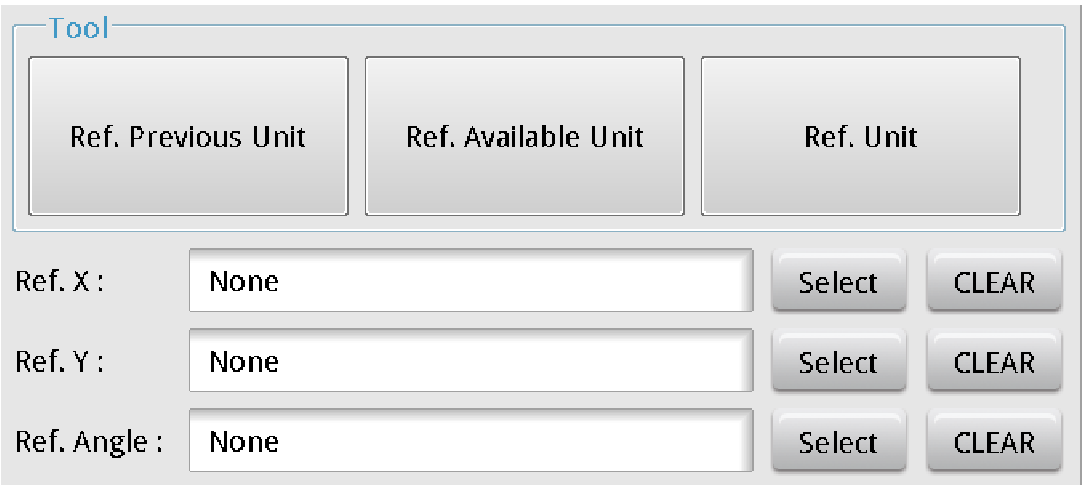
◎ **Locate**

This configures whether the inspection region will follow an inspection result for adjusting its coordinates (X, Y) and Angles (Theta). The inspection tools that can be used as a reference include [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.





➤ Three tools are also provided in this item for quick configuration.



◆ Reference Previous Unit

When clicked, the nearest inspection tool that can provide reference for Locate will be automatically filled in the Ref. X, Ref. Y, and Ref. Angle fields below.

◆ Reference Available Unit

When clicked, the nearest unit with Locate configured will be automatically filled in the Ref. X, Ref. Y, and Ref. Angle fields below.

◆ Reference Unit

The option arbitrarily selects an inspection tool that can provide locating reference and automatically fills in the reference values of the selected unit in the Ref. X, Ref. Y, and Ref. Angle fields below.

Reference Please refer to Section 9.1 for detailed locating configurations.

◎ **Execute**

Configures whether to execute the inspection function in the inspection process.

➤ Always Execute

Always execute the inspection function in run mode.

➤ Never Execute

Never execute the inspection function in run mode.

◎ **Save**

All modified parameters and values can be saved by clicking this button.

◎ **Exit**

Click to leave the setup page.

◎ **Output Item**

➤ Window

By selecting the output window, the total judge result of the Edge Width tool will be output on the designated interface.

➤ Item

1) Edge Width (L): Outputs the width data found by Edge Width. (unit in pixels)
2) First Edge Position X (X1): Outputs the X coordinate of the first edge position found by Edge Width.
3) First Edge Position Y (Y1): Outputs the Y coordinate of the first edge position found by Edge Width.
4) First Edge Absolute Angle (AG1): When Ring and Arc ROIs are selected, First Edge Absolute Angle outputs the absolute angle of the first edge found by Edge Width.
5) First Edge Relative Angle (RA1): When Ring and Arc ROIs are selected, First Edge Relative Angle outputs the relative angle of the first edge found by Edge Width.
6) Second Edge Position X (X2): Outputs the X coordinate of the second edge position found by Edge Width.
7) Second Edge Position Y (Y2): Outputs the Y coordinate of the second edge position found by Edge Width.
8) Second Edge Absolute Angle (AG2): When Ring and Arc ROIs are selected, First Edge Absolute Angle outputs the absolute angle of the second edge found by Edge Width.

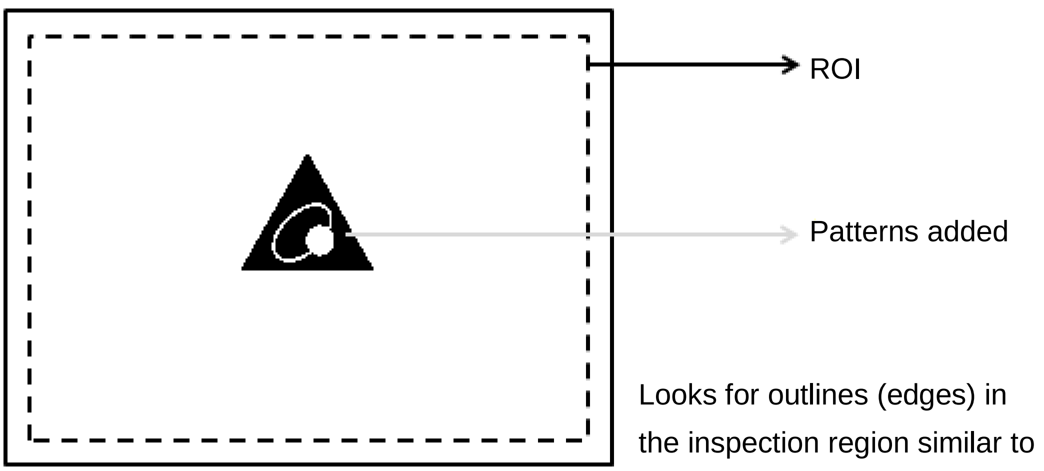
9) Second Edge Relative Angle (RA2): When Ring and Arc ROIs are selected, Second Edge Relative Angle outputs the relative angle of the second edge found by Edge Width.
10) Edge Width ID: Outputs the ID of the inspection tool.
11) Edge Width (J) (L): Outputs the logical (Judge) result of the edge widths found by Edge Width.
12) First Edge Position X (J) (X1): Outputs the logical (Judge) result of the X coordinates of the first edge found by Edge Position.
13) First Edge Position Y (J) (Y1): Outputs the logical (Judge) result of the Y coordinates of the first edge found by Edge Position.
14) First Edge Absolute Angle (J) (AG1): When Ring and Arc ROIs are selected, First Edge Absolute Angle (J) outputs the logical (Judge) result of the absolute edge angle found by Edge Width.
15) Second Edge Position X (J) (X2): Outputs the logical (Judge) result of the X coordinates of the second edge found by Edge Position.
16) Second Edge Position Y (J) (Y2): Outputs the logical (Judge) result of the Y coordinates of the second edge found by Edge Position.
17) Second Edge Absolute Angle (J) (AG2): When Ring and Arc ROIs are selected, First Edge Absolute Angle (J) outputs the logical (Judge) result of the absolute edge angle found by Edge Width.

5.9 Shape

Shape can compare samples (Pattern) previously added in the controller and find the number of detections similar to the patterns and the corresponding X and Y coordinates, angles, and degrees of similarity.

◎ **Algorithmic Processing**

The patterns to look for must be added in advance when using Shape. Parameters such as the search angles and range and degrees of similarity must also be configured.

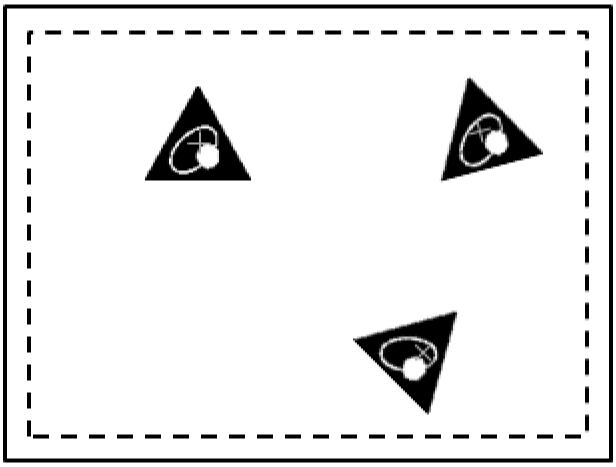


◎ **Procedural Results**

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

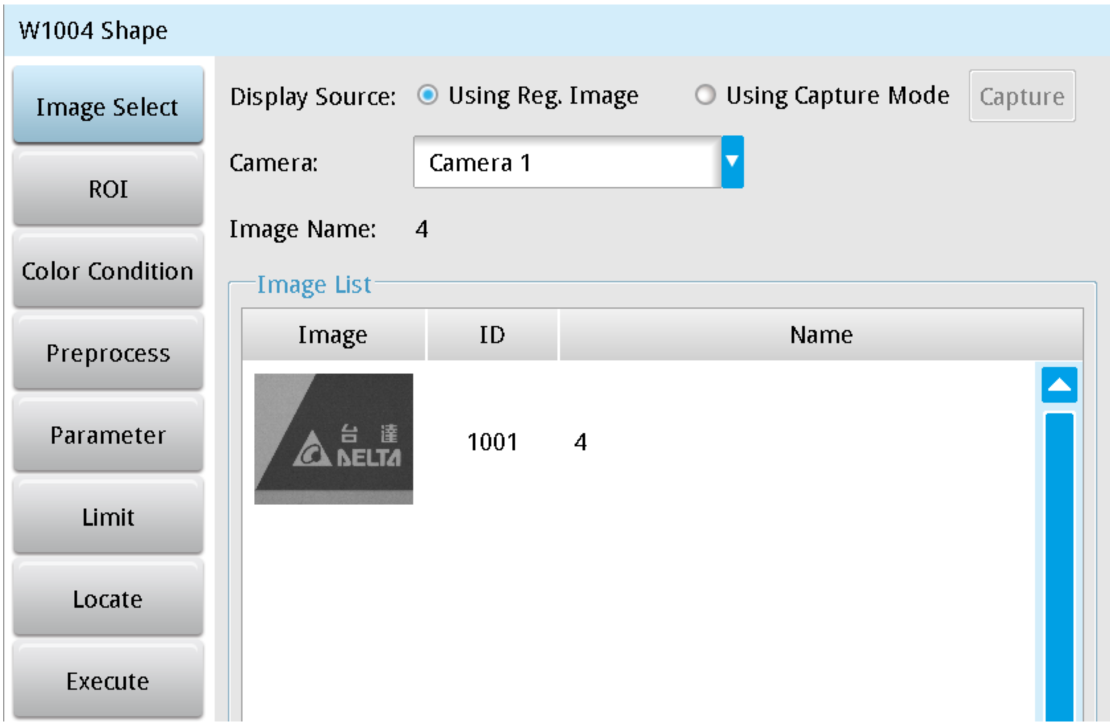
Shape Position X [1] = 400

Shape Position Y [1] = 200

Shape Angle [1] = 0

◎ **Shape Main Menu**

The Shape setup page includes the following items.



- Image Select (select Register Image)

Before entering inspection configurations, the registered image to be inspected must first be selected from the register gallery.

- ROI (configure detection region)

The desired inspection regions can be selected through ROI configurations. Optional ROI shapes include Rectangle, Circle, Arc, Ellipse, Ring, Polygon, and Rotated Rect.

- Color Condition

When using color camera, Color to Binary, Color to Grayscale, RGB grayscale, R Grayscale, G Grayscale, and B Grayscale can be configured on this page.

- Preprocess

When the camera image cannot perfectly highlight the emphasized effect, feature points can be enhanced through preprocessing.

- Parameters

The Shape inspection conditions can be adjusted in Parameter Setting.

- Limit

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.

- 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**

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)**

Optional ROI types include Rectangle, Circle, Ellipse, Ring, Arc, Polygon, and Rotated Rect. Polygon can support up to 16 points according to the requirement. Additionally, up to 8 mask functions are provided to ignore particular segments.

◎ **Color Condition**

Color images can be processed according to need. In Color Condition, images can be converted using the methods of Color to Binary, Color to Grayscale, RGB Grayscale, R grayscale, G grayscale, and B grayscale.

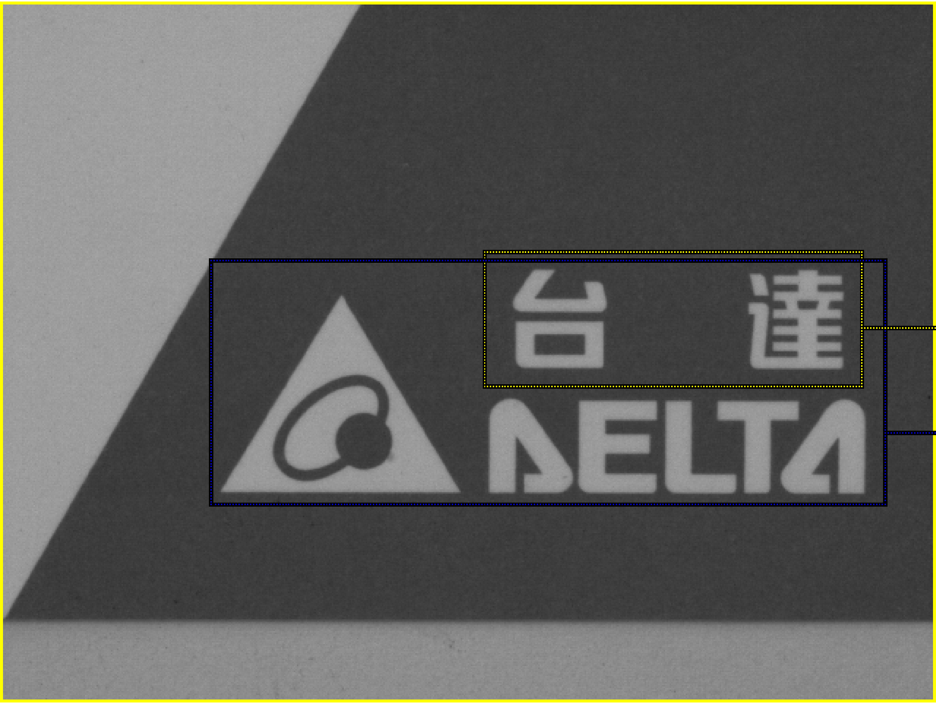
◎ **Preprocess**

Preprocess includes Binary, Dilation, Erosion, Average, Median, Laplacian, Sobel X, Sobel Y, Sobel XY, Intensity, Contrast, Shade, and Custom (filter) and can superimpose up to 6 options or produce custom preprocessed effect through Custom.

◎ **Parameters**

➤ Add Pattern:

- Angle: Configures the range of angles to search for; a configured value of 10 means searching from -10 degrees to 10 degrees; a configured value of 179 means searching from -180 degrees to 180 degrees; larger range of angles takes longer inspection times
- Scale Tolerance: When the dimensions of the object to look for differs, please turn on Scale Tolerance
- Accuracy: Refers to the search accuracy; provides the options of Most Accurate, Accurate, General, Rough, and Most Rough; higher accuracies takes longer inspection times
- ROI/MASK: Use Region and Region Mask to select the shape to look for to build a model



Region Mask

Region

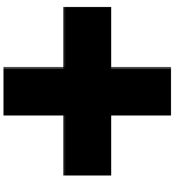
- Shape Comparison Setting

Similarity: Configures the degree of similarity to the added pattern for shape recognition

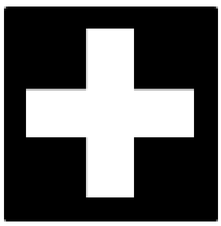
- Reference: Output the n-th result when scanning multiple targets.
- Search Number: Configures the number of shapes to look for
- Sort Rule: When searching for multiple units, the following sorting methods are provided.
  Similarity: Sorts shapes based on degrees of similarity; shapes of higher similarities are arranged ahead.
  Horizontal Position Ascend: Sorts shapes based on the horizontal positions; smaller horizontal coordinates are arranged ahead.
  Horizontal Position Descend: Sorts shapes based on the horizontal positions; larger horizontal coordinates are arranged ahead.
  Vertical Position Ascend: Sorts shapes based on the vertical positions; smaller vertical coordinates are arranged ahead.
  Vertical Position Descend: Sorts shapes based on the vertical positions; larger vertical coordinates are arranged ahead.
  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: When the characteristic contrast is strong in the image to look for, Contrast Sensitive can be adjusted to Very Coarse to speed up the inspection. Contrarily, Contrast Sensitive must be adjusted to Very Sensitive when the characteristic contrast of the image to look for is weak to improve the inspection accuracy.
- Ignore Polarity: The function configures whether to ignore edge polarity. As shown in the black mark on white background and white mark on black background in the following diagram, both images can be found 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 after the inspection are both based on the center position of the pattern. When rotation center is enabled, the user can manually adjust the X and Y coordinates of the rotation center. After completing the customization, the X and Y inspection outputs will be based on the user configured position.
- Origin: The position of the origin (0, 0) in System Setting is displayed on the upper left corner of the screen. The desired coordinates can be entered to change and move the origin to the new coordinates.

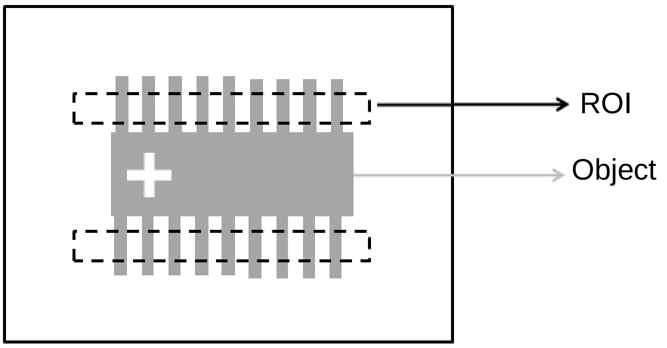
◎ **Limit**

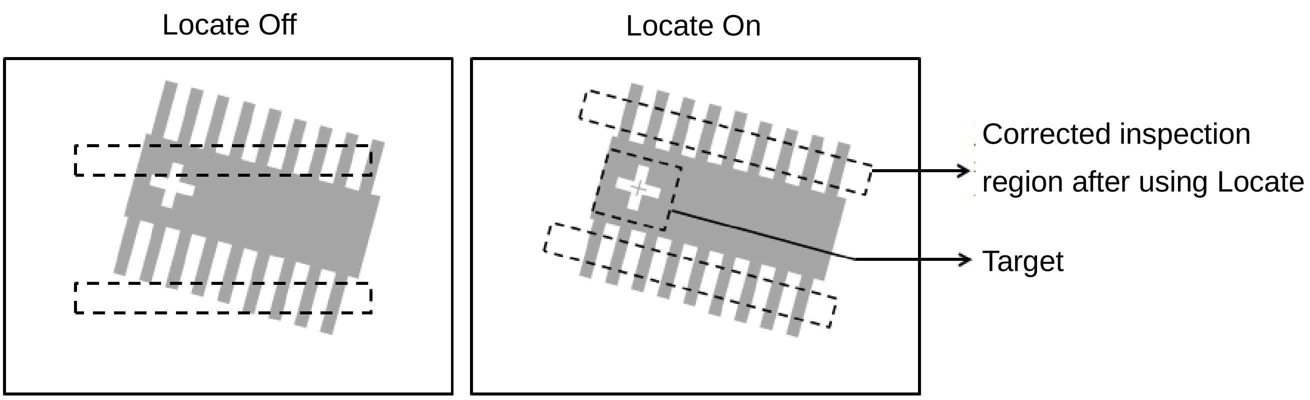
After acquiring the inspection results, Upper and Lower must be configured in this item to determine whether the result is qualified. The following items can be configured in Area.

- Number of Shapes: Configures the upper and lower limits of the number of shapes.
- Shape Position X: Configures the shapes' upper and lower X coordinate limits.
- Shape Position Y: Configures the shapes' upper and lower Y coordinate limits.
- Similarity: Upper and lower limits of shape similarity.
- Shape Angle: Upper and lower limits of shape angles.

◎ **Locate**

This configures whether the inspection region will follow an inspection result for adjusting its coordinates (X, Y) and Angles (Theta). The inspection tools that can be used as a reference include [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.





➢ Three tools are also provided in this item for quick configuration.

◆ Reference Previous Unit

When clicked, the nearest inspection tool that can provide reference for Locate will be automatically filled in the Ref. X, Ref. Y, and Ref. Angle fields below.

◆ Reference Available Unit

When clicked, the nearest unit with Locate configured will be automatically filled in the Ref. X, Ref. Y, and Ref. Angle fields below.

◆ Reference Unit

The option arbitrarily selects an inspection tool that can provide locating reference and automatically fills in the reference values of the selected unit in the Ref. X, Ref. Y, and Ref. Angle fields below.

Reference Please refer to Section 9.1 for detailed locating configurations.

◎ **Execute**

Configures whether to execute the inspection function in the inspection process

Always Execute: Always execute the inspection function in run mode

Never Execute: Never execute the inspection function in run mode

◎ **Save**

All modified parameters and values can be saved by clicking this button

◎ **Exit**

Click to leave the setup page

◎ **Output Item**

➤ Window

By selecting the output window, the total judge result of the Shape tool will be output 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.

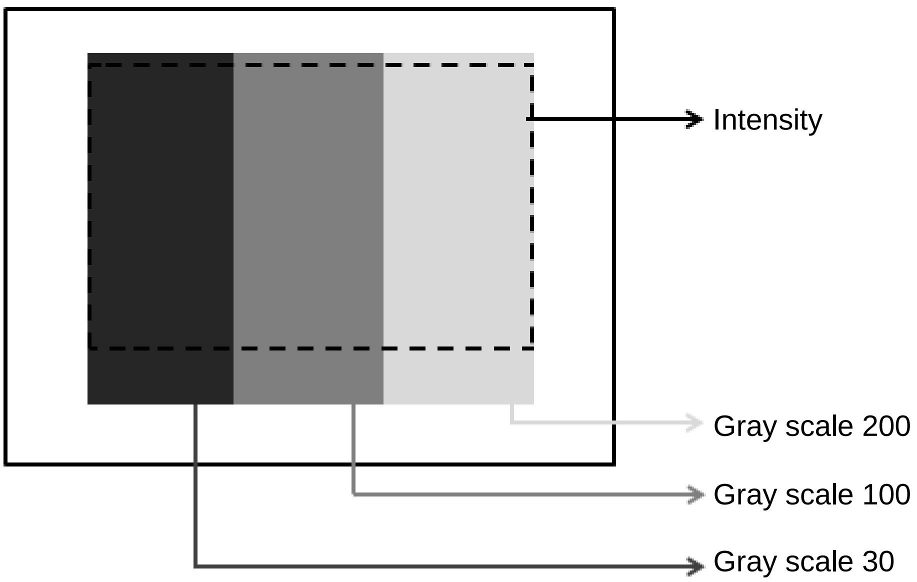
5.10 Intensity

Intensity can measure Maximum Intensity, Minimum Intensity, Average Intensity, and Standard Deviation of Intensity of the gray scale image in the inspection region.

◎ **Algorithmic Processing**

Intensity can detect Maximum Intensity, Minimum Intensity, Average Intensity, and Standard Deviation of Intensity in the inspection region. As shown in the following diagram, assume the inspection region consists of the 3 different gray scale distributions of 200, 100, and 30, the 4 following results can be obtained using Intensity.

- Maximum Intensity = 200
- Minimum Intensity = 30
- Average Intensity = (30+100+200) / 3 = 110
- Standard Deviation of Intensity = 121

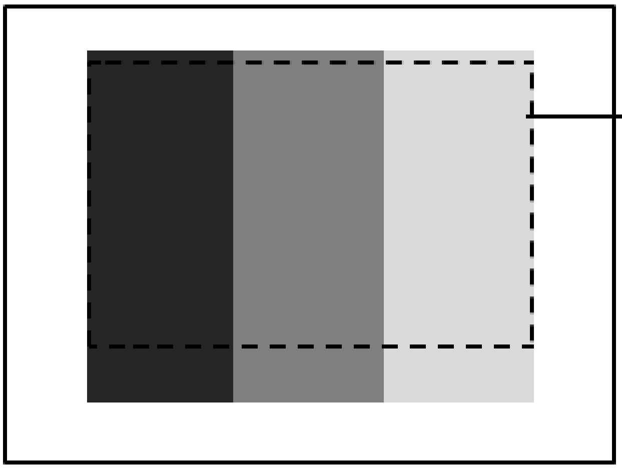


◎ **Procedural Results**

Intensity 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**



Maximum Intensity = 200

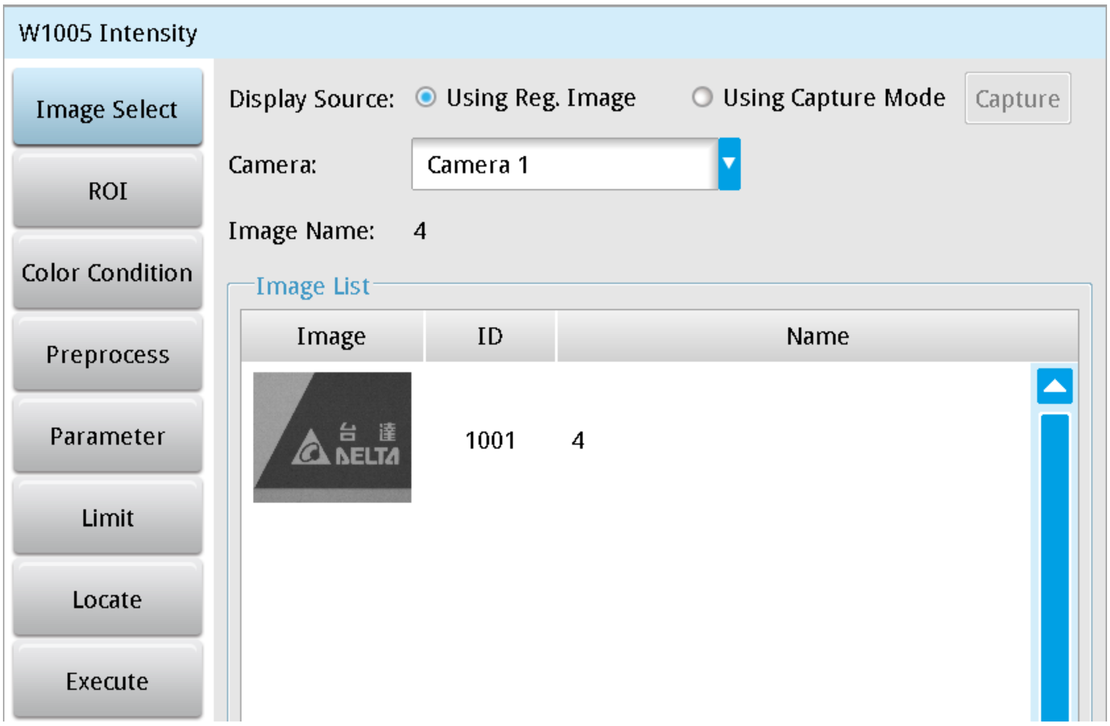
Minimum Intensity = 30

Average Intensity = 110

Standard Deviation of Intensity = 121

◎ **Intensity Main Menu**

The Intensity setup page includes the following items.



➤ Image Select (select Register Image)

Before entering inspection configurations, the registered image to be inspected must first be selected from the register gallery.

➤ ROI (configure detection region)

The desired inspection regions can be selected through ROI configurations. Optional ROI shapes include Rectangle, Circle, Arc, Ellipse, Ring, Polygon, and Rotated Rect.

- Color Condition

When using color camera, Color to Binary, Color to Grayscale, RGB grayscale, R Grayscale, G Grayscale, and B Grayscale can be configured on this page.

- Preprocess

When the camera image cannot perfectly highlight the emphasized effect, feature points can be enhanced through preprocessing.

- Parameters

The Blob inspection conditions can be adjusted in Parameter Setting.

- Limit

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.

- 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**

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)**

Optional ROI types include Rectangle, Circle, Ellipse, Ring, Arc, Polygon, and Rotated Rect. Polygon can support up to 16 points according to the requirement. Additionally, up to 8 mask functions are provided to ignore particular segments.

◎ **Color Condition**

Color images can be processed according to need. In Color Condition, images can be converted using the methods of Color to Binary, Color to Grayscale, RGB Grayscale, R grayscale, G grayscale, and B grayscale.

◎ **Preprocess**

Preprocess includes Binary, Dilation, Erosion, Average, Median, Laplacian, Sobel X, Sobel Y, Sobel XY, Intensity, Contrast, Shade, and Custom (filter) and can superimpose up to 6 options or produce custom preprocessed effect through Custom.

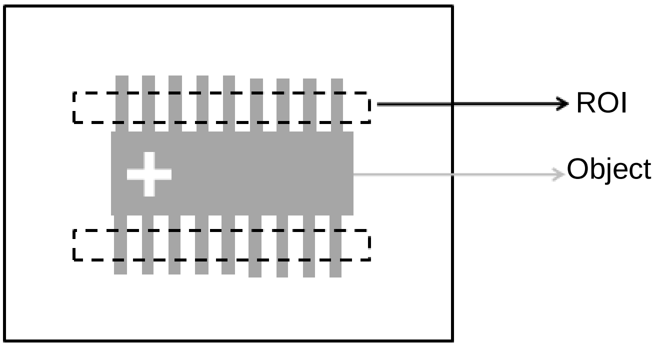
◎ **Limit**

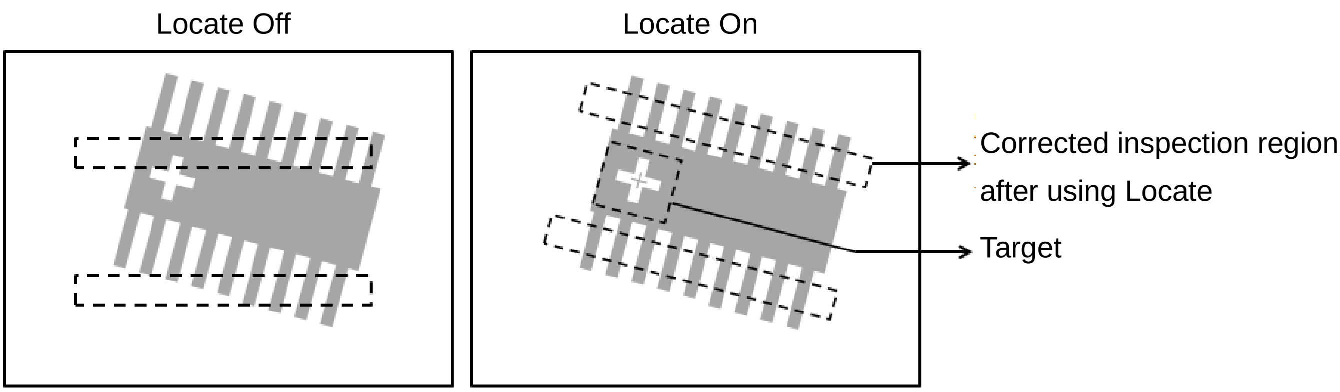
After acquiring the inspection results, Upper and Lower must be configured in this item to determine whether the result is qualified. The following items can be configured in Area.

➤ Area: Configures the upper and lower limits of Area.

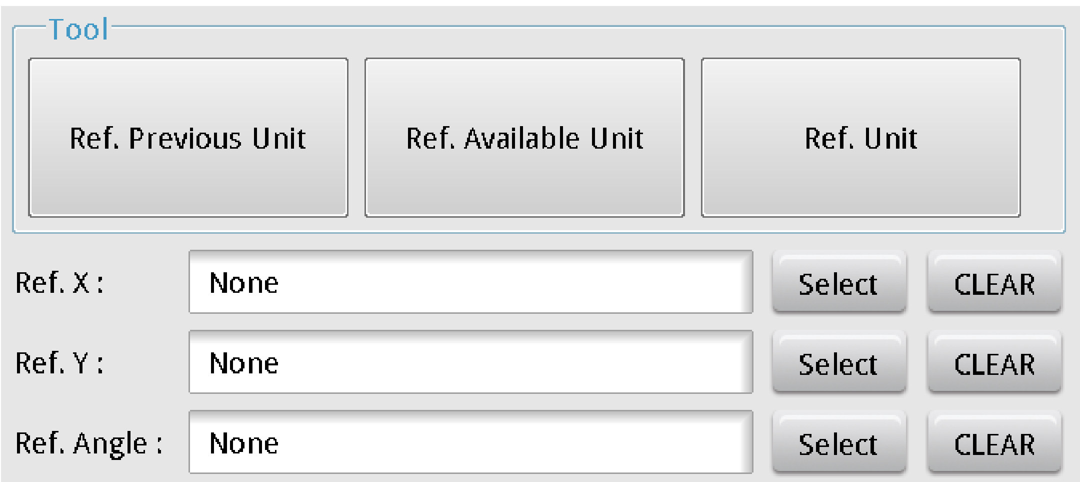
◎ **Locate**

This configures whether the inspection region will follow an inspection result for adjusting its coordinates (X, Y) and Angles (Theta). The inspection tools that can be used 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.





➤ Three tools are also provided in this item for quick configuration.



◆ Reference Previous Unit

When clicked, the nearest inspection tool that can provide reference for Locate will be automatically filled in the Ref. X, Ref. Y, and Ref. Angle fields below.

◆ Reference Available Unit

When clicked, the nearest unit with Locate configured will be automatically filled in the Ref. X, Ref. Y, and Ref. Angle fields below.

◆ Reference Unit

The option arbitrarily selects an inspection tool that can provide locating reference and automatically fills in the reference values of the selected unit in the Ref. X, Ref. Y, and Ref. Angle fields below.

Reference Please refer to Section 9.1 for detailed locating configurations.

◎ **Execute**

Configures whether to execute the inspection function in the inspection process.

➤ Always Execute

Always execute the inspection function in run mode.

➤ Never Execute

Never execute the inspection function in run mode.

◎ **Save**

All modified parameters and values can be saved by clicking this button.

◎ **Exit**

Click to leave the setup page.

◎ **Output Item**

➤ Window

By selecting the output window, the total judge result of the Intensity tool will be output on the designated interface.

➤ Item

1) Average Intensity: Outputs the average intensity found by Image Intensity
2) Standard Deviation of Intensity: Outputs the standard deviation of intensity found by Image Intensity
3) Maximum Intensity: Outputs the maximum intensity found by Image Intensity
4) Minimum Intensity: Outputs the minimum intensity found by Image Intensity
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 Image Intensity
7) Standard Deviation of Intensity (J): Outputs the logical (Judge) result of the standard deviation of intensity found by Image Intensity
8) Maximum Intensity (J): Outputs the logical (Judge) result of the maximum intensity found by Image Intensity
9) Minimum Intensity (J): Outputs the logical (Judge) result of the minimum intensity found by Image Intensity

5.11 Position Trace

The Position Trace tool is an advanced function of the Edge Width tool and has identical search methods. Using rectangular ROI as an example, search range can be configured to find edges through horizontal/vertical scanning. When segments of increased contrast is detected on the image, the tool identifies the region as a target edge. A feature of Position Trace is that the tool can simultaneously find multiple edge positions on a surface and output the coordinates.

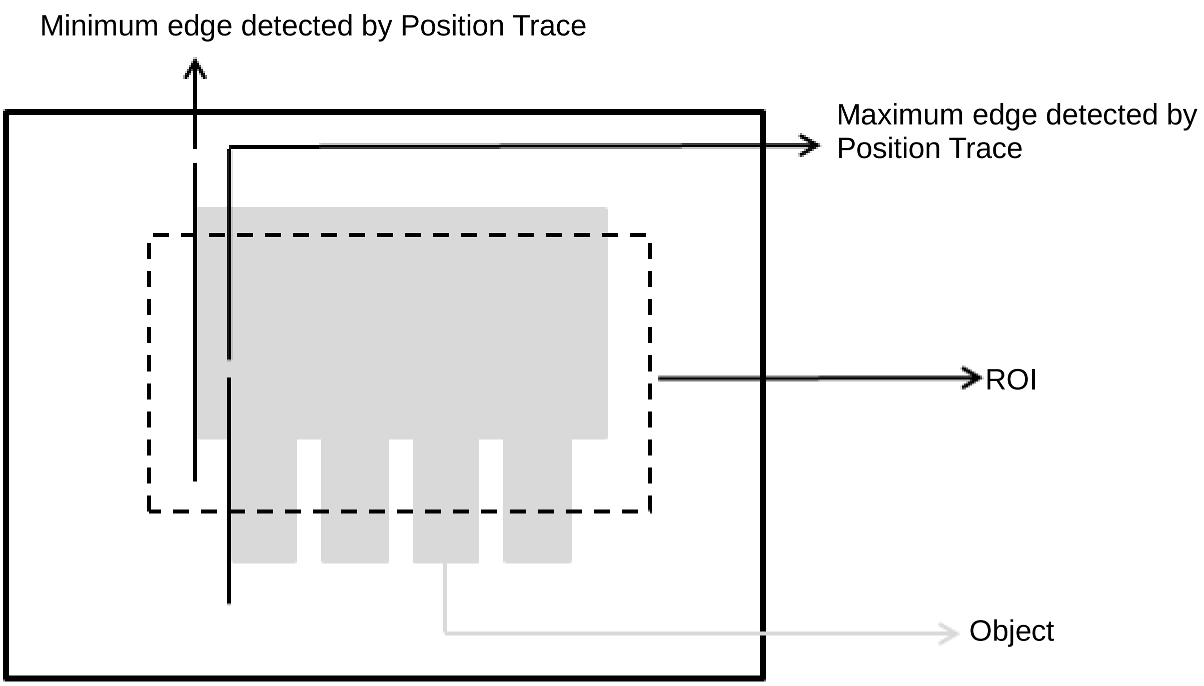
◎ **Algorithmic Processing**

➤ Position Trace Scan Methods

Position Trace includes diversified ROI options. Varying types of ROI options provide differing edge scanning methods.

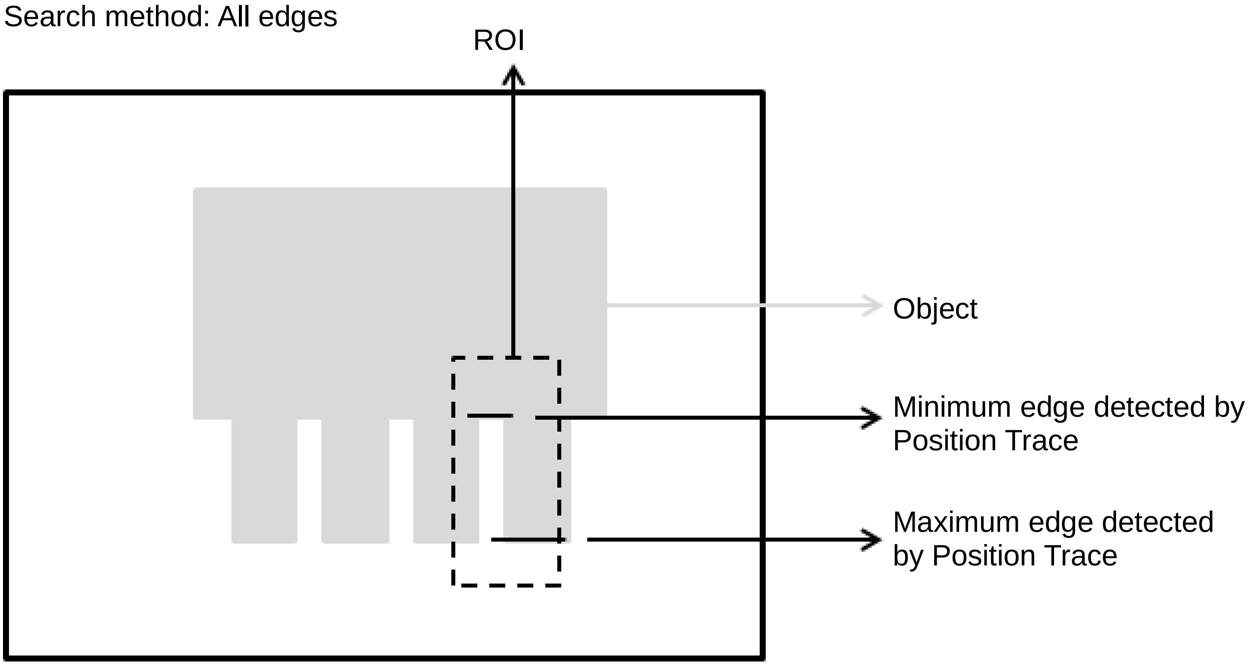
◆ When ROIs other than [Ring] and [Arc] are selected, Position Trace will calculate the furthest and the nearest edges relative to the screen origin and mark the two edges. This includes the two common conditions shown as follows.

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



Scanning direction: Downward

Search method: All edges

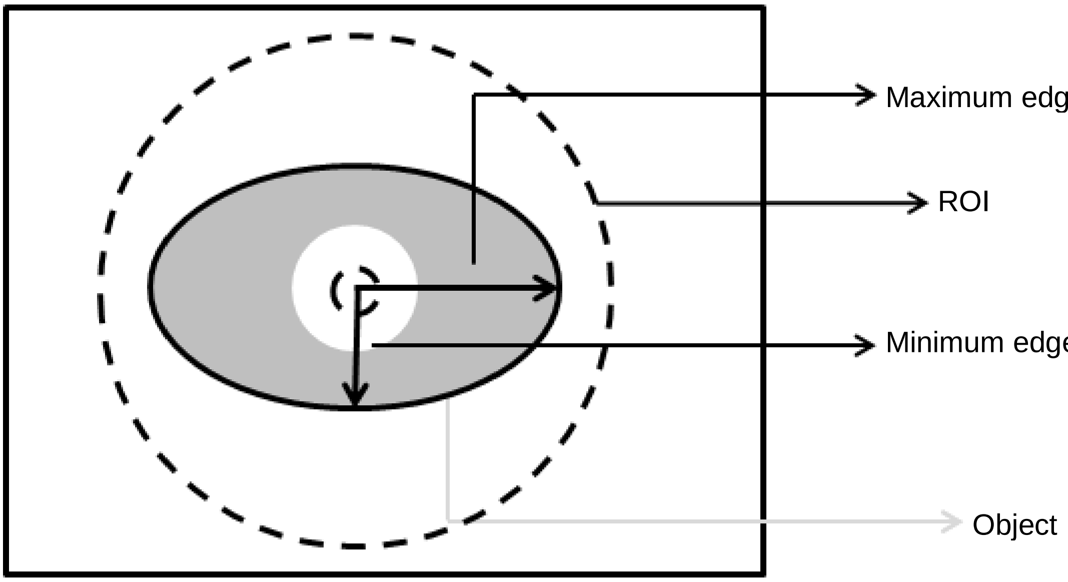


◆ When ROIs other than [Ring] and [Arc] are selected, Position Trace will calculate the furthest and the nearest edges relative to the origin (the center of the circle regressed from all positions detected on the object) and mark the two edges. This includes the two common conditions shown as follows.

Scanning direction: Outside→Center

Search method: Bright to dark

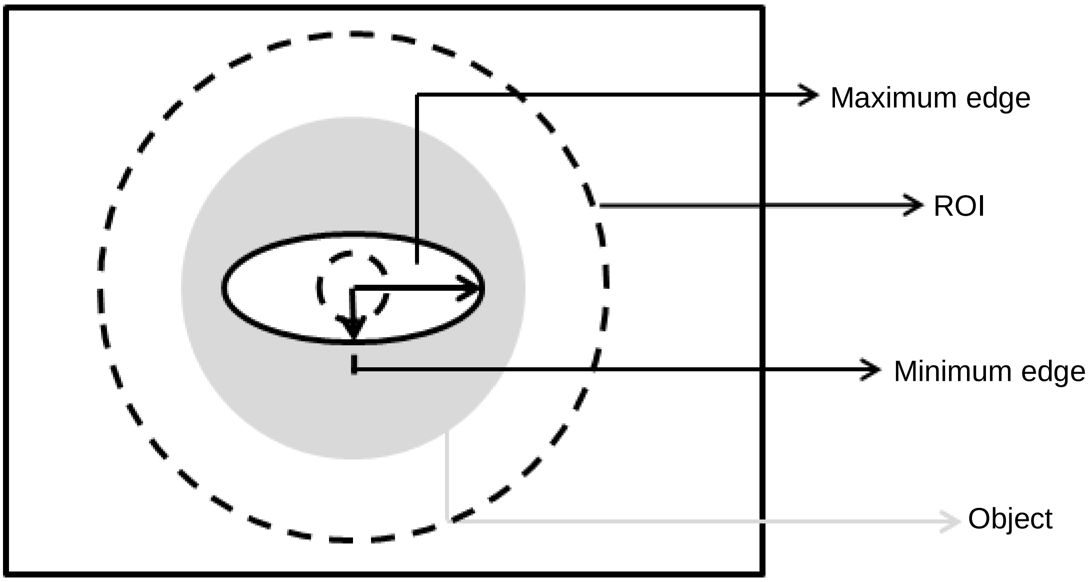
Angle: 0



Scanning direction: Inside-Out

Search method: All edges

Angle: 0



◎ **Procedural Results**

Position Trace returns the following inspection results.

- Number of Segments: Outputs the total number of edges found by Edge Position.
- Maximum Edge Position X: Outputs the X coordinate of the maximum edge position detected in the scanned region by Position Trace.
- Minimum Edge Position X: Outputs the X coordinate of the minimum edge position detected in the scanned region by Position Trace.
- Maximum Edge Position Y: Outputs the Y coordinate of the maximum edge position detected in the scanned region by Position Trace.
- Minimum Edge Position Y: Outputs the Y coordinate of the minimum edge position detected in the scanned region by Position Trace.
- Average Edge Position X: Outputs the X coordinate of the average edge position detected in the scanned region by Position Trace.
- Average Edge Position Y: Outputs the Y coordinate of the average edge position detected in the scanned region by Position Trace.
- Roundness: When ROI is [Ring] or [Arc], the system detects all edge positions on the object and regresses roundness data.
- Circle Center Position X: When ROI is [Ring] or [Arc], 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 ROI is [Ring] or [Arc], 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 Position Trace.
- Maximum Vertex Pitch: Outputs the widest pitch among vertexes found by Position Trace.
- Minimum Vertex Pitch: Outputs the shortest pitch among vertexes found by Position Trace.

- Edge Position X: Outputs the X coordinate of the assigned edge position selected in the parameters configured in Position Trace.
- Edge Position Y: Outputs the Y coordinate of the assigned edge position selected in the parameters configured in Position Trace.
- Edge Distance: Outputs the distance between the assigned edge position selected in the parameters configured in Position Trace and the edge of the fitting line/circle.
- Vertex Position X: Outputs the X coordinate of the assigned vertex among vertexes found by Position Trace.
- Vertex Position Y: Outputs the Y coordinate of the assigned vertex among vertexes found by Position Trace.
- Vertex Pitch: Outputs the assigned pitch data among vertexes found by Position Trace.

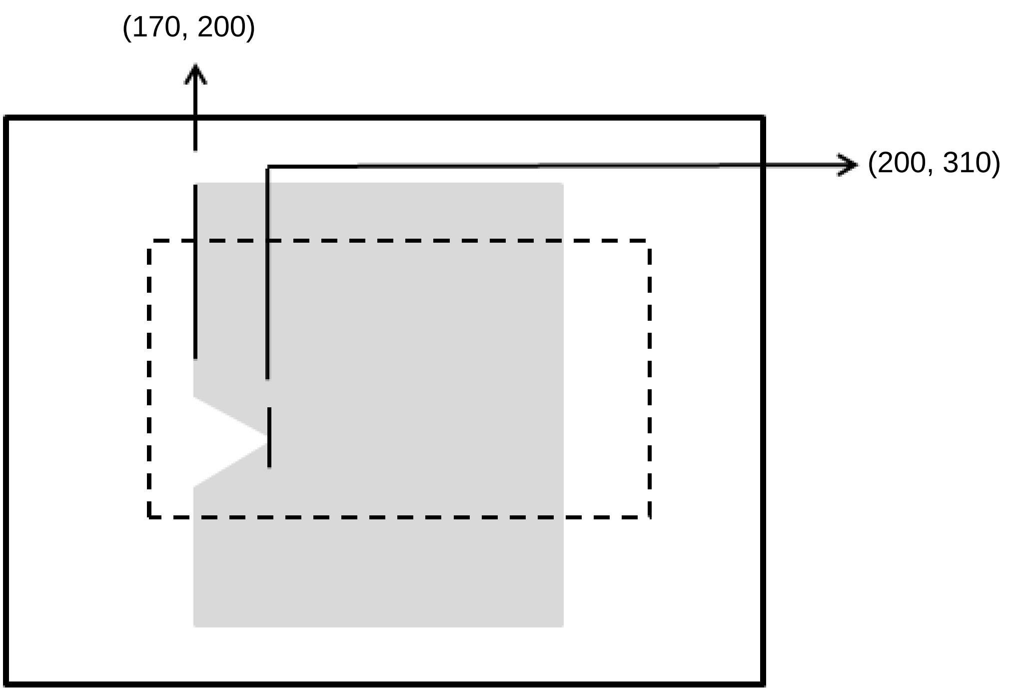
◎ **Example**

◆ For ROIs other than [Ring] and [Arc]

Scanning direction: Left to Right

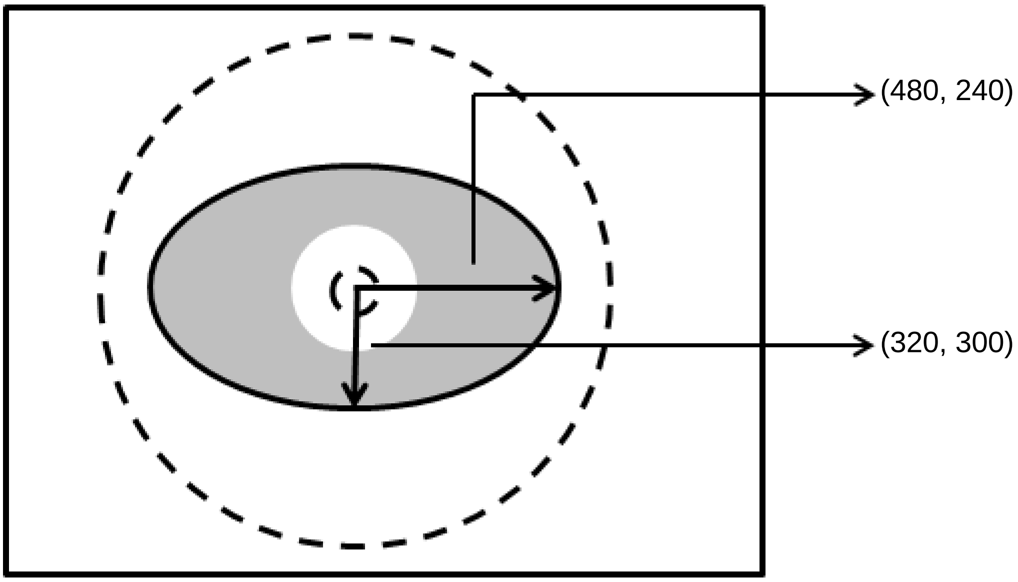
Search method: Bright to dark

Inspection result: The coordinates of the maximum edge position is (200, 310) and the coordinates of the minimum edge position is (170, 200). Gaps on the surface can be identified based on these data.

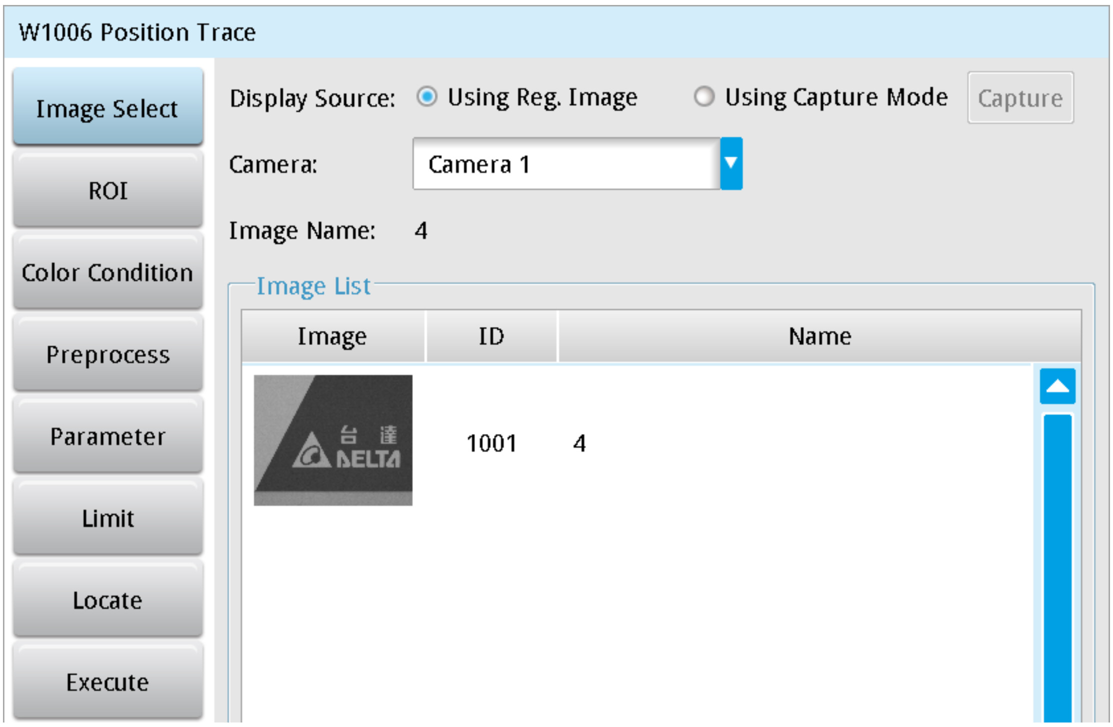


◆ For [Ring] and [Arc] ROIs

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)



◎ **Position Trace Main Menu**



➤ Image Select (select Register Image)

Before entering inspection configurations, the registered image to be inspected must first be selected from the register gallery.

- ROI (configure detection region)

The desired inspection regions can be selected through ROI configurations. Optional ROI shapes include Rectangle, Ring, Arc, and Rotated Rect.

- Color Condition

When using color camera, Color to Binary, Color to Grayscale, RGB grayscale, R Grayscale, G Grayscale, and B Grayscale can be configured on this page.

- Preprocess

When the camera image cannot perfectly highlight the emphasized effect, feature points can be enhanced through preprocessing.

- Parameters

The Position Trace inspection conditions can be adjusted in Parameter Setting.

- Limit

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.

- 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**

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)**

ROI options include Rectangle, Ring, Arc, and Rotated Rect. Up to 8 mask functions are also provided for masking unwanted segments.

◎ **Color Condition**

Color images can be processed according to need. In Color Condition, images can be converted using the methods of Color to Binary, Color to Grayscale, RGB Grayscale, R grayscale, G grayscale, and B grayscale.

◎ **Preprocess**

Preprocess includes Binary, Dilation, Erosion, Average, Median, Laplacian, Sobel X, Sobel Y, Sobel XY, Intensity Adj, Contrast, Shade, and Custom (filter) and can superimpose up to 6 options or produce custom preprocessed effect through Custom.

◎ **Parameters**

Position Trace

➤ Direction

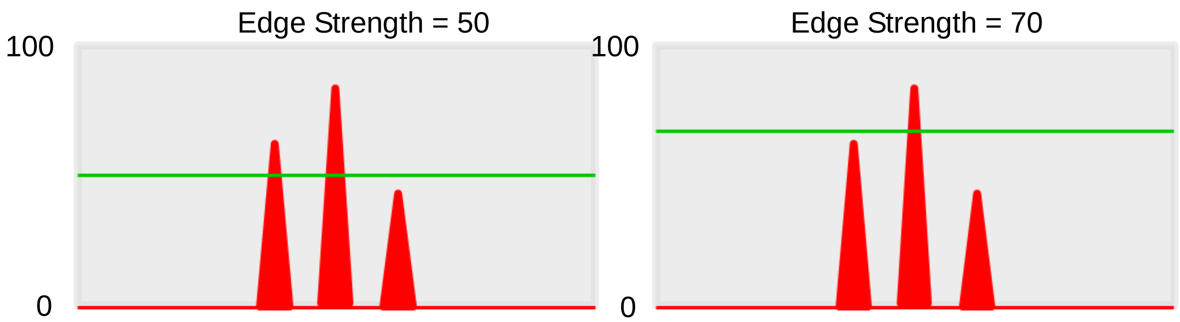
When ROI is configured as ring or arc, [Center→Outside] and [Outside→Center] can be selected as the two modes of scanning directions. When other shapes of ROIs are selected, [Left to Right], [Right to Left], [Downward], and [Upward] can be selected as the four modes of scanning directions.

➤ Look For

The search method can be configured according to need and can be divided into the three modes of [All Edges], [Light to Dark], and [Dark to Light].

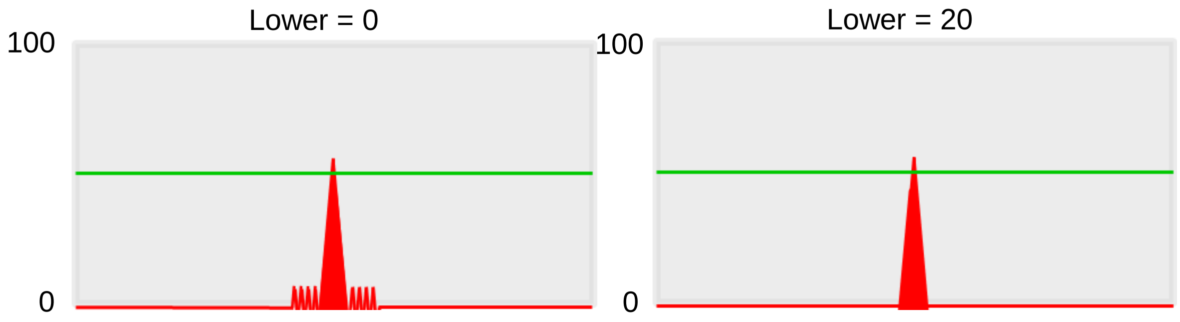
➤ Edge Strength

Edge Strength is the threshold of edge search (Look For) and can be fine-tuned between 0 and 100 based on the waveform displayed in the preview. When the wave is larger than the configured edge strength, Look For will identify the segment as an edge. As shown in the lower left diagram, the system will find two edges when Edge Strength is set to 50. As shown in the lower right diagram, only one edge, which is greater than the configured Edge Strength threshold of 70, remains.



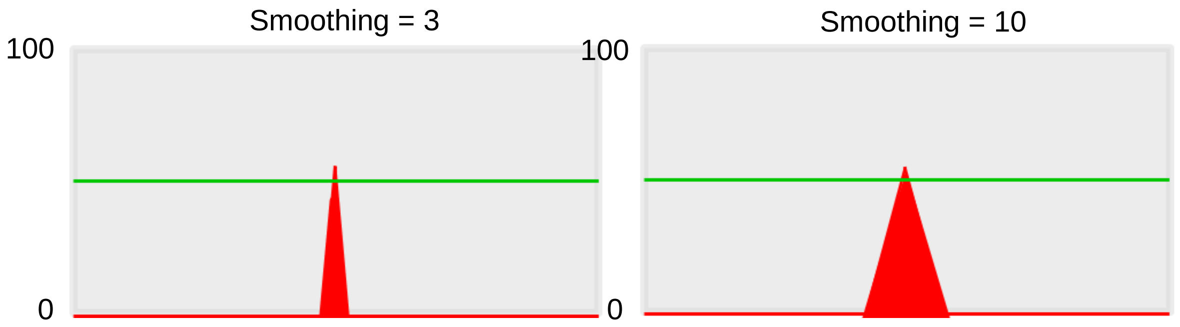
➤ Lower

Lower (limit) is used to filter small noise signals on the image and the parameter can be adjusted between 0 and 100. Waves less than the Lower configured value will disappear in the waveform. As shown in the lower left diagram, some noise appears when Lower is set to 0 and the noise will be filtered when Lower is set to 20.



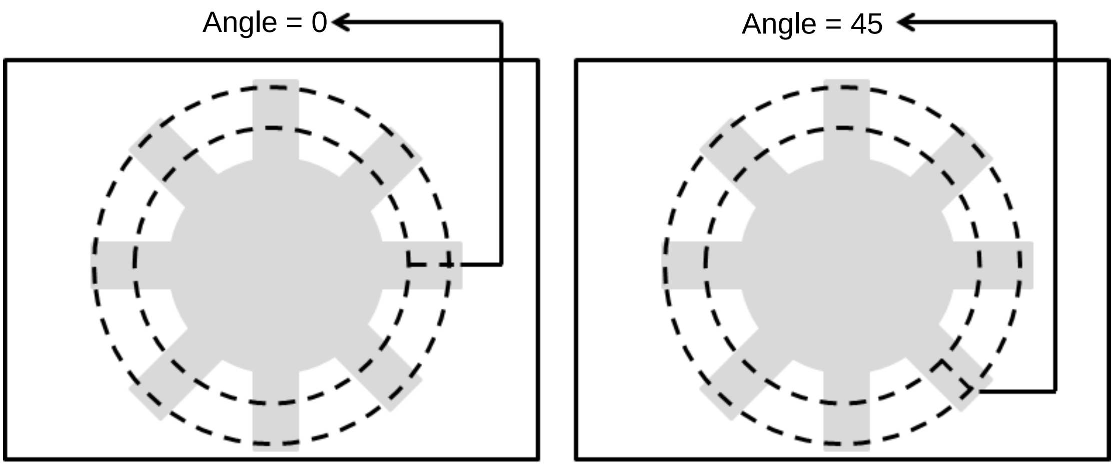
➤ Smoothing

RGB Grayscale of edges can be set between 1 and 30 for calculations. When Smoothing is increased, Slope of waveform changes, thereby attenuating the effect caused by noise signals.



➤ Angle

When ROI is set to [Ring] or [Arc], the starting angle for edge scans can be configured in this item. As shown in the lower left and right diagrams, the starting angles are 0 and 45 degrees, respectively.



➤ Segment Width

For ROIs other than [Ring] and [Arc], the range can be configured between 1 and 128. When ROIs are [Ring] and [Arc], the range can be configured between 0.1 and 45.0. Segment Width is the width of the horizontal pixel in each system scan.

➤ Segment Offset

The function can be configured between 0.1 and 45. When Segment Width is set to 4 and Segment Offset is set to 1, the system horizontally offsets 1 pixel after completing each edge scan of a width of 4 pixels before proceeding to another 4-pixel edge scan.

Vertex Inspection

➤ Vertex Function

Vertex Inspection can be enabled here

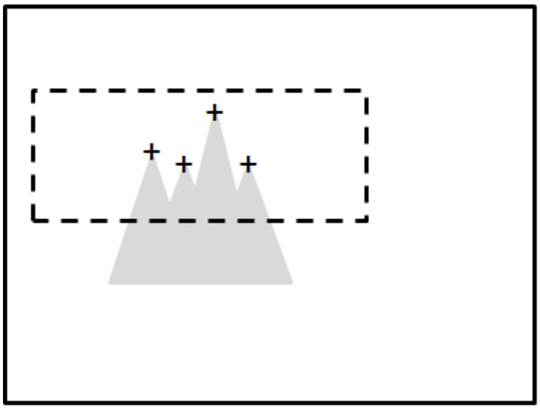
➤ Vertex Search Mode

This parameter can be adjusted to determine whether to search the top or bottom vertex

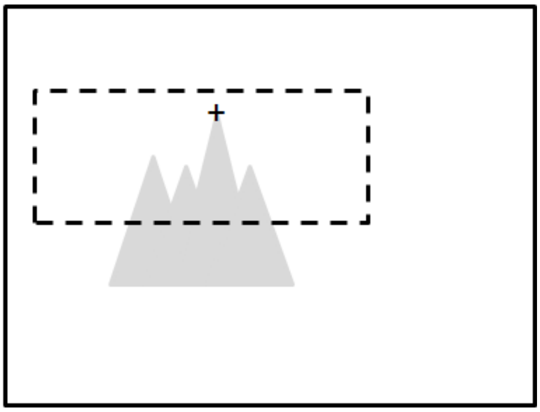
➤ Vertex Exclusivity Width

Can be configured between 0 and 128; only the top vertex is kept according to the configured width in Edge Position; larger configured values correspond to lesser number of vertexes kept.

Vertex Exclusivity Width = 0



Vertex Exclusivity Width = 2



➤ Regression Function

After turning on this function, the system generates a parabolic fitting curve for the detected vertexes and outputs the coordinates based on the vertex of the parabola.

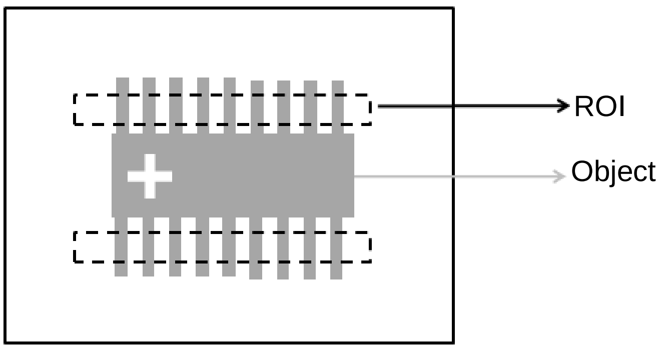
◎ **Limit**

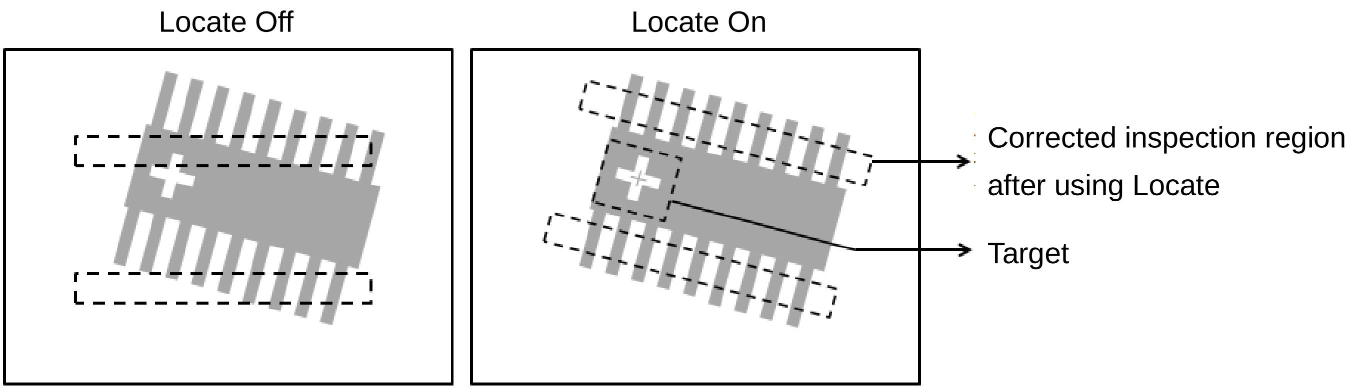
After acquiring the inspection results, Upper and Lower must be configured in this item to determine whether the result is qualified. The 5 following items can be configured in Position Trace.

- Maximum Edge Position X Can configure the upper and lower limits of the X coordinates of the maximum edge positions found by the system.
- Maximum Edge Position Y: Can configure the upper and lower limits of the Y coordinates of the maximum edge positions found by the system.
- Minimum Edge Position X: Can configure the upper and lower limits of the X coordinates of the minimum edge positions found by the system.
- Minimum Edge Position Y: Can configure the upper and lower limits of the Y coordinates of the minimum edge positions found by the system.
- Roundness: When enabled, the system inspects the roundness of circular objects. The upper and lower limits can be configured here.

◎ **Locate**

This configures whether the inspection region will follow an inspection result for adjusting its coordinates (X, Y) and Angles (Theta). The inspection tools that can be used as a reference include [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.





➢ Three tools are also provided in this item for quick configuration.

◆ Reference Previous Unit

When clicked, the nearest inspection tool that can provide reference for Locate will be automatically filled in the Ref. X, Ref. Y, and Ref. Angle fields below.

◆ Reference Available Unit

When clicked, the nearest unit with Locate configured will be automatically filled in the Ref. X, Ref. Y, and Ref. Angle fields below.

◆ Reference Unit

The option arbitrarily selects an inspection tool that can provide locating reference and automatically fills in the reference values of the selected unit in the Ref. X, Ref. Y, and Ref. Angle fields below.

Reference Please refer to Section 9.1 for detailed locating configurations.

◎ **Execute**

Configures whether to execute the inspection function in the inspection process.

➢ Always Execute

Always execute the inspection function in run mode.

➢ Never Execute

Never execute the inspection function in run mode.

◎ **Save**

All modified parameters and values can be saved by clicking this button.

◎ **Exit**

Click to leave the setup page.

◎ **Output Item**

➤ Window

By selecting the output window, the total judge result of the Position Trace tool will be output on the designated interface.

➤ Item

1) Number of Segments (N): Outputs the total number of edges found by Edge Position.
2) Edge Position X (X): Outputs the X coordinate of the assigned edge position selected in the parameters configured in Position Trace.
3) Edge Position (Y): Outputs the Y coordinate of the assigned edge position selected in the parameters configured in Position Trace.
4) Edge Distance (D): Outputs the distance between the assigned edge position selected in the parameters configured in 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 Position Trace.
6) Minimum Edge Position X (XL): Outputs the X coordinate of the minimum edge position detected in the scanned region by Position Trace.
7) Average Edge Position X (XA): Outputs the X coordinate of the average edge position detected in the scanned region by Position Trace.
8) Maximum Edge Position Y (YH): Outputs the Y coordinate of the maximum edge position detected in the scanned region by Position Trace.
9) Minimum Edge Position Y (YL): Outputs the Y coordinate of the minimum edge position detected in the scanned region by Position Trace.
10) Average Edge Position Y (YA): Outputs the Y coordinate of the average edge position detected in the scanned region by Position Trace.
11) Maximum Edge Distance (DH): Outputs the distance between the maximum edge position found by Position Trace and the edge of the fitting line/circle.
12) Minimum Edge Distance (DL): Outputs the distance between the minimum edge position found by Position Trace and the edge of the fitting line/circle.
13) Average Edge Distance (DA): Outputs the distance between the average edge position found by Position Trace and the edge of the fitting line/circle.
14) Roundness (RD): When ROI is [Ring] or [Arc], the system detects all edge positions on the object and regresses roundness data.
15) Circle Center Position X (CX): When ROI is [Ring] or [Arc], 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 ROI is [Ring] or [Arc], 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 Position Trace.
18) Vertex Position X (VTX): Outputs the X coordinate of the assigned vertex among vertexes found by Position Trace.

19) Vertex Position Y (VTY): Outputs the Y coordinate of the assigned vertex among vertexes found by Position Trace.
20) Vertex Pitch (VP): Outputs the assigned pitch data among vertexes found by Position Trace.
21) Maximum Vertex Pitch (VPH): Outputs the widest pitch among vertexes found by Position Trace.
22) Minimum Vertex Pitch (VPL): Outputs the shortest pitch among vertexes found by Position Trace.
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 Position Trace 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 Position Trace 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 Position Trace 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 Position Trace and the results judged based on the standard configured values.
28) Roundness (J) (RD): Outputs the roundness data regressed using Position Trace 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 has identical search methods. Using ROI as an example, search range can be configured to find plural edges through horizontal/vertical scanning. When a segment of increased contrast is detected on the image, the tool identifies the region as an ROI. Moreover, various measurement methods can be configured to inspect the maximum, minimum, and average widths of the inner and outer edges of the object.

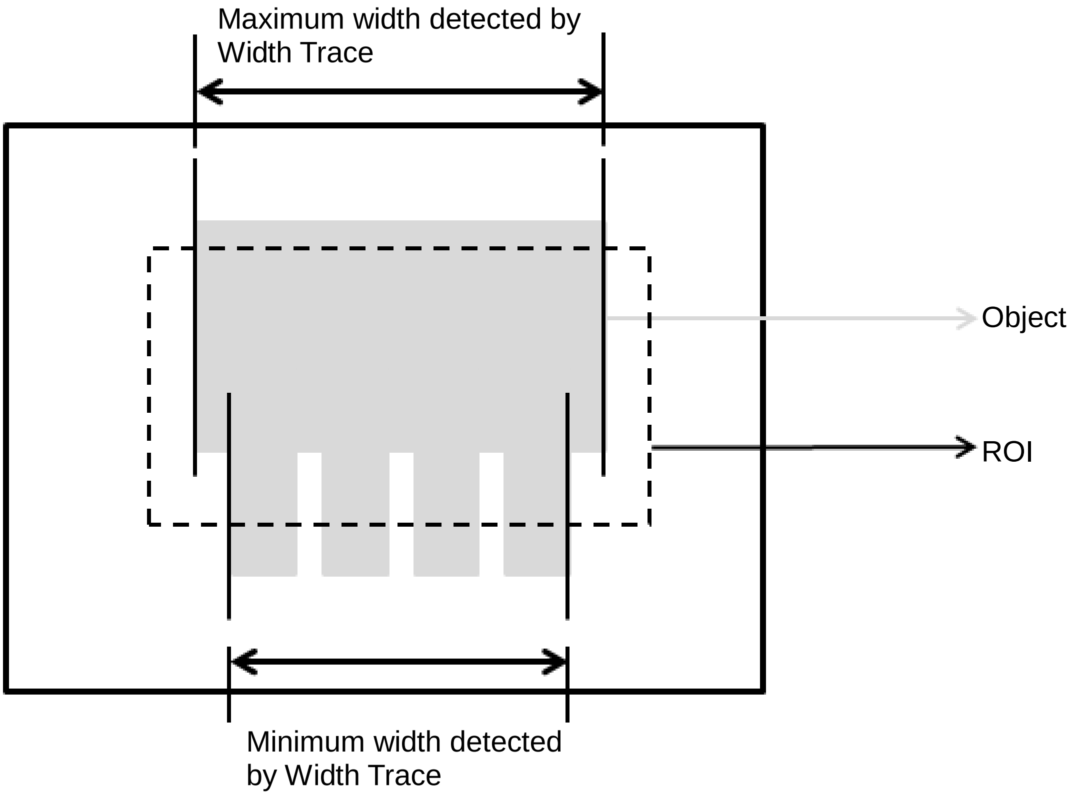
◎ **Algorithmic Processing**

➤ Width Trace Scan Methods

Width Trace includes diversified ROI options. Varying types of ROI options provides differing edge scanning methods.

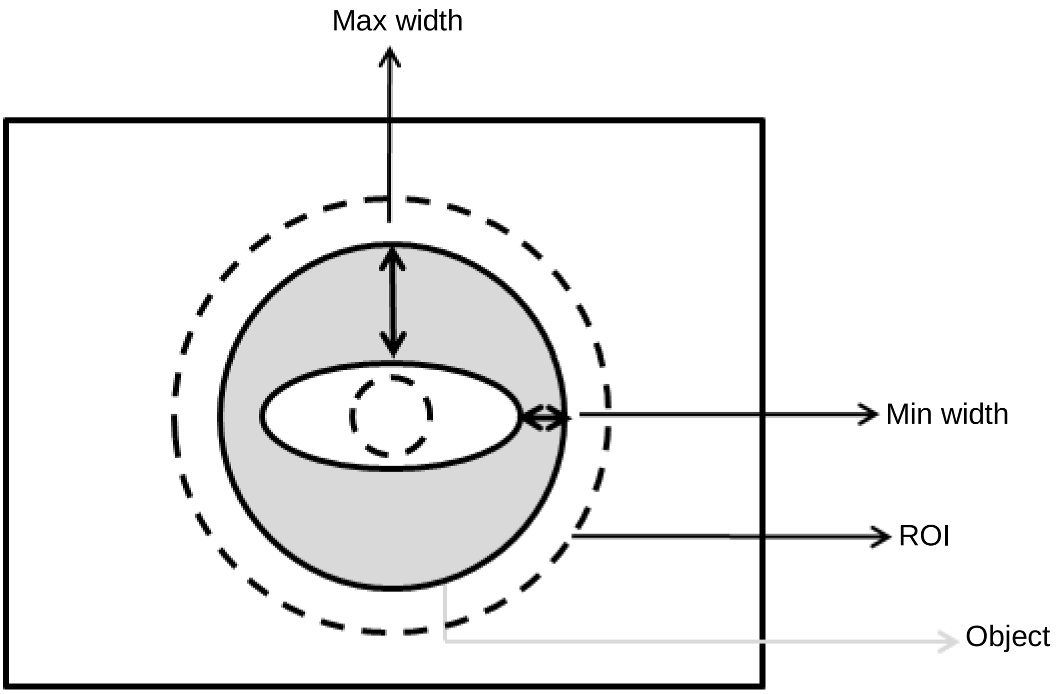
◆ The two following conditions usually occur for ROIs other than [Ring] and [Arc].

Scanning direction: Horizontal
Search method: All edges
Measure method: Outside-in



◆ The two following conditions usually occur for ROIs other than [Ring] and [Arc].

Scanning direction: Outside→Center
Search method: All edges
Measure method: Outside-in



◎ **Procedural Results**

Width Trace returns the following inspection results.

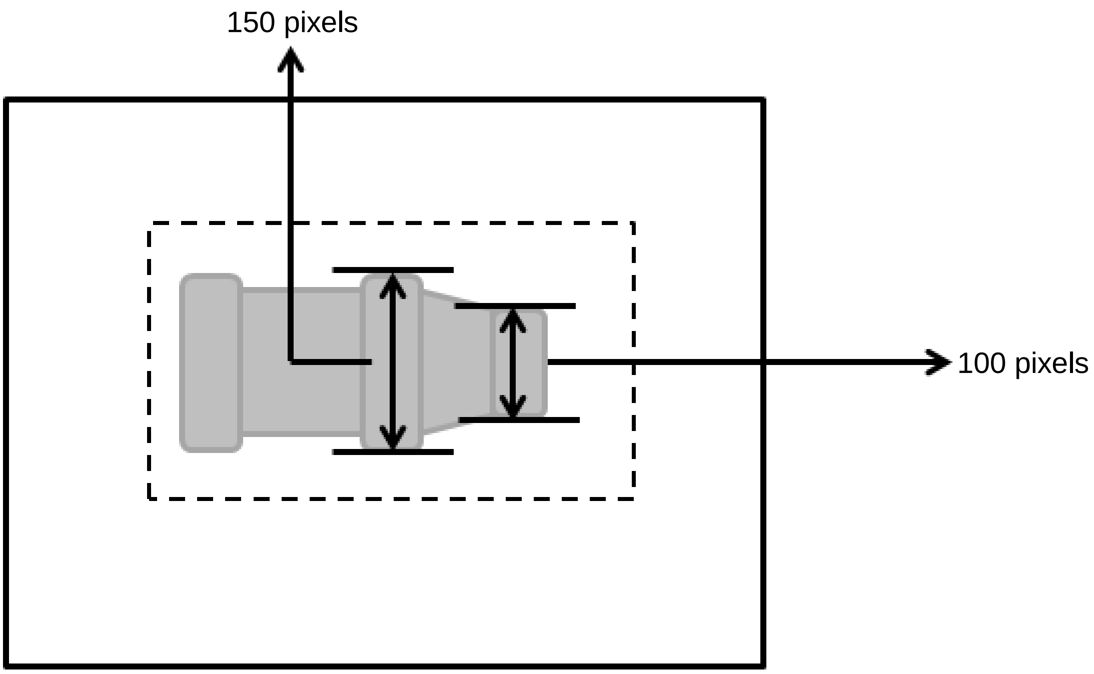
- Number of Segments: Outputs the total number of widths found by Width Trace. (unit in pixels)
- Maximum Edge Distance: Outputs the maximum edge distance among all widths found by Width Trace.
- Minimum Edge Distance: Outputs the minimum edge distance among all widths found by Width Trace.
- Average Edge Distance: Outputs the average edge distance among all widths found by Width Trace.
- Roundness 1: When ROI is [Ring] or [Arc], the system detects all edge positions on the inner edge of the object and 1 the Inner Circle Roundness.
- Inner Circle Position X: When ROI is [Ring] or [Arc], the system detects all edge positions on the inner edge of the object and regresses Inner Circle Position X.
- Inner Circle Position Y: When ROI is [Ring] or [Arc], 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 Width Trace on the inner circle.
- Roundness 2: When ROI is [Ring] or [Arc], the system detects all edge positions on the outer edge of the object and regresses Outer Circle Roundness.
- Outer Circle Position X: When ROI is [Ring] or [Arc], the system detects all edge positions on the outer edge of the object and regresses Outer Circle Position X.

- Outer Circle Position Y: When ROI is [Ring] or [Arc], 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 Width Trace on the outer circle.

◎ **Example**

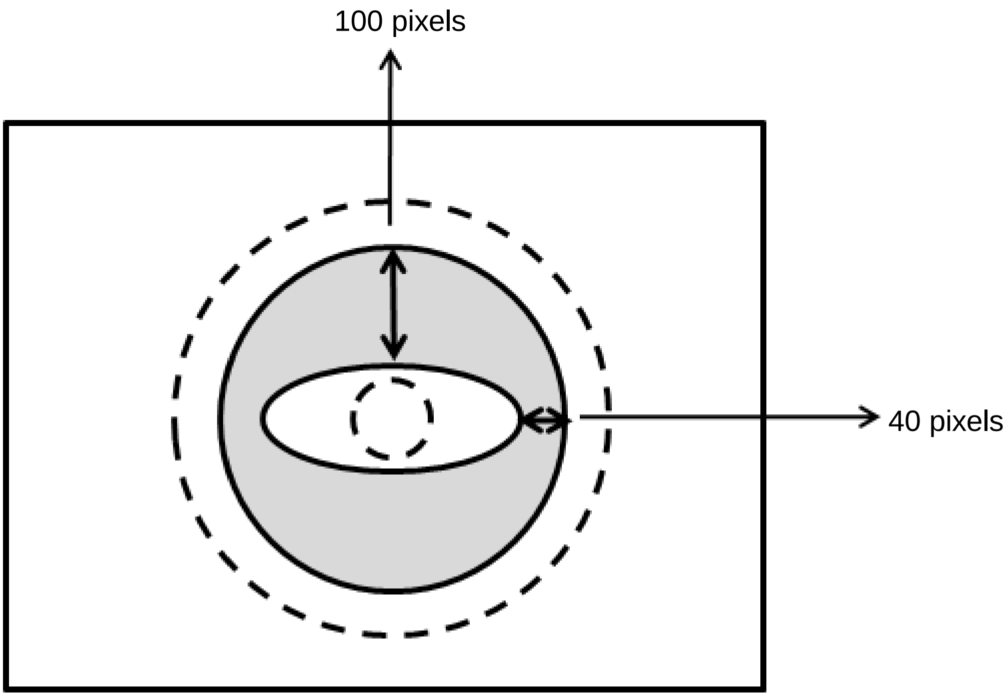
◆ For ROIs other than [Ring] and [Arc]

Scanning direction: Vertical
Search method: All edges
Measure method: Outside-in
Inspection result: Maximum Width is 150 pixels, Minimum Width is 100 pixels, Average Width is 125 pixels

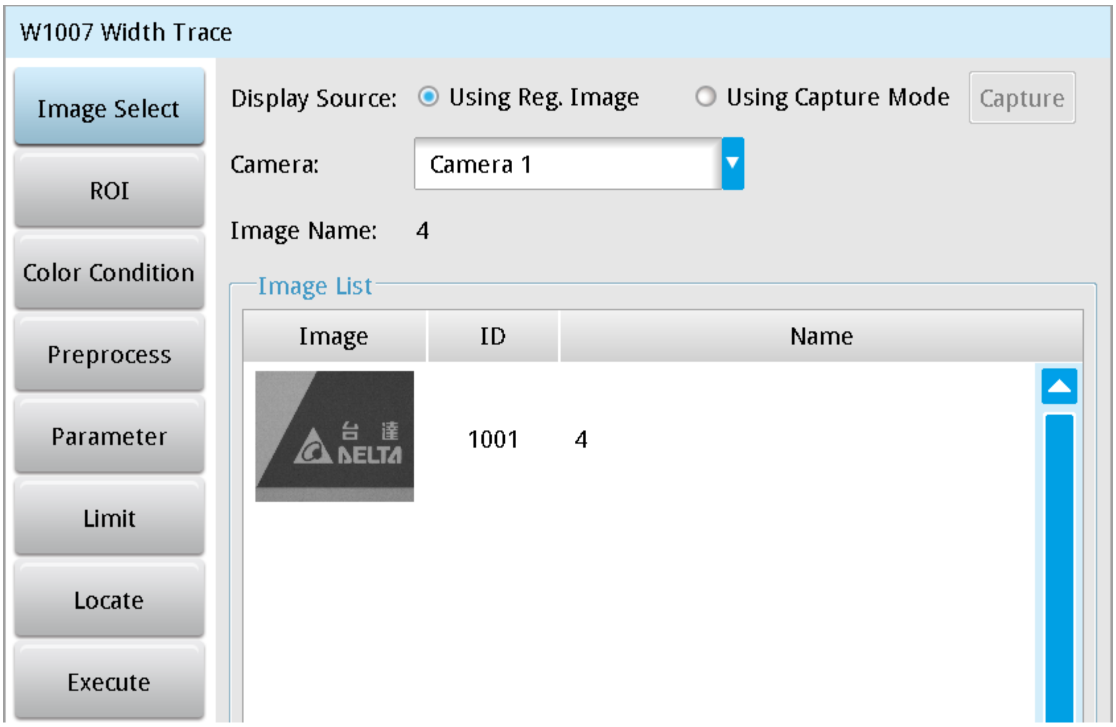


- For [Ring] and [Arc] ROIs

Scanning direction: Outside→Center
Search method: All edges
Measure method: Outside-in
Inspection result: Maximum Width is 100 pixels, Minimum Width is 40 pixels, Average Width is 70 pixels



◎ **Width Trace Main Menu**



- Image Select (select Register Image)

Before entering inspection configurations, the registered image to be inspected must first be selected from the register gallery.

- ROI (configure detection region)

The desired inspection regions can be selected through ROI configurations. Optional ROI shapes include Rectangle, Ring, Arc, and Rotated Rect.

- Color Condition

When using color camera, Color to Binary, Color to Grayscale, RGB grayscale, R Grayscale, G Grayscale, and B Grayscale can be configured on this page.

- Preprocess

When the camera image cannot perfectly highlight the emphasized effect, feature points can be enhanced through preprocessing.

- Parameters

The Width Trace inspection conditions can be adjusted in Parameter Setting.

- 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.

- 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**

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)**

Optional ROI types include Rectangle, Circle, Ellipse, Ring, Arc, Polygon, and Rotated Rect. Polygon can support up to 16 points according to the requirement. Additionally, up to 8 mask functions are provided to ignore particular segments.

◎ **Color Condition**

Color images can be processed according to need. In Color Condition, images can be converted using the methods of Color to Binary, Color to Grayscale, RGB Grayscale, R grayscale, G grayscale, and B grayscale.

◎ **Preprocess**

Preprocess includes Binary, Dilation, Erosion, Average, Median, Laplacian, Sobel X, Sobel Y, Sobel XY, Brightness, Contrast, Shade, and Custom (filter) and can superimpose up to 6 options or produce custom preprocessed effect through Custom.

◎ **Parameters**

Width Trace

➤ Direction

When ROI is configured as ring or arc, [Center→Outside] and [Outside→Center] can be selected as the two modes of scanning directions. When other shapes of ROIs are selected [Vertical] and [Horizontal] can be selected as the two modes of scanning directions.

➤ Look For

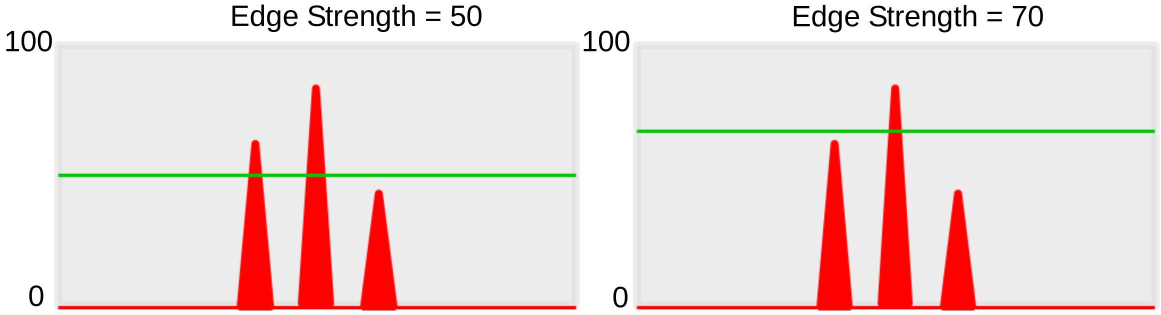
The search method can be configured according to need and can be divided into the three modes of [All Edges], [Light to Dark], and [Dark to Light].

➤ Measure

The measuring method can be configured according to need and can be divided into the two methods of [Outside-In] and [Inside-Out].

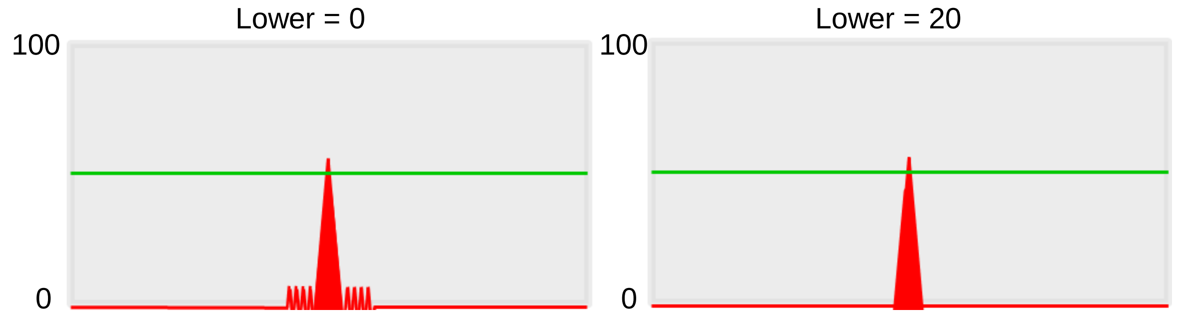
➤ Edge Strength

Edge Strength is the threshold of edge search (Look For) and can be fine-tuned between 0 and 100 based on the waveform displayed in the preview. When the wave is larger than the configured edge strength, Look For will identify the segment as an edge. As shown in the lower left diagram, the system will find two edges when Edge Strength is set to 50. As shown in the lower right diagram, only one edge, which is greater than the configured Edge Strength threshold of 70, remains.



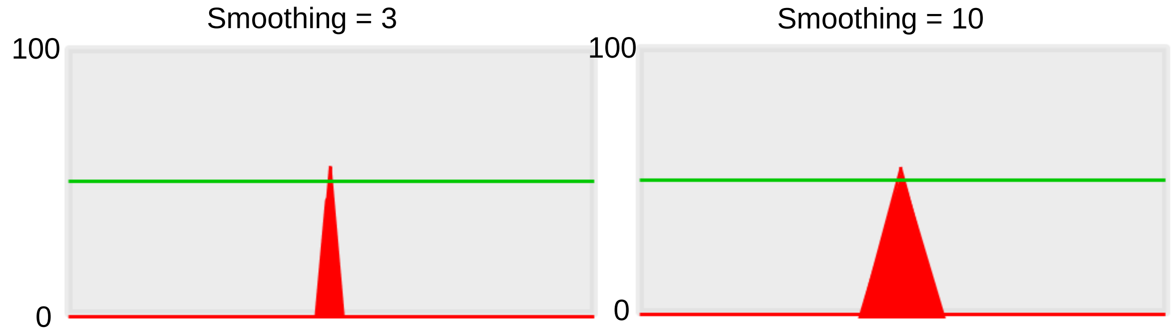
➤ Lower

Lower (limit) is used to filter small noise signals on the image and the parameter can be adjusted between 0 and 100. Waves less than the Lower configured value will disappear in the waveform. As shown in the lower left diagram, some noise appears when Lower is set to 0 and the noise will be filtered when Lower is set to 20.



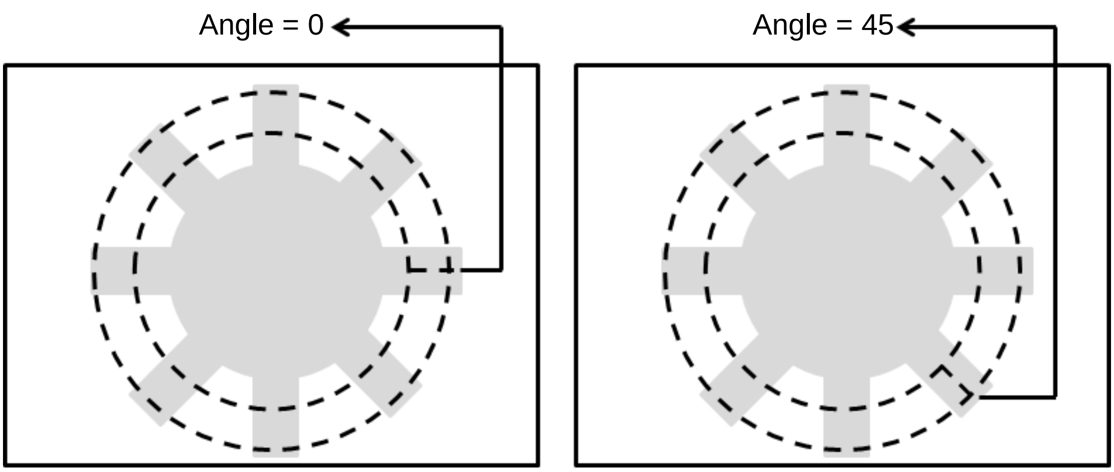
➤ Smoothing

RGB Grayscale of edges can be set between 1 and 30 for calculations. When Smoothing is increased, Slope of waveform changes, thereby attenuating the effect caused by noise signals.



➤ Angle

When ROI is set to [Ring] or [Arc], the starting angle for edge scans can be configured in this item. As shown in the lower left and right diagrams, the starting angles are 0 and 45 degrees, respectively.



- Segment Width

For ROIs other than [Ring] and [Arc], the range can be configured between 1 and 128. When ROIs are [Ring] and [Arc], the range can be configured between 0.1 and 45.0. Segment Width is the width of the horizontal pixel in each system scan.

- Segment Offset

The function can be configured between 0.1 and 45. When Segment Width is set to 4 and Segment Offset is set to 1, the system horizontally offsets 1 pixel after completing each edge scan of a width of 4 pixels before proceeding to another 4-pixel edge scan.

Circle Check

- Circle Inspect

When using [Ring] and [Arc] ROIs, Circle Inspect can be opened. When 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. The desired coordinates can be entered to change and move the origin to the new coordinates.

- Select

When the widths found by Width Trace are plural, the system can output the information of the assigned widths when adjusting optional parameters.

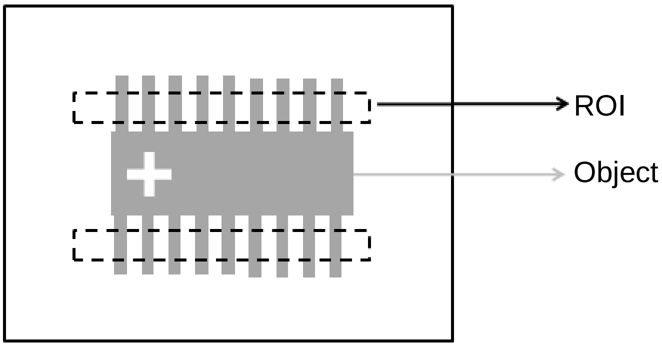
◎ **Limit**

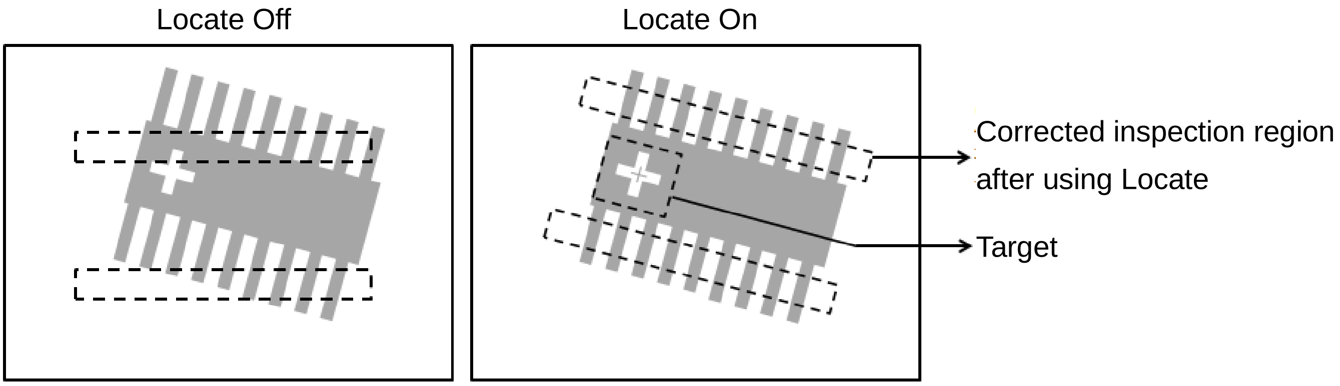
After acquiring the inspection results, Upper and Lower must be configured in this item to determine whether the result is qualified. The 5 following items can be configured in Width Trace.

- Maximum Edge Distance: Can configure the upper and lower width limits the system can identify from Maximum Edge Position.
- Minimum Edge Distance: Can configure the upper and lower width limits the system can identify from Minimum Edge Position.
- Average Edge Distance: Can configure the upper and lower width limits the system can identify from Average Edge Position.
- Roundness 1: When enabled, the system inspects the roundness of circular objects. The upper and lower limits of Inner Circle Roundness can be configured here.
- Roundness 2: When enabled, the system inspects the roundness of circular objects. The upper and lower limits of Inner Circle Roundness can be configured here.

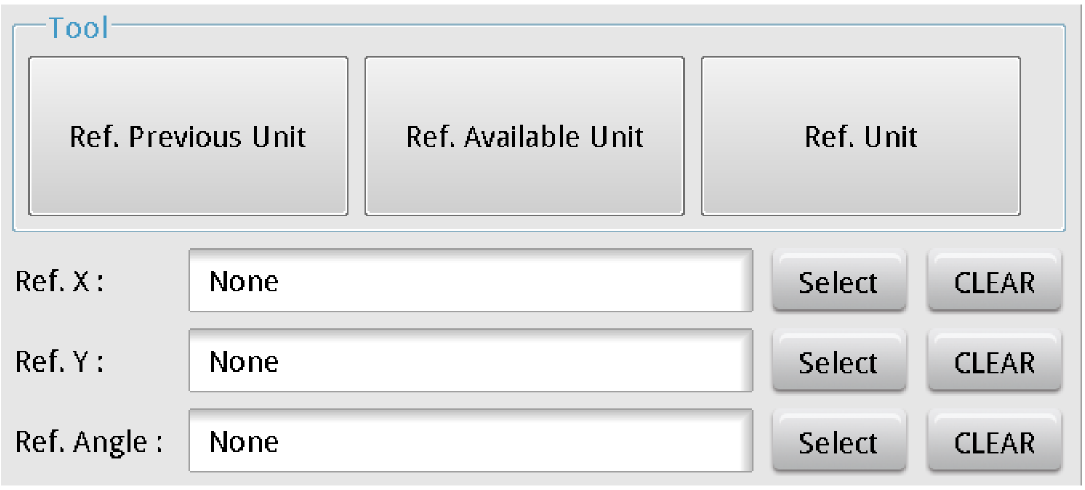
◎ **Locate**

This configures whether the inspection region will follow an inspection result for adjusting its coordinates (X, Y) and Angles (Theta). The inspection tools that can be used 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.





➤ Three tools are also provided in this item for quick configuration.



◆ Reference Previous Unit

When clicked, the nearest inspection tool that can provide reference for Locate will be automatically filled in the Ref. X, Ref. Y, and Ref. Angle fields below.

◆ Reference Available Unit

When clicked, the nearest unit with Locate configured will be automatically filled in the Ref. X, Ref. Y, and Ref. Angle fields below.

◆ Reference Unit

The option arbitrarily selects an inspection tool that can provide locating reference and automatically fills in the reference values of the selected unit in the Ref. X, Ref. Y, and Ref. Angle fields below.

Reference Please refer to Section 9.1 for detailed locating configurations.

◎ **Execute**

Configures whether to execute the inspection function in the inspection process.

➤ Always Execute

Always execute the inspection function in run mode.

➤ Never Execute

Never execute the inspection function in run mode.

◎ **Save**

All modified parameters and values can be saved by clicking this button.

◎ **Exit**

Click to leave the setup page.

◎ **Output Item**

➤ Window

By selecting the output window, the total judge result of the Width Trace tool will be output on the designated interface.

➤ Item

1) Number of Segments (N): Outputs the total number of widths found by Width Trace.
2) Maximum Edge Distance (WH): Outputs the maximum edge distance among all widths found by Width Trace.
3) Minimum Edge Distance (WL): Outputs the minimum edge distance among all widths found by Width Trace.
4) Average Edge Distance (WA): Outputs the average edge distance among all widths found by Width Trace.
5) Edge Width (W): Outputs the designated width data of the plural widths identified by Width Trace
6) Maximum Edge Width Position X1 (HX1): Outputs the X coordinate of the first edge of the maximum width found by Width Trace.
7) Maximum Edge Width Position Y1 (HY1): Outputs the Y coordinate of the first edge of the maximum width found by Width Trace.
8) Maximum Edge Width Position X2 (HX2): Outputs the X coordinate of the second edge of the maximum width found by Width Trace.

9) Maximum Edge Width Position Y2 (HY2): Outputs the Y coordinate of the second edge of the maximum width found by Width Trace.
10) Minimum Edge Width Position X1 (LX1): Outputs the X coordinate of the first edge of the minimum width found by Width Trace.
11) Minimum Edge Width Position Y1 (LY1): Outputs the Y coordinate of the first edge of the minimum width found by Width Trace.
12) Minimum Edge Width Position X2 (LX2): Outputs the X coordinate of the second edge of the minimum width found by Width Trace.
13) Minimum Edge Width Position Y2 (LY2): Outputs the Y coordinate of the second edge of the minimum width found by Width Trace.
14) Edge Width Position X1 (XS): Outputs the X coordinate of the first edge from the designated widths in the identified plural widths using Width Trace.
15) Edge Width Position Y1 (YS): Outputs the Y coordinate of the first edge from the designated widths in the identified plural widths using Width Trace.
16) Edge Width Position X2 (XE): Outputs the X coordinate of the second edge from the designated widths in the identified plural widths using Width Trace.
17) Edge Width Position Y2 (YE): Outputs the Y coordinate of the second edge from the designated widths in the identified plural widths using Width Trace.
18) Roundness 1 (RD1): When ROI is [Ring] or [Arc], the system detects all edge positions on the inner edge of the object and regresses Inner Circle Roundness.
19) Inner Circle Position X (CX1): When ROI is [Ring] or [Arc], the system detects all edge positions on the inner edge of the object and regresses Inner Circle Position X.
20) Inner Circle Position Y (CY1): When ROI is [Ring] or [Arc], the system detects all edge positions on the inner edge of the object and regresses Inner Circle Position Y.
21) Inner Circle Radius (CR1): Outputs all Inner Circle Radius values for circles fitting all edge positions found by Width Trace on the inner circle.
22) Roundness 2 (RD2): When ROI is [Ring] or [Arc], the system detects all edge positions on the outer edge of the object and regresses Outer Circle Roundness.
23) Outer Circle Position X (CX2): When ROI is [Ring] or [Arc], the system detects all edge positions on the outer edge of the object and regresses Outer Circle Position X.
24) Outer Circle Position Y (CY2): When ROI is [Ring] or [Arc], the system detects all edge positions on the outer edge of the object and regresses Outer Circle Position Y.
25) Outer Circle Radius (CR2): Outputs all Outer Circle Radius values for circles fitting all edge positions found by Width Trace 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 Width Trace.
28) Minimum Edge Distance (J) (WL): Outputs the minimum edge distance determined (Judge result) among all widths found by Width Trace.

29) Average Edge Distance (J) (WA): Outputs the average edge distance determined (Judge result) among all widths found by Width Trace.
30) Roundness 1 (J) (RD1): Outputs the Inner Circle Roundness data regressed using Width Trace and the results judged based on the standard configured values.
31) Roundness 2 (J) (RD2): Outputs the Outer Circle Roundness data regressed using Width Trace and the results judged based on the standard configured values.

5.13 OCV

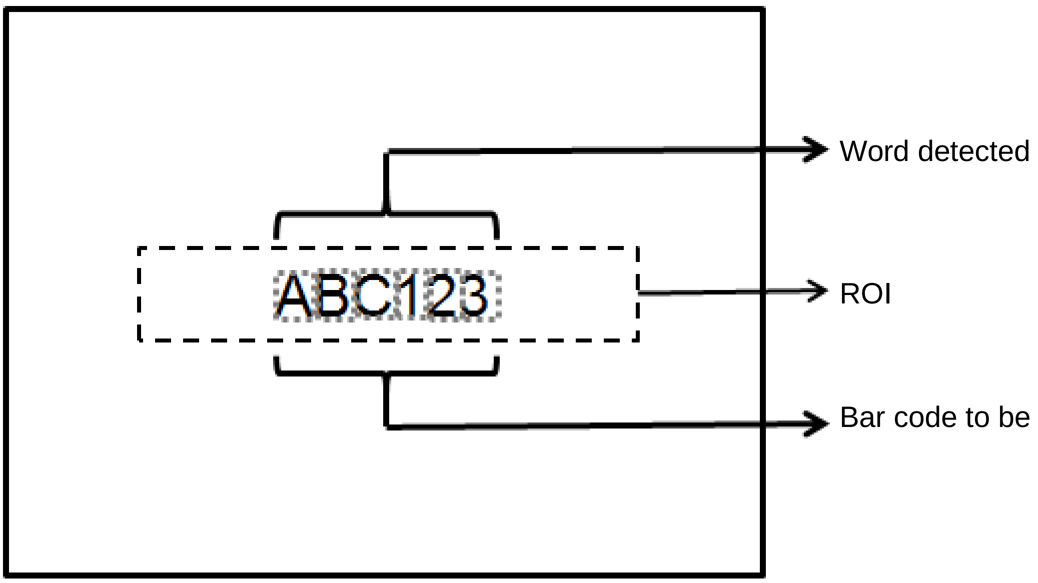
OCV is a function for comparing characters and searches the ROI through font outlines to detect the number of characters. Each character is then automatically (through the system) or manually divided and added to the dictionary. All objects subsequently appear in the ROI that are potentially characters will be compared to the established characters. The characters will then be recognized as the designated characters in the dictionary in cases of high degrees of similarity.

◎ **Algorithmic Processing**

➤ OCV Scanning Methods

OCV only supports one type of ROIoption, which is the rectangular ROI.

Custom: Disable
Verification Mode: Smart
Word Direction: Left to Right
Detect Word: Black
Row Number 1



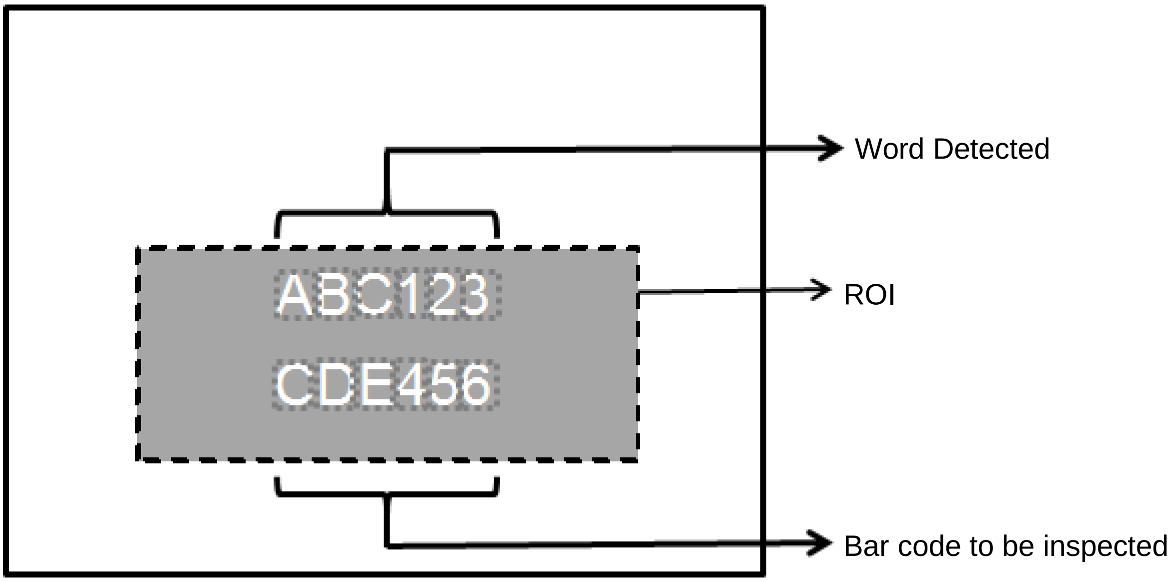
Custom: Disable

Verification Mode: Smart

Word Direction: Left to Right

Detect Word: White

Row Number 2



◎ **Procedural Results**

OCV returns the following inspection results.

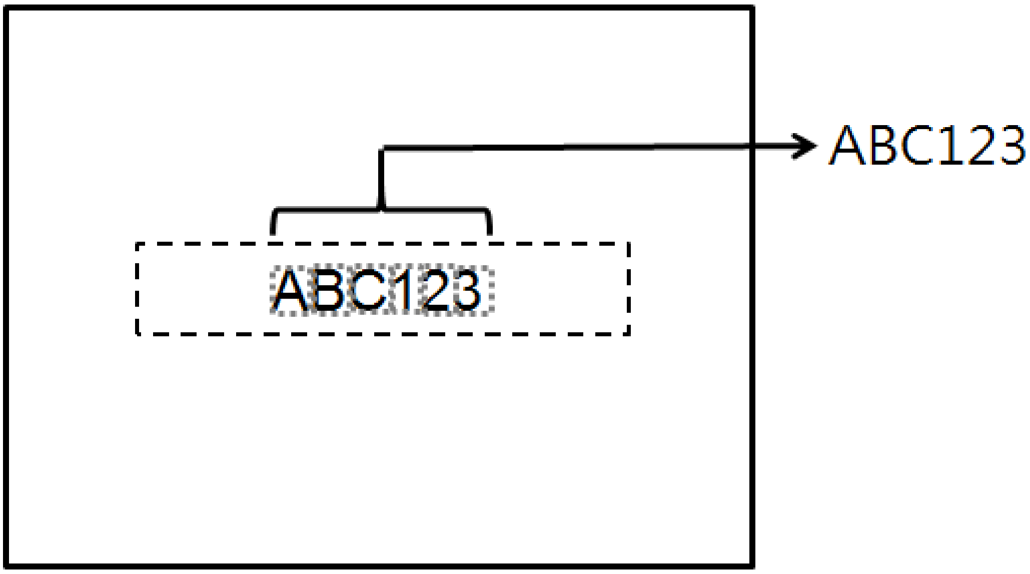
- High: Will output the total number of words detected by the system.
- Row1 Number of Characters: Will output the number of words in the first row detected and recognized by the system in the ROI.
- Row2 Number of Characters: Will output the number of words in the second row detected and recognized by the system in the ROI.
- Row1 Maximum X: Outputs the largest X coordinate in all characters found by the system from the strings in the first row.
- Row1 Maximum Y: Outputs the largest Y coordinate in all characters found by the system from the strings in the first row.
- Row1 Minimum X: Outputs the smallest X coordinate in all characters found by the system from the strings in the first row.
- Row1 Minimum Y: Outputs the smallest Y coordinate in all characters found by the system from the strings in the first row.
- Row2 Maximum X: Outputs the largest X coordinate in all characters found by the system from the strings in the second row.
- Row2 Maximum Y: Outputs the largest Y coordinate in all characters found by the system from the strings in the second row.
- Row2 Minimum X: Outputs the smallest X coordinate in all characters found by the system from the strings in the second row.

- Row2 Minimum Y: Outputs the smallest Y coordinate in all characters found by the system from the strings in the second row.
- Row1 Maximum Similarity: Outputs the value of the highest degree of character similarity among all characters found by the system from the strings in the first row.
- Row1 Minimum Similarity: Outputs the value of the lowest degree of character similarity among all characters found by the system from the strings in the first row.
- Row2 Maximum Similarity: Outputs the value of the highest degree of character similarity among all characters found by the system from the strings in the second row.
- Row2 Minimum Similarity: Outputs the value of the lowest degree of character similarity among all characters found by the system from the strings in the second row.

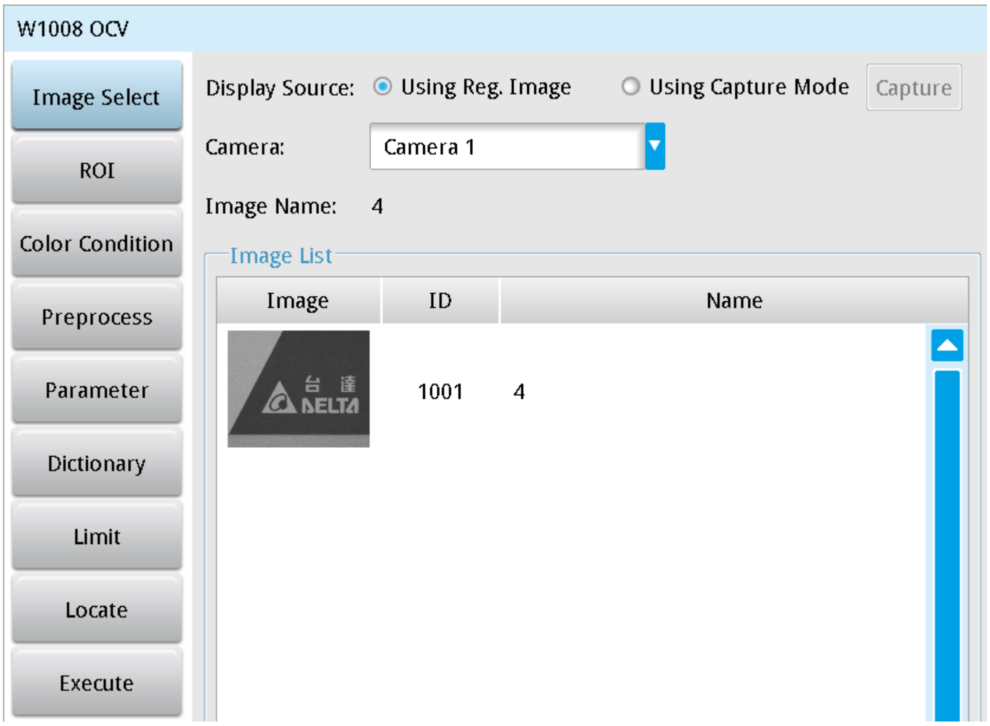
◎ **Example**

After selecting the text to be inspected using a rectangular ROI, the system will show the detected text using yellow outlines.

Custom: Disable
Verification Mode: Smart
Word Direction: Left to Right
Detect Word: Black
Row Number: 1
Inspection result: ABC123



◎ **OCV Main Menu**



➤ Image Select (select Register Image)

Before entering inspection configurations, the registered image to be inspected must first be selected from the register gallery.

➤ ROI (configure detection region)

The desired inspection regions can be selected through ROI configurations. The shape of the ROI is only available in rectangles.

➤ Color Condition

When using color camera, Color to Binary, Color to Grayscale, RGB grayscale, R Grayscale, G Grayscale, and B Grayscale can be configured on this page.

➤ Preprocess

When the camera image cannot perfectly highlight the emphasized effect, feature points can be enhanced through preprocessing.

➤ Parameters

The OCV inspection conditions can be adjusted in Parameter Setting.

➤ Dictionary

A single word or an entire string can be registered through this item.

➤ 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.

➤ 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**

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)**

Rectangle is the only type of ROI available. Up to 8 mask functions are also provided for ignoring unwanted segments.

◎ **Color Condition**

Color images can be processed according to need. In Color Condition, images can be converted using the methods of Color to Binary, Color to Grayscale, RGB Grayscale, R grayscale, G grayscale, and B grayscale.

◎ **Preprocess**

Preprocess includes Binary, Dilation, Erosion, Average, Median, Laplacian, Sobel X, Sobel Y, Sobel XY, Brightness, Contrast, Shade, and Custom (filter) and can superimpose up to 6 options or produce custom preprocessed effect through Custom.

◎ **Parameters**

Verification Mode.

➤ Custom

This option determines whether to enable the manual selection of each independent character. If [Disable] is selected, the system automatically detects and selects characters.

- Character Cutting Setting

When [On] is selected in [Custom], the selection of independent characters can be configured here.

- Verification Mode

When [Off] is selected in [Custom], the user can choose optional identification modes here, including [Smart] and [Strengthen].

- Word Direction:

Four character search directions are supported, including [Left to Right], [Right to Left], [Up to Down], and [Down to Up].

- Detect Word

Two conditions may arise when characters need to be detected. These conditions are black characters on white background and white characters on black background. This item provides the option to read black or white characters in gray scale images.

- Row Number

The number of rows of strings to be detected within the selected ROI can be configured here. The range can be configured to 1~2 rows.

- Tilt Correction

When making comparisons, characters can sometimes appear tilted. Enabling this item can correct character tilt to improve character recognition.

- Wave Strengthen

When each character has close gap distance, this item can be used to strengthen character cutting. The item includes the options [None], [Low], [Medium], [High].

- 1st Row

The string length to be detected within the the first row of strings can be configured here. The range can be configured between 1 and 22.

- 2nd Row

The string length to be detected within the the second row of strings can be configured here. The range can be configured between 1 and 22.

➢ Level

This item will only open when [Strengthen] is selected in [Verification Mode]. Level can be fine-tuned between 0 and 100 based on the waveform displayed in the preview. When the wave is larger than the configured Level, the OCV tool will identify the segment as a character. As shown in the lower left diagram, the system will find two characters when Edge Strength is set to 50. As shown in the lower right diagram, only one character, which is greater than the configured Edge Strength threshold of 70, remains.

➢ String Adjust

This item includes 5 configurable items, which are described as follows.

- Threshold: When an object in the ROI exceeds the configured threshold, the object will be recognized as a string by the system. When this string is poorly cut, this parameter can be lowered to improve the accuracy of string cutting.
- Lower: The purpose of the lower limit is to filter fine noise signals from images. Lower can be adjusted between a range of 0 and 100. Waves smaller than the configured value of Lower will disappear in the waveform.
- Minimum Width: The minimum width of a single character can be configured in this item.
- Maximum Width: The maximum width of a single character can be configured in this item.
- Smoothing: RGB Grayscale of edges can be set between 0 and 10 for calculations. When Smoothing is increased, Slope of waveform changes, thereby attenuating the effect caused by noise signals.

➢ Word Adjust Row1

This item includes 5 configurable items, which are described as follows

- Threshold: Characters that exceed the configured threshold in a string will be recognized as a character by the system. When this string is poorly cut, this parameter can be lowered to improve the accuracy of string cutting.
- Lower: Lower (limit) is used to filter small noise signals on the image and the parameter can be adjusted between 0 and 100. Waves less than the Lower configured value will disappear in the waveform. As shown in the lower left diagram, some noise appears when Lower is set to 0 and the noise will be filtered when Lower is set to 20.
- Minimum Width: The minimum width of a single character can be configured in this item.
- Maximum Width: The maximum width of a single character can be configured in this item.
- Smoothing: RGB Grayscale of edges can be set between 0 and 10 for calculations. When Smoothing is increased, Slope of waveform changes, thereby attenuating the effect caused by noise signals.

➤ Word Adjust Row2

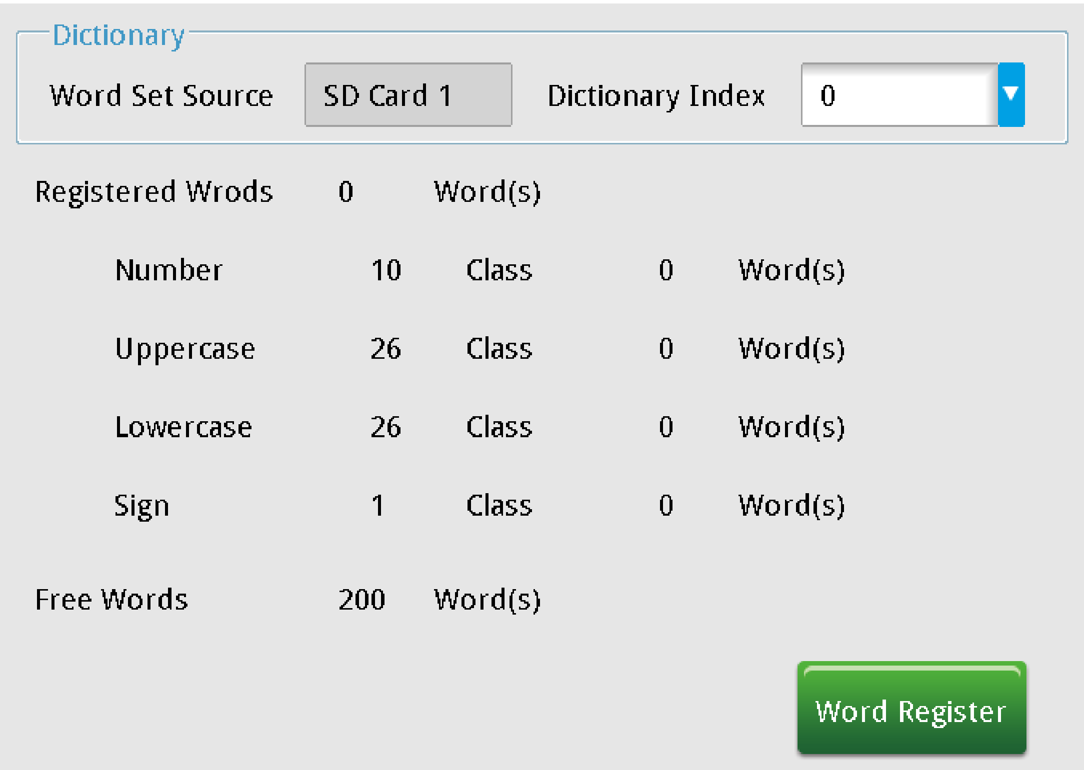
This item includes 5 configurable items, which are described as follows

- Threshold: Characters that exceed the configured threshold in a string will be recognized as a character by the system. When this string is poorly cut, this parameter can be lowered to improve the accuracy of string cutting.
- Lower: The purpose of the lower limit is to filter fine noise signals from images. Lower can be adjusted between a range of 0 and 100. Waves smaller than the configured value of Lower will disappear in the waveform.
- Minimum Width: The minimum width of a single character can be configured in this item.
- Maximum Width: The maximum width of a single character can be configured in this item.
- Smoothing: RGB Grayscale of edges can be set between 0 and 10 for calculations. When Smoothing is increased, Slope of waveform changes, thereby attenuating the effect caused by noise signals.

➤ Origin

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

◎ **Dictionary**

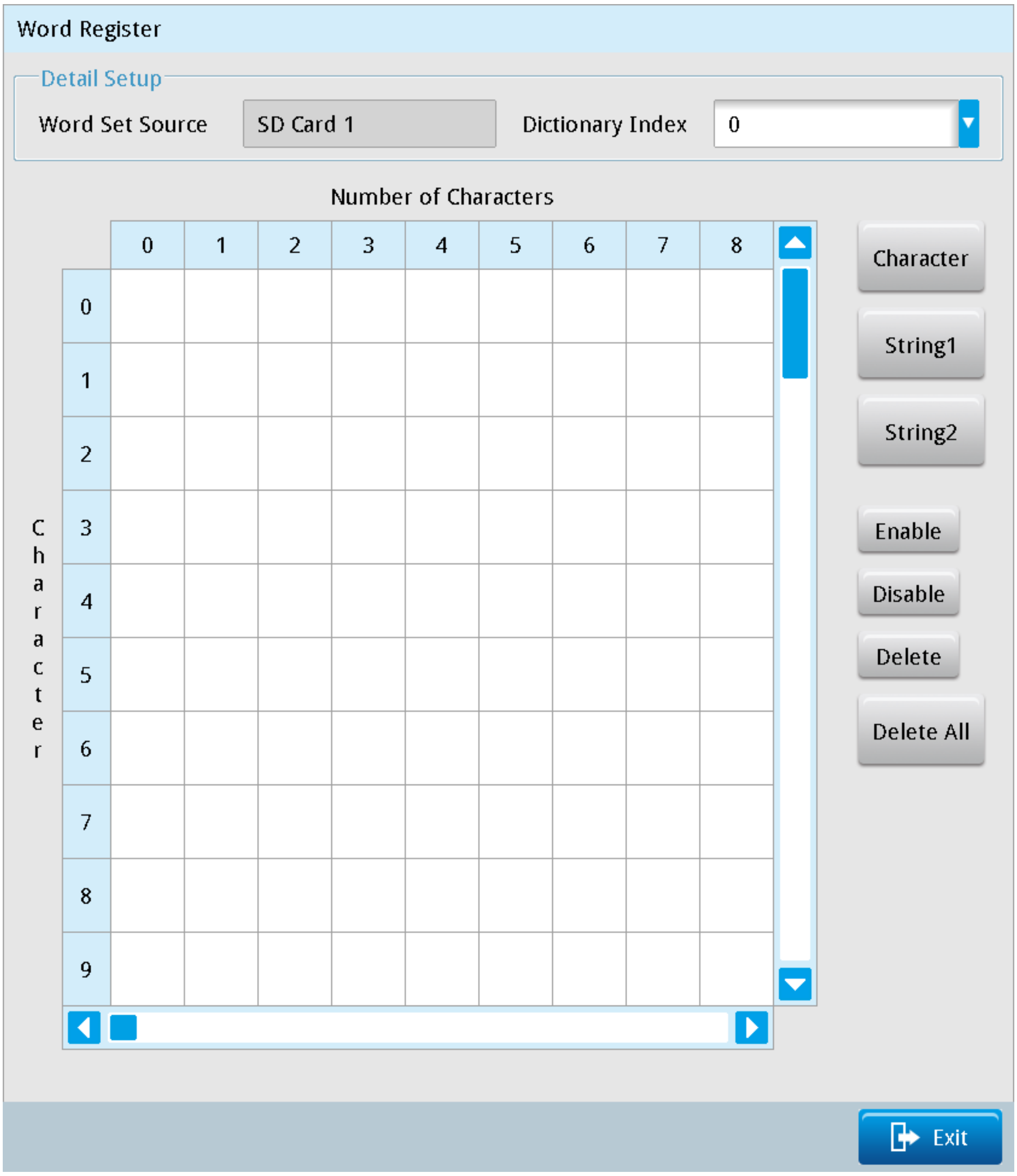


➤ Dictionary Index

The dictionary to be assessed can be configured here up to a maximum of 10 dictionaries (0~9).

➤ Word Register

Settings related to registering characters can be configured by clicking this item.



◆ Character

Each character can be established in order into the dictionary by clicking this item. If the first detected character is "A", then configure [Character Selection] to 1 and fill in "A" in the [Character] item and click OK. This completes registering the first character.

◆ String1

This item registers the first string. Click this item, fill in the contents of the first string, and click OK to complete string register.

◆ String2

This item registers the second string. Click this item, fill in the contents of the second string, and click OK to complete string register.

◆ Enable

When the dictionary stores characters not in use, the characters in the dictionary on the left side can be selected and activated by clicking on [Enable].

◆ Disable

When some of the enabled characters in the dictionary are unwanted as search reference, the characters can be selected from the dictionary on the left side and excluded from the search reference by clicking [Disable].

◆ Delete

When some of the characters are created incorrectly or unclear in the details, the characters can be selected form the dictionary on the left side and removed by clicking [Delete].

◆ Delete All

When the characters created in the dictionary are invalid, the dictionary can be cleared by clicking [Delete All].

◎ **Restrictions**

After acquiring the inspection results, upper and lower must be configured in this item to determine whether the result is qualified. The 6 following items can be configured in OCV.

➤ 1st Row String

◆ String Content

Can select [Normal] or [Date] formats for String Content

◆ String Content1

Can input any content as the standard string for comparison; the format is limited to English letters, numbers, and some punctuations

◆ Similarity Limit

This configures the similarity inspection between the current string and the standard string.

➤ 2nd Row String

◆ String Content

Can select [Normal] or [Date] formats for String Content

◆ String Content2

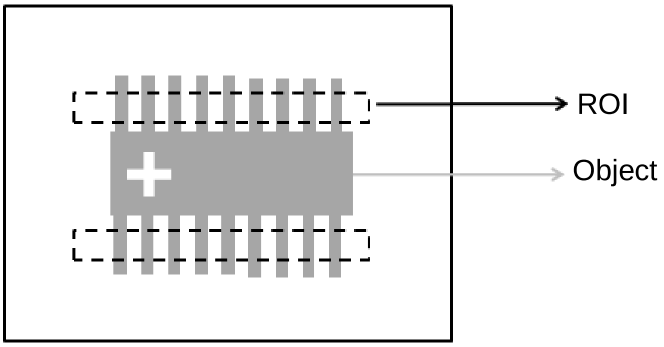
Can input any content as the standard string for comparison; the format is limited to English letters, numbers, and some punctuation

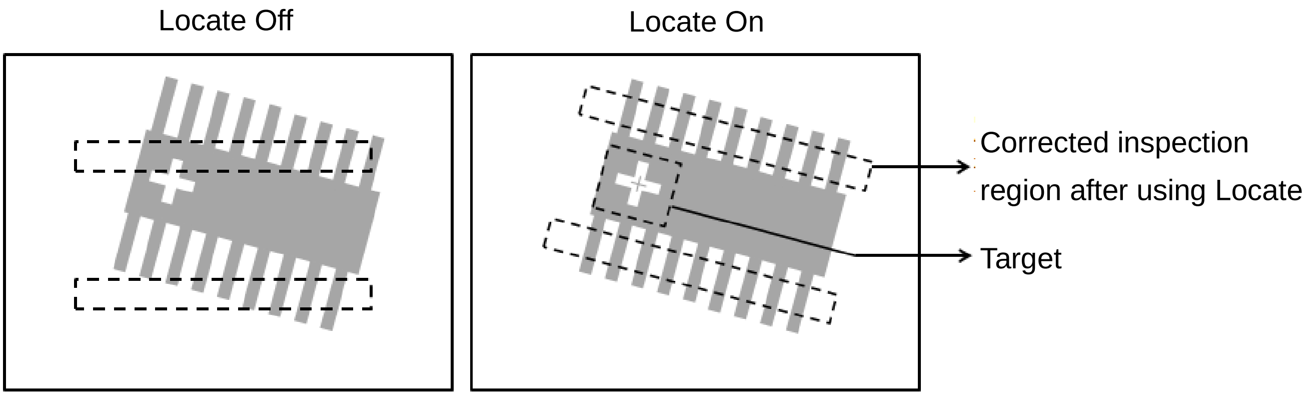
◆ Similarity Limit

This configures the similarity inspection between the current string and the standard string.

◎ **Locate**

This configures whether the inspection region will follow an inspection result for adjusting its coordinates (X, Y) and Angles (Theta). The inspection tools that can be used 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.





➤ Three tools are also provided in this item for quick configuration.

◆ Reference Previous Unit

When clicked, the nearest inspection tool that can provide reference for Locate will be automatically filled in the Ref. X, Ref. Y, and Ref. Angle fields below.

◆ Reference Available Unit

When clicked, the nearest unit with Locate configured will be automatically filled in the Ref. X, Ref. Y, and Ref. Angle fields below.

◆ Reference Unit

The option arbitrarily selects an inspection tool that can provide locating reference and automatically fills in the reference values of the selected unit in the Ref. X, Ref. Y, and Ref. Angle fields below.

Reference Please refer to Section 9.1 for detailed locating configurations.

◎ **Execute**

Configures whether to execute the inspection function in the inspection process.

➤ Always Execute

Always execute the inspection function in run mode.

➤ Never Execute

Never execute the inspection function in run mode.

◎ **Save**

All modified parameters and values can be saved by clicking this button.

◎ **Exit**

Click to leave the setup page.

◎ **Output Item**

➤ Window

By selecting the output window, the total judge result of the OCV tool will be output on the designated interface.

➤ Item

1) High (N): Outputs the total number of words detected by the system.
2) Row1 Number of Characters (R1N): Outputs the total number of characters identified by the system in the first row.
3) Row2 Number of Characters (R2N): Outputs the total number of characters identified by the system in the second row.
4) Row1 Start X of Character (X1S): Outputs the starting X coordinate of the designated character found by the system from the strings in the first row.
5) Row1 End X of Character (X1E): Outputs the ending X coordinate of the designated character found by the system from the strings in the first row.
6) Row1 Start Y of Character (Y1S): Outputs the starting Y coordinate of the designated character found by the system from the strings in the first row.
7) Row1 End Y of Character (Y1E): Outputs the ending Y coordinate of the designated character found by the system from the strings in the first row.
8) Row1 Identified Result (C1): Outputs the result of the designated character found by the system from the strings in the first row.
9) Row1 Similarity of Character (S1): Outputs the degree of similarity of the designated character found by the system from the strings in the first row.
10) Row2 Start X of Character (X2S): Outputs the starting X coordinate of the designated character found by the system from the strings in the second row.
11) Row2 End X of Character (X2E): Outputs the ending X coordinate of the designated character found by the system from the strings in the second row.
12) Row2 Start Y of Character (Y2S): Outputs the starting Y coordinate of the designated character found by the system from the strings in the second row.
13) Row2 End Y of Character (Y2E): Outputs the ending Y coordinate of the designated character found by the system from the strings in the second row.
14) Row2 Identified Result (C2): Outputs the result of the designated character found by the system from the strings in the second row.
15) Row2 Similarity of Character (S2): Outputs the degree of similarity of the designated character found by the system from the strings in the second row.
16) Row1 Maximum X (X1H): Outputs the largest X coordinate in all characters found by the system from the strings in the first row.
17) Row1 Maximum Y (Y1H): Outputs the largest Y coordinate in all characters found by the system from the strings in the first row.
18) Row1 Minimum X (X1L): Outputs the smallest X coordinate in all characters found by the system from the strings in the first row.

19) Row1 Minimum Y (Y1L): Outputs the smallest Y coordinate in all characters found by the system from the strings in the first row.
20) Row2 Maximum X (X2H): Outputs the largest X coordinate in all characters found by the system from the strings in the second row.
21) Row2 Maximum Y (Y2H): Outputs the largest Y coordinate in all characters found by the system from the strings in the second row.
22) Row2 Minimum X (X2L): Outputs the smallest X coordinate in all characters found by the system from the strings in the second row.
23) Row2 Minimum Y (Y2L): Outputs the smallest Y coordinate in all characters found by the system from the strings in the second row.
24) Row1 Maximum Similarity (S1H): Outputs the value of the highest degree of character similarity among all characters found by the system from the strings in the first row.
25) Row1 Minimum Similarity (S1L): Outputs the value of the lowest degree of character similarity among all characters found by the system from the strings in the first row.
26) Row2 Maximum Similarity (S2H): Outputs the value of the highest degree of character similarity among all characters found by the system from the strings in the second row.
27) Row2 Minimum Similarity (S2L): Outputs the value of the lowest degree of character similarity among all characters found by the system from the strings in the second row.
28) OCV String1 (R1): Outputs the result obtained by the system from the strings in the first row.
29) OCV String2 (R2): Outputs the result obtained by the system from the strings in the second row.
30) OCV ID: Outputs the ID of the inspection tool.
31) OCV String1 (J) (R1): Outputs the character contents obtained by the system from the strings in the first row and logical results (Judge) based on the standard configured values.
32) OCV String2 (J) (R2): Outputs the character contents obtained by the system from the strings in the second row and logical results (Judge) based on the standard configured values.
33) Row1 Similarity of Character (J) (R1S): Outputs the degree of similarity of the designated character found by the system from the strings in the first row and logical results (Judge) based on the standard configured values.
34) Row2 Similarity of Character (J) (R2S): Outputs the degree of similarity of the designated character found by the system from the strings in the second row and logical results (Judge) based on the standard configured values.

5.14 Bar Code

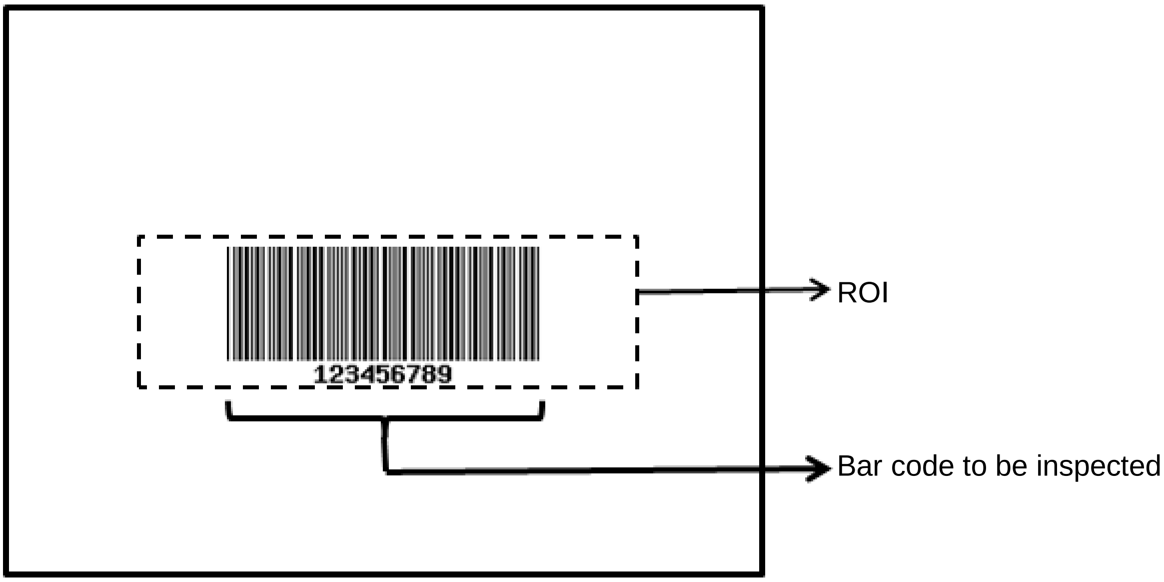
Bar Code reads 1D bar codes by searching valid 1D bar codes in the ROI, decoding after detection, and outputting the result. The function supports Code 39, Code 93, Code 128, I25, EAN8, UPCE, ISBN 10, UPCA, EAN13, ISBN 13, and Delta's custom DAH Code.

◎ **Algorithmic Processing**

➤ Bar Code Scanning Methods

Bar Code only supports one type of ROI, which is the rectangular ROI.

Type: Auto Detect



◎ **Procedural Results**

Bar Code returns the following inspection results.

➤ Type: After completing inspections, the type ID will output to this field. Please refer to the following table ofr the type IDs.

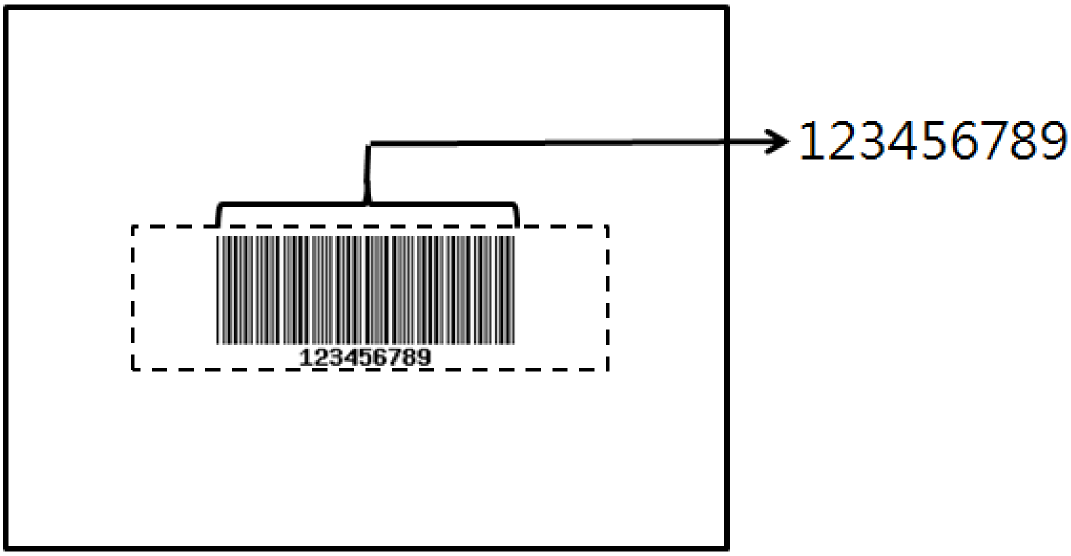
Serial No.	**Barcode Type**
0	No barcode
1	CODE39
2	CODE93
3	CODE128
4	I25
5	EAN8
6	UPCE
7	ISBN10
8	UPCA
9	EAN13
10	ISBN13
11	DAH CODE

◎ **Example**

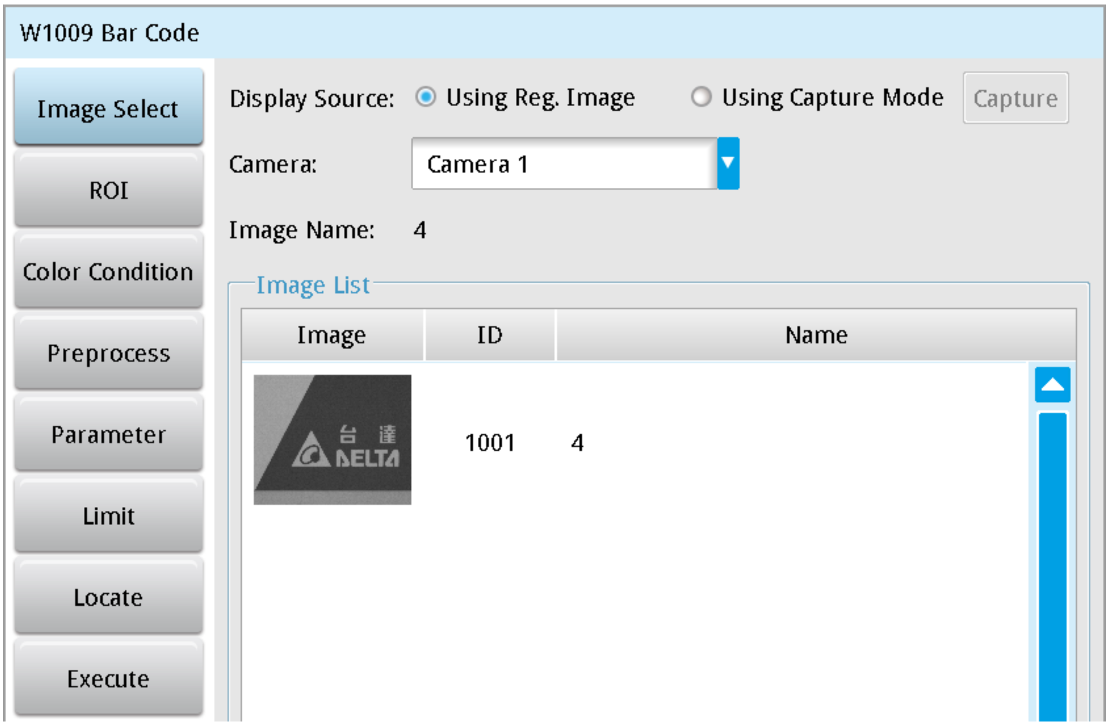
Select the text to be inspected using the rectangular ROI and the system will display the inspection result above the bar code.

Type: Auto Detect

Inspection result: 123456789



◎ **Bar Code Main Menu**



➤ Image Select (select Register Image)

Before entering inspection configurations, the registered image to be inspected must first be selected from the register gallery.

➤ ROI (configure detection region)

The desired inspection regions can be selected through ROI configurations. The shape of the ROI is only available in rectangles.

➤ Color Condition

When using color camera, Color to Binary, Color to Grayscale, RGB grayscale, R Grayscale, G Grayscale, and B Grayscale can be configured on this page.

➤ Preprocess

When the camera image cannot perfectly highlight the emphasized effect, feature points can be enhanced through preprocessing.

➤ Parameters

The Bar Code inspection conditions can be adjusted in Parameter Setting.

➤ 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.

➤ 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**

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)**

Rectangle is the only type of ROI available. Up to 8 mask functions are also provided for ignoring unwanted segments.

◎ **Color Condition**

Color images can be processed according to need. In Color Condition, images can be converted using the methods of Color to Binary, Color to Grayscale, RGB Grayscale, R grayscale, G grayscale, and B grayscale.

◎ **Preprocess**

Preprocess includes Binary, Dilation, Erosion, Average, Median, Laplacian, Sobel X, Sobel Y, Sobel XY, Brightness, Contrast, Shade, and Custom (filter) and can superimpose up to 6 options or produce custom preprocessed effect through Custom.

◎ **Parameters**

Detail Setup.

➤ Type

The type of Bar Code to read can be configured here. Options include Code 39, Code 93, Code 128, I25, EAN8, UPCE, ISBN 10, UPCA, EAN13, ISBN 13, and Delta's custom DAH Code. The user can also select Auto Detect for automatic system determination.

➤ Origin

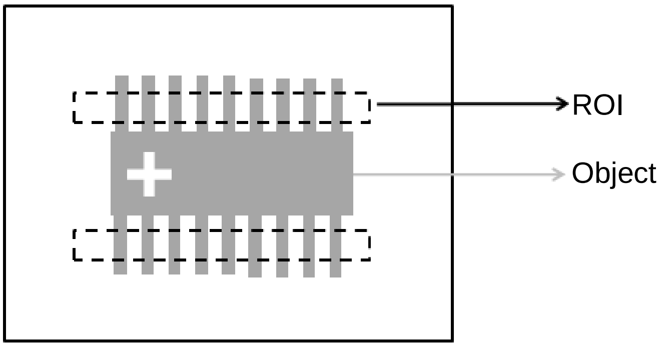
The position of the origin (0, 0) in System Setting is displayed on the upper left corner of the screen. The desired coordinates can be entered to change and move the origin to the new coordinates.

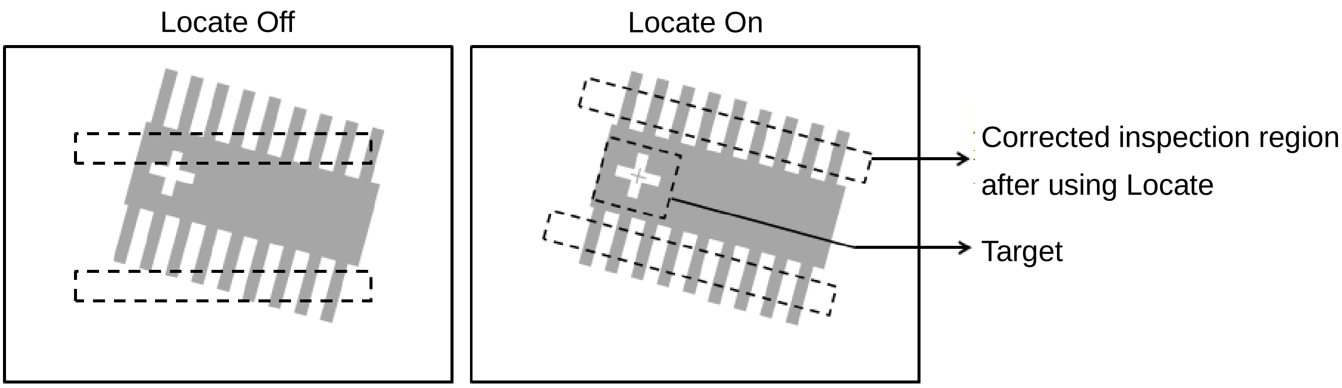
◎ **Restrictions**

After acquiring inspection results, correct bar code contents must be configured in this item for determining whether the result qualifies. The content can be entered through the on-screen keyboard after clicking the option.

◎ **Locate**

This configures whether the inspection region will follow an inspection result for adjusting its coordinates (X, Y) and Angles (Theta). The inspection tools that can be used as a reference include [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.





➤ Three tools are also provided in this item for quick configuration.

◆ Reference Previous Unit

When clicked, the nearest inspection tool that can provide reference for Locate will be automatically filled in the Ref. X, Ref. Y, and Ref. Angle fields below.

◆ Reference Available Unit

When clicked, the nearest unit with Locate configured will be automatically filled in the Ref. X, Ref. Y, and Ref. Angle fields below.

◆ Reference Unit

The option arbitrarily selects an inspection tool that can provide locating reference and automatically fills in the reference values of the selected unit in the Ref. X, Ref. Y, and Ref. Angle fields below.

Reference Please refer to Section 9.1 for detailed locating configurations.

◎ **Execute**

Configures whether to execute the inspection function in the inspection process.

➤ Always Execute

Always execute the inspection function in run mode.

➤ Never Execute

Never execute the inspection function in run mode.

◎ **Save**

All modified parameters and values can be saved by clicking this button.

◎ **Exit**

Click to leave the setup page.

◎ Output Item

➤ Window

By selecting the output window, the total judge result of the Bar Code tool will be output on the designated interface.

➤ Item

1) Barcode Type: This item can output the type ID (Serial No.) of the 1D bar code found. Please refer to the following table for 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: This function can outputs the designated character contents from a string.
3) Barcode Character Count: This function can output the number of characters from the bar code found.
4) Bar Code.ID: Outputs the ID of the inspection tool
5) String Content: This item can output the content of strings from the bar code found.
6) String Content (J): This item can determine whether the bar code content found is consistent with the configuration and output the OK signal when the contents are identical.

5.15 2D Bar Code

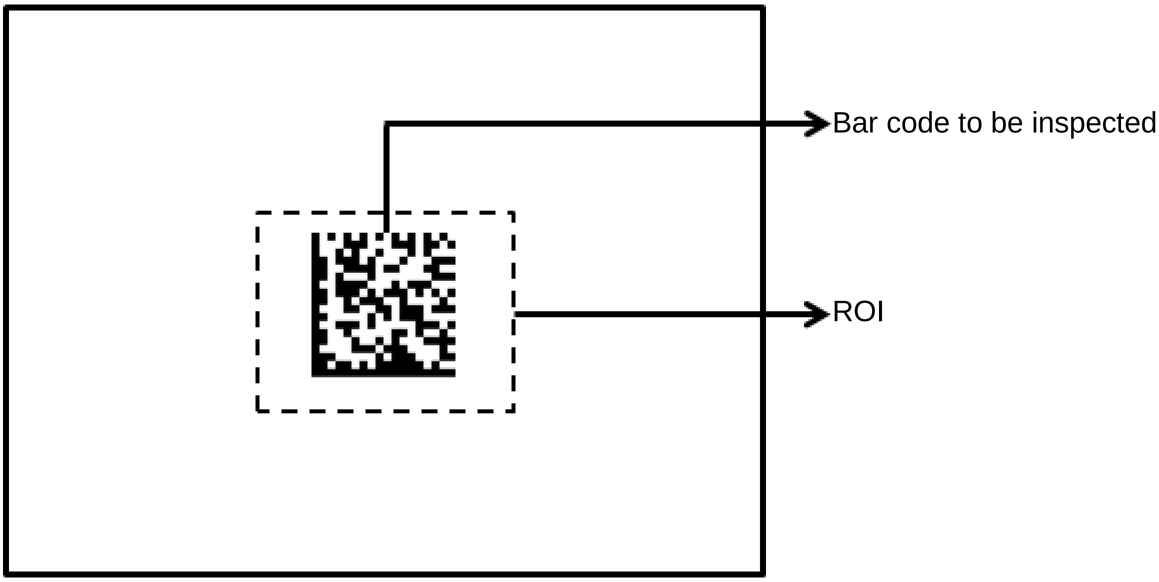
2D Bar Code is a function for reading two dimensional bar codes by searching for valid 2D bar codes in the ROI, decoding the bar code upon detection and outputting the result. The function supports QR Code and Data Matrix.

◎ **Algorithmic Processing**

➤ 2D Bar Code Scanning Methods

2D Bar Code only supports one type of ROI, which is the rectangular ROI.

Type: Auto Detect



◎ **Procedural Results**

2D Bar Code returns the following inspection results.

➤ Type: This item can output the type ID (Serial No.) of the 2D bar code found. Please refer to the following table for the type IDs.

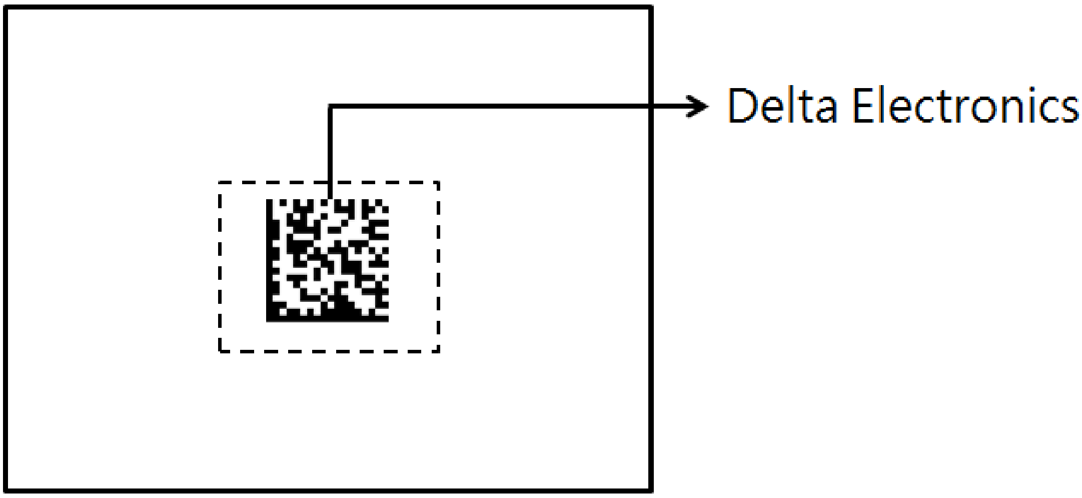
Serial No.	Barcode Type
0	No barcode
1	QR CODE
2	DATA MATRIX

◎ **Example**

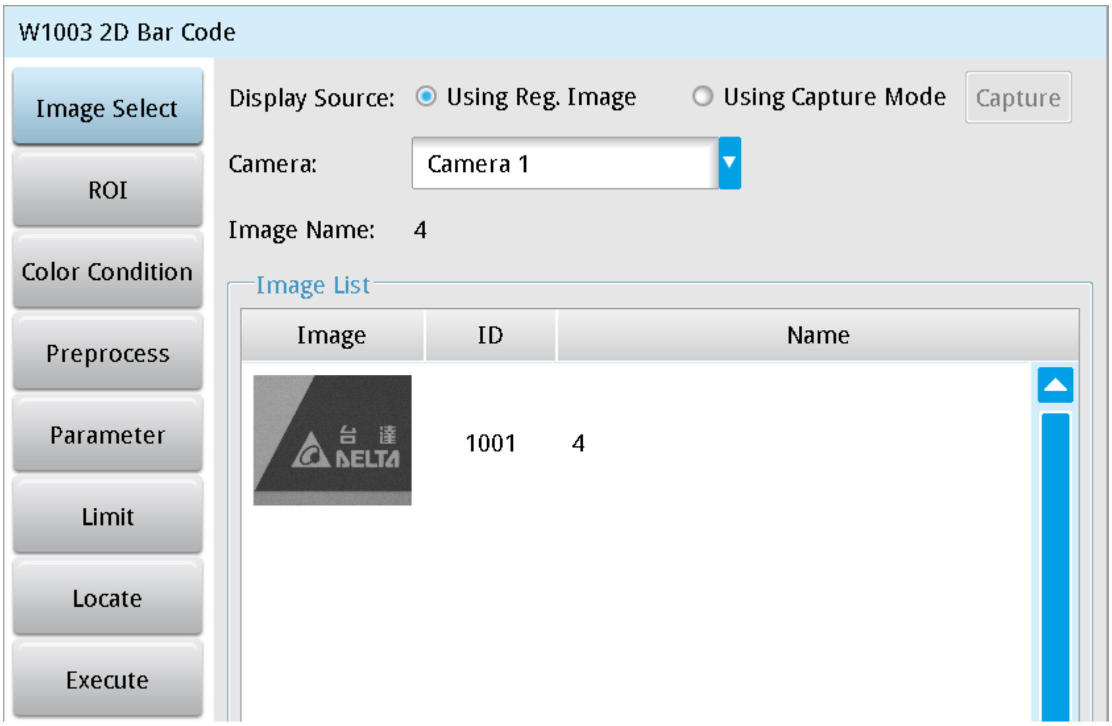
Select the text to be inspected using the rectangular ROI and the system will display the inspection result above the bar code.

Type: Auto Detect

Inspection result: Delta Electronics



◎ **2D Bar Code Main Menu**



➤ Image Select (select Register Image)

Before entering inspection configurations, the registered image to be inspected must first be selected from the register gallery.

- ROI (configure detection region)

The desired inspection regions can be selected through ROI configurations. The shape of the ROI is only available in rectangles.

- Color Condition

When using color camera, Color to Binary, Color to Grayscale, RGB grayscale, R Grayscale, G Grayscale, and B Grayscale can be configured on this page.

- Preprocess

When the camera image cannot perfectly highlight the emphasized effect, feature points can be enhanced through preprocessing.

- Parameters

The 2D Bar Code inspection conditions can be adjusted in Parameter Setting.

- 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.

- 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**

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)**

Rectangle is the only type of ROI available. Up to 8 mask functions are also provided for ignoring unwanted segments.

◎ **Color Condition**

Color images can be processed according to need. In Color Condition, images can be converted using the methods of Color to Binary, Color to Grayscale, RGB Grayscale, R grayscale, G grayscale, and B grayscale.

◎ **Preprocess**

Preprocess includes Binary, Dilation, Erosion, Average, Median, Laplacian, Sobel X, Sobel Y, Sobel XY, Brightness, Contrast, Shade, and Custom (filter) and can superimpose up to 6 options or produce custom preprocessed effect through Custom.

◎ **Parameters**

Detail Setup.

➤ Type

The type of 2D Bar Code to read can be configured here. Options include QR Code and Data Matrix. The user can also select Auto Detect for automatic system determination.

➤ Origin

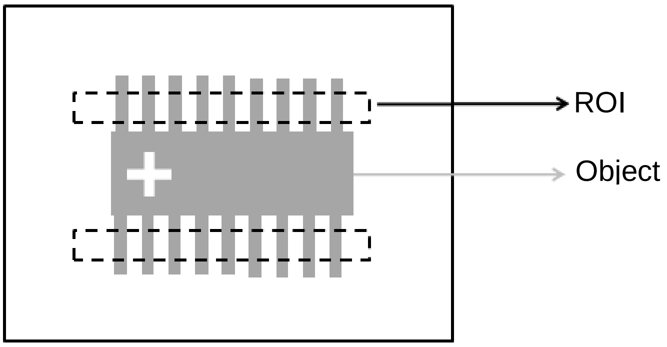
The position of the origin (0, 0) in System Setting is displayed on the upper left corner of the screen. The desired coordinates can be entered to change and move the origin to the new coordinates.

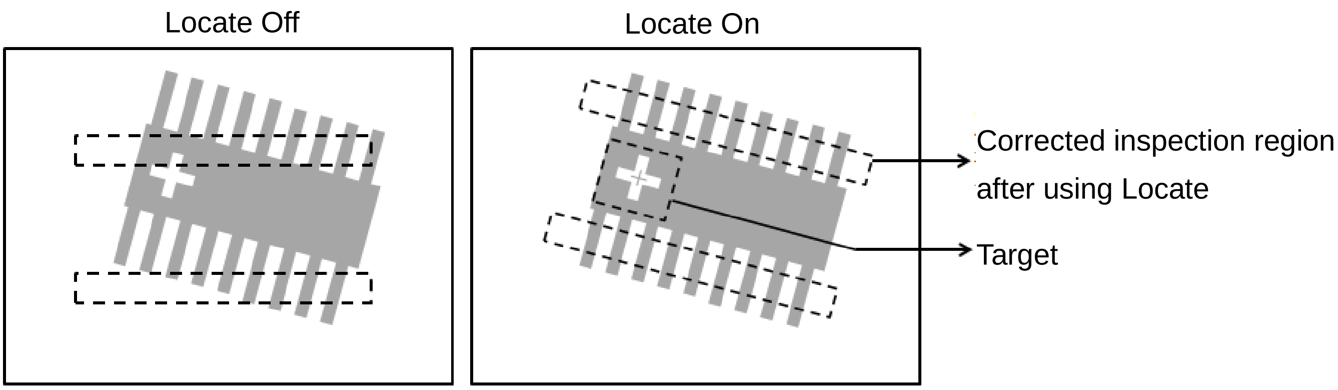
◎ **Restrictions**

After acquiring inspection results, correct bar code contents must be configured in this item for determining whether the result qualifies. The content can be entered through the on-screen keyboard after clicking the option.

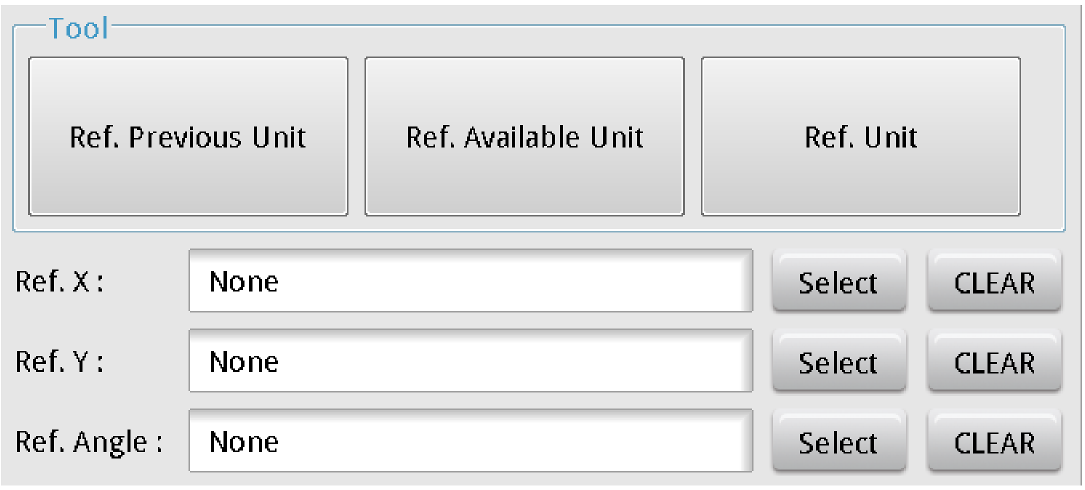
◎ **Locate**

This configures whether the inspection region will follow an inspection result for adjusting its coordinates (X, Y) and Angles (Theta). The inspection tools that can be used as a reference include [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.





➤ Three tools are also provided in this item for quick configuration.



◆ Reference Previous Unit

When clicked, the nearest inspection tool that can provide reference for Locate will be automatically filled in the Ref. X, Ref. Y, and Ref. Angle fields below.

◆ Reference Available Unit

When clicked, the nearest unit with Locate configured will be automatically filled in the Ref. X, Ref. Y, and Ref. Angle fields below.

◆ Reference Unit

The option arbitrarily selects an inspection tool that can provide locating reference and automatically fills in the reference values of the selected unit in the Ref. X, Ref. Y, and Ref. Angle fields below.

Reference Please refer to Section 9.1 for detailed locating configurations.

◎ **Execute**

Configures whether to execute the inspection function in the inspection process.

➤ Always Execute

Always execute the inspection function in run mode.

➤ Never Execute

Never execute the inspection function in run mode.

◎ **Save**

All modified parameters and values can be saved by clicking this button.

◎ **Exit**

Click to leave the setup page.

◎ **Output Item**

➤ Window

By selecting the output window, the total judge result of the 2D Bar Code tool will be output on the designated interface.

➤ Item

1) Barcode Type: This item can output the type ID (Serial No.) of the 2D bar code found. Please refer to the following table for the type IDs.

Serial No.	**Barcode Type**
0	No barcode
1	QR CODE
2	DATA MATRIX

2) Barcode Character: This function outputs the designated character contents from a string.
3) Barcode Character Count: This function can output the number of characters from the barcode found.
4) 2D Bar Code. ID: Outputs the ID of the inspection tool.
5) String Content: This item can output the content of strings from the barcode found.
6) String Content (J): This item can determine whether the bar code content found is consistent with the configuration and output the OK signal when the contents are identical.

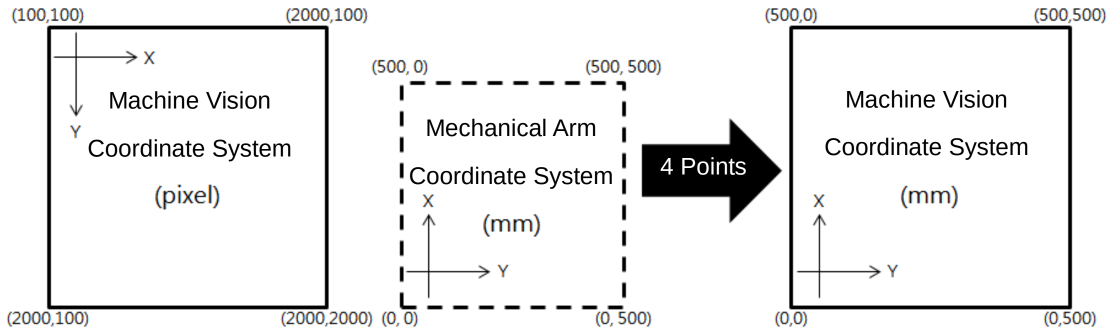
5.16 1P Position

The coordinate units of machine vision and devices (i.e., mechanical arms) are in pixels and actual physical units (i.e., mm), respectively. When machine vision is coordinated with these devices, the coordinate conversion matrix (CCM) is configured to convert between the coordinate systems.

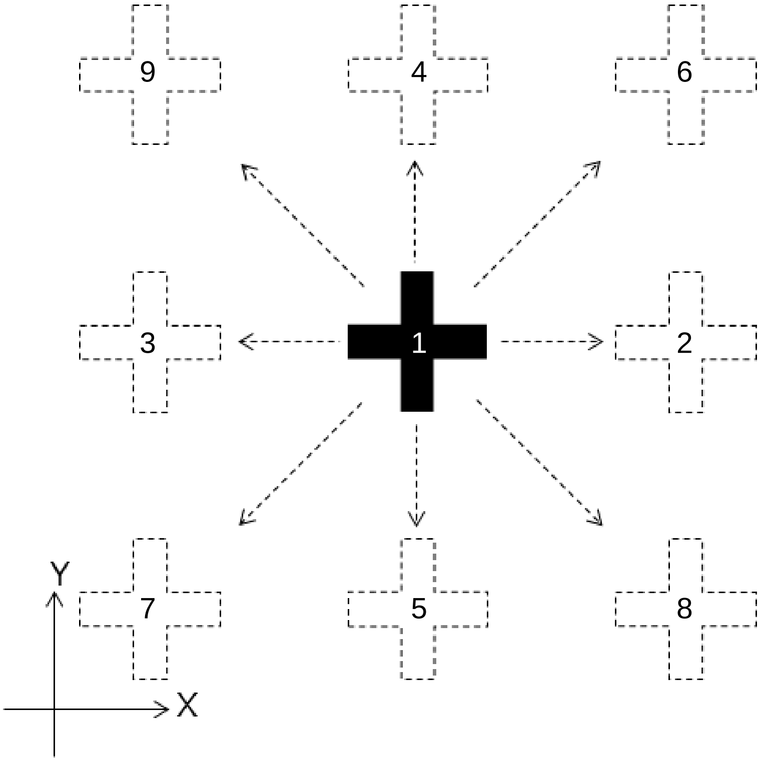
5.16.1 Coordinate Conversion Matrix Models

Three CCM models are currently provided.

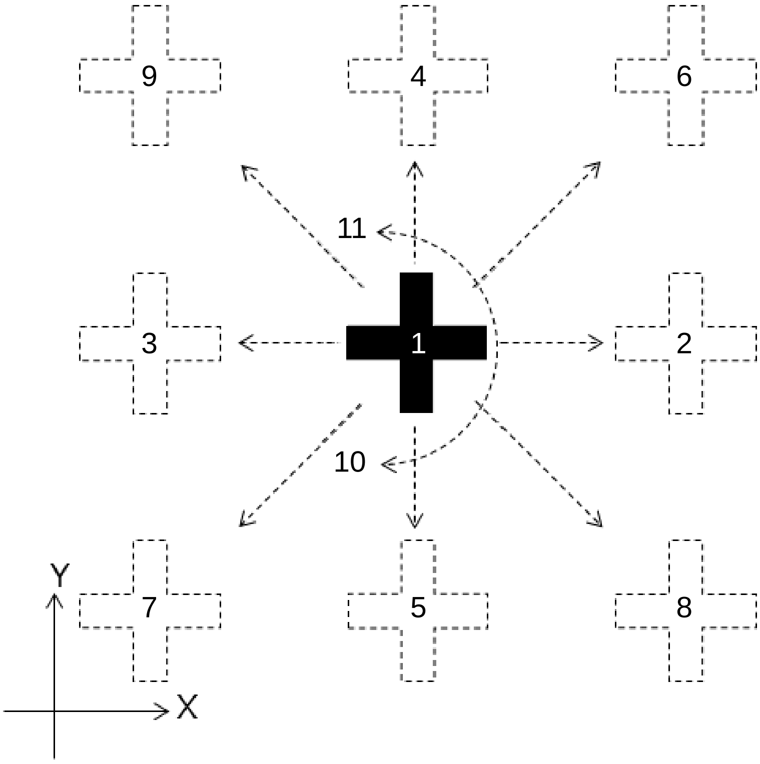
1) 4 Points Learning: The pixel and mechanical coordinates of 4 target points in the viewing region are first determined. After inputing the pixel and mechanical coordinates through the DMV2000 interface, the machine vision coordinate system can be converted to the mechanical arm coordinate system.



2) 9 Points Learning: After moving the target object using a mechanical arm or mechanics by a total of 9 points in the viewing region (the 9 points are shown in the following diagram; angles excluded), the machine vision system can complete the conversion between pixel and mechanical coordinates. The learning path in 9 Points Learning does not cover the angles. Therefore, 9 Point Learning cannot be used when the object shows angular deviations.



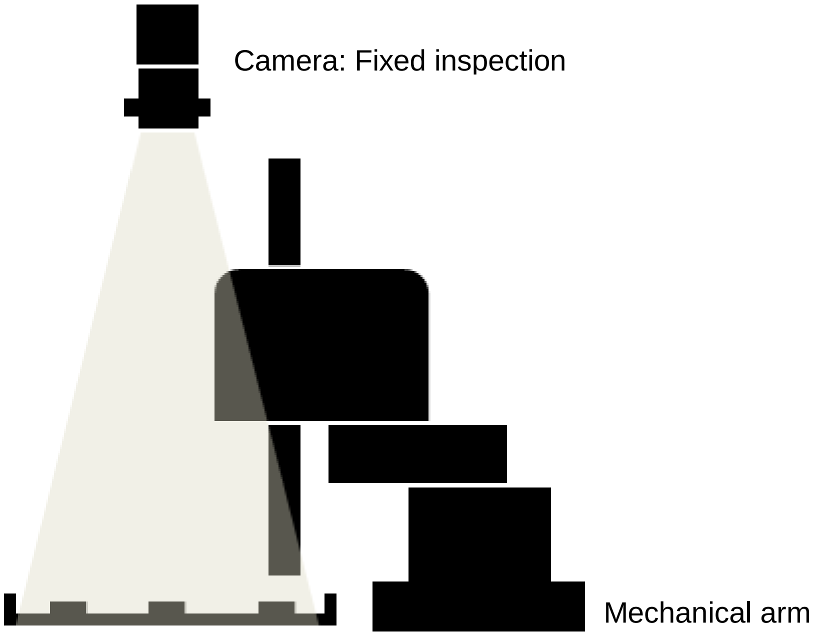
3) 11 Points Learning: After moving the target object using a mechanical arm or mechanics by a total of 11 points in the viewing region (the 11 points are shown in the following diagram; angles excluded), the machine vision system can complete the conversion between pixel and mechanical coordinates.



5.16.2 The Coordinate Conversion Matrix

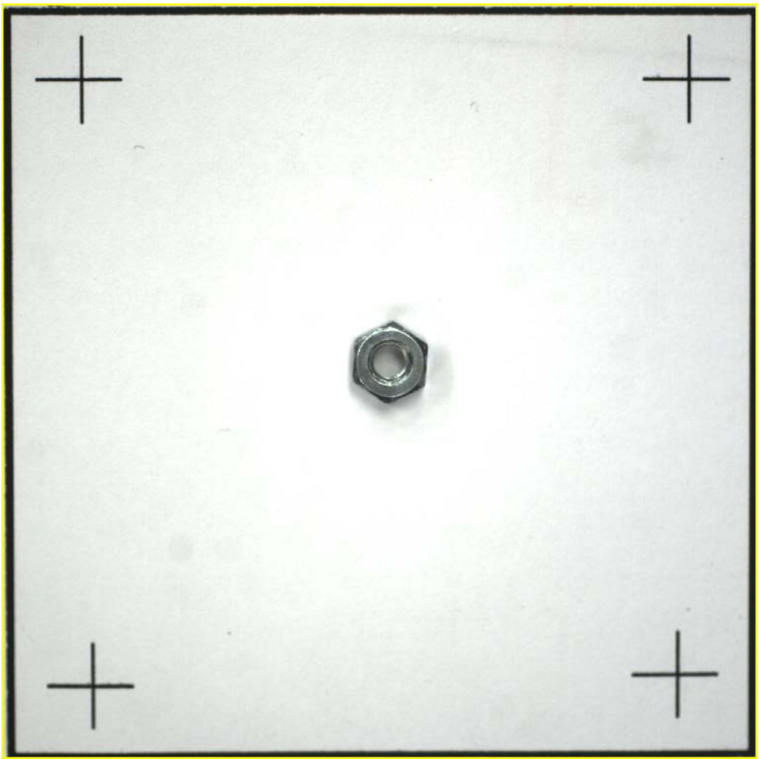
◎ **4 Points Learning**

➢ Suitable Mechanism: Suitable for inspecting object positions for cameras of fixed positions; all 4 calibration points must be visible within the viewing region (shown in the following diagram)

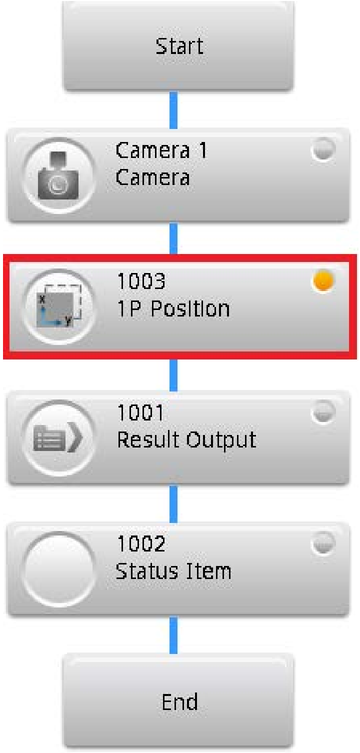


➢ Flow Configuration

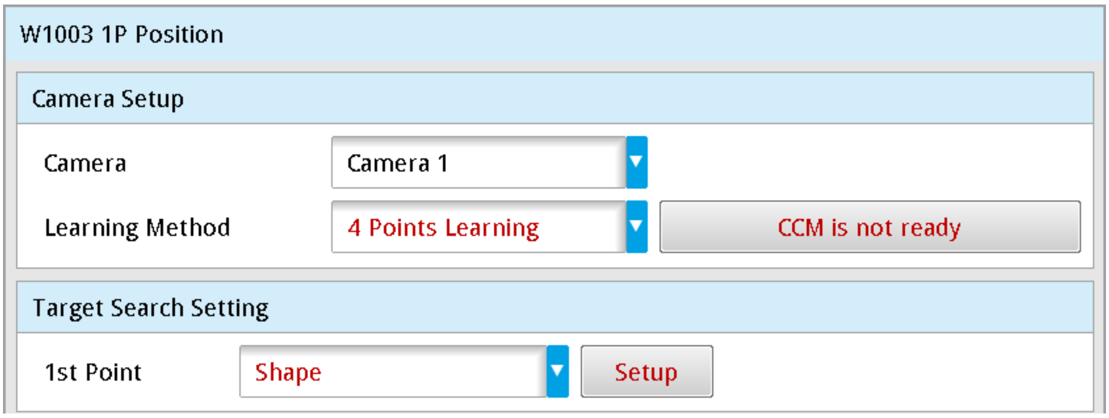
1) The function confirms whether 4 specific points are present in the inspection region for 4 Points Learning. If the points are absent, the 4 specific points must first be identified and marked in the inspection region, as shown in the following diagram.



2) Add a new 1P Position inspection in the flow process.



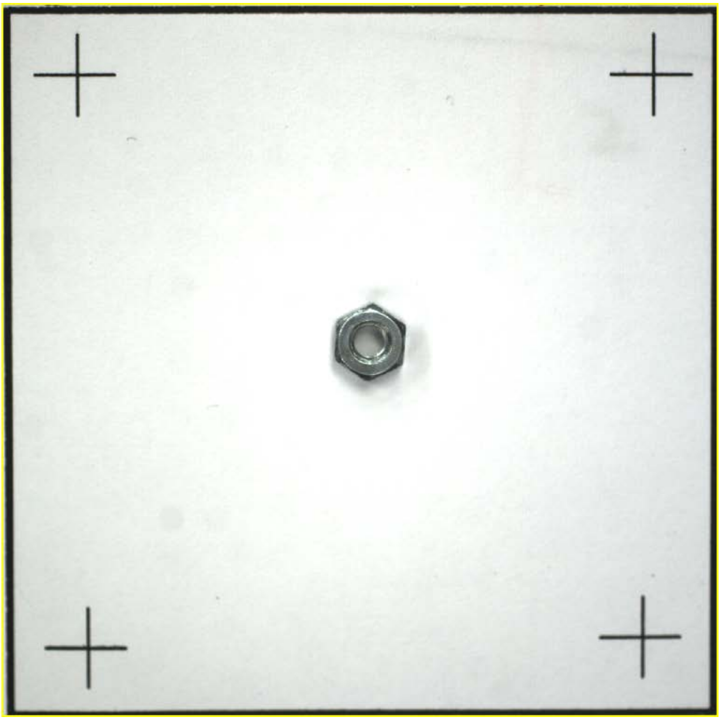
3) After entering the 1P position setup page (dialog), as shown in the following diagram, configure the camera and select 4 Points Learning as the learning method; If the CCM is not yet completely configured, the lower right button shows [CCM is not ready]; click this button to configure the coordinate conversion.



4) In CCM configuration, the pixel coordinates of the 4 points must be first identified. First, select P1 in Image Points and then move the cursor to the first point on the screen and click the left mouse button to obtain the pixel coordinate for P1. Repeat this 4 times to obtain the pixel coordinates of the 4 points (as shown in the following diagram).

Image Points

P1	X:	210.000	Y:	194.000
P2	X:	1856.000	Y:	192.000
P3	X:	1821.000	Y:	1810.000
P4	X:	240.000	Y:	1840.000



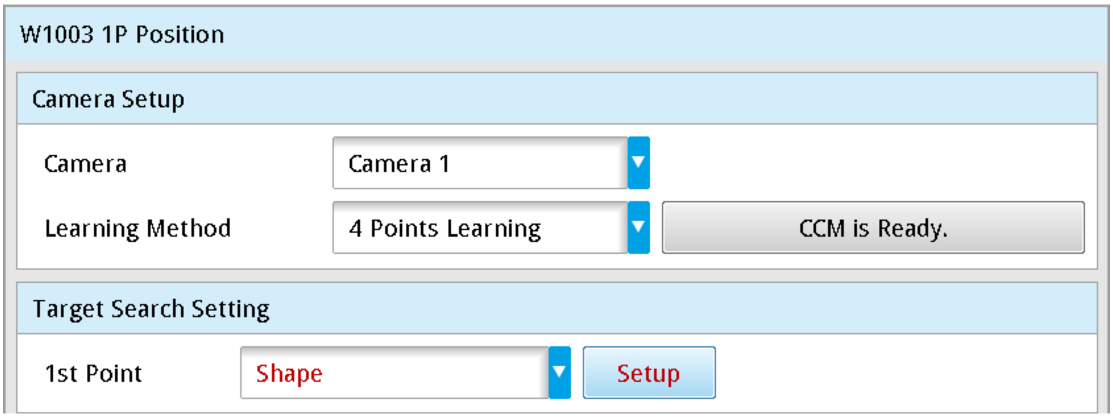
5) Similarly, move the mechanical arm to points 1, 2, 3, and 4 in CCM configuration and fill in the respective mechanical arm coordinates in P1 to P4, as shown in the following diagram.

Robot Arm Points

P1	X:	0.000	Y:	0.000
P2	X:	5.000	Y:	0.000
P3	X:	5.000	Y:	5.000
P4	X:	0.000	Y:	5.000

6) Click on [Learning] to complete the 4 Points Learning function.

7) Return to the 1P Position setup page (dialog); configure the searching algorithm (i.e., Shape) in Target Search Setting; and click on [Setup] to configure Shape



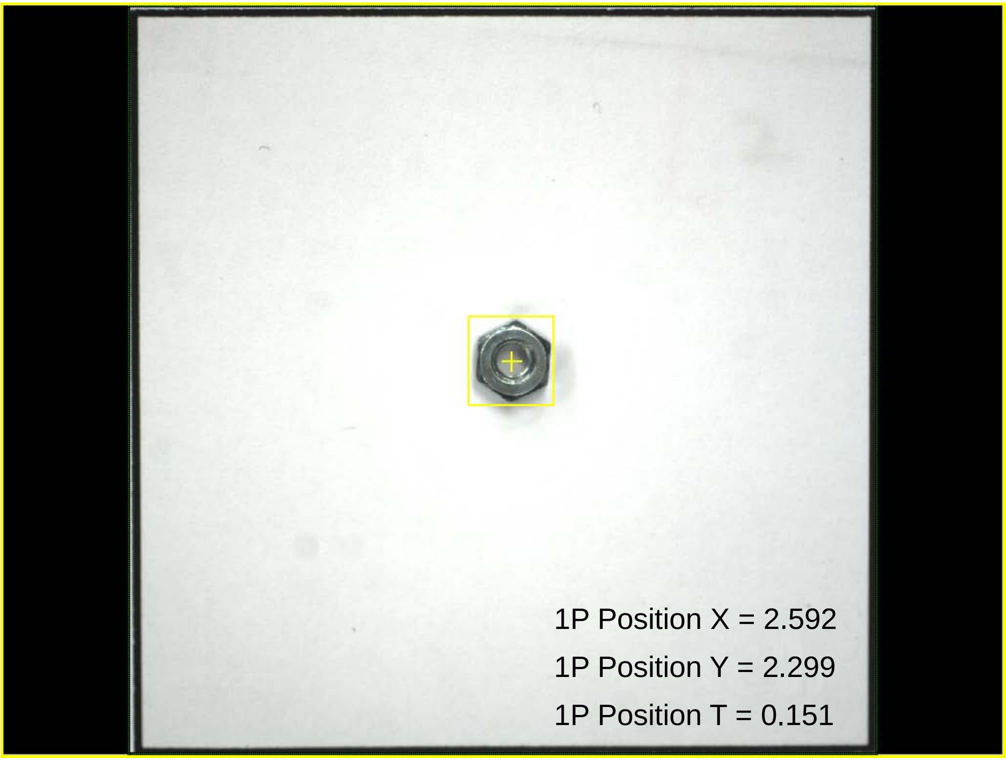
➤ Procedural Results

1P Position with 4 Points Learning returns the following inspection results

1) 1P Position X: The output absolute X coordinate of the target object after applying 4 Points Learning
2) 1P Position Y: The output absolute Y coordinate of the target object after applying 4 Points Learning
3) 1P Position T: The output absolute angle of the target object after applying 4 Points Learning

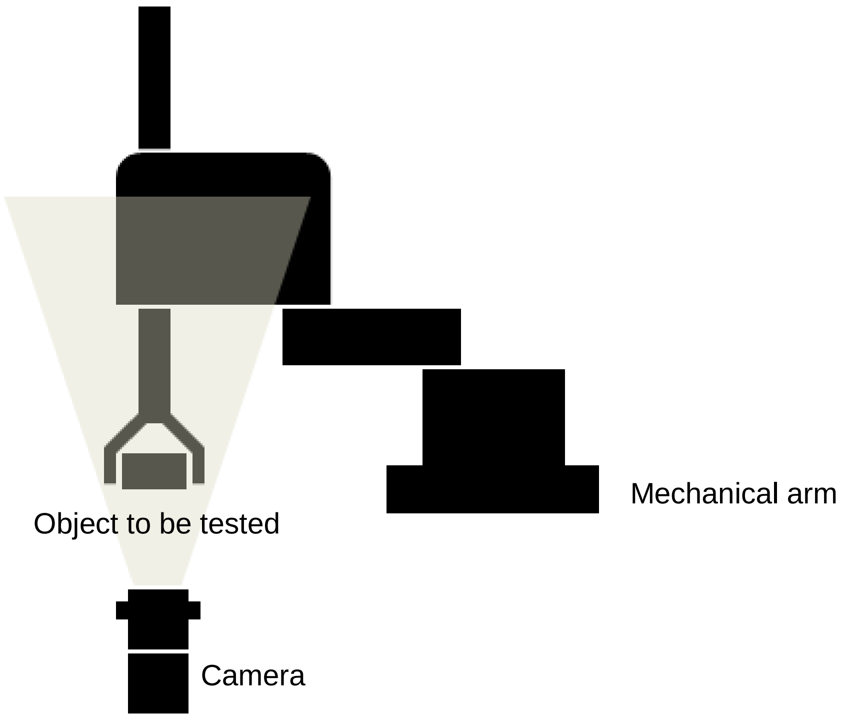
➤ Execution Result

The X, Y, and T acquired from using 1P Position with 4 Points Learning denotes the absolute coordinates of the target object after applying 4 Points Learning (shown in the following diagram).



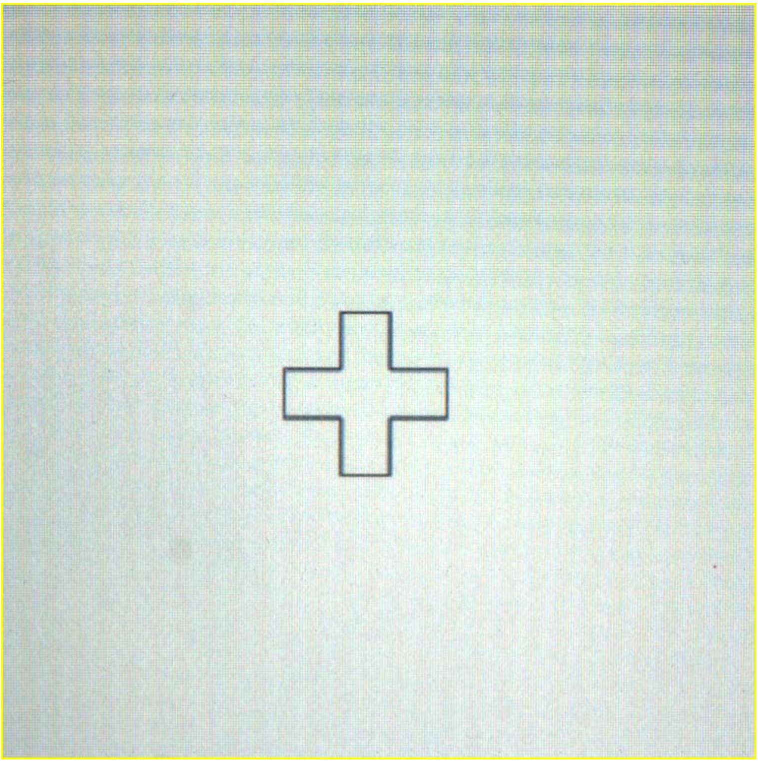
◎ **9 Points Learning**

- Suitable Mechanism: Suitable for target objects with architectures that can be carried using the mechanical arm and for objects without angular deviations (shown in the following diagram)

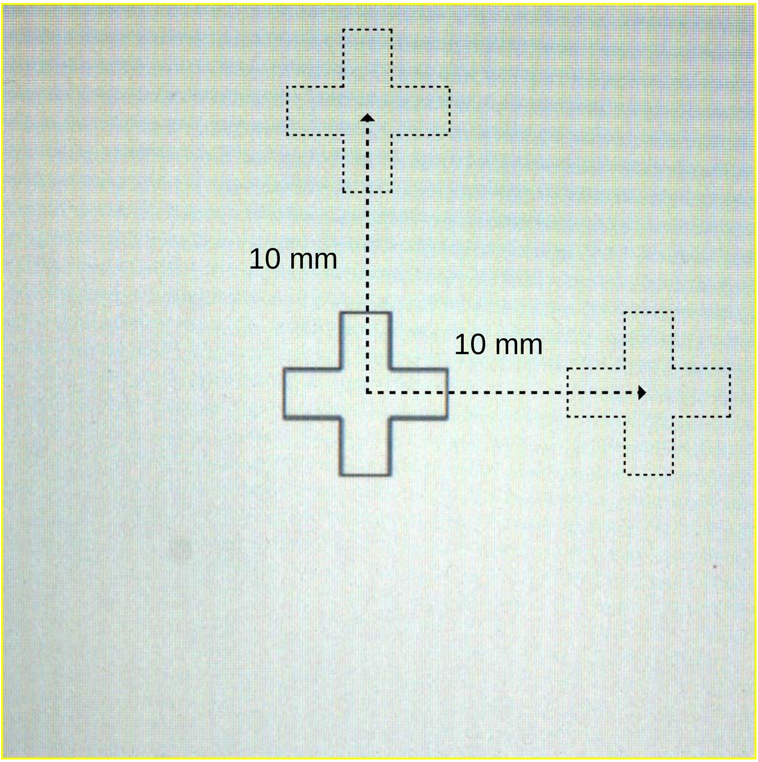


- Flow Configuration

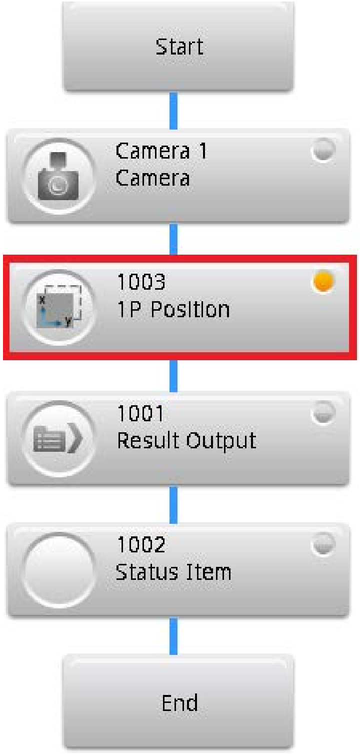
1) The mechanical arm carries the target object into the inspection region and positions the feature of the object as close to the center of the screen as possible (as shown in the following diagram). This point can be viewed as the first learning point, or P1.



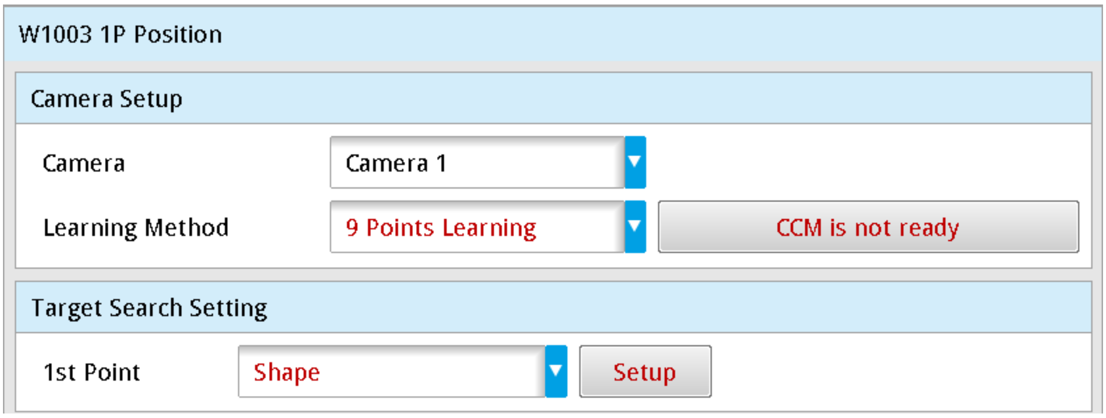
2) Try using the mechanical arm to move the target object towards the X and Y directions and confirm the maximum X and Y displacement within the DMV system's inspection region; as shown in the following diagram, the maximum X and Y displacements are both 10 mm; therefore, the X and Y displacements during the learning process must be limited to within 10 mm to ensure successful learning.



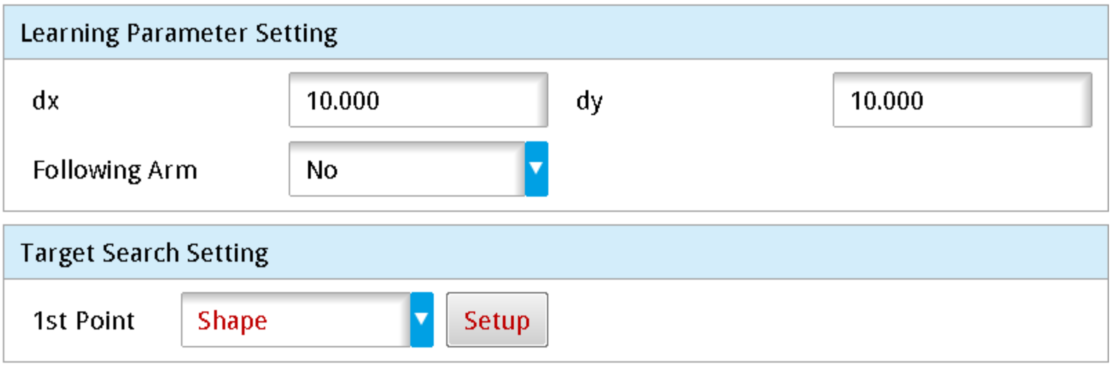
3) Add a new 1P Position inspection in the flow process.



4) After entering the 1P position setup page (dialog), as shown in the following diagram, configure the camera and select 9 Points Learning as the learning method; If the CCM is not yet completely configured, the lower right button shows [CCM is not ready]; click this button to configure the coordinate conversion.



5) In the parameter setting of CCM configurations, if both input dx and dy are 10 mm, the user can directly input 10.000 (as shown in the following diagram). However, the learning process will fail if the feature exceeds the viewing region during the learning process. After entering the displacements, Target Search Setting can be configured (i.e., Shape).



After configuring dx and dy, the learning path can be laid out (shown as follows).

P1: X, Y

P2: X + (dx), Y

P3: X - (dx), Y

P4: X, (Y + dy)

P5: X, (Y - dy)

P6: X + (dx), Y + (dy)

P7: X - (dx), Y - (dy)

P8: X + (dx), Y - (dy)

P9: X - (dx), Y + (dy)

The learning path in 9 Points Learning does not cover the angles. Therefore, 9 Point Learning cannot be used when the object shows angular deviations.

6) After clicking on [Learning], the system enters the learning mode and shows a progress bar on the screen, which displays the learning progress. During the learning process, the mechanical arm must be moved to P1 with DMV2000 triggered, followed by moving the mechanical arm to P2 through P9 and triggering DMV2000 at each point, thereby completing the learning process.

7) Return to the 1P Position setup page (dialog); configure the searching algorithm (i.e., Shape) in Target Search Setting; and click on [Setup] to configure Shape.

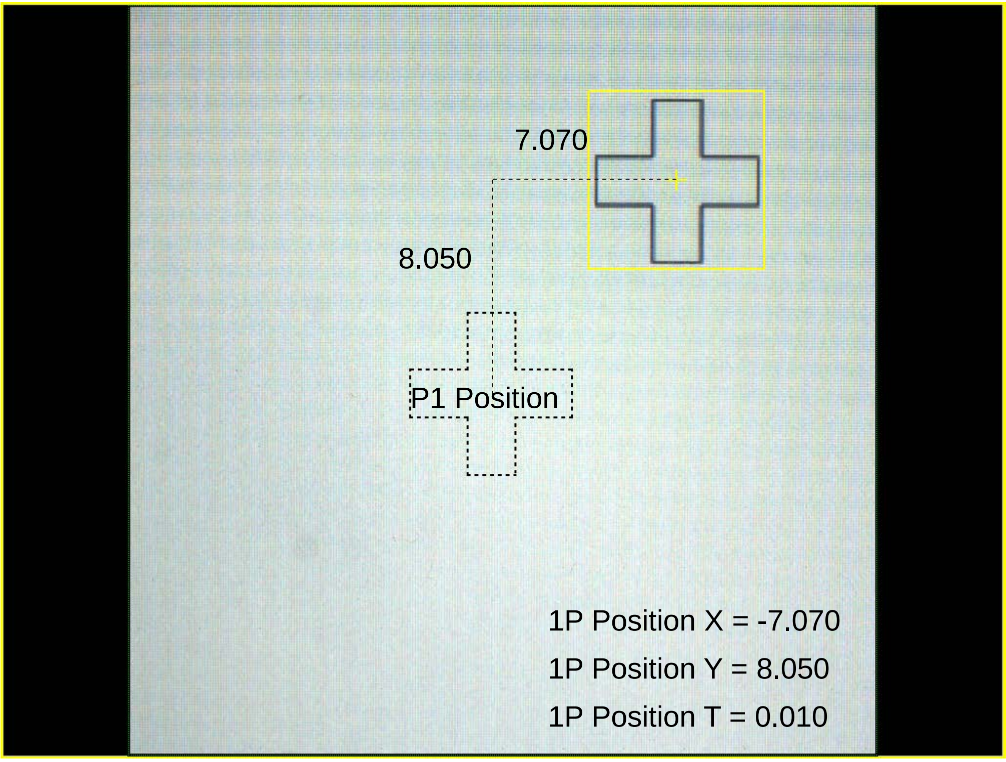
➤ Procedural Results

1P Position with 9 Points Learning returns the following inspection results

1) 1P Position X: Outputs the relative X coordinate (relative to P1) of the target object using mechanical arm units
2) 1P Position Y: Outputs the relative Y coordinate (relative to P1) of the target object using mechanical arm units
3) 1P Position T: Outputs the relative angle (relative to P1) of the target object using mechanical arm units

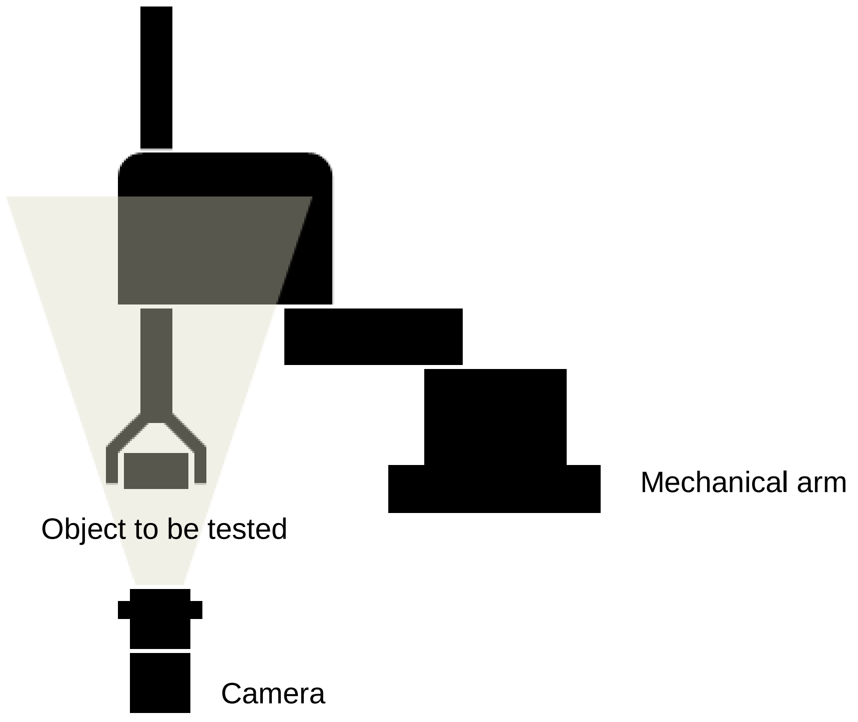
➤ Execution Result

The X, Y, and T obtained from using 1P Position with 9 Points Learning denotes the relative coordinates respective to the learning point P1 and are output in mechanical arm units (shown in the following diagram).



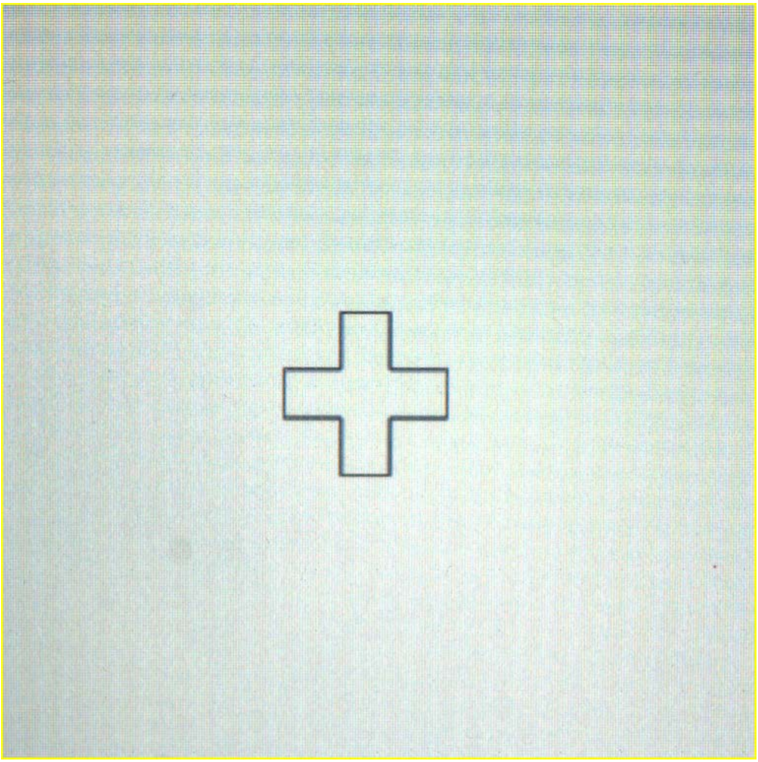
◎ **11 Points Learning**

➤ Suitable Mechanism: Suitable for target objects with architectures that can be carried using the mechanical arm (shown in the following diagram)

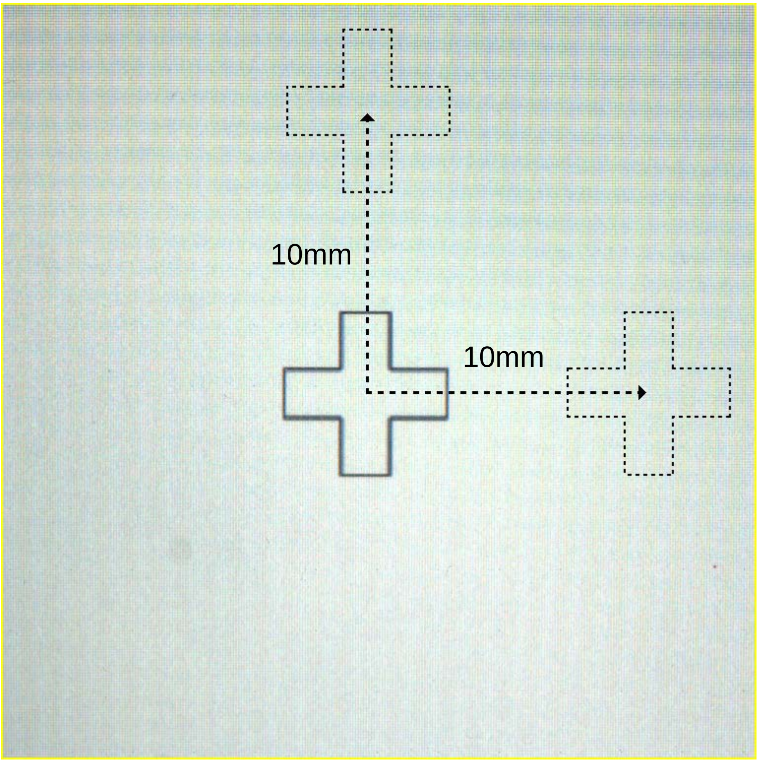


- Flow Configuration

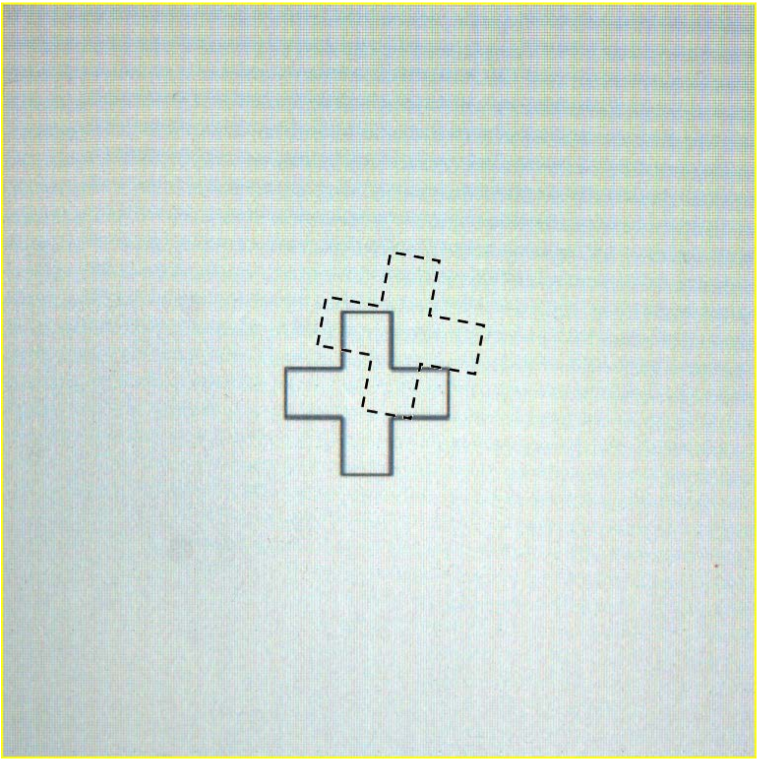
1) The mechanical arm carries the target object into the inspection region and positions the feature of the object as close to the center of the screen as possible (as shown in the following diagram). This point can be viewed as the first learning point, or P1.



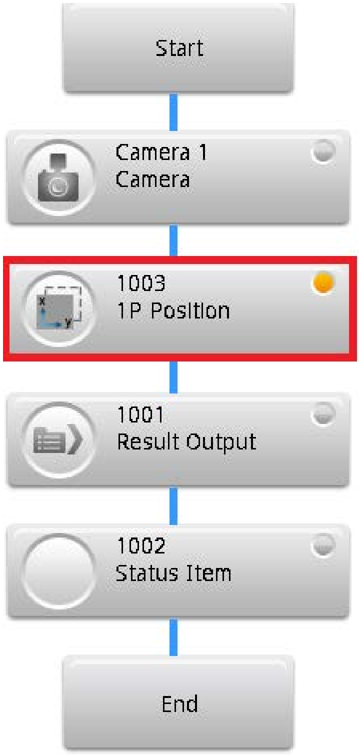
2) Try using the mechanical arm to move the target object towards the X and Y directions and confirm the maximum X and Y displacement within the DMV system's inspection region; as shown in the following diagram, the maximum X and Y displacements are both 10 mm; therefore, the X and Y displacements during the learning process must be limited to within 10 mm to ensure successful learning.



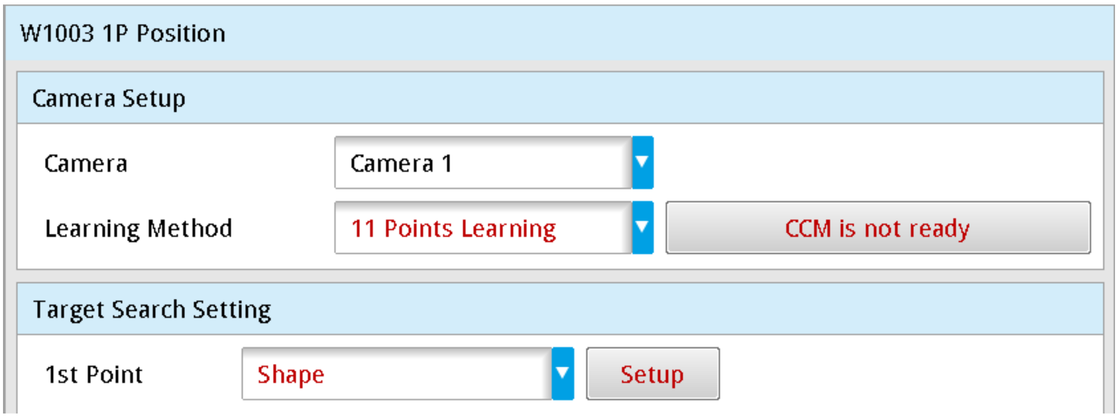
3) The mechanical arm returns to P1. Try rotate and move the target object using the mechanical arm and confirm the reasonable rotation angle within the DMV system's inspection region (as shown in the following diagram, the rotation angle is 10 degrees).



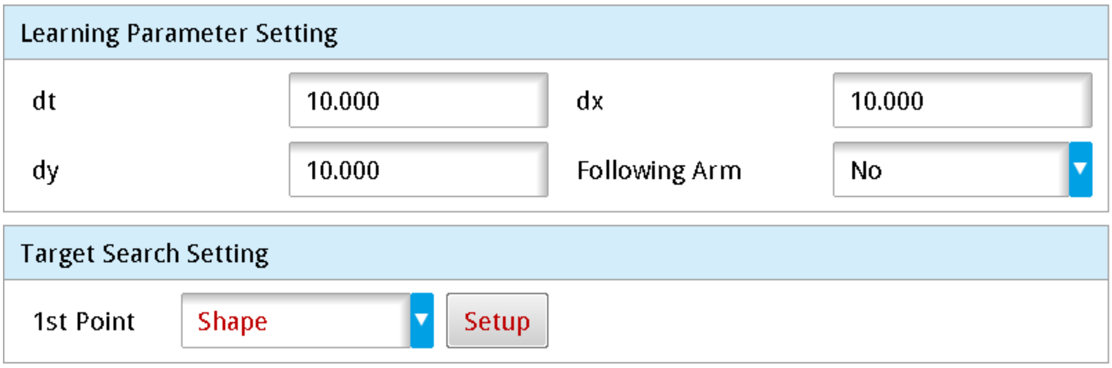
4) Add a new 1P Position inspection in the flow process.



5) After entering the 1P position setup page (dialog), as shown in the following diagram, configure the camera and select 11 Points Learning as the learning method; If the CCM is not yet completely configured, the lower right button shows [CCM is not ready]; click this button to configure the coordinate conversion.



6) In the parameter setting of CCM configurations, the input parameters are dt, dx, and dy in which dt represents the angle of rotation. If the angle of rotation is 10 degrees, the user can directly enter 10.000. If both input dx and dy are 10 mm, the user can directly input 10.000 (as shown in the following diagram). However, the learning process will fail if the feature exceeds the viewing region during the learning process. After entering the displacements, Target Search Setting can be configured (i.e., Shape).



After configuring dx and dy, the learning path can be laid out (shown as follows).

P1: X, Y

P2: X + (dx), Y

P3: X - (dx), Y

P4: X, (Y + dy)

P5: X, (Y - dy)

P6: X + (dx), Y + (dy)

P7: X - (dx), Y - (dy)

P8: X + (dx), Y - (dy)

P9: X - (dx), Y + (dy)

P10: X, Y, T + (dt)

P11: X, Y, T - (dt)

The learning path in 9 Points Learning does not cover the angles. Therefore, 9 Point Learning cannot be used when the object shows angular deviations.

7) After clicking on [Learning], the system enters the learning mode and shows a progress bar on the screen, which displays the learning progress. During the learning process, the mechanical arm must be moved to P1 with DMV2000 triggered, followed by moving the mechanical arm to P2 through P9 and triggering DMV2000 at each point, thereby completing the learning process.

8) Return to the 1P Position setup page (dialog); configure the searching algorithm (i.e., Shape) in Target Search Setting; and click on [Setup] to configure Shape.

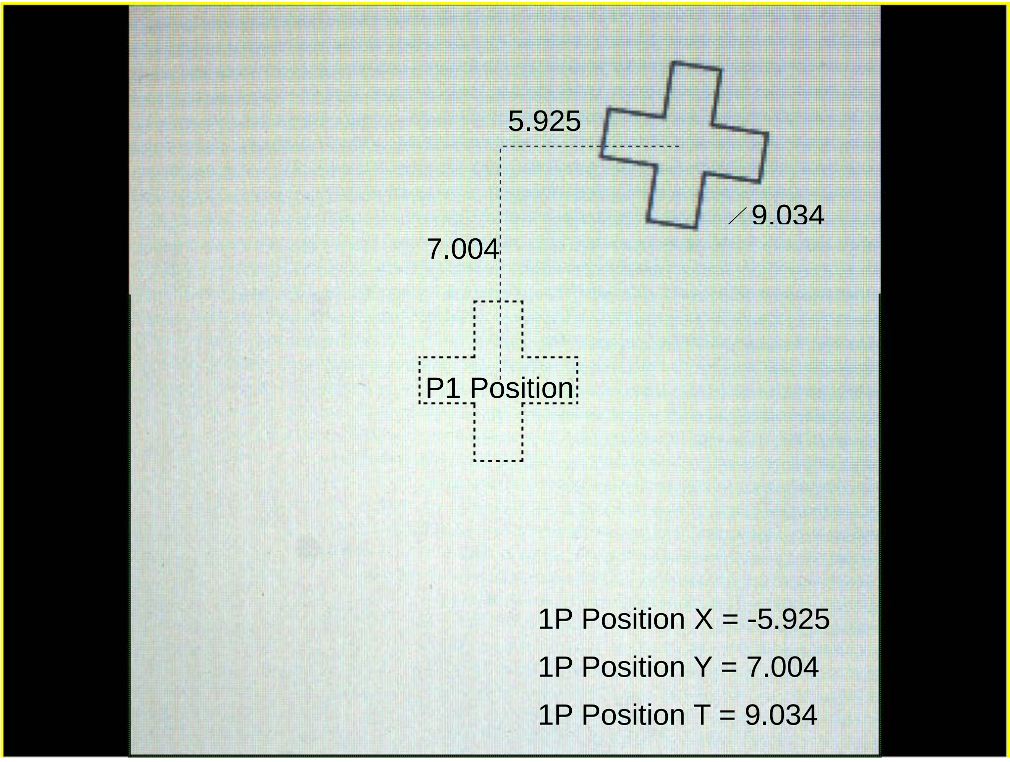
➤ Procedural Results

1P Position with 11 Points Learning returns the following inspection results

1) 1P Position X: Outputs the relative X coordinate (relative to P1) of the target object using mechanical arm units
2) 1P Position Y: Outputs the relative Y coordinate (relative to P1) of the target object using mechanical arm units
3) 1P Position T: Outputs the relative angle (relative to P1) of the target object using mechanical arm units

➤ Execution Result

The X, Y, and T obtained from using 1P Position with 11 Points Learning denotes the relative coordinates respective to the learning point P1 and are output in mechanical arm units (shown in the following diagram).



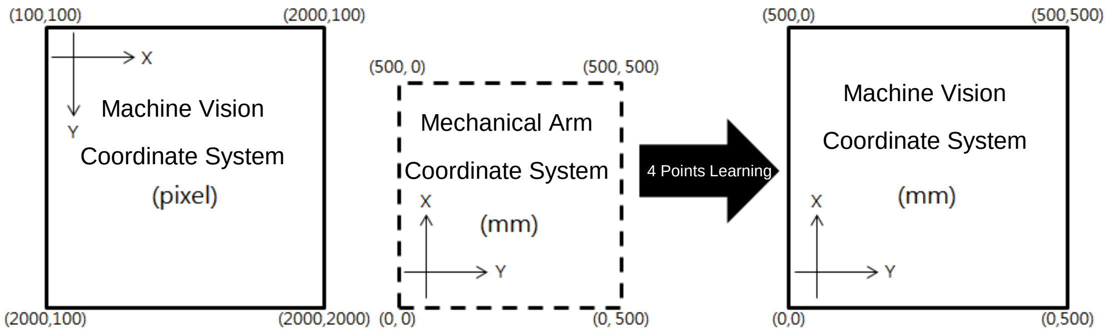
5.17 1P Location

The coordinate units of machine vision and devices (i.e., mechanical arms) are in pixels and actual physical units (i.e., mm), respectively. When machine vision is coordinated with these devices, the coordinate conversion matrix (CCM) is configured to convert between the coordinate systems.

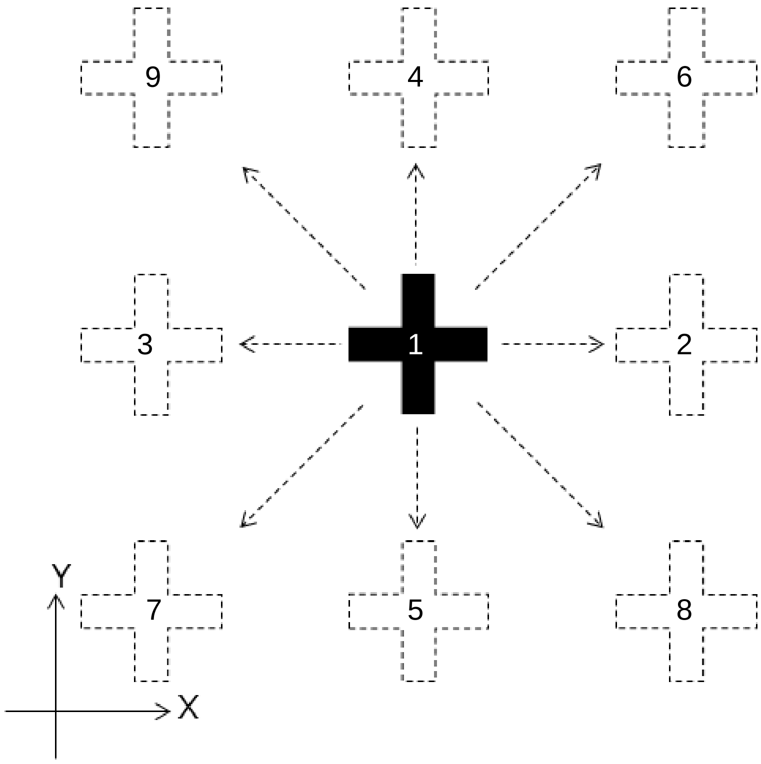
5.17.1 Coordinate Conversion Matrix Models

Three CCM models are currently provided

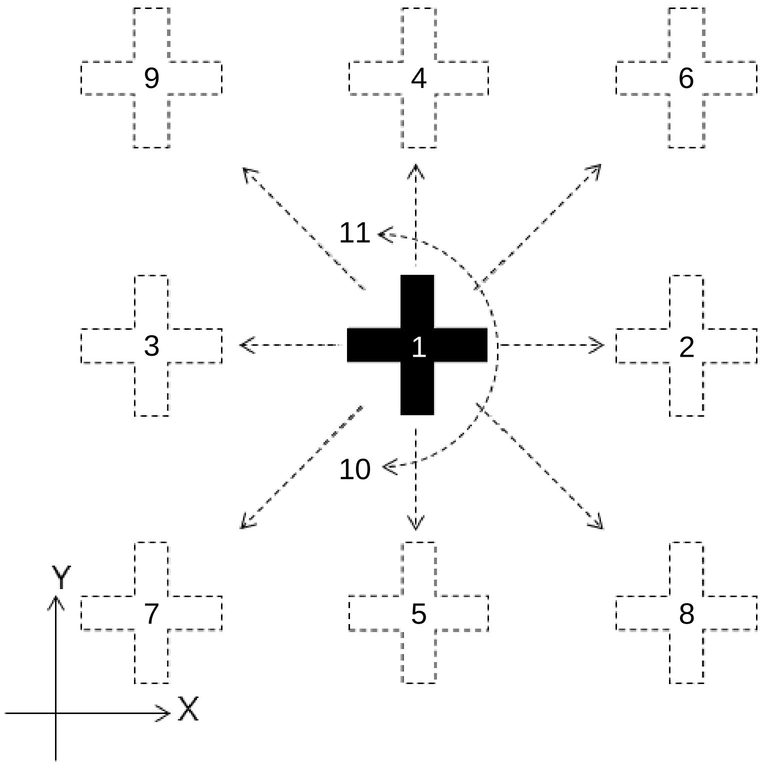
1) 4 Points Learning: The pixel and mechanical coordinates of 4 target points in the viewing region are first determined. After inputing the pixel and mechanical coordinates through the DMV2000 interface, the machine vision coordinate system can be converted to the mechanical arm coordinate system.



2) 9 Points Learning: After moving the target object using a mechanical arm or mechanics by a total of 9 points in the viewing region (the 9 points are shown in the following diagram; angles excluded), the machine vision system can complete the conversion between pixel and mechanical coordinates. The learning path in 9 Points Learning does not cover the angles. Therefore, 9 Point Learning cannot be used when the object shows angular deviations.



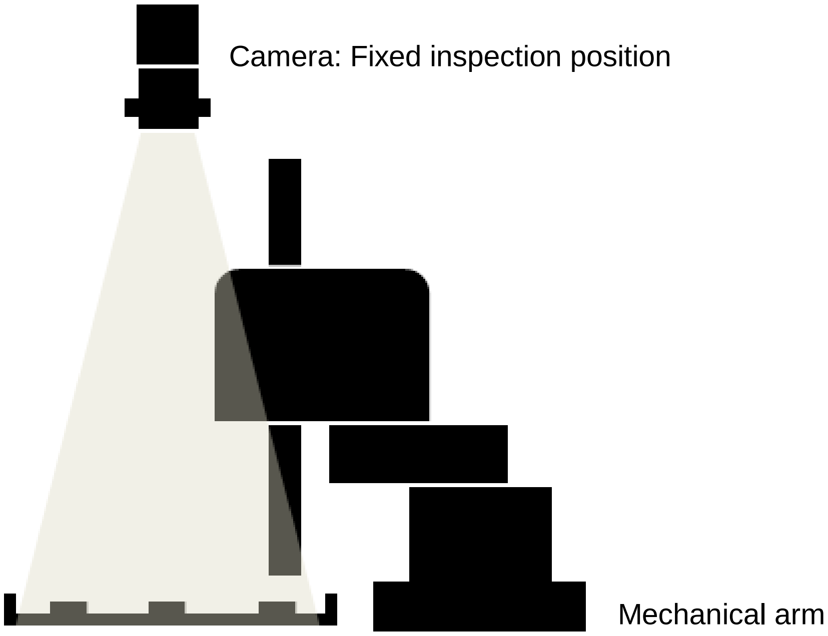
3) 11 Points Learning: After moving the target object using a mechanical arm or mechanics by a total of 11 points in the viewing region (the 11 points are shown in the following diagram; angles excluded), the machine vision system can complete the conversion between pixel and mechanical coordinates.



5.17.2 The Coordinate Conversion Matrix

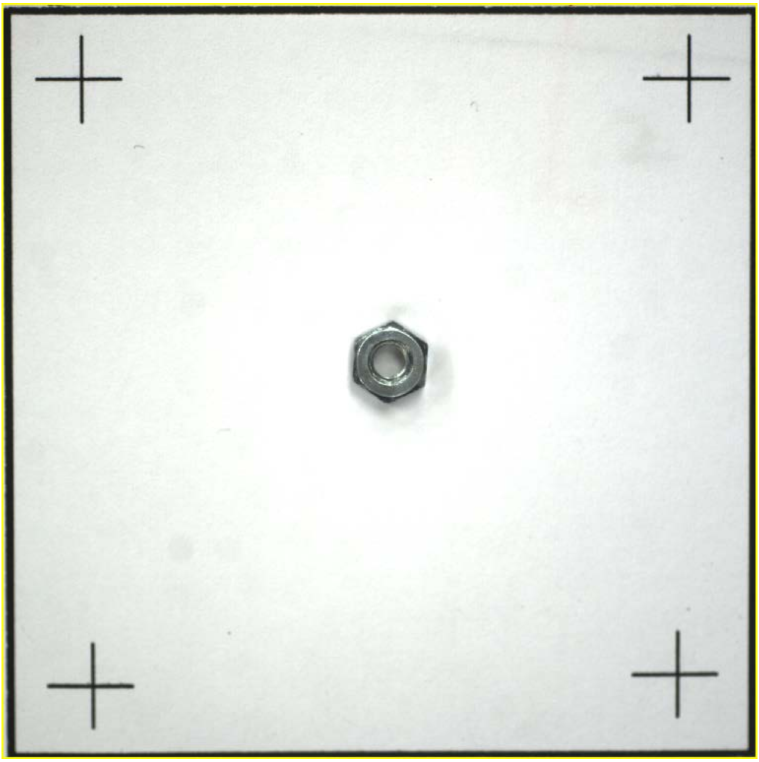
◎ **4 Points Learning**

➤ Suitable Mechanism: Suitable for inspecting object positions for cameras of fixed positions; all 4 calibration points must be visible within the viewing region (shown in the following diagram)

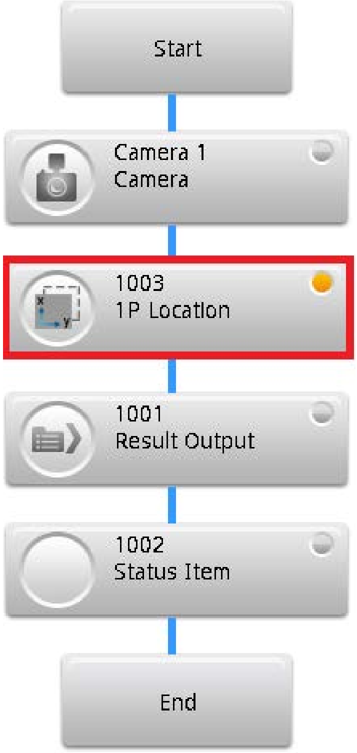


➤ Flow Configuration

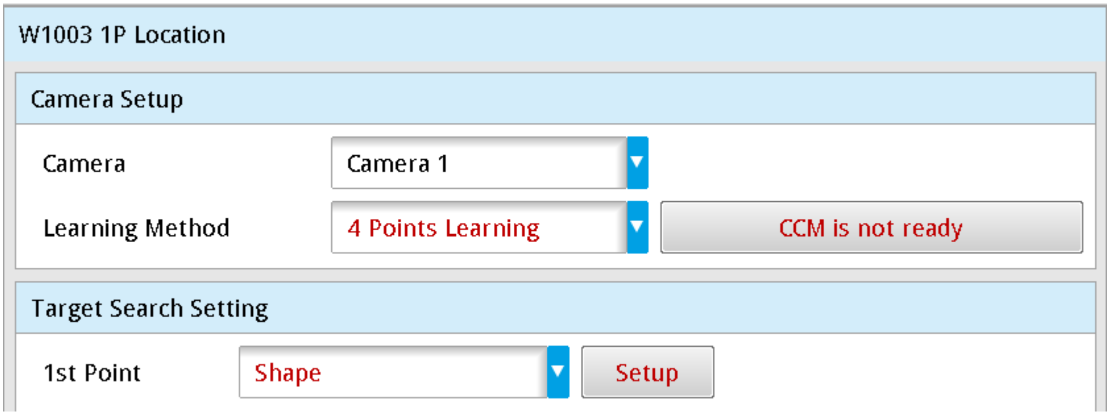
1) The function confirms whether 4 specific points are present in the inspection region for 4 Points Learning. If the points are absent, the 4 specific points must first be identified and marked in the inspection region, as shown in the following diagram.



2) Add a new 1P Location inspection in the flow process.



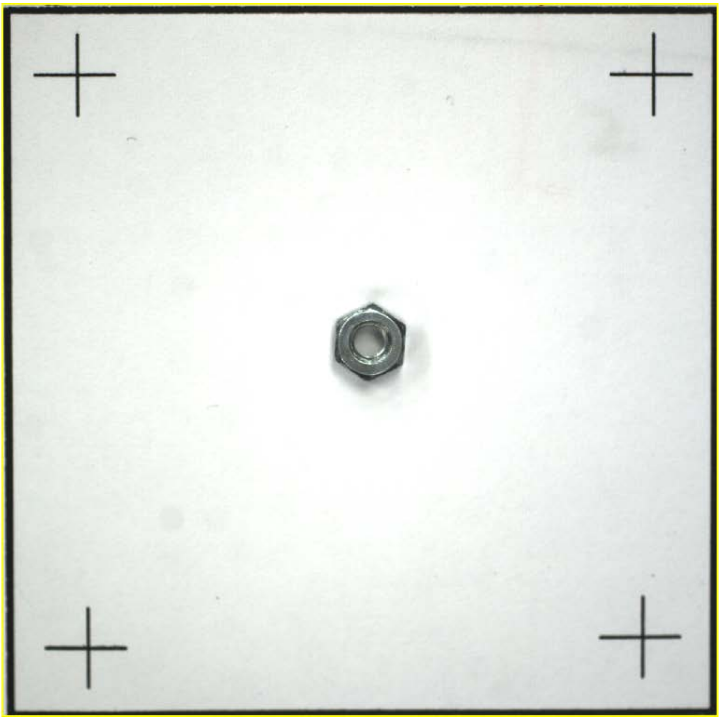
3) After entering the 1P Location setup page (dialog), as shown in the following diagram, configure the camera and select 4 Points Learning as the learning method. If the CCM is not yet completely configured, the lower right button shows [CCM is not ready]; click this button to configure the coordinate conversion.



4) In CCM configuration, the pixel coordinates of the 4 points must be first identified. First, select P1 in Image Points and then move the cursor to the first point on the screen and click the left mouse button to obtain the pixel coordinate for P1. Repeat this 4 times to obtain the pixel coordinates of the 4 points (as shown in the following diagram).

Image Points

P1	X:	210.000	Y:	194.000
P2	X:	1856.000	Y:	192.000
P3	X:	1821.000	Y:	1810.000
P4	X:	240.000	Y:	1840.000



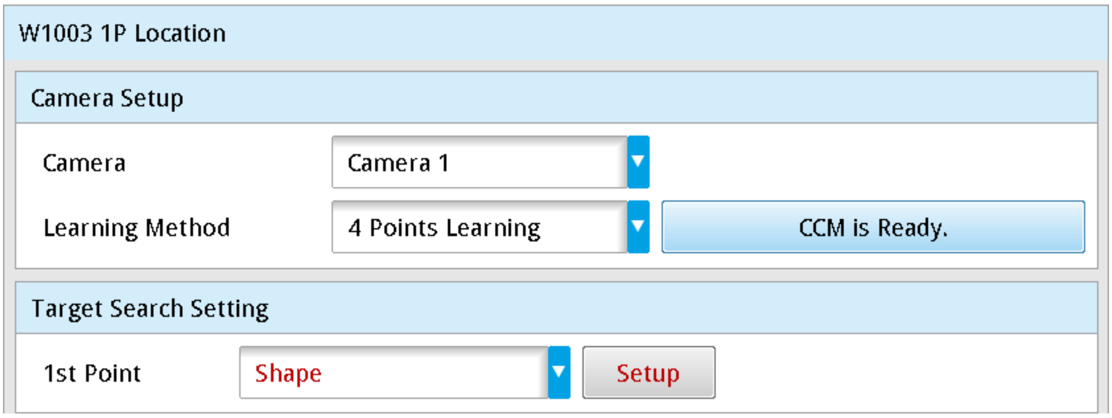
5) Similarly, move the mechanical arm to points 1, 2, 3, and 4 in CCM configuration and fill in the respective mechanical arm coordinates in P1 to P4, as shown in the following diagram.

Robot Arm Points

P1	X:	0.000	Y:	0.000
P2	X:	5.000	Y:	0.000
P3	X:	5.000	Y:	5.000
P4	X:	0.000	Y:	5.000

6) Click on [Learning] to complete the 4 Points Learning function.

7) Return to the 1P Position setup page (dialog); configure the searching algorithm (i.e., Shape) in Target Search Setting; and click on [Setup] to configure Shape



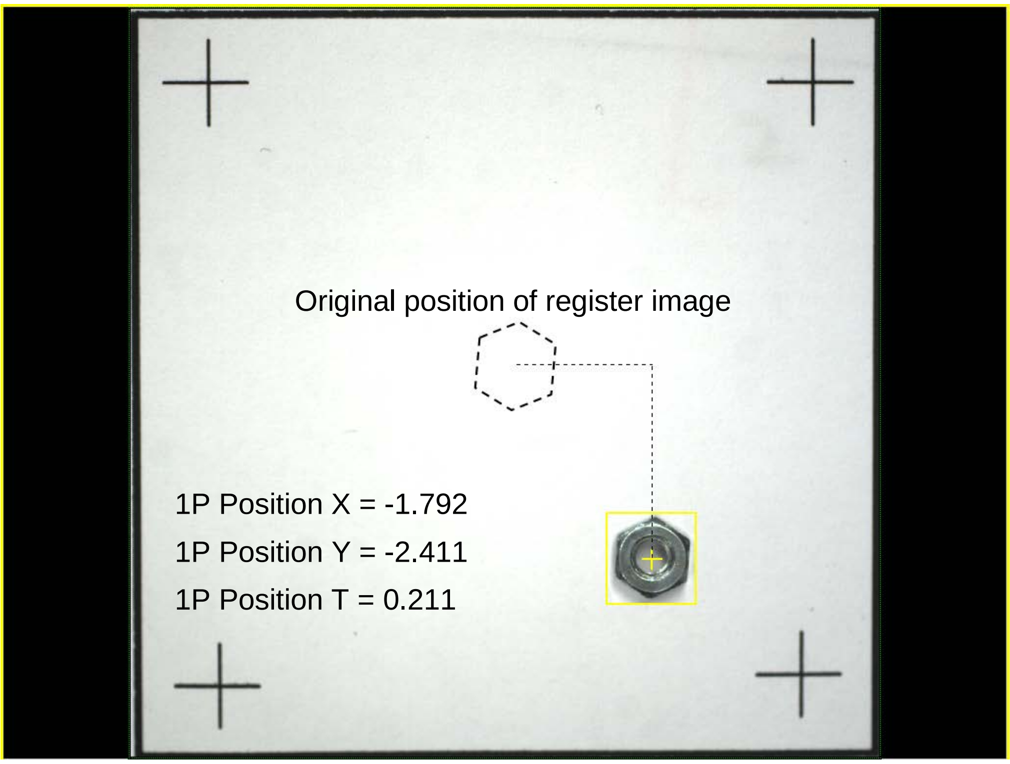
➤ Procedural Results

1P Location with 4 Points Learning returns the following inspection results

1) 1P Location X: The output relative X coordinate (relative to register image) of the target object after applying 4 Points Learning.
2) 1P Location Y: The output relative Y coordinate (relative to register image) of the target object after applying 4 Points Learning.
3) 1P Location T: The output relative angle of the target object after applying 4 Points Learning.

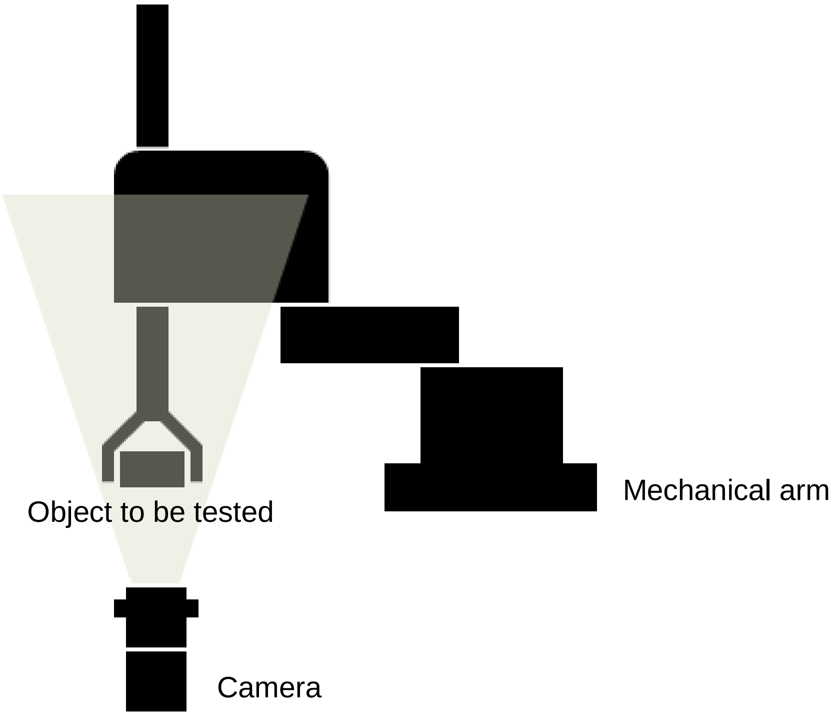
➤ Execution Result

The X, Y, and T acquired from using 1P Position with 4 Points Learning denotes the absolute coordinates of the target object after applying 4 Points Learning (shown in the following diagram).



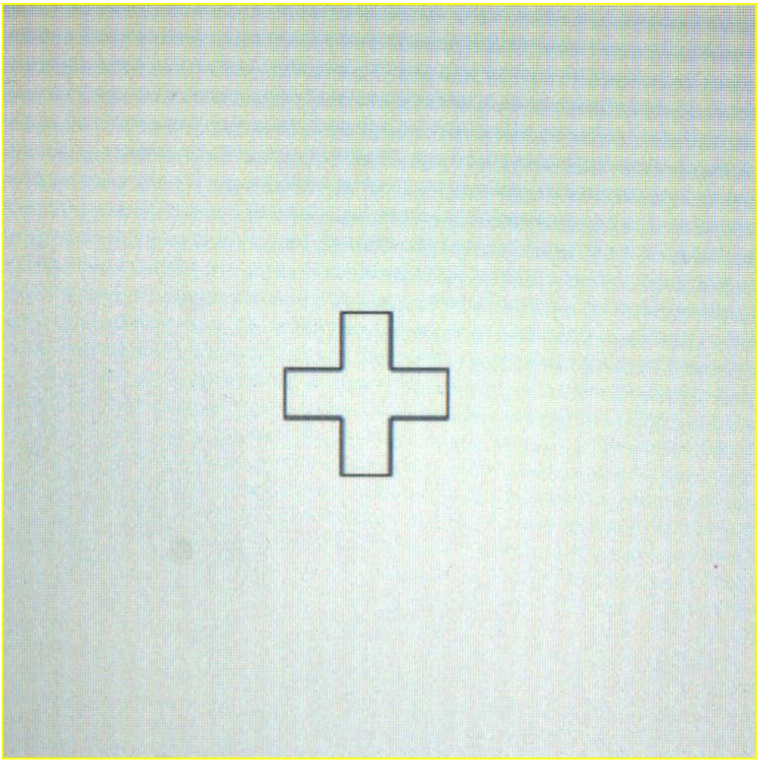
◎ **9 Points Learning**

- Suitable Mechanism: Suitable for target objects with architectures that can be carried using the mechanical arm and for objects without angular deviations (shown in the following diagram)

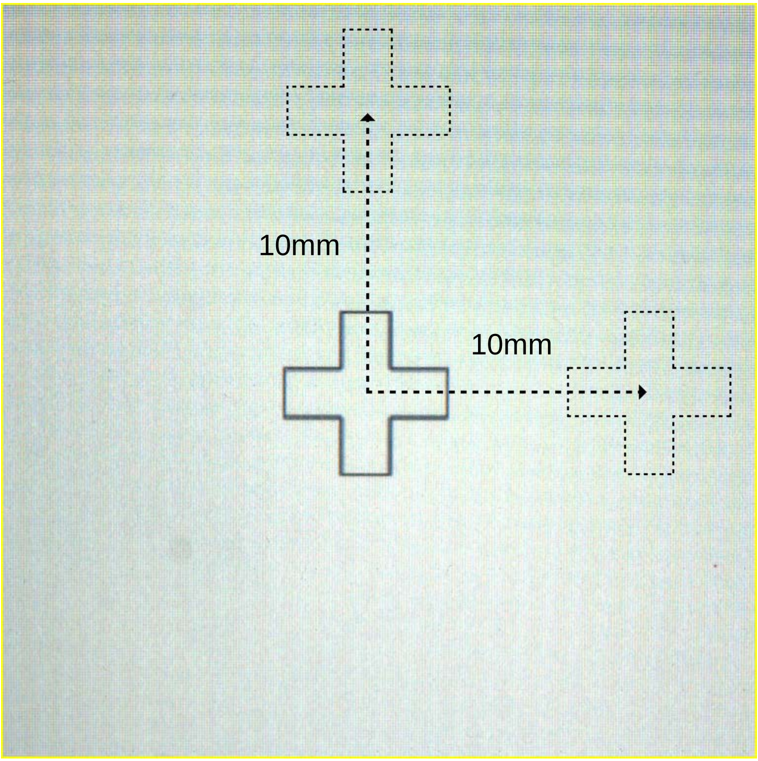


- Flow Configuration

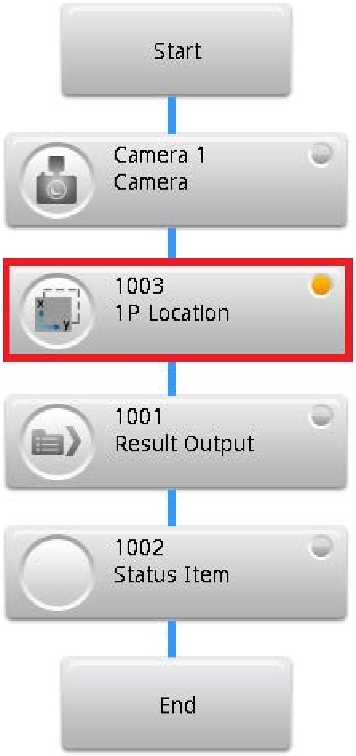
1) The mechanical arm carries the target object into the inspection region and positions the feature of the object as close to the center of the screen as possible (as shown in the following diagram). This point can be viewed as the first learning point, or P1.



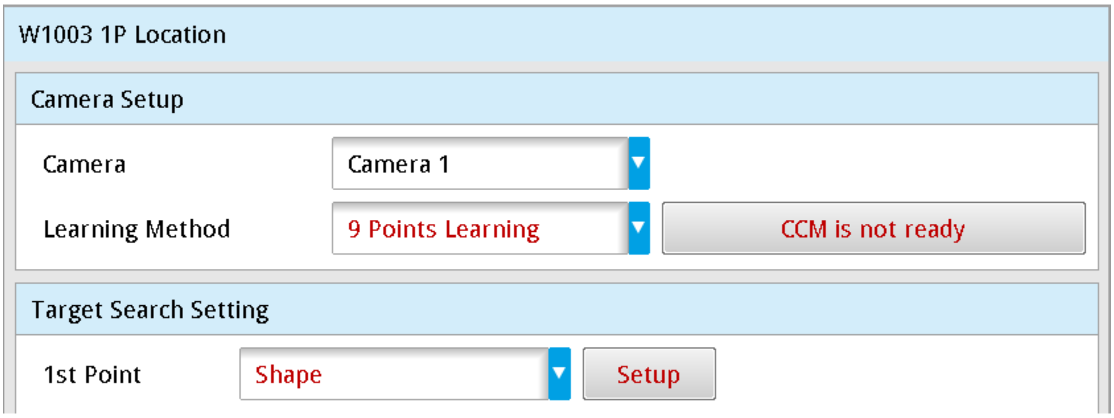
2) Try using the mechanical arm to move the target object towards the X and Y directions and confirm the maximum X and Y displacement within the DMV system's inspection region; as shown in the following diagram, the maximum X and Y displacements are both 10 mm; therefore, the X and Y displacements during the learning process must be limited to within 10 mm to ensure successful learning.



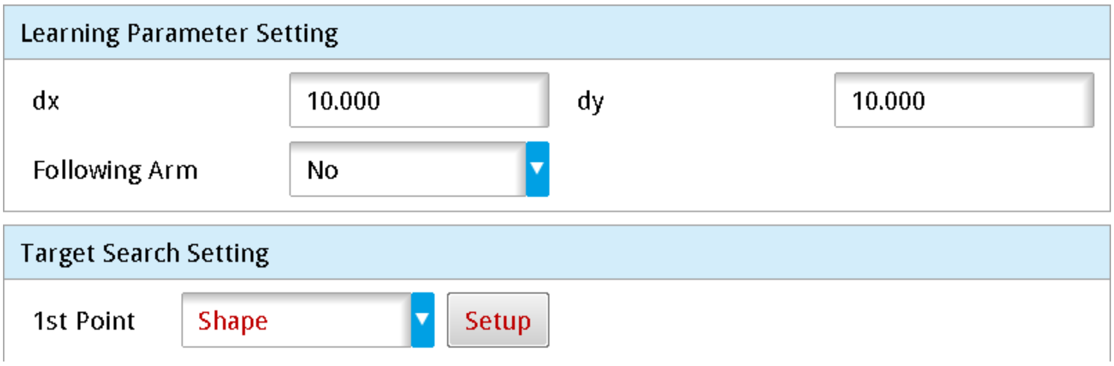
3) Add a new 1P Location inspection in the flow process.



4) After entering the 1P Position setup page (dialog), as shown in the following diagram, configure the camera and select 9 Points Learning as the learning method; If the CCM is not yet completely configured, the lower right button shows [CCM is not ready]; click this button to configure the coordinate conversion.



5) In the parameter setting of CCM configurations, if both input dx and dy are 10 mm, the user can directly input 10.000 (as shown in the following diagram). However, the learning process will fail if the feature exceeds the viewing region during the learning process. After entering the displacements, Target Search Setting can be configured (i.e., Shape).



After configuring dx and dy, the learning path can be laid out (shown as follows).

P1: X, Y

P2: X + (dx), Y

P3: X - (dx), Y

P4: X, (Y + dy)

P5: X, (Y - dy)

P6: X + (dx), Y + (dy)

P7: X - (dx), Y - (dy)

P8: X + (dx), Y - (dy)

P9: X - (dx), Y + (dy)

The learning path in 9 Points Learning does not cover the angles. Therefore, 9 Point Learning cannot be used when the object shows angular deviations.

6) After clicking on [Learning], the system enters the learning mode and shows a progress bar on the screen, which displays the learning progress. During the learning process, the mechanical arm must be moved to P1 with DMV2000 triggered, followed by moving the mechanical arm to P2 through P9 and triggering DMV2000 at each point, thereby completing the learning process.

7) Return to the 1P Position setup page (dialog); configure the searching algorithm (i.e., Shape) in Target Search Setting; and click on the Setup button to configure Shape.

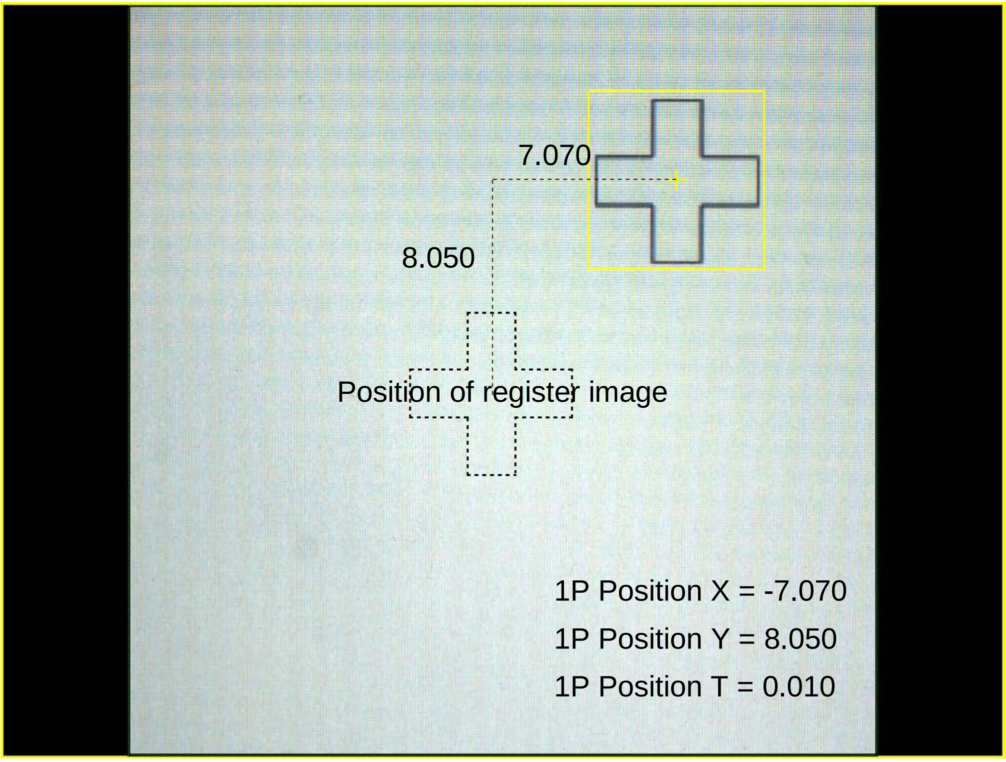
➤ Procedural Results

1P Location with 9 Points Learning returns the following inspection results

1) 1P Location X: Outputs the relative X coordinate (relative to register image) of the target object using mechanical arm units
2) 1P Location Y: Outputs the relative Y coordinate (relative to register image) of the target object using mechanical arm units
3) 1P Location T: Outputs the relative angle (relative to register image) of the target object using mechanical arm units

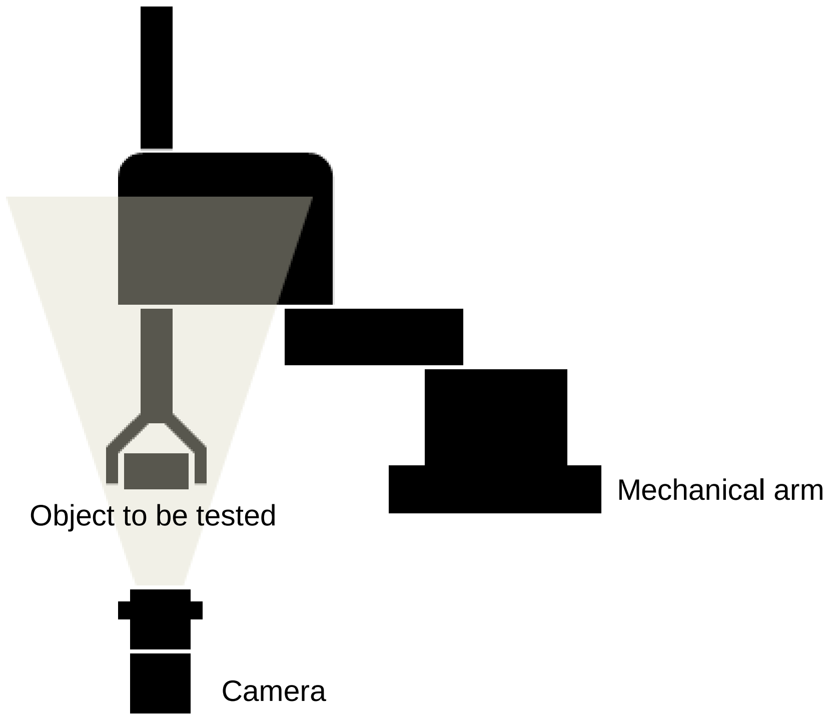
➤ Execution Result

The X, Y, and T obtained from using 1P Location with 9 Points Learning denotes the relative coordinates of the target object respective to the register image and are output in mechanical arm units (shown in the following diagram).



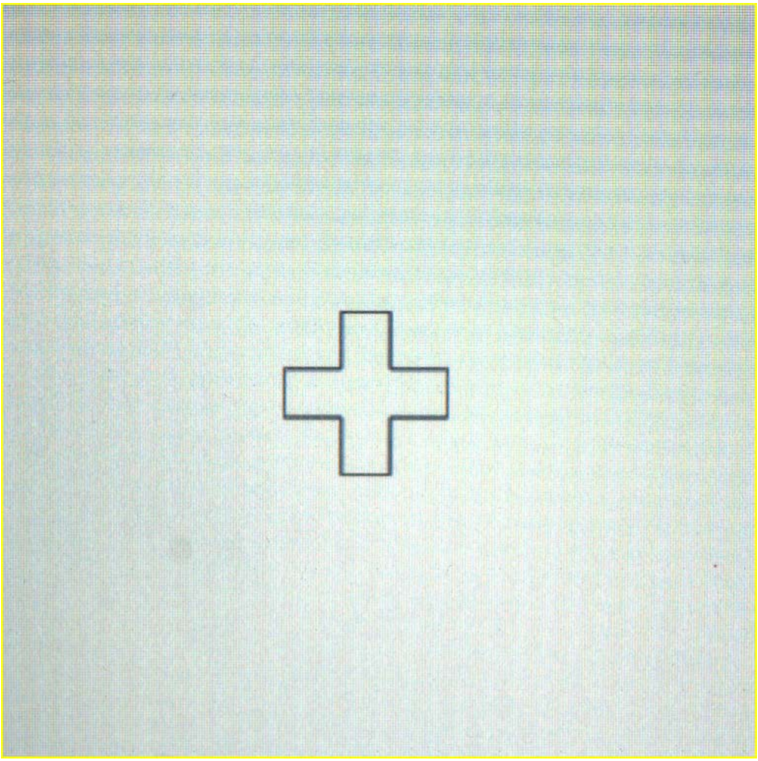
◎ **11 Points Learning**

➤ Suitable Mechanism: Suitable for target objects with architectures that can be carried using the mechanical arm (shown in the following diagram)

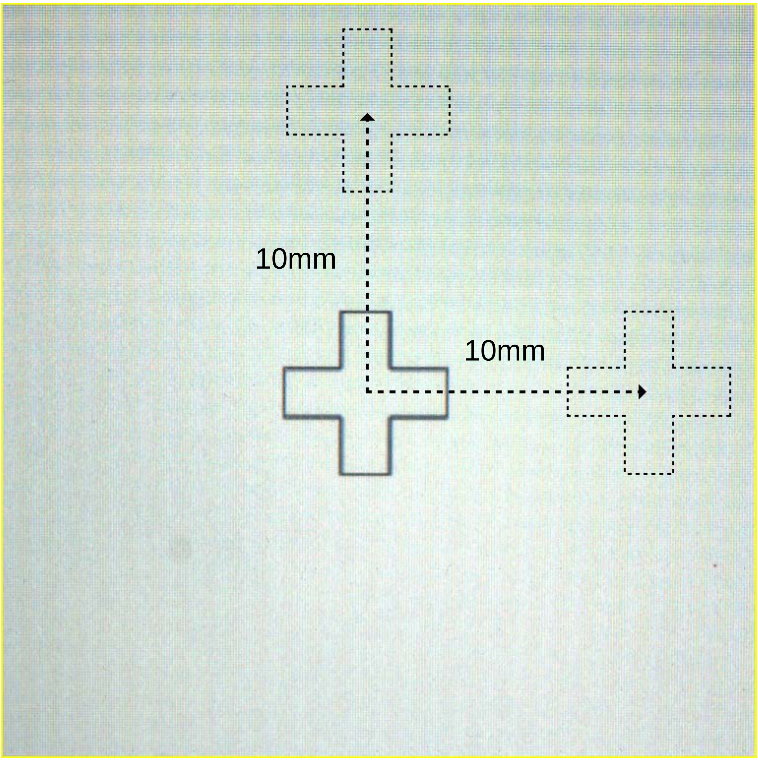


- Flow Configuration

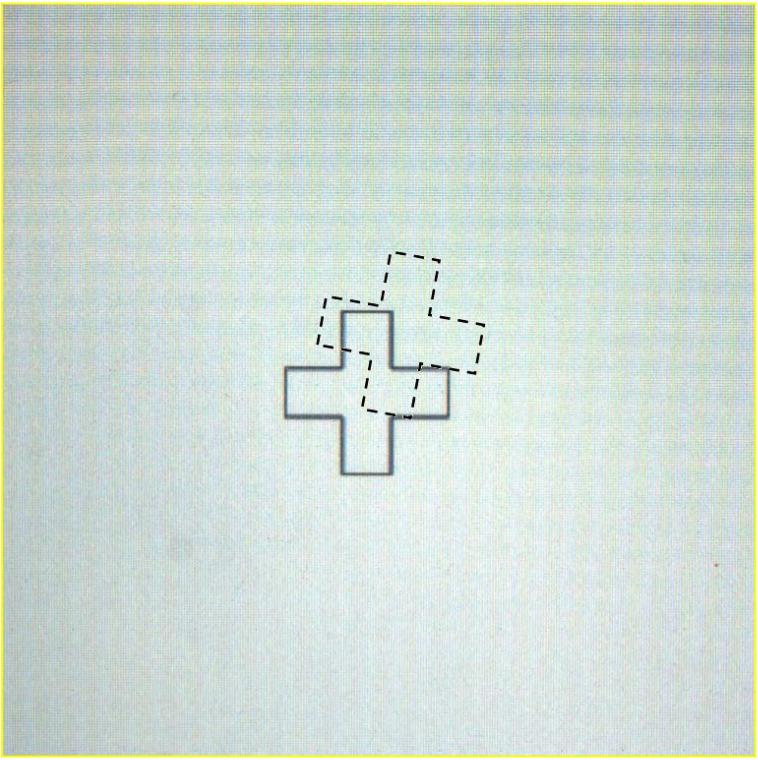
1) The mechanical arm carries the target object into the inspection region and positions the feature of the object as close to the center of the screen as possible (as shown in the following diagram). This point can be viewed as the first learning point, or P1.



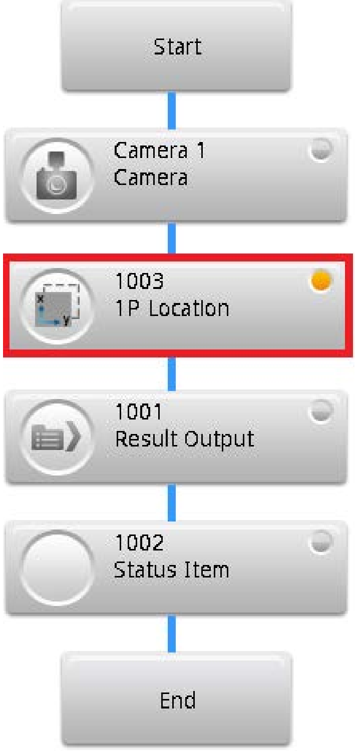
2) Try using the mechanical arm to move the target object towards the X and Y directions and confirm the maximum X and Y displacement within the DMV system's inspection region; as shown in the following diagram, the maximum X and Y displacements are both 10 mm; therefore, the X and Y displacements during the learning process must be limited to within 10 mm to ensure successful learning.



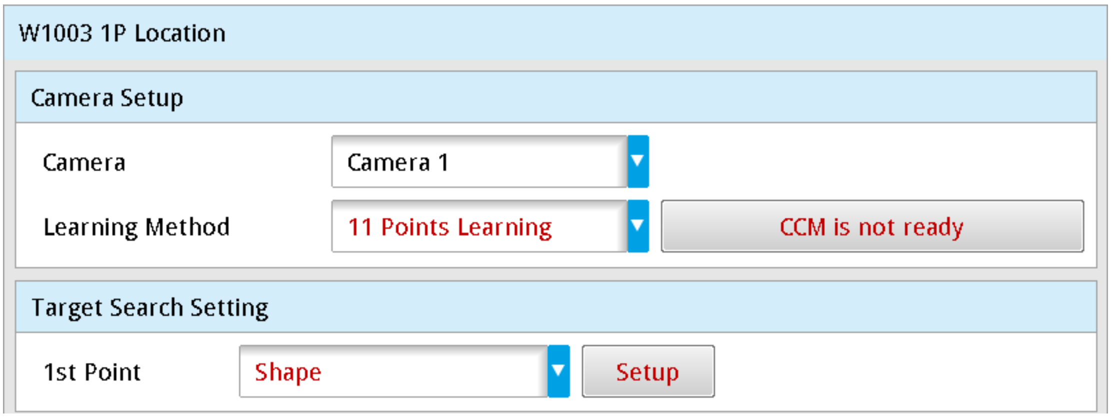
3) The mechanical arm returns to P1. Try rotate and move the target object using the mechanical arm and confirm the reasonable rotation angle within the DMV system's inspection region (as shown in the following diagram, the rotation angle is 10 degrees)



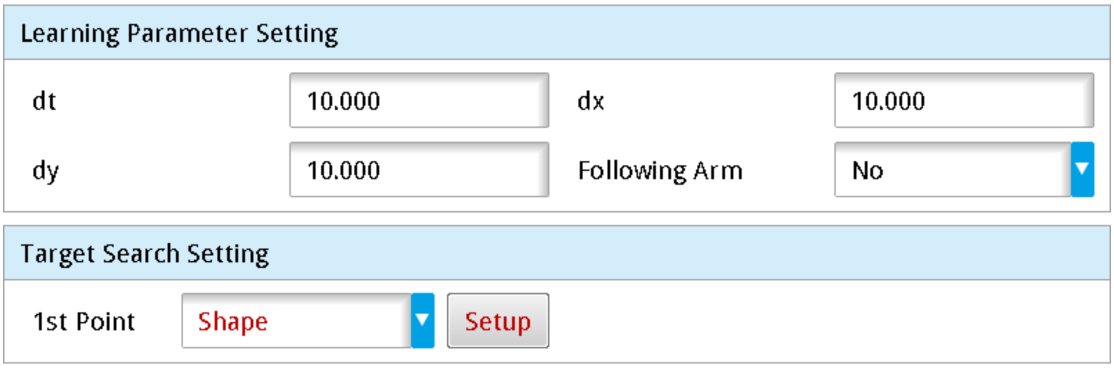
4) Add a new 1P Location inspection in the flow process.



5) After entering the 1P Position setup page (dialog), as shown in the following diagram, configure the camera and select 11 Points Learning as the learning method; If the CCM is not yet completely configured, the lower right button shows [CCM is not ready]; click this button to configure the coordinate conversion.



6) In the parameter setting of CCM configurations, the input parameters are dt, dx, and dy in which dt represents the angle of rotation. If the angle of rotation is 10 degrees, the user can directly enter 10.000. If both input dx and dy are 10 mm, the user can directly input 10.000 (as shown in the following diagram). However, the learning process will fail if the feature exceeds the viewing region during the learning process. After entering the displacements, Target Search Setting can be configured (i.e., Shape).



After configuring dx and dy, the learning path can be laid out (shown as follows).

P1: X, Y

P2: X + (dx), Y

P3: X - (dx), Y

P4: X, (Y + dy)

P5: X, (Y - dy)

P6: X + (dx), Y + (dy)

P7: X - (dx), Y - (dy)

P8: X + (dx), Y - (dy)

P9: X - (dx), Y + (dy)

P10: X, Y, T + (dt)

P11: X, Y, T - (dt)

7) After clicking on [Learning], the system enters the learning mode and shows a progress bar on the screen, which displays the learning progress. During the learning process, the mechanical arm must be moved to P1 with DMV2000 triggered, followed by moving the mechanical arm to P2 through P9 and triggering DMV2000 at each point, thereby completing the learning process.

8) Return to the 1P Position setup page (dialog); configure the searching algorithm (i.e., Shape) in Target Search Setting; and click on the Setup button to configure Shape

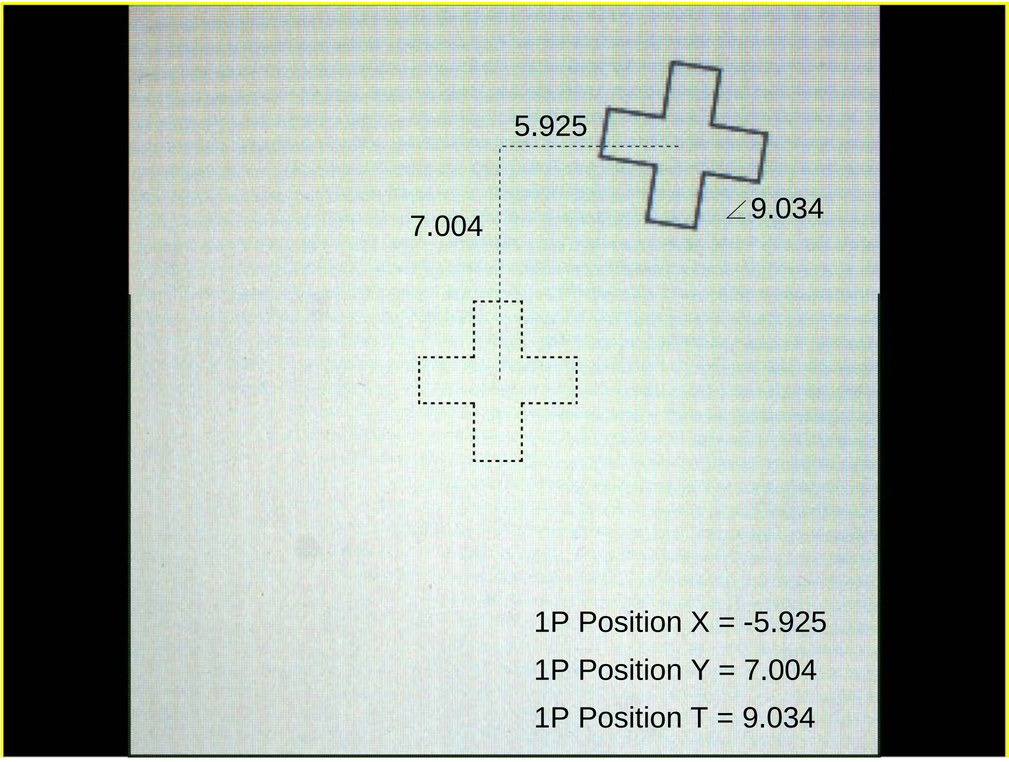
➤ Procedural Results

1P Location with 11 Points Learning returns the following inspection results

1) 1P Location X: Outputs the relative X coordinate (relative to register image) of the target object using mechanical arm units
2) 1P Location Y: Outputs the relative Y coordinate (relative to register image) of the target object using mechanical arm units
3) 1P Location T: Outputs the relative angle (relative to register image) of the target object using mechanical arm units

➤ Execution Result

The X, Y, and T obtained from using 1P Location with 11 Points Learning denotes the relative coordinates of the target object respective to the register image and are output in mechanical arm units (shown in the following diagram).



Chapter 6

Calculator, Result Output, Status Item

[Calculator], [Result Output], and [Status Item] can only be edited sequentially after completing [Inspection] configurations.
Main functions:

◎ **Calculator**
Enter numeric [Inspection] 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 pass this result to subsequent [Output] configurations.

◎ **Result Output**
The user can choose to output the resulting numeric data of [Inspection] and [Calculate] and the logic flags through any communication interface (i.e., RS232, RS485, I/O, and Ethernet).

◎ **Status Item**
Select the numeric data from [Inspection] and [Calculate] or logic flags to display in the [LED] menu on the RUN screen to provide the user an overview of the resulting inspection data.

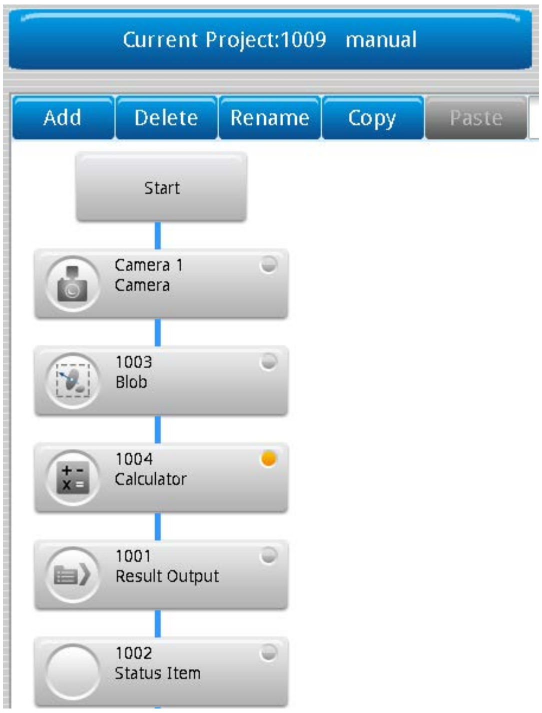
6.1 What is Calculator

The Calculator function provides an interface for mathematic operations to compute [Inspection] results (i.e., numbers, coordinates, angles) and generate the required new results. For example, two counters with results 2 and 3 can be added to each other using the calculator. The final result, 5, can then be passed on to the subsequent [Output] program. (i.e., sending the numeric result 5 to the upper PC via RS232)
In addition to simple arithmetic, the calculator also provides trigonometry and functions for calculating the distance between coordinates.
Each individual project independently supports up to 999 calculators and upper/lower limits can be configured for each ID according to results from Calculate to obtain the logic flag of the specific calculator. The results can be passed on for configuring subsequent logical [Output] options. For example, if a standard value of 100 (with +/-1 tolerance) pixels for a size measurement is obtained from arithmetic computation, the upper/lower limits of the calculator can be set to 101 and 99, respectively. Thus results in between 99~101 is OK and NG otherwise.

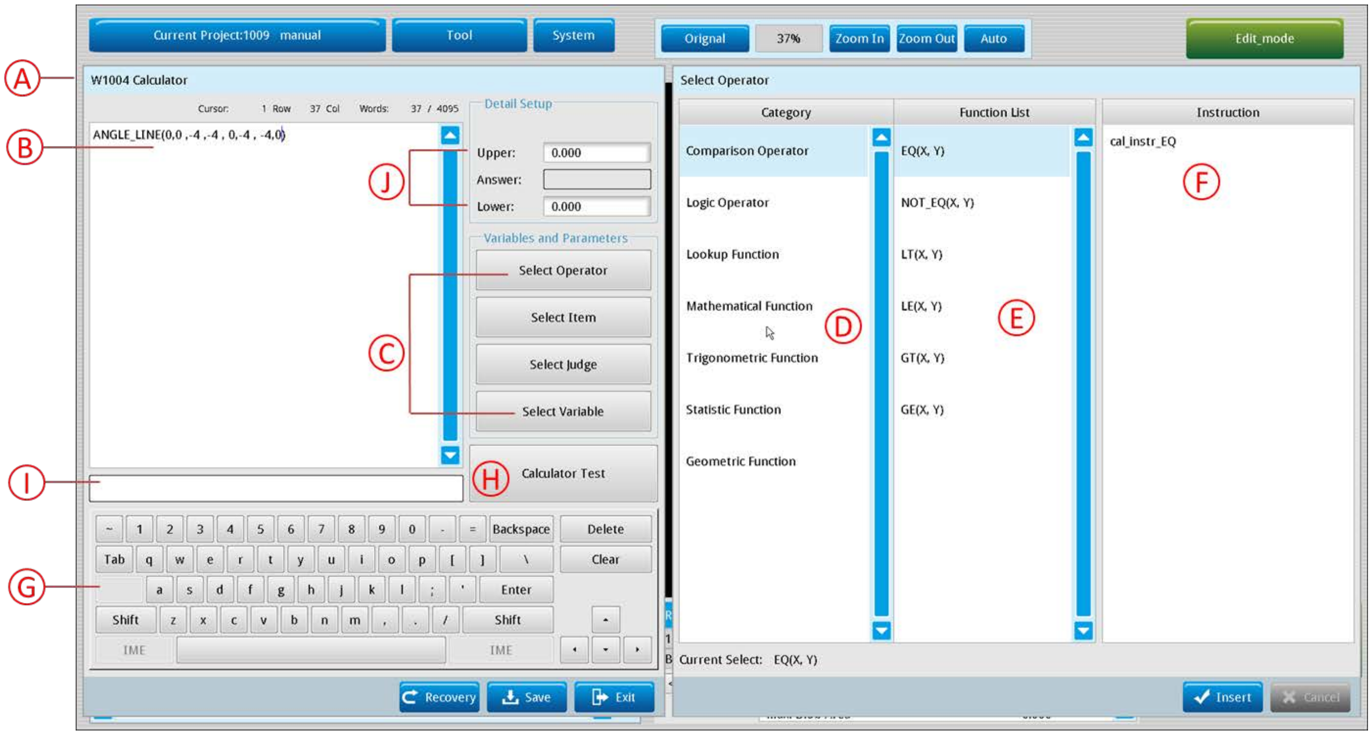
6.2 Edit Calculator Functions

6.2.1 Calculator Interface

During the inspection process, click on the [Calculator] icon to enter the calculator function edit screen.



The following diagram shows an opened calculator edit screen. The function in each region is explained as follows.



A. Current Calculate ID being edited

Multiple calculator functions (up to 999) can be configured for each project. Therefore, the system will automatically generate a number to provide identification for the user when adding new calculator units.

B. Function display area

Area where the functions and equations created are displayed.

C. Variables and Parameters

Select the mathematic function or inspection result to create the required equation.

D. Type

Option is opened after selecting the previously mentioned [Variables and Parameters].

For example, after selecting [Select Operator], multiple sublevel options, such as [Comparison Operator], [Logic Operator], and [Mathematical Function] will be opened in the [Type] menu.

E. Function List

After selecting the previously mentioned [Variables and Parameters] and [Type], each final function will be displayed in [Function List] for user's selection.

F. Description

After selecting the required function in the previously mentioned [Function List], the system will automatically describe the function in text in the [Instruction] field.

G. Keyboard Operation

When editing functions, the required text or numeric inputs must be entered through this keyboard.

H. & I. Calculator Test and Display Area

When finished creating the function, Calculator Test can first be performed to confirm whether the function is configured correctly.

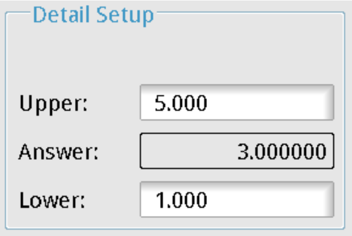
The syntax and configuration of the function list is tested. The display area will show [The expression is correct] if the test result is correct.

Contrarily, the display area will show [syntax error] if the syntax of the function is incorrectly configured.

J. Detail Setup

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 this calculator is NG (=0). The OK or NG results of this calculator can serve as a basis for logical (Judge) decisions in subsequent processes.

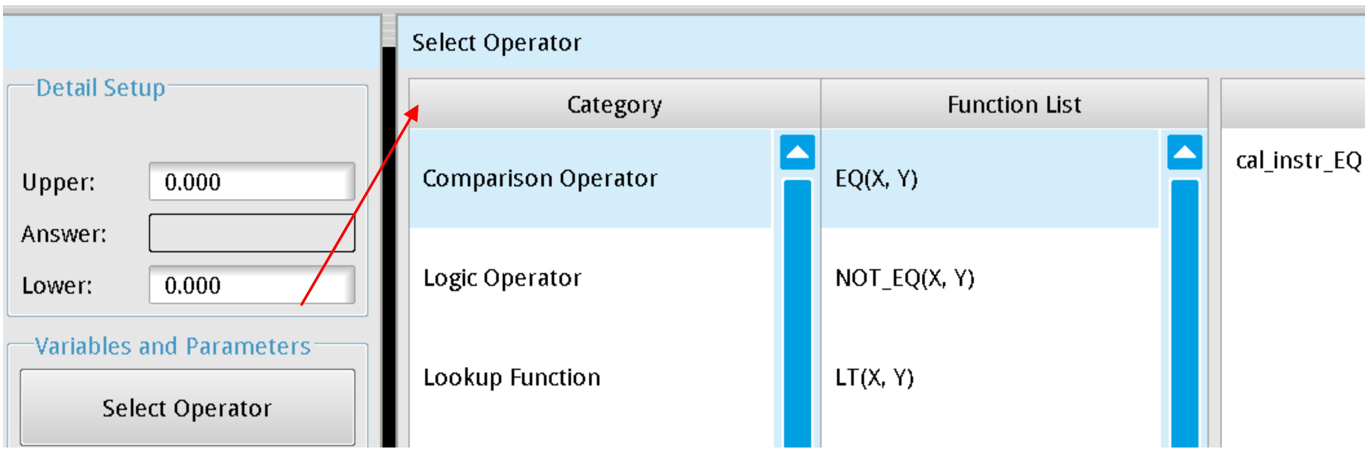


6.2.2 Variable and Parameter Functions

In [Variables and Parameters], all required units for creating calculator equations are provided. The functions and definitions for each unit are introduced as follows.

◎ **[Select Operator] Unit**

- As shown in the following diagram, [Select Operator] provides various [Type] options in which the function to be used can be selected in [Function List].
- The following diagram exemplifies the Comparison Operator. EQ (X, Y) is selected in [Function List]. After inserting the addition, the unit is created in [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] function: EQ, NOT_EQ, LT, LE, GT, GE

The [Logic Operator] function: AND, BIT_AND, OR, BIT_OR, XOR, BIT_XOR, NOT, BIT_NOT

The [Lookup Function] function: INRANGE, CHOOSE, MAXN, MINN, MAXthN, MINthN

The [Mathematical Function] function: ABS, POW, MOD, LOG10, LN, EXP, SQR, SQRT, SUM, TRUNC, ROUND, CEIL, FLOOR

The [Trigonometric Function] function: SIN, SINH, COS, COSH, TAN, TANH, ASIN, ACOS, ATAN, ATAN2, RAD, EDG, PI

The [Statistic Function] function: MAX, AVG, AVG_RANGE, MIN, SDEV, MEDIAN

The [Geometric Function] function: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

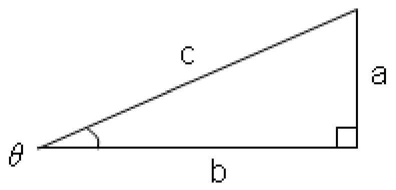
Logic Operator			
Function	Description	Example	Note
AND	AND gate	AND(1,1) = 1	The result will only be 1 when both are 1
BIT_AND	Numerical AND gate	BIT_AND(2,6) = 2	Performs AND after converting numerical value to bits 2 = 0010; 6 = 0110 BIT_AND = 0010
OR	OR gate	OR(1,0) = 1	Outputs 1 if any input is 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 bit15 is 1.

Lookup Function			
Function	Description	Example	Note
INRANGE	(X,LL,UL) determines whether X lies between LL and UL.	INRANGE(20,5,88) = 1	20 lies between 5 and 88 and outputs a result of 1; else the function outputs 0.
CHOOSE	(M,X0…Xn) obtains 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) obtains the maximum value sorting index	MAXN(88,56,100,2,25) = 2	The 3rd data index is 2.
MINN	(X0…Xn) obtains the minimum value sorting index	MINN(88,56,100,2,25) = 3	The 4th data index is 3.
MAXthN	(M,X0…Xn) obtains the maximum value sorting index of the Mth value	MAXthN(2,88,56,100,2,25) = 0	The maximum value sorting index of 100 is 0.
MINthN	(M,X0…Xn) obtains the minimum value sorting index of the Mth value	MINthN(2,88,56,100,2,25) = 4	The minimum value sorting index of 100 is 4.

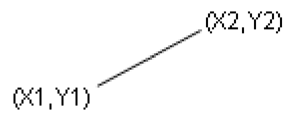
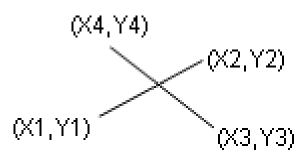
Mathematical Function			
Function	Description	Example	Note

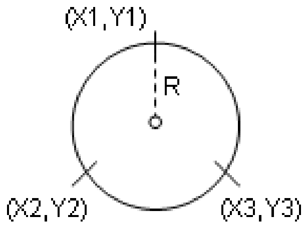
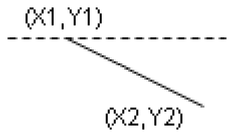
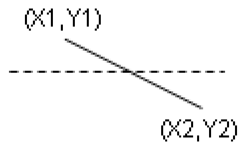
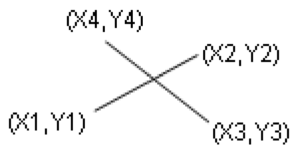
ABS	Absolute value	ABS(-10) = 10	
POW	Raised to the power N	POW(2,3) = 8 POW(3,4) = 81	3 * 3 * 3 * 3 = 81
MOD	Take remainder	MOD(5,2) = 1 MOD(8,3) = 2	8 / 3 = 2 remainder 2
LOG10	Calculate logarithmic value	LOG10(10) = 1	
LN	Calculate natural logarithmic value	LN(1) = 0	
EXP	Return exponential value	EXP(1) = 2.718281828…	
SQR	Square	SQR(2) = 4 SQR(-2) = 4	
SQRT	Square root	SQRT(9) = 3	
SUM	Calculate the sum of (X0… Xn)	SUM(1,2,3,4,5,) = 15	
TRUNC	Truncate	TRUNC(3.14) = 3	
ROUND	Round to integer	Round(1.55) = 2	
CEIL	Obtain the nearest integer greater than X	CEIL(3.5) = 4 CEIL(-3.5) = -3	
FLOOR	Obtain the nearest integer lesser than X	FLOOR(3.5) = 3 FLOOR(-3.5) = -4	

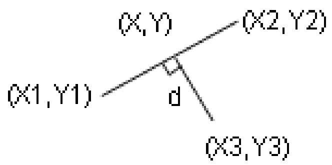
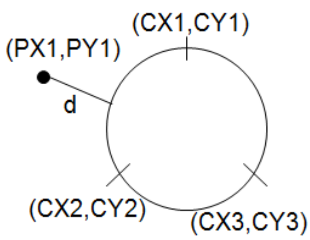
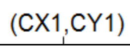
Trigonometric Function			
Function	Description	Example	Note
SIN	Sine	SIN(30) = 0.5	SIN(θ) = a / c COS(θ) = b / c TAN(θ) = a / b ASIN(a/c) = θ ACOS(b/c) = θ ATAN(a/b) = θ 
COS	Cosine	COS(30) = 0.866	
TAN	Tangent	TAN(30) = 0.577	
ASIN	Arcsine function	ASIN(1) = 90	
ACOS	Arccosine function	ACOS(1) = 0	
ATAN	Arctangent function	ATAN(1) = 45	
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	ATAN2(1,1) = 45	

	function (X/Y)	
RAD	Convert to radians	RAD(180) = 3.14
DEG	Convert to degrees	DEG(3.14) = 179.90
PI	π constant	3.14159

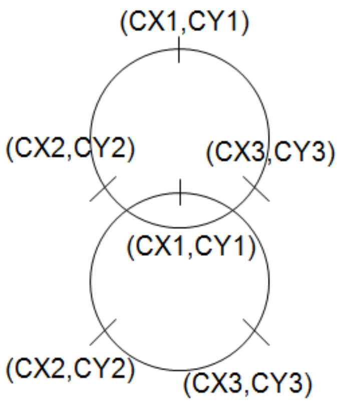
Statistic Function]			
Function	Description	Example	Note
MAX	Obtain the maximum in (X0…Xn)	MAX(88,56,100,2,25) = 100	
AVG	Obtain the average in (X0…Xn)	AVG(88,56,100,2,25) = 54.199...	
AVG_RANGE	(LL,UL,X0…Xn) Calculate the average between LL and UL	AVG_RGANGE(50,90,88,56,100,2,25) = 72	
MIN	Obtain the minimum in (X0…Xn)	MIN(88,56,100,2,25) = 2	
SDEV	Calculate the standard deviation of (X0...Xn)	SDEV(5,6,8,9) = 1.5811388…	
MEDIAN	Calculate 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_X(-14.6,8.94,-11.64,4.15,-15.61,3.47) = -14	

	circle formed by three points		
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 the horizontal surface (connected at X1,Y1) In clockwise direction (range +/-180°)	ANGLE(0,0,5,5) = 45 ANGLE(5,5,0,0) = -135	
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	LINE_FITC(1,1,3,2) = 0.5	Return result c

	Y=mX+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_CIR	(PX1,PY1,PX2,P	ISEC_LINE_CIRCLE_CNT(1,1,6,6,	

CLE_CNT	Y2,CX1,CY1,CX2,CY2,CX3,CY3) Number of intersections between a line generated by two points and the circle	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 points and the circle	ISEC_LINE_CIRCLE_X0(1,1,6,6,0,3,3,0,6,3) = 0.8786796…	
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	ISEC_LINE_CIRCLE_Y1(1,1,6,6,0,3,3,0,6,3) = 5.1213203…	

	,CY2,CX3,CY3) The coordinate of the second intersection (Y1) between a line generated by two points and the circle		
ISEC_CIRCLE_CIRCLE_CNT	(C1X1,C1Y1,C1X2,C1Y2,C1X3,C1Y3,C2X1,C2Y1,C2X2,C2Y2,C2X3,C2Y3) Number of intersections between two circles	ISEC_CIRCLE_CIRCLE_CNT(0,2,2,0,4,2,0,2,2,0,-2,0) = 2	
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,C	ISEC_CIRCLE_CIRCLE_X1(0,2,2,0,4,2,0,2,2,0,-2,0)= 2	

	2X2,C2Y2,C2X3,C2Y3) The coordinate of the second intersection (X1) between two circles		
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 circles	ISEC_CIRCLE_CIRCLE_Y1(0,2,2,0,4,2,0,2,2,0,-2,0) = 0	

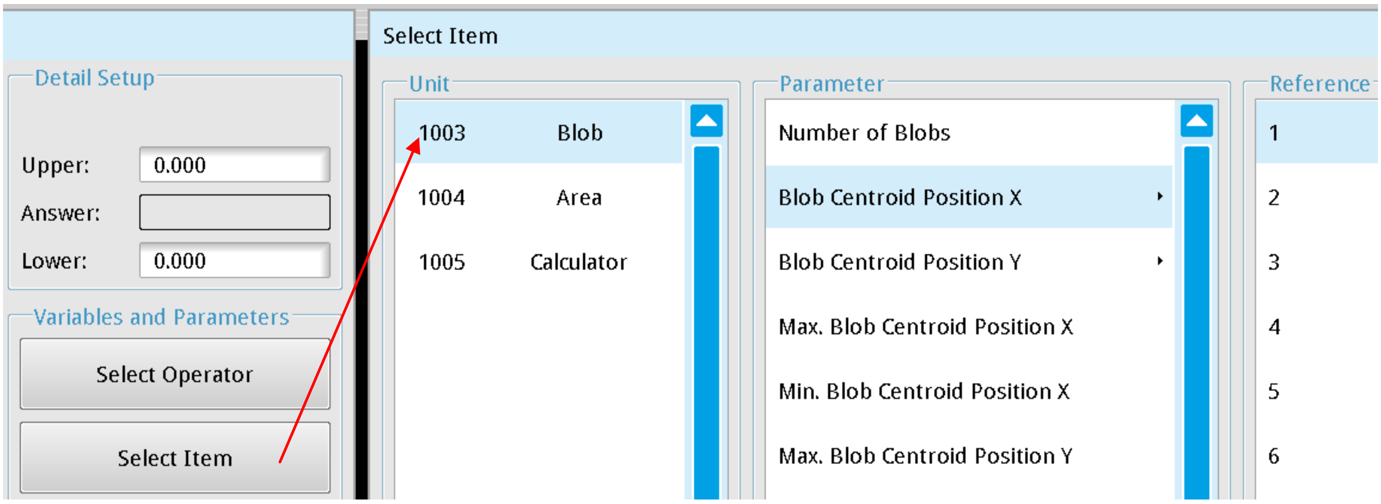
Remark A comma separates the elements. For example: AVG(2,3,4)

◎ **The [Select Item] Unit**

➤ As shown in the following diagram, the [Select Item] unit will display the [Inspection] already created in the project, including not only the configured inspections (windows) but also calculator units.

➤ 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] (i.e., Number of Blobs, Blob Centroid Position X)

➤ In [Parameter] options, the attached ▶ symbol means additional [Parameter] option is required. (i.e., Blob Centroid Position X provides the ▶ symbol because the sorting function configured during blob inspection can identify multiple blobs with reference sequence numbers (meaning multiple centroids X coordinates). Therefore, the resulting value must be selected based on the configurations.



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 of 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 2nd edge will be used as the calculation (output) content.

X: Represents that the results are the contents of the Xcoordinate; please refer to the following table for the result codes of each inspection function.

Inspection Function	Syntax	Description	Reference	Calculator data format
Area	TAR	Total area	--	WIN(□□□□,TAR,0)
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,△△)
Count	N	Number of edges	--	WIN(□□□□,N,0)
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)
Pitch	N	Quantity	--	WIN(□□□□,N,0)
	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,△△)
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	Max brightness	--	WIN(□□□□,IH,0)
	IL	Minimum Intensity	--	WIN(□□□□,IL,0)
Shape Comparison	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	Max X coordinates from all objects	--	WIN(□□□□,XH,0)
	XL	Min X coordinates from all objects	--	WIN(□□□□,XL,0)
	YH	Max Y coordinates from all objects	--	WIN(□□□□,YH,0)
	YL	Min Y coordinates from all objects	--	WIN(□□□□,YL,0)
	AG	Object angle found	[△△]	WIN(□□□□,AG,△△)
Pattern Comparison	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	Max X coordinates from all objects	--	WIN(□□□□,XH,0)
	XL	Min X coordinates from all objects	--	WIN(□□□□,XL,0)
	YH	Max Y coordinates from all objects	--	WIN(□□□□,YH,0)
	YL	Min Y coordinates from all objects	--	WIN(□□□□,YL,0)
	AG	Object angle found	[△△]	WIN(□□□□,AG,△△)
Spot	N	Quantity	--	WIN(□□□□,N,0)
	X	Center X coordinates	[△△]	WIN(□□□□,X,△△)
	Y	Center Y coordinates	[△△]	WIN(□□□□,X,△△)
	XH	Max X coordinates of all spot centers	--	WIN(□□□□,XH,0)
	XL	Min X coordinates of all spot centers	--	WIN(□□□□,XL,0)
	YH	Max Y coordinates of all spot centers	--	WIN(□□□□,YH,0)

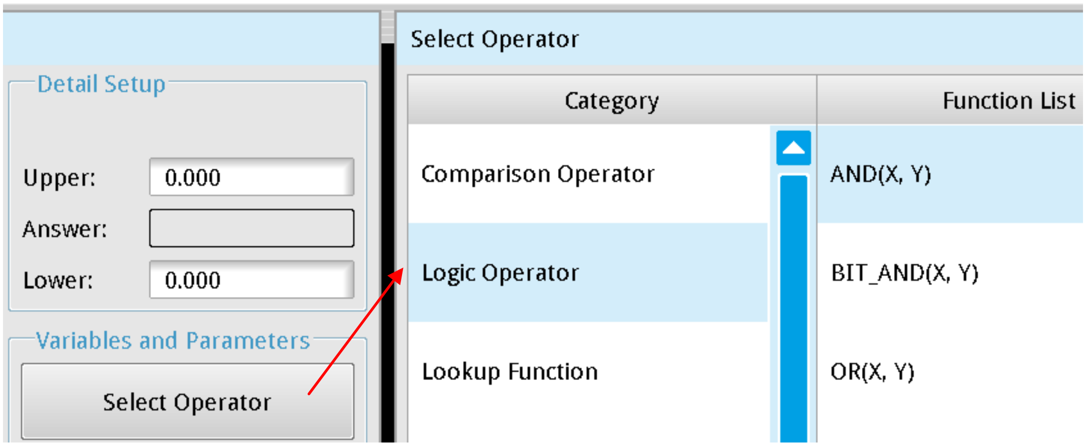
	YL	Min Y coordinates of all spot centers	--	WIN(□□□□,YL,0)
	AR	Blob Area	[△△]	WIN(□□□□,AR,△△)
	ARH	Maximum Blob Area	--	WIN(□□□□,ARH,0)
	ARL	Minimum Blob Area	--	WIN(□□□□,ARL,0)
	RD	Roundness	[△△]	WIN(□□□□,RD,△△)
	RDH	Maximum Roundness	--	WIN(□□□□,RDH,0)
	RDL	Minimum Roundness	--	WIN(□□□□,RDL,0)
	AG	Incident clockwise angle of main axis to horizontal axis	[△△]	WIN(□□□□,AG,△△)
	AGH	Max incident clockwise angle of all main axis to horizontal axis	--	WIN(□□□□,AGH,0)
	AGL	Min 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)
Stain	TAR	Total defective area	--	WIN(□□□□,N,0)
	N	Cluster	--	WIN(□□□□,N,0)
	AR	Defective area	[△△]	WIN(□□□□,AR,△△)
	ARH	Max defective area	--	WIN(□□□□,ARH,0)
	ARL	Min defective area	--	WIN(□□□□,ARL,0)
	X	Center X coordinates of all defects	[△△]	WIN(□□□□,X,△△)
	Y	Center Y coordinates of all defects	[△△]	WIN(□□□□,Y,△△)
	XH	Max X coordinates from all defect centers	--	WIN(□□□□,XH,0)
	XL	Min X coordinates from all defect centers	--	WIN(□□□□,XL,0)
	YH	Max Y coordinates from all defect centers	--	WIN(□□□□,YH,0)

	YL	Min 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 max outline	--	WIN(□□□□,XH,0)
	XL	X coordinates of min outline	--	WIN(□□□□,XL,0)
	YH	Y coordinates of max outline	--	WIN(□□□□,YH,0)
	YL	Y coordinates of min 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	Max distance from all outlines	--	WIN(□□□□,DH,0)
	DL	Min 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	Max Width	--	WIN(□□□□,WH,0)
	WL	Min Width	--	WIN(□□□□,WL,0)
	WA	Average Width	--	WIN(□□□□,WA,0)
	W	All Widths	[△△]	WIN(□□□□,W,△△)
	HX1	X1 coordinates of max width	--	WIN(□□□□,HX1,0)
	HY1	Y1 coordinates of max width	--	WIN(□□□□,HY1,0)
	HX2	X2 coordinates of max width	--	WIN(□□□□,HX2,0)
	HY2	Y2 coordinates of max width	--	WIN(□□□□,HY2,0)
	LX1	X1 coordinates of min width	--	WIN(□□□□,LX1,0)
	LY1	Y1 coordinates of min width	--	WIN(□□□□,LY1,0)
	LX2	X2 coordinates of min width	--	WIN(□□□□,LX2,0)
	LY2	Y2 coordinates of min 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)

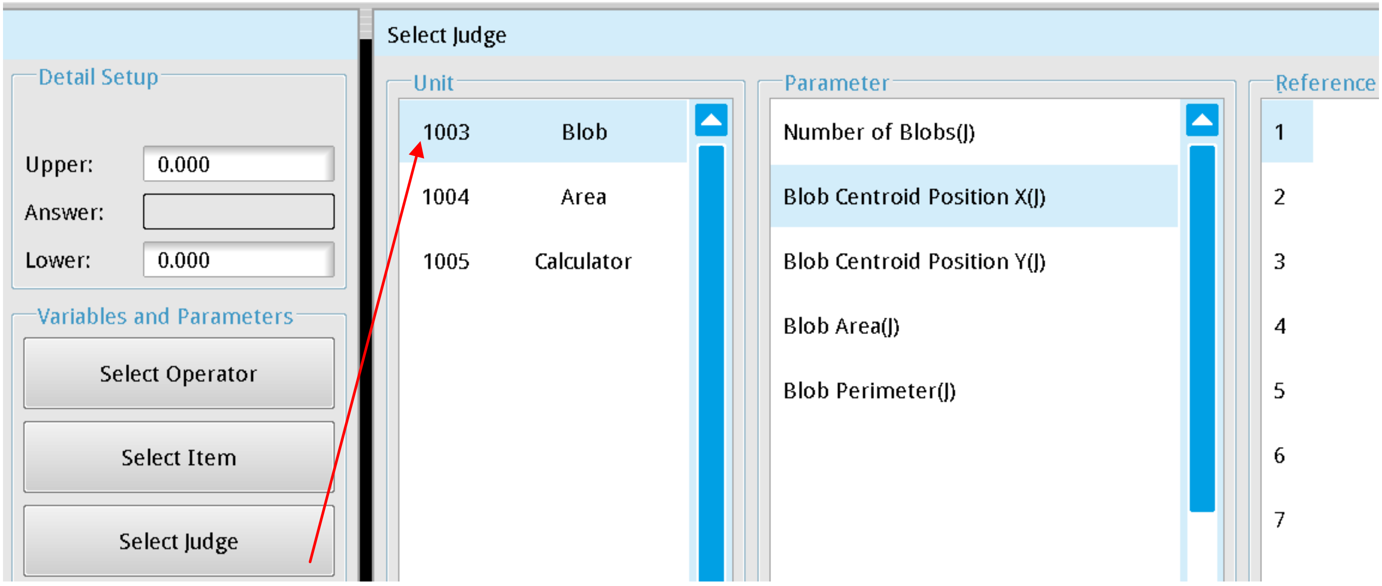
	RD2	Roundness 2 (outer)	--	WIN(□□□□,RD2,0)
	CX2	Centre X coordinates of circle 2	--	WIN(□□□□,CX2,0)
	CY2	Centre Y coordinates of circle 2	--	WIN(□□□□,CY2,0)
	CR2	circle 2 radius	--	WIN(□□□□,CR2,0)
1P Position	X	X coordinates of found object	[△△]	WIN(□□□□, X, △△)
	Y	Y coordinates of found object	[△△]	WIN(□□□□, Y, △△)
	T	Object angle found	[△△]	WIN(□□□□, T, △△)
	CNT	Number of objects found	--	WIN(□□□□, CNT, 0)
	S	Similarity of objects found	[△△]	WIN(□□□□, S, △△)
	OX	Image X coordinate of the object found	[△△]	WIN(□□□□, OX, △△)
	OY	Image Y coordinate of the object found	[△△]	WIN(□□□□, OY, △△)
1P Location	X	Offset in X coordinate of the object found	[△△]	WIN(□□□□, X, △△)
	Y	Offset in Y coordinate of the object found	[△△]	WIN(□□□□, Y, △△)
	T	Offset in angle of the object found	[△△]	WIN(□□□□, T, △△)
	CNT	Number of objects found	--	WIN(□□□□, CNT, 0)
	S	Similarity score of objects found	[△△]	WIN(□□□□, S, △△)
	OX	Offset in image X coordinate of the object found	[△△]	WIN(□□□□, OX, △△)
	OY	Offset in image Y coordinate of the object found	[△△]	WIN(□□□□, OY, △△)

◎ **The [Select Judge] Unit**

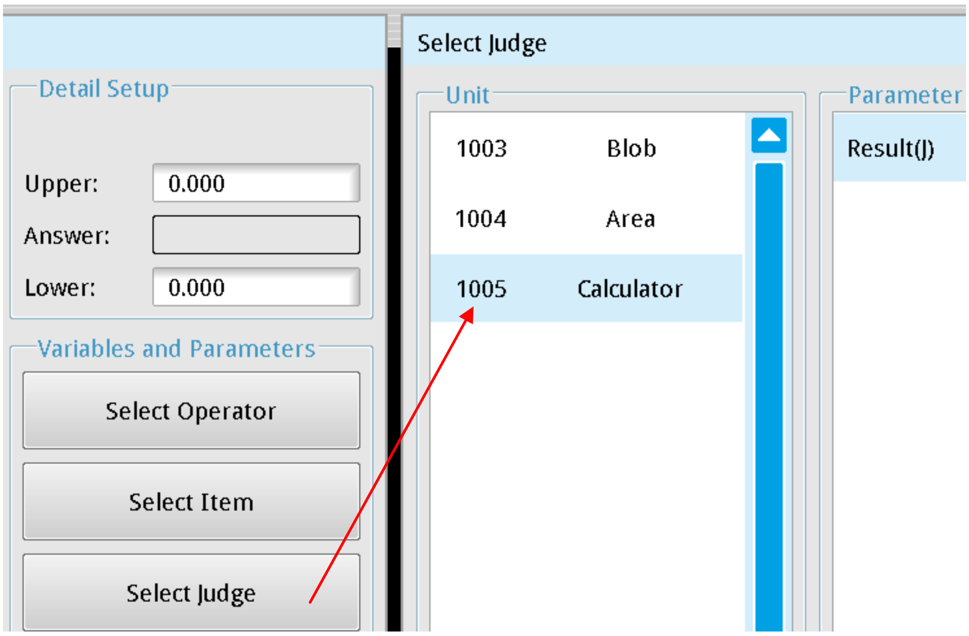
➤ [Select Judge] generally carries out Boolean operations in coordination with the previously mentioned [Logic Operator] function under [Select Operator].



- As shown in the following diagram, the [Select Judge] unit will display the [Inspection] already created in the project, including not only the configured inspections (windows) but also calculator units.
- 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., Number of Blobs, Blob Centroid Position X)
- In [Parameter] options, the attached ▶ symbol means additional [Parameter] option is required. (i.e., Blob Centroid Position X provides the ▶ symbol because the sorting function configured during blob inspection can identify multiple blobs with reference sequence numbers (meaning multiple centroids X coordinates). Therefore, the resulting value must be selected based on the configurations.



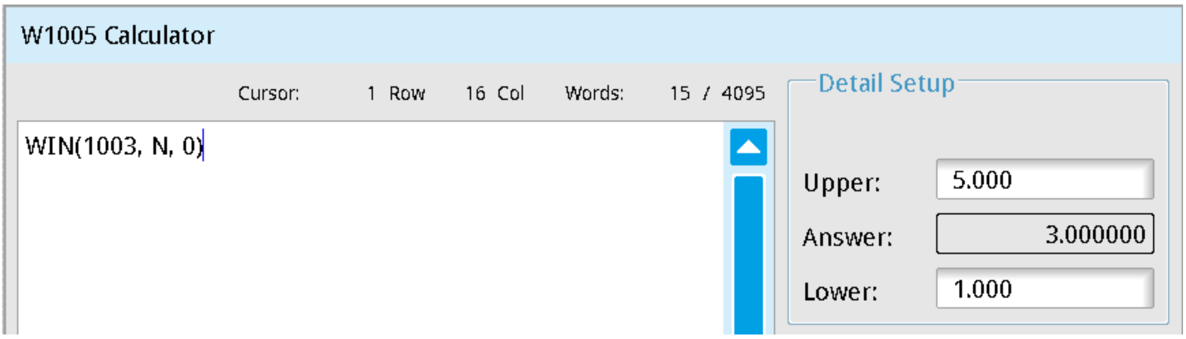
- In [Select Judge], not only the logical (Judge) result from [Inspection] but also that from [Calculator] can be selected and carried out in Boolean operations.



➤ The generation of logical results

◆ The logical Inspection results (OK=1; NG=0) are generated through result comparison after configuring [Limit] for each Inspection function. (shown in the following diagram)

◆ The logical Inspection results (OK=1; NG=0) are generated through result comparison after configuring [Detail Setup] for each Calculator. (shown in the following diagram)



➤ The final inspection result is usually generated through several logical (OK/NG) inspections results. Therefore, the logical OK(1)/NG(0) result from [Select Judge] + [Select Operator] > [Logic Operator] 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 and representation is explained using (Edge Position - X coordinate) JUG(□□□□,X,△△) as an example.

□□□□: Represents the nth inspection function For example: 1005 represents the 5th inspection function

[△△]: Represents using the nth sorting result as the output For example, 1005 detected 3 edge positions. If [△△] is configured to 2, the logical OK/NG result from the 2ndedge will be used as the calculated value.

X: Represents the logical (Judge) result of the X coordinate; please see the following table for the codes of each inspection function

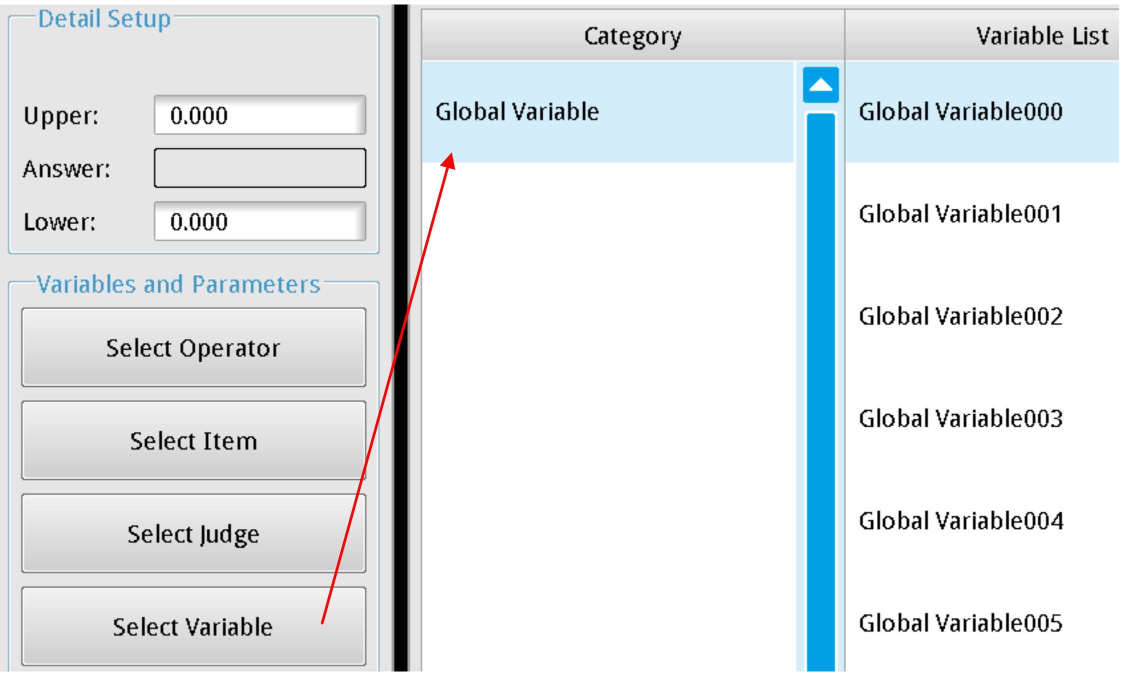
Inspection Function	Syntax	Description	Reference	Judge Data format
Area	TAR	Total area	--	JUG(□□□□,TAR,0)
Position	X	X coordinate	[△△]	JUG(□□□□,X,△△)
	Y	Y coordinate	[△△]	JUG(□□□□,Y,△△)
	AG	Absolute Angle (0° in the horizontal direction) of ring and arc	[△△]	JUG(□□□□,AG,△△)
Count	N	Number of edges	--	JUG(□□□□,N,0)
Width	W	Width (unit in pixels or degrees)	--	JUG(□□□□,W,0)
	X	X coordinates of first edge	--	JUG(□□□□,X,0)
	Y	Y coordinates of first edge	--	JUG(□□□□,Y,0)
	AG	Absolute Angle 1 of circle and arc	--	JUG(□□□□,AG,0)

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)
Angle	AG	Angle (0˚ in the horizontal direction)	--	JUG(□□□□,AG,0)
Intensity	IA	Average brightness	--	JUG(□□□□,IA,0)
	ID	Standard brightness deviation	--	JUG(□□□□,ID,0)
	IH	Max brightness	--	JUG(□□□□,IH,0)
	IL	Minimum Intensity	--	JUG(□□□□,IL,0)
Shape	N	Quantity	--	JUG(□□□□,N,0)
	X	X coordinates of found object	[△△]	JUG(□□□□,X,△△)
	Y	Y coordinates of found object	[△△]	JUG(□□□□,Y,△△)
	AG	Object angle found	[△△]	JUG(□□□□,AG,△△)
	S	Similarity	[△△]	JUG(□□□□,S,△△)
Pattern Comparison	N	Quantity	--	JUG(□□□□,N,0)
	X	X coordinates of found object	[△△]	JUG(□□□□,X,△△)
	Y	Y coordinates of found object	[△△]	JUG(□□□□,Y,△△)
	AG	Object angle found	[△△]	JUG(□□□□,AG,△△)
	S	Similarity	[△△]	JUG(□□□□,S,△△)
Spot	N	Quantity	--	JUG(□□□□,N,0)
	X	Center X coordinates	[△△]	JUG(□□□□,X,△△)
	Y	Center Y coordinates	[△△]	JUG(□□□□,Y,△△)
	AR	Blob Area	[△△]	JUG(□□□□,AR,△△)
	PE	Circumference	[△△]	JUG(□□□□,PE,△△)
Stain	N	Cluster	--	JUG(□□□□,N,0)
	TAR	Total defective area	--	JUG(□□□□,TAR,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 max outline	--	JUG(□□□□,XH,0)
	YH	Y coordinates of max outline	--	JUG(□□□□,YH,0)
	XL	X coordinates of min outline	--	JUG(□□□□,XL,0)
	YL	Y coordinates of min outline	--	JUG(□□□□,YL,0)
	RD	Roundness	--	JUG(□□□□,RD,0)
Width Trace	WH	Max Width	--	JUG(□□□□,WH,0)
	WL	Min Width	--	JUG(□□□□,WL,0)

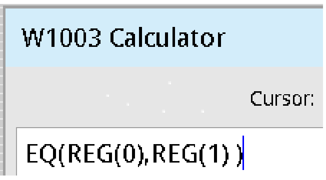
	WA	Average Width	--	JUG(□□□□,WA,0)
	RD1	Roundness 1 (inner)	--	JUG(□□□□,RD1,0)
	RD2	Roundness 2 (outer)	--	JUG(□□□□,RD2,0)

◎ **The [Select Variable] Unit**

➤ The system provides 32 internal variable registers, from REG(0) to REG(31). The registers adopt global variables, which are shared in all projects in the system.



➤ The user can also write/read temporary variable values 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.



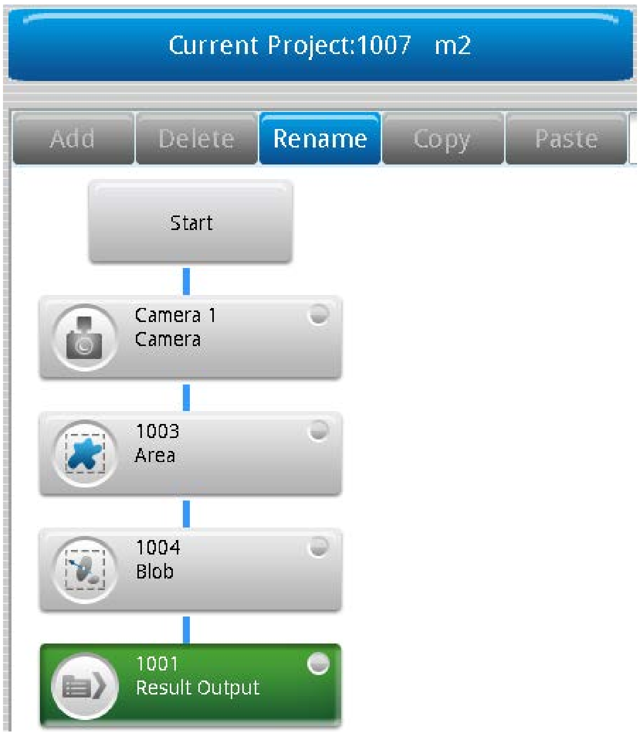
6.3 What is Output?

The content of each inspection result (including each numerical and logical result from inspection, calculator, and judge) to output to upper PC or PLC can be configured through [Result Output]. The system provides various interfaces, such as [External I/O Terminal], [RS232], [RS485], [Ethernet], and [SD Card]. The user can choose according to the varying interfaces of the upper controller.

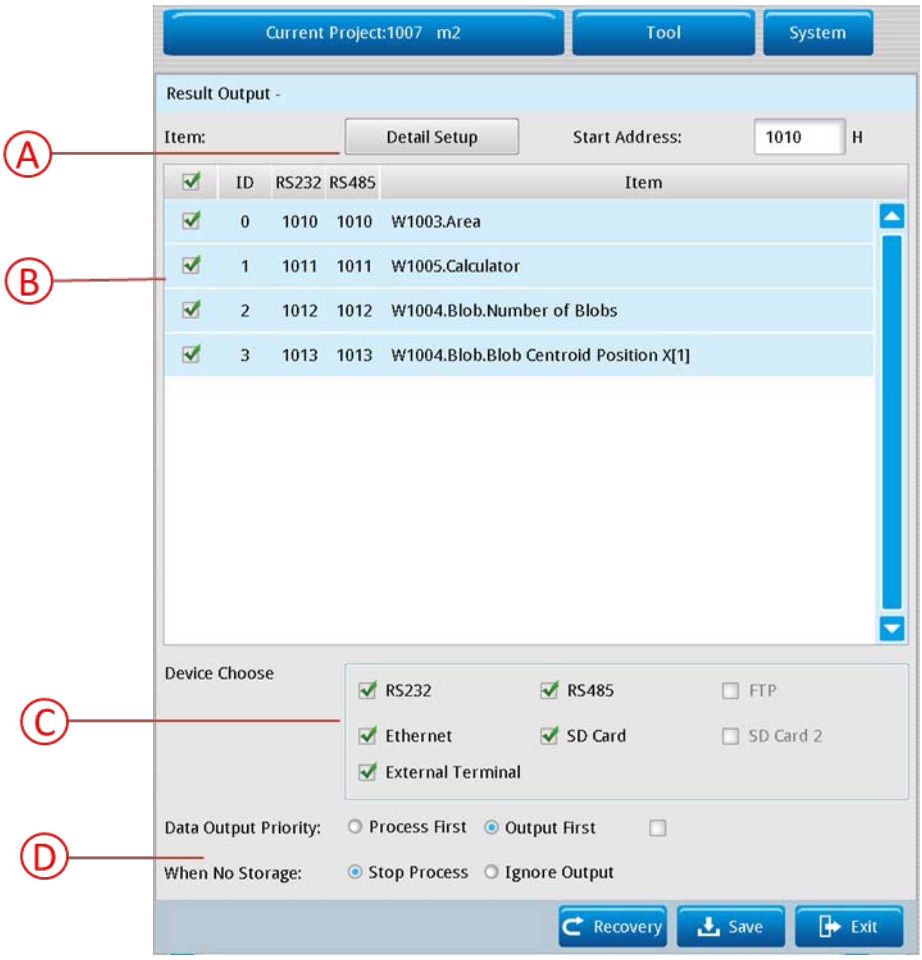
The output interface and data can be independently selected. For example, when RS232 to PLC and Ethernet to PC are enabled at the same time, three data sets will be output for RS232 and ten data sets will be output for Ethernet; as such, the system will initiate data output for these two interfaces simultaneously after the inspection is complete.

6.3.1 Result Output Configurations

During the inspection process, click on the [Result Output] icon to enter the output function edit screen.



The following diagram shows an opened calculator edit screen. The function in each region is explained as follows.



A. Detail Setup

Click on [Detail Setup] to enter the option menu and select the data content for output.

B. Output Item Display Area

Displays the data currently selected for output

C. Device Choose

Select the hardware interface to output the contents configured in the aforementioned [Output Item Display Area]

Multiple output devices can be selected for simultaneous and independent operation.

The external terminal uses I/O pins, which outputs data using a register consisting of OUT1~OUT16.

D. Other Relevant Configurations

1) Data Output Priority

[Process First]: When inspection is complete but before data is fully transmitted, the system activates inspection and simultaneously completes transmitting the remaining data when TRIG triggers inspection signal input.

[Output First]: When inspection is complete but before data is fully transmitted, the system ignores the trigger command and completes transmitting the remaining data when TRIG triggers inspection signal input.

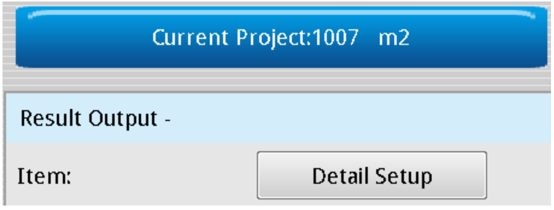
2) When No Storage

[Stop Process]: When data are being output to the Micro SD memory card and the memory card happens to be out of memory, all subsequent trigger inspection will be stopped.

[Ignore Output]: When data are being output to the Micro SD memory card and the memory card happens to be out of memory, the system stops saving data into the memory card but inspections may still proceed.

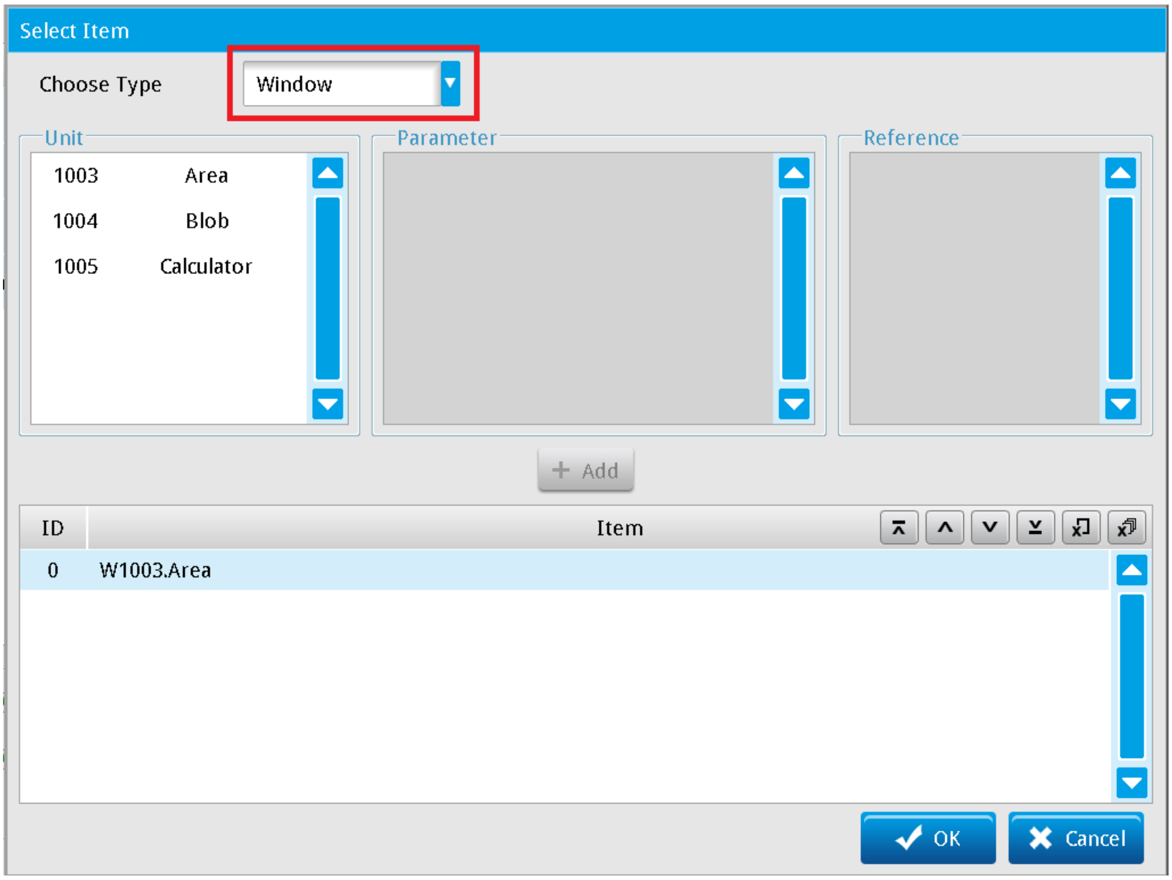
◎ **Detail Setup**

Click [Detail Setting] shown in the following diagram and the system will open the following dialog box.



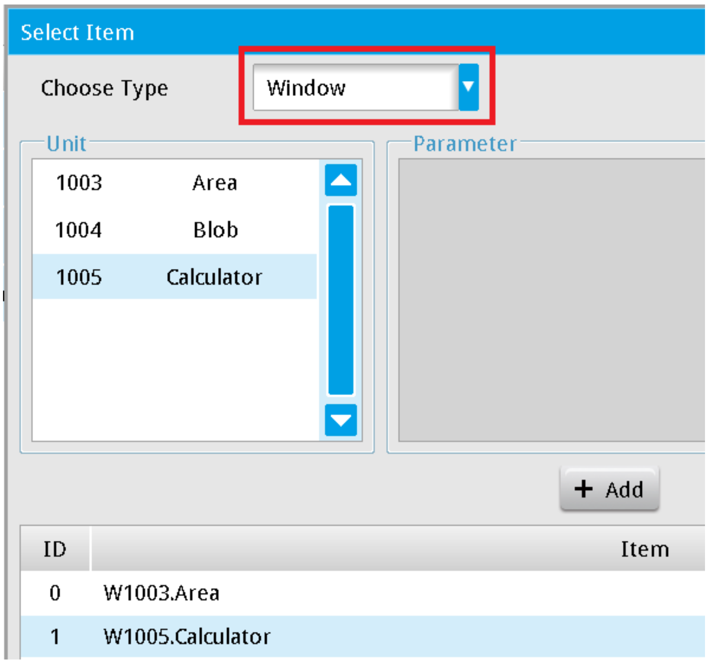
- When [Window] is selected in [Choose Type], the output is the logical (OK=1/NG=0) result of the [Inspection]. The logical OK/NG (Judge) result is generated according to the [Limit] configured for the inspection.

  Next, choose the [Add] button to add an output result in the items.



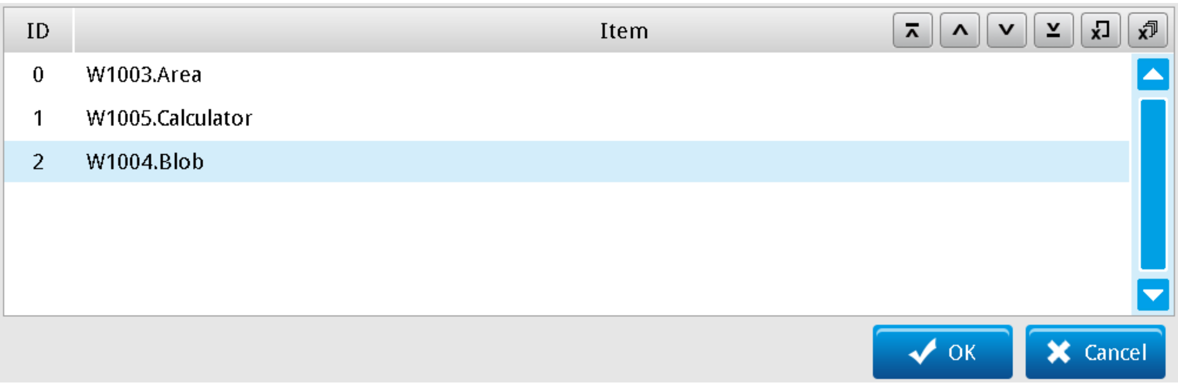
OK/NG (Judge) results can be generated in not only Inspection but also Calculator after configuring [Upper/Lower].

As shown in the following diagram, when [Window] is selected in Choose Type, select Calculator and then Add to output the calculator's OK/NG results.

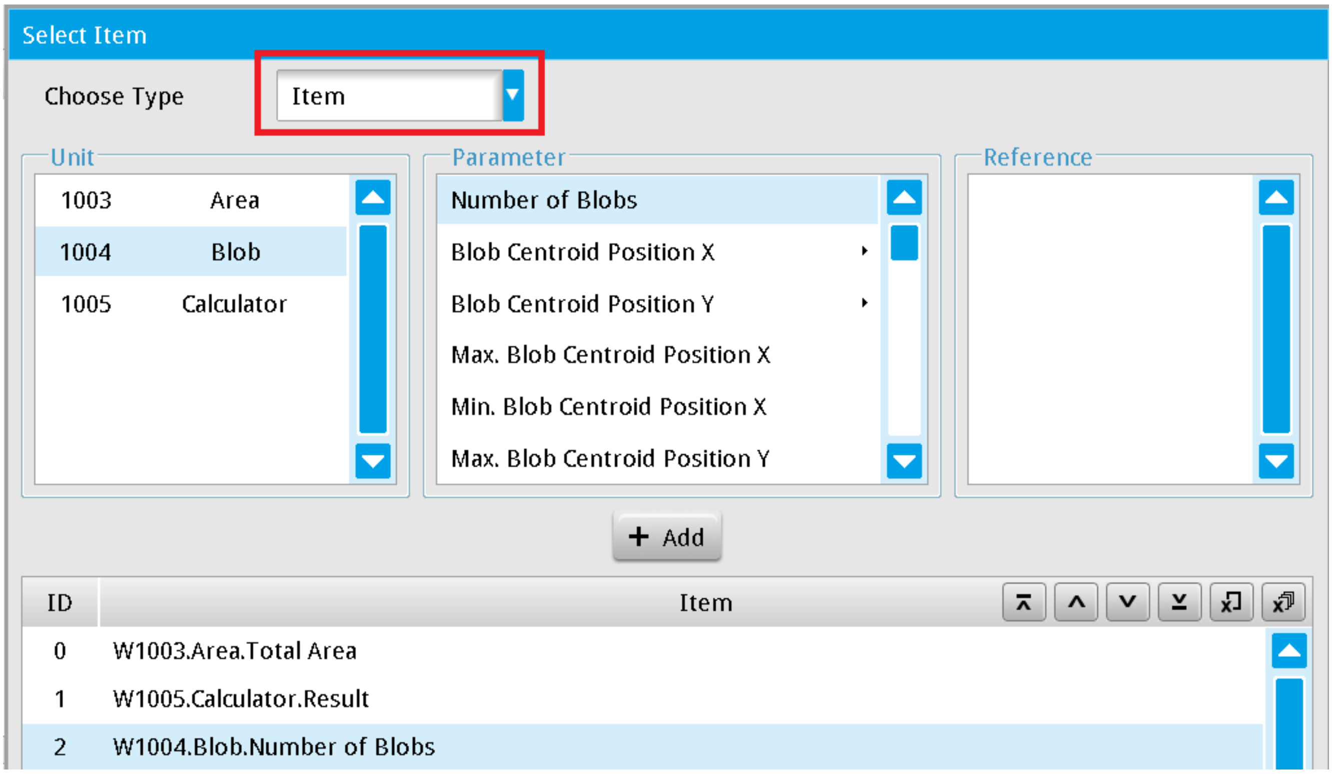


The order of result output is based on the top-to-bottom arrangement in this item. Therefore, the upper right corner of the item provides an adjustment tool for editing the output items.

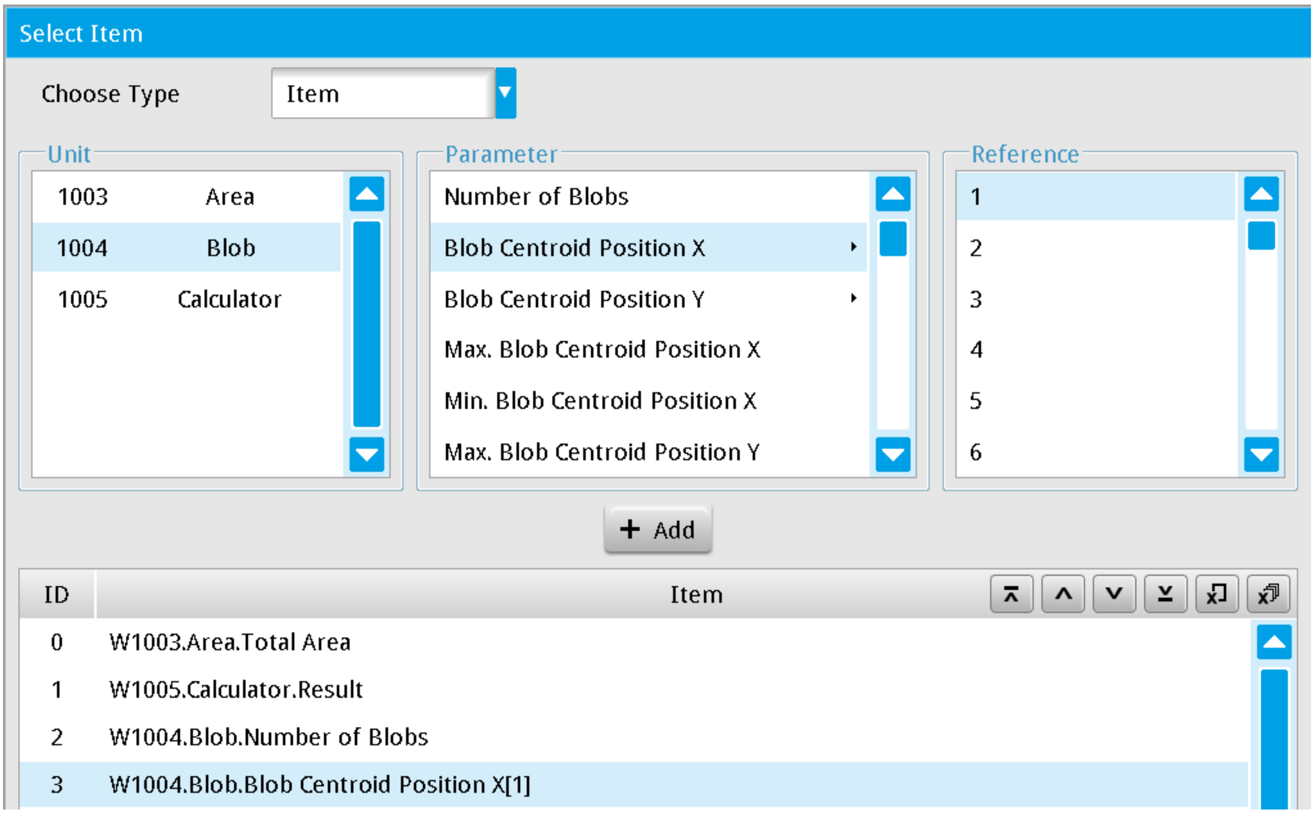
Move to top Move up one level Move down one level Move to bottom Delete output Delete all output



- When [Item] is selected in [Choose Type], the output result is the numerical result of the [Inspection]. After selecting [Add] (as shown in the following diagram), a blob count inspection is added to the result items.



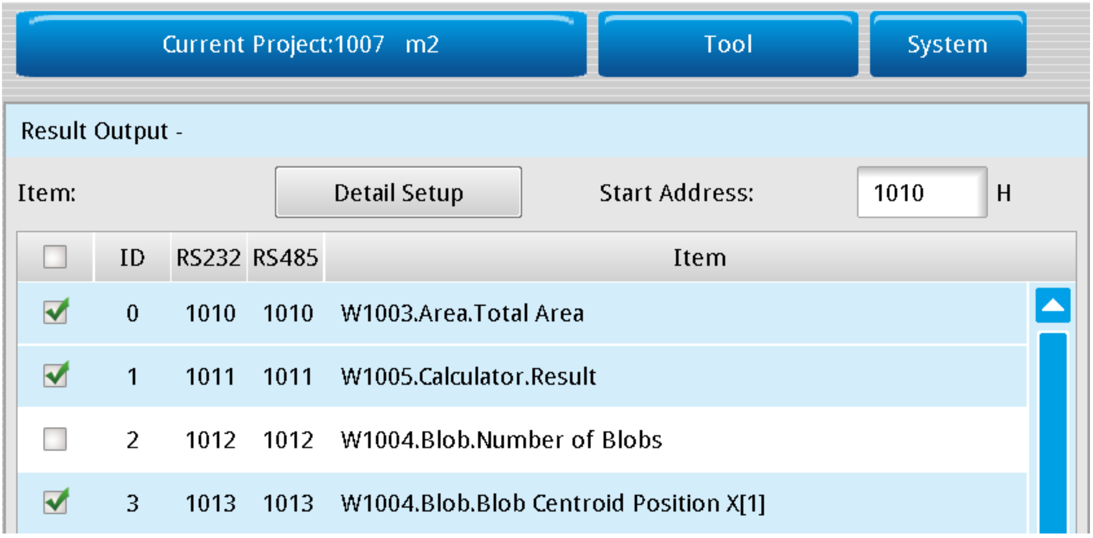
As shown in the following diagram, [Blob Centroid Position X] consists of several inspection results. Therefore, the order must be selected in [Reference].



- After creating output items in [Output Item Display Area], the options on the left side  can be edited to determine whether to close the item.

  When checked: Outputs the result of the item.

  When unchecked: The result of the item is skipped in the output.

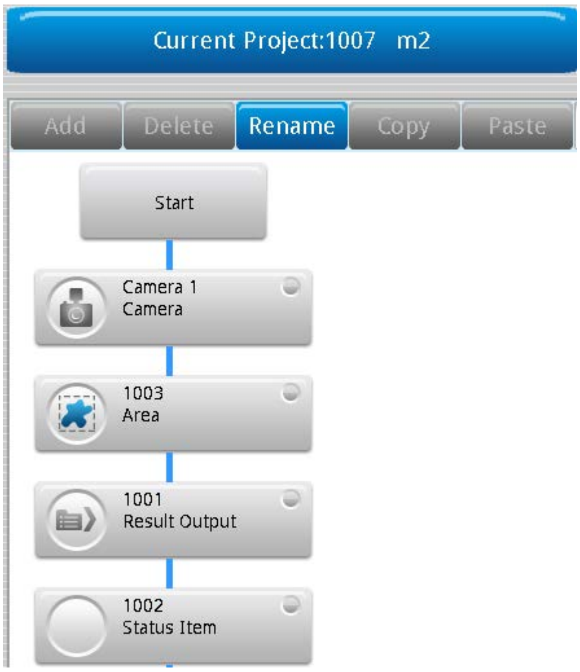


6.4 What is Status Item

To facilitate on-site operators observe the logical (OK/NG) and numerical inspection results, status light is provided on the RUN mode screen to enable the user to choose the specific data to display in the status table.

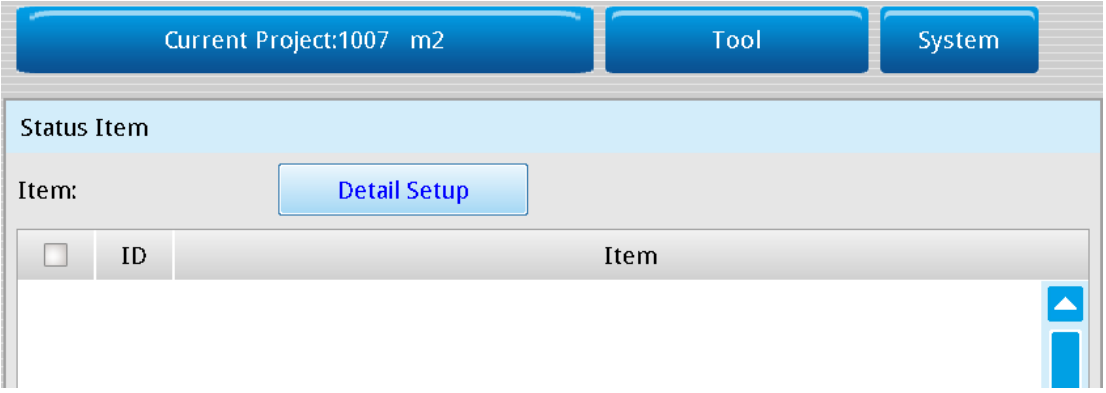
6.4.1 Status Item Configurations

During the inspection process, click on the [Status Item] icon to enter the status item edit screen.



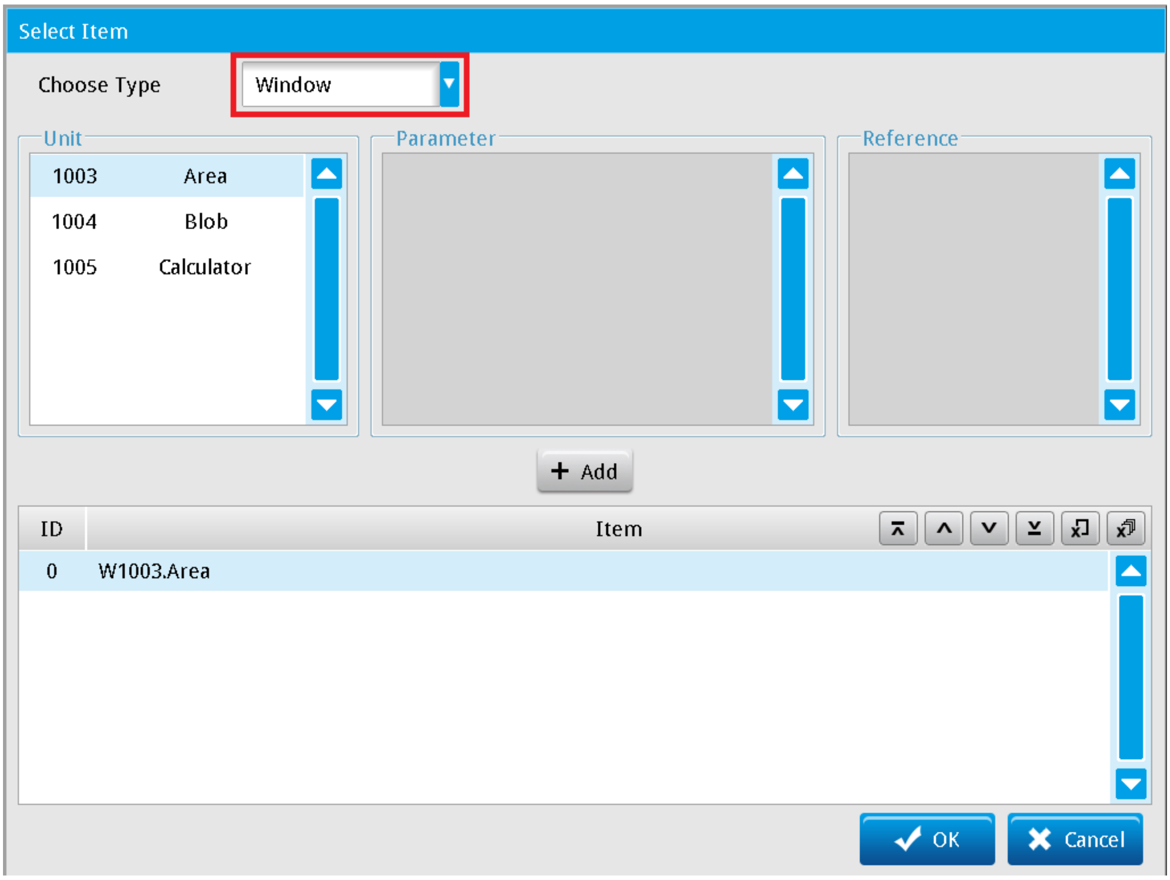
◎ **Detail Setup**

Click [Detail setting] shown in the following diagram and the system will open the following dialog box.



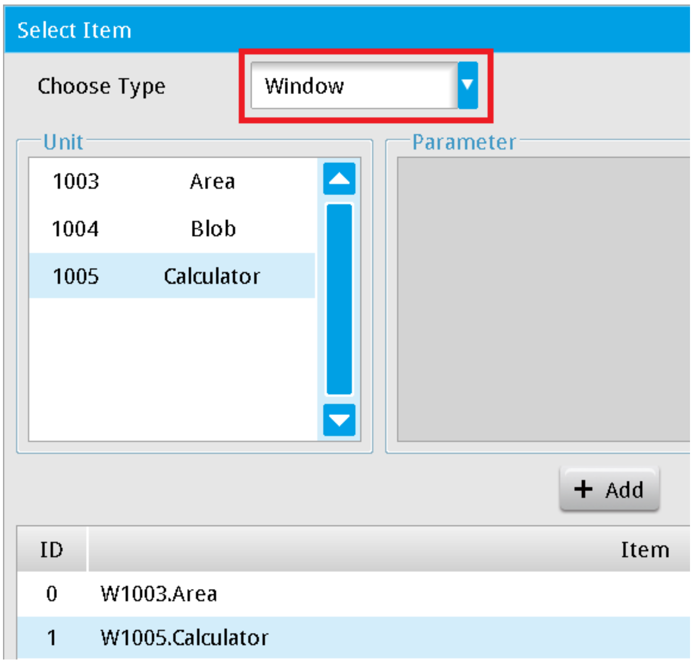
- When [Window] is selected in [Choose Type], the output is the logical (OK=1/NG=0) result of the [Inspection]. The logical OK/NG (Judge) result is generated according to the [Limit] configured for the inspection.

  Next, choose the [Add] button to add an output result in the items.

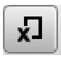


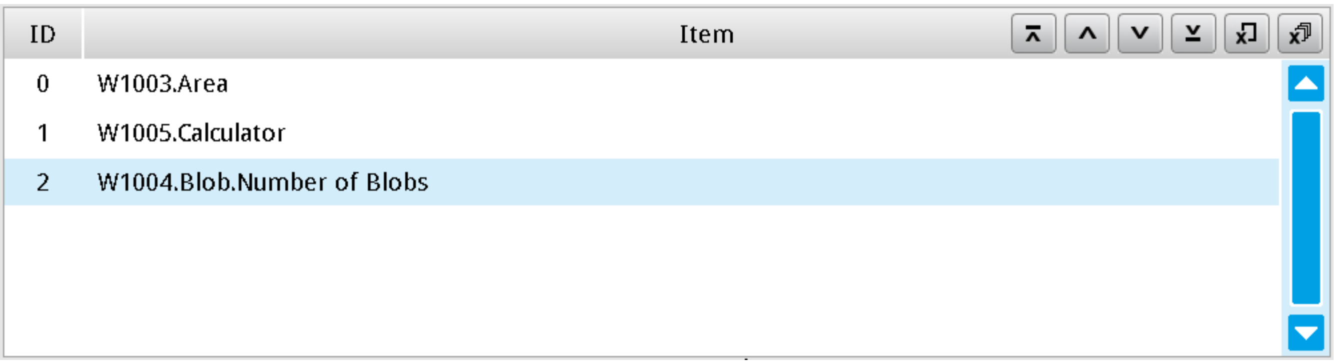
OK/NG (Judge) results can be generated in not only Inspection but also Calculator after configuring [Upper/Lower].

As shown in the following diagram, when [Window] is selected in Choose Type, select Calculator and then Add to output the calculator's OK/NG results.

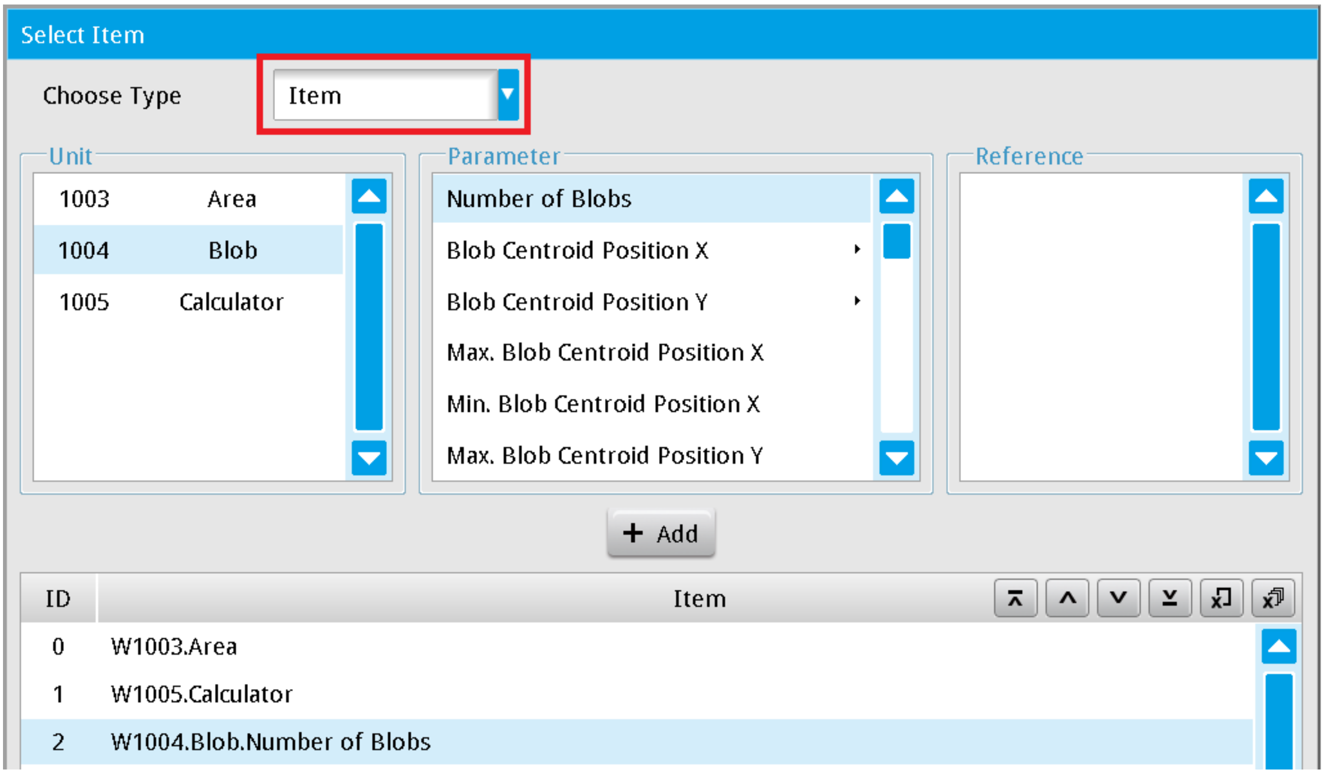


This is because the order of result output is based on the top-to-bottom arrangement in this item. Therefore, the upper right corner of the item provides an adjustment tool for editing the output items.

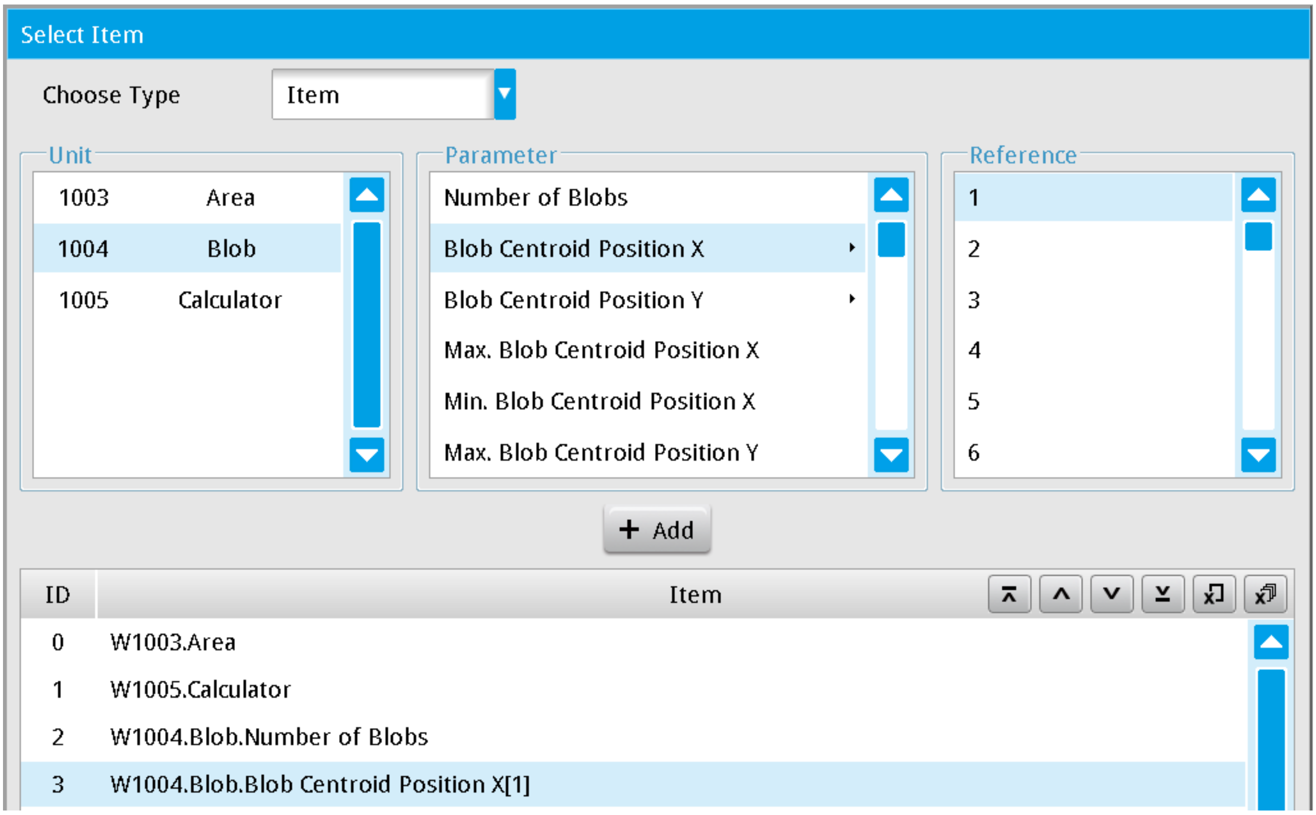
Move to top Move up one level Move down one level Move to bottom Delete output Delete all output



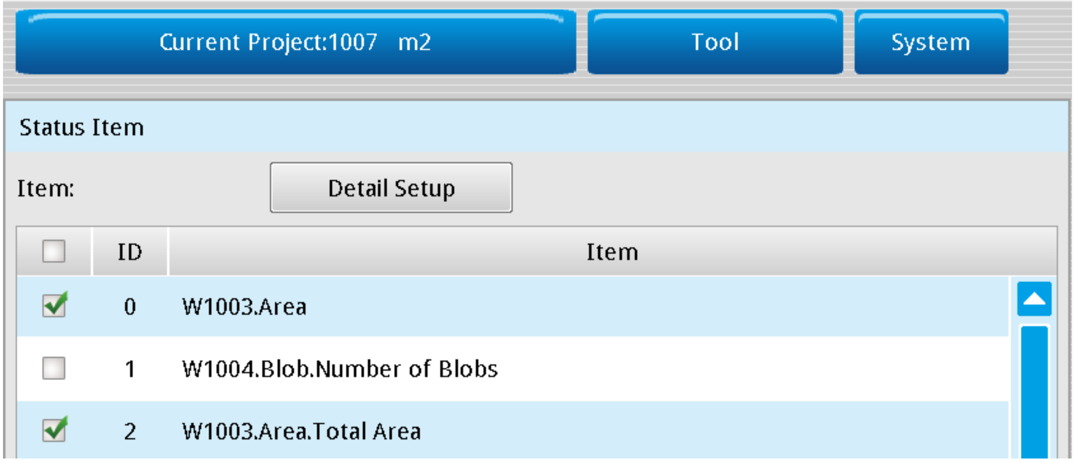
➢ When [Item] is selected in [Choose Type], the output result is the numerical result of the [Inspection]. After selecting [Add] (as shown in the following diagram), a blob count inspection is added to the result items.



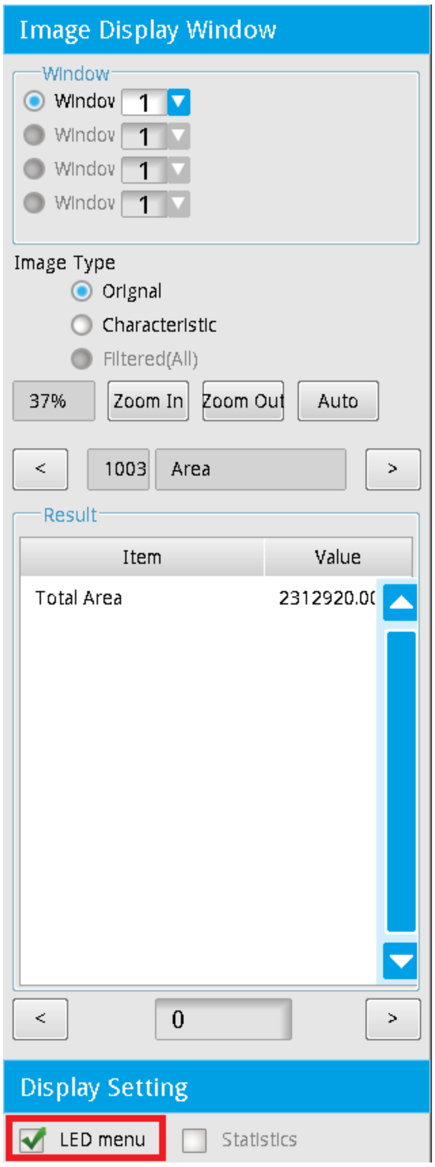
As shown in the following diagram, [Blob Centroid Position X] consists of several inspection results. Therefore, the order must be selected in [Reference].

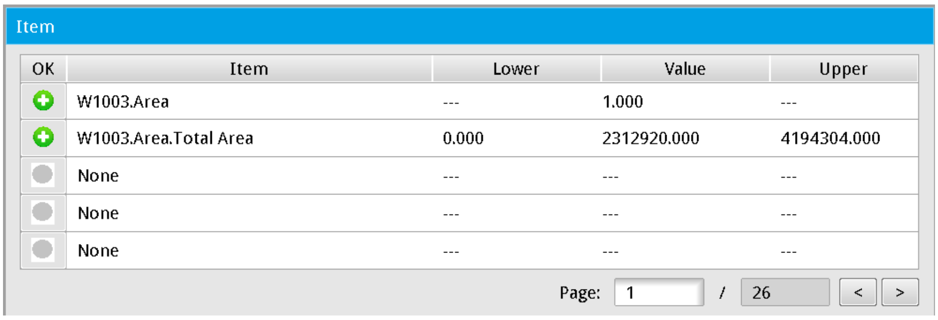


- After creating status light display item in [Status Light Item Display Area], the options on the left side  can be edited to determine whether to close the item.
  When checked: Light signal is displayed for the item.
  When unchecked: Light signal is skipped for the item.



After completing the aforementioned configurations and switched to RUN mode, [Image Display Window] will appear on the left side of the screen. Check [LED menu] at the bottom (as shown in the lower left diagram) and the LED data table will open and display the user defined result items. (as shown in the lower right diagram)





Chapter 7

Input and Output I/O Terminal

I/O interface provides the main communication method between the DMV and the upper controller and features the following functions.

◎ **Current system state indicator**
For example: Ready, Run, Error…

◎ **Camera imaging trigger capture**
This trigger action can also be issued through the RS232 or Ethernet ports, however the I/O channel is more responsive than the communication channels.

◎ **Flash output**
The system parameters control the flash output with the camera shutter action. (must use with the light controller)

◎ **Project switching**
Multiple I/O signals to switch projects. This trigger action can also be issued through the RS232 or Ethernet ports.

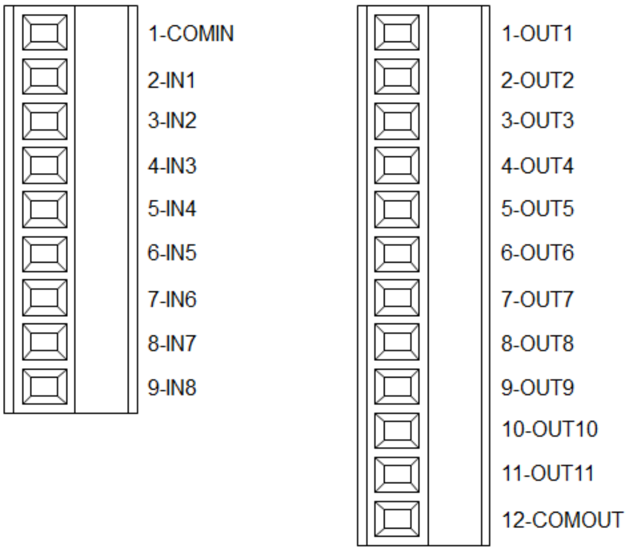
◎ **Output results**

After each inspection, the logical OK(1) / NG(0) and numerical results can be transmitted 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**

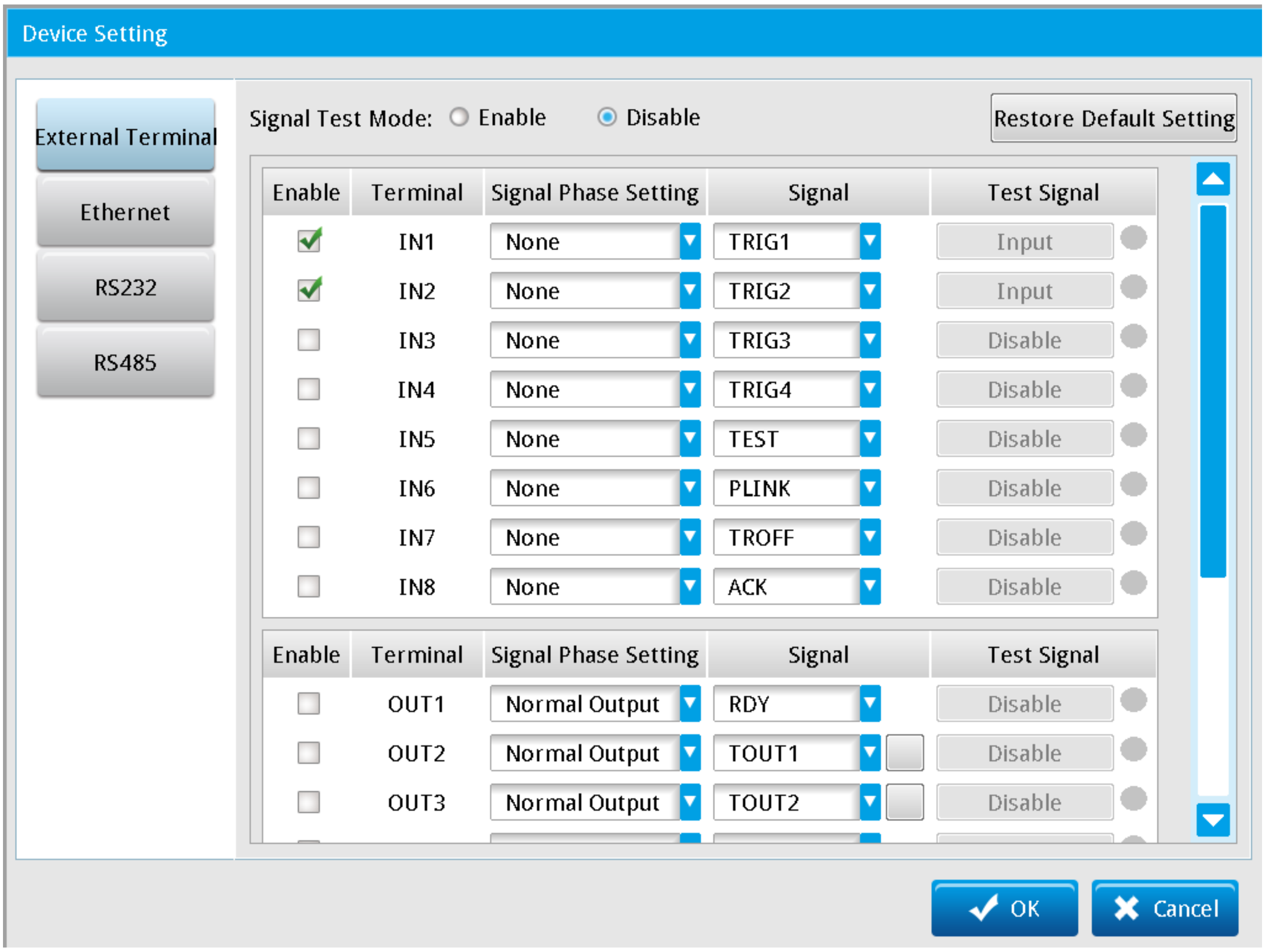
8-point input and 11-point output removable I/O terminals are provided on the left side of the system. (shown in the following diagram)



7.1 Definition of I/O Functions

According to varying model numbers, DMV2000 can support up to 8 cameras and execute 8 parallel processes. Therefore, 8 TRIG signals are also provided.

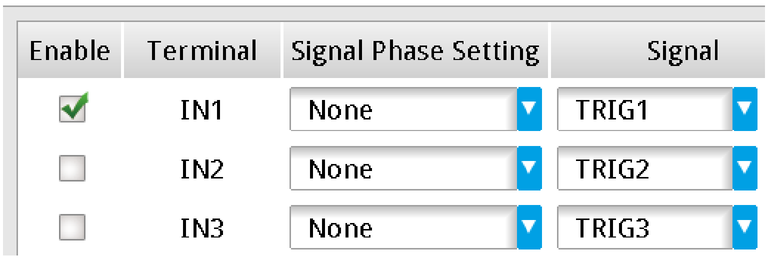
The function of each I/O point can be defined by the user. During operation, select [System] > [Communication Settings] > [External Communication Device Setting] > [External Terminal] to view the I/O configuration table.



Reference The definition of functions for each I/O terminal is explained in Section 2.1.3.

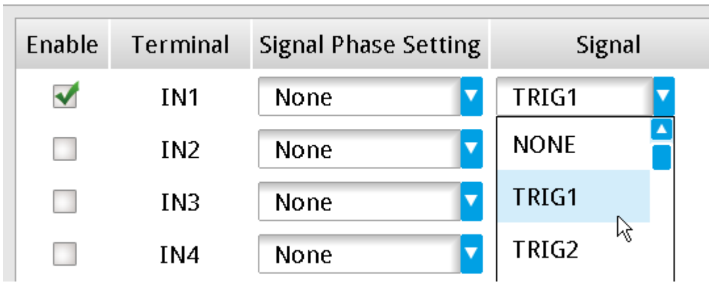
◎ **Enable Input Terminal**

Check the terminal to enable



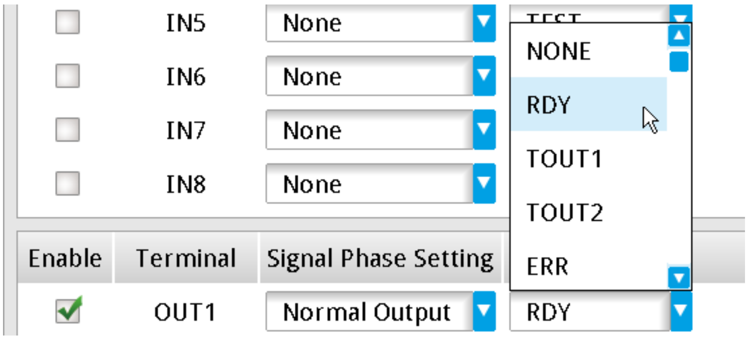
◎ **Change Input Function**

Select in the [Signal] pull-down menu



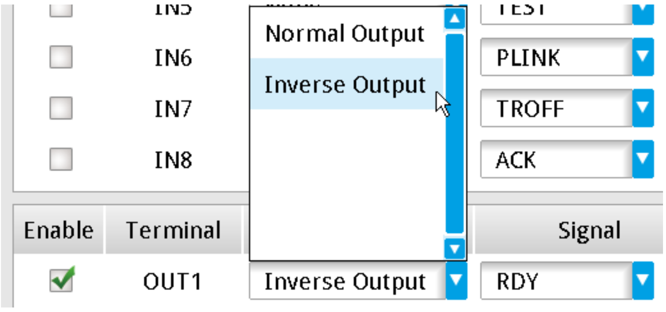
◎ **Enable Output Terminal and Change Output Function**

Check the terminal to enable in the [Signal] pull-down menu



◎ **Inverse Output**

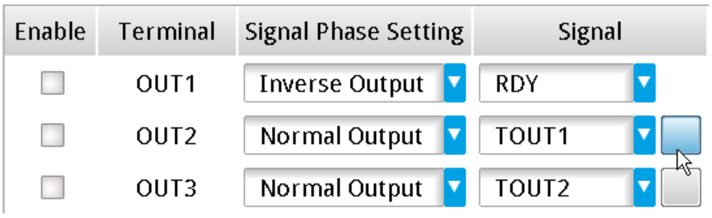
NC (normally closed) and NO (normally open) options are provided for output signals. Output signal is NO when [Inverse Output] is selected (contact remains on when output is not active).

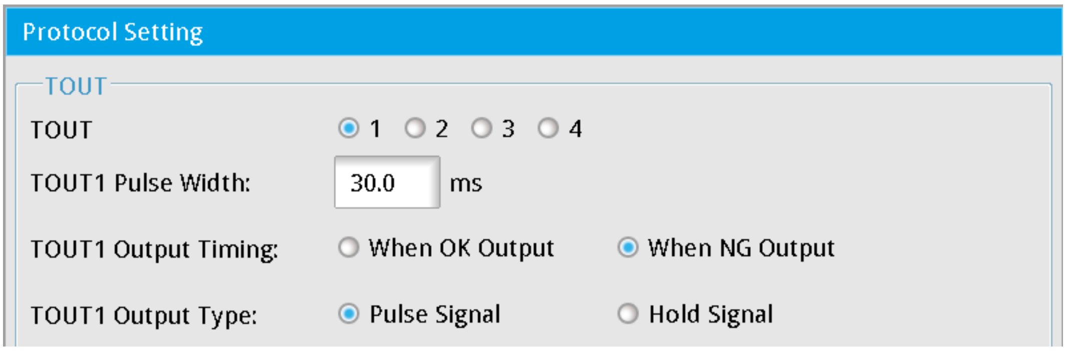


◎ Advanced Settings for TOUT1 and TOUT2

The system simultaneously provides two independent output signals (TOUT1 and TOUT2) to be flexibly configured by the user.

TOUT1 and TOUT2 are used for total result output according to varying upper controller requirements. Therefore, various output methods are provided for configuration and adjustments. Please click the button on the right before making configurations.





➤ TOUT1 Pulse Width

Configure the output pulse width when [Pulse Signal] is selected in [Output Type]

➤ TOUT1 Output Timing

Configure whether to output when total result is OK or NG

➤ TOUT1 Output Type

When [Pulse Signal] is selected, the aforementioned [TOUT1 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.

➤ TOUT2 is configured similarly as TOUT1

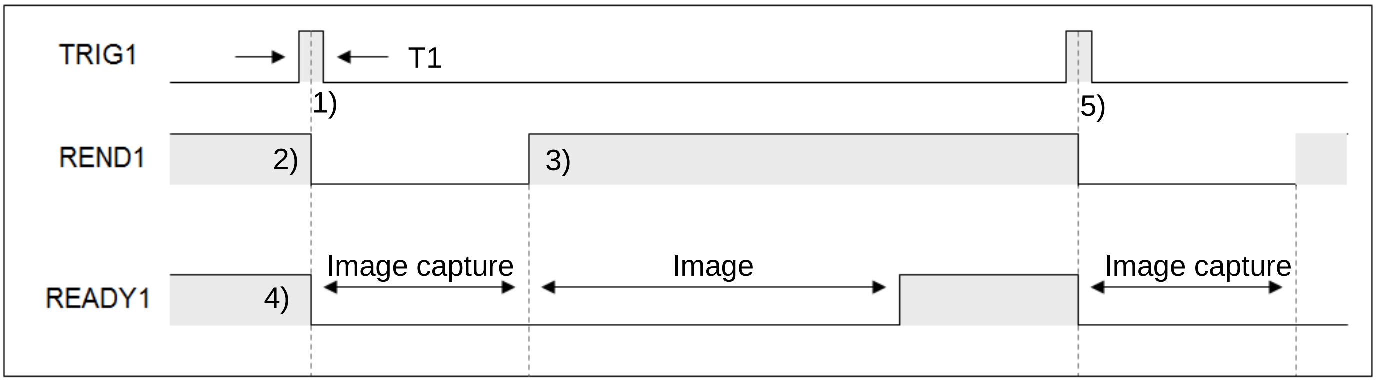
7.2 I/O Activation Timing

7.2.1 TRIG (Trigger) Capture

- The system can support up to 8 cameras. Therefore, 8 TRIG trigger signals (TRIG1~TRIG8) are also provided.
- Each camera can independently be paired with 1 TRIG trigger signal: For example, pair Camera1 with TRIG1, Camera2 with TRIG2...
- Multiple cameras can also share an identical TRIG trigger signal: For example, Camera1 and Camera2 can both share TRIG1.

◎ **Use Single Flow Process**

1 camera coupled with 1 TRIG trigger signal



Description:

1) Trigger period T1 must be longer than 1ms. (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 completes an inspection cycle and the system is ready for the next trigger signal.

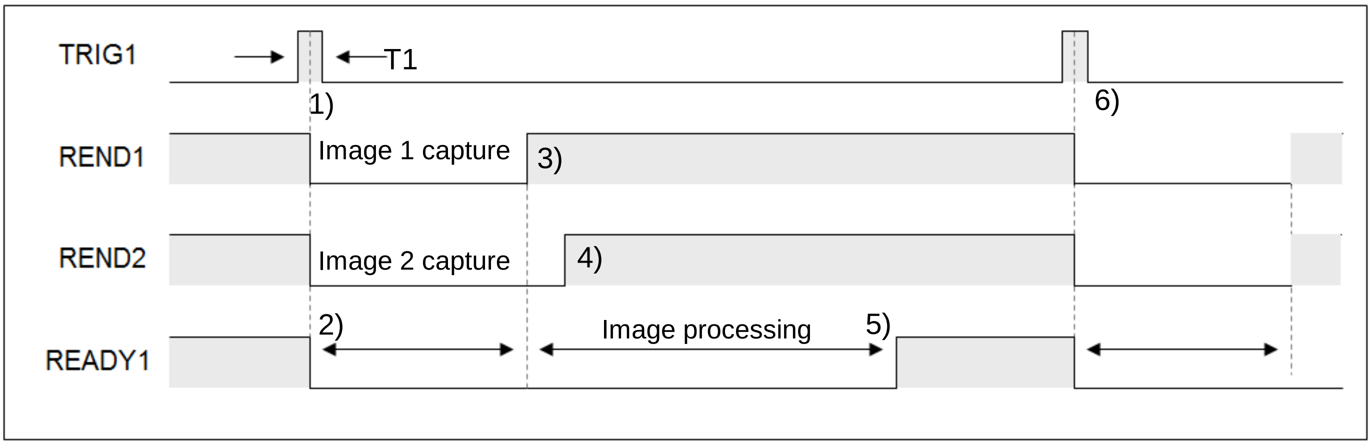
Please use the READY1 signal as the logical (Judge) condition for the TRIG1 trigger timing.

Total period = image capture time + image processing time

◎ **Use Single Flow Process**

2 cameras coupled with 1 TRIG trigger signal: Camera1 and Camera2 are both configured coupled with TRIG1 trigger.

➤ TRIG1 initiates the system to automatically capture Image1 and Image2.



Description:

1) Trigger period T1 must be longer than 1ms. (if T1 is too short, the trigger may not respond)
2) After Trigger1 is initiated, READY1 and camera REND1 and REND2 switche 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 completes an inspection cycle and the system is ready for the next trigger signal.

Please use the READY1 signal as the logical (Judge) condition for the TRIG1 trigger timing.

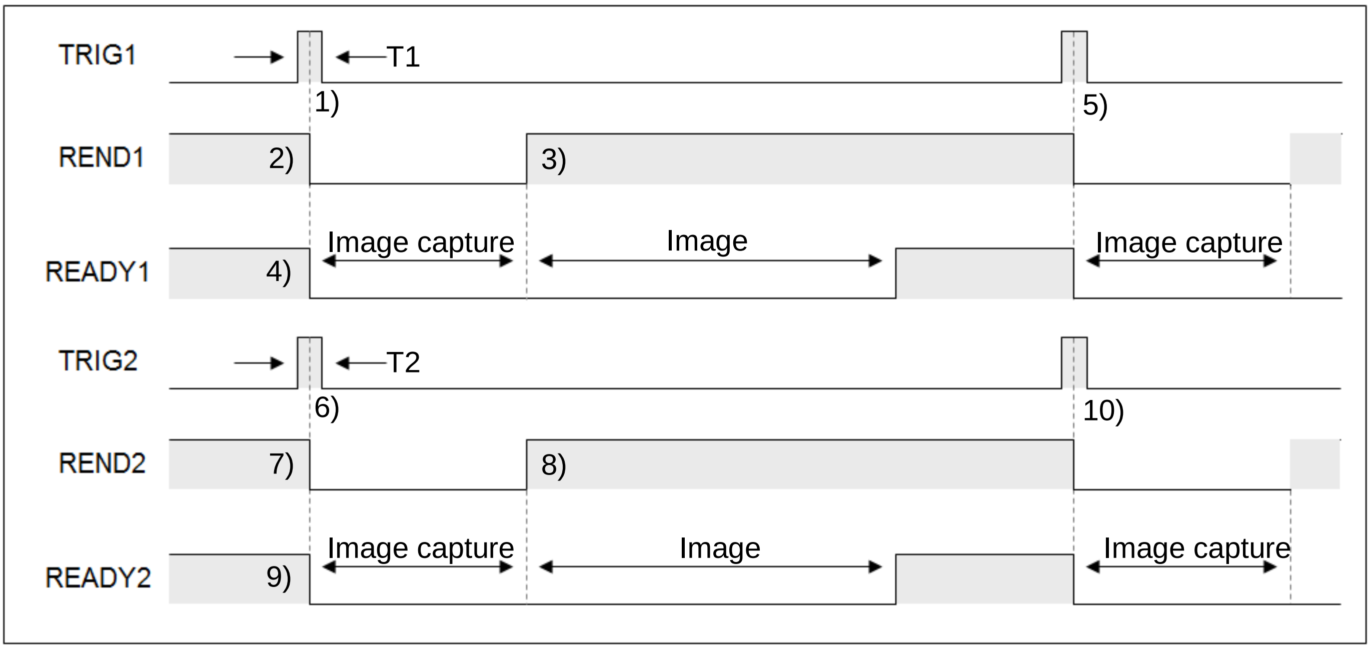
Total cycle time = (Image1 capture time + Image2 capture time) + image processing time

◎ **Multiplexing Flow Process (Asynchronous Flow)**

2 cameras coupled with 2 TRIG trigger signal

- Camera1 is coupled with TRIG1, Camera2 is coupled with TRIG2, and the trigger order of TRIG1 and TRIG2 are unrestricted.

Each flow process generates independent outputs, instantly after completing each trigger inspection. The outputs are irrelevant to TRIG signals of other flow processes.



Description:

1) Trigger period T1 must be longer than 1ms. (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 completes an inspection cycle and the system is ready for the next trigger signal.
6) Trigger period T2 must be longer than 1 ms. (if T1 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 completes an inspection cycle and the system is ready for the next trigger signal.

Please use the READY signal as the logical (Judge) condition for TRIG trigger timing.

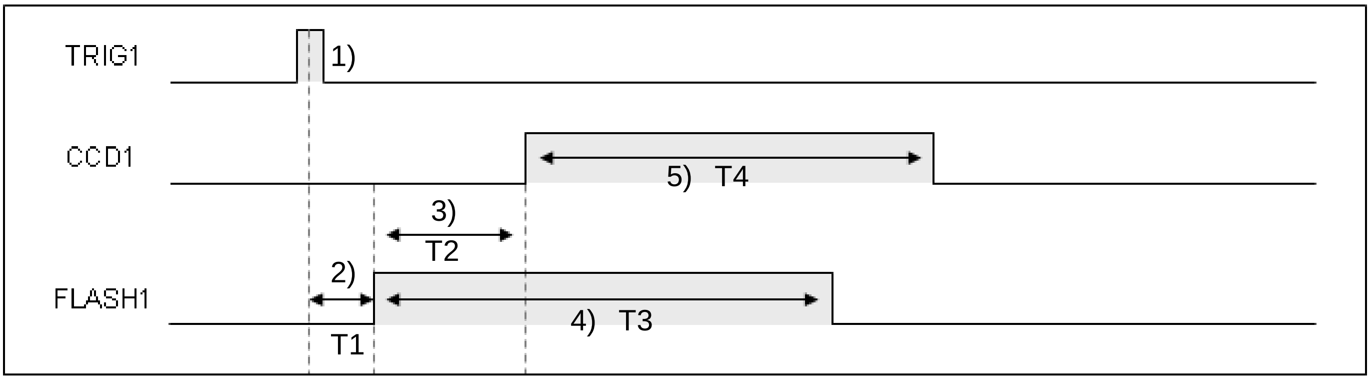
Total period = image capture time + image processing time

7.2.2 Flash Timing

Proper timing of the light source is crucial to the quality of the image taken. Therefore, 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 the 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 1 ms (reaction times vary according to differing dimmers)

T2: Configured in [Output Start Time] (Unit: 0.1 ms)

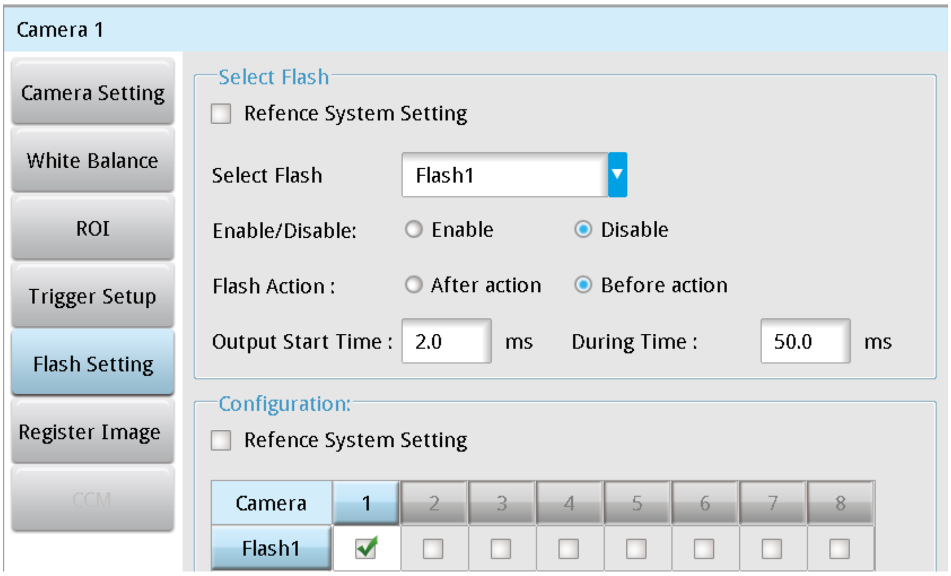
T3: Configured in [During Time] (Unit: 0.1 ms)

T4: Configured in [Shutter Time] of the camera

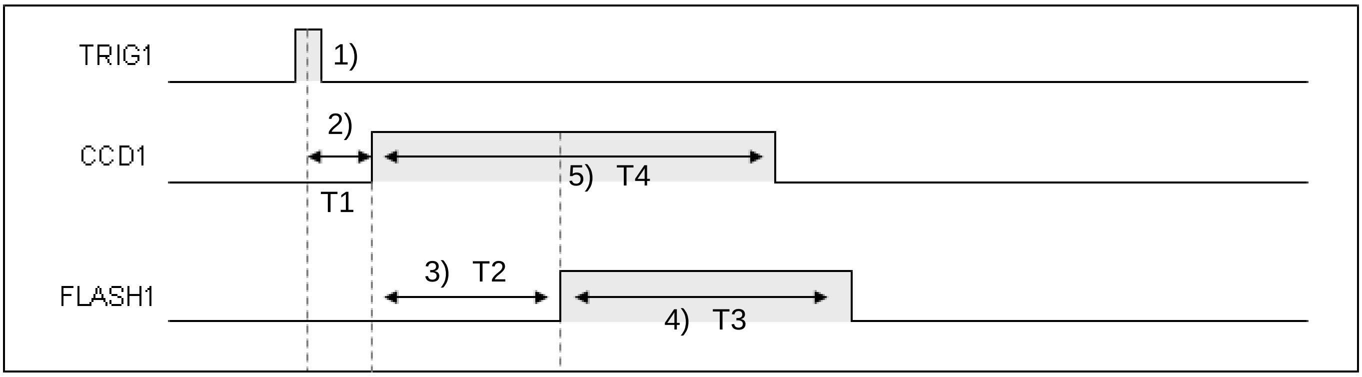
Description:

1) When TRIG is triggered, timed flash output is enabled.
2) Due to processing delays of the dimmer, 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 CCD1 (2) signal is controlled internally in the system unlike typical external terminals. Therefore, external pins are not provided.



- The output of flash activation signal occurs after the activation of camera shutter.



T1: Delay by approximately 1 ms

T2: Configured in [Output Start Time] (Unit: µs)

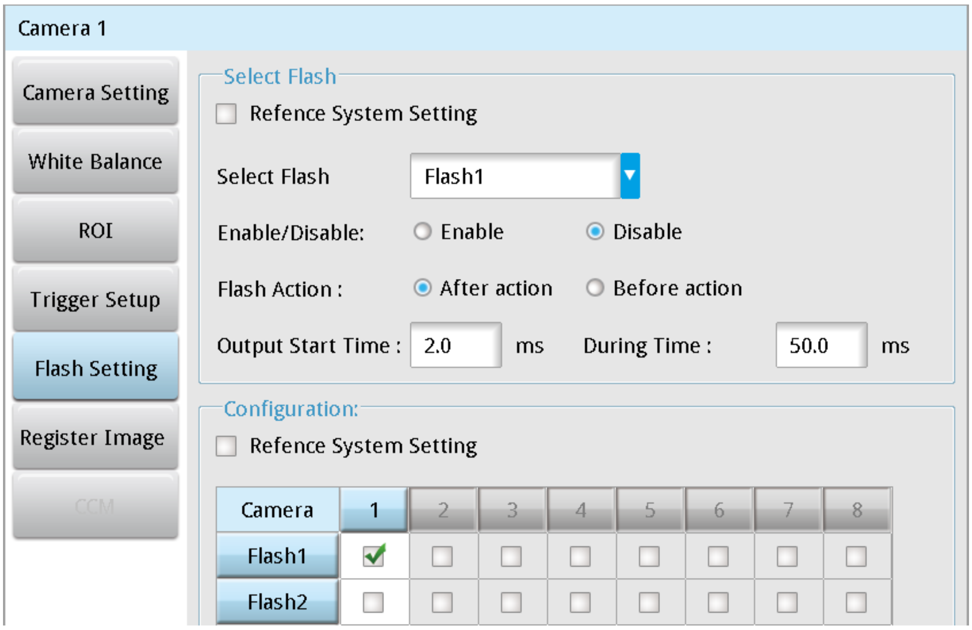
T3: Configured in [During Time] (Unit: 100 µs)

T4: Configured in [Shutter Time] of the camera

Description:

1) When TRIG is triggered, timed flash output is enabled.
2) Due to processing delays of the dimmer, the flash output is delayed by approximately 1 ms.
3) The flash output occurs after the camera shutter. Therefore, the flash output activation is delayed.
4) Total time of flash output
5) Shutter duration of the camera.

If the flash duration time is greater than (shutter duration + frame refresh time + internal processing time), the flash will always remain ON.



7.2.3 External Terminal Result Output

The DMV system supports parallel I/O, RS232, USB, Ethernet, PLC Link, and SD card output methods. The communication interface may consist of a combination of different channels based on the controller hardware or speed requirement.

- Parallel I/O Output: (Output Delay)

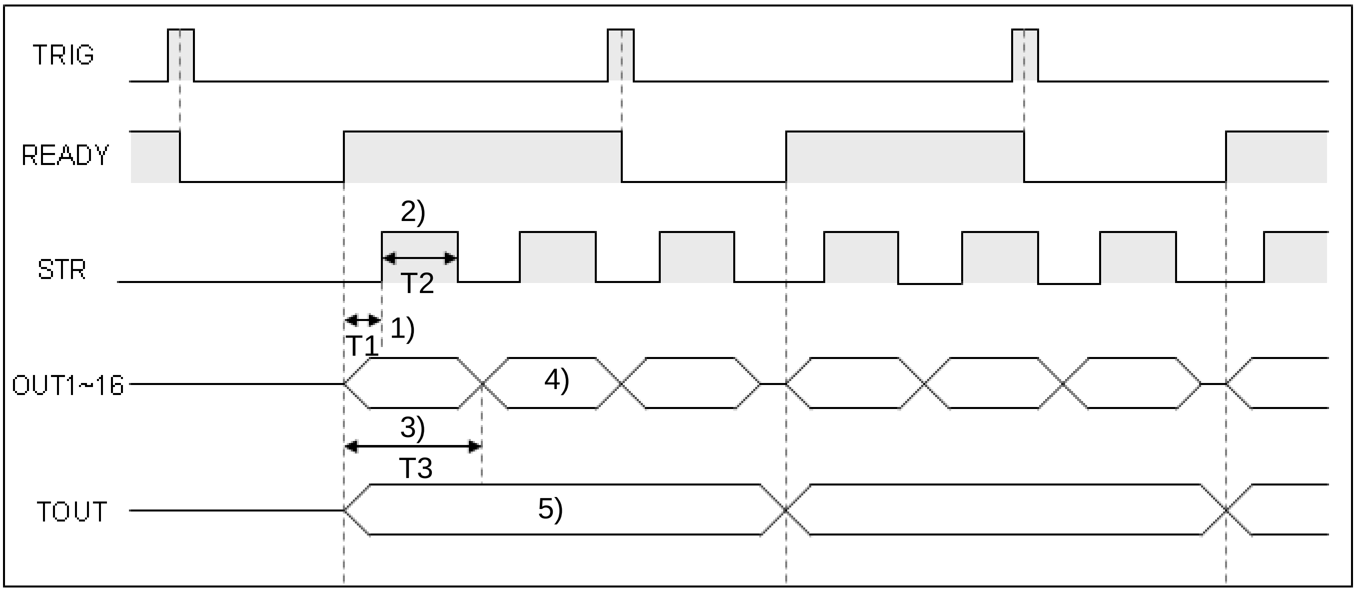
When using external I/O terminal for output, the system provides configurations for [Data Output Delay Time].

Refer to the diagram below: If configured to 10 ms, the system delays 10 ms before activating the external terminal for I/O output after completing the inspection.

- Parallel I/O Output: (No Handshake)

Only applicable in [Single Process] projects when transmitting resulting values using the I/O

In addition to the total output (TOUT), there are 16 output points for status indicator or numerical output.



T1: Configure in [STR Start Delay] (Unit: ms)

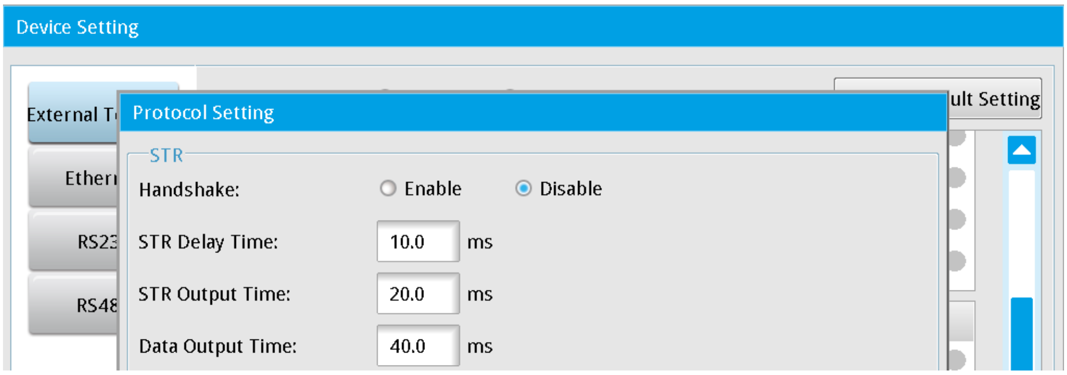
T2: Configure in [STR Output Time] (Unit: ms)

T3: Configure in [Data Output Time] (Unit: ms)

Description:

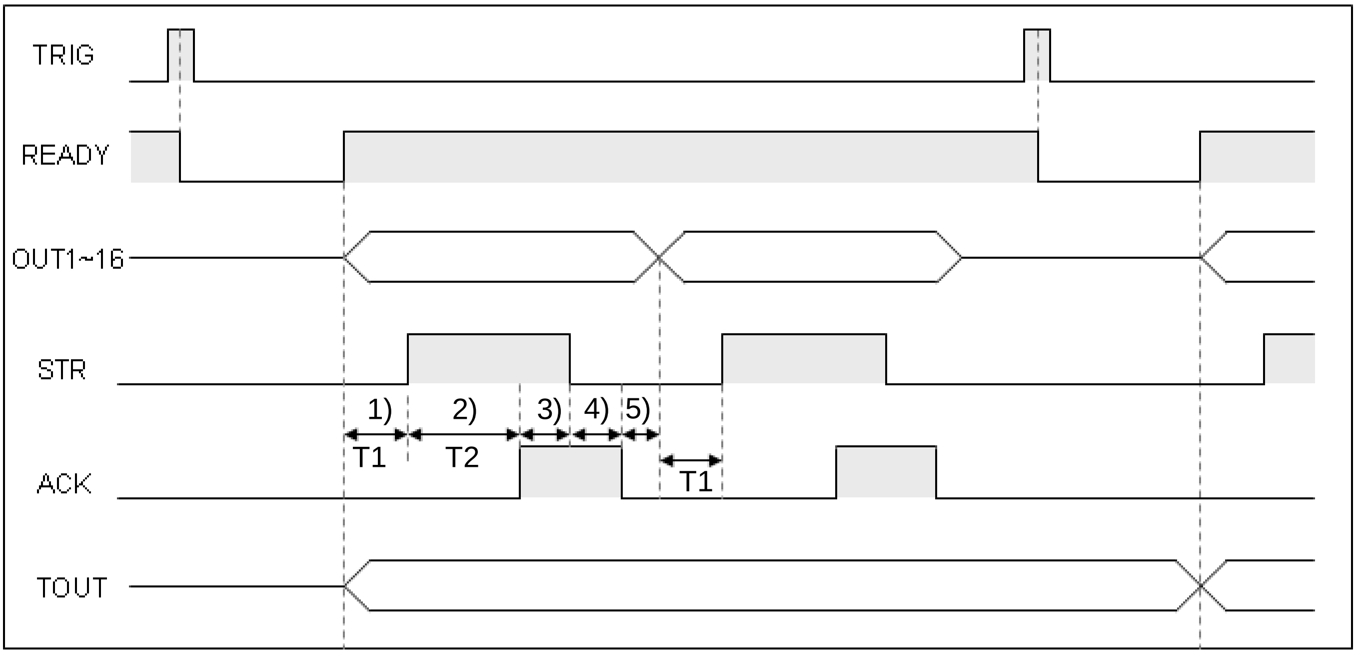
1) When READY is ON, delay count begins for STR; STR is outputted after the delay count is reached.
   When the READY signal is ON, delay count begins for STR; STRoutputs when the delay counter is reached.
2) The STR output cycle can be configured. Status in which the upper controller can stably read is recommended as a reference for configurations.
3) OUT1~16 output cycle configurations must satisfy the requirement of ([Data Output Time]≧[STR Start Delay] + [STR Output Time]).

Make selection in [System] > [Communication Setting] > [External Signal Device Setting] > [STR Output Function]



➤ Parallel I/O Output: (Handshake Control)

Only applicable in [Single Process] projects when transmitting resulting values using the I/O



T1: Configure in [STR Start Delay] (Unit: ms)

T2: Configure in [Communication Timeout] (Unit: ms)

Description:

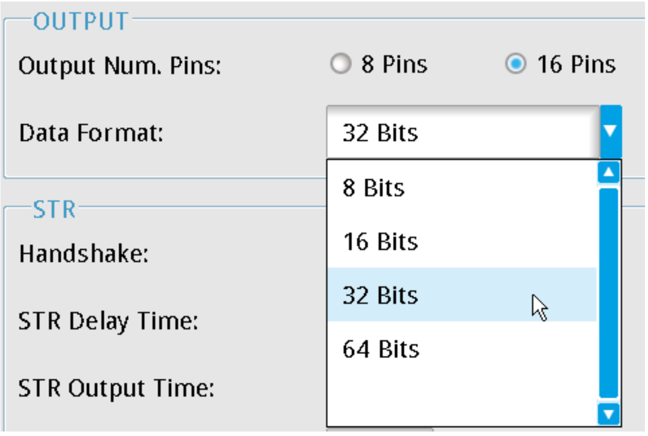
1) When READY is ON, delay count begins for STR; STR is outputted after the delay count is reached.
   When the READY signal is ON, delay count begins for STR; STRoutputs when the delay counter is reached.
2) STR outputs and waits for the input of the handshake signal ACK. Output will be interrupted if no response is detected within "Communication Timeout". Moreover, ERROR signal is sent out and the ERROR indicator light is lit.
3) After STR is sent out, the switch turns OFF after the ACK signal is detected.
4) After STR is switched OFF, the ACK signal must also be turned OFF to enable the next data output.
5) After ACK is off, the next batch of data is output.

➤ Parallel I/O Output: (8/16/32/64-bit output data formats)

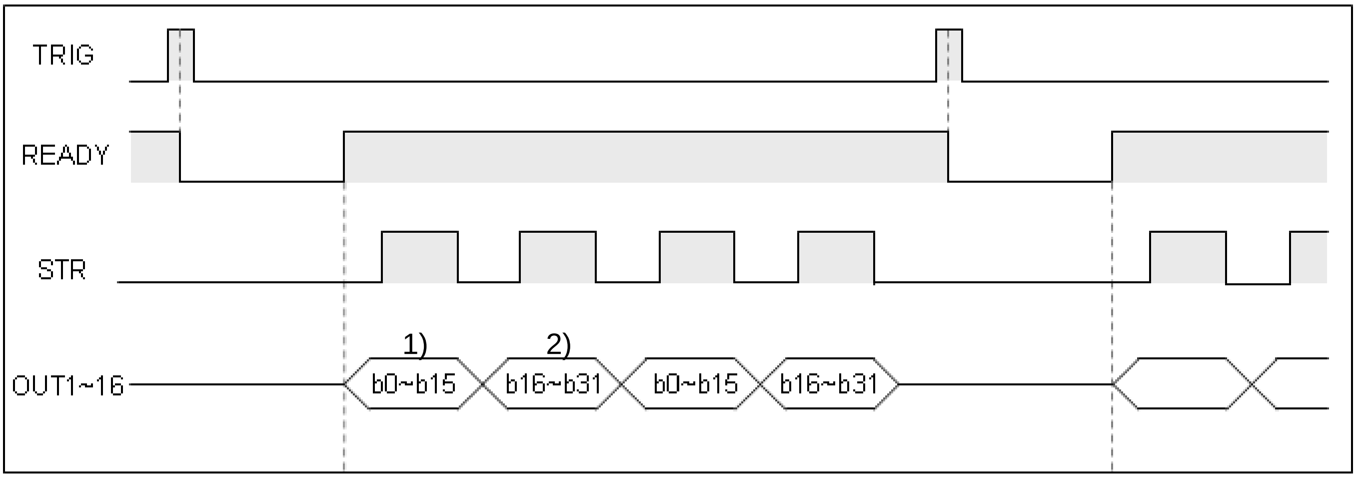
Only applicable in [Single Process] projects when transmitting resulting values using the I/O

In the [OUTPUT] options, [Output Num. Pins] can be either [8 Pins] or [16 Pins]. [Data Format] includes the options of [8 Bits]/[16 Bits]/[32 Bits]/[64 Bits]. Various pin numbers and data formats can be paired to generate different outputs.

1) [8 Pins] paired with [8 Bits]: Data outputs in 8 bits through OUT1~OUT7 in one transmission. Two 16-bit output data entries will be divided into 4 transmissions.
2) [16 Pins] paired with [16 Bits]: Data outputs in 16 bits through OUT0~OUT15 in one transmission. Two 16-bit output data entries will be divided into 2 transmissions.
3) [16 Pins] paired with [32 Bits]: Data outputs in 16 bits through OUT0~OUT15 in one transmission. Two 32-bit output data entries will be divided into 4 transmissions.
4) [16 Pins] paired with [64 Bits]: Data outputs in 16 bits through OUT0~OUT15 in one transmission. One 64-bit output data entry will be divided into 4 transmissions.



An example is shown in the following diagram: When using 32-bit output format, each data entry is divided into two parts for transmission.



Description:

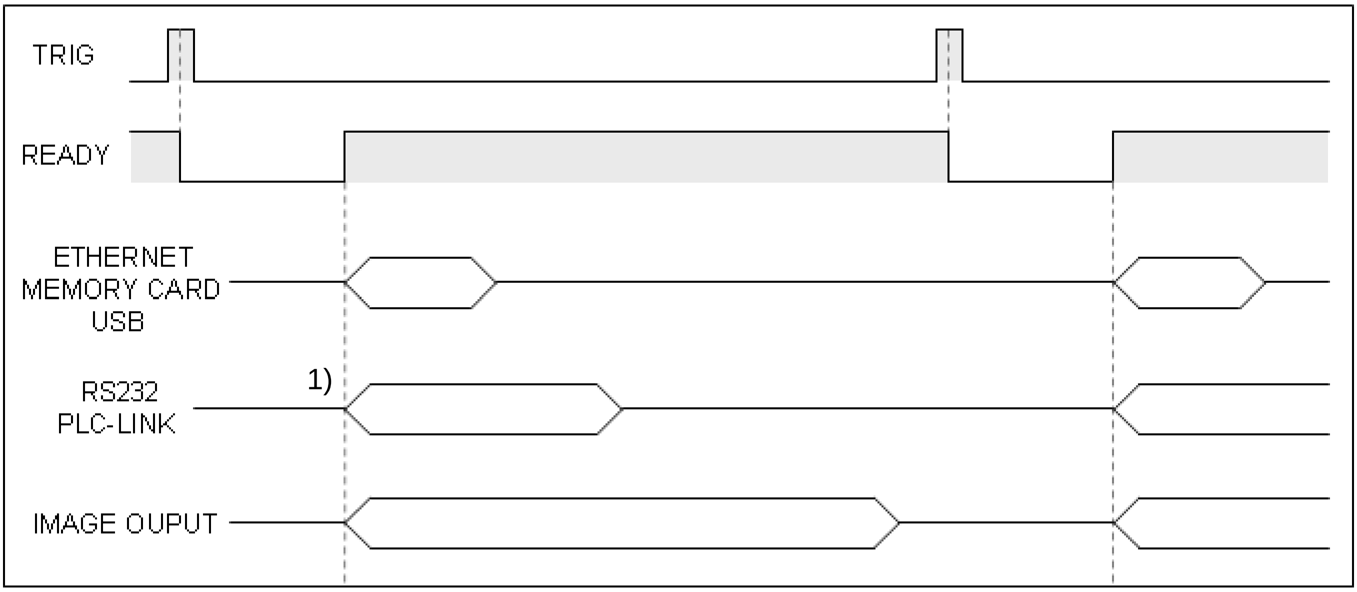
1) Leading 16 bits of the 32-bit data.

2) Trailing 16 bits of the 32-bit data.

Remark 16-bit data range: Signed binary (-32768~32767), unsigned binary (0~65535). 32-bit data range: -2147483648~2147483647

7.2.4 Communication Result Output

- RS232, USB, ETHERNET, memory card, PLC-Link, and image storage output



Description:

1) The outputs are in sync with the READY ON signal.

Remark

Communication speed: ETHERNET > RS232 > IMAGE OUTPUT.

7.2.5 Function Switch: FNC1~4, IN1~8, FRDY, FCH, SW, NSW

The non-imaging and imaging inspection functions can be switched through the I/O terminals, e.g. switching between inspection projects or adjusting the camera shutter speed.

Function Selection				Description of Function	Setting Value
FNC4	FNC3	FNC2	FNC1		IN8~IN1
OFF	OFF	OFF	OFF	0: Switch process (internal memory)	0~31 (IN5~IN1 configurations)
OFF	OFF	OFF	ON	1: Switch process (SD card)	
OFF	OFF	ON	OFF	2: Switch viewing window	0~127 (IN7~IN1 configurations)
OFF	OFF	ON	ON	3: Modify shutter speed	Shutter 0~9 (IN4~IN1); camera No. 0~1 (IN8)
OFF	ON	OFF	OFF	4: Camera gain	Gain 0~100 (IN7~IN1); camera No. 0~1 (IN8)
OFF	ON	OFF	ON	5: Camera brightness	Brightness 0~100 (IN7~IN1); camera No. 0~1 (IN8)
OFF	ON	ON	OFF	6: Image capture	N/A

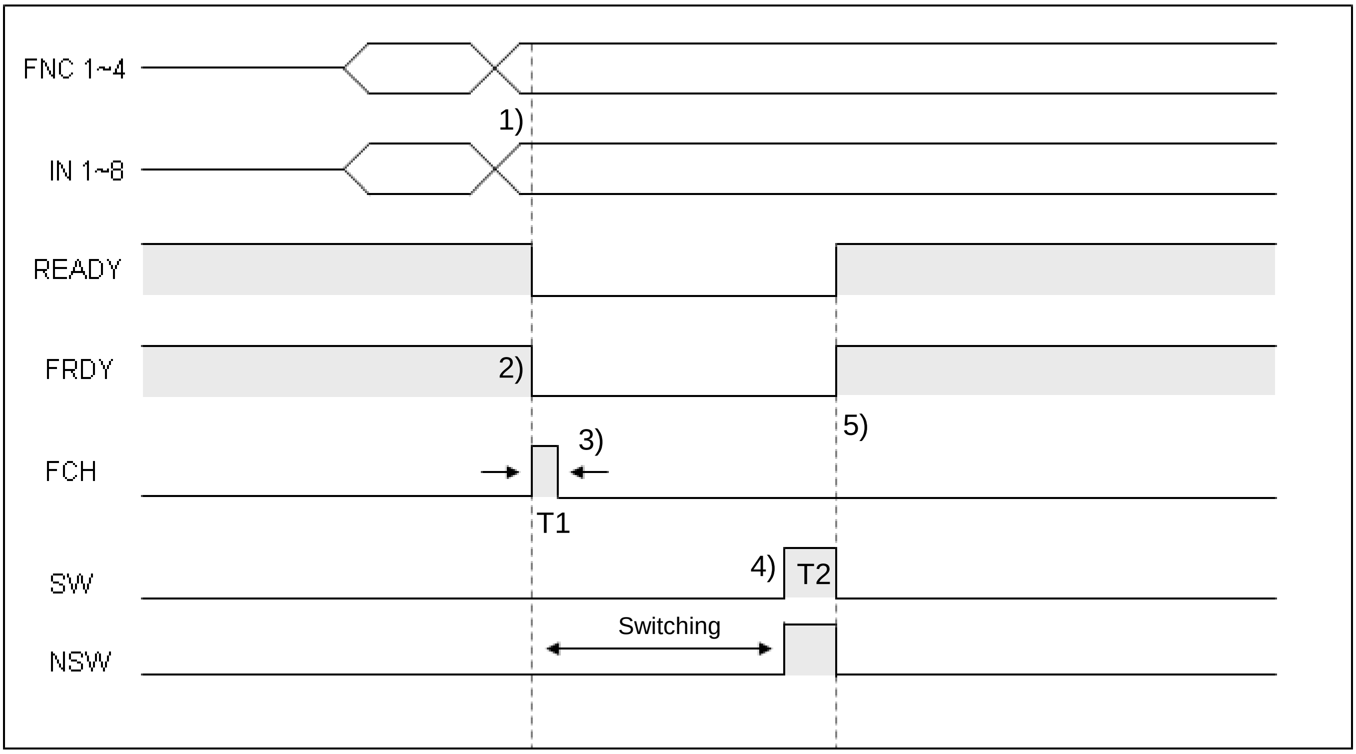
➤ IN8~IN1 numerical input table: (O=ON, X=OFF)

Numerical Value	Switch state								Numerical Value	Switch state							
	IN8	IN7	IN6	IN5	IN4	IN3	IN2	IN1		IN8	IN7	IN6	IN5	IN4	IN3	IN2	IN1
0	X	X	X	X	X	X	X	X	**32**	X	X	O	X	X	X	X	X
1	X	X	X	X	X	X	X	O	**33**	X	X	O	X	X	X	X	O
2	X	X	X	X	X	X	O	X	**34**	X	X	O	X	X	X	O	X
3	X	X	X	X	X	X	O	O	**35**	X	X	O	X	X	X	O	O
4	X	X	X	X	X	O	X	X	**36**	X	X	O	X	X	O	X	X
5	X	X	X	X	X	O	X	O	**37**	X	X	O	X	X	O	X	O
6	X	X	X	X	X	O	O	X	**38**	X	X	O	X	X	O	O	X
7	X	X	X	X	X	O	O	O	**39**	X	X	O	X	X	O	O	O
8	X	X	X	X	O	X	X	X	**40**	X	X	O	X	O	X	X	X
9	X	X	X	X	O	X	X	O	**41**	X	X	O	X	O	X	X	O
10	X	X	X	X	O	X	O	X	**42**	X	X	O	X	O	X	O	X
11	X	X	X	X	O	X	O	O	**43**	X	X	O	X	O	X	O	O
12	X	X	X	X	O	O	X	X	**44**	X	X	O	X	O	O	X	X
13	X	X	X	X	O	O	X	O	**45**	X	X	O	X	O	O	X	O
14	X	X	X	X	O	O	O	X	**46**	X	X	O	X	O	O	O	X
15	X	X	X	X	O	O	O	O	**47**	X	X	O	X	O	O	O	O
16	X	X	X	O	X	X	X	X	**48**	X	X	O	O	X	X	X	X
17	X	X	X	O	X	X	X	O	**49**	X	X	O	O	X	X	X	O
18	X	X	X	O	X	X	O	X	**50**	X	X	O	O	X	X	O	X
19	X	X	X	O	X	X	O	O	**51**	X	X	O	O	X	X	O	O
20	X	X	X	O	X	O	X	X	**52**	X	X	O	O	X	O	X	X
21	X	X	X	O	X	O	X	O	**53**	X	X	O	O	X	O	X	O
22	X	X	X	O	X	O	O	X	**54**	X	X	O	O	X	O	O	X
23	X	X	X	O	X	O	O	O	**55**	X	X	O	O	X	O	O	O
24	X	X	X	O	O	X	X	X	**56**	X	X	O	O	O	X	X	X

25	X	X	X	O	O	X	X	O
26	X	X	X	O	O	X	O	X
27	X	X	X	O	O	X	O	O
28	X	X	X	O	O	O	X	X
29	X	X	X	O	O	O	X	O
30	X	X	X	O	O	O	O	X
31	X	X	X	O	O	O	O	O
Numerical Value	**Switch state**							
	IN8	**IN7**	**IN6**	**IN5**	**IN4**	**IN3**	**IN2**	**IN1**
64	X	O	X	X	X	X	X	X
65	X	O	X	X	X	X	X	O
66	X	O	X	X	X	X	O	X
67	X	O	X	X	X	X	O	O
68	X	O	X	X	X	O	X	X
69	X	O	X	X	X	O	X	O
70	X	O	X	X	X	O	O	X
71	X	O	X	X	X	O	O	O
72	X	O	X	X	O	X	X	X
73	X	O	X	X	O	X	X	O
74	X	O	X	X	O	X	O	X
75	X	O	X	X	O	X	O	O
76	X	O	X	X	O	O	X	X
77	X	O	X	X	O	O	X	O
78	X	O	X	X	O	O	O	X
79	X	O	X	X	O	O	O	O
80	X	O	X	O	X	X	X	X
81	X	O	X	O	X	X	X	O
82	X	O	X	O	X	X	O	X
83	X	O	X	O	X	X	O	O
84	X	O	X	O	X	O	X	X
85	X	O	X	O	X	O	X	O
86	X	O	X	O	X	O	O	X
87	X	O	X	O	X	O	O	O
88	X	O	X	O	O	X	X	X
89	X	O	X	O	O	X	X	O
90	X	O	X	O	O	X	O	X
91	X	O	X	O	O	X	O	O
92	X	O	X	O	O	O	X	X
93	X	O	X	O	O	O	X	O
94	X	O	X	O	O	O	O	X
95	X	O	X	O	O	O	O	O

57	X	X	O	O	O	X	X	O
58	X	X	O	O	O	X	O	X
59	X	X	O	O	O	X	O	O
60	X	X	O	O	O	O	X	X
61	X	X	O	O	O	O	X	O
62	X	X	O	O	O	O	O	X
63	X	X	O	O	O	O	O	O
Numerical Value	**Switch state**							
	IN8	**IN7**	**IN6**	**IN5**	**IN4**	**IN3**	**IN2**	**IN1**
96	X	O	O	X	X	X	X	X
97	X	O	O	X	X	X	X	O
98	X	O	O	X	X	X	O	X
99	X	O	O	X	X	X	O	O
100	X	O	O	X	X	O	X	X
101	X	O	O	X	X	O	X	O
102	X	O	O	X	X	O	O	X
103	X	O	O	X	X	O	O	O
104	X	O	O	X	O	X	X	X
105	X	O	O	X	O	X	X	O
106	X	O	O	X	O	X	O	X
107	X	O	O	X	O	X	O	O
108	X	O	O	X	O	O	X	X
109	X	O	O	X	O	O	X	O
110	X	O	O	X	O	O	O	X
111	X	O	O	X	O	O	O	O
112	X	O	O	O	X	X	X	X
113	X	O	O	O	X	X	X	O
114	X	O	O	O	X	X	O	X
115	X	O	O	O	X	X	O	O
116	X	O	O	O	X	O	X	X
117	X	O	O	O	X	O	X	O
118	X	O	O	O	X	O	O	X
119	X	O	O	O	X	O	O	O
120	X	O	O	O	O	X	X	X
121	X	O	O	O	O	X	X	O
122	X	O	O	O	O	X	O	X
123	X	O	O	O	O	X	O	O
124	X	O	O	O	O	O	X	X
125	X	O	O	O	O	O	X	O
126	X	O	O	O	O	O	O	X
127	X	O	O	O	O	O	O	O

➤ Non-imaging (inspection) mode:



Description:

1) Enable FNC1~4 and IN1~8 to setup the function and parameters.

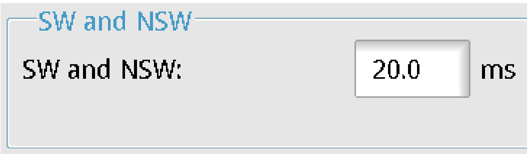
2) When FRDY (Function Ready) is ON, function switching can be enabled.

3) Trigger FCH (Function Change) to execute function switching (T1 must be longer than 1 ms) After FCH is enabled, READY and FRDY are OFF.

4) After the switch is made, one of the output flags, SW (success) or NSW (fail), is sent out to notify whether the switch was successful. If switching is disabled or illegal, the NSW flag output is set.

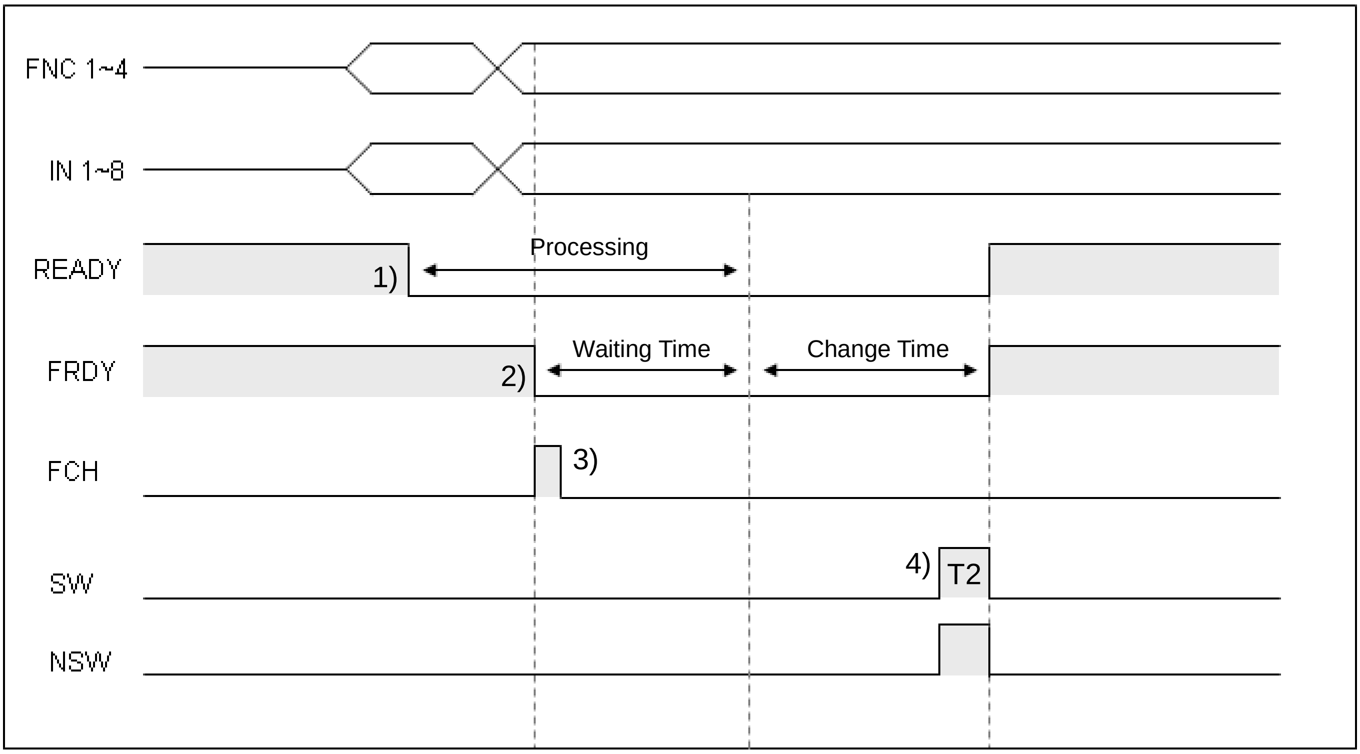
(T2 is configured in [System] > [Communication Setting] > [Protocol Setting] > [External Terminal])

Refer to the diagram below: When configured to 20 ms, SW or NSW will output using 20-ms pulse width to indicate whether the switch was made successfully after each switch.



5) When any output from SW or NSW is complete, READY and FRDY signals will be set to ON.

➤ Imaging (inspection) mode



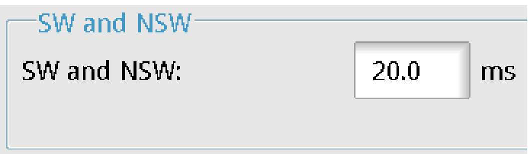
Description:

1) When READY is OFF, the system in under image processing condition.
2) FRDY is ON, function switching is enabled.
3) FCH is triggered to initiate function switching (T1 must be longer than 1 ms). After FCH is enabled, FRDY is OFF.

   Image processing must be completed before the function can be switched.
4) After the switch is made, one of the output flags, SW (success) or NSW (fail), is sent out to notify whether the switch was successful. If switching is disabled or illegal, the NSW flag output is set.

   (T2 is configured in [System] > [Communication Setting] > [Protocol Setting] > [External Terminal])

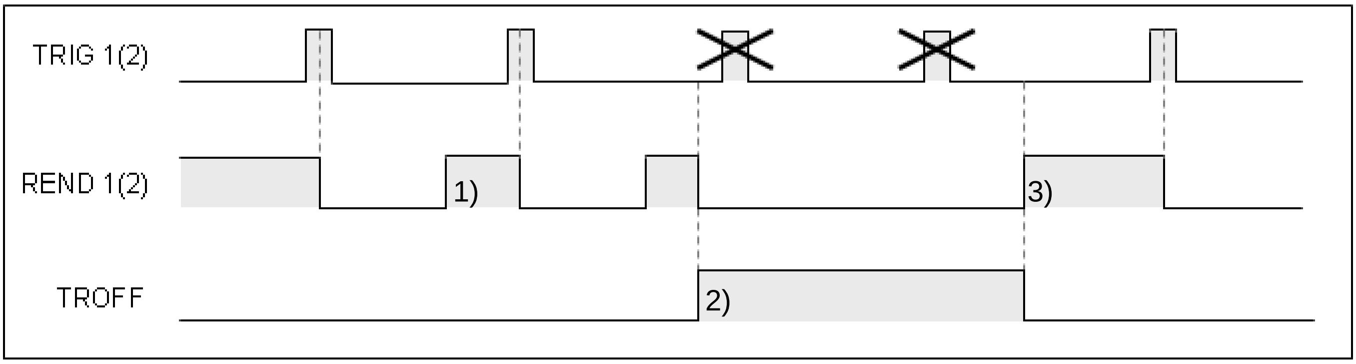
   Refer to the diagram below: When configured to 20 ms, SW or NSW will output using 20-ms pulse width to indicate whether the switch was made successfully after each switch.



5) When any output from SW or NSW is complete, READY and FRDY signals will be set to ON.

7.2.6 Others: TROFF, TEST, RESET

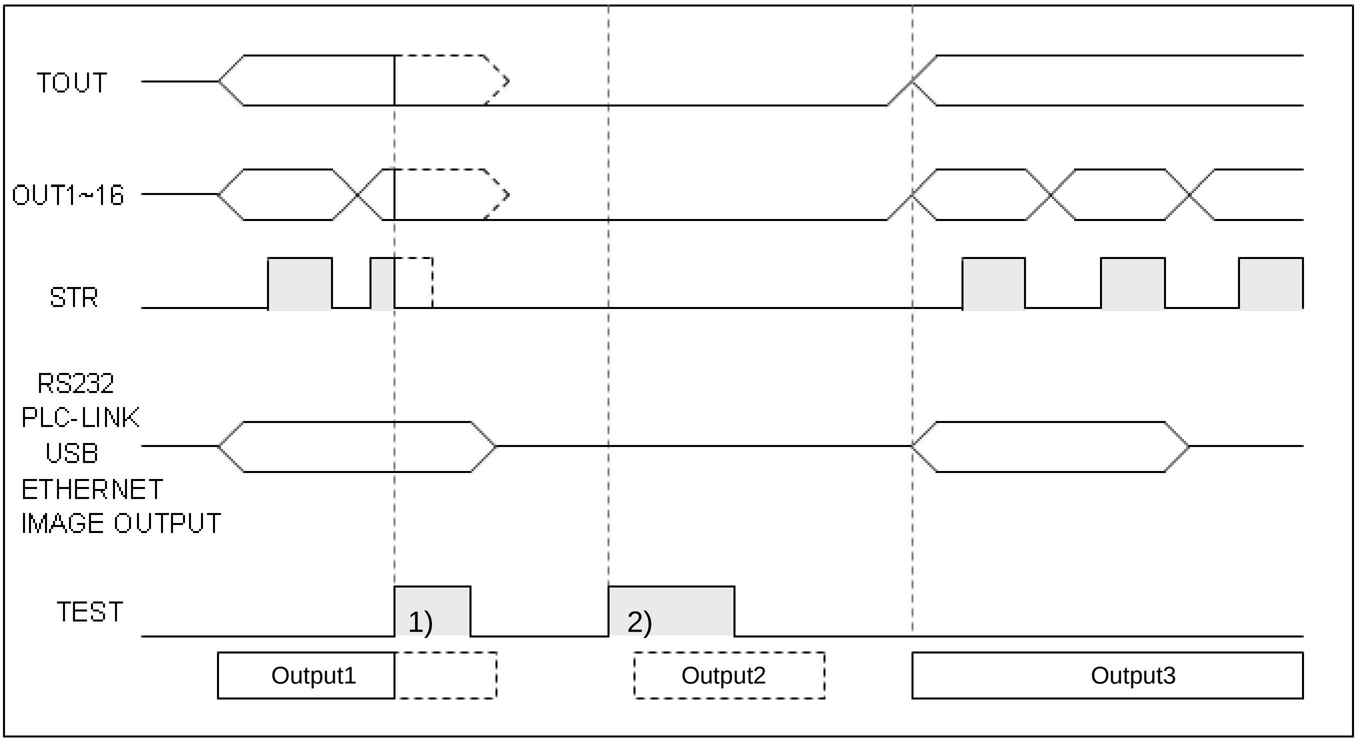
- TROFF (trigger disabled)



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. The user 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, 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 output are disabled.

Chapter 8

Serial Communication

8.1 RS232/RS485 Serial Communication Method

The following 3 types of serial communication methods are provided for user selection.

◎ **Private Code Mode: (DMV in Master Mode)**
After each inspection, the system will send out the configured output results through the RS232/RS485 communication ports in custom DMV communication format. After receiving the communication strings, the user must work out the result data according to the DMV defined method.

◎ **RS232/RS485 PLC Automatic Link Mode: (DMV in Master Mode)**
After each inspection, the system will automatically write the configured output results into the assigned PLC register. This eliminates the decoding step after string reception, thereby simplifying the work of programmers. The required numerical results can be directly assessed from the PLC register. PLC automatic link is currently supported by the Delta DVP series PLC only.

◎ **RS232/RS485 MODBUS Communication Format: (DMV in Master Mode)**
Check RS232 / RS485 in result output of flow process, then the data will be automatically sent out in MODBUS format to mechanical arm or other brands PLC after the inspection.

◎ **RS232/RS485 MODBUS Communication Format: (DMV in Slave Mode)**
When "MODBUS" is selected, the controller will automatically switch to slave mode without the output configured. This enables externally entering MODBUS commands, prompting response from the controller. The commands used in the MODBUS communication format are identical to that of the Ethernet MODBUS TCP. (Please refer to Section 8.5.3 for more information about the MODBUS command format)

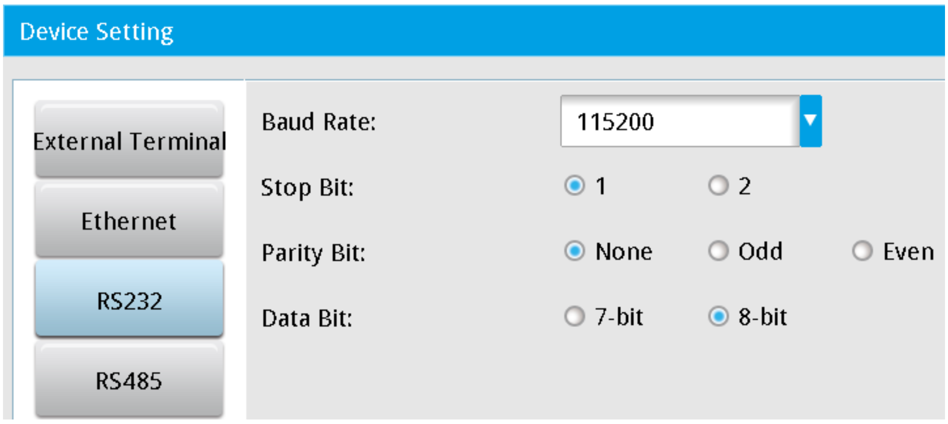
Remark Only one of the 4 aforementioned communication methods can be selected. After confirming the selection, RS232/RS485/Ethernet interfaces will all adopt the same settings.

8.2 RS232/RS485 Private Code Communication Method

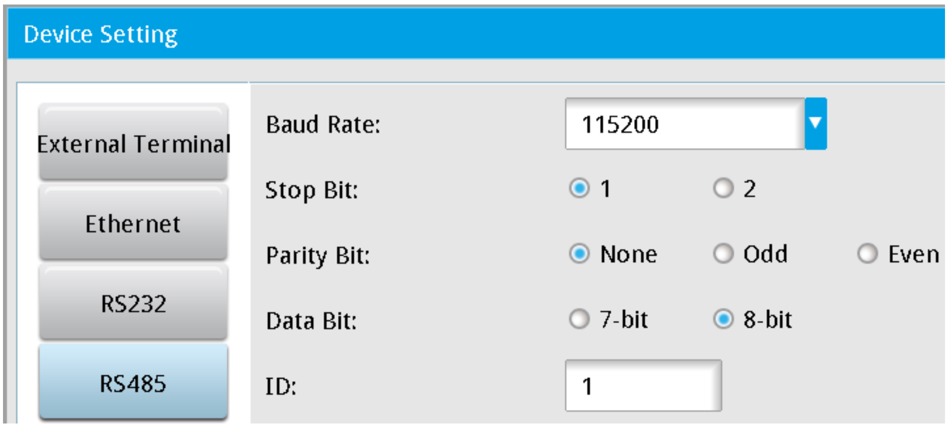
In private code communication, the system will automatically send out the results from the DMV after completing the inspection. After the upper controller receives the strings, the required results are generated through manual decoding according to the defined format. Besides transmitting inspection results, private code also supports multiple written control commands.

The following explains the private code communication format configurations for RS232 and RS485.

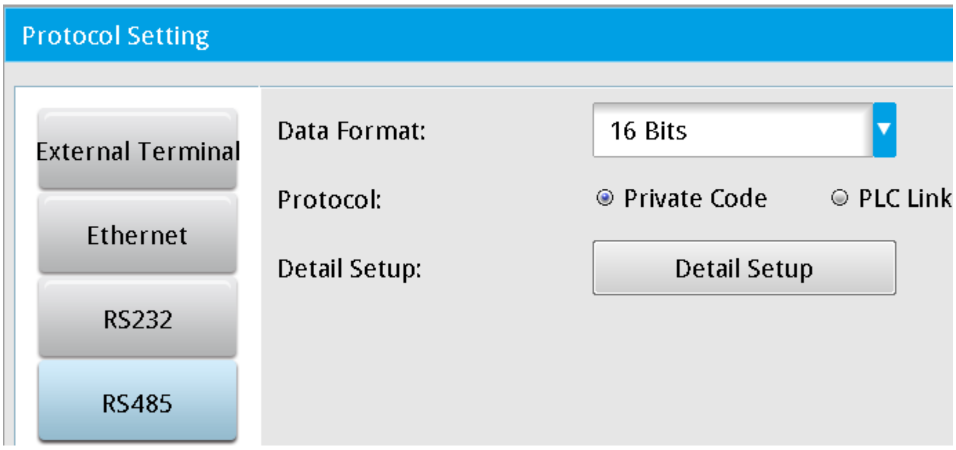
- Configure communication format in [System] > [Communication Setting] > [Device Setting] > [RS232]/[RS485]



- Configure DMV host station number in RS485 [ID] options



➤ Select [Private Code] option in [System] > [Communication Setting] > [Protocol Setting] > [RS232]/[RS485]



Reference The private code result output can also adopt user-defined format (please refer to Section 8.2.3).

8.2.1 Private Code Mode Command Table: (DMV Custom Communication Format)

	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	Trigger 3 action and output	T3 CR LF	T3 CR LF T0 + Output Data CR		
4	Trigger 4 action and output	T4 CR LF	T4 CR LF T0 + Output Data CR		
5	Go to run mode	RN CR LF	RN CR LF		O
6	Go to program mode	PG CR LF	PG CR LF	O	
7	Repeat data output	DQ CR LF	DQ + Output Data CR LF	O	
8	Switch program ID	PCnnnn CR LF	PC CR LF	O	O
9	Read program ID	PR CR LF	PRnnnn CR LF	O	
10	Switch window ID	WCwnnnn CR LF	WC CR LF	O	
11	Read window ID	WR CR LF	WRwnnnn CR LF	O	
12	Capture image	CP CR LF	CP CR LF	O	O
13	Enable input trigger	TO CR LF	TO CR LF	O	

14	Disable input trigger	TF CR LF	TF CR LF	O	
15	Write upper/lower (Window)	LWWmnnnnaaaaaaaabbbbb bbb CR LF	LW CR LF	O	
16	Write upper/lower limit (calculator)	LWCAnnaaaaaaaabbbbbbbb CR LF	LC CR LF	O	
17	Read upper/lower (Window)	LRWmnnnn CR LF	LRaaaaaaaabbbbbbbb CR LF	O	
18	Read upper/lower limit (calculator)	LRCAnn CR LF	LRaaaaaaaabbbbbbbb CR LF	O	
19	Save all program setting	SV CR LF	SV CR LF		O
20	Set time/date	DWyymmddhhmmss CR LF	DW CR LF	O	O
21	Read time/date	DR CR LF	DRyymmddhhmmss CR LF	O	O
22	Set camera shutter speed	SHCnmm CR LF	SH CR LF	O	
23	Set camera gain and brightness	SECnmmmkkk CR LF	SE CR LF	O	
24	Clear statistics	QC CR LF	QC CR LF	O	O
25	System reset	RS CR LF	RS CR LF	O	

8.2.2 Private Code Mode Command: (DMV Communication Format)

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:**

- String length should be set to 5 for 2 data (1234, 345) and 3 judgments (1, 0, 1) in the case of integers.

  Return: T1 CR LF T00123400345101 CR

- String length should be set to 5 for 2 data (12.3, 34.5) and 3 judgments (1, 0, 1) in the case of decimals.

  Return: T1 CR LF T01230034500101 CR

System returns T1 CR LF upon receiving the command, and then returns the result after inspection completes. Inspection time varies with the inspection item. Please increase the controller timeout as required if inspection time is too long.

◎ **Error Handling:** Return string

- E01: Incorrect permission mode. (incorrect RUN/PROG 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

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:**

- String length should be set to 5 for 2 data (1234, 345) and 3 judgments (1, 0, 1) in the case of integers.

  Return: T2 CR LF T00123400345101 CR
- String length should be set to 5 for 2 data (12.3, 34.5) and 3 judgments (1, 0, 1) in the case of integers.

  Return: T2 CR LF T01230034500101 CR

System returns T2 CR LF upon receiving the command, and then returns the result after inspection completes. Inspection time varies with the inspection item. Please increase the controller timeout as required if inspection time is too long.

◎ **Error Handling:** Return string

- E01: Incorrect permission mode. (incorrect RUN/PROG 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) Trigger 3 Action and Output Data (RUN Mode enabled)

Input string: T3 CR LF   Return string: T3 CR LF T0 + Output Data CR

◎ **Description:**

- String length should be set to 5 for 2 data (1234, 345) and 3 judgments (1, 0, 1) in the case of integers.

  Return: T3 CR LF T00123400345101 CR
- String length should be set to 5 for 2 data (12.3, 34.5) and 3 judgments (1, 0, 1) in the case of integers.

  Return: T3 CR LF T01230034500101 CR

System returns T3 CR LF upon receiving the command, and then returns the result after inspection completes. Inspection time varies with the inspection item. Please increase the controller timeout as required if inspection time is too long.

◎ **Error handling:** Return string

- E01: Incorrect permission mode. (incorrect RUN/PROG 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

4) Trigger 4 Action and Output Data (RUN Mode enabled)

Input string: T4 CR LF Return string: T4 CR LF T0 + Output Data CR

◎ **Description:**

- String length should be set to 5 for 2 data (1234, 345) and 3 judgments (1, 0, 1) in the case of integers.

  Return: T4 CR LF T00123400345101 CR

  String length should be set to 5 for 2 data (12.3, 34.5) and 3 judgments (1, 0, 1) in the case of integers.

  Return: T4 CR LF T01230034500101 CR

  System returns T4 CR LF upon receiving the command, and then returns the result after inspection completes. Inspection time varies with the inspection item. Please increase the controller timeout as required if inspection time is too long.

◎ **Error Handling:** Return string

- E01: Incorrect permission mode. (incorrect RUN/PROG 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

5) 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/PROG 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)
- E05: Program ID does not exist (or program ID not set)
- E17: System busy, cannot respond

6) 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/PROG 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)
- E17: System busy, cannot respond

7) 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/PROG mode)
- E02: Incorrect string data. (string length is too long or too short to be recognized)
- E17: System busy, cannot respond

8) 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)

Please 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. (please confirm the I/O status)
- E05: Program ID does not exist (or program ID not set)
- E17: System busy, cannot respond

9) **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/PROG mode)
- E02: Incorrect string data. (string length is too long or too short to be recognized)
- E17: System busy, cannot respond

10) **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/PROG 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

11) **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. (incorret RUN/PROG mode)
- E02: Incorrect string data. (string length is too long or too short to be recognized)
- E17: System busy, cannot respond

12) 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

13) Enable Trigger Input (RUN Mode enabled)

Input string: TO CR LF Return string: TO CR LF

◎ **Description:** The controller remains in the "Trigger Enabled" state during each bootup, therefore this command can be used with the "Disable Trigger Input" command.

◎ **Error Handling:** Return string

- E01: Incorrect permission mode. (incorrect RUN/PROG mode)
- E02: Incorrect string data. (string length is too long or too short to be recognized)
- E17: System busy, cannot respond

14) Disable Trigger Input (RUN Mode enabled)

Input string: TF CR LF Return string: TF CR LF

◎ **Description:** Disable all enabled trigger sources
Set trigger source from [Program] > [Camera] > [Trigger]

◎ **Error Handling:** Return string

- E01: Incorrect permission mode. (incorrect RUN/PROG mode)
- E02: Incorrect string data. (string length is too long or too short to be recognized)
- E17: System busy, cannot respond

15) Write Upper/Lower Data - Window (RUN Mode enabled)

Input string: LWWmnnnnaaaaaaaabbbbbbbb CR LF Return string: LW CR LF

◎ **Description:** m denotes the data ID (please see Table 1 below), nnnn represents the window ID, aaaaaaaa is the upper limit, and bbbbbbbb is the lower limit Upper/lower limits are fixed 8-digit numbers.

To configure the upper/lower limits of W015 to 300 and 200, please enter the string LWW20015000300000020000 CR LF

If the upper/lower input limits are coordinates or angle data (hundredth decimal format), the data can be entered using the following method:

To input the upper/lower range of angles to 120.00 and 50.00, please enter the string LWW20015000120000005000 CR LF

◎ **Error Handling:** Return string

- E01: Incorrect permission mode. (incorrect RUN/PROG 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)
- E08: Upper/Lower input error (invalid range or Upper is less than Lower)
- E14: Incorrect data ID (not available from current inspection)
- E17: System busy, cannot respond

16) Write Upper/Lower Data - Calculator (RUN Mode enabled)

Input string: LWCAnnaaaaaaaaabbbbbbbb CR LF Return string: LC CR LF

◎ **Description:** nn (calculator ID), aaaaaaaaaa (upper limit), bbbbbbbbbb (lower limit). Upper/lower limits are fixed 8-digit numbers.

To set the calculator C25's Upper/Lower to 123.45 and 12.34, please enter the string LWCA250001234500001234 CR LF

◎ **Error Handling:** Return string

- E01: Incorrect permission mode. (incorrect RUN/PROG 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: Calculator ID does not exist (or calculator ID not set)
- E08: Upper/Lower input error (exceeds range or Upper is less than Lower)
- E17: System busy, cannot respond

17) Read Upper/Lower Data - Window (RUN Mode enabled)

Input string: LRWmnnnn CR LF   Return string: LRaaaaaabbbbbb CR LF

◎ **Description:** m denotes the data ID (please see Table 1 below), nnnn represents the window ID, aaaaaaaa is the upper limit, and bbbbbbbb is the lower limit Upper/lower limits are fixed 8-digit numbers.

If Window W015's Upper/Lower read limits are 3.00 and 2.00, send out the string LRW20015 CR LF

Return string LR0000030000000200 CR LF

If the Upper/Lower read limits are coordinates or angle data (hundredth decimal format), the data is returned using the following method:

If Upper/Lower are 120.00 and 50.00, return string LR0001200000005000 CR LF

◎ **Error Handling:** Return string

- E01: Incorrect permission mode. (incorrect RUN/PROG mode)
- E02: Incorrect string data. (string length is too long or too short to be recognized)
- E06: Window ID does not exist (or window ID not set)
- E14: Incorrect data ID (not available from current inspection)
- E17: System busy, cannot respond

(Table 1)

Item Number	Area	Description
0	Total Area	000000~999999
Item Number	**Position**	**Description**
0	Horizontal Position	-99999.99~+99999.99
1	Vertical Position	-99999.99~+99999.99
2	Angle	-180~+180
Item Number	**Count**	**Description**
0	Number	0~999
Item Number	**Width**	**Description**
0	Width	-99999.99~+99999.99
1	Horizontal Position	-99999.99~+99999.99
2	Vertical Position	-99999.99~+99999.99
3	Angle	-180~+180
Item Number	**Pitch**	**Description**
0	Number	0~999
1	Width	-99999.99~+99999.99
2	Maximum Width	-99999.99~+99999.99
3	Minimum Width	-99999.99~+99999.99

4	Average Width	-99999.99~+99999.99
Item Number	**Angle**	**Description**
0	Angle	-180~+180
Item Number	**Shape**	**Description**
0	Number	0~999
1	Horizontal Position	-99999.99~+99999.99
2	Vertical Position	-99999.99~+99999.99
3	Similarity	0~100
4	Angle	-180~+180
Item Number	**Spot**	**Description**
0	Number	0~999
1	Horizontal Position	-99999.99~+99999.99
2	Vertical Position	-99999.99~+99999.99
3	Area	0~999999
4	Circumference	0~999999
Item Number	**Stain**	**Description**
0	Total Area	0~999999
1	Area	0~999999
2	Horizontal Position	-99999.99~+99999.99
3	Vertical Position	-99999.99~+99999.99
4	Number	0~999
Item Number	**Intensity**	**Description**
0	Average brightness	0~255
1	Standard brightness deviation	0~255
2	Max brightness	0~255
3	Min brightness	0~255
Item Number	**Position Trace**	**Description**
0	Maximum Horizontal Position	-99999.99~+99999.99
1	Maximum Vertical Position	-99999.99~+99999.99
2	Minimum Horizontal Position	-99999.99~+99999.99
3	Minimum Vertical Position	-99999.99~+99999.99
4	Roundness	0~100.00
Item Number	**Width Trace**	**Description**
0	Maximum Width	0~99999.99
1	Minimum Width	0~99999.99
2	Average Width	0~99999.99
3	Roundness1	0~100.00
4	Roundness2	0~100.00
Item Number	**Pattern Comparison**	**Description**

0	Number	0~999
1	Horizontal Position	-99999.99~+99999.99
2	Vertical Position	-99999.99~+99999.99
3	Similarity	0~100
4	Angle	-180~+180

18) Read Upper/Lower Data - Calculator (RUN Mode enabled)

Input string: LRCAnn CR LF Return string: LRaaaaaaaabbbbbbbb CR LF

◎ **Description:** nn (calculator ID), aaaaaaaa (upper limit), bbbbbbbb (lower limit). Upper/lower limits are fixed 8-digit numbers.
If the Calculator C25's Upper/Lower read limits are 123.45 and 12.34, return string LR0001234500001234 CR LF

◎ **Error Handling:** Return string

- E01: Incorrect permission mode. (incorrect RUN/PROG mode)
- E02: Incorrect string data. (string length is too long or too short to be recognized)
- E06: Calculator ID does not exist (or calculator ID not set)
- E17: System busy, cannot respond

19) 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/PROG 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

20) Set Date/Time (RUN Mode and Edit Mode enabled)

Input string: DWyymmddhhmmss CR LF Returun 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

21) 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

22) Configure Camera Shutter Speed (RUN Mode enabled)

Input string: SHCnmm CR LF   Return string: SH CR LF

◎ **Description:** n denotes the camera ID (configured between 1 and 8) and mm represents the shutter speed option

Shutter speed configuration table: (range 01~20)

01= 6000ms	05= 2000ms	09= 33.33ms	13= 4.17ms	17= 0.2ms
02= 5000ms	06= 1000ms	10=16.67ms	14= 2ms	18= 0.1ms
03= 4000ms	07= 500ms	11=10ms	15= 1ms	19= 0.05ms
04= 3000ms	08= 66.67ms	12= 8.33ms	16= 0.5ms	20= 0.025ms

◎ **Error Handling:** Return string

- E01: Incorrect permission mode. (incorrect RUN/PROG mode)
- E02: Incorrect string data. (string length is too long or too short to be recognized)
- E11: Incorrect camera settings.
- E17: System busy, cannot respond

23) Configure Camera Gain and Luminance (RUN Mode enabled)

Input string: SECnmmmkkk CR LF   Return string: SE CR LF

◎ **Description:** n denotes the camera ID. (configured between 1 and 8), mmm represents the gain, and kkk is the luminance (mmm and kkk are configured between 00 and 100)

◎ **Error Handling:** Return string

- E01: Incorrect permission mode. (incorrect RUN/PROG mode)
- E02: Incorrect string data. (string length is too long or too short to be recognized)
- E11: Incorrect camera settings.
- E17: System busy, cannot respond

Remark: Higher gain can compensate for insufficient lighting, but may also add noise to the image.

24) Clear Statistics (RUN Mode and Edit Mode enabled)

Input string: QC CR LF   Return string: QC 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

25) System Reset (RUN Mode enabled)

Input string: RS CR LF   Return string: RS CR LF

◎ **Description:** Reset clears the following data:

Total, NG, defect rate, statistics, output terminals.

◎ **Error Handling:** Return string

- E02: Incorrect string data. (string length is too long or too short to be recognized)
- E17: System busy, cannot respond

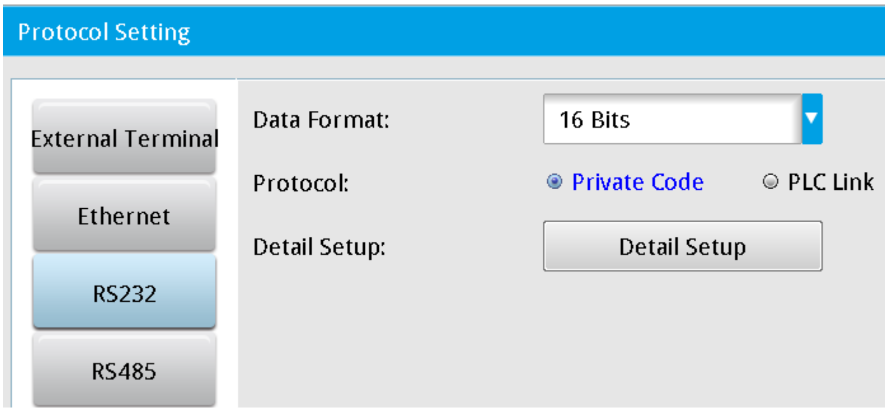
Return Error Message Table

Error Code	Description
E01	Incorrect mode enabled (incorrect RUN/PROG 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).
	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)
	Calculator ID does not exist (or calculator ID not set)
E07	No SD card
E08	Upper/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

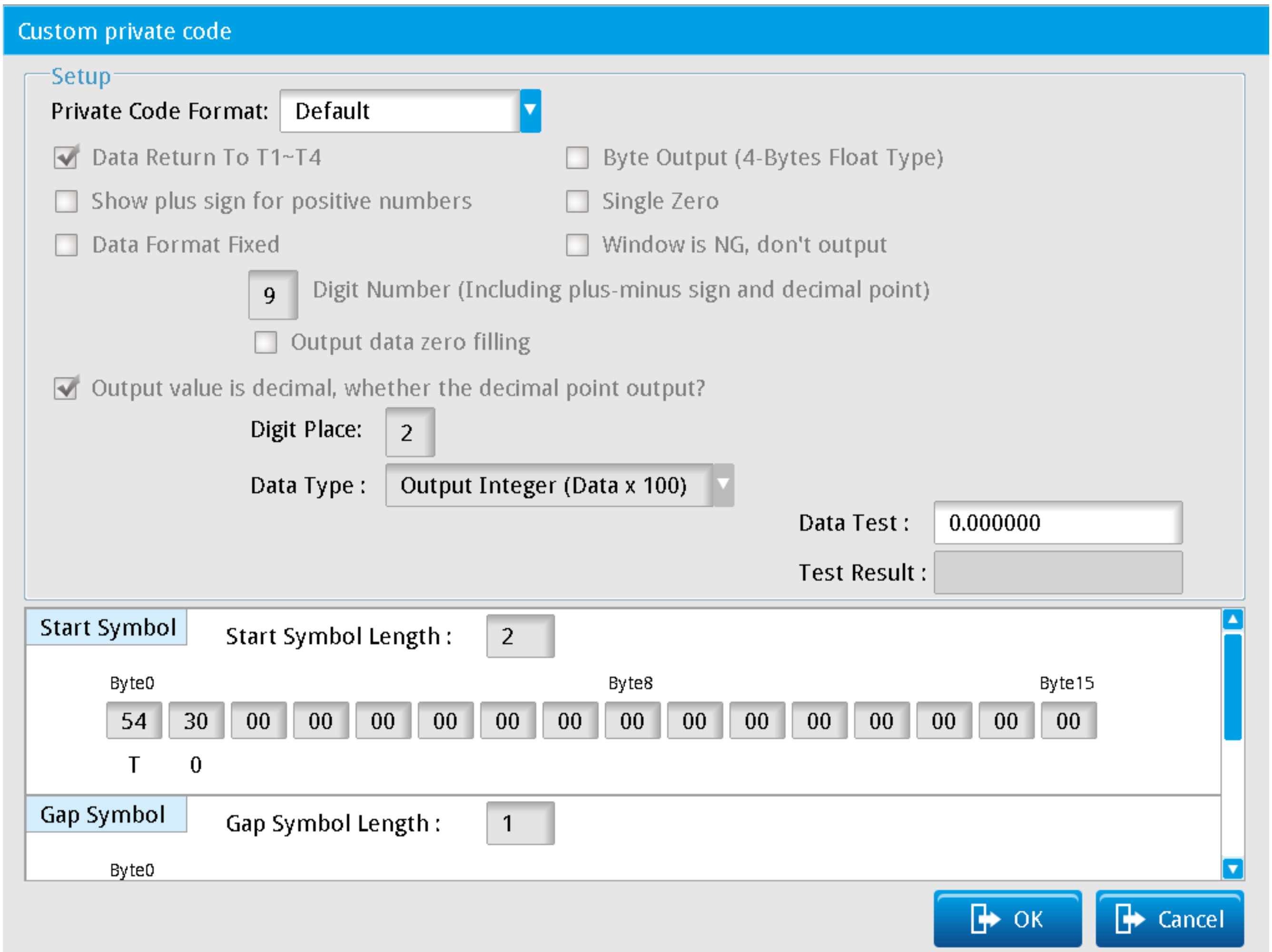
8.2.3 Private Code Custom Output Data Format

When outputting result data using private code, the user can also define the output data format.

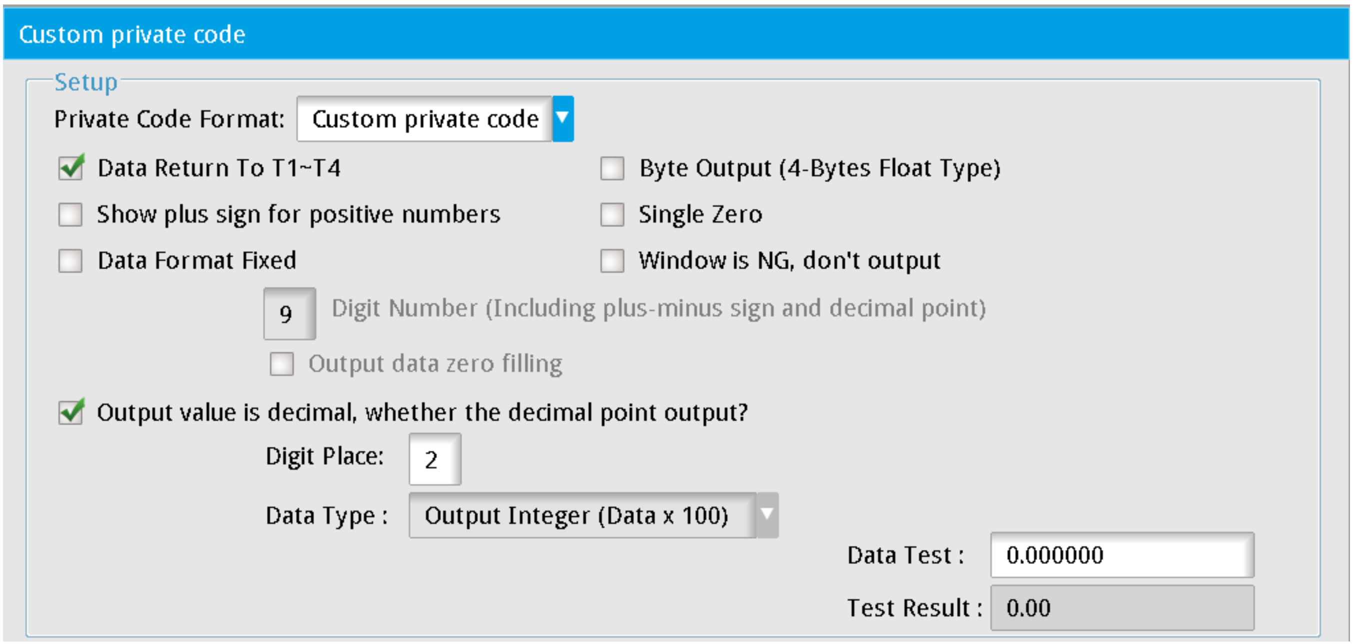
➤ Select [Detail Setup] in [System] > [Communication Setting] > [Protocol Setting] > [RS232]/[RS485]



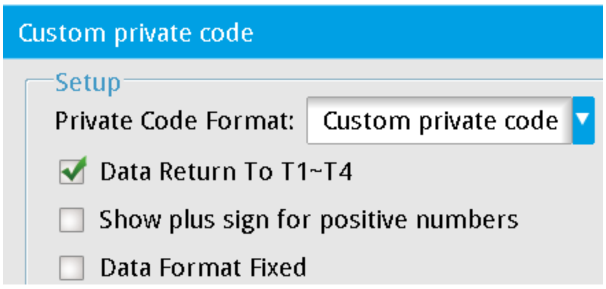
➤ Open the [Custom private code] dialog box; the factory setting of [Private Code Format] is [Default] In default condition, the result output format adopts the standard method in the aforementioned Section 8.2.1.



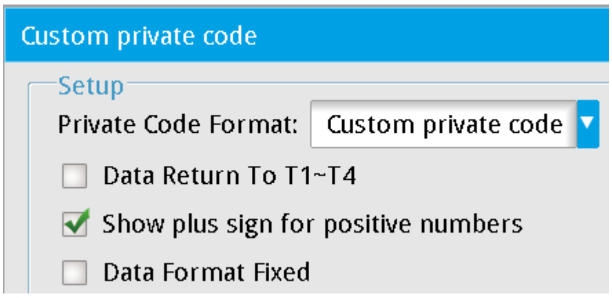
➢ Selecting [Custom private code] in [Private Code Format] opens the configuration items below.



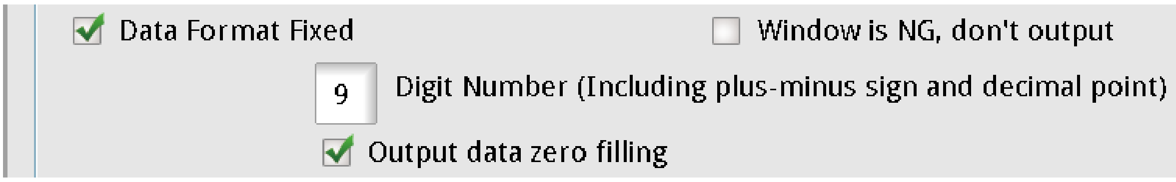
➢ [Data Return T1~T4]: When checked, result data will be transmitted according to the camera ID After T1~T4 CR LF , result data are subsequently sent out.
When unchecked, the system directly sends out the result data according to the configured method below.



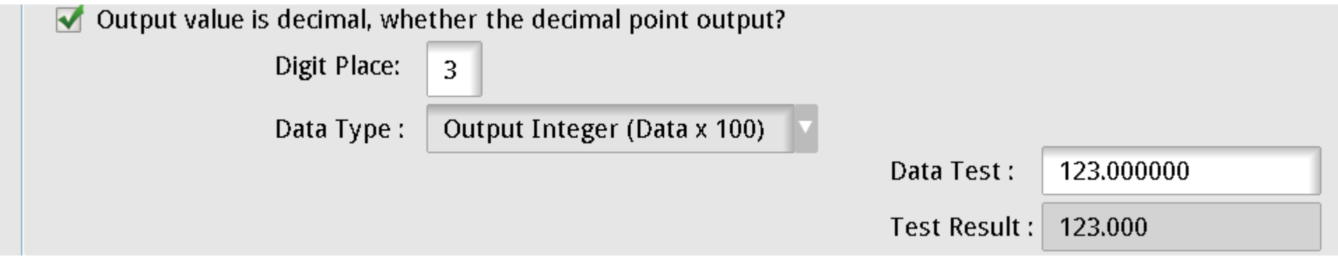
➢ [Show plus sign for positive numbers]: When checked, plus sign will be added to all positive result data.
When private code sends out negative data, negative signs will always be added before the values regardless of this option.



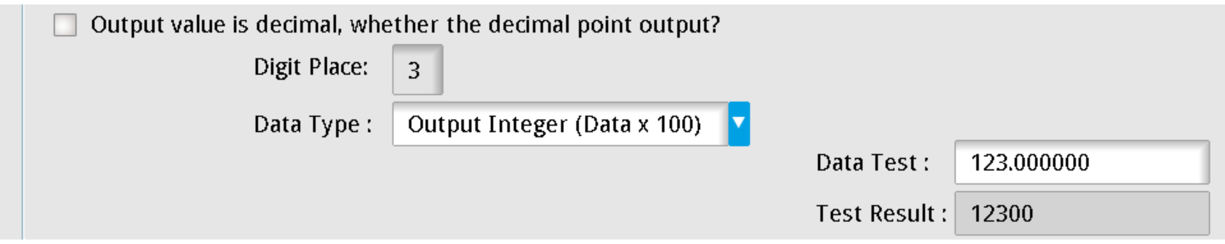
- [Data Format Fixed]: When checked, data will output in fixed decimal places.
  For example: The original output value is 123.00, checking the option will output the data as 000123.00.



- [Output value is decimal, whether the decimal point output?] : When checked, the output decimal place will be based on the configured [Digit Place].
  For example: The original value on the lower right is 123.000000 and the actual output will be 123.000.



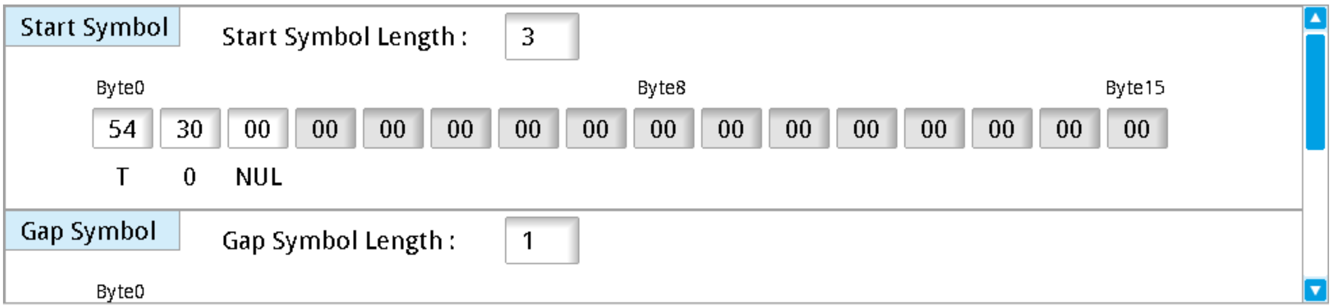
- [Output value is decimal, whether the decimal point output?] : When unchecked, the output result will be generated after multiplying [Data Type].
  For example: The original value on the lower right is 123.000000 and "Output Integer (Data x 100)" is selected as the Data Type, and the actual output will be 12300.



- Custom output result string format

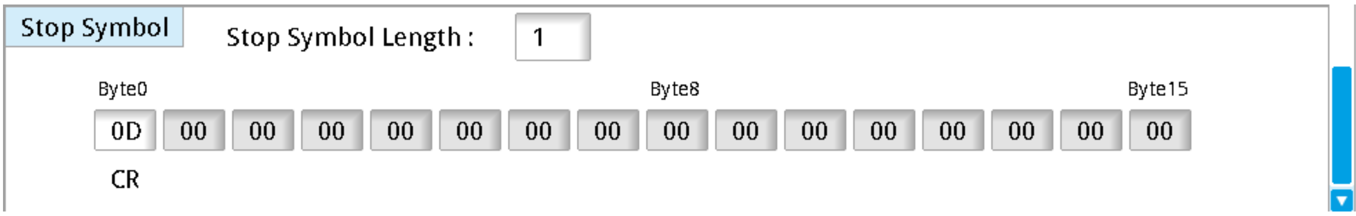
  Output format is [Start Symbol] + [Result1] + [Gap Symbol] + [Result2] + [Gap Symbol]…+ [Stop Symbol].

- [Start Symbol]: First determine [Start Symbol Length] As shown in the following diagram, configuring Start Symbol Length to 3 means that the start symbol comprises 3 characters. Please refer to the ASCII table in Section 8.6 to enter the hexadecimal values corresponding to the ASCII characters.



- [Gap Symbol]: First determine [Gap Symbol Length] As shown in the following diagram, configuring Gap Symbol Length to 1 means that the gap symbol consists of 1 character. Please refer to the ASCII table in Section 8.6 to enter the hexadecimal values corresponding to the ASCII characters.

- [Stop Symbol]: First decide [Stop Symbol Length] As shown in the following diagram, configuring Stop Symbol Length to 1 means that the stop symbol consists of 1 character. Please refer to the ASCII table in Section 8.6 to enter the hexadecimal values corresponding to the ASCII characters.

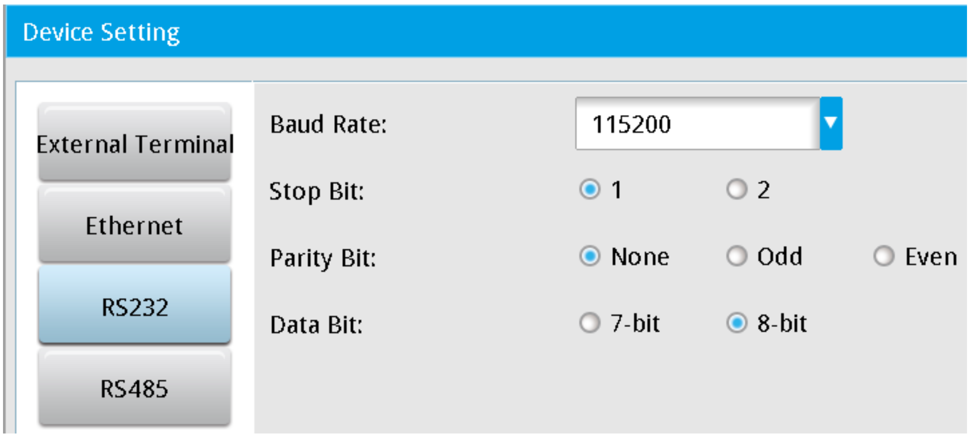


After completing the aforementioned configurations, the system will output data through the RS232/RS485 serial port according to the aforementioned configured methods when private code output is selected.

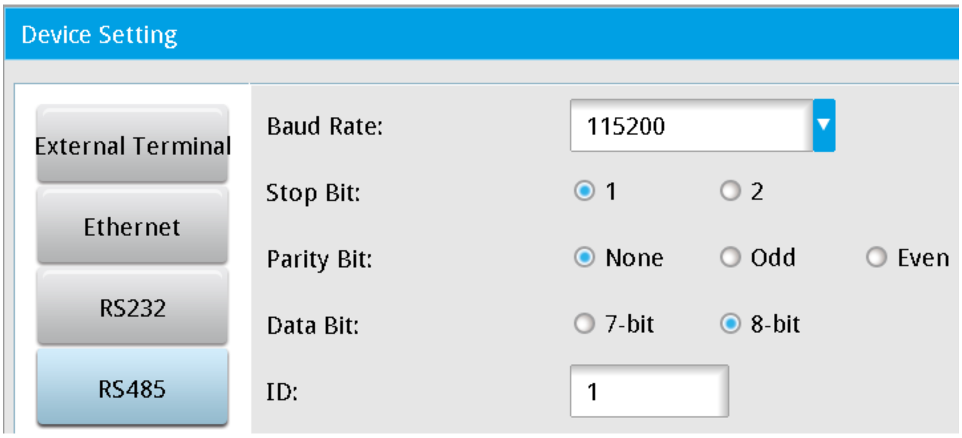
8.3 PLC Automatic Linking Communication Method

In PLC automatic linking communication, the inspection result is automatically written from the DMV to the PLC register and the program developer can directly access the data from the PLC register without the need to decode the data format.

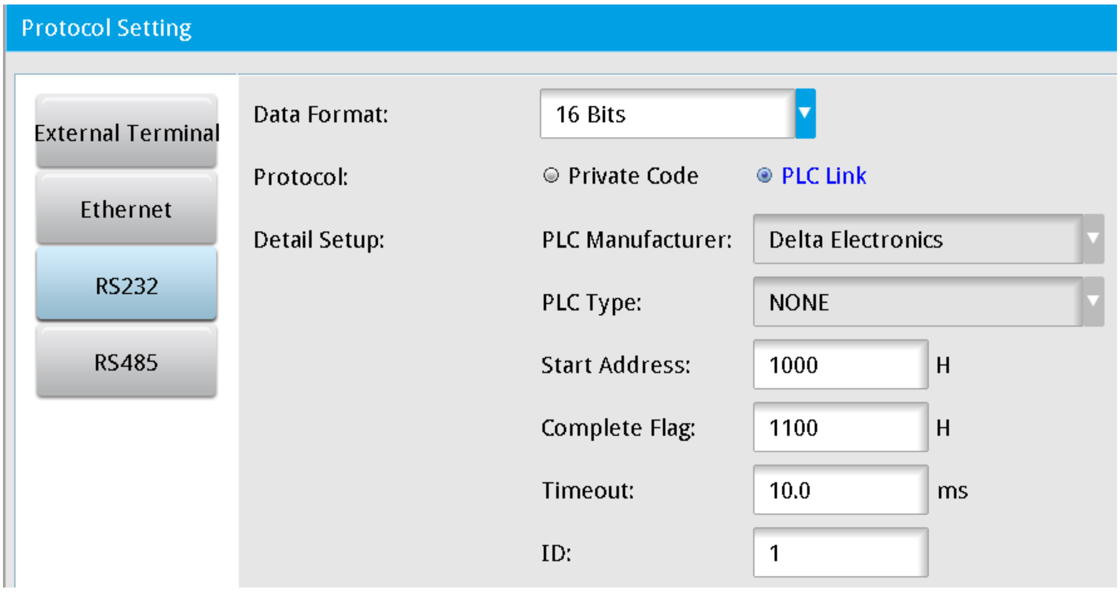
- Configure protocol settings in [System] > [Communication Setting] > [Device Setting] > [RS232]/[RS485]



- Configure DMV host station number in RS485 [ID] options.



➤ Select [PLC Link] in [System] > [Communication Setting] > [Protocol Setting] > [RS232]/[RS485] After making the selections, the system will automatically open the required configuration parameters for PLC automatic linking.



- [Data Format]: 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.

- [PLC Manufacturer]: Currently supports Delta PLC only.

- [PLC Type]: Differing series of PLC from particular brands vary in communication protocols. Therefore, PLC Type must be reselected.

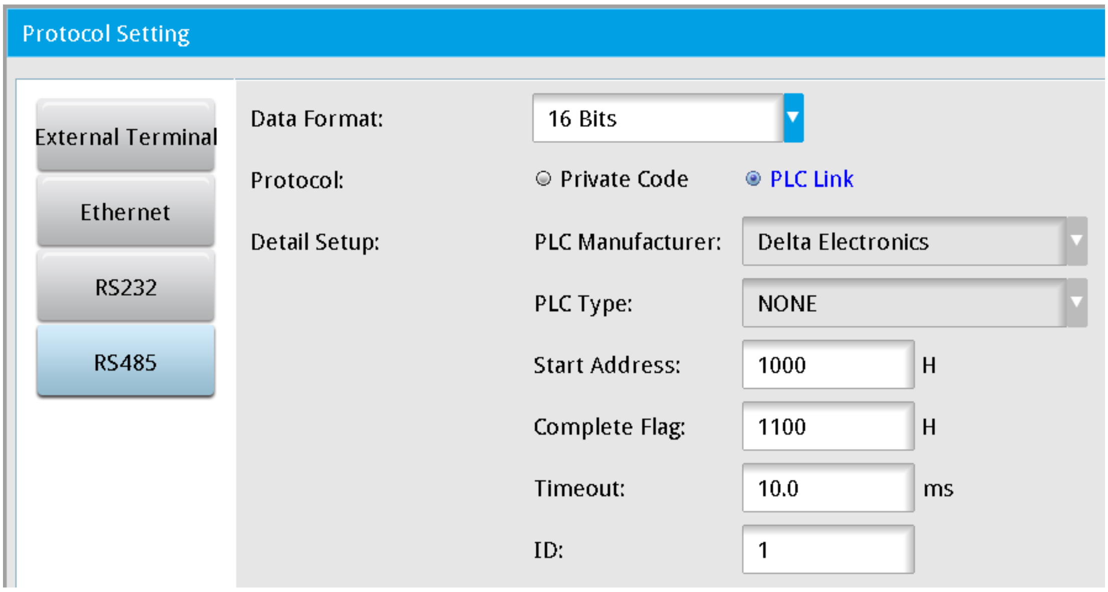
- [Start Address]: Configuring to 1000 means to start saving from the D1000 register address.

- [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., D1100 = 1), please manually set the [Complete Flag] register to 0 for the next write access.

- [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.

- [ID]: Configure the PLC station number to link.

➤ The configuration method for RS485 is identical to that of RS232.

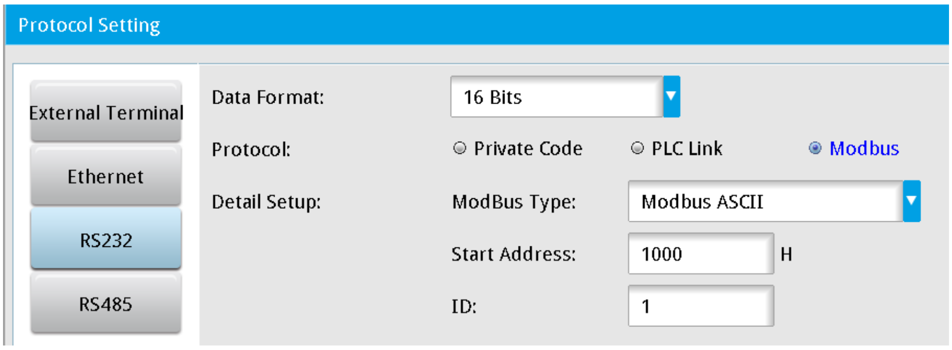


Remark This function currently supports only RS232 and RS485 communication interfaces.

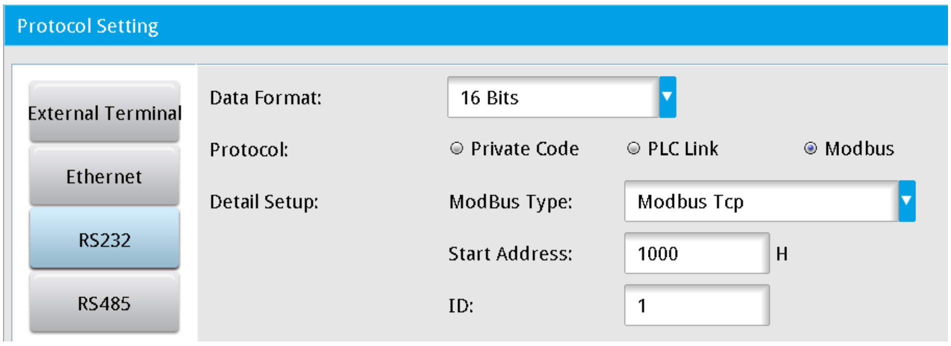
8.4 MODBUS Master Mode Communication Method

When MODBUS communication method is selected, the system will actively sent the data and is definded as Master mode.

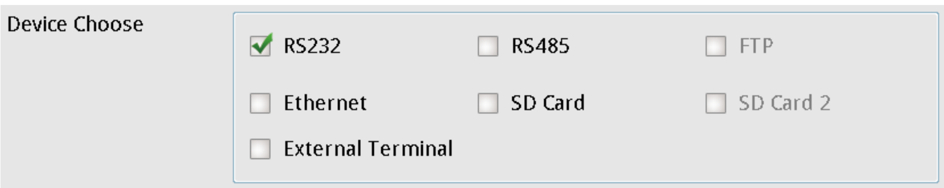
- Select [Modbus] option in [System] > [Communication Setting] > [Protocol Setting] > [RS232]/[RS485] If you need to send the command format in ASCII, please select [Modbus ASCII] in [Modbus Type].



- Select [Modbus] option in [System] > [Communication Setting] > [Protocol Setting] > [RS232]/[RS485] If you need to send the command format in Tcp, please select [Modbus Tcp] in [Modbus Type].



- When modbus is selected, RS232 and RS485 need to be checked in [Result Output] > [Device Choose]. Then the system will start sending data and commands to mechanical arm or other brands PLC.



8.4.1 Modbus ASCII Master Mode Command Table:

When the inspection is completed, DMV will send the data in Modbus ASCII type.

◎ **Write 06 Single Entry Write Command Description: (**the correctly written data string is sent as is)

Output format

:	01	06	1000	0001	E8	CR LF
Header	Node ID	Function code (write)	Function address	Write data	Parity	Suffix

Send 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 6 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

Send format

:	01	10	1070	0002	6E	CR LF
Header	Node ID	Function code	Function address	Writes	Parity	Suffix

Check parity:

Sum two-by-two, then take the two's complement of the last two digits. (add in hexadecimal without 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)

1's complement = FF - 0C = F3 (1's complement is FF minus the value)

Obtain 2' complement = F3 +1 = F4 (2's complement is the sum of 1's complement and 1)

8.4.2 Modbus TCP Master Mode Command Table:

When the inspection is completed, DMV will send the data in Modbus Tcp type.

◎ **Write 06 Single Entry Write Command Description:** (the correctly written data string is sent as is)

Output format

000000000000	01	06	1000	0001
	Node ID	Function code(write)	Function address	Writes

Send format

000000000000	01	06	1000	0001
	Node ID	Function code(write)	Function address	Writes

◎ **Write 10 Multiple Entry Write Command Description:** (maximum length of 6 entries)

Output format

000000000000	01	10	1070	0002	04	0060	0015
	Node ID	Function code(writes)	Function address	Writes	Byte count	Data 1	Data2

Send format

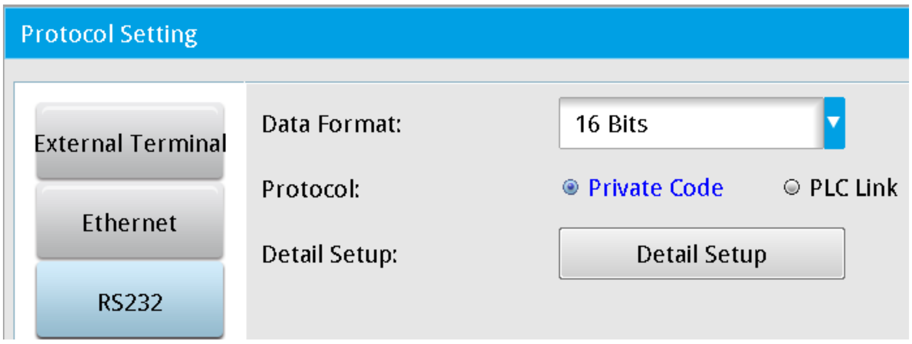
000000000000	01	10	1070	0002
	Node ID	Function code(writes)	Function address	Writes

8.5 MODBUS Communication Method

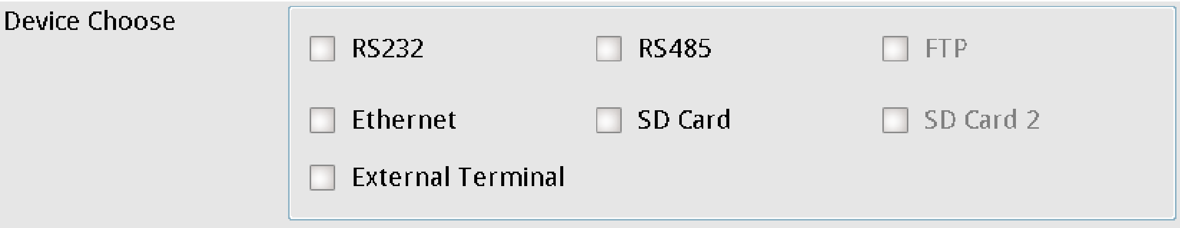
When MODBUS communication method is selected, the system is defined as Slave mode.

➤ Select [Private Code] option in [System] > [Communication Setting] > [Protocol Setting] > [RS232]/[RS485]

When the output data for read access is in 32-bit format, please select [32 Bits] in [Data Format].



- When private code is selected, the system automatically sends out data using the private code method instead of the MODBUS method after completing an inspection. Therefore, RS232 and RS485 need to be unchecked in [Result Output] > [Device Choose]. The system will stop sending data using the private code method and switch to the MODBUS method and await to receive commands.



8.5.1 Slave Mode Command Table: (Modbus Communication Format)

Only ASCII mode is supported. Please refer to the ASCII table in Section 8.5 for detail on ASCII and hexadecimal conversion.

R represents supporting Read commands (03H code; maximum64 entries)

W represents supporting 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:** (the correctly written data string is returned 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 6 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

Check parity:

Sum two-by-two, then take the two's complement of the last two digits. (add in hexadecimal without 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)

1's complement = FF - 0C = F3 (1's complement is FF minus the value)

Obtain 2' complement = F3 +1 = F4 (2's complement is the sum of 1'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	
1002H(W)	(06H)	Trigger 3 action	Trigger if Data 1 is written	O	
1003H(W)	(06H)	Trigger 4 action	Trigger if Data 1 is written	O	
1010H ~ 104FH(R)	(03H)	Output data (total 64 entries)	(please 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 PROG mode	Trigger if Data 1 is written	O	
1060H(R/W)	(03H,06H)	Read/switch program ID	0~999(0~31 internal memory; 32~999memory card)	O	O

1062H(R/W)	(03H,06H)	Read/switch window ID	1000 Start	O	
1070H(W)	(10H)	Read Upper/Lower (Window)	Data ID to read	O	
1071H(W)			Window ID to read		
1072H(R)	(03H)		Read upper limit (Low word)		
1073H(R)	(03H)		Read upper limit (High word)		
1074H(R)	(03H)		Read lower limit (Low word)		
1075H(R)	(03H)		Read lower limit (High word)		
1077H(W)	(10H)	Write Upper/Lower (Window)	Data ID to write		
1078H(W)			Window ID to write		
1079H(W)			Write upper limit (Low word)		
107AH(W)			Write upper limit (High word)		
107BH(W)			Write lower limit (Low word)		
107CH(W)			Write lower limit (High word)		
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)		
10A0H(W)	(10H)	Set camera shutter speed	Camera ID (1~2)	O	
10A1H(W)			Shutter speed (1~15)		
10A2H(W)	(10H)	Set camera gain and brightness	Camera ID (1~2)	O	
10A3H(W)			Gain (00~100)		
10A4H(W)			Luminance (00~100)		
10A5H(W)	(10H)	Password Type	0: Old password 1: New password	O	O
10B0H(W)	(06H)	Enable input trigger	Trigger if Data 1 is written	O	
10B1H(W)	(06H)	Disable input trigger	Trigger if Data 1 is written	O	
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
10B4H(W)	(06H)	Clear statistics	Trigger if Data 1 is written	O	O
10B5H(W)	(06H)	System reset	Trigger if Data 1 is written	O	
10F0H(W)	(10H)	Read Window parameter	Window ID (0~127)	O	O
10F1H(W)			Item Number (0~20)		
10F2H(R)	(03H)		Window Parameter (Low word)		
10F3H(R)	(03H)		Window Parameter (High word)		
10F7H(W)	(10H)	Write Window parameter	Window ID (0~127)	O	O
10F8H(W)			Item Number (0~20)		
10F9H(W)			Window Parameter (Low word)		
10FAH(W)			Window Parameter (High word)		

Common Error Message Code

◎ **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 a "1" is written, the switch is successful if the string returned is identical.

After triggered in Modbus mode, the system will not automatically send out results after completing an inspection. The inspection result will be saved in the 1010H~104H register. When Ready turns ON again, Read command can be sent out to obtain 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 a "1" is written, the switch is successful if the string returned is identical.

After triggered in Modbus mode, the system will not automatically send out results after completing an inspection. The inspection result will be saved in the 1010H~104H register. When Ready turns ON again, Read command can be sent out to obtain 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) Trigger3 Action 1000H (W) (RUN Mode enabled)

Input string: 010610020001 E6 CR LF   Return string: 010610020001 E6 CR LF

◎ **Description:** After a "1" is written, the switch is successful if the string returned is identical.

After triggered in Modbus mode, the system will not automatically send out results after completing an inspection. The inspection result will be saved in the 1010H~104H register. When Ready turns ON again, Read command can be sent out to obtain 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)

4) Trigger4 Action 1000H (W) (RUN Mode enabled)

Input string: 010610030001 E5 CR LF   Return string: 010610030001 E5 CR LF

◎ **Description:** After a "1" is written, the switch is successful if the string returned is identical.
After triggered in Modbus mode, the system will not automatically send out results after completing an inspection. The inspection result will be saved in the 1010H~104H register. When Ready turns ON again, Read command can be sent out to obtain 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)

5) 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 2 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 2 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 output value exceeds 65535, please select set data format to [32bits] to prevent writing to the wrong register.

Judge (0/1) Data Format: (return bit2=0, bit3=1, bit4=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 settings ([16bits] or [32bits]).
For example: (Return data is 400,000 and a set of Judge values of bit2=0, bit3=1, bit4=1)
Now, please read 3 entries of string length: 010310100003 D9 CR LF (one entry of DW data and one entry of W Judge content)
System will return: 01030600061A8000183E CR LF

◎ **Error Handling:** Return string

- :01830478 CR LF : Unable to execute (system permits incorrect operating status)

6) Switch to RUN Mode 1050H (W) (Edit Mode enabled)

Input string: 010610500001 5A CR LF Return string: 010610500001 5A CR LF

◎ **Description:** After a "1" is written, 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)

7) Switch to Edit_mode 1051H (W) (RUN Mode enabled)

Input string: 010610510001 97 CR LF Return string: 010610510001 97 CR LF

◎ **Description:** After a "1" is written, 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)

8) 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: 010310600001 8B CR LF Return string: 010302000A F0 CR LF

◎ **Description:** 10(dec) is 000A(hex).

Switch Program ID: (switch program ID to 20)

Input string: 010610600014 75 CR LF Return string: 010610600014 75 CR LF

◎ **Description:** 20(dec) is 0014(hex).

After the value is written, 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 configured)
- :01860B6E CR LF : Unable to execute (current page unsupported)

9) Read/Switch Window ID 1062H (R/W) (RUN Mode enabled)

Read Window ID: (returns current window ID 50)

Input string: 010310620001 89 CR LF Return string: 0103020032 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 the value is written, 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 configured)
- :01860475 CR LF : Unable to execute (system permits incorrect operating status)

10) Read Upper/Lower (Window) 1070H~1075H (RUN Mode enabled)

The following 6 registers are required to read the Upper/Lower limits of [Window].

1070H (R/W) – Data Item Number to Read/Write

1071H (R/W) – Window ID to Read/Write

1072H (R) – Upper Read Limit (Low word)

1073H (R) – Upper Read Limit (High word)

1074H (R) – Lower Read Limit (Low word)

1075H (R) – Lower Read Limit (High word)

◆ The data to be accessed, [Data Item Number 1070H] and [Window ID 1071H], are first written to the register, then the required data can be accessed from the addresses 1072H~1075H.

Read Upper/Lower Limit: (i.e., data ID =2, window ID = 5, upper/lower limits are 500,000 and 300)

First enter string: 01101070000204000200 05 62 CR LF Return string: 011010700002 6D CR LF

◎ **Description:** Entering 2 words now is represented by 0002.

2 words consist of 4 bytes. Enter 04

Decimal 2 is 0002 (hex).

Decimal 5 is 0005 (hex).

Then enter read string: 010310720004 76 CR LF

Return string: 0103080007A1200000012C FF CR LF

◎ **Description:** Now the system will read 4 words, which consist of 8 bytes. Enter 08
Decimal 500,000 is 0007A120 (hex).
300(dec) is 0000012C (hex).
Upper/lower limits are fixed DW (32bits) format.

◎ **Error Handling:** Return string

- :01830379 CR LF : Incorrect content or length of read data
- :01830478 CR LF : Unable to execute (system permits incorrect operating status and no data item number or window ID)
- :01860376 CR LF : Incorrect content or length of write data
- :01860475 CR LF : Unable to execute (system permits incorrect operating status and no window ID)
- :01860B6E CR LF : Unable to execute (data item number does not exist)

11) Write Upper/Lower (Window) 1077H~107CH (RUN Mode enabled)

The following 6 registers are required to write the Upper/Lower limits of [Window]. Through multiple write commands, the 6 entries of values can be simultaneously written to the register according to the following order to complete modifying the Upper/Lower limits.

1077H (W) – data item number written
1078H (W) – window ID written
1079H (W) – upper limit written (Low word)
107AH (W) – upper limit written (High word)
107BH (W) – lower limit written (Low word)
107CH (W) – lower limit written (High word)

Write Upper/Lower: (i.e., data ID =6, window ID = 20, upper/lower limits are 600,000 and 400)
Input string: 0110107700060C00060014000927C000000190 BB CR LF
Return string: 011010770006 62 CR LF

◎ **Description:** Entering 6 words now is represented by 0006.
6 words consist of 12 bytes. Enter 0C
Decimal 6 is 0006 (hex).
Decimal 20 is 0014 (hex).
Decimal 600,000 is 000927C0 (hex).
Decimal 400 is 00000190 (hex).
Upper/lower limits are fixed DW (32bits) format.

◎ **Error Handling:** Return string

- :01860475 CR LF : Unable to execute (system permits incorrect operating status and no window ID)
- :01860B6E CR LF : Unable to execute (data item number does not exist)

12) 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: (i.e., 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: (i.e., the content to write is 2011/08/25 12:30:40)

First enter string 0110109000060C000B00080019000C001E0028 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 to the date/time, single write 06 is also supported.

◎ **Error Handling:** Return string

➤ :01860376 CR LF : Incorrect content or length of write data

13) Set Camera Shutter Speed 10A0H~10A1H(RUN Mode enabled)

The following two registers are required to write [Camera shutter speed]. With multi write, both register writes can be issued at the same time.

10A0H (W) – Camera ID (1~2)

10A1H (W) – Shutter Speed (1~20)

01= 6000ms	05= 2000ms	09= 33.33ms	13= 4.17ms	17= 0.2ms
02= 5000ms	06= 1000ms	10=16.67ms	14= 2ms	18= 0.1ms
03= 4000ms	07= 500ms	11=10ms	15= 1ms	19= 0.05ms
04= 3000ms	08= 66.67ms	12= 8.33ms	16= 0.5ms	20= 0.025ms

Write Settings: (i.e., set Camera2 shutter speed to 0.5 ms)

Input string: 011610A00002040002000A 2D CR LF

Return string: 011610A00002 3D CR LF

◎ **Description:** Entering 2 words now is represented by 0002.

2 words consist of 4 bytes. Enter 04

2(dec) is 0002(hex).

Decimal 10 is 000A (hex).

◎ **Error Handling:** Return string

- :01860475 CR LF : Unable to execute (system permits incorrect operating status and no cameras)

14) Set Camera Gain and Luminance 10A2H~10A4H (RUN Mode enabled)

The following three registers are required to write [Gain and brightness]. With multi write, the three register writes can be issued at the same time.

10A2H (W) – Camera ID (1~2)

10A3H (W) – Gain (00~100; larger values generate brighter images)

10A4H (W) – Luminance (00~100; larger values generate brighter images)

Write Settings: (i.e., set Camera2 Gain and Luminance to 50 and 70, respectively)

Input string: 011010A2000306000200320046 BA CR LF

Return string: 011010A20003 3A CR LF

◎ **Description:** 2(dec) is 0002(hex).

Decimal 50 is 0032 (hex).

Decimal 70 is 0046 (hex).

◎ **Error Handling:** Return string

- :01860475 CR LF : Unable to execute (system permits incorrect operating status and no cameras)

15) Change Password 10A5H~10ADH (RUN Mode and Edit Mode enabled)

The following registers are required to change the password. Multiple write commands are used in which, a command must be entered according to the specific password type to confirm the old password before entering a command to change the password.

10A5H (W) – Password Type (2 codes)

10A6H~10AD (W) – Enter Password (4~16codes according to password length)

Write Settings: (i.e., change the password from 1234 to 5678)

Input string: 011010A50003060000041424344 27 CR LF

011010A5000306000145464748 16 CR LF

Return string: 011010A50003 36 CR LF

◎ **Description:** According to the ASCII conversion table, the numeric value 1234 will be converted to 41424344.

According to the ASCII conversion table, the numeric value 5678 will be converted to 45464748.

◎ **Error Handling:** Return string

- :01860376 CR LF : Incorrect content or length of write data
- :01860772 CR LF : Unable to execute (old password input error)

HEX	ASCII	HEX	ASCII	HEX	ASCII
20	SPACE	41	A	61	a
21	!	42	B	62	b
25	%	43	C	63	c
28	(	44	D	64	d
29	)	45	E	65	e
2B	+	46	F	66	f
2D	-	47	G	67	g
2E	.	48	H	68	h
30	0	49	I	69	i
31	1	4A	J	6A	j
32	2	4B	K	6B	k
33	3	4C	L	6C	l
34	4	4D	M	6D	m
35	5	4E	N	6E	n
36	6	4F	O	6F	o
37	7	50	P	70	p
38	8	51	Q	71	q
39	9	52	R	72	r

3D	=	53	S	73	s
5B	[	54	T	74	t
5D	]	55	U	75	u
5F	_	56	V	76	v
		57	W	77	w
		58	X	78	s
		59	Y	79	y
		5A	Z	7A	z

16) Enable Trigger Input 10B0H (W) (RUN Mode enabled)

Input string: 010610B00001 38 CR LF   Return string: 010610B00001 38 CR LF

◎ **Description:** After writing the numeric value "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
- 01860475 CR LF : Unable to execute (system permits incorrect operating status)

17) Disable Trigger Input 10B1H (W) (RUN Mode enabled)

Input string: 010610B10001 37 CR LF   Return string: 010610B10001 37 CR LF

◎ **Description:** After writing the numeric value "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
- :01860475 CR LF : Unable to execute (system permits incorrect operating status)

18) 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 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)

19) 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", image capture is successful if the string returned is identical.

◎ **Error Handling:** Return string

➤ :01860376 CR LF : Incorrect content or length of write data

20) Clear Statistics 10B4H (W) (RUN Mode and Edit_mode enabled)

Input string: 010610B40001 34 CR LF Return string: 010610B40001 34 CR LF

◎ **Description:** After writing the numeric value "1", statistics data is successfully cleared if the string returned is identical.

◎ **Error Handling:** Return string

➤ Please refer to common error message code

21) System Reset 10B5H (W) (RUN Mode enabled)

Input string: 010610B50001 33 CR LF Return string: 010610B50001 33 CR LF

◎ **Description:** After writing the numeric value "1", system reset is successful if the string returned is identical.

◎ **Error Handling:** Return string

➤ Please refer to common error message code

22) Read Window Parameter 10F0H~10F1H (W) 10F2H~10F3H (R) (RUN Mode enabled)

The following 4 registers must be used to read the configured value of [Parameter].

10F0H (W) – Item number to read

10F1H (W) – Window ID to read

10F2H (R) – Read window parameter (Low word)

10F3H (R) – Read window parameter (High word)

◆ The data to be accessed, [Data Item Number 10F0H] and [Window ID 10F1H] (please see Table 4), are written to the register, then the required data can be accessed from the addresses 10F2H~10F3H.

Read Upper/Lower Limit: (i.e., read W010, the binary lower limit of [Area], which is 50)

First enter string 010610F00001 08 CR LF Return string: 010610F00001 08 CR LF

◎ **Description:** 1(dec) is 0001(hex).

First enter string 010610F1000A FE CR LF Return string: 010610F1000A FE CR LF

◎ **Description:** 10(dec) is 000A(hex).

Then enter read string: 010310F20002 08 CR LF

Return string: 01030400320000 C6 CR LF

◎ **Description:** 50(dec) is 0032(hex).

Upper/lower limits are fixed DW (32 bits) data structures.

◎ **Error Handling:** Return string

- :01830379 CR LF : Incorrect content or length of read data
- :01830478 CR LF : Unable to execute (system permits incorrect operating status and no window ID or item number)
- :01860475 CR LF : Unable to execute (system permits incorrect operating status and no item number)
- :01860B6E CR LF : Unable to execute (window ID does not exist)

23) Write Window Parameter 10F7H~10FAH (W) (RUN Mode enabled)

The following 4 registers must be used to write the configured value of [Parameter]. Through multiple entries of write commands, 4 entries of numeric values can be simultaneously written to the register to complete modifying the upper and lower limits.

10F7H (W) – Item number to write

10F8H (W) – Window ID to write

10F9H (W) – Write window parameter (Low word)

10FAH (W) – Write window parameter (High word)

Write Upper/Lower: (i.e., write W001; the [Edge Intensity] parameter of [Edge Position] is 20)

Numeric values must be written to 10F7H according to order. Select the item number to write, write the window ID to the address 10F8H, and then

fill in the numeric value to configure.

Input string: 011010F70004080002000100140000 C5 CR LF

Return string: 011010F70004 E4 CR LF

◎ **Description:** 20(dec) is 0014(hex).

Upper/lower limits are fixed DW (32bits) format.

◎ **Error Handling:** Return string

- :01860475 CR LF : Unable to execute (system permits incorrect operating status and no item number)
- :01860B6E CR LF : Unable to execute (window ID does not exist)

8.6 ASCII Code Table

The bolded characters are currently used by DMV. (HEX denotes hexadecimal)

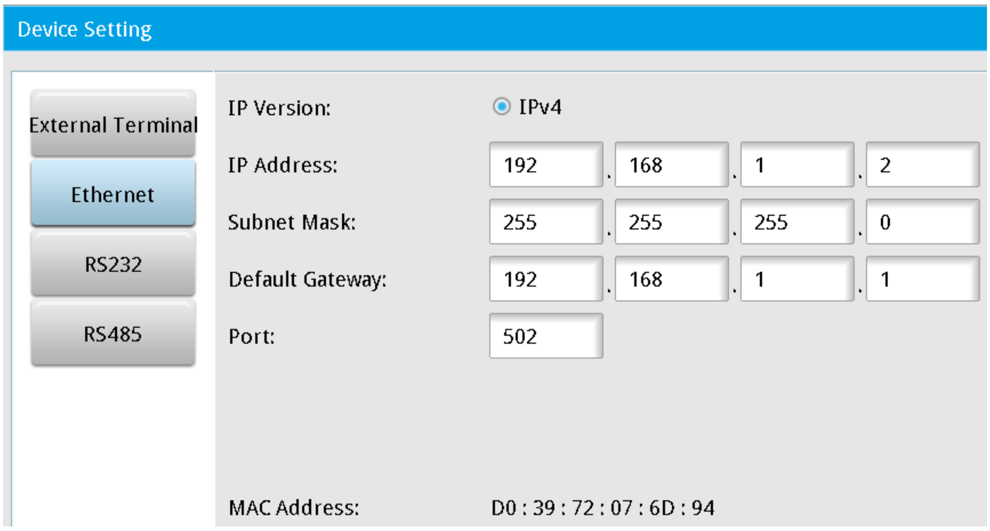
HEX	ASCII	HEX	ASCII	HEX	ASCII	HEX	ASCII
0	NUL	20	SPACE	40	@	60	`
1	SOH	21	!	**41**	**A**	61	a
2	STX	22	“	**42**	**B**	62	b
3	ETX	23	#	**43**	**C**	63	c
4	EOT	24	$	**44**	**D**	64	d
5	ENQ	25	%	**45**	**E**	65	e
6	ACK	26	&	**46**	**F**	66	f
7	BEL	27	‘	**47**	**G**	67	g
8	BS	28	(	**48**	**H**	68	h
9	TAB	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

8.7 Ethernet Private Code Communication

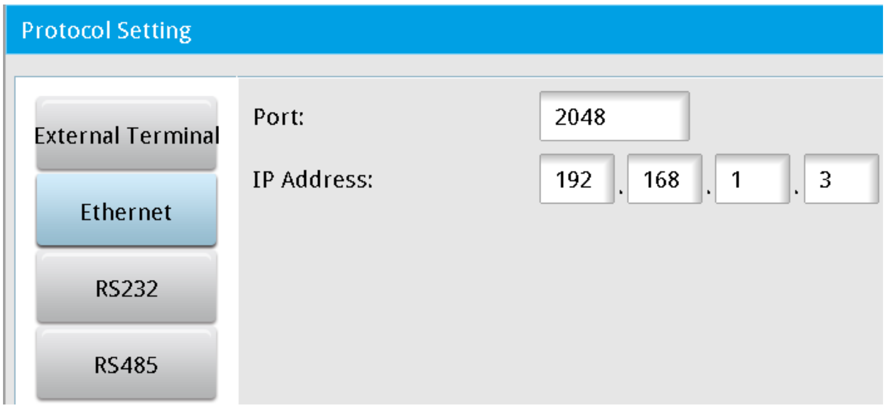
In private code communication, the system will automatically send out the results from the DMV after completing the inspection. After receiving the strings, the required results are generated through manual decoding according to the defined format. Besides transmitting inspection results, private code also supports multiple written control commands.

The following explains the private code communication format configurations through the Ethernet.

- Configure the DMV2000 IP location in [System] > [Communication Setting] > [Device Setting] > [Ethernet]



- Configure the IP location for data source reception in [System] > [Communication Setting] > [Device Setting] > [Ethernet]
- [IP Address]: For example, configure to 192.168.1.3
- [Port]: Configure to 503



After completing each inspection, the system actively returns the following string: T0 + Output data CR

◎ **Description:** For example, in Integer Type, the data to return is (1234).

The system returns: T001234.00 CR

Reference The user can customize the format to determine whether the output data type consists of decimal places and specific decimal lengths. Please refer to Section 8.6.3.

8.7.1 Ethernet Private Code Mode Command Table: (DMV Custom Communication Format)

	Function	**Input string**	**Permission**	
			Run	Edit
1	Trigger 1 action and output	T1	O	
2	Trigger 2 action and output	T2	O	
3	Trigger 3 action and output	T3		
4	Trigger 4 action and output	T4		
5	Go to run mode	RN		O
6	Go to program mode	PG	O	

8.7.2 Ethernet Private Code Mode Commands: (DMV Custom Communication Format)

1) Trigger1 Action and Output Data (RUN Mode enabled)

Input string: T1 Return string: T0 + Output data CR

◎ **Description:** In Integer Type, the data to return is (1234).

Return: T001234.00 CR

Reference The user can customize the format to determine whether the output data type consists of decimal places and specific decimal lengths. Please refer to Section 8.6.3.

2) Trigger2 Action and Output Data (RUN Mode enabled)

Input string: T2 Return string: T0 + Output data CR

◎ **Description:** In Integer Type, the data to return is (1234).

Return: T001234.00 CR

Reference The user can customize the format to determine whether the output data type consists of decimal places and specific decimal lengths. Please refer to Section 8.6.3.

3) Trigger3 Action and Output Data (RUN Mode enabled)

Input string: T3 Return string: T0 + Output data CR

◎ **Description:** In Integer Type, the data to return is (1234).

Return: T001234.00 CR

Reference The user can customize the format to determine whether the output data type consists of decimal places and specific decimal lengths. Please refer to Section 8.6.3.

4) Trigger4 Action and Output Data (RUN Mode enabled)

Input string: T4 Return string: T0 + Output data CR

◎ **Description:** In Integer Type, the data to return is (1234).

Return: T001234.00 CR

Reference The user can customize the format to determine whether the output data type consists of decimal places and specific decimal lengths. Please refer to Section 8.6.3.

5) To Run Mode (Edit Mode enabled)

Input string: RN

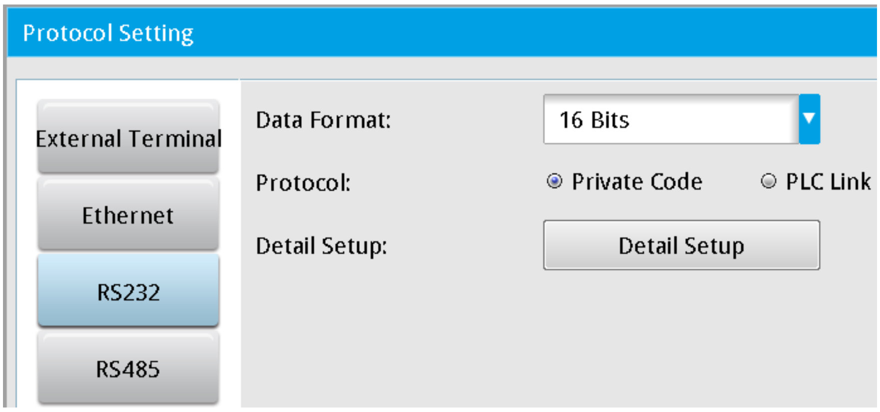
6) To Setting Mode (Run Mode enabled)

Input string: PG

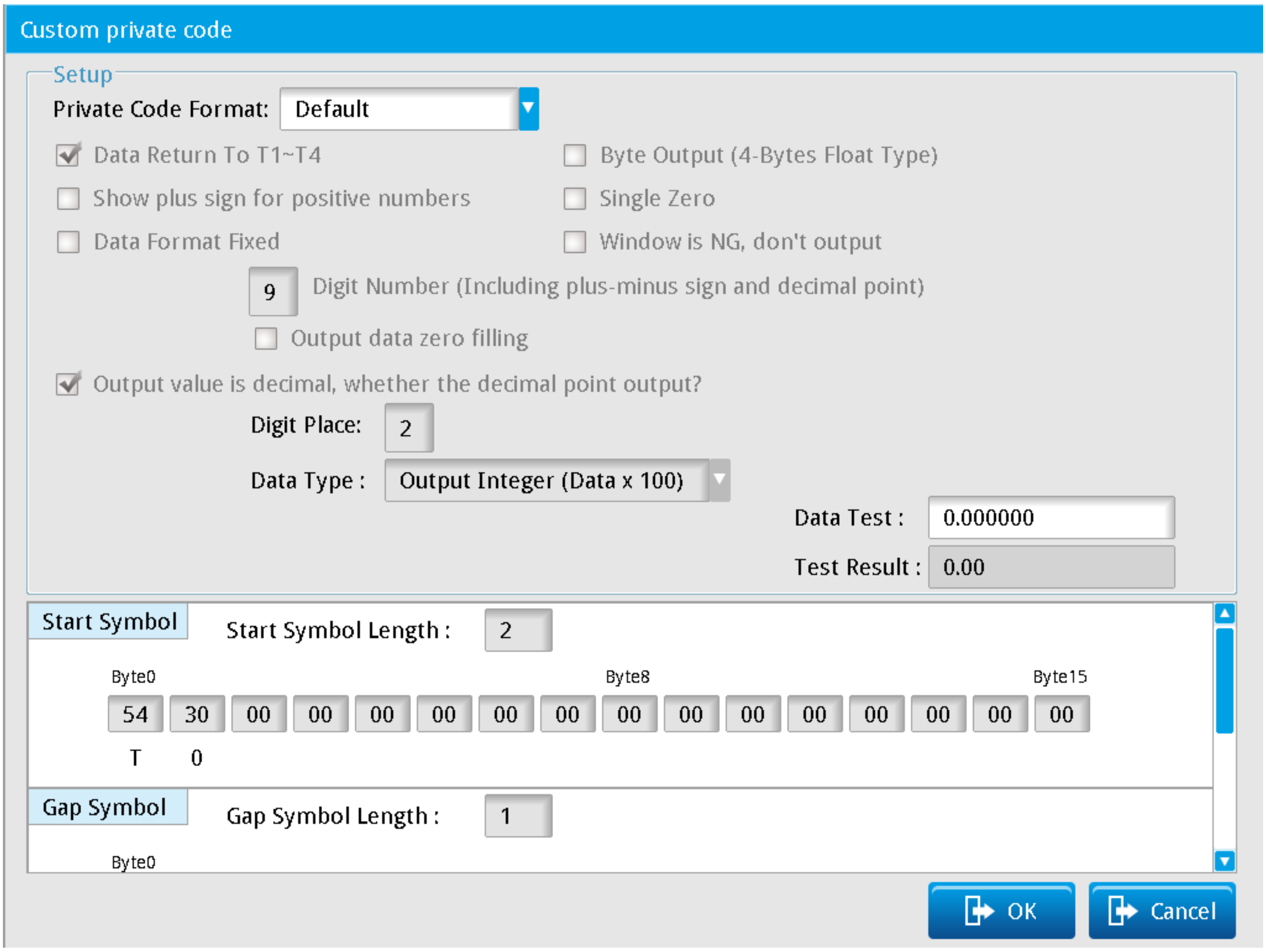
8.7.3 Ethernet Private Code Custom Output Data Format

When outputting result data using private code through Ethernet, the user can also define the output data format.

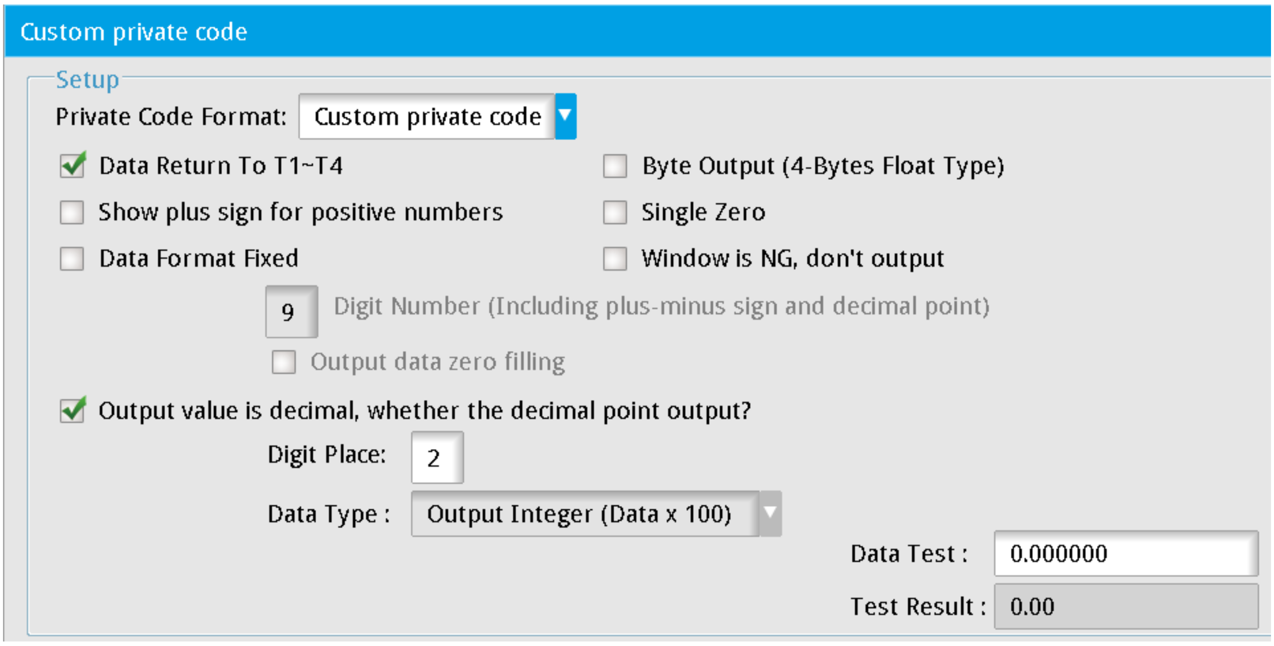
➤ Select [Detail Setup] in [System] > [Communication Setting] > [Protocol Setting] > [RS232]/[RS485]



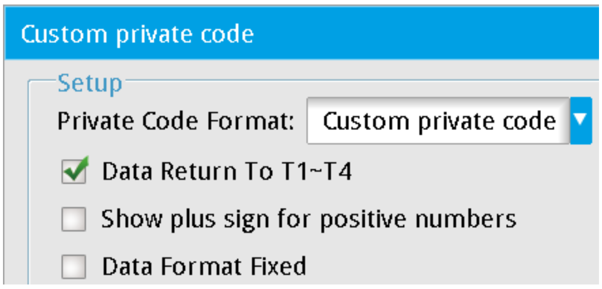
➤ Open the [Custom private code] dialog box; the factory setting of [Private Code Format] is [Default] In default conditions, the format of result output is shown in the following diagram.



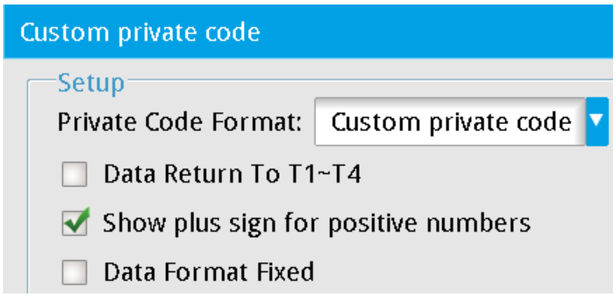
➤ Selecting [Custom private code] in [Private Code Format] opens the configuration items below.



➤ [Data Return T1~T4] The option is unavailable when outputting results through the Ethernet.

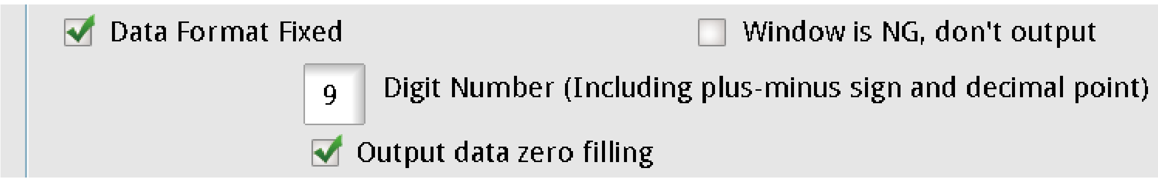


➤ [Show plus sign for positive numbers]: When checked, plus sign will be added to all positive result data.
When private code sends out negative data, negative signs will always be added before the values regardless of this option.



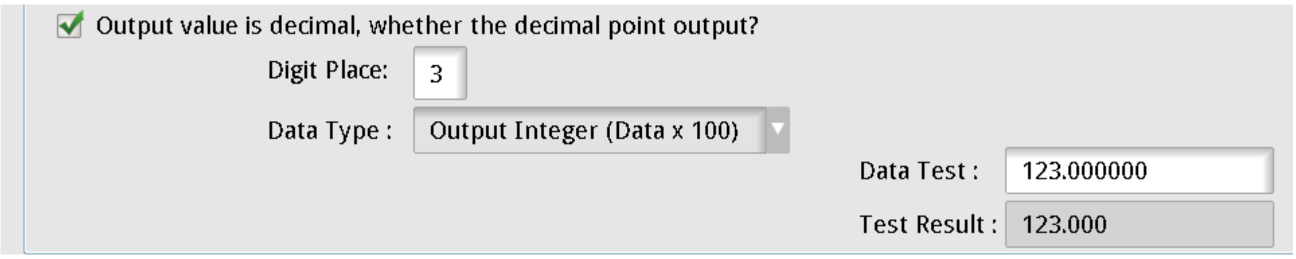
➤ [Data Format Fixed]: When checked, data will output in fixed decimal places.

For example: The original output value is 123.00, checking the option will output the data as 000123.00.



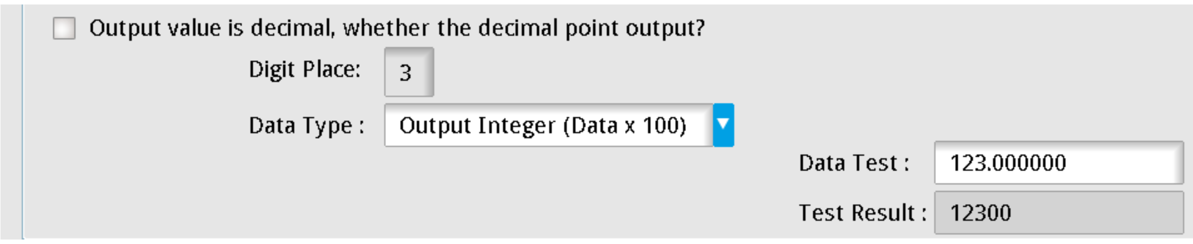
➤ [Output value is decimal, whether the decimal point output?] : When checked, the output decimal place will be based on the configured [Digit Place].

For example: The lower right value was originally 123.000000, the actual output will be 123.000.



➤ [Output value is decimal, whether the decimal point output?] : When unchecked, the output result will be generated after multiplying [Data Type].

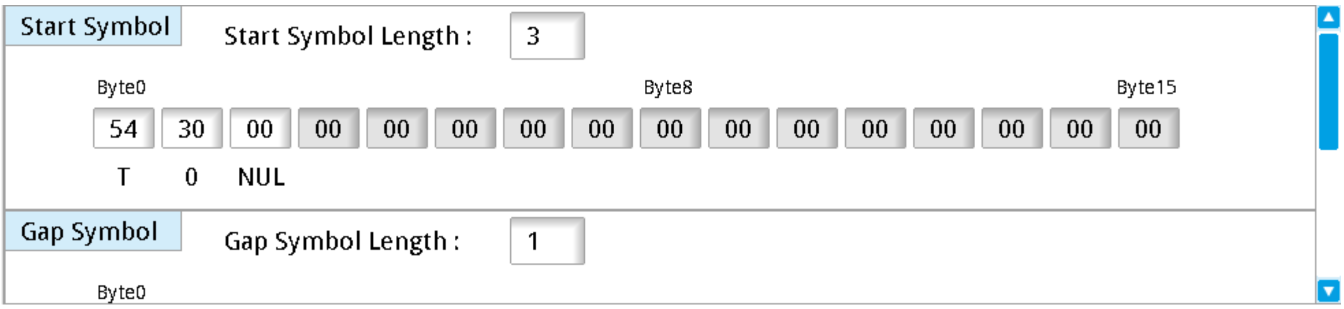
For example: The original value on the lower right is 123.000000 and "Output Integer (Data x 100)" is selected as the Data Type, and the actual output will be 12300.



➤ Custom output result string format

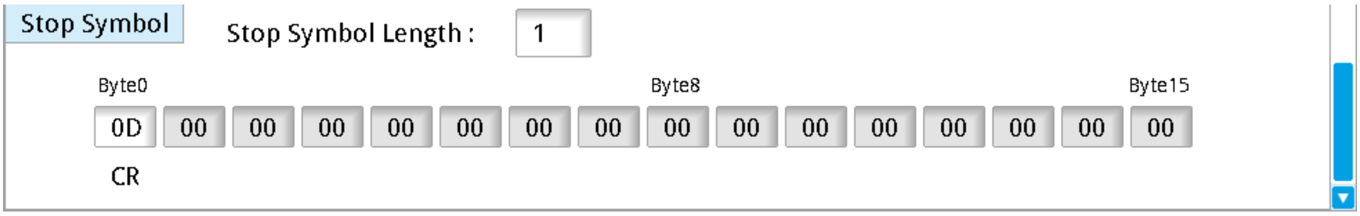
Output format is [Start Symbol] + [Result1] + [Gap Symbol] + [Result2] + [Gap Symbol]…+ [Stop Symbol].

◆ [Start Symbol]: First determine [Start Symbol Length] As shown in the following diagram, configuring Start Symbol Length to 3 means that the start symbol comprise 3 characters. Please refer to the ASCII table in Section 8.6 to enter the hexadecimal values corresponding to the ASCII characters.



- [Gap Symbol]: First determine [Gap Symbol Length] As shown in the following diagram, configuring Gap Symbol Length to 1 means that the gap symbol consists of 1 character. Please refer to the ASCII table in Section 8.6 to enter the hexadecimal values corresponding to the ASCII characters.

- [Stop Symbol]: First decide [Stop Symbol Length] As shown in the following diagram, configuring Stop Symbol Length to 1 means that the stop symbol consists of 1 character. Please refer to the ASCII table in Section 8.6 to enter the hexadecimal values corresponding to the ASCII characters.

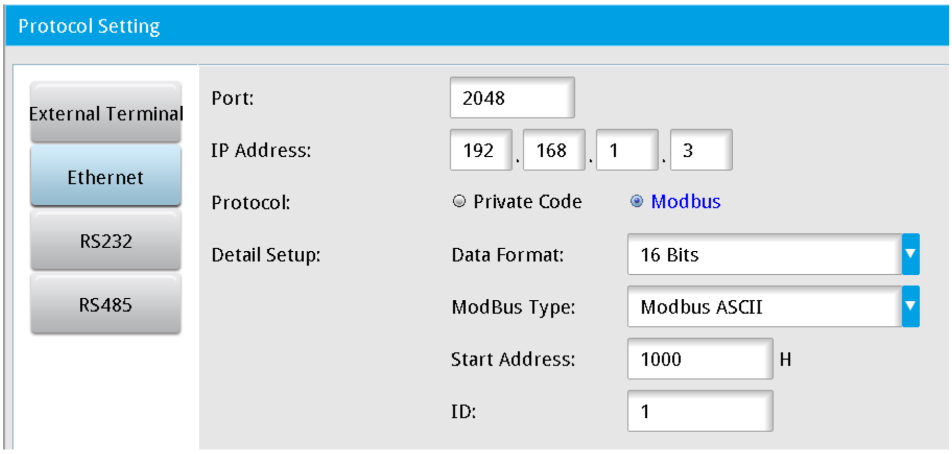


After completing the aforementioned configurations, the system will output data through the Ethernet port according to the aforementioned configured methods when private code output is selected.

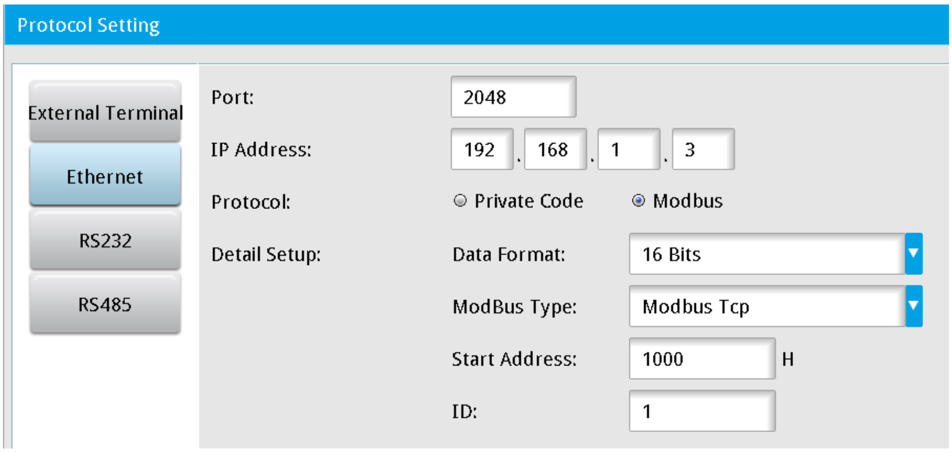
8.8 Ethernet MODBUS Server Mode Communication Method

MODBUS Master (Server) communication mode is divided into MODBUS ASCII and MODBUS TCP
.

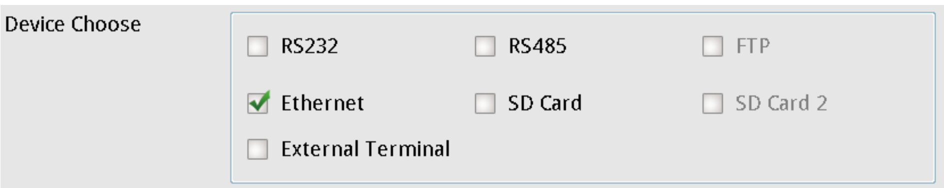
- Select [Modbus] option in [System] > [Communication Setting] > [Protocol Setting] > [Ethernet]
  If you need to send the command format in ASCII, please select [Modbus ASCII] in [Modbus Type].



- Select [Modbus] option in [System] > [Communication Setting] > [Protocol Setting] > [Ethernet]
  If you need to send the command format in Tcp, please select [Modbus Tcp] in [Modbus Type].



- When modbus is selected, RS232 and RS485 need to be checked in [Result Output] > [Device Choose]. Then the system will start sending data and commands to mechanical arm or other brands PLC.



8.8.1 Ethernt Modbus ASCII Server Mode Command Table:

When the inspection is completed, DMV will send the data in Modbus ASCII type.

◎ **Write 06 Single Entry Write Command Description:** (the correctly written data string is sent as is)

Output format

000000000000	:	01	06	1000	0001	E8	CR LF
	Header	Node ID	Function code (write)	Function address	Write data	Parity	Suffix

Send format

000000000000	:	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 6 entries)

Output format

000000000000	:	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

Send format

000000000000	:	01	10	1070	0002	6E	CR LF
	Header	Node ID	Function code	Function address	Writes	Parity	Suffix

Check parity:

Sum two-by-two, then take the two's complement of the last two digits. (add in hexadecimal without header)

For example: 01101070000204006000015 F4 CR LF

01+10+10+70+00+02+04+00+60+00+15 = 10C (take the last 2 codes 0C)

1's complement = FF - 0C = F3 (1's complement is FF minus the value)

Obtain 2' complement = F3 +1 = F4 (2's complement is the sum of 1's complement and 1)

8.8.2 Ethernt Modbus TCP Server Mode Command Table:

When the inspection is completed, DMV will send the data in Modbus Tcp type.

◎ **Write 06 Single Entry Write Command Description:** (the correctly written data string is sent as is)

Output format

000000000000	01	06	1000	0001
	Node ID	Function code (write)	Function address	Write data

Send format

000000000000	01	06	1000	0001
	Node ID	Function code (write)	Function address	Write data

◎ **Write 10 Multiple Entry Write Command Description:** (maximum length of 6 entries)

Output format

000000000000	01	10	1070	0002	04	0060	0015
	Node ID	Function code	Function address	Writes	Byte count	Data 1	Data 2

Send format

000000000000	01	10	1070	0002
	Node ID	Function code	Function address	Writes

8.9 Ethernet MODBUS TCP Communication Method

The MODBUS TCP/IP communication method is a built-in model. The system is defined as slave (Client) mode.

8.9.1 Ethernet Client Mode Command Table: (Modbus TCP Communication Format)

R represents for supporting Read commands (03H code; maximum64 entries)
W represents supporting 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

000000000000	01	03	1010	0002
	Node ID	Function code (read)	Function address	Data ID

Return format

000000000000	01	03	04	0010	0015
	Node ID	Function code (read)	Number of entries (Byte)	Result 1	Result 2

◎ **Write 06 Single Entry Write Command Description:** (the correctly written data string is returned as is)

Output format

000000000000	01	06	1000	0001
	Node ID	Function code (write)	Function address	Write data

Return format

000000000000	01	06	1000	0001
	Node ID	Function code (write)	Function address	Write data

◎ **Write 10 Multiple Entry Write Command Description:** (maximum length of 6 entries)

Output format

000000000000	01	10	1070	0002	04	0060	0015
	Node ID	Function code	Function address	Writes	Byte count	Data 1	Data 2

Return format

000000000000	01	10	1070	0002
	Node ID	Function code	Function address	Writes

◆ **MODBUS TCP 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	
1002H(W)	(06H)	Trigger 3 action	Trigger if Data 1 is written	O	
1003H(W)	(06H)	Trigger 4 action	Trigger if Data 1 is written	O	
1010H ~ 104FH(R)	(03H)	Output data (total 64 entries)	(please refer to the following descriptions for output data)	O	
1050H(W)	(06H)	Switch to RUN mode	Trigger if Data 1 is written		O
1051H(W)	(06H)	Switch to PROG mode	Trigger if Data 1 is written	O	
1060H(R/W)	(03H,06H)	Read/switch program ID	0~999(0~31 internal memory; 32~999memory card)	O	O
1062H(R/W)	(03H,06H)	Read/switch window ID	0~127	O	
1070H(W)	(10H)	Read Upper/Lower (Window)	Data ID to read	O	
1071H(W)			Window ID to read		
1072H(R)	(03H)		Read upper limit (Low word)		
1073H(R)	(03H)		Read upper limit (High word)		
1074H(R)	(03H)		Read lower limit (Low word)		
1075H(R)	(03H)		Read lower limit (High word)		

1077H(W)	(10H)	Write Upper/Lower (Window)	Data ID to write		
1078H(W)			Window ID to write		
1079H(W)			Write upper limit (Low word)		
107AH(W)			Write upper limit (High word)		
107BH(W)			Write lower limit (Low word)		
107CH(W)			Write lower limit (High word)		
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)		
10A0H(W)	(10H)	Set camera shutter speed	Camera ID (1~2)	O	
10A1H(W)			Shutter speed (1~15)		
10A2H(W)	(10H)	Set camera gain and brightness	Camera ID (1~2)	O	
10A3H(W)			Gain (00~100)		
10A4H(W)			Luminance (00~100)		
10A5H(W)	(10H)	Password Type	0: Old password 1: New password	O	O
10B0H(W)	(06H)	Enable input trigger	Trigger if Data 1 is written	O	
10B1H(W)	(06H)	Disable input trigger	Trigger if Data 1 is written	O	
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
10B4H(W)	(06H)	Clear statistics	Trigger if Data 1 is written	O	O
10B5H(W)	(06H)	System reset	Trigger if Data 1 is written	O	
10F0H(W)	(10H)	Read Window parameter	Window ID (0~127)	O	O
10F1H(W)			Item Number (0~20)		
10F2H(R)	(03H)		Window Parameter (Low word)		
10F3H(R)	(03H)		Window Parameter (High word)		
10F7H(W)	(10H)	Write Window parameter	Window ID (0~127)	O	O
10F8H(W)			Item Number (0~20)		

10F9H(W)			Window Parameter (Low word)		
10FAH(W)			Window Parameter (High word)		

Common Error Message Code

◎ **Error Handling (W):** Return string

- 00000000000001860178: Function code unsupported
- 00000000000001860277: Write address error

Error Handling (R): Return string

- 0000000000000183017B: Function code unsupported
- 0000000000000183027A: Read address error

1) Trigger 1 Action 1000H (W) (RUN Mode enabled)

Input string: 000000000000010610000001 Return string: 000000000000010610000001

◎ **Description:** After a "1" is written, the switch is successful if the string returned is identical.
After triggered in Modbus mode, the system will not automatically send out results after completing an inspection. The inspection result will be saved in the 1010H~104H register. When Ready turns ON again, Read command can be sent out to obtain inspection results.

◎ **Error Handling:** Return string

- 00000000000001860376: Incorrect content or length of write data (only one entry is allowed)
- 00000000000001860475: Unable to execute (system permits incorrect operating status and trigger source interface)

2) Trigger 2 Action 1000H (W) (RUN Mode enabled)

Input string: 000000000000010610010001 Return string: 000000000000010610010001

◎ **Description:** After a "1" is written, the switch is successful if the string returned is identical.
After triggered in Modbus mode, the system will not automatically send out results after completing an inspection. The inspection result will be saved in the 1010H~104H register. When Ready turns ON again, Read command can be sent out to obtain inspection results.

◎ **Error Handling:** Return string

- 00000000000001860376: Incorrect content or length of write data (only one entry is allowed)
- 00000000000001860475: Unable to execute (system permits incorrect operating status and trigger source interface)

3) Trigger 3 Action 1000H (W) (RUN Mode enabled)

Input string: 0000000000000010610020001 Return string: 0000000000000010610020001

◎ **Description:** After a "1" is written, the switch is successful if the string returned is identical.
After triggered in Modbus mode, the system will not automatically send out results after completing an inspection. The inspection result will be saved in the 1010H~104H register. When Ready turns ON again, Read command can be sent out to obtain inspection results.

◎ **Error Handling:** Return string

- 00000000000001860376: Incorrect content or length of write data (only one entry is allowed)
- 00000000000001860475: Unable to execute (system permits incorrect operating status and trigger source interface)

4) Trigger 4 Action 1000H (W) (RUN Mode enabled)

Input string: 0000000000000010610030001 Return string: 0000000000000010610030001

◎ **Description:** After a "1" is written, the switch is successful if the string returned is identical.
After triggered in Modbus mode, the system will not automatically send out results after completing an inspection. The inspection result will be saved in the 1010H~104H register. When Ready turns ON again, Read command can be sent out to obtain inspection results.

◎ **Error Handling:** Return string

- 00000000000001860376: Incorrect content or length of write data (only one entry is allowed)
- 00000000000001860475: Unable to execute (system permits incorrect operating status and trigger source interface)

5) Output Data 1010H~104FH (R) (RUN Mode enabled)

Output the previous inspection result if there is no inspection program to run.

<u>**16 Bits (Word) Data Mode**</u>**:** If 2 data entries need to be returned (50,000, 300)

Input string: 0000000000000010310100002 Return string: 000000000000010304C350012C

◎ **Description:** 50,000 is C350 (hex) and 300 is 12C (hex).

<u>**32 Bits (Double Word) Data Mode**</u>**:** If 2 data entries need to be returned (400,000, 300)

Input string: 0000000000000010310100004

Return string: 0000000000000010308000061A800000012C

◎ **Description:** 400,000 is 61A80 (hex) and 300 is 12C (hex).

- If output value exceeds 65535, please select set data format to [32bits] to prevent writing to the wrong register.

Judge (0/1) Data Format: (return bit2=0, bit3=1, bit4=1)

Input string: 00000000000010310100001 Return string: 0000000000000103020018

◎ **Description:** 0018 (hex) is 0000000000011000 (binary)

- Judge output format is [16bits] regardless of the settings ([16bits] or [32bits]).
  For example: (Return data is 400,000 and a set of Judge values of bit2=0, bit3=1, bit4=1)
  Now, please read 3 entries of string lengths: 00000000000010310100003 (one entry of DW data and one entry of W Judge content)
  The system will return 000000000000001030600061A800018

Error Handling: Return string

- 00000000000001830478: Unable to execute (system permits incorrect operating status)

6) Switch to RUN Mode 1050H (W) (Edit Mode enabled)

Input string: 00000000000010610500001 Return string: 00000000000010610500001

◎ **Description:** After a "1" is written, the switch is successful if the string returned is identical.

◎ **Error Handling:** Return string

- 00000000000001860376: Incorrect content or length of write data (only one entry is allowed)
- 00000000000001860475: Unable to execute (system permits incorrect operating status)

7) Switch to Edit Mode 1051H (W) (RUN Mode enabled)

Input string: 00000000000010610510001 Return string: 00000000000010610510001

◎ **Description:** After a "1" is written, the switch is successful if the string returned is identical.

◎ **Error Handling:** Return string

- 00000000000001860376: Incorrect content or length of write data (only one entry is allowed)
- 00000000000001860475: Unable to execute (system permits incorrect operating status)

8) Read/Switch Program ID 1060H (R/W) (RUN Mode and Edit Mode enabled)

Read Program ID: (returns the current program ID 10)

Input string: 00000000000010310600001 Return string: 0000000000001030200 0A

◎ **Description:** 10(dec) is 000A(hex).

Switch Program ID: (switch program ID to 20)

Enter string 000000000000010610600014 Return string 000000000000010610600014

◎ **Description:** 20(dec) is 0014(hex).

After the value is written, the switch is successful if the string returned is identical.

◎ **Error Handling:** Return string

- 0000000000001830379: Incorrect content or length of read data (only one entry is allowed)
- 0000000000001860376: Incorrect write data length (only one entry is allowed); program ID does not exist (or no configured)

9) Read/Switch Window ID 1062H (R/W) (RUN Mode enabled)

Read Window ID: (returns current window ID 50)

Input string: 000000000000010310620001 Return string: 000000000000103020032

◎ **Description:** 50(dec) is 0032(hex).

Switch Window ID: (switch window ID to 30)

Input string: 00000000000001061062001E Return string: 00000000000001061062001E

◎ **Description:** 30(dec) is 001E(hex).

After the value is written, the switch is successful if the string returned is identical.

◎ **Error Handling:** Return string

- 0000000000001830379: Incorrect content or length of read data (only one entry is allowed)
- 0000000000001830478: Unable to execute (system permits incorrect operating status)
- 0000000000001860376: Incorrect content or length of write data (only one entry is allowed); window ID does not exist (or not configured)
- 0000000000001860475: Unable to execute (system permits incorrect operating status)

10) Read Upper/Lower (Window) 1070H~1075H (RUN Mode enabled)

The following 6 registers are required to read the Upper/Lower limits of [Window].

1070H (R/W) – Data Item Number to Read/Write

1071H (R/W) – Window ID to Read/Write

1072H (R) – Upper Read Limit (Low word)

1073H (R) – Upper Read Limit (High word)

1074H (R) – Lower Read Limit (Low word)

1075H (R) – Lower Read Limit (High word)

- [1070H data ID] and [1071H window ID] are first written to the registers to be accessed, then data from the read data values required in 1072H~1075H

Read Upper/Lower Limit: (i.e., data ID =2, window ID = 5, upper/lower limits are 500,000 and 300)

First enter string 0000000000000110107000020400020005 Return string: 000000000000011010700002

◎ **Description:** Entering 2 words now is represented by 0002.

2 words consist of 4 bytes. Enter 04

2(dec) is 0002(hex).

5(dec) is 0005(hex).

Then enter read string: 000000000000010310720004

Return string: 0000000000000103080007A1200000012C

◎ **Description:** Now the system will read 4 words, which consist of 8 bytes. Enter 08

Decimal 500,000 is 0007A120 (hex).

Decimal 300 is 0000012C (hex).

Upper/lower limits are fixed DW (32bits) format.

◎ **Error Handling:** Return string

- 00000000000001830379: Incorrect content or length of read data
- 00000000000001830478: Unable to execute (system permits incorrect operating status and no data item number or window number)
- 00000000000001860376: Incorrect content or length of write data
- 00000000000001860475: Unable to execute (system permits incorrect operating status and no window ID)

11) Write Upper/Lower (Window) 1077H~107CH (RUN Mode enabled)

The following 6 registers are required to write the Upper/Lower limits of [Window]. Through multiple write commands, the 6 entries of values can be simultaneously written to the register according to the following order to complete modifying the Upper/Lower limits.

1077H (W) – data item number written

1078H (W) – window ID written

1079H (W) – upper limit written (Low word)

107AH (W) – upper limit written (High word)

107BH (W) – lower limit written (Low word)

107CH (W) – lower limit written (High word)

Write Upper/Lower: (i.e., data ID =6, window ID = 20, upper/lower limits are 600,000 and 400)

Input string: 000000000000110107700060C00060014000927C000000190

Return string: 0000000000000110107700006

◎ **Description:** Entering 6 words now is represented by 0006.

6 words consist of 12 bytes. Enter 0C

Decimal 6 is 0006 (hex).

Decimal 20 is 0014 (hex).

Decimal 600,000 is 000927C0 (hex).

Decimal 400 is 00000190 (hex).

Upper/lower limits are fixed DW (32bits) format.

◎ **Error Handling:** Return string

- 00000000000001860475: Unable to execute (system permits incorrect operating status and no window ID)

12) 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: (i.e., the content to read is 2011/07/22 08:30:58)

Input string: 0000000000000103109000006

Return string: 00000000000001030C000B000700160008001E003A

◎ **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: (i.e., the content to write is 2011/08/25 12:30:40)

First enter string 00000000000000110109000060C000B00080019000C001E0028

Return string: 000000000000011000900006

◎ **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 to the date/time, single write 06 is also supported.

◎ **Error Handling:** Return string

- 00000000000001860376: Incorrect content or length of write data

13) Set Camera Shutter Speed 10A0H~10A1H(RUN Mode enabled)

The following two registers are required to write [Camera shutter speed]. With multi write, both register writes can be issued at the same time.

10A0H (W) – Camera ID (1~2)

10A1H (W) – Shutter Speed (1~20)

01= 6000ms	05= 2000ms	09= 33.33ms	13= 4.17ms	17= 0.2ms
02= 5000ms	06= 1000ms	10=16.67ms	14= 2ms	18= 0.1ms
03= 4000ms	07= 500ms	11=10ms	15= 1ms	19= 0.05ms
04= 3000ms	08= 66.67ms	12= 8.33ms	16= 0.5ms	20= 0.025ms

Write Settings: （i.e., set Camera2 shutter speed to 0.5 ms)

Input string: 000000000000011610A00002040002000A

Return string: 000000000000011610A00002

◎ **Description:** Entering 2 words now is represented by 0002.

2 words consist of 4 bytes. Enter 04

2(dec) is 0002(hex).

Decimal 10 is 000A (hex).

◎ **Error Handling:** Return string

- 00000000000001860475: Unable to execute (system permits incorrect operating status and no cameras)

14) Set Camera Gain and Luminance 10A2H~10A4H (RUN Mode enabled)

The following three registers are required to write [Gain and brightness]. With multi write, the three register writes can be issued at the same time.

10A2H (W) – Camera ID (1~2)

10A3H (W) – Gain (00~100; larger values generate brighter images)

10A4H (W) – Luminance (00~100; larger values generate brighter images)

<u>Write Settings</u>: (i.e., set Camera2 Gain and Luminance to 50 and 70, respectively)

Input string: 000000000000011010A2000306000200320046

Return string: 000000000000011010A20003

◎ **Description:** 2(dec) is 0002(hex).

Decimal 50 is 0032 (hex).

Decimal 70 is 0046 (hex).

◎ **Error Handling:** Return string

- 0000000000001860475: Unable to execute (system permits incorrect operating status and no cameras)

15) Change Password 10A5H~10ADH (RUN Mode and Edit Mode enabled)

The following registers are required to change the password. Multiple write commands are used in which, a command must be entered according to the specific password type to confirm the old password before entering a command to change the password.

10A5H (W) – Password type (2 codes)

10A6H~10AD (W) – Enter password (4~16 codes and varies according to password lengths)

<u>Write Settings</u>: (i.e., change the password from 1234 to 5678)

Input string: 000000000000011010A5000306000041424344

000000000000011010A5000306000145464748

Return string: 000000000000011010A50003

◎ **Description:**

According to the ASCII conversion table, the numeric value 1234 will be converted to 41424344.

According to the ASCII conversion table, the numeric value 5678 will be converted to 45464748.

◎ **Error Handling:** Return string

- 0000000000001860376: Incorrect content or length of write data
- 0000000000001860772: Unable to execute (old password input error)

HEX	ASCII	HEX	ASCII	HEX	ASCII
20	SPACE	41	A	61	a
21	!	42	B	62	b

25	%	43	C	63	c
28	(	44	D	64	d
29	)	45	E	65	e
2B	+	46	F	66	f
2D	-	47	G	67	g
2E	.	48	H	68	h
30	0	49	I	69	i
31	1	4A	J	6A	j
32	2	4B	K	6B	k
33	3	4C	L	6C	l
34	4	4D	M	6D	m
35	5	4E	N	6E	n
36	6	4F	O	6F	o
37	7	50	P	70	p
38	8	51	Q	71	q
39	9	52	R	72	r
3D	=	53	S	73	s
5B	[	54	T	74	t
5D	]	55	U	75	u
5F	_	56	V	76	v
		57	W	77	w
		58	X	78	s
		59	Y	79	y
		5A	Z	7A	z

16) Enable Trigger Input 10B0H (W) (RUN Mode enabled)

Input string: 000000000000010610B00001 Return string: 000000000000010610B00001

◎ **Description:** After writing the numeric value "1", the switch is successful if the string returned is identical.

◎ **Error Handling:** Return string

- 00000000000001860376: Incorrect content or length of write data
- 00000000000001860475: Unable to execute (system permits incorrect operating status)

17) Disable Trigger Input 10B1H (W) (RUN Mode enabled)

Input string: 000000000000010610B10001 Return string: 000000000000010610B10001

◎ **Description:** After writing the numeric value "1", the switch is successful if the string returned is identical.

◎ **Error Handling:** Return string

- 00000000000001860376: Incorrect content or length of write data
- 00000000000001860475: Unable to execute (system permits incorrect operating status)

18) Save All Program Setting 10B2H (W) (Edi Mode enabled)

Input string: 000000000000010610B20001 Return string: 000000000000010610B20001

◎ **Description:** After writing the numeric value "1", saving is successful if the string returned is identical.

◎ **Error Handling:** Return string

- 00000000000001860376: Incorrect content or length of write data
- 00000000000001860475: Unable to execute (system permits incorrect operating status)

19) Capture Image 10B3H (W) (RUN Mode and Edit Mode enabled)

Input string: 000000000000010610B30001 Return string: 000000000000010610B30001

◎ **Description:** After writing the numeric value "1", image capture is successful if the string returned is identical.

◎ **Error Handling:** Return string

- 00000000000001860376: Incorrect content or length of write data

20) Clear Statistics 10B4H (W) (RUN Mode and Edit Mode enabled)

Input string: 000000000000010610B40001 Return string: 000000000000010610B40001

◎ **Description:** After writing the numeric value "1", statistics data is successfully cleared if the string returned is identical.

◎ **Error Handling:** Return string

- Please refer to common error message code

21) System Reset 10B5H (W) (RUN Mode enabled)

Input string: 000000000000010610B50001 Return string: 000000000000010610B50001

◎ **Description:** After writing the numeric value "1", system reset is successful if the string returned is identical.

◎ **Error Handling:** Return string

- Please refer to common error message code

22) Read Window Parameter 10F0H~10F1H (W) 10F2H~10F3H (R) (RUN Mode enabled)

The following 4 registers must be used to read the configured value of [Parameter].

10F0H (W) – Item number to read

10F1H (W) – Window ID to read

10F2H (R) – Read window parameter (Low word)

10F3H (R) – Read window parameter (High word)

- ◆ The data to be accessed, [Data Item Number 10F0H] and [Window ID 10F1H], are written to the register, then the required data can be accessed from the addresses 10F2H~10F3H.

Read Upper/Lower: (i.e., read W010, the binary lower limit of [Area], which is 50)

First enter string 000000000000010610F00001 Return string: 000000000000010610F00001

◎ **Description:** 1(dec) is 0001(hex).

First enter string 000000000000010610F1000A Return string: 000000000000010610F1000A

◎ **Description:** 10(dec) is 000A(hex).

Then enter read string: 000000000000010310F20002

Return string: 00000000000001030400320000

◎ **Description:** 50(dec) is 0032(hex).
Content fixed to the DW (32 bits) data structure.

◎ **Error Handling:** Return string

- ➤ 00000000000001830379: Incorrect content or length of read data
- ➤ 00000000000001830478: Unable to execute (system permits incorrect operating status and no window ID or item number)
- ➤ 00000000000001860475: Unable to execute (system permits incorrect operating status and no item number)

23) **Write Window Parameter 10F7H~10FAH (W)** (RUN Mode enabled)

The following 4 registers must be used to write the configured value of [Parameter]. Through multiple entries of write commands, 4 entries of numeric values can be simultaneously written to the register to complete modifying the upper and lower limits.

10F7H (W) – Item number to write
10F8H (W) – Window ID to write
10F9H (W) – Write window parameter (Low word)
10FAH (W) – Write window parameter (High word)

Write Upper/Lower: (i.e., write W001; the [Edge Intensity] parameter of [Edge Position] is 20)

Numeric values must be written to 10F7H according to order. Select the item number to write, write the window ID to the address 10F8H, and then fill in the numeric values to configure.

Input string: 00000000000011010F70004080002000100140000

Return string: 00000000000011010F70004

◎ **Description:** 20(dec) is 0014(hex).
Upper/lower limits are fixed DW (32bits) format.

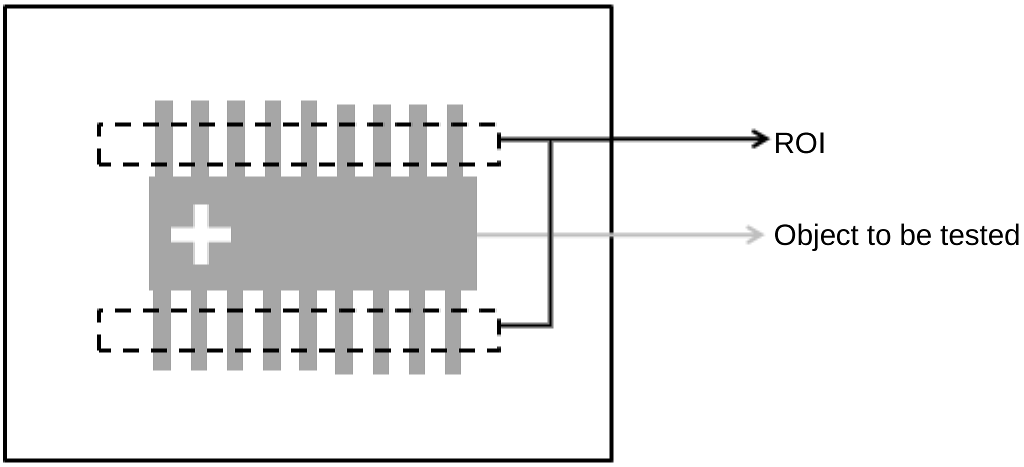
◎ **Error Handling:** Return string
000000000000001860475: Unable to execute (system permits incorrect operating status and no item number)

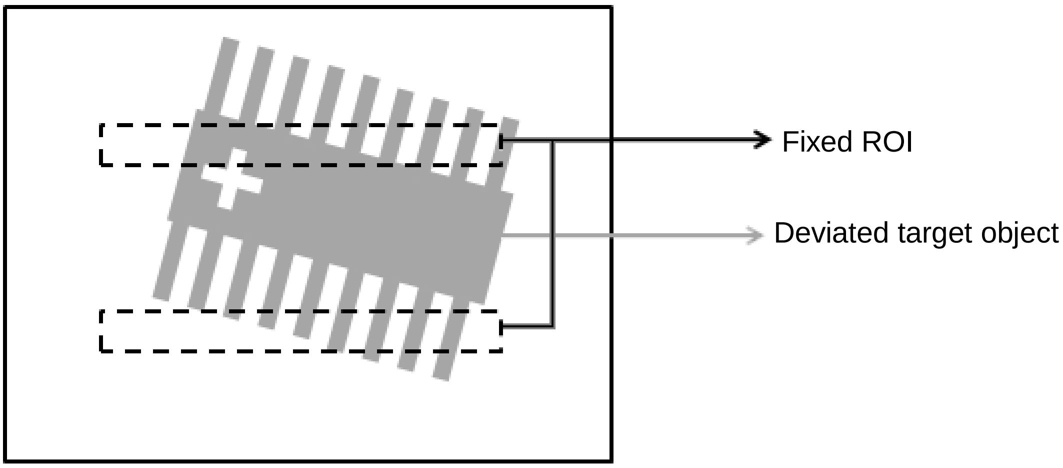
Chapter 9

Appendix

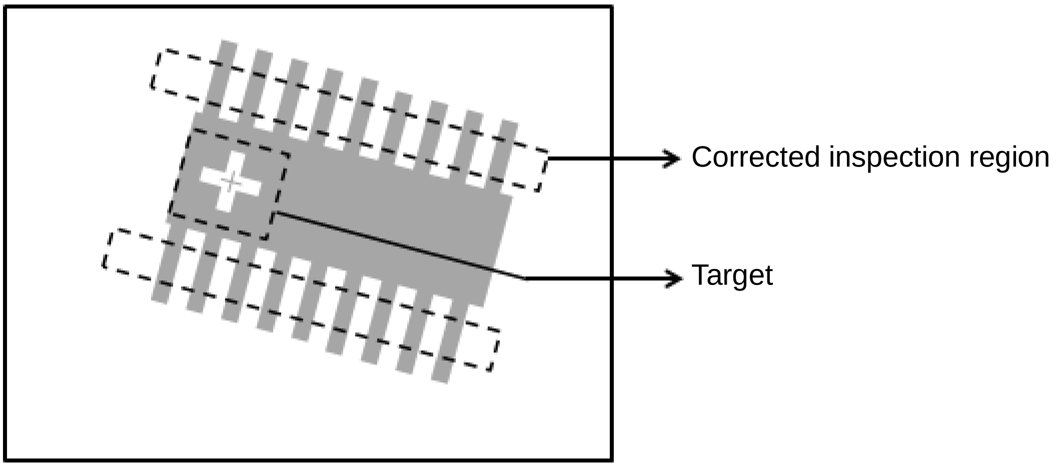
9.1 Locate

The Locate tool can follow ROI inspections, originally at a fixed position, moving along feature points as shown in the following diagram. Before using the Locate tool, inspections can only be performed at fixed positions. However, when the position of the target object deviates, fixed ROIs cannot be correctly inspected due to deviation of the target object.





After using the Locate tool, a feature on the target object can be identified to confirm the object position before using Locate to correct the position of the ROI. As shown in the following diagram, the crosshair on the target object can be used to confirm the object position. The position of the ROI can then be corrected.



9.1.1 Locate Parameters

Ref. X, Ref. Y, and Ref. Angle can be selected in the locate options of 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 Provide Locate

The output results of the following types of inspection tools can be used for reference locations.

◎ **Blob**

- Ref. X:

Blob Centroid Position X [N]

Blob Bounding Rectangle Upper Left Position X [N]

- Ref Y:

Blob Centroid Position Y [N]

Blob Bounding Rectangle Upper Left Position Y [N]

- Ref. Angle:

Blob Major Axis Angle [N]

◎ **Stain**

➤ Ref. X:

Stain Centroid Position X [N]

➤ Ref Y:

Stain Centroid Position Y [N]

◎ **Angle**

➤ Ref. Angle:

Edge Angle

◎ **Pitch**

➤ Ref. X:

Edge Pitch Center Position X

Edge Pitch First Edge Position X [N]

Edge Pitch Second Edge Position X [N]

➤ Ref Y:

Edge Pitch Center Position Y

Edge Pitch First Edge Position Y [N]

Edge Pitch Second Edge Position Y [N]

➤ 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]

◎ **Position**

➤ Ref. X:

Edge Position X [N]

➤ Ref Y:

Edge Position Y [N]

➤ Ref. Angle:

Edge Position Edge Absolute Angle [N]

Edge Position Edge Relative Angle [N]

◎ **Shape**

➤ Ref. X:

Shape Position X [N]

➤ Ref Y:

Shape Position Y [N]

➤ Ref. Angle:

Shape Angle [N]

◎ **Position Trace**

➤ Ref. X:

Position Trace Edge Position X [N]

Position Trace Vertex Position X [N]

➤ Ref Y:

Position Trace Edge Position Y [N]

Position Trace Vertex Position Y [N]

◎ **Width Trace**

➤ Ref. X:

Width Trace Edge Width Position X1 [N]

Width Trace Edge Width Position X2 [N]

➤ Ref Y:

Width Trace Edge Width Position Y1 [N]

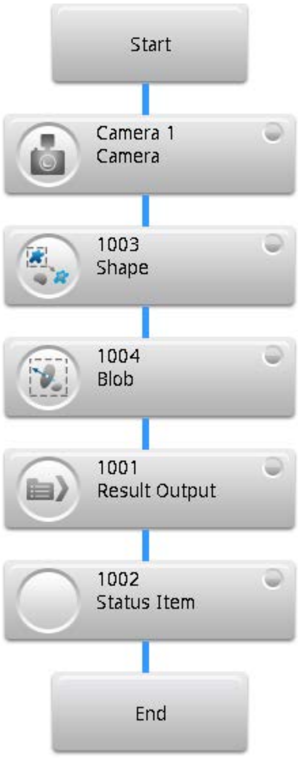
Width Trace Edge Width Position Y2 [N]

9.1.3 Locate Configuration Process

The following examples explain the configuration of Locate flow processes.
A register image is shown in the following diagram. Blob is used to inspect the number of pins on the communication terminal and Shape is used for positioning.

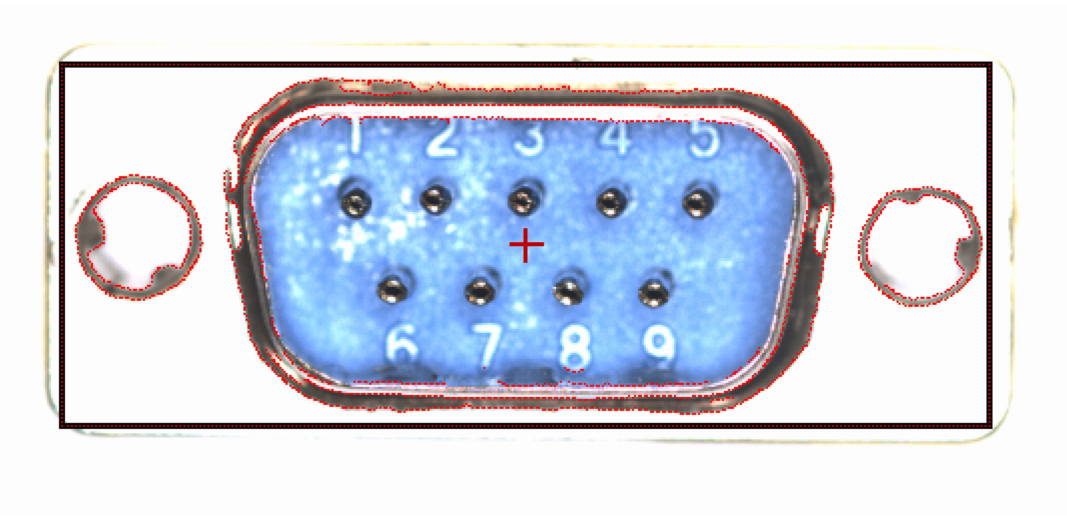
◎ **Flow Configuration**

1) Create 1 Shape function for positioning and 1 Blob function to count the number of pins

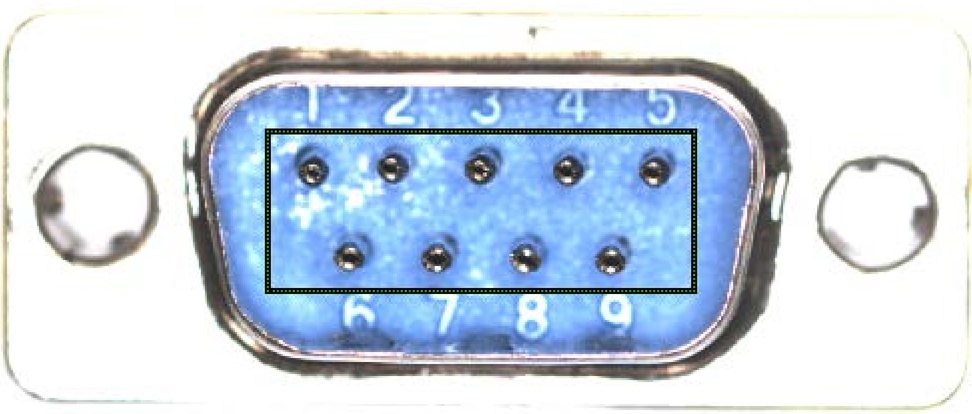


2) The same register image must be used for both the Shape and Blob functions.

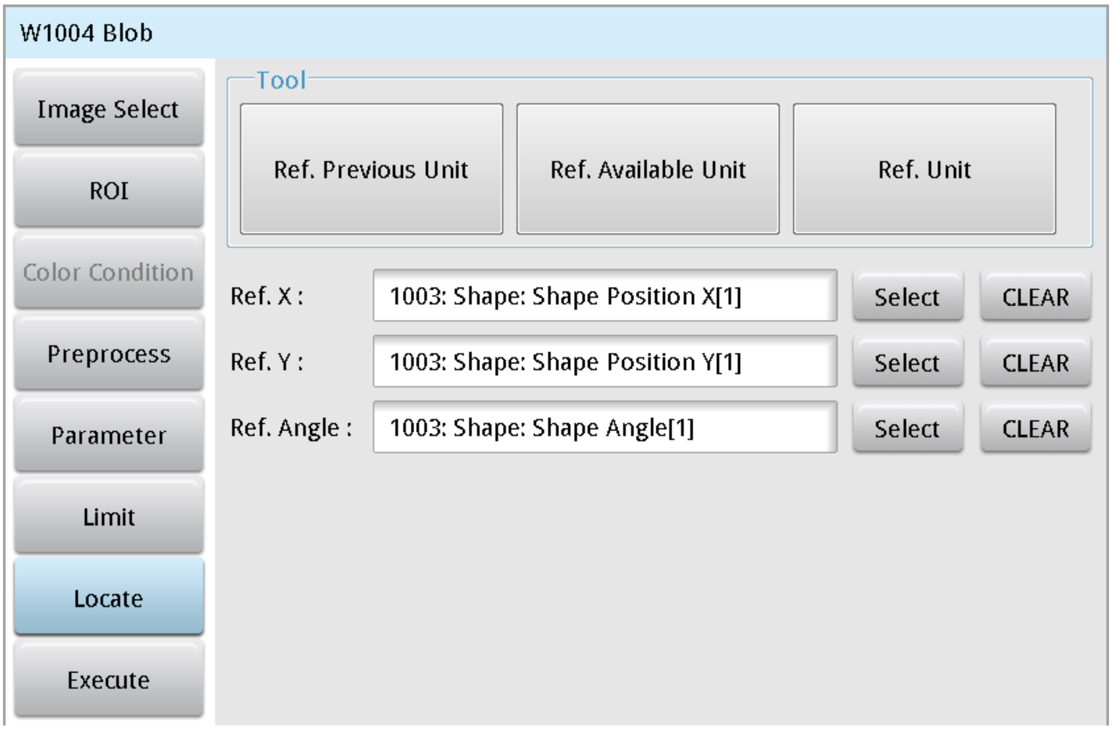
3) The shape feature of the communication terminal is used as the target pattern in the Shape function.



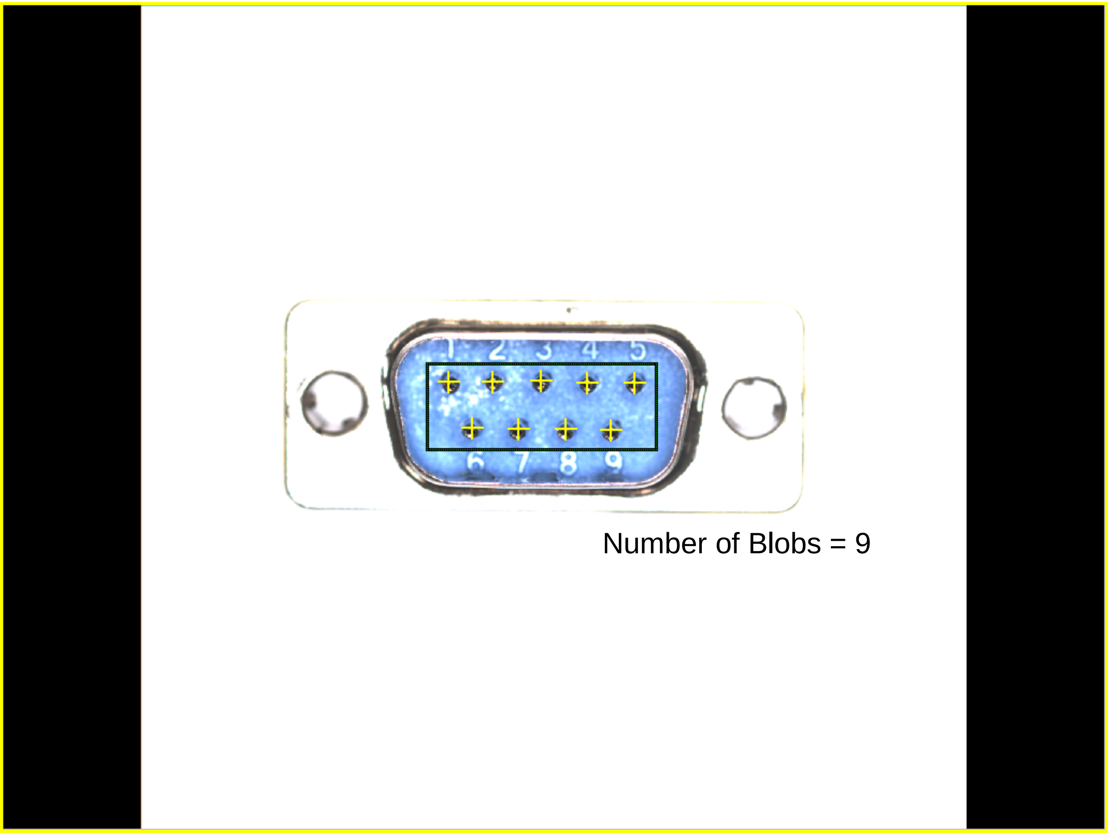
4) The ROI is configured as follows in the Blob function.



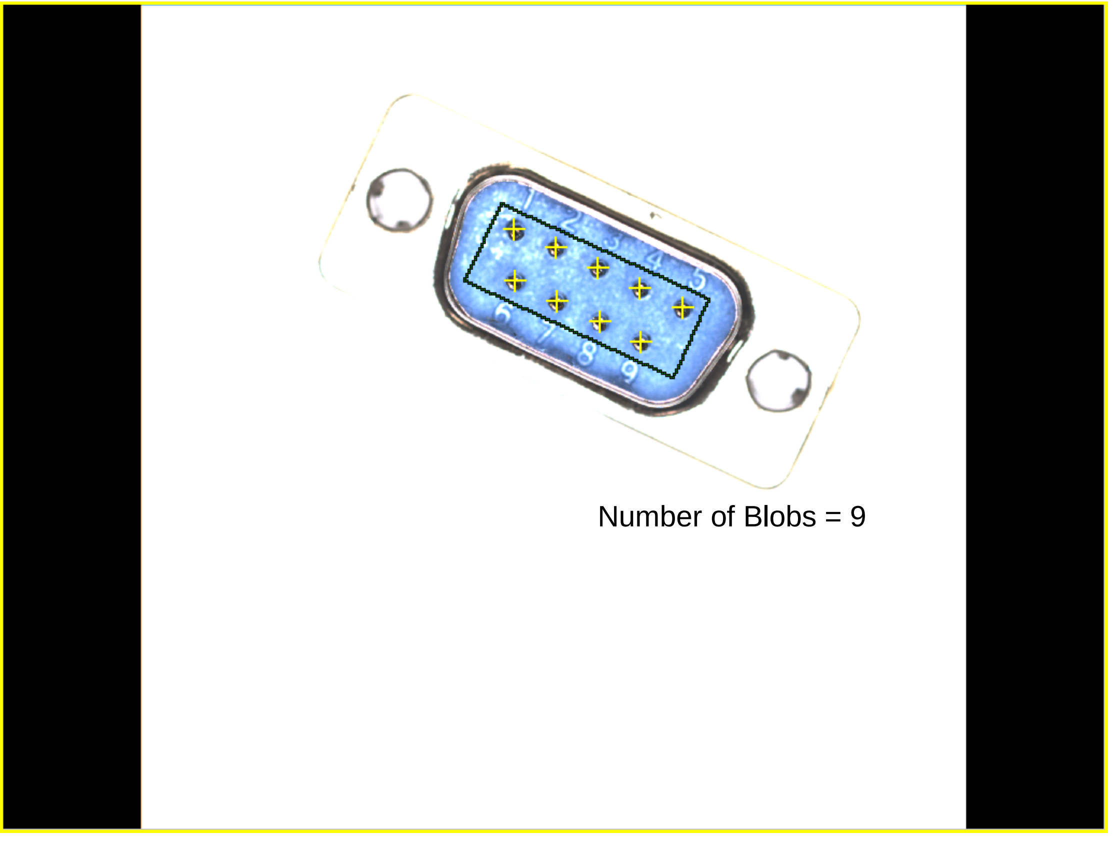
5) Locate is configured as shown in the following diagram for the Blob function. Ref. X, Ref. Y, and Ref. Angle are configured to Shape Position X, Shape Position Y, and Shape Angle, respectively.

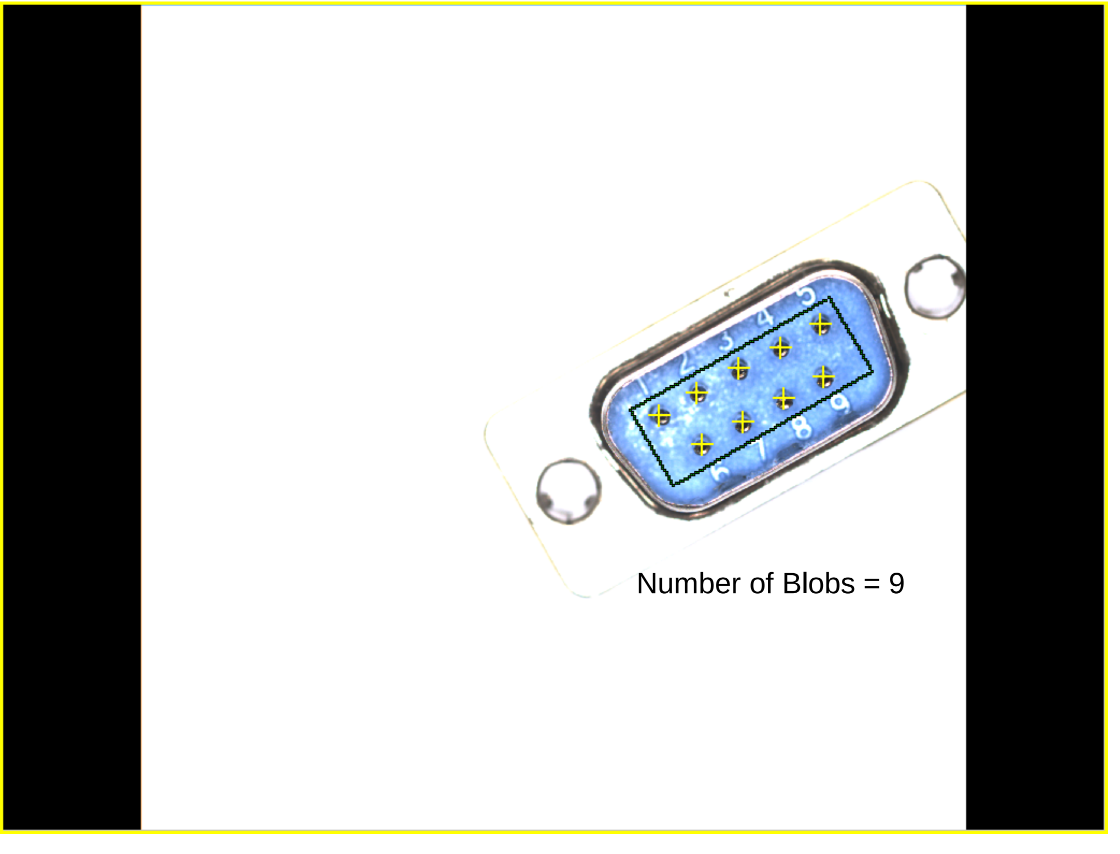


6) When the target object does not have an offset, the number of pins can be correctly counted as shown in the following operation screen.



When the position of the target object deviates, the Blob function can follow the Shape function to correctly count the number of pins as long as the Shape function can correctly locate.



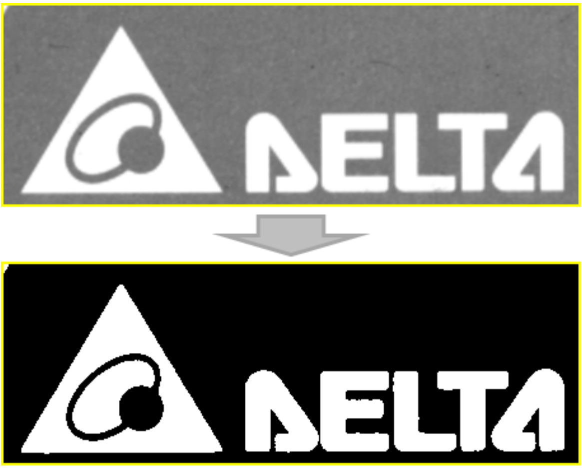


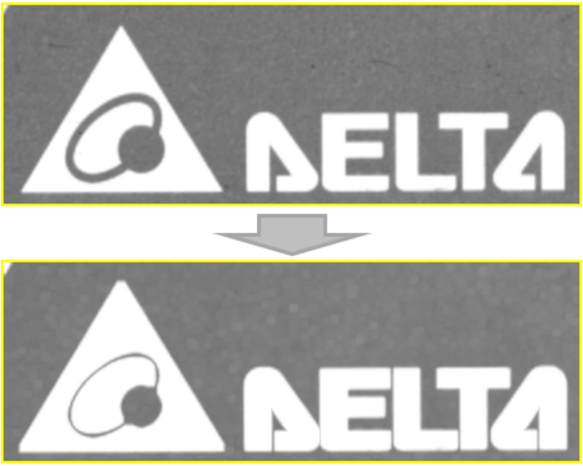
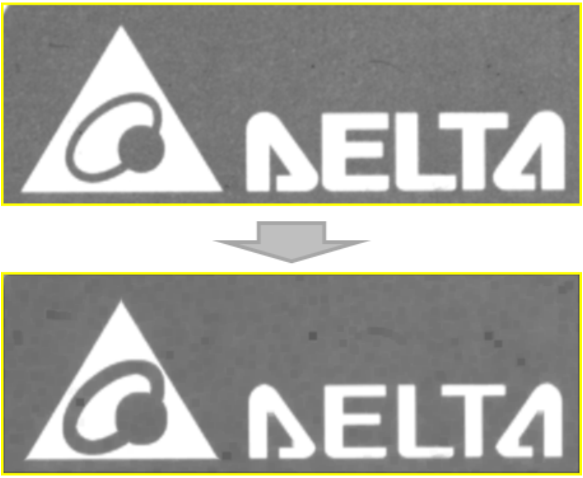
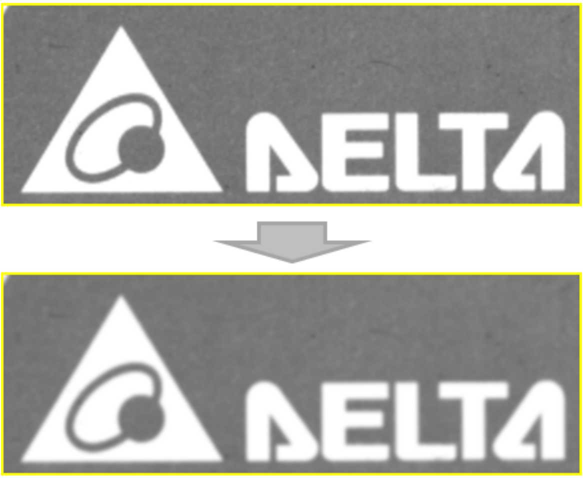
9.2 Preprocess

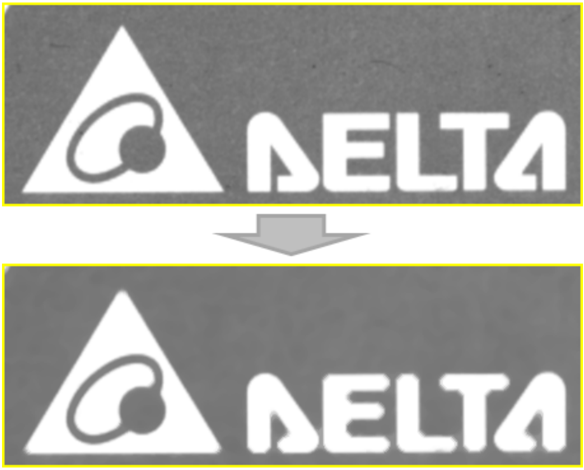
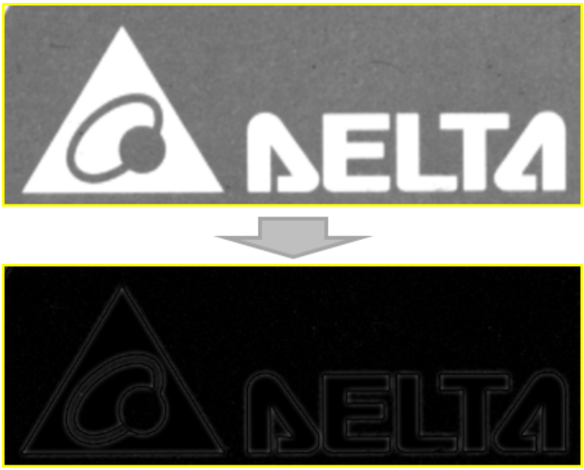
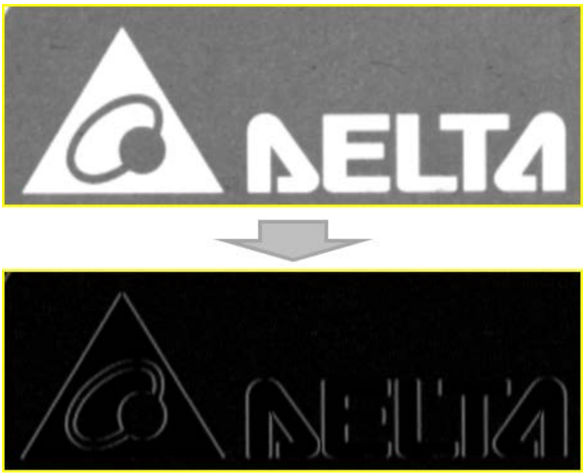
In the vision inspection application environment, inspections can misjudge or fail due to unclear target features in the images captured by the camera. Therefore, preprocessing before image capture and processing is required for feature enhancement to increase the accuracy and success rate of inspections.

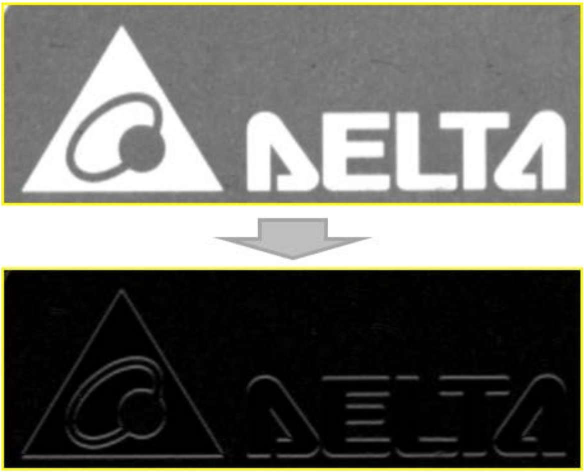
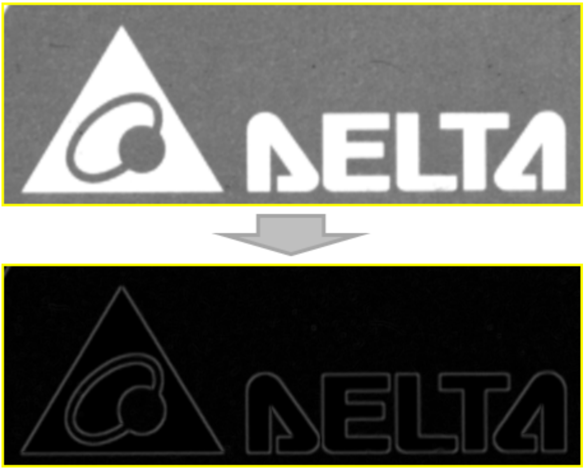
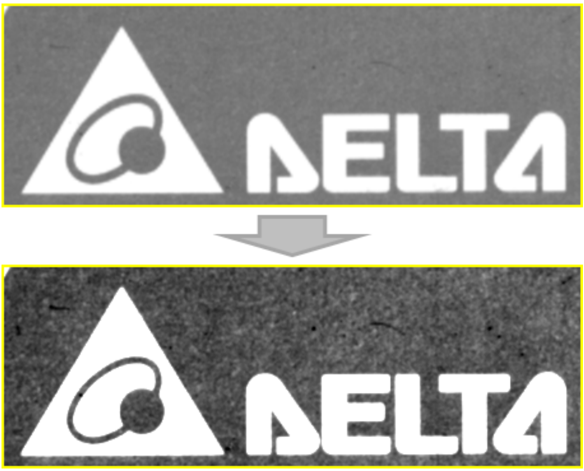
9.2.1 Preprocess Types

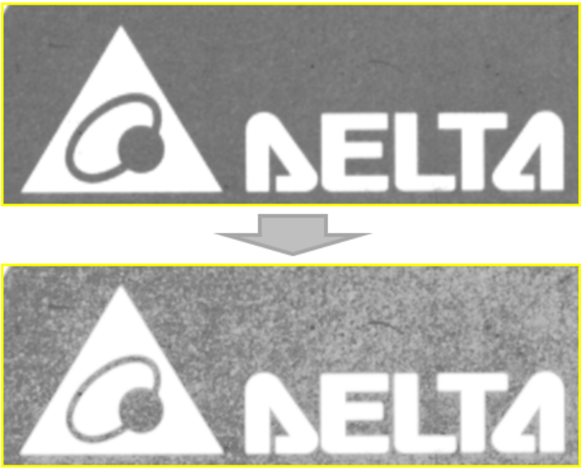
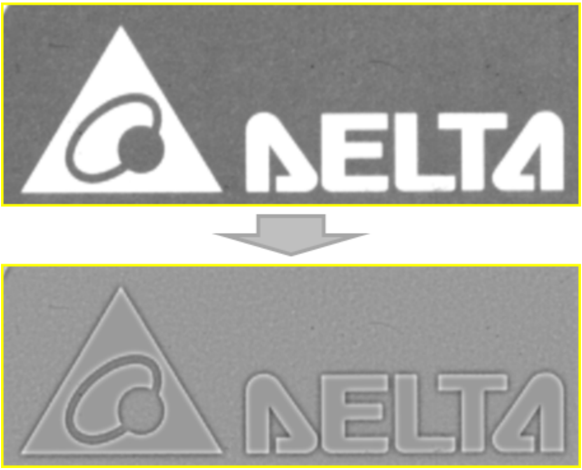
Up to 6 sets of preprocesses can be applied and overlaid to each inspection unit. Through overlaying different preprocesses, various effects can be obtained to enhance image features. The system currently supports 13 preprocess effects, including Binary, Dilate, Erosion, Average, Median, Laplacian, SobelX, 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 will dilate (expand) the white pixels. 	ON/OFF: ON Filter Size: 3x3 Filter Direction: XY Frequency: 2
4	Erosion	The system will (shrink) the white pixels. 	ON/OFF: ON Filter Size: 3x3 Filter Direction: XY Frequency: 2
5	Average	The system will average 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 will take the median after comparing with surrounding pixels to reduce noise without blurring the image. 	ON/OFF: ON Filter Size: 5x5 Filter Direction: XY Frequency: 5
7	Laplacian	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 will extract edge in the X direction. 	ON/OFF: ON Filter Size: 3x3 Frequency: 1

9	SobelY	The system will extract edge in the Y direction. 	ON/OFF: ON Filter Size: 3x3 Frequency: 1
10	SobelXY	The system will simultaneously extract edge in the X and Y directions. 	ON/OFF: ON Filter Size: 3x3 Frequency: 1
11	Intensity Adj.	The system will adjust 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	Select ON/OFF to turn on or off Contrast 	ON/OFF: ON
13	Shade	When the gray scale on the surface of the target object is uneven, Shade can make adjustments to emphasize the Stain effect. 	ON/OFF: ON Filter Size: 5

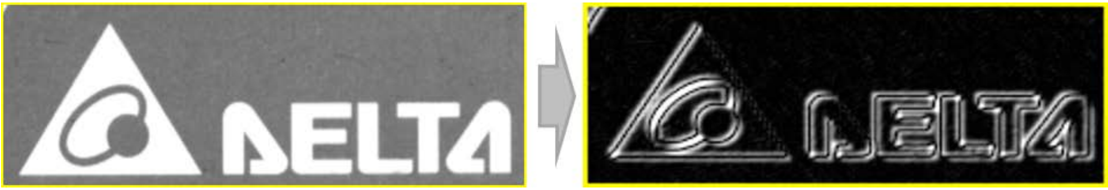
9.2.2 Custom Filter

When none of the default system filters can emphasize image features, the user can select custom filters to customize filter parameters. The numerical parameters comprise 3x3 and 5x5 types. This is a special function and is explained as follows.

◎ **5x5 45-Degree Edge Strengthen**

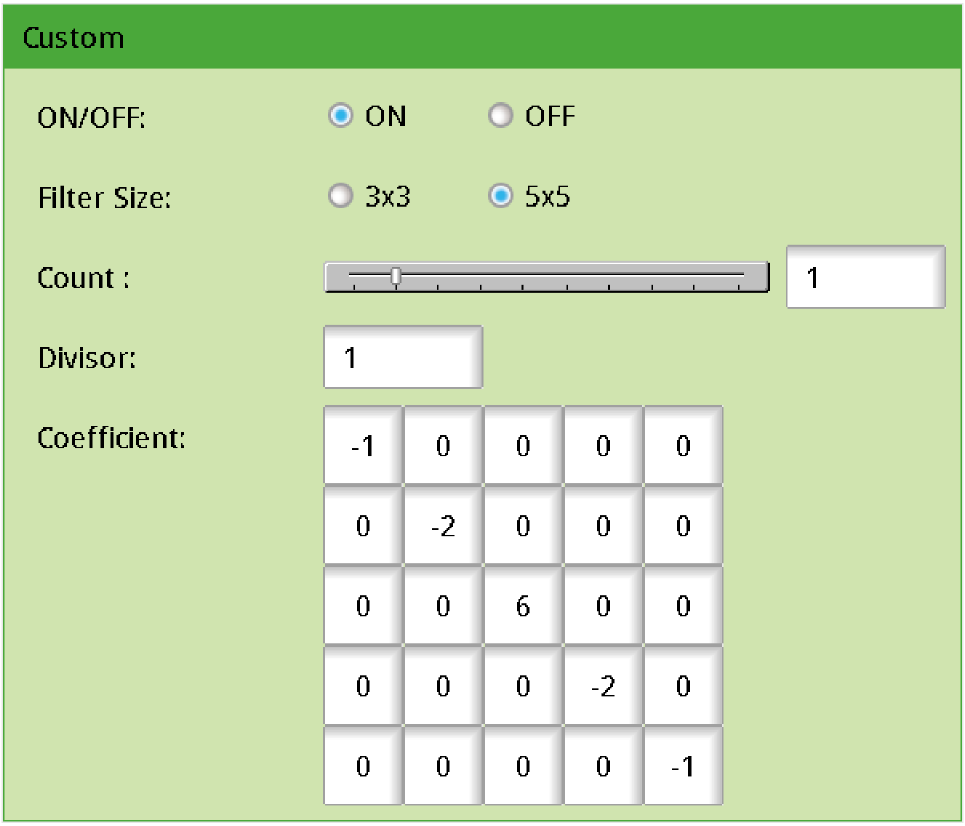
Customized parameters can be used to strengthen 45-degree edge features.

- Applied effect



- Configuration Parameter

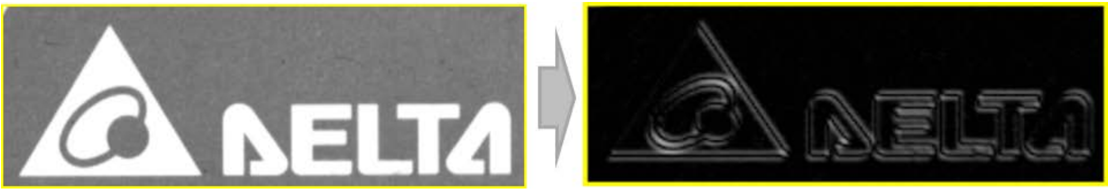
Custom must be added and turned ON in the preprocess items. Filter Size is adjusted to 5x5 and Frequency and Divisor are configured to 1 and Coefficient is configured as shown in the following illustration.



◎ **5x5 63-Degree Edge Strengthen**

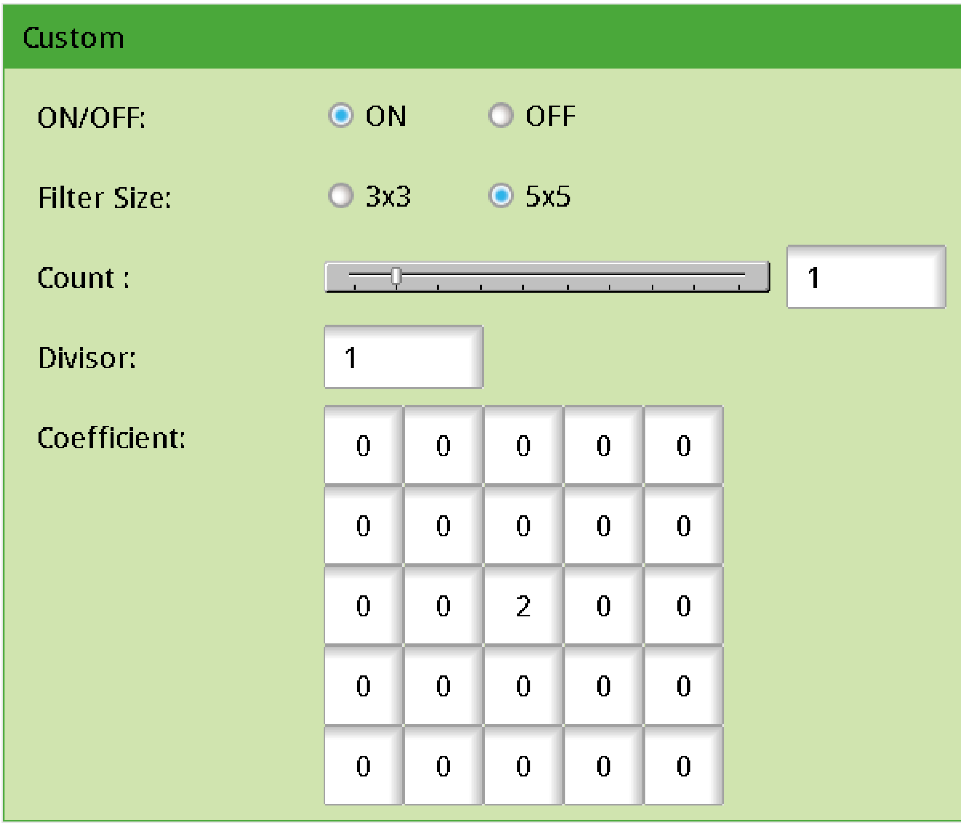
Customized parameters can be used to strengthen 63-degree edge features.

➤ Applied effect



➤ Configuration Parameter

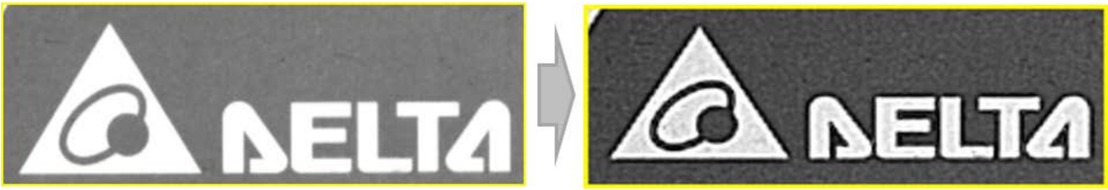
Custom must be added and turned ON in the preprocess items. Filter Size is adjusted to 5x5 and Frequency and Divisor are configured to 1 and Coefficient is configured as shown in the following illustration.



◎ 3x3 Edge Strengthen

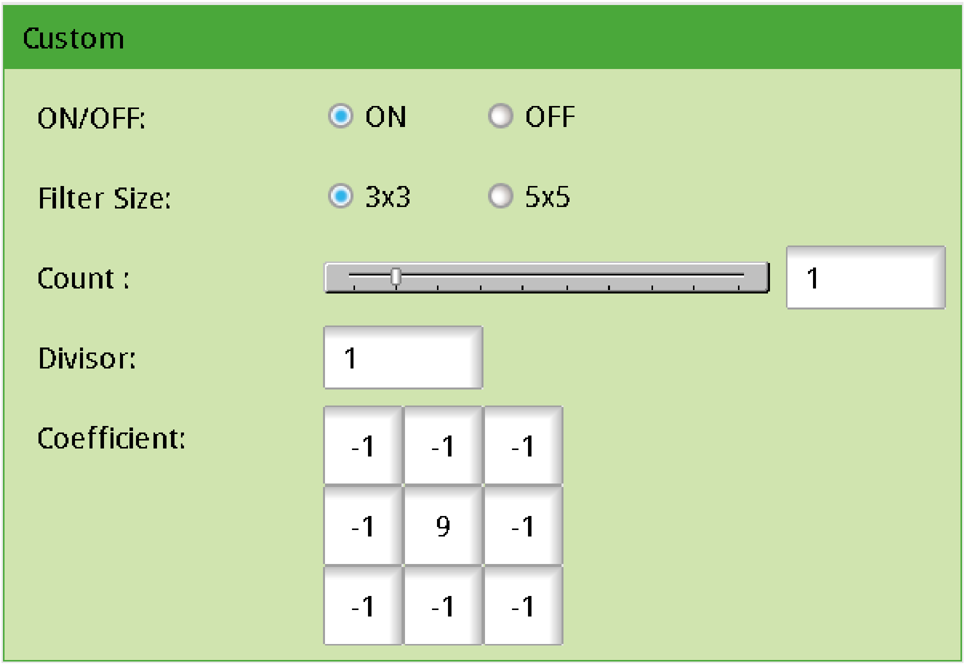
Custom can be used to strengthen edge sharpness in the image.

➤ Applied effect



➤ Configuration Parameter

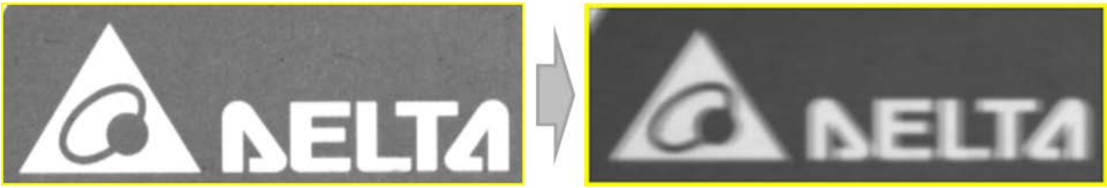
Custom must be added and turned ON in the preprocess items. Filter Size is adjusted to 3x3 and Frequency and Divisor are configured to 1 and Coefficient is configured as shown in the following illustration.



◎ **3x3 45-Degree Average**

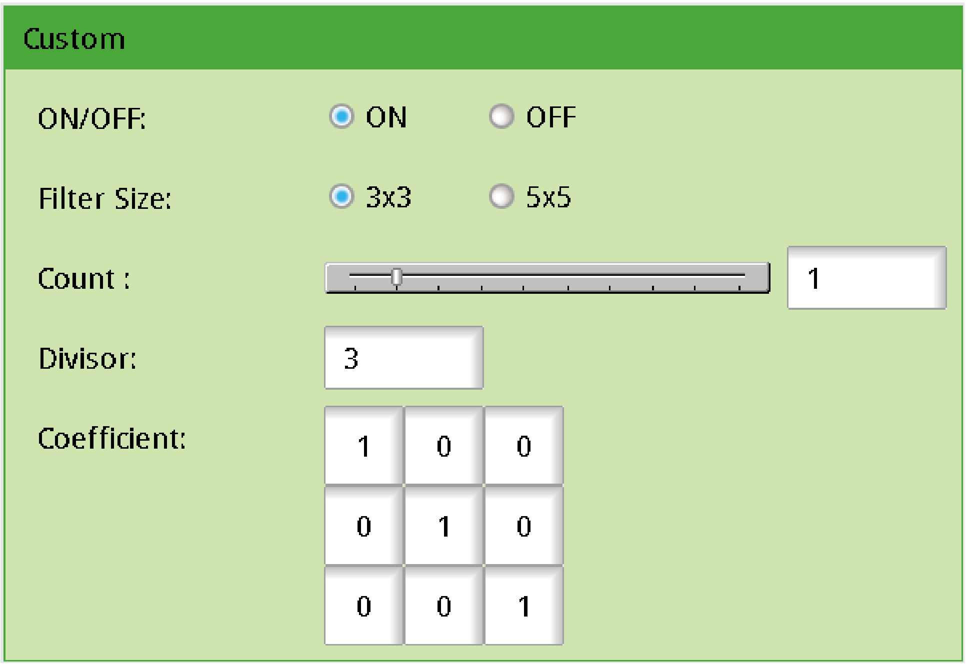
Custom can be used to highlight the average effect in the 45-degree direction.

➤ Applied effect



➤ Configuration Parameter

Custom must be added and turned ON in the preprocess items. Filter Size is adjusted to 3x3, Frequency is set to 1, Divisor is configured to 3, and Coefficient is set up as shown in the following illustration.



◎ **Item Description**

➤ ON/OFF: Preprocess can be turned ON or OFF according to need.

➤ Filter Size: The optional items mainly consist of 3x3 and 5x5; 7x7 and 9x9 only support Average, Laplacian, SobelX, SobelY, and SobelXY. Filter Size in Shade is different and can be adjusted between 1 and 20.

➤ Filter Direction: The 3 optional scanning directions consist of X, Y, and XY.

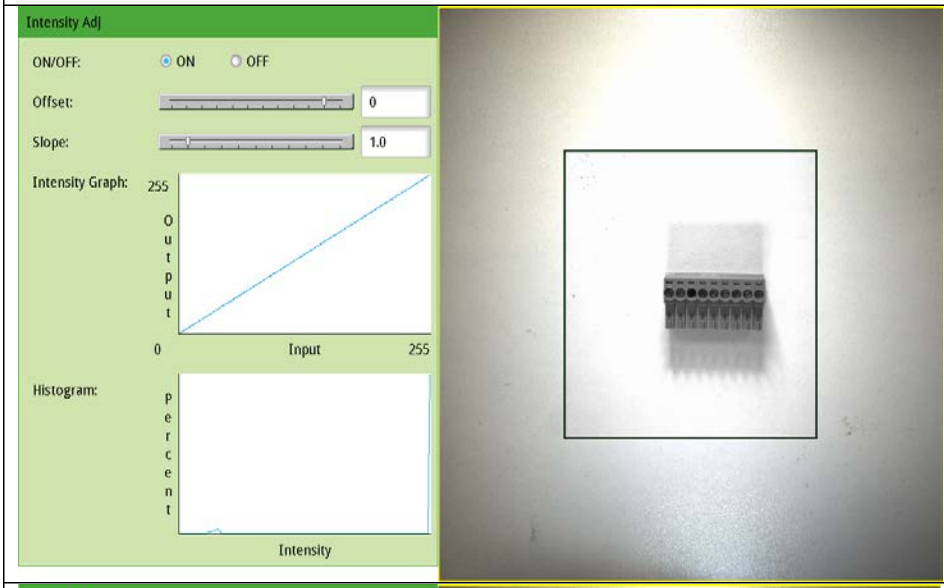
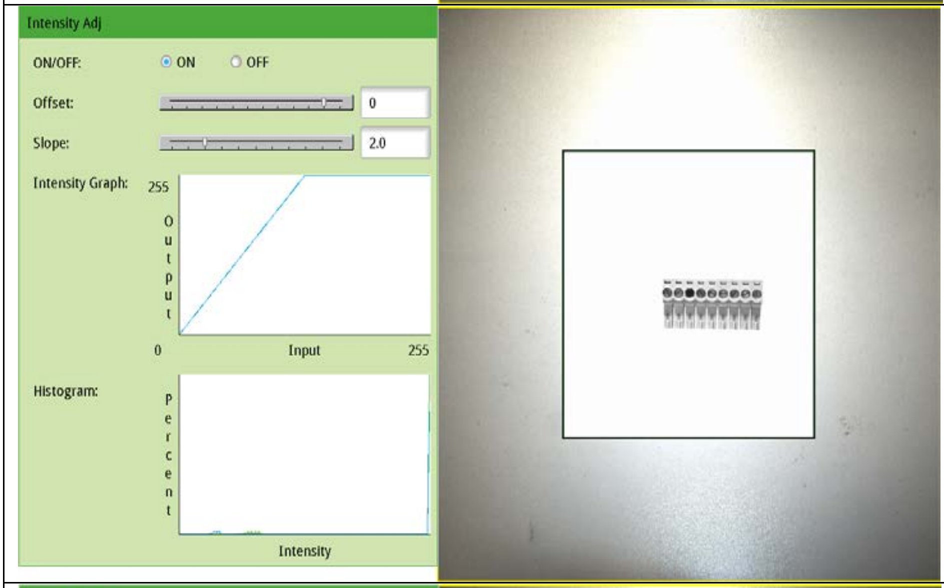
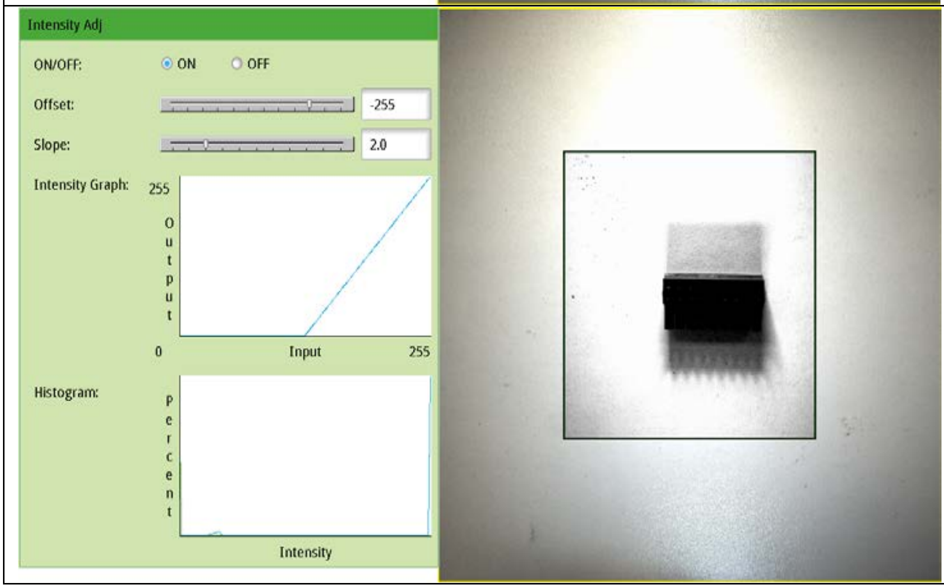
➤ Frequency: Configures the number of preprocesses.

➤ Color Condition: Can select whether to search for black or white pixels.

➤ Histogram: When using Binary, the Upper/Lower limits can be configured through Histogram.

➤ Offset: Increase/decrease overall image brightness (Intensity).

➤ Slope: Increase/decrease image brightness and contrast.

Parameter Effect Display	Description
	These configuration parameters give the original image. Offset = 0 Slope = 1.0
	Adjusts Slope; pixels of grayscale greater than 128 becomes brighter. Offset = 0 Slope = 2.0
	Simultaneously adjusts Offset and Slope; pixels of grayscale lesser than 128 are converted to black. Offset = -255 Slope = 2.0

◎ **Strengthen Feature and Stain**

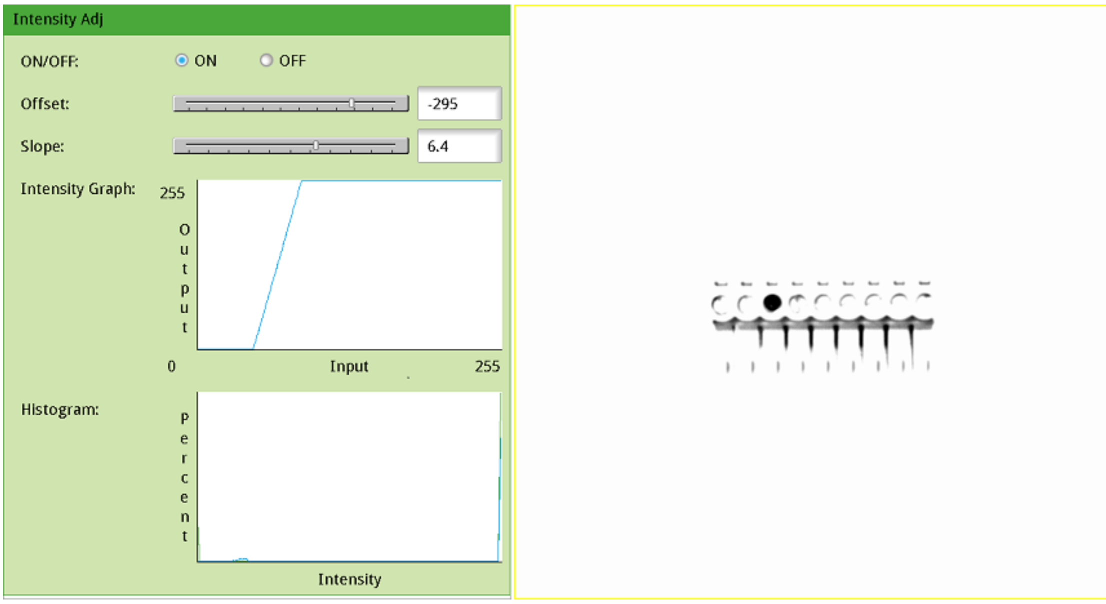
When using a single preprocess function cannot highlight the feature or Stain, multiple preprocess can be overlaid to strengthen the image and increase the system inspection accuracy. Several examples are provided as follows.

➤ Highlight Stain

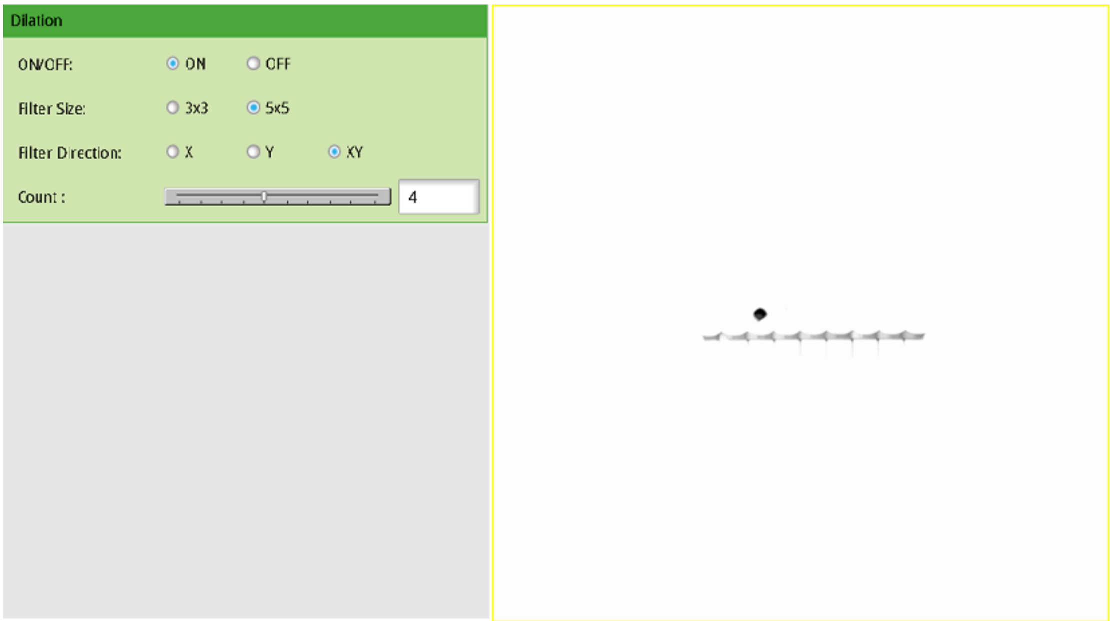
Using the terminal block in the following diagram as an example, 4 preprocess effects can be overlaid to highlight the locations on the terminal block that lack fixing screws.

1) Intensity Adj.

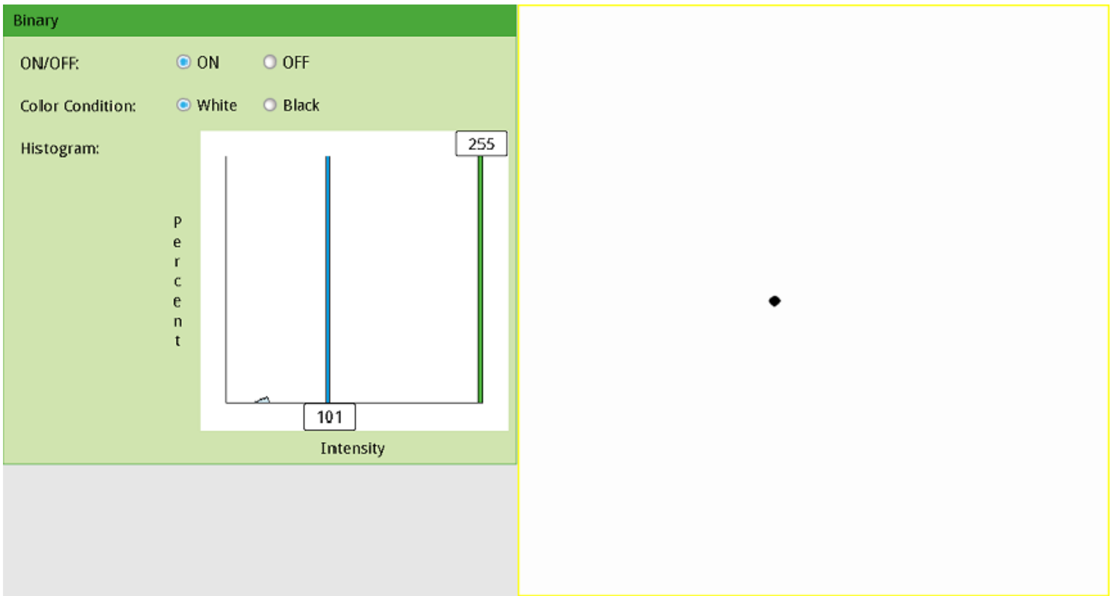
The overall brightness of the image is nonuniform, therefore [Intensity Adj.] can first be used to improve image uniformity.



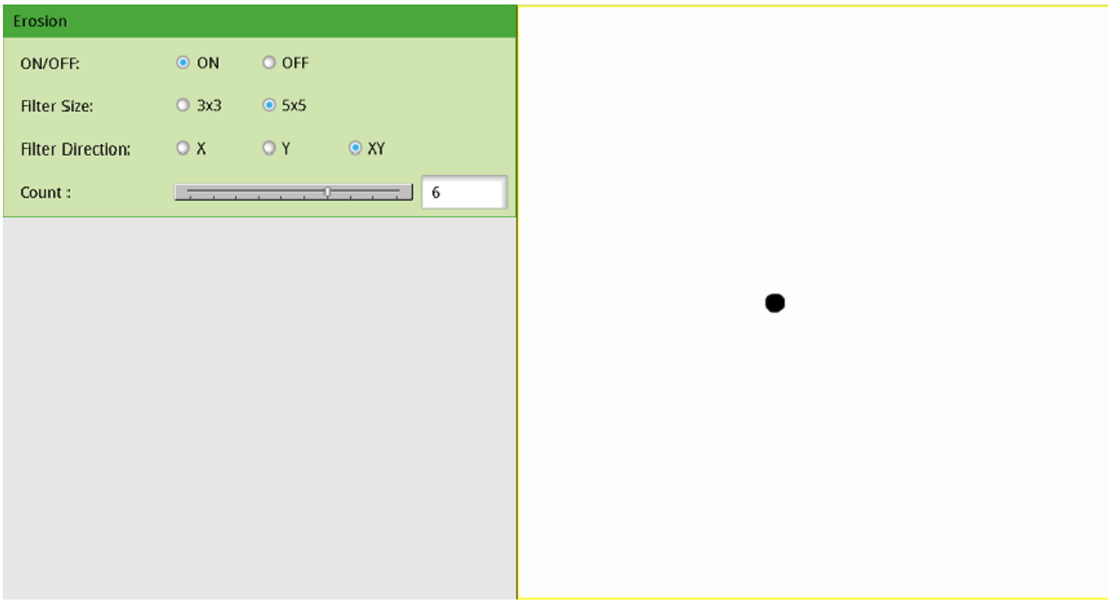
2) After brightness adjustment, parts of the image have been filtered. However, some finer areas may be misjudged, therefore [Dilation] can be added to remove these areas.



3) After dilating the white pixels, the areas that can cause potential misjudgement are mostly removed. However, some areas are not thoroughly cleaned in the lower edge. Therefore, [Binary] is added here to remove these areas.



4) Through the Binary process, the Stain becomes excessively small. Therefore, [Erosion] is finally added to enlarge the feature to facilitate system inspection.



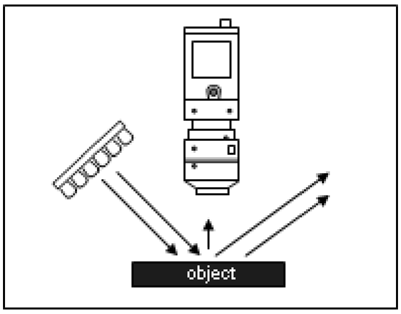
9.3 Lighting

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 will reflect at right angle away from the image sensor and light bouncing off non-smooth areas will scatter into the CCD. As a result, the smooth surfaces appear darker and the rough areas appear brighter.

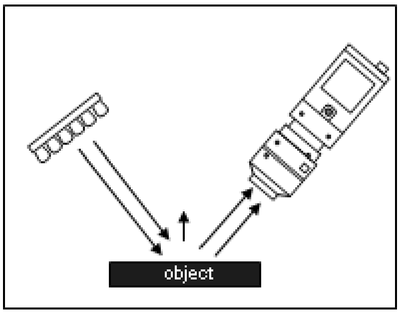


Raised text on black plastic

Target object 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, glare due to bright reflections should also be prevented in bright field lighting.



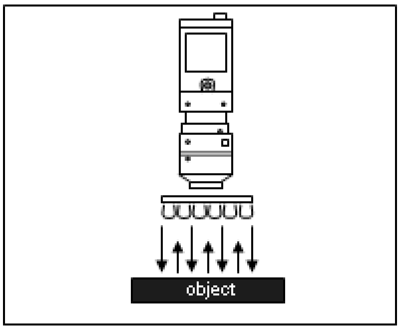
Raised text on black plastic

Target object

Dark field

◎ **Front Lighting**

Front lighting is a commonly used technique, with ring or strip light source, and is suitable for acquiring surface images of general objects. As the circle light is installed at a different angle, it casts a different shadow effect. For highly reflective objects, the diffuser or diffuse softening series can be used to clarify images.

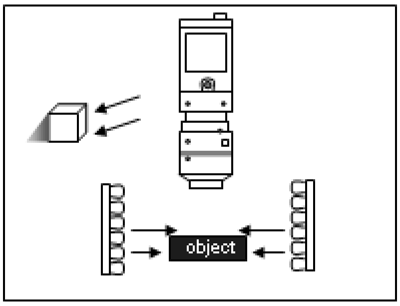


Lighting on flat

◎ **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, 0° and 30° can be used for oblique lighting.

To reduce errors in edge position caused by the shadowing, oblique lighting should be avoided in edge detection.



Printed text on the fuse

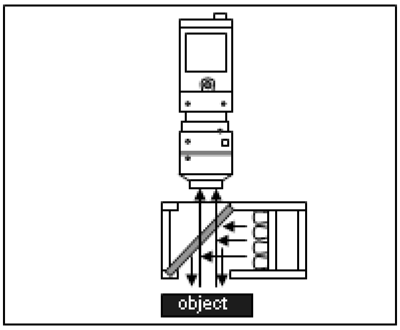
Target object

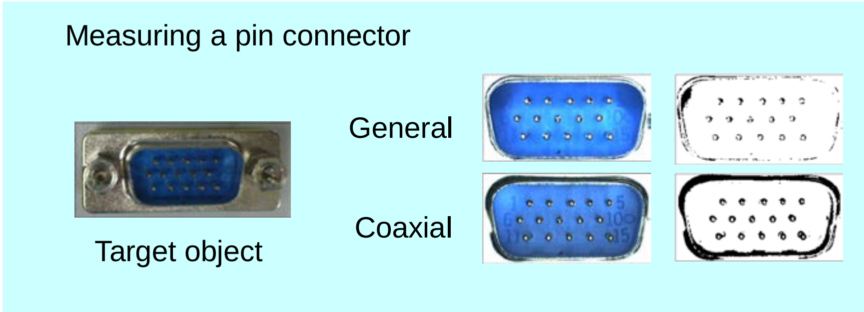
General Circle lighting

Low angle Circle lighting

◎ **Coaxial Lighting**

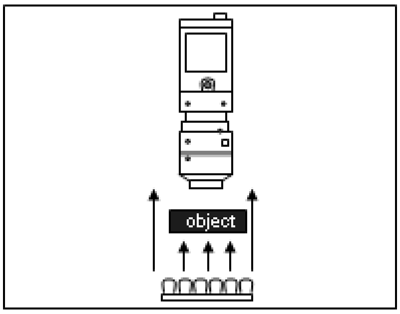
The light source can be either inside or outside the lens (inner/outer coaxial). A beam splitter is also used to create a soft light field that can reduce reflections or glare. Suitable for objects with high reflectivity, e.g. glass or metallic material.





◎ **Back Lighting**

The object outline can be captured by shielding the light source, but the surface characteristics are lost. Generally used for Measuring an object's size, positioning, or defect detection.

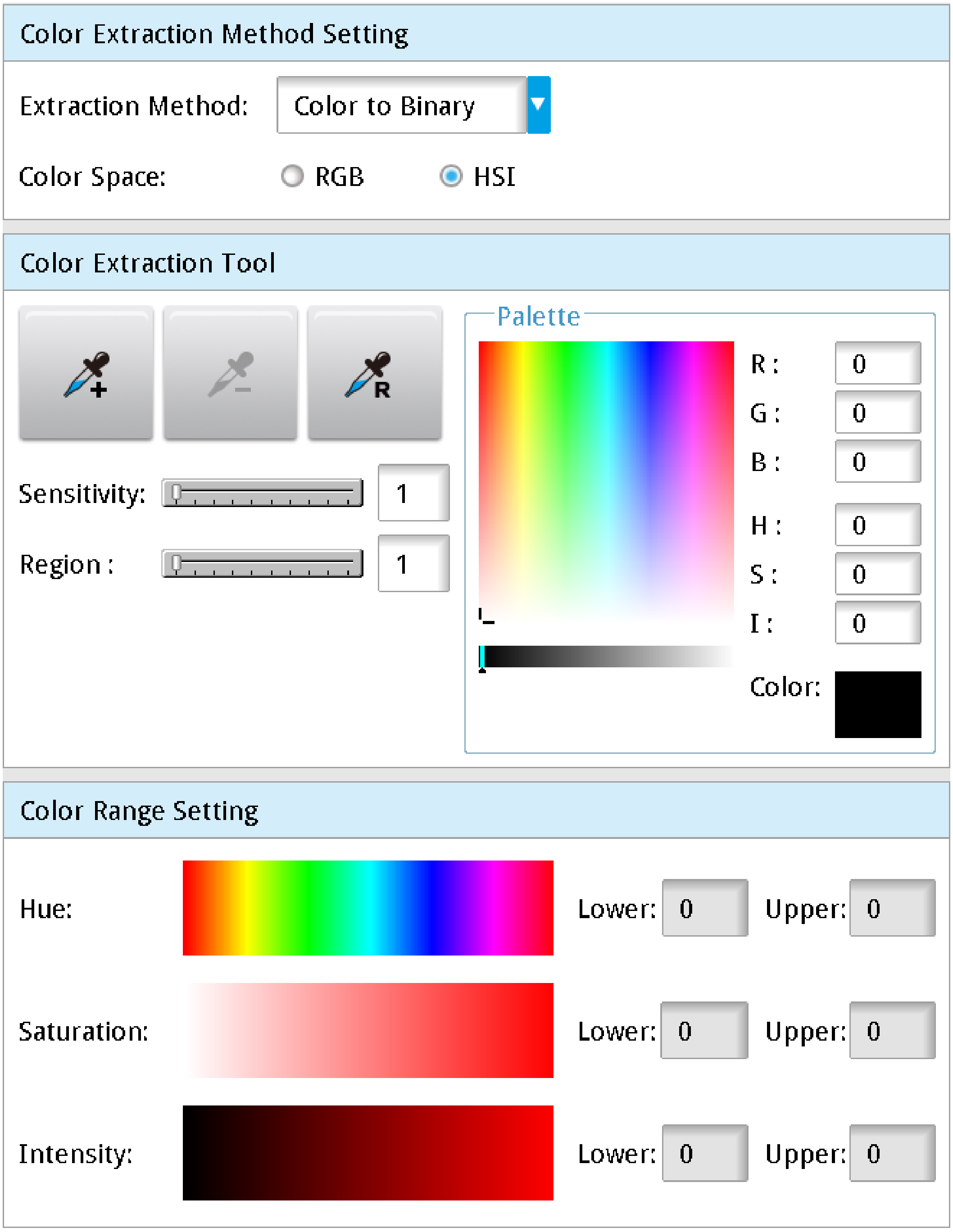


9.4 Color

When using color camera, every inspection tool can use color condition to extract and convert the specific colors of color images to binary or gray-scale images.

9.4.1 Color Condition Configuration

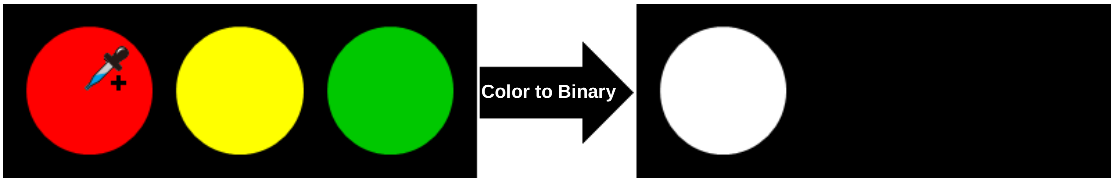
The following shows the color condition configuration interface, which includes Color Extraction Method Setting, Color Extraction Tool, and Color Range Setting.



◎ **Extraction Method**

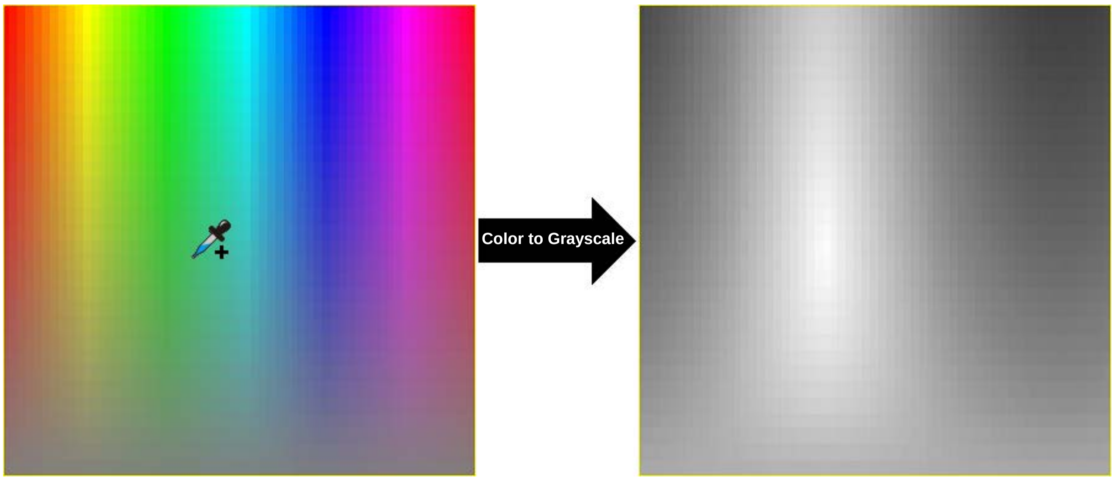
➤ Color to Binary

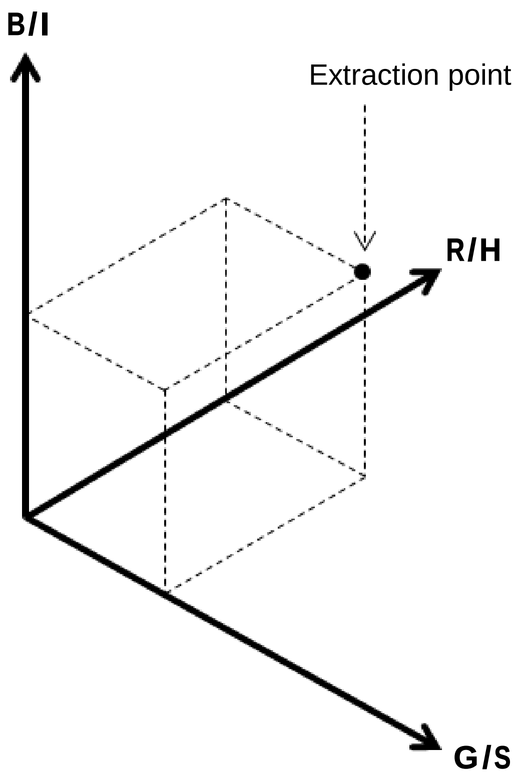
The Color Extraction Tool extracts specific colors and converts color images to binary images. The extracted color is white and the remaining colors are black, as shown in the following diagram.



➤ Color to Grayscale

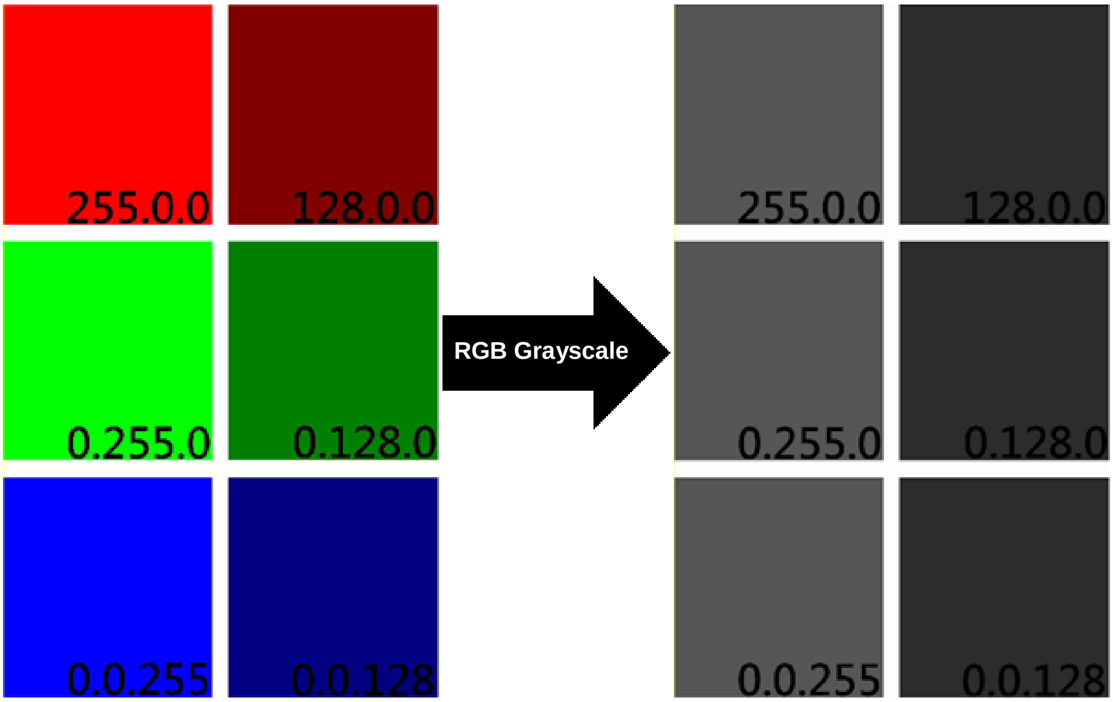
The Color Extraction Tool extracts specific colors and converts color images to gray-scale images. The extracted color is the brightest (a grayscale of 255), as shown in the following diagram.





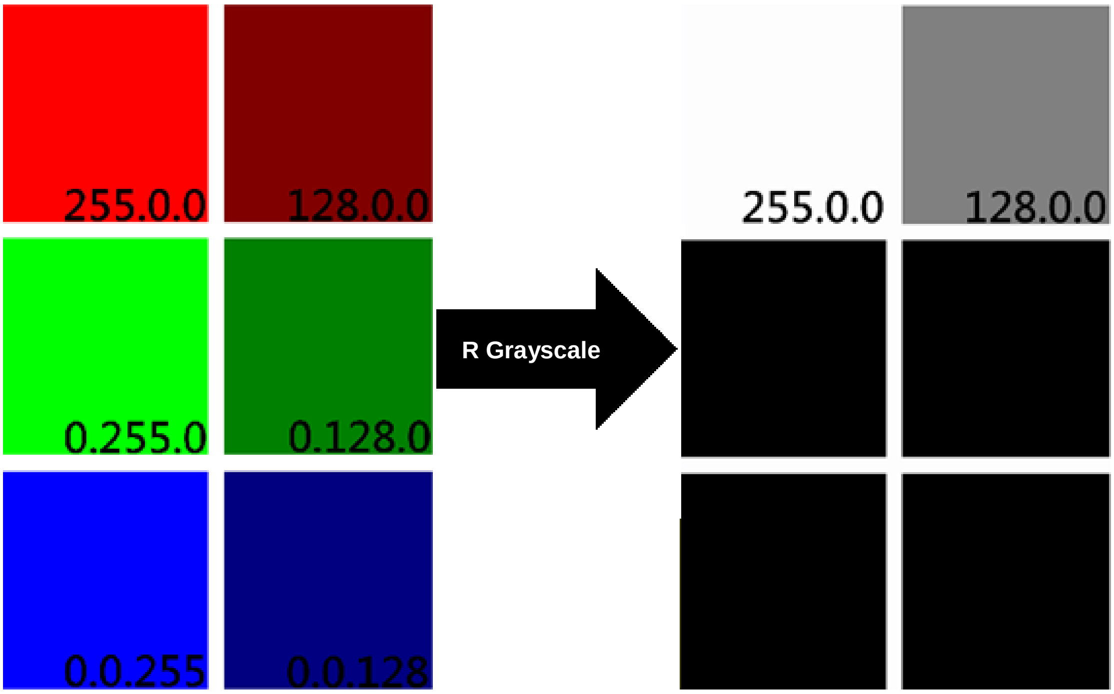
- RGB Grayscale

After averaging the R, G, and B grayscales for each pixel, the color image is converted to gray-scale image.



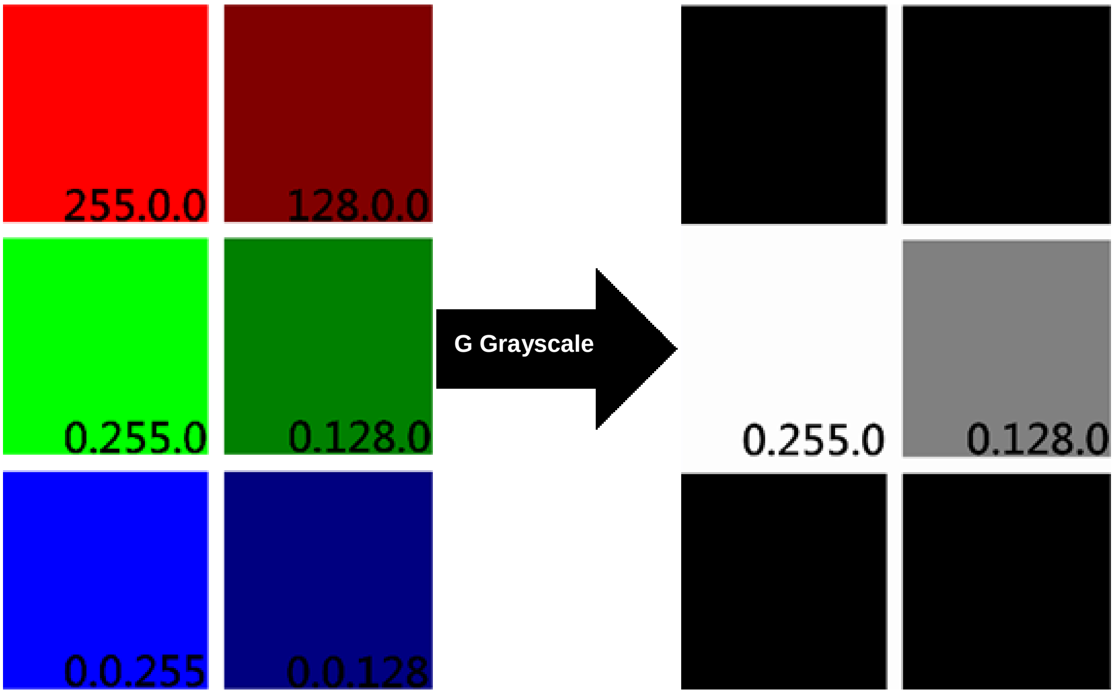
- R Grayscale

The R grayscale for each pixel are extracted and the color image is converted to gray-scale image according to the intensity of the R grayscale.



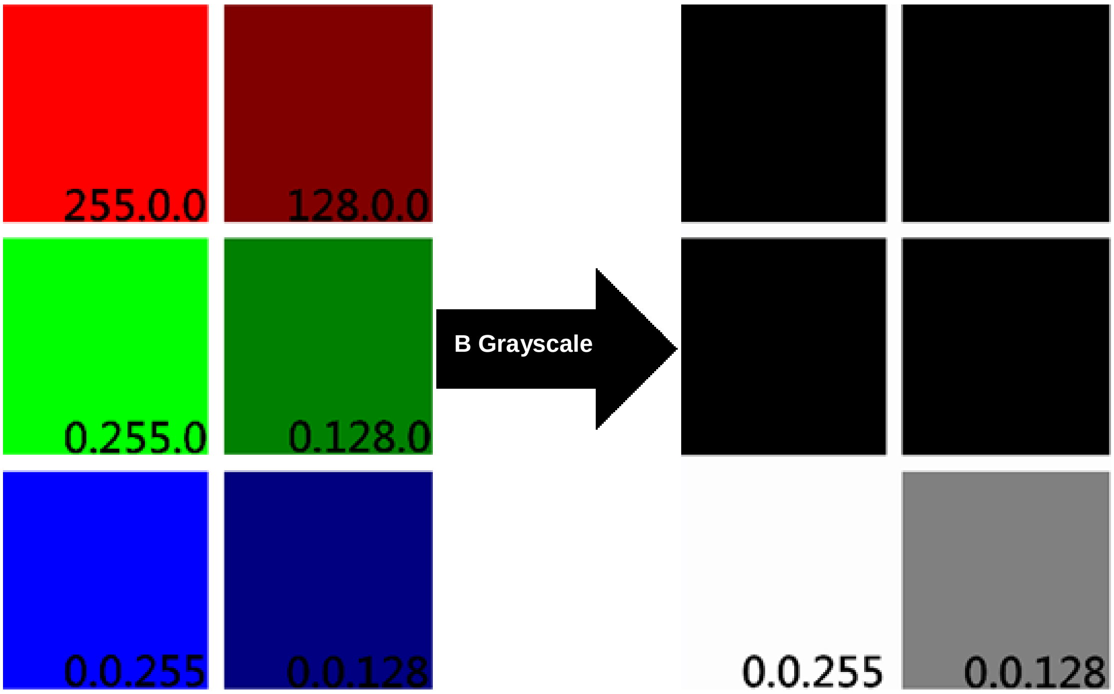
- G Grayscale

The G grayscale for each pixel are extracted and the color image is converted to gray-scale image according to the intensity of the G grayscale.



- B Grayscale

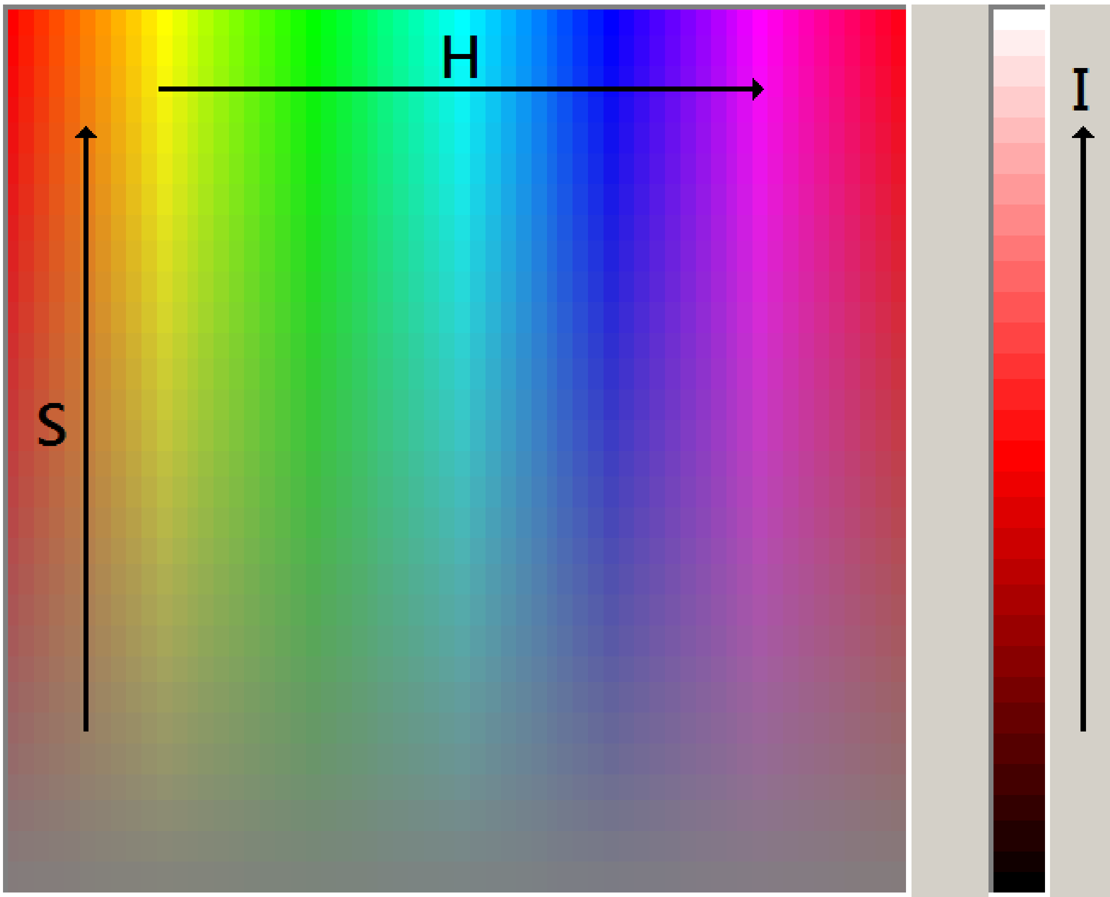
The B grayscale for each pixel are extracted and the color image is converted to gray-scale image according to the intensity of the B grayscale.



◎ **RGB VS HSI**

A color can be presented using the intensities of the 3 primary color R, G, and B components. For example, dark red can be represented by R = 50, G = 0, B = 0 and bright red can be represented by R = 255, G = 0, B = 0. Dark yellow can be represented by R = 50, G = 50, B = 0 and bright yellow can be represented by R = 255, G = 255, B = 0. Therefore, at least 2 parameters must be adjusted to change color intensity and saturation when colors are defined using RGB. Moreover, the adjustments are non-intuitive.

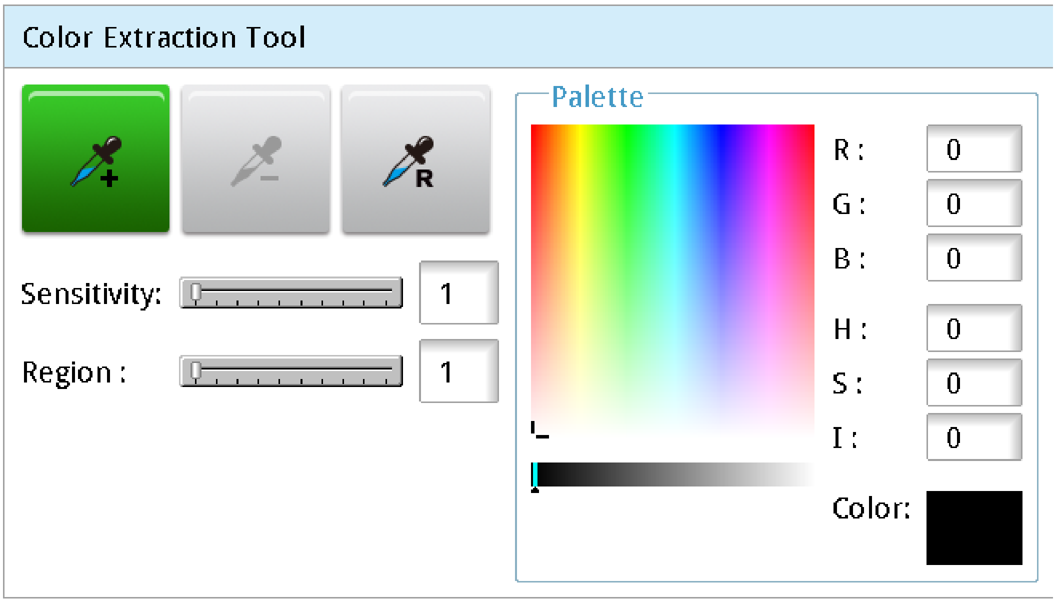
Therefore, HSI is often selected when using color extraction tools for more intuitive operations. Similar to RGB, HSI also uses 3 color components to represent 1 color. However, HSI comprise the 3 components of hue (H), saturation (S), and intensity (I) instead of the red, green, and blue components in RGB (as shown in the following diagram). 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.



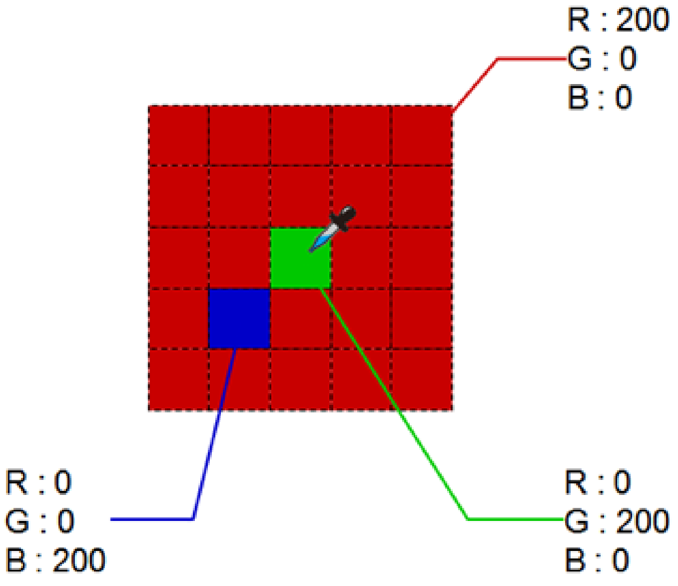
◎ **Color Extraction Tool**

The Color Extraction Tool provides the dropper icon to assist users extract the target color.

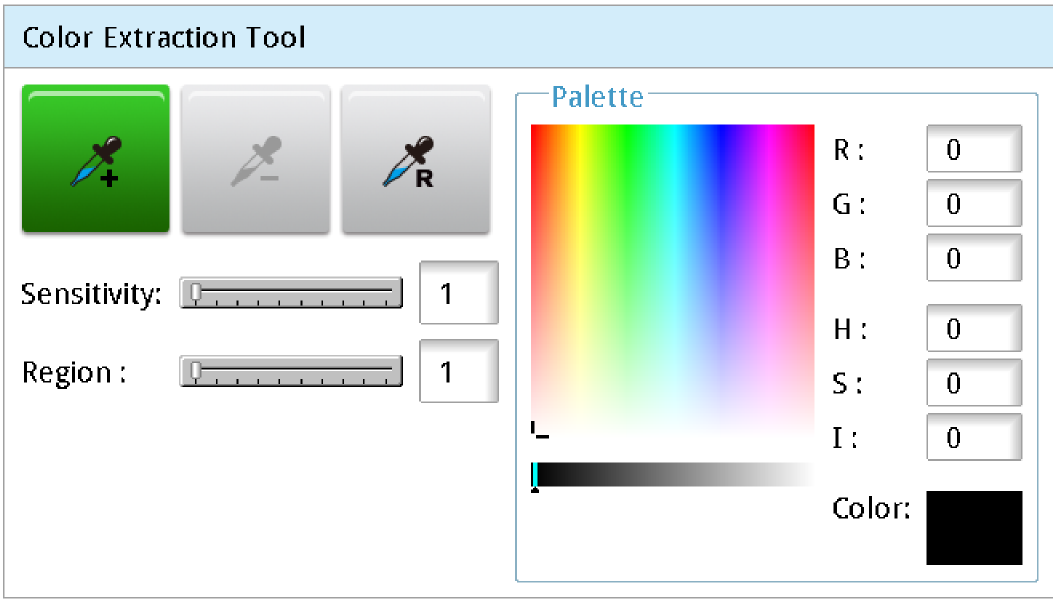
➤ When using Color to Binary, the interface of Color Extraction Tool is shown as follows. Color to Binary requires extracting a color range. Therefore, when extracting colors, Dropper+ and Dropper- must be used repeatedly to increase and decrease the color range; DropperR can be used to reset the extracted color range.



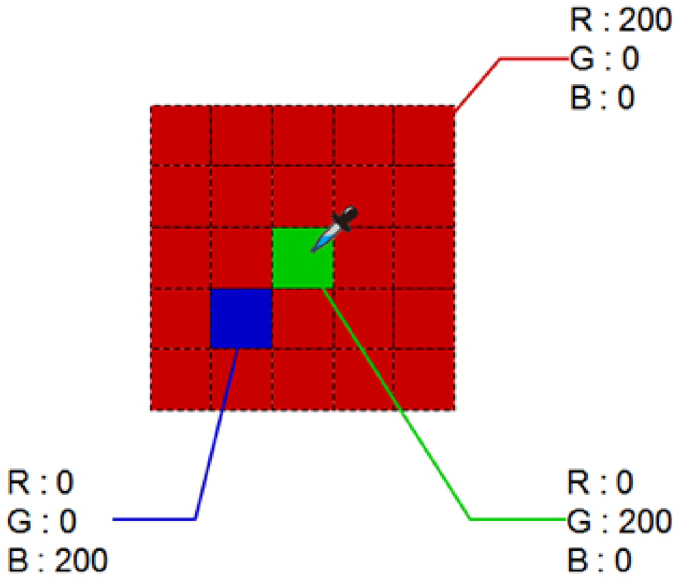
- The Sensitivity and Region configurations will influence the color range during each extraction. An example is provided as follows.
  The extraction position is shown in the following diagram. Assume Region and Sensitivity are set to 1 and 5, respectively:
  When Region is set to 1, the selected pixel region will be extended by +/-1 pixel in the X and Y directions. Therefore, the selected region will become 3*3 and 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.
  Because Sensitivity is set to 5, the extracted RGB range will extend by +/-5. Therefore, the final extraction will result in R = 151~161, G = 17~27, and B = 17~27.



- When using Color to Grayscale, the interface of Color Extraction Tool is shown as follows.
  Color to Grayscale only extract one specific color. Therefore, when extracting colors, only Dropper+ will appear for the extraction of a single color. DropperR can be used to reset the range of the extracted color.



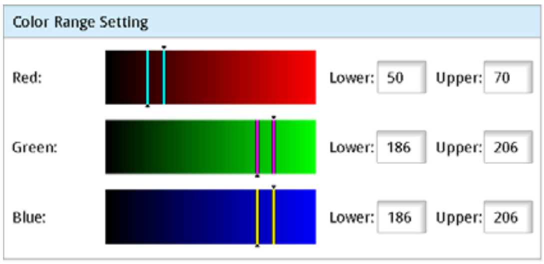
◆ The configuration in Region will influence the extracted color, as shown in the following example. The extraction position is shown in the following diagram. Assume Region is set to 1: When Region is set to 1, the selected pixel region will be extended by +/-1 pixel in the X and Y directions. Therefore, the selected region will become 3*3 and 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.

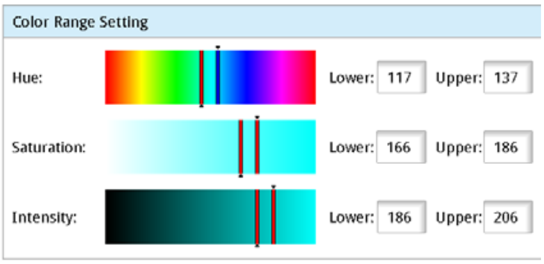


◎ **Color Range Setting**

The Color Range Setting Interface enables users to adjust the extracted color range.

- When using Color to Binary, the interface is shown as follows. The handle bar on the color picker can be adjusted. The Upper/Lower values can also be directly modified to adjust the extracted color range.

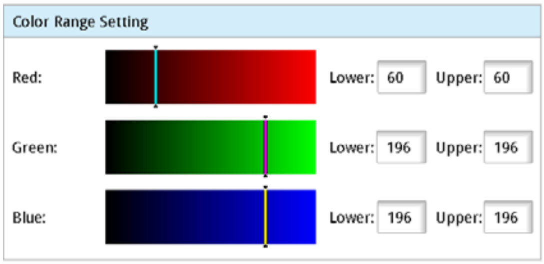


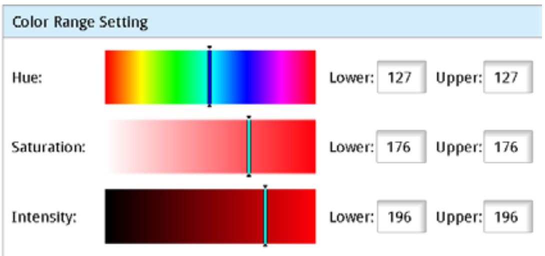


RGB color picker interface

HSI color picker interface

- When using Color to Grayscale, the interface is shown as follows. The handle bar on the color picker can be adjusted. The Upper/Lower values can also be directly modified to adjust the extracted color range.





RGB color picker interface

HSI color picker interface