DMV1000 Technical Manual

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Thank you for your purchase of the high performance Delta Machine Vision DMV-1000 from Delta Electronics Inc. This operating manual covers the component description, installation, operation, troubleshooting, peripherals, and maintenance.
To guarantee proper installation and operation of the system, please carefully read this operating manual and safe keep it for future reference.

Precautions:

1. Please check the signal connections, for example input voltage and polarity, before powering on to prevent damages due to an incorrect voltage input level.
2. Please check that system power is turned off before inspecting the input power source or connecting the wires. Do not touch the terminals or connect the wires while system power is turned on; as this runs the risk of electric shock.
3. Please do not disassemble or modify the internal components of the controller.
4. The controller unit is a open-type chassis and must be installed in an panel box to keep away from dust, water, moisture, electric shock, and external impact.
5. Keep away from metal scraps that may interfere with operation or even cause damage to the components.
6. Keep away from interference sources such as high voltage and high frequency noise during installation. Avoid system operation under the following situations:
   (a) Excessive dust or corrosive gasses (b) High temperature, high humidity, and high levels of radiation
   (c) External shock and impact (d) Direct sunlight
7. Please use a dry cloth to clean the system. Do not use cleaning solutions containing acidic or alkaline chemicals.
8. Check the ground terminal to the power source for proper connection. Check the terminals for secure connection.
9. Only use the blower to remove dust from the camera sensor or lens. Do not blow using the mouth to avoid getting moisture on the components.
10. Please gently wipe off the lens only with a lens cloth. The lens may be scratched if excessive force or inappropriate material is used.

Chapter 1 :

Components and Specifications

1.1 Packaging and Optional Parts:

A complete DMV system requires the following basic components:

1) Controller unit and keypad
2) Camera and 4.5m cable (first set is included with the controller with an optional second set)
3) Lens (optional)
4) Light source and dimmer (optional)

1.1.1 Controller Packaging:

The following is included:

- Controller: DMV1000-80GX
- Operator: DMV1000-KEY
- 0.8 Megapixel (1024*768) grayscale camera: DMV-CD80GS
- 4.5m 1394a-to-1394b cable: DMV-CA45

1.1.2 Camera (optional second camera):

Spec: 1/3”CCD with C mount

- 0.8 Megapixel (1024*768) grayscale camera: DMV-CD80GS
- 0.3 Megapixel (640*480) grayscale camera: DMV-CD30GS
- 4.5m 1394a-to-1394b cable: DMV-CA45
- 1m 1394a trigger cable: DMV-CA10T

1.1.3 Lens (optional):

Megapixel lens: 2/3” image size with C mount

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

Telecentric Lens:

- 50mm focal length: DMV-LN50T

1.1.4 LED Light Source (optional):

Ring:

- Red: DMV-DR6736R
- White: DMV-DR6736W
- Diffuser: DMV-DR6736D

30 degree lighting angle, 36mm inner diameter, and 67mm outer diameter for general text surfaces.

Coaxial:

- White: DMV-CX40W

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

Backlight:

- Red: DMV-BL60R

60mm*60mm for backlight illumination during size measurement.

Power Supply:

- 1-channel output: DMV-PS12C1
- 2-channel output: DMV-PS12C2
- Power cable extension: DMV-CA30

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

1.2 Controller unit and Keypad:

1.2.1 Specifications:

■ **General Specifications:**

Input power	DC24V
Operation voltage	90%~110% of rated voltage
Power consumption	Less than 1A
Vibration resistance	10~55Hz@10m/s in 3-axis for 10min
Shock resistance	Max 300m/s in 3-axis and 6-orientation for 3-repetition
Operating temperature	0°C~+50°C
Storage temperature	-20°C ~+65°C
Operating humidity	35%~65% RH (no condensation)
Operating altitude	Lower than 2,000m
Battery lifespan	More than 5 years

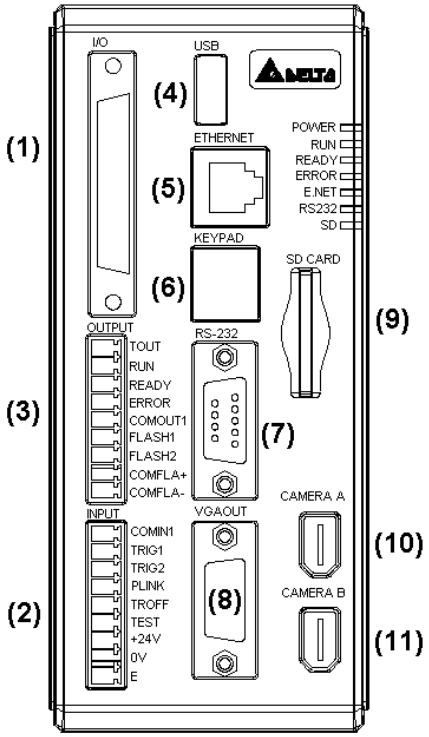
■ **Functionality:**

Camera	Type	IEEE1394a digital grayscale camera
	Resolution	0.8 Megapixel camera: 1024(H)*768(V)@80fps
		0.3 Megapixel camera: 640(H)*480(V)@30fps
	Connected systems	Up to 2 units
	Shutter speed	0.05ms~1s and custom (15 options)
	Lens mount	C mount
Project quantity		Internal memory: 32 (P000~P031); memory card: 968 (P032~P999) Switch through either I/O or RS232/Ethernet
Inspection window	Quantity	128 per project
	Inspection item	Area, position, count, width, angle, match pattern, shape, intensity, blob, stain, position trace, width trace
	ROI type	Rectangle, circle, polygon, ellipse, ring, arc, rotation rectangle
	Mask quantity	4 per inspection window
Pre-processing	Total	13
	Mode	Gray cut, dilation, erosion, average, median, sharpen, Laplacian, SobelX, SobelY, Sobel, Prewitt, Roberts, subtract
Execute mode		Always execute, never execute, reference execute
Calculation processing	Total	32
	Arithmetic	Add, subtract, multiply, divide
	Function (14 total)	ABS, SQR, SQRT, MOD, POW, DIST, AVEG, MIN, MAX, LE, EQ, SIN, COS, TAN

Judgment processing	Total	32
	Mode	AND, OR, XOR, NOT
Communication port		RS-232 (max 115,200bps), USB2.0, Ethernet (10BASE-T), Delta PLC-Link
Display	Monitor screen	SVGA 800*600 output
	Display ratio	Adjustable 4~999%
	Operating language	Traditional Chinese, Simplified Chinese, English
Flashlight control		I/O port with 2 independent control sets
Memory card		SD card (max 16GB)

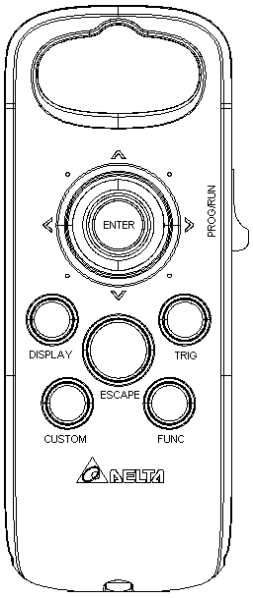
■ **Controller parts:**

Serial No.	Name	Description
1	Parallel I/O port	Input/output terminal
2	Input I/O terminal block	Input terminal
3	Output I/O terminal block	Output terminal
4	USB 2.0 port	Reserved
5	Ethernet port	10/100 BASE-T communication
6	Operator port	Connects to the keypad
7	RS232 serial port	Supports master/slave serial communication
8	VGA output port	Connects to external aftermarket VGA monitor
9	SD memory card	Saving project configuration and image backup
10	Camera 1 port	For cameras with 1024*768 and 640*480 resolutions
11	Camera 2 port	For cameras with 1024*768 and 640*480 resolutions



■ **Keypad:**

Serial No.	Name	Description
1	Direction and enter keys	8-way movement and confirm
2	PROG/RUN	Switch between program and run modes
3	TRIGGER	Inspection trigger key
4	FUNC	Mode display while running
5	DISPLAY	Switch screen display between camera 1/2
6	CUSTOM	Switch between image pre-processing (RUN mode)
8	ESCAPE	Quit



1.3 Camera and Lens:

DMV1000 controller supports the 1394a camera; Delta DMV-80GS (0.8 Megapixel) or DMV-30GS (0.3 Megapixel) camera models are recommended. Before selecting the lens, please confirm the field of view and working distance between the lens and test object. Refer to the table below for a suitable lens.

Field of view (mm) Horizontal (H)*Vertical (V)	**Focal length 8mm**		**Focal length 12mm**		**Focal length 16mm**		**Focal length 25mm**		**Focal length 35mm**		**Focal length 50mm**		**Resolution um/pixel**	
	Dis.	R	Dis.	R	Dis.	R	Dis.	R	Dis.	R	Dis.	R	640 * 480	1024 * 768
1000(H)*750(V)	1667	0											1562	977
800(H)*600(V)	1333	0	2013	0									1250	781
600(H)*450(V)	1000	0	1513	0	2015	0							938	586
500(H)*375(V)	833	0	1263	0	1683	0							781	488
400(H)*300(V)	667	0	1013	0	1348	0	2181	0					625	391
350(H)*263(V)	583	0	888	0	1181	0	1906	0					547	342
300(H)*225(V)	500	0	763	0	1014	0	1631	0	2253	0			469	293
250(H)*188(V)	417	0	638	0	847	0	1356	0	1878	0			391	244
225(H)*169(V)	375	0	575	0	764	0	1218	0	1690	0			352	220
200(H)*150(V)	333	0	513	0	681	0	1081	0	1503	0	2241	0	313	195
175(H)*131(V)	292	0	450	0	597	0	943	0	1315	0	1963	0	273	171
150(H)*113(V)	244	0	389	0	514	0	806	0	1128	0	1686	0	234	146
140(H)*105(V)	228	0	362	0	480	0	751	0	1053	0	1575	0	219	137
130(H)*98(V)	210	0	334	0	444	0	696	0	978	0	1464	0	203	127
120(H)*90(V)	193	0	307	0	407	0	641	0	903	0	1353	0	188	117

Field of view (mm) Horizontal (H)*Vertical (V)	**Focal length 8mm**		**Focal length 12mm**		**Focal length 16mm**		**Focal length 25mm**		**Focal length 35mm**		**Focal length 50mm**		**Resolution um/pixel**	
	Dis.	R	Dis.	R	Dis.	R	Dis.	R	Dis.	R	Dis.	R	640 * 480	1024 * 768
110(H)*83(V)	175	0	280	0	371	0	586	0	828	0	1242	0	172	107
100(H)*75(V)	158	0	253	0	336	0	532	0	753	0	1131	0	156	97
90(H)*68(V)	142	0	227	0	300	0	477	0	678	0	1020	0	141	88
80(H)*60(V)	124	0	200	0	265	0	423	0	603	0	909	0	125	78
75(H)*56(V)	115	0.5	183	0	247	0	397	0	565	0	853	0	117	73
70(H)*53(V)	107	0.5	176	0	230	0	370	0	528	0	798	0	109	68
65(H)*49(V)	98	0.5	160	0	212	0	344	0	490	0	742	0	102	63
60(H)*45(V)	90	0.5	147	0	193	1	316	0	453	0	687	0	94	59
55(H)*41(V)	81	0.5	133	0.5	175	1	290	0	417	0	631	0	86	54
50(H)*38(V)	72	1	120	0.5	158	1	262	0	378	0	576	0	78	48.8
45(H)*34(V)	63	1	106	0.5	142	1.5	235	0	341	0	520	0	70	43.9
40(H)*30(V)	55	1	93	1	123	1.5	208	0	304	0	465	0	63	39.1
35(H)*26(V)	47	1	79	1	108	1.5	183	1	268	0	409	0	55	34.2
32.5(H)*24.4(V)	42	1	72	1	99	2	168	2	247	0	382	0	51	31.7
30.0(H)*22.5(V)	37	1.5	66	1.5	89	2	153	2	229	0	354	0	46.9	29.3
27.5(H)*20.6(V)	33	1.5	58	1.5	80	2	139	2	211	0	325	0	43.0	26.9
25.0(H)*18.8(V)	28	1.5	53	2	72	2	126	2	189	5	298	0	39.1	24.4
22.5(H)*16.9(V)	23	2	45	2			111	5	170	5	272	0	35.2	22.0
20.0(H)*15.0(V)	19	2	40	2			94	5	153	5	243	0	31.3	19.5
18.0(H)*13.5(V)	16	2	33	2			87	5	137	5	221	0	28.1	17.6
17.0(H)*12.8(V)	14	2					81	5	130	5	210	5	26.6	16.6
16.0(H)*12.0(V)					40	5	76	6	122	5	199	5	25.0	15.6
15.0(H)*11.3(V)					36	5	70	6	116	5	189	5	23.4	14.6
14.0(H)*10.0(V)			23	5	32	5	64	7	106	10	177	5	21.9	13.7
13.0(H)*9.8(V)			21	5	29	6	59	7	99	10	166	5	20.3	12.7
12.0(H)*9.0(V)			18	5	25	6	54	8	92	10	153	10	18.8	11.7
11.0(H)*8.3(V)			15	5	23	7	49	9	85	15	145	10	17.2	10.7
10.0(H)*7.5(V)			13	5	19	8	44	10	77	15	133	10	15.6	9.77
9.0(H)*6.75(V)			11	6	16	9	39	11	68	15	122	15	14.1	8.79
8.0(H)*6.00(V)			8	7	13	10	34	13	63	20	111	20	12.5	7.81
7.5(H)*5.63 (V)			8	7	10	10	31	14	58	20	104	20	11.7	7.32
7.0(H)*5.25(V)					7	11	27	16	53	20	99	25	10.9	6.84
6.5(H)*4.88(V)							25	18	51	25	92	25	10.2	6.35
6.0(H)*4.50(V)							23	20	46	25	88	30	9.38	5.86
5.5(H)*4.13(V)							21	22	44	30	84	35	8.59	5.37

Field of view (mm) Horizontal (H)*Vertical (V)	**Focal length 8mm**		**Focal length 12mm**		**Focal length 16mm**		**Focal length 25mm**		**Focal length 35mm**		**Focal length 50mm**		**Resolution um/pixel**	
	Dis.	R	Dis.	R	Dis.	R	Dis.	R	Dis.	R	Dis.	R	640 * 480	1024 * 768
5.0*H)*3.75(V)							17	24	39	30	76	40	7.81	4.88
4.5(H)*3.38(V)							14	26	35	35	72	45	7.03	4.39
4.0(H)*3.00(V)							12	30	33	40	66	50	6.25	3.91
3.5(H)*2.63(V)							9	34	27	45	60	60	5.47	3.42

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

When the depth of field increases, the range of focus also increases. The following conditions will affect the depth of field.

- The longer the extension ring, the shallower the depth of field will be; thus the depth of field will increase when the shorter extension ring is used.
- Longer working distance results in a deeper depth of field.
- Smaller aperture results in a deeper depth of field.
- Shorter focal distance of the lens results in a deeper depth of field.

Chapter 2 :

Input and Output Interface

DMV input and output interfaces include:

1. I/O terminal
2. RS232
3. USB
4. Ethernet
5. SD card

Pin definition and wiring connection are detailed as below.

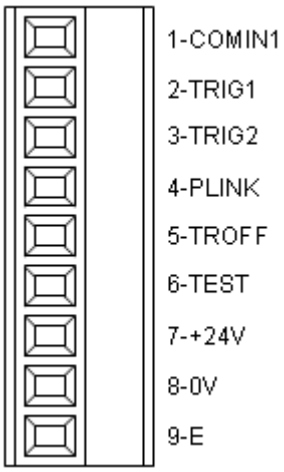
2.1 I/O Terminal Block

I/O terminals are of the 9pin and 50pin types, wherein the most used signals are on the 9pin removable terminal and the remaining signals are on the 50pin.

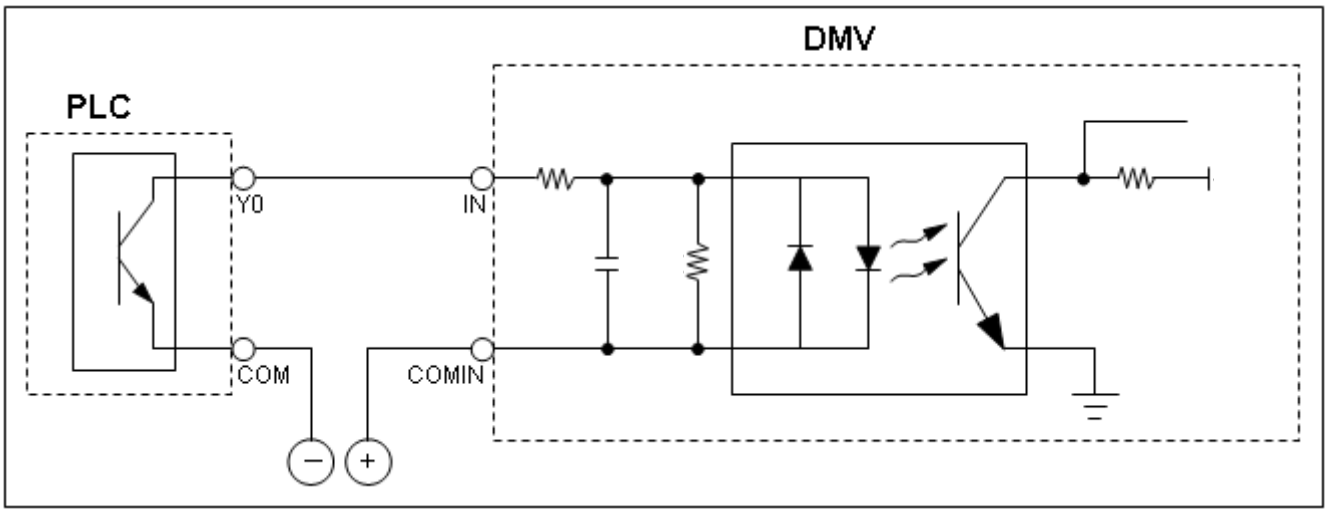
Reference Please refer to Chapter 8 for the purpose and timing for each terminal.

2.1.1 9pin input terminal

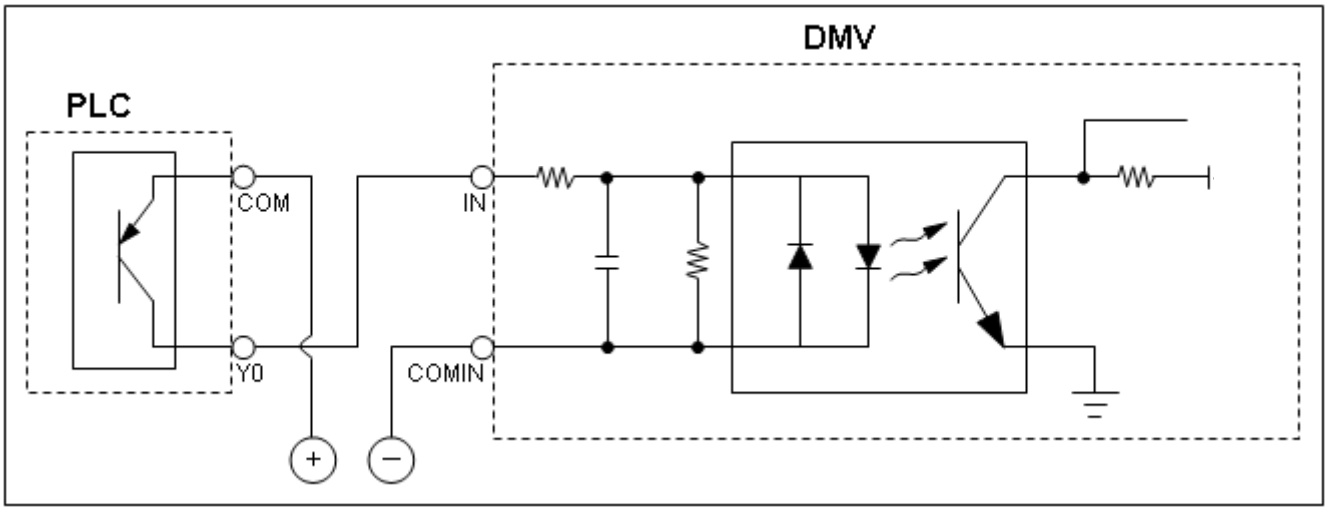
Serial No.	Name	Description
1	COMIN1	9pin common input (NPN / PNP)
2	TRIG1	Camera 1 trigger
3	TRIG2	Camera 2 trigger
4	PLINK	PLC data communication enable flag
5	TROFF	Trigger disabled (inspection disabled)
6	TEST	Status test (all results are not shown)
7	+24V	Positive input power
8	0V	Negative input power
9	E	Grounding



■ **Input schematic** (NPN input)

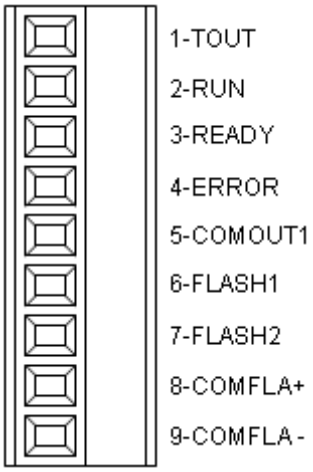


■ **Input schematic** (PNP input)

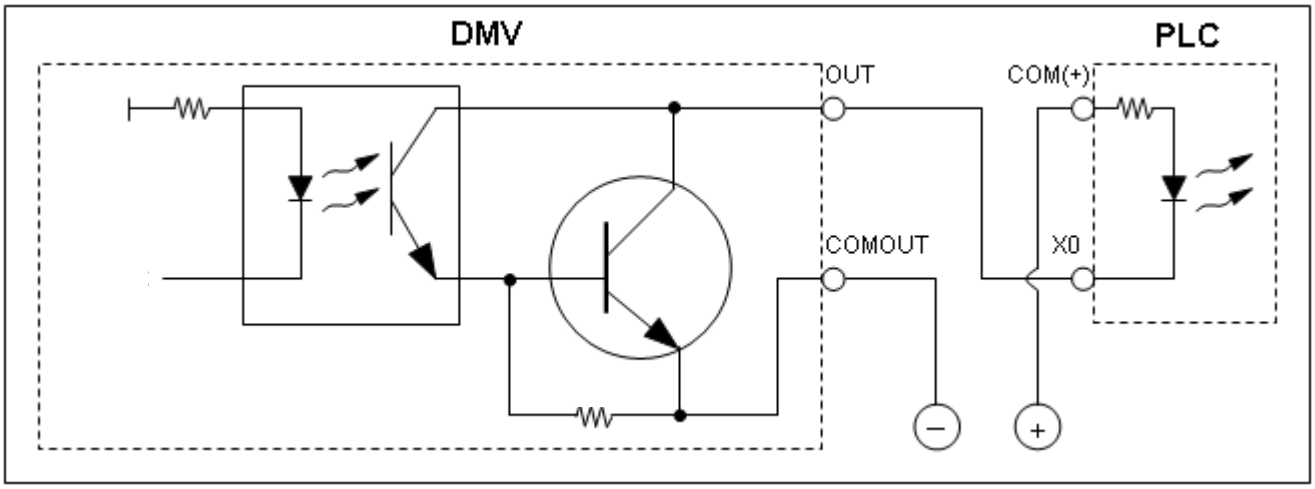


2.1.2 9pin output terminal

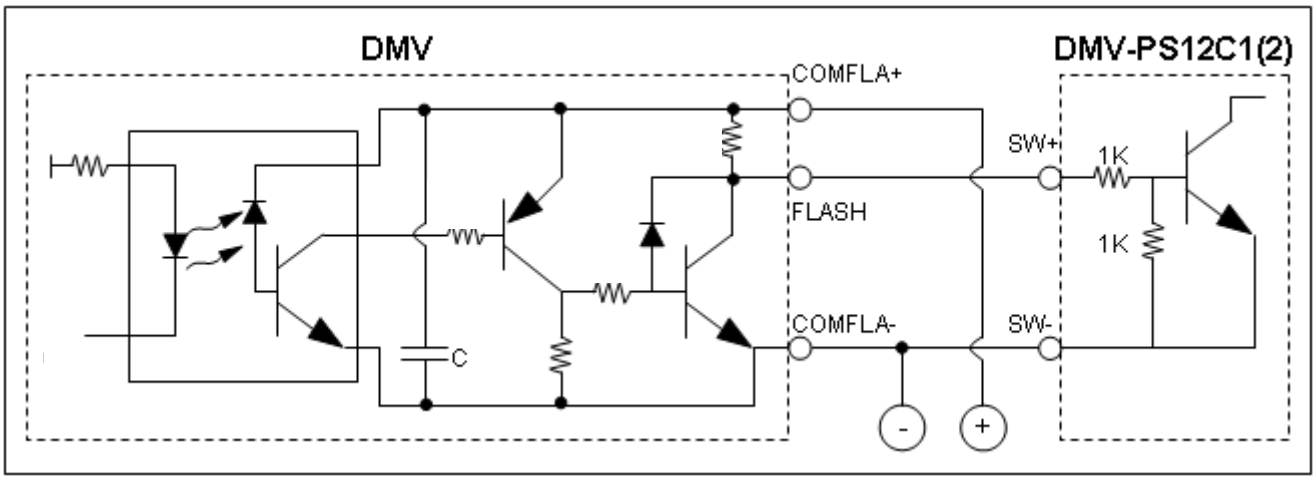
Serial No.	Name	Description
1	TOUT	Overall result output (shown with OK/NG running on display)
2	RUN	Operation status indicator
3	READY	Controller in standby waiting for command and image inspection
4	ERROR	Error status indicator
5	COMOUT1	9pin output common contact (please connect the NPN type to negative power source)
6	FLASH1	Camera 1 flashlight output
7	FLASH2	Camera 2 flashlight output
8	COMFLA+	Flashlight common positive output
9	COMFLA -	Flashlight common negative output



■ **Output Schematic** (NPN output) (excluding FLASH1 and FLASH2)

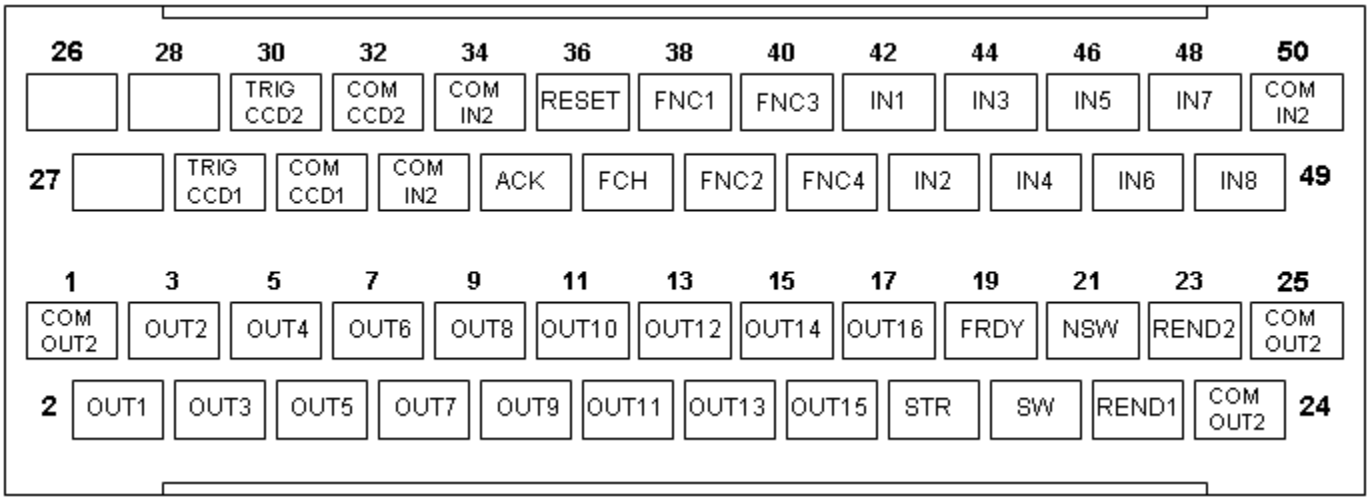


■ **Light control FLASH1/2 output schematic** (NPN output)



Reference DMV-PS12C1(2) is the light controller for the DMV series.

2.1.3 50pin I/O mixed terminal



(Pin out of I/O male connector)

Input and output connection as instructed in sections 2.1.1 and 2.1.2

Pin	Name	Description	Type
1	COMOUT2	Common 50pin output	Output
2	OUT1	Parallel output 1	Output
3	OUT2	Parallel output 2	Output
4	OUT3	Parallel output 3	Output
5	OUT4	Parallel output 4	Output
6	OUT5	Parallel output 5	Output
7	OUT6	Parallel output 6	Output
8	OUT7	Parallel output 7	Output
9	OUT8	Parallel output 8	Output
10	OUT9	Parallel output 9	Output
11	OUT10	Parallel output 10	Output
12	OUT11	Parallel output 11	Output
13	OUT12	Parallel output 12	Output
14	OUT13	Parallel output 13	Output
15	OUT14	Parallel output 14	Output
16	OUT15	Parallel output 15	Output
17	OUT16	Parallel output 16	Output
18	STR	Parallel output handshaking flag	Output
19	FRDY	Allow function switching flag	Output
20	SW	Function switching success flag	Output
21	NSW	Function switching failed flag	Output
22	REND1	Camera 1 captured	Output
23	REND2	Camera 2 captured	Output
24	COMOUT2	Common 50pin output	Output
25	COMOUT2	Common 50pin output	Output

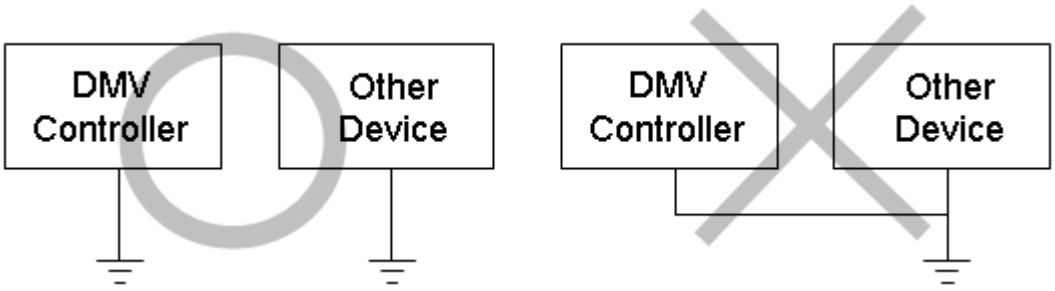
Pin	Name	Description	Type
26		Reserved	---
27		Reserved	---
28		Reserved	---
29	TRIGCCD1	Camera 1 internal trigger	Internal
30	TRIGCCD2	Camera 2 internal trigger	Internal
31	COMCCD1	Common TRIGCCD1	Internal
32	COMCCD2	Common TRIGCCD2	Internal
33	COMIN2	Common 50pin input	Input
34	COMIN2	Common 50pin input	Input
35	ACK	Parallel output handshaking flag	Input
36	RESET	System reset	Input
37	FCH	Function select trigger	Input
38	FNC1	Function select 1	Input
39	FNC2	Function select 2	Input
40	FNC3	Function select 3	Input
41	FNC4	Function select 4	Input
42	IN1	Number input 1	Input
43	IN2	Number input 2	Input
44	IN3	Number input 3	Input
45	IN4	Number input 4	Input
46	IN5	Number input 5	Input
47	IN6	Number input 6	Input
48	IN7	Number input 7	Input
49	IN8	Number input 8	Input
50	COMIN2	Common 50pin input	Input

2.2 Grounding and Installation:

2.2.1 Grounding:

Precautions:

- Do not connect or disconnect the wires while system is powered on.
- The grounding wire should be at minimum length using the regulated wire gauge. The grounding resistance must be under 100Ω.
- Please ground the grounding terminal using the third method. Do not directly connect to other power devices.



2.2.2 Installation:

DMV supports the DIN rail-type and screw-type installations.

- DIN rail-type:
  - Install: (Install in the 35mm rail groove)
    1. Place the controller onto the DIN rails.
    2. Gently push down on the controller to fit into the DIN rails.
  - Uninstall:
    1. Insert the screwdriver into the DIN rail latch.
    2. Push down onto the latch and lift the controller away.

Please reserve at least 50mm above and 30mm left/right of the controller for proper ventilation. Excessive operating temperature due to insufficient cooling will damage the controller.
Please reserve at least 100mm in front of the wiring panel for ease of access.

Chapter 3 :

Basic Operation

3.1 Keypad:

The DMV keypad unit can be used to configure the interface. This chapter covers using the keypad to adjust the size of the viewing window.

3.1.1 What is the ROI (Region of Interest):

Each inspection function must be configured with the imaging area to inspect. This area is the ROI. The ROI can be configured as follows:

1) [Program] > [Camera] > [Camera 1] and [Camera 2] > [Setup Area] to adjust the effective imaging window size.
2) [Program] > [Window] > [ROI] to adjust the [ROI].
3) [Program] > [Window] > [ROI] to adjust the [Mask 1~4].
4) [Program] > [Window] > [Shape] > [Parameter] > [Add Pattern] to set the pattern size.

The following window shapes are provided for different imaging requirements:

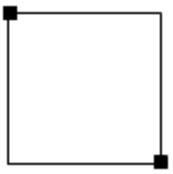
1) Rectangle
2) Circle
3) Polygon
4) Ellipse
5) Ring
6) Arc
7) Rotation rectangle

3.2 Draw ROI (Region of Interest):

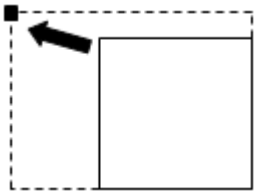
3.2.1 Draw Rectangle:

Follow the steps below to draw the rectangle:

1) Initial rectangle; press [Enter] to show the top/bottom positions.
   Use [Up] / [Down] / [Left] / [Right] on the keypad to move the entire object.

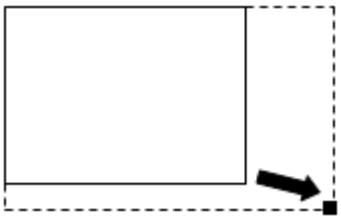


2) Press [Enter] to switch to the top position.
   Use [Up] / [Down] / [Left] / [Right] on the keypad to move the top position.



3) Press [Enter] to switch to the bottom position.
   Use [Up] / [Down] / [Left] / [Right] on the keypad to move the bottom position.

4) Press [Enter] to set the position of the rectangle.

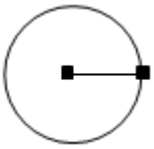


5) Select the  icon on the right side of the screen, press [Enter] to finish drawing the rectangle and go back.

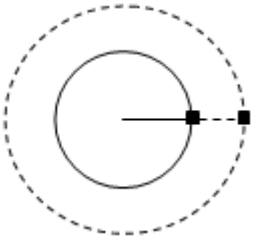
3.2.2 Draw Circle:

Follow the steps below to draw the circle:

1) Initial circle; press [Enter] to show the center and right position.
   Use [Up] / [Down] / [Left] / [Right] on the keypad to move the entire object.



2) Press [Enter] to switch to the right position.
   Use [Up] / [Down] on the keypad to adjust the radius of the circle.



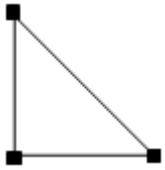
3) Press [Enter] to set the position of the circle.

4) Select the  icon on the right side of the screen, press [Enter] to finish drawing the circle and go back.

3.2.3 Draw Polygon:

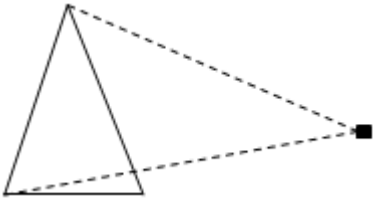
Follow the steps below to draw the polygon: (up to 12 sides)

1) Press [Enter] to show 3 vertexes.
   Use [Up] / [Down] / [Left] / [Right] on the keypad to move the entire object.

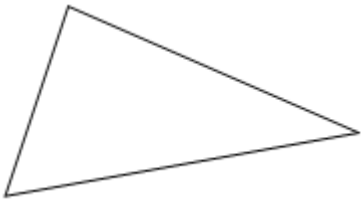


2) Press [Enter] to switch to the top vertex (first).
   Use [Up] / [Down] / [Left] / [Right] on the keypad to move the top vertex.

3) Press [Enter] to switch to the second vertex (clockwise).
   Use [Up] / [Down] / [Left] / [Right] on the keypad to move the second vertex.

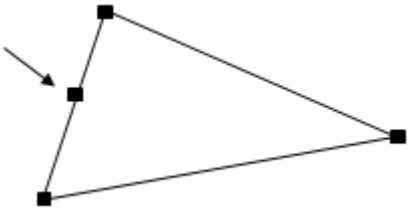


4) Set all vertexes in the clockwise direction.
   Under this state (no vertex labels), the [region] at the right becomes available.

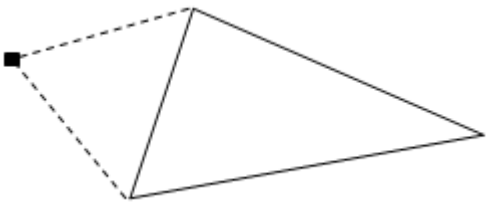


5) Select 

to add the fourth vertex counter clockwise to the first vertex. Press [Enter] to show the 4 vertexes.

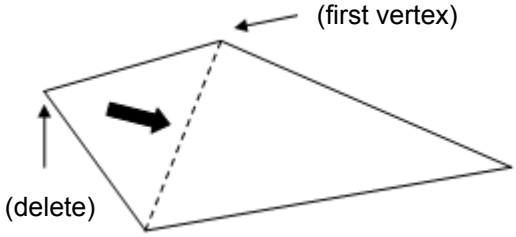


6) Follow above steps 1~4 to configure the polygon.



7) Select 

as in step 5 to delete the last vertex.

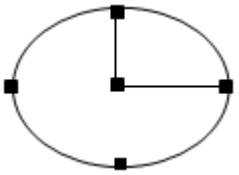


8) Select the  icon on the right side of the screen, press [Enter] to finish drawing the polygon and go back.

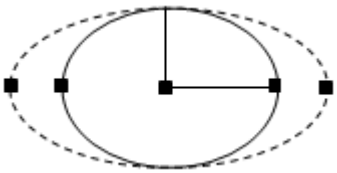
3.2.4 Draw Ellipse:

Follow the steps below to draw the ellipse:

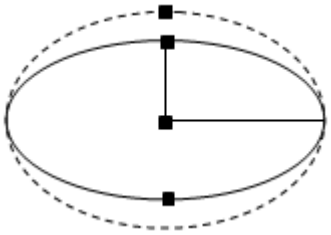
1) Initial ellipse; press [Enter] to show the center and 4 positions.
   Use [Up] / [Down] / [Left] / [Right] on the keypad to move the entire object.



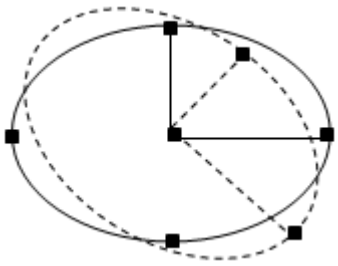
2) Press [Enter] to switch to the left/right positions.
   Use [Up] / [Down] on the keypad to adjust the width of the ellipse.



3) Press [Enter] to switch to the top/bottom positions.
   Use [Up] / [Down] on the keypad to adjust the height of the ellipse.



4) Press [Enter] to select all positions.
   Use [Up] / [Down] on the keypad to adjust the orientation angle of the ellipse.



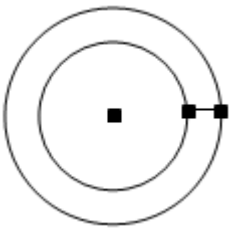
5) Press [Enter] to set the position of the ellipse.

6) Select the  icon on the right side of the screen, press [Enter] to finish drawing the ellipse and go back.

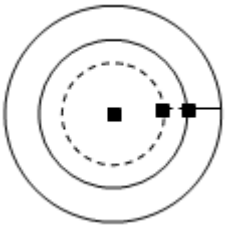
3.2.5 Draw Ring:

Follow the steps below to draw the ring:

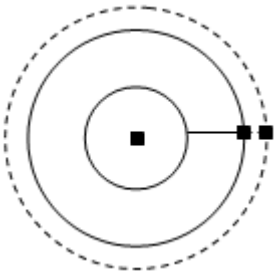
1) Initial ring; press [Enter] to show the center and inner/outer positions.
   Use [Up] / [Down] / [Left] / [Right] on the keypad to move the entire object.



2) Press [Enter] to switch to the inner position.
   Use [Up] / [Down] on the keypad to adjust the inner radius.



3) Press [Enter] to switch to the outer position.
Use [Up] / [Down] on the keypad to adjust the outer radius.



4) Press [Enter] to set the position of the ring.

5) Select the  icon on the right side of the screen, press Enter to finish drawing the ring and go back.

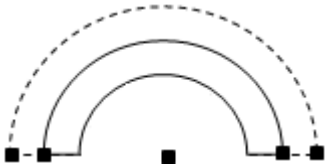
3.2.6 Draw Arc:

Follow the steps below to draw the arc:

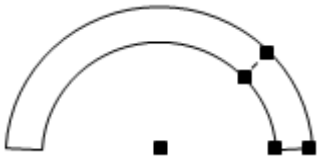
1) Initial arc; press [Enter] to show the center and inner/outer positions.
Use [Up] / [Down] / [Left] / [Right] on the keypad to move the entire object.

2) Press [Enter] to switch to the inner position.
Use [Up] / [Down] on the keypad to adjust the radius of the inner ring.

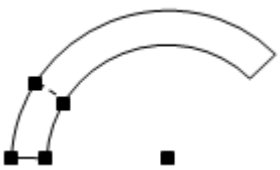
3) Press [Enter] to switch to the outer position.
Use [Up] / [Down] on the keypad to adjust the outer radius.



4) Press [Enter] to switch to the inner/outer positions on the right.
Use [Up] / [Down] on the keypad to adjust the right angle of the arc.



5) Press [Enter] to switch to the inner/outer positions on the left.
Use [Up] / [Down] on the keypad to adjust the left angle of the arc.



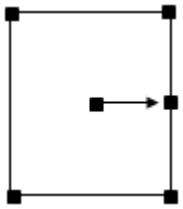
6) Press [Enter] to set the position of the arc.

7) Select the  icon on the right side of the screen, press [Enter] to finish drawing the arc and go back.

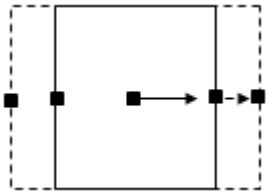
3.2.7 Draw Rotation Rectangle:

Follow the steps below to draw the rotation rectangle:

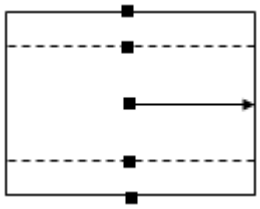
1) Initial rectangle; press [Enter] to show the center and 4 positions.
   Use [Up] / [Down] / [Left] / [Right] on the keypad to move the entire object.



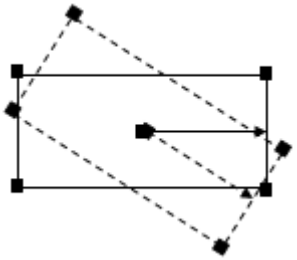
2) Press [Enter] to switch to the left/right positions.
   Use [Up] / [Down] on the keypad to adjust width of the rectangle.



3) Press [Enter] to switch to the top/bottom positions.
   Use [Up] / [Down] on the keypad to adjust height of the rectangle.



4) Press [Enter] to switch to the center and 4 positions.
   Use [Up] / [Down] on the keypad to adjust the orientation angle of the rectangle.



5) Press [Enter] to set the position of the rectangle.

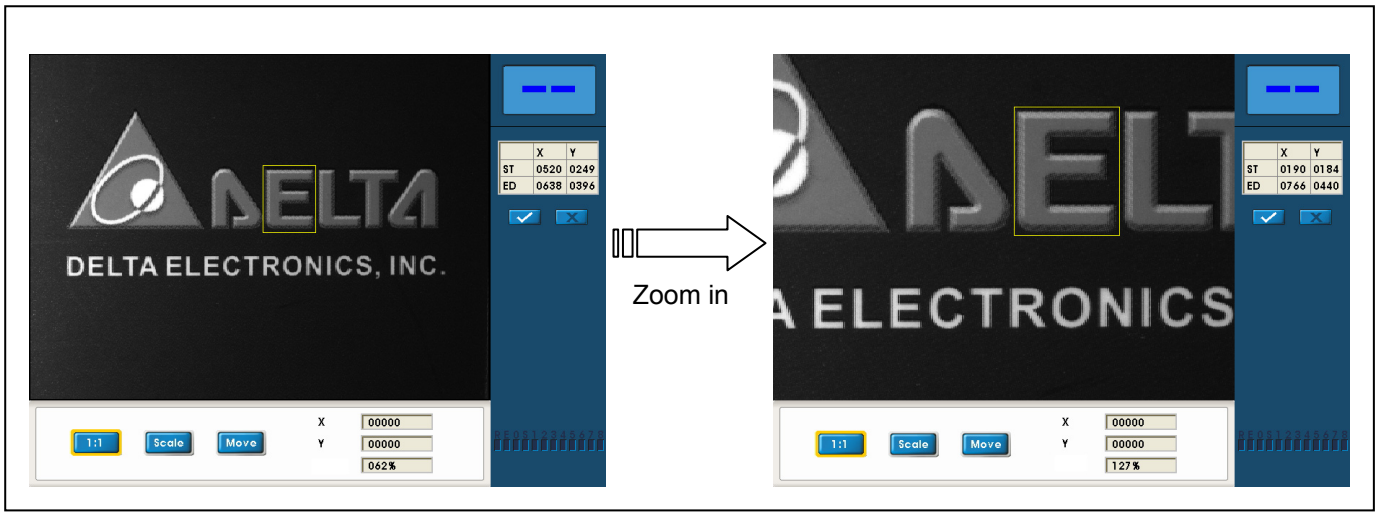
6) Select the  icon on the right side of the screen, press [Enter] to finish drawing the rectangle and go back.

3.3 ROI (Region of Interest) Zoom:

3.3.1 What is Zoom:

For drawing the ROI from section 3.2, the imaging can be zoomed in/out/shifted to enable more precise drawing.

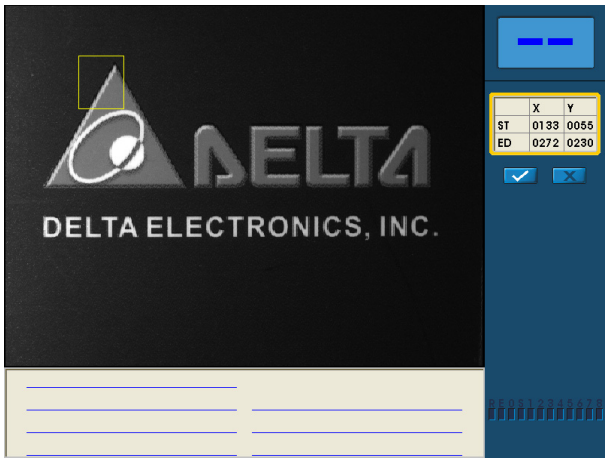
As shown below, to fit the letter "E" in DELTA into the ROI the imaging can be zoomed in for more precise adjustments.



3.3.2 Zoom Instructions:

Zoom function is available in the 5 ROI states below.

1) [Program] > [Camera 1~2] > [Setup Area] to adjust the window size
2) [Program] > [Window] > [ROI] for setup
3) [Program] > [Window] > [Mask Area 1~4] for setup
4) [Program] > [Window] to setup the pattern for [Shape]
5) [System] > [Display] > [Screen] to move the group



■ **Open the ROI adjustment screen, [Program] > [Window] > [ROI] for setup.**

Initial screen is a 1:1 image.

■ Press [DISPLAY]

Adjust the zoom controls at the bottom of the screen, select using the [Left] / [Right] keys.
[1:1]**:** Return to original image.
[Scale]**:** Press [ENTER] and use the [Up] / [Down] keys to zoom. (range between 1%~999%)
[Move]**:** Press [ENTER] and use [Up] / [Down] / [Left] / [Right] to move the image.
[X] [Y] [SIZE]**:** Show current position and zoom level.

Remark At 1:1, the zoom level is 62% due to the difference in 640*480 image resolution and 1024*768 camera resolution.

■ Edit ROI

Adjust the image to size and then press [Escape] to close the configuration screen.
While zoomed in, refer to section 3.2 "Draw ROI (Region of Interest)" to edit the required ROI.

Chapter 4 :

Steps for Setting Up the Inspection Process

The initial screen of the controller setup displays [Project list], [Program], and [System]. Project list and program process flow are discussed in the following section.

- [Project list] Settings

  The controller features 32 built-in internal memories for projects. Projects can be created, edited, renamed, copied, and deleted. The total number of projects can be increased to 999 if a memory card is used.

- [Program] Settings

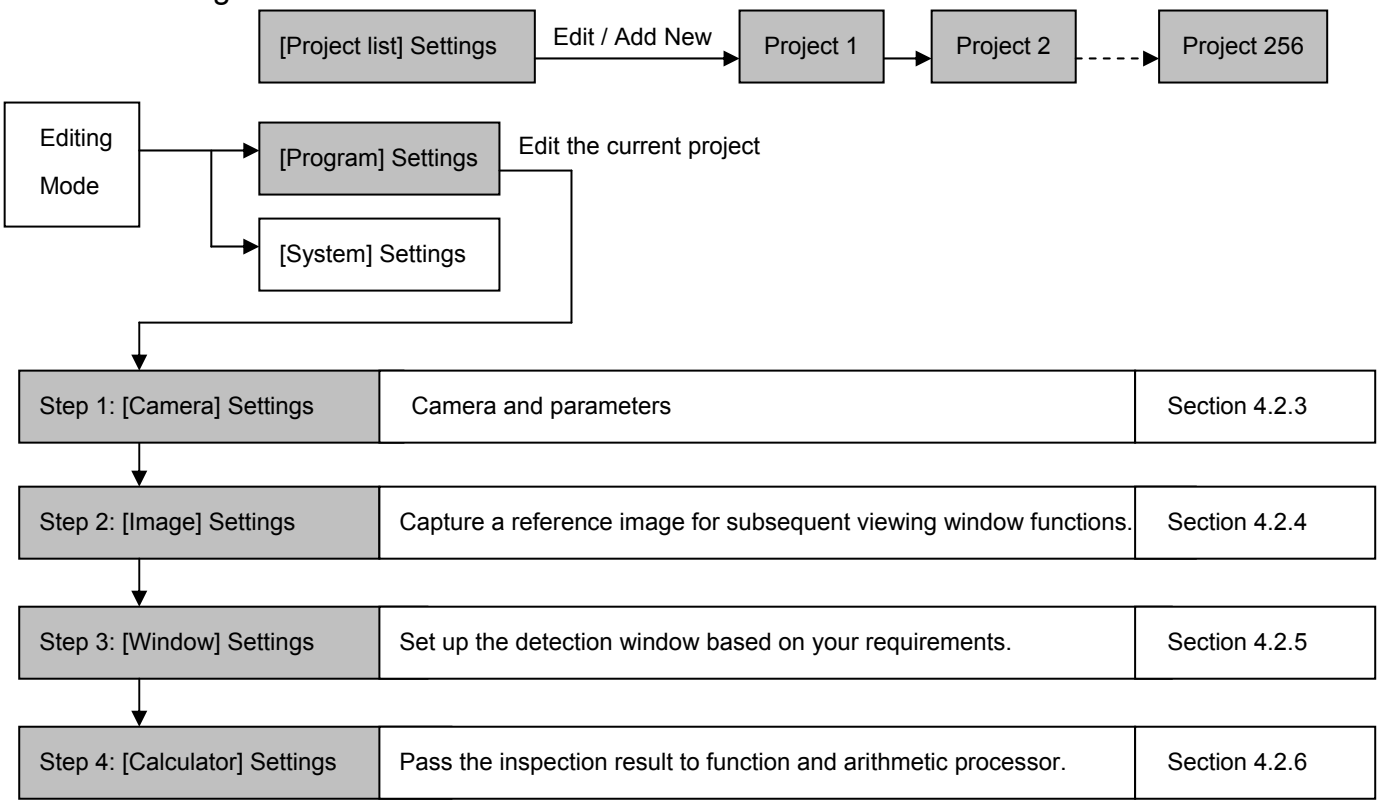
  Program parameters can be modified for the currently selected project. The six settings are [Camera], [Image], [Window], [Calculator], [Judgment], and [Output]. Configure all items to complete setting up an inspection program.

- [System] Settings

  The setting parameters for all inspection projects. The settings are not affected by the project selected.

Reference Please refer to Chapter 5 for [System].

- Block diagram:



Step 5: [Judgment] Settings	Perform Boolean logic on the inspection and calculator results.	Section 4.2.7
Step 6: [Output] Settings	Set up the device and data output.	Section 4.2.8

4.1 [Project list]:

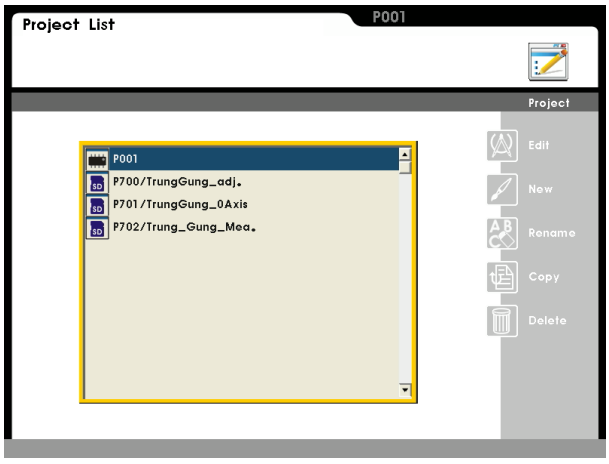
4.1.1 What is a project

Each complete inspection cycle is a project. A new project is setup specifically for different test subjects, and project settings do not overlap.

For example, counter and width measurement for test subject A; positioning and defect detection for test subject B. As the inspection functions for A and B are different, they are individual projects.

4.1.2 Project setup (add project)

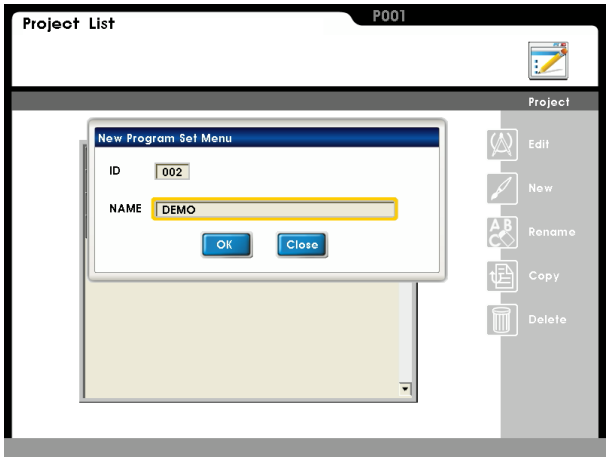
Select [Project list] in the edit screen:
Internal memory supports 32 projects and expandable to 999 with memory card.



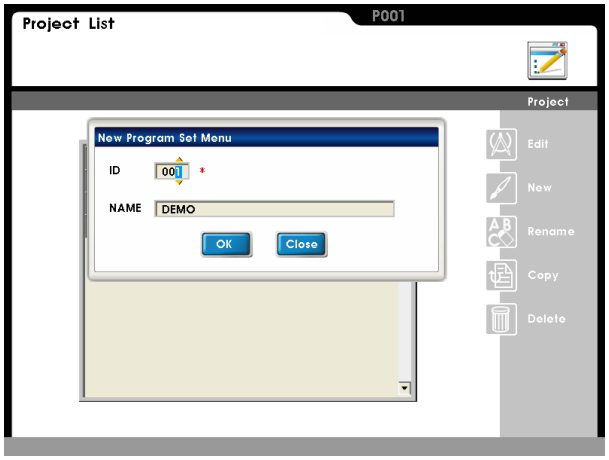
Remark The left and right arrow keys can be used to quickly flip back and forth between multiple display pages.

■ Select [New] to open a new dialog for the project ID and name.

Please set the ID to P000~P031 for internal memory.
Please set the ID to P032~P999 for memory card.

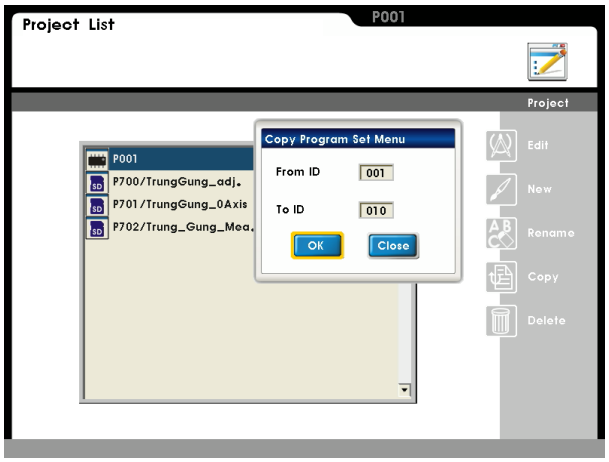


If an ID is already in use, the red * will be shown to the right of the ID. Please pick another ID for the project.
A warning message will be shown if a duplicate ID is added.



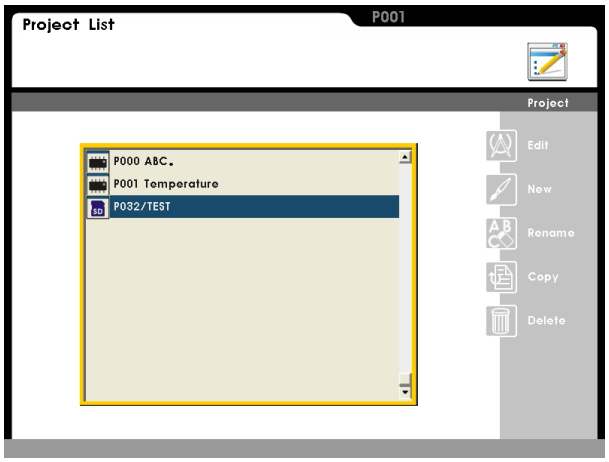
■ Select [Rename] to rename the project.

■ Select [Copy] to copy a duplicate of the project.
As shown to the right: Selecting '001' for [From ID] and '010' for [To ID] will copy the project contents from P001 to P010. (the project name is also copied)



■ Select [Delete] to delete the project's name and all settings content.

■ Select [Edit] to enter the program settings interface for the project and select a project which you wish to edit.
Select the ID and press [Enter] button to switch to the editing project window.
The project ID and name currently in use is listed to the right. For example, switching from P000 ABC to P004 DELTA.
In addition to switching projects from the keypad, the RS232 (serial) and I/O (parallel) channels can also be used.



Reference Please refer to sections 8.1.7 and 9.4 for RS232 and I/O project switching.

4.2 [Program] Settings:

4.2.1 What is a [Program]:

[Program] includes the complete settings (for an inspection cycle) of [Camera], [Image], [Window], [Calculator], [Judgment], and [Output]; these settings are what constitute a process.

4.2.2 [Program] Setup

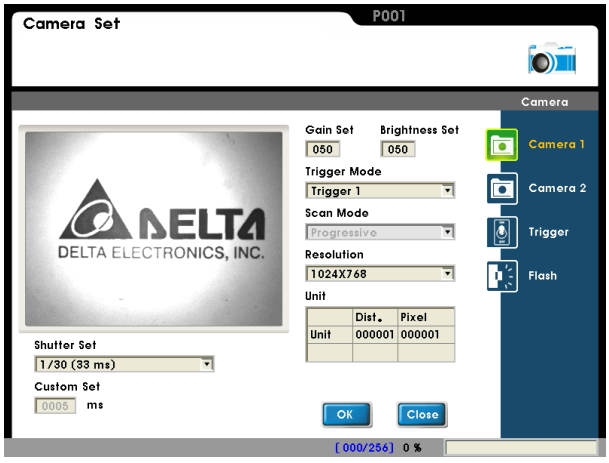
■ Select [Program] from the edit screen:

There are six options on top of the screen:[Camera], [Image], [Window], [Calculator], [Judgment], and [Output].Please edit each option from left to right to fully program a project.

4.2.3 [Camera] setup

DMV supports two cameras working simultaneously, so there are separate settings for [Camera 1], [Camera 2], [Trigger], and [Flash].

■ [Camera 1] and [Camera 2] are set up identically:



- [Gain]:

Range 0~100 (default is 50).Higher gain results in a brighter image but may generate more noise.

- [Brightness]:

Range 0~100 (default 50). Higher brightness results in a brighter image but is less effective than the gain setting in terms of actual luminosity.

- [Trigger mode]:

If the cameras are triggered externally, Camera 1 will take priority when the same trigger source is set for both camera 1 and camera 2.

- [Scan mode]:

Progressive: Scan all lines in the image. All 0.80M pixels will be transferred for a 1024*768 image.

Interlaced: Scan every other line in the image. Only 1024*384 pixels will be transferred for a 1024*768 image to reduce data and transfer time. Although image quality is reduced, the overall inspection speed is increased if the quality is within tolerance.

- [Resolution]:

Resolution to display on the screen (1024*768, 800*600, or 640*480)

- [Unit]:

Ratio of image pixels to actual distance.

- [Shutter Setting]:

List the shutter settings (default 33 ms).A slower shutter speed (i.e., longer exposure time) is well-suited for dimly lit occasions.

However, movement captured with a longer shutter speed is prone to result in blurry images.

- [Custom]:

A custom shutter speed is to be used when the default options are unable to satisfy the requirements. The user can set a custom shutter speed in milliseconds (ms).

The top left image will be refreshed when the [Gain], [Brightness], and [Shutter] settings are changed. The user can check to ensure that the final settings satisfy requirements.

Reference Please refer to section 3.2.3 for drawing the rectangle in the inspection area.

■ [Trigger]:

Set up the camera trigger from either external or internal sources.

- [External trigger]:

Enable the external trigger(s).

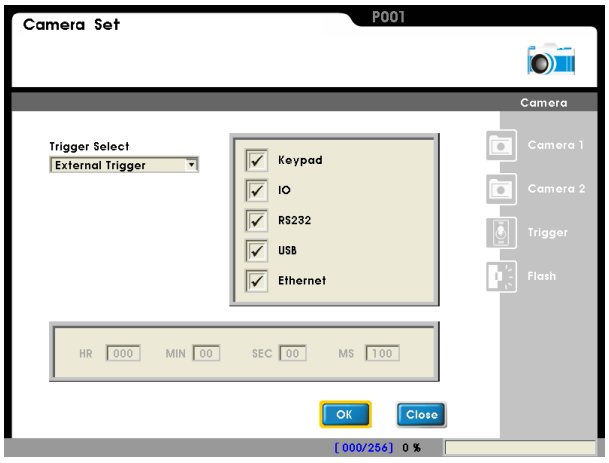
External terminal: Trigger camera through I/O terminal.

Keypad: Press the trigger button to capture an image.

RS232: Trigger camera through the serial interface.

USB: Trigger camera through the USB interface.

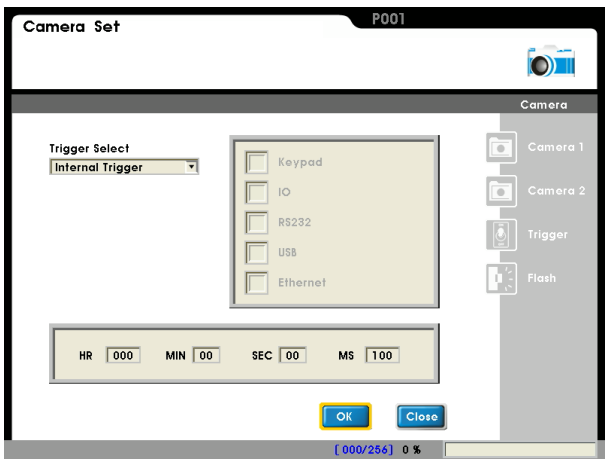
Ethernet: Trigger camera through the Ethernet interface.



- [Internal trigger]:

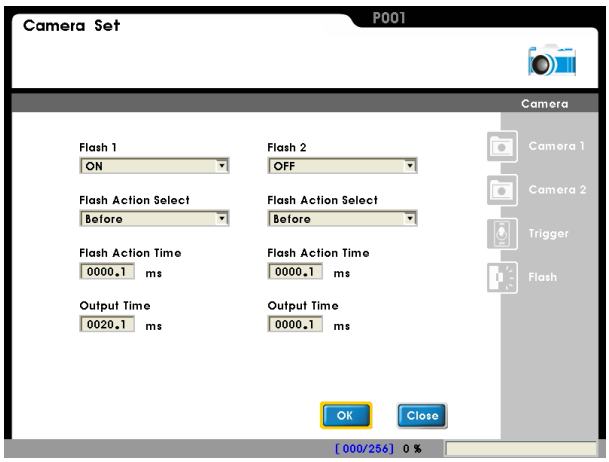
Auto trigger periodically for a timed inspection application.

Please note the counter time must be longer than the image inspection time. If the counter time is shorter than the inspection time, the current inspection cycle must be completed before the next cycle can start. As a result, the time interval will be delayed due to the waiting time.



■ [Flash]:

Flash controls the lighting output in sync with the camera shutter. As an LED's lifespan is greatly affected by the operating temperature, the majority of LED dimmers features the flash trigger input.



- [Flash 1] [Flash 2]

Enable flash output.

Camera 1 and Camera 2 are configured independently.

- [Flash action select]

Before: Output flash before the shutter.

After: Output flash after the shutter.

- [Flash action time]

Relative timing between flash and shutter output.

Before: Activate shutter after flash output for this time duration.

After: Output flash after shutter has activated for this time.

- [Output time]

Time of flash output. Set the flash output time for both before and after actions.

Flash output is generally triggered before the shutter for stable and sufficient illumination. The flash controller (DMV-PS12C2) has 2ms latency from receiving the trigger signal to LED output.

The following setting is therefore recommended: When the shutter time is set to 33ms,

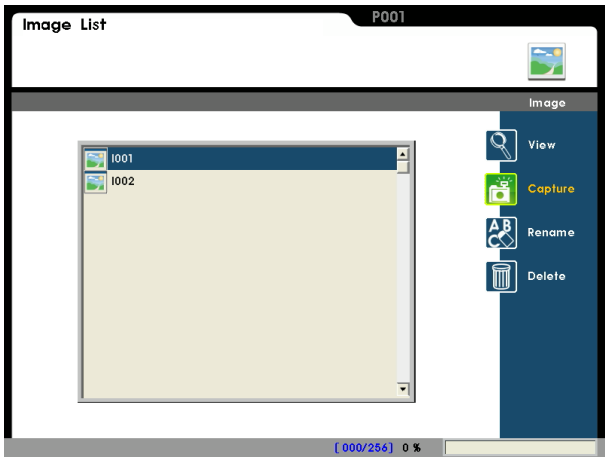
1) [Flash action select] is set to "before".
2) [Flash action time] must be set to greater than 2ms so that the shutter is activated only after the LED output is fully lit.
3) [Output time] requires minimum 35ms (2ms + 33ms) to match the shutter with flash output.

Reference Please refer to section 82.3.for the flash timing sequence.

4.2.4 [Image] Settings:

Save the image as reference for subsequent inspection processes.

- The image list includes saved reference image and file name.



- Select [View] to preview the saved image.

- Select [Capture] to add a new image. Choose [Camera 1/2] and then click 

button to capture the camera image.

Enable [Live] for live image display. The image will be refreshed continuously for making real-time adjustments.

- Set the image ID and filename. ID currently in use is marked with a red * to its right. Click the  to save image.

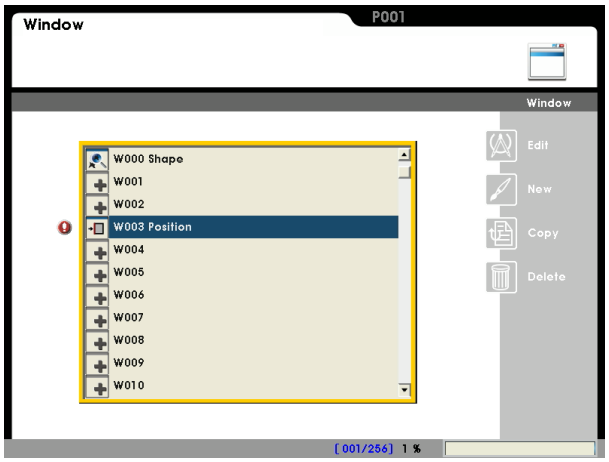
To use an existing ID, please delete the ID and then recapture the image. The existing ID cannot be directly overwritten.

- Select [Rename] to rename the saved image.
- Select [Delete] to delete the saved image.

4.2.5 [Detection Window] settings:

Each project supports 128 (W000~W127) detection windows. As the windows are processed in ascending order, positioning functions should be set to a smaller ID so that the position can be referenced later by the system. Please reserve the first few IDs for detection window positioning functions; we recommend to start from ID W005.

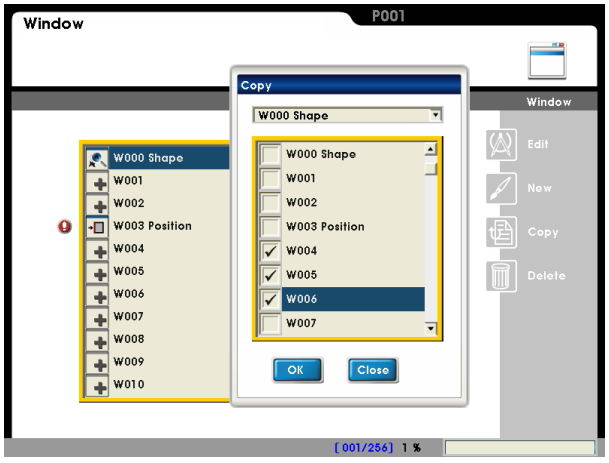
■ Detection Window setup:



- [Edit]: Edit the window function. The function selection dialog is automatically opened for a new inspection window.
- [New]: Open the function selection dialog of the detection window to select a new item.
- [Copy]: Use the multiple copy mode to copy more than one inspection setting from the current detection window to other inspection functions (as explained below)
- [Delete]: Delete the detection window.

An incomplete detection window is indicated with a red exclamation mark.

■ [Copy] a detection window:



Select a single source and then select multiple destinations to copy.

As shown: First select W000 Shape and then select W004, W005, W006 to simultaneously copy W000 to W004~W006.

■ Select [Edit] > [Setup]:

Please set up the functions from top to bottom: [Camera], [Pre-processing], [ROI], [Parameters], [Limit], [Coordinate], and [Execute].

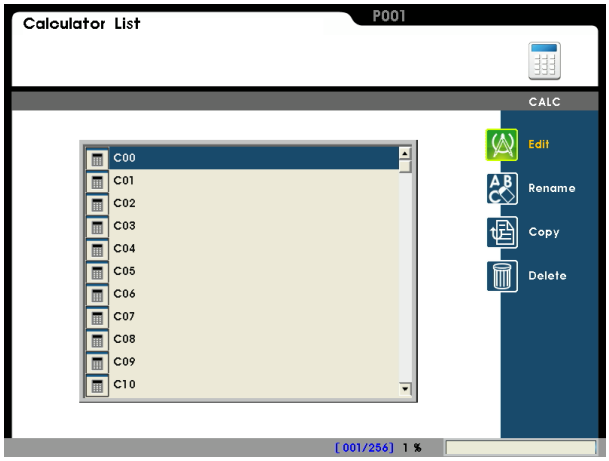
Reference Please refer to Chapter 6 for detailed description on each function.

4.2.6 [Calculator] settings:

Each project supports 32 (C00~C31) calculator functions to be applied on inspection results. The calculator function can perform algebra and trigonometry calculations, where the result can also be used by the subsequent [Judgment] and [Output] programs.

For example: [Edge position] can be used twice to determine the sides and angles of a triangle. Then the third side and angle can be calculated to simplify inspection functions and reduce overall inspection time.

■ Calculator editor:



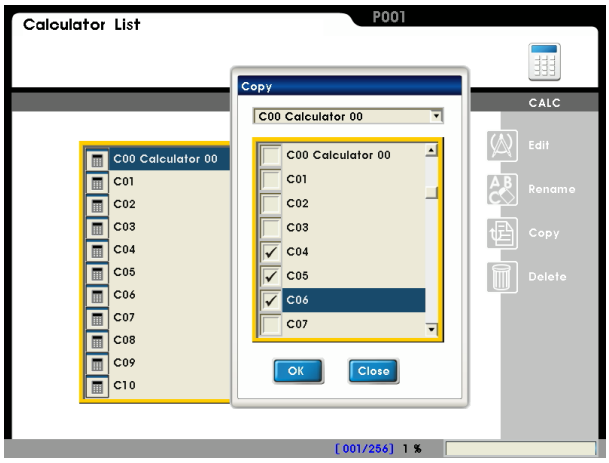
- [Edit]: Calculator edit window.
- [Rename]: Set or modify the calculator name (max 20 characters)
- [Copy]: Copy other calculator contents (as explained below)
- [Delete]: Clear all calculator contents.

A red exclamation mark indicates that the calculator contains invalid settings.

■ [Copy] calculator:

Select a single source and then select multiple destinations to copy.

As shown: First select calculator ID C00 and then select C04, C05, C06 to simultaneously copy C00 to C04~C06.

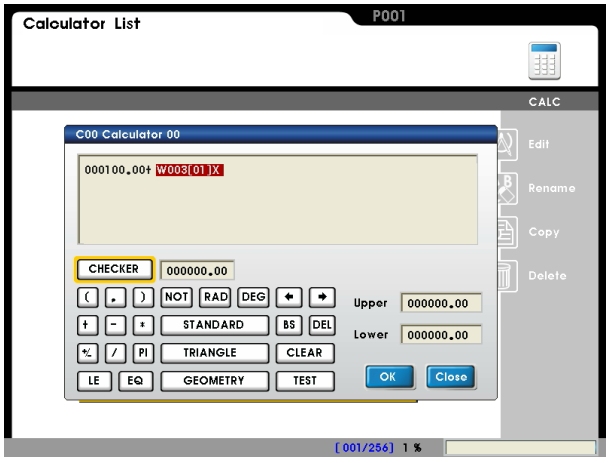


■ [Edit] calculator:

This opens the calculator editor interface. Use the buttons to enter the equation as shown in the display dialog.

Calculator results can be compared to the [Upper/lower] bounds to the right. The Boolean result OK (1) and NG (0) can also be used by the subsequent [Judgment] and [Output] programs.

Calculator results can also be used by subsequent calculators. For example, if C00 output is 500 and C01 = C00 + 200, then C01 output is 700.

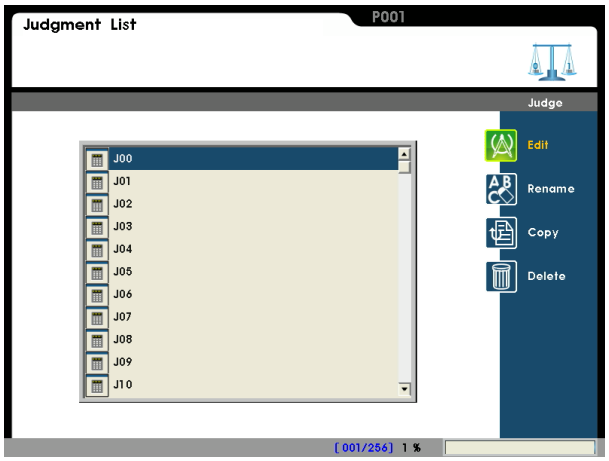


Reference Please refer to Chapter 7 for detailed description on [Calculator].

4.2.7 [Judgment] settings:

Each project supports 32 (J00~J31) judgment for the inspection function and calculator results. The Boolean result OK (1) and NG (0) can also be used by the subsequent [Output] process.

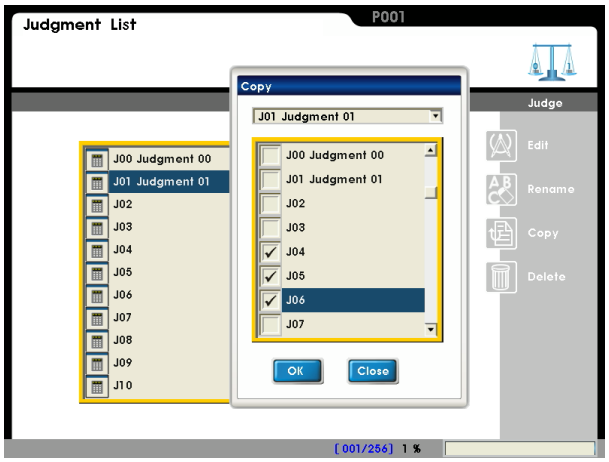
■ Judgment editor:



- [Edit]: Judgment editor window.
- [Rename]:Setup or modify judgment name (max 20 characters)
- [Copy]: Copy other judgment contents (as explained below)
- [Delete]: Clear all judgment contents.

A red exclamation mark indicates the judgment contains invalid settings.

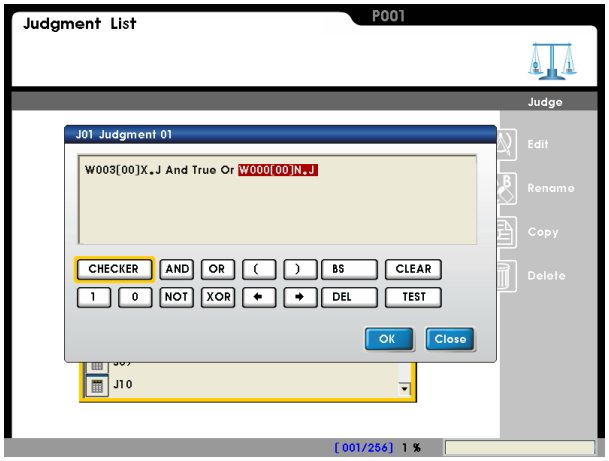
■ [Copy] Judgment:



Select a single source and then select multiple destinations to copy.

As shown: First select judgment ID J01 and then select J04, J05, J06 to simultaneously copy J00 to J04~J06.

■ [Edit] Judgment:



This opens the judgment editor interface. Use the buttons to enter the logic equation as shown in the display dialog.

Judgment results can also be used by subsequent judgments. For example, if J00 output is OK (1) and J01=J00 OR 0, then J01 output is 1.

Reference Please refer to Chapter 7 for detailed description on [Judgment].

4.2.8 [Output]

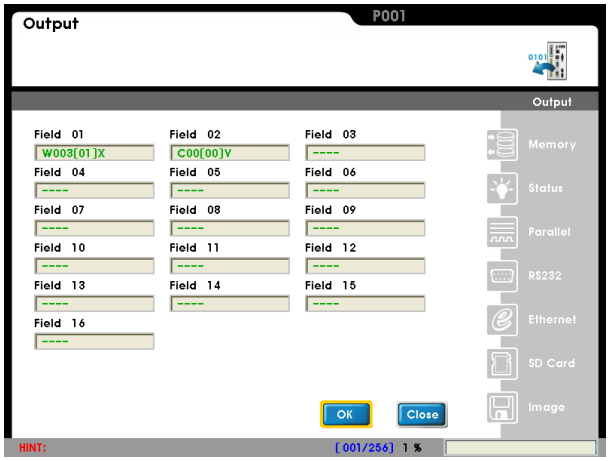
After inspection and calculation are completed, the [Window], [Calculator], and [Judgment] results can be selected for output. Output supports multiple interfaces and display methods, including [Memory], [Status], [Parallel], [RS232], [Ethernet], [SD Card], and [Image].

Interfaces can be selected independently or in multiples simultaneously based on requirements. For example, only the inspection result is sent to PLC through RS232, while all data is sent to the PC through Ethernet for database management.

■ **[Memory] Settings**

A total of 16 internal registers are accessible by the user in the system.

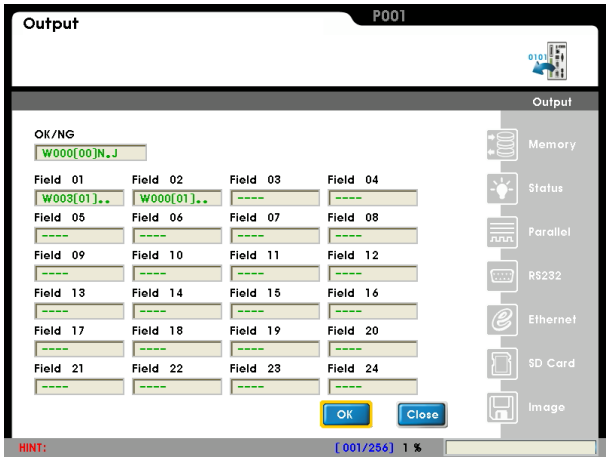
- For example, if Field02 is set to C00 (00) V, it indicates that the result of calculator C00 is written into this internal register.



■ **[Status] Settings**

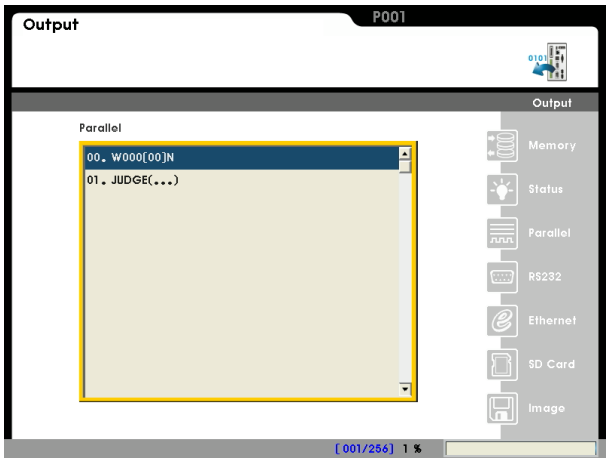
The following status indicators are accessible by the user at the RUN screen.

- Summary output for the inspection - OK (green) and NG (red) status indicators in the top right corner.
- Logic state display - Gray (pending), green (OK), and red (NG) status indicators along the bottom.



■ Setup interface output:

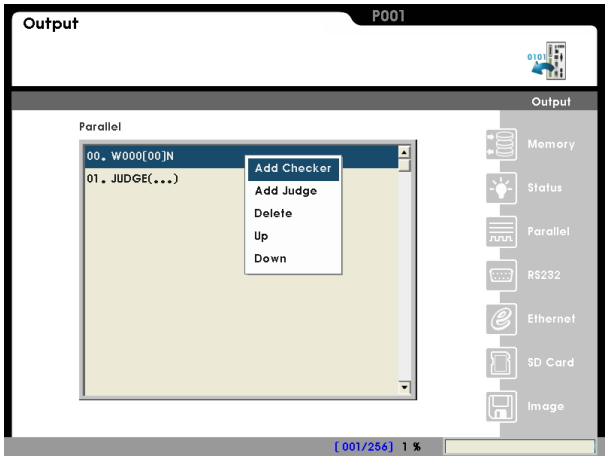
- [Parallel]: Output to the 16 I/O terminals.
- [RS232]: Output to the RS232 interface either directly or to PLC-link.
- [Ethernet]: Output data to Ethernet.
- [USB]: Output data to USB.
- [SD Card]: Save data to a memory card in the CSV format to be opened in Microsoft Excel on a PC.
- [Image]: Save image source and interface (Ethernet, USB, SD Card).



■ Output setup:

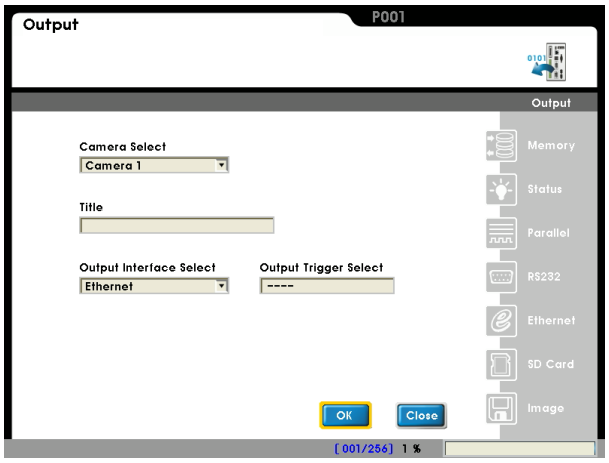
Use the [Add Parameter] and [Add Judgment] options to output to the following interfaces: [Parallel], [RS232], [Ethernet], [USB], and [SD Card].

The output sequence starts from the top of the list and goes down in order. Use the [Up] and [Down] options to change the output ordering.



■ [Image] Settings:

Image output can be used to determine if the image is properly saved during the inspection. It can also be later referenced for statistics and defect analysis.



Reference Please refer to Chapter 7 for a detailed description of [Output].

Chapter 5 :

System Setup

The initial screen of the controller setup displays [Project list], [Program], and [System]. The [System] settings are described below.

[Project list] Settings:

The controller features 32 built-in internal memories for projects. The projects can be created, switched, edited, renamed, copied, and deleted. The total number of projects can be increased to 999 if a SD card is used.

Reference Please refer to section 4.1 for [Project list].

[Program] Settings:

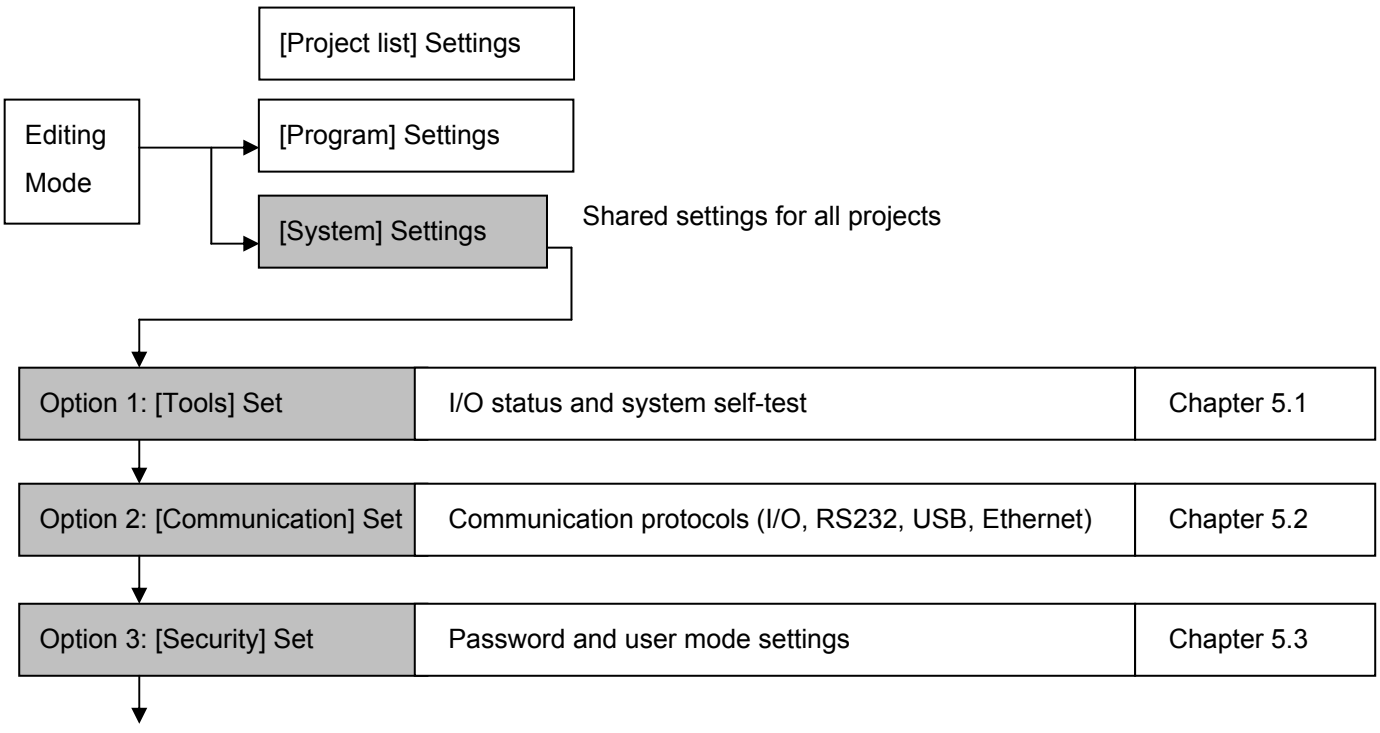
Project parameters can be modified for the currently selected project. The six settings are [Camera], [Image], [Window], [Calculator], [Judge], and [Output]. Configure all items to complete setting up an inspection project.

Reference Please refer to section 4.2 for [Program].

[System] Settings:

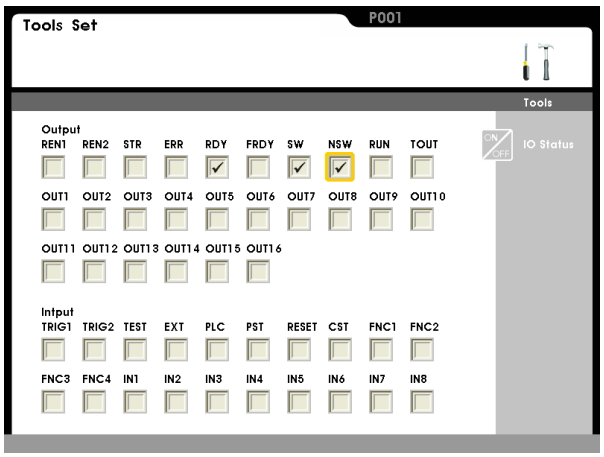
The system's built-in controller parameters are applicable to all inspection projects. These will not be changed with the selected project.

Block diagram:



Option 4: [Display] Set	Display language, ROI sync, and imaging display method settings	Chapter 5.4
Option 5: [Global] Set	Startup state and system calendar	Chapter 5.5
Option 6: [Information]	System information and factory default	Chapter 5.6

5.1 [Tools] Set:

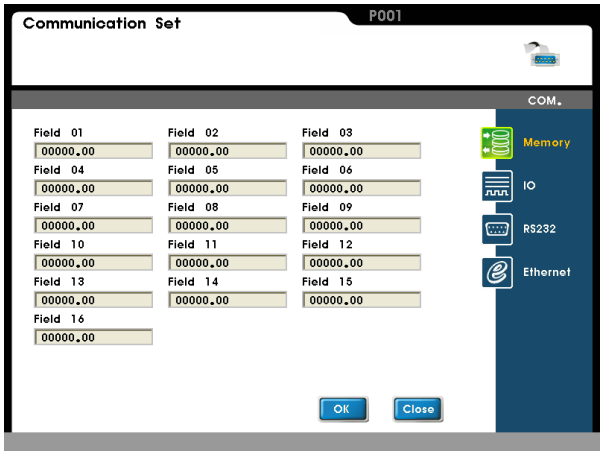


■ Option 1: [I/O Status]

Manually set the output state and view the current input states for initial troubleshooting.

The output state can be manually set to ON/OFF. The output is ON when selected and the hardware output is enabled.
Input state is read only. External input signals will be immediately updated on the screen.

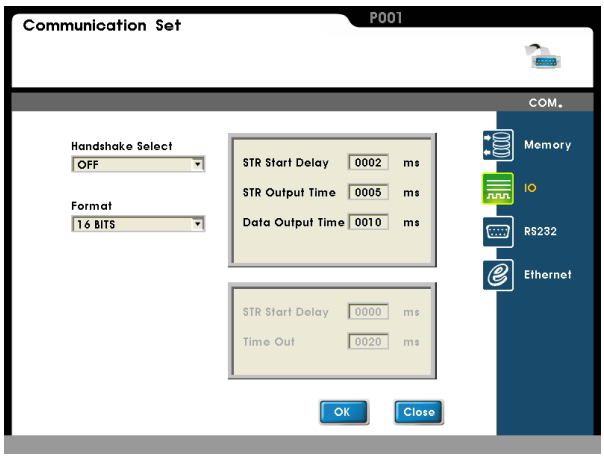
5.2 [Communication] Set:



■ Option 1: [Memory]

Configure and review the 16 built-in internal memories.

■ Option 2-1: [External terminal] > [Handshake Select] = OFF

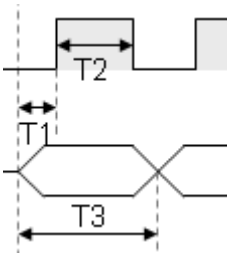


When the external terminal (I/O output) signal handshake is OFF, the STR and result output signals are transmitted by a set timer.

STR start delay: STR start delay time after data output. (T1)

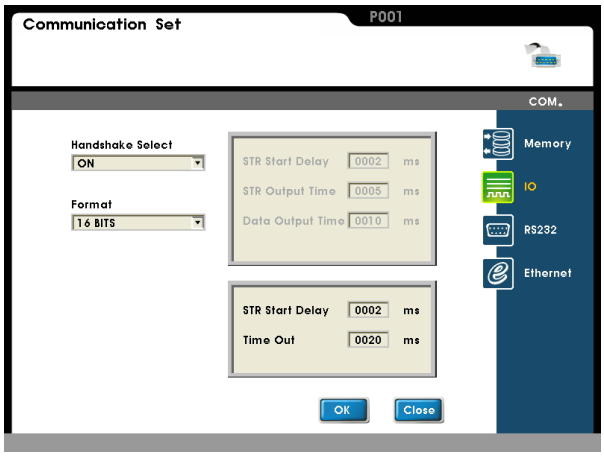
STR Output Time: Allows time for DMV STR duration to ensure that PLC data output is complete. (T2)

Data Output Time: Required output time for each data entry. (T3)



Reference Please refer to section 8.1.4 for detailed timing sequence.

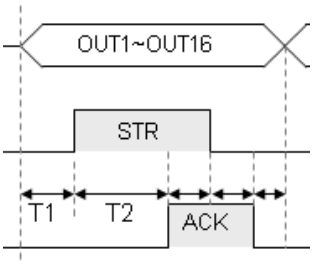
■ Option 2-2: [External terminal] > [Handshake Select] = ON



When the external terminal (I/O output) signal handshake is ON, the STR and ACK signal handshakes control the result output.

STR start delay: STR start delay time after data output. (T1)

Time Out: PLC returns the ACK signal after STR output. Communication error occurs when this timeout is reached.



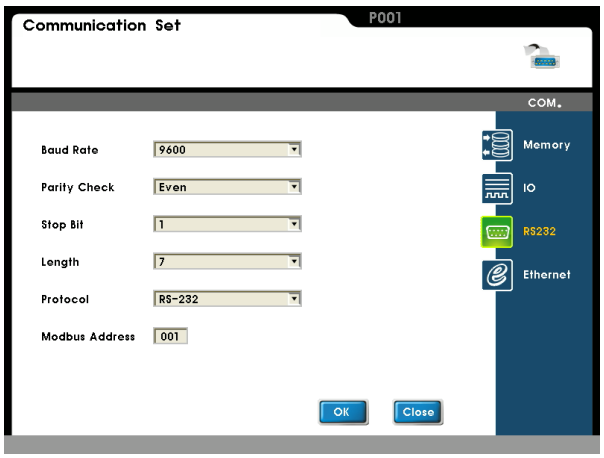
Reference Please refer to section 8.1.4 for detailed timing sequence.

■ Option 3: [RS232]

Communication format for RS232.

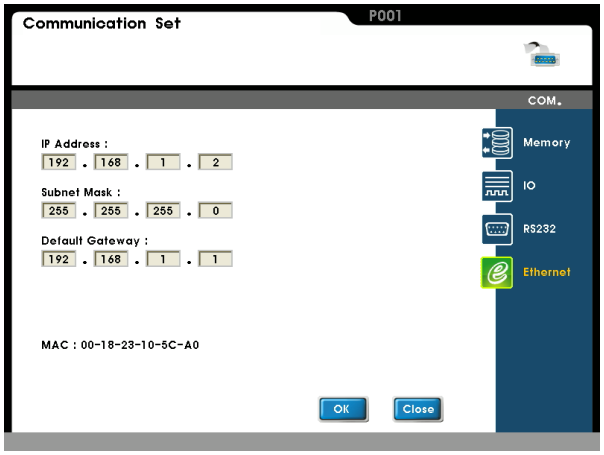
Default: 9600, 7, E, 1 (Delta PLC default communication format)

For PLC-link function to console.



■ Option 4: [Ethernet]

Set the Ethernet IP address.

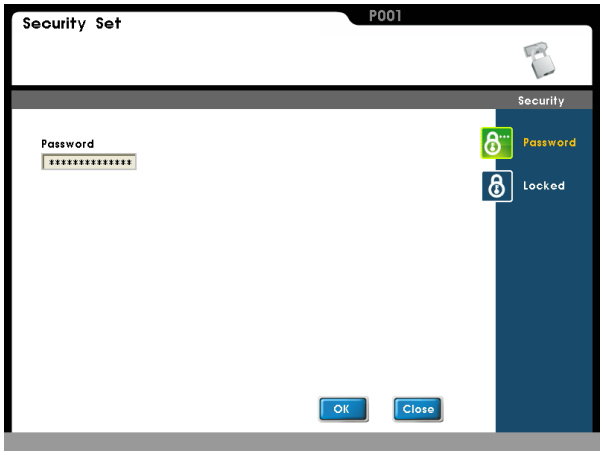


5.3 [Security] Set:

■ Option 1: [Password]

The system features a password protection user mode. When the password is enabled, the user must enter the password in order to access the operation mode.

Set the user password on this screen.

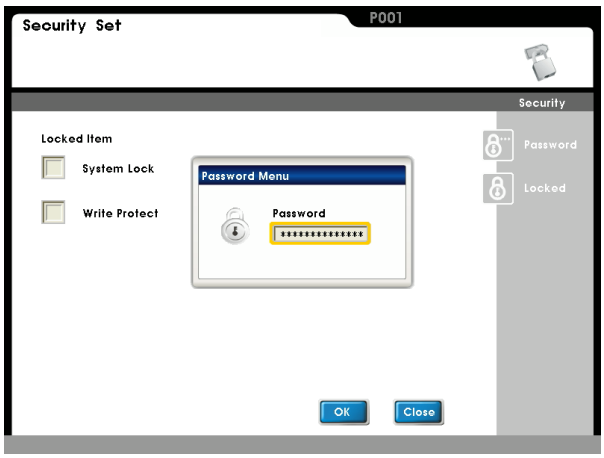


■ Option 2: [Locked]

Enable the user protection mode. The password is required to enable/disable the lock.

System Lock: The password is required to switch RUN/PROG modes.

Write protect: The password is required to change this setting.

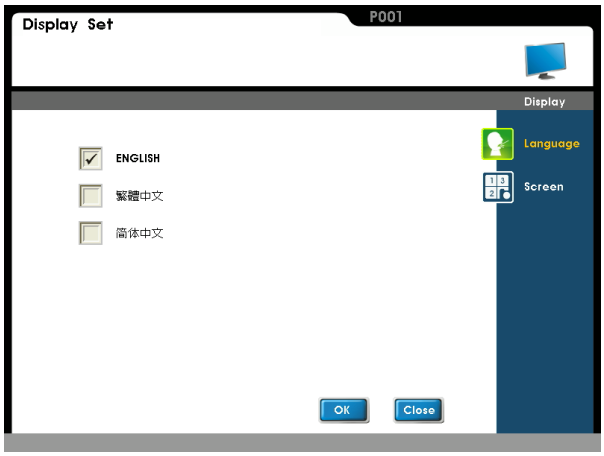


5.4 [Display] Set:

■ Option 1: [Language]

The system features three built-in language modes: English, Traditional Chinese, and Simplified Chinese.

Selecting a different language mode will immediately change the language displayed.



■ Option 3: [Screen]

Set the Setting/RUN mode to control auto/trigger camera capture.

- Setting Mode:

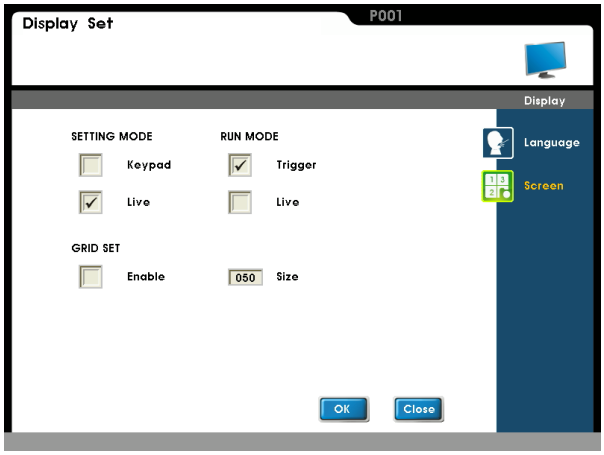
Keypad: Press [TRIG] on the keypad to capture an image.

Live: The system will automatically update the image continuously.

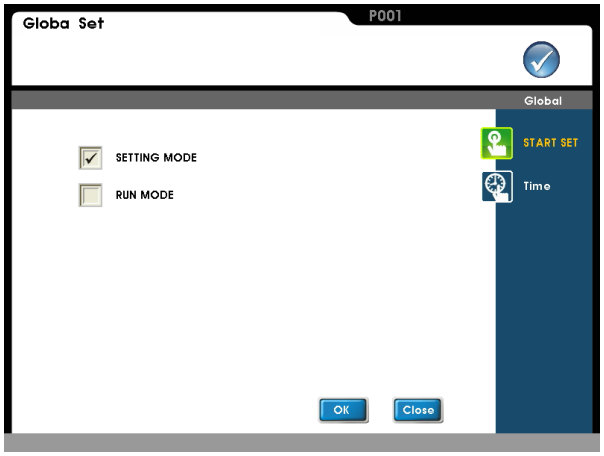
- RUN mode:

Trigger: Press [TRIG] on the keypad to capture and inspect an image.

Live: Automatically update the image continuously before inputting [TRIG]. After entering [TRIG], capture a new image for inspection.



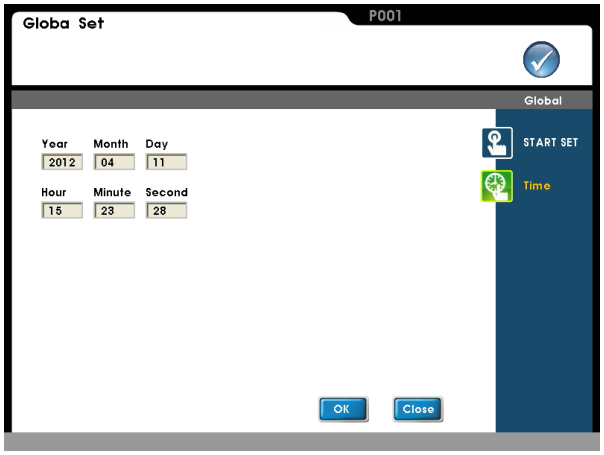
5.5 [Global] Set:



■ Option 1: [Start Set]

Specify the preferred startup mode for the system (program mode or run mode).

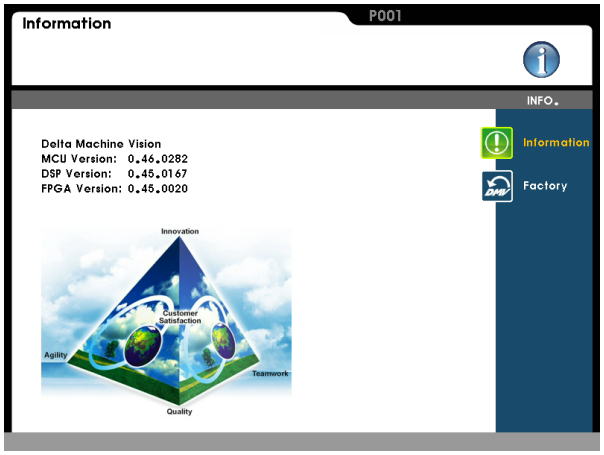
- Setting Mode: Enter program mode at system startup.
- RUN Mode: Enter run mode at system startup.



■ Option 2: [Time]

Set system calendar and time.

5.6 [Information]:



■ Option 1: [Information]

Show current machine vision.

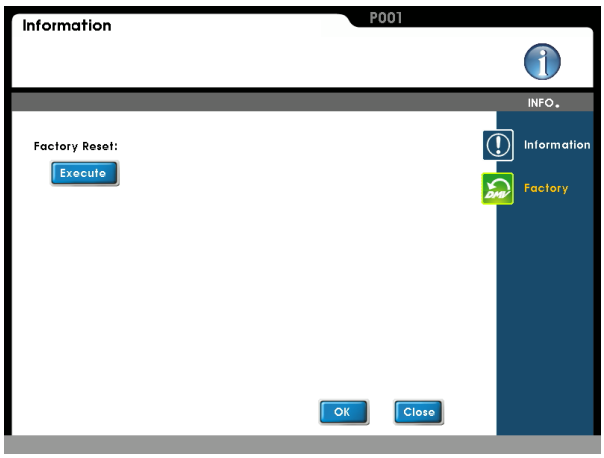
MCU, DSP, and FPGA modules.

■ Option 2: [Factory]

Restore the system to factory default settings.

Projects stored in internal memory: Wiped.

Projects on SD Card: Project content will not be wiped.



Chapter 6 :

Introduction to the Window

6.1 Window Functionality:

The main visual items to be detected are "quantity", "defects", "coordinates", and "size." The detection items are provided to meet a variety of custom requirements. In real-world applications, a reliable inspection system is commonly dependent on a combination of detection items rather than a single detection function. For example, coordinates of an object in motion must first be positioned before the size can be measured. This is a mixed combination of "coordinates" and "size."
However, please pay attention to the characteristics and targets of the items to be detected before designing the system, as the run length of each item may vary. Choosing the optimal function will not only improve system reliability, but also decrease the detection cycle and thereby improve productivity.

6.1.1 Types of Inspection Windows

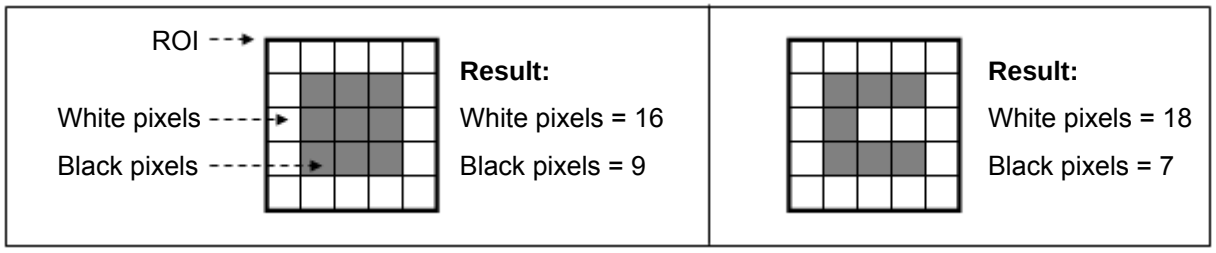
Detection item	Description
Area	Counts the number of black/white binarized pixels within the window.
Position	Finds a specific edge where grayscale gradient is over the threshold in a grayscale image.
Count	Find number of edges where grayscale gradient is over the threshold in a grayscale image.
Width	Finds distance between two edges where grayscale gradient is over the threshold in a grayscale image.
Pitch	Finds all edges where grayscale gradient is over the threshold in a grayscale image, then calculates the max/min width between each edge.
Angle	Calculates the angle between two edges where grayscale gradient is over the threshold in two areas of a grayscale image.
Match pattern	Finds coordinates and angle of pattern in designated window referenced to the sample.
Blob	Counts the number of clusters of black/white pixels in the window and then calculates the coordinates and center of weight of each cluster.
Intensity	Calculates the mean of all grayscale pixels in window.
Position Trace	Finds all edges where grayscale gradient is over the threshold in a grayscale image.
Width Trace	Finds all distances between two edges where grayscale gradient is over the threshold in a grayscale image.
Mark	Marks a line, pattern, or text on the detection result screen.

Each detection item is further detailed in sections 6.2~6.10.

6.2 Area:

6.2.1 What defines the [Area]

The purpose of the Area is to measure the number of black or white pixels within the specified window. Because the camera image has 256 gray levels (0~255), it first must be binarized into pure black and pure white levels before measuring the area. The result is OK if the number of pixels falls within designated range; otherwise the result is NG.



6.2.2 Detection Result

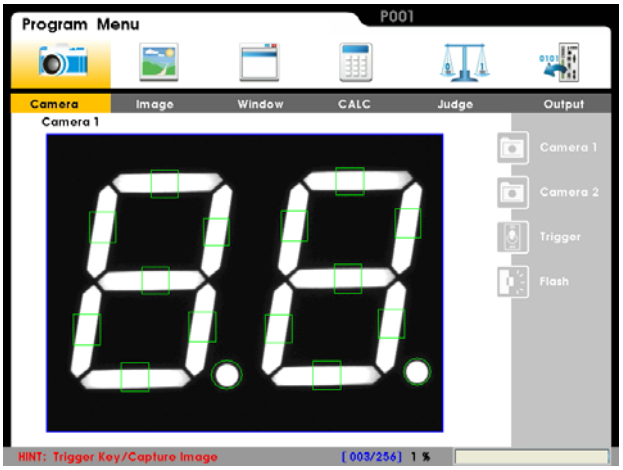
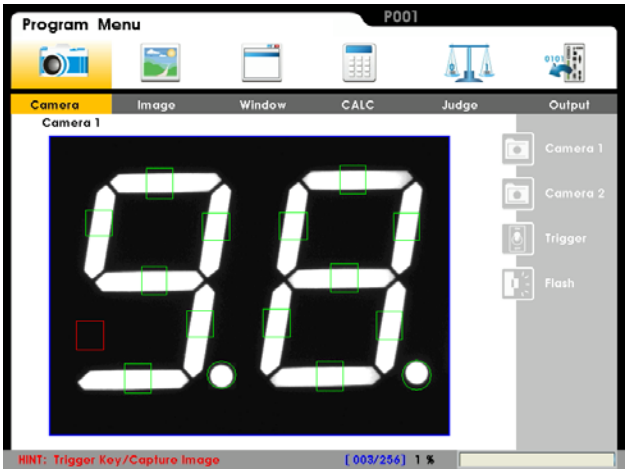
Area output report:

- **"Value" Output**
  - Number of black/white pixels:
    For a 0.30 megapixel camera: 0~307,200 (640*480)
    For a 0.80 megapixel camera: 0~786,432 (1024*768)

- **"Logic output (OK/NG)"**
  - The pixel count is OK=1 if within the [Limit] range; otherwise the result is NG=0.

6.2.3 Example Application of [Area]

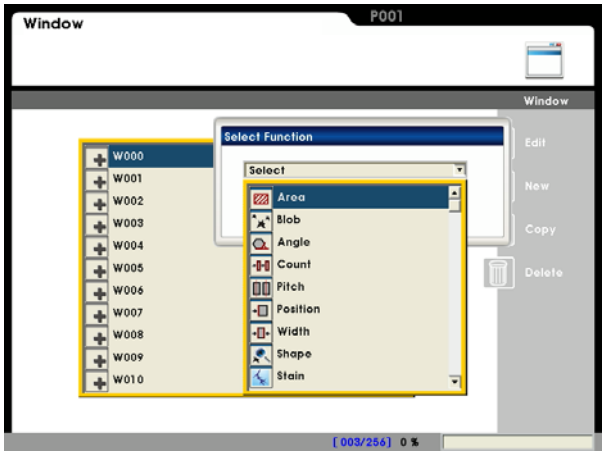
As shown below, the 7-segment display is checked for defective LED segments and decimal points.

(full image)	(defective image)
	

■ **Detection method:**

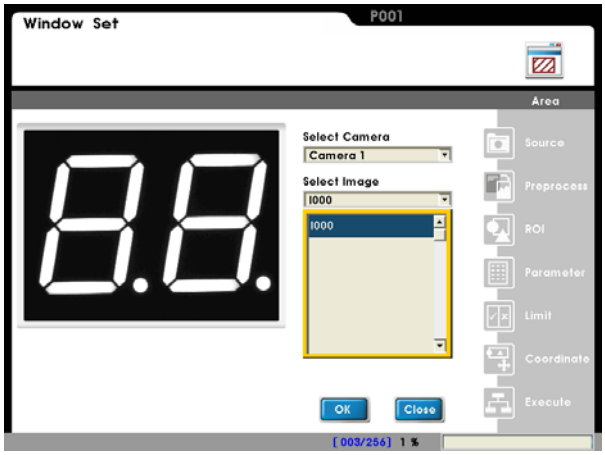
The area for each LED segment is detected individually. If the LED is properly lit, the white pixel count will exceed an acceptable range and the detection result will be OK. If the LED is defective then the white pixel count will be insufficient and the detection result will be NG.

6.2.4 Set up [Area] settings



■ **From [Select Function], select [Area] detection function.**

Select [Edit] or [New].
Please set up the following items in this sequence: [Source], [Preprocess], [ROI], [Parameter], [Limit], [Coordinate], and [Execute].



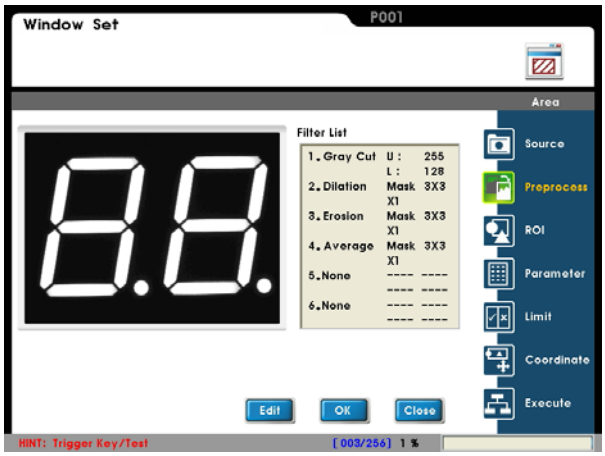
■ **Item 1: [Source]**

Select camera:

Up to two cameras are supported simultaneously. Please select Camera 1 or Camera 2 for this detection.

Select image:

Select a pre-captured image as the reference sample for this detection.



■ **Item 2: [Preprocess]**

A software filter is used to first enhance the image in order to better meet the requirements. Thus, an appropriate preprocess filter can improve accuracy and reliability of the inspection.

More than a dozen preprocess filters are provided, including binarization, dilation, erosion, etc.
Up to six preprocess filters (numbered 1~6) can be applied in order.

Reference For more information about preprocess, please refer to Chapter 10.

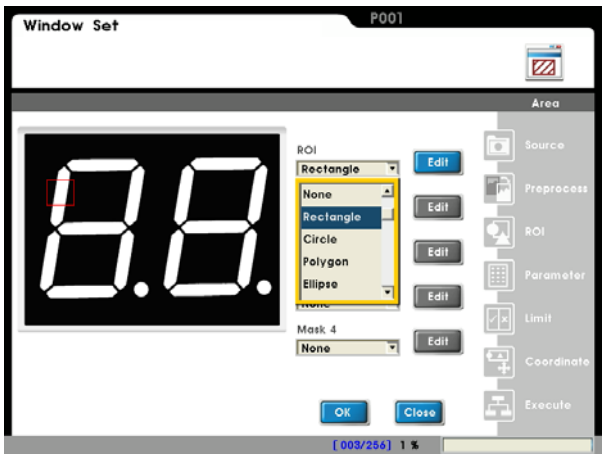
■ Item 3: [ROI]

ROI:

A smaller area covers less black/white pixels and thus less time is required to carry out the detection.

Different measurement window shapes can be drawn, including rectangles, ellipses, polygons, and circles.

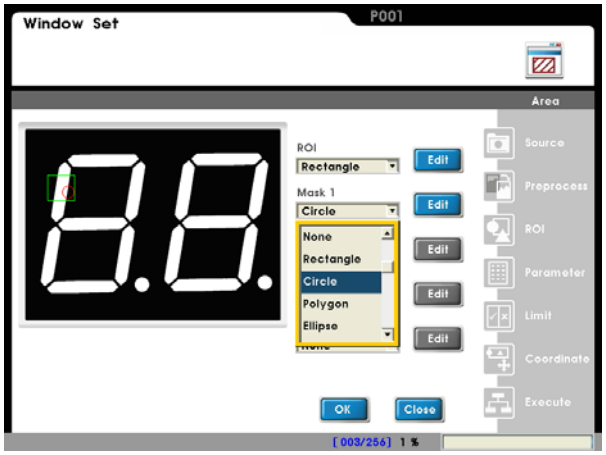
Reference Please refer to Chapter 3.2 [Draw ROI (Region Of Interesting)]



Mask 1~Mask 4:

The mask is the area to be excluded from measurement. A mask can be set within the [ROI] to exclude an area from detection.

In the example to the right, the red circle is a mask.



Up to four masks are supported for one [Window] program.

Different mask shapes can be drawn, such as rectangles, ellipses, polygons, and circles.

■ Item 4: [Parameter]

Binarization:

The grayscale image is binarized into black and white pixels for area inspection.

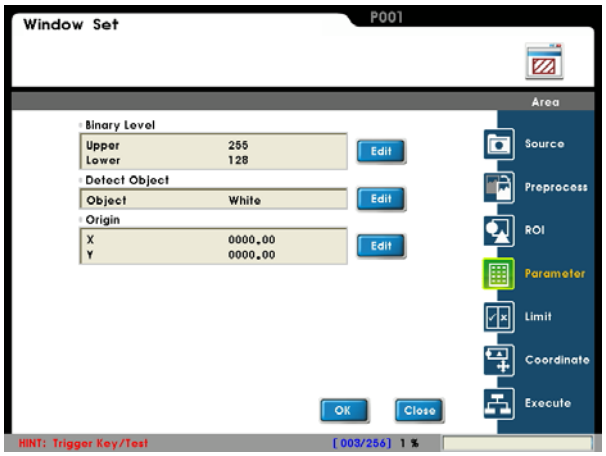
Detect Object:

Count the black pixels or white pixels.

Origin:

Define the position of the origin.

Reference For more information about binarization, refer to Chapter 10.

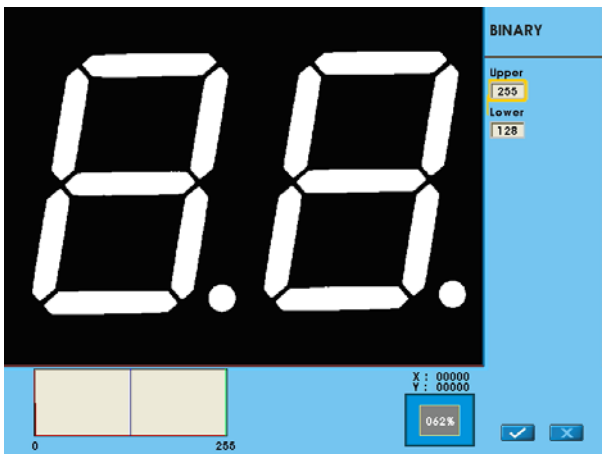


Set up binarization:

Select [Edit] and adjust the upper/lower limits. The resulting image is displayed dynamically.

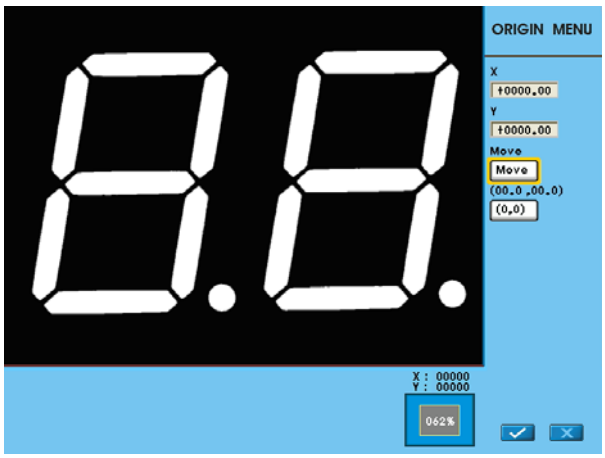
White pixels indicate the grayscale image inside the ROI, and black pixels are outside the area.

The grayscale level histogram is shown lower left of the screen.



Set up origin:

Select [Edit] to open the Origin Menu.

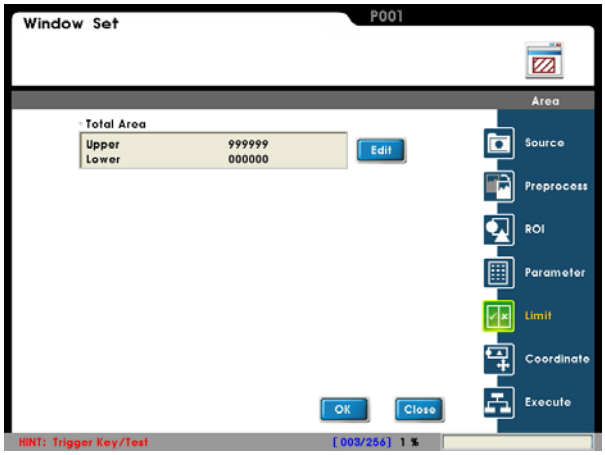


■ Item 5: [Limit]

Set the range for OK/NG detection. The result is OK if within the limit and NG otherwise.

Factory defaults to maximum range and thus the result is 1 (OK).

This logic output result of OK=1 and NG=0 can be passed onto the subsequent [Judge] program.



Reference Please refer to Chapter 7 for a detailed description of [Judge]

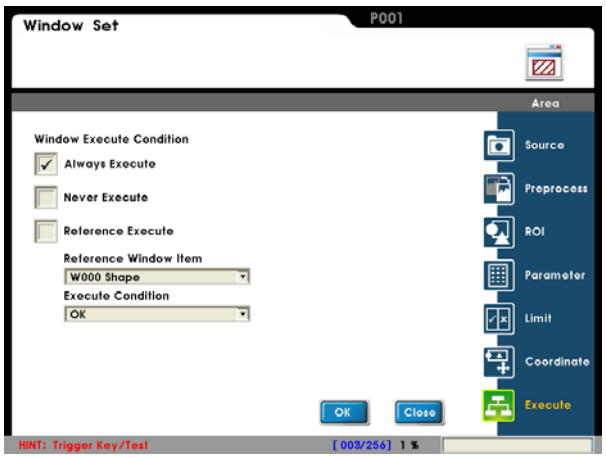
■ Item 6: [Coordinate]

Specify whether the coordinates (X/Y) and angle (Theta) will be adjusted to match the [Window] result in the [ROI] window. As shown to the right, the window X/Y/θ parameters will be automatically adjusted to the [Shape] detection results.

The [ROI] and [Mask 1]~[Mask 4] can be configured for the detection window.

Reference For more information on coordinates, please refer to section 6.8.

■ Item 7: [Execute]



Execute or disable the [Window] function.

[Always Execute]: The current [Window] will always be executed while running.

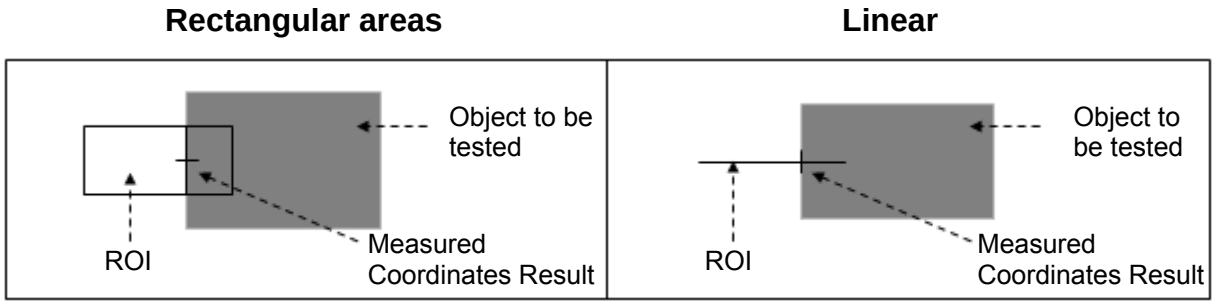
[Never Execute]: The current [Window] will never be executed while running. This is useful during initial testing.

[Reference Execute]: Set the [Reference Window Item] and [Execute Condition] for flow control. Execution of [Window] is determined by the conditions above.

6.3 Position:

6.3.1 What is [Position]

The Position is where the grayscale gradient satisfies the threshold. If the threshold is satisfied, that position is determined to be the ending position; the X/Y coordinates are calculated and the result is OK. If the grayscale gradient does not satisfy the threshold in the ROI, the result is NG.



6.3.2 Detection Result

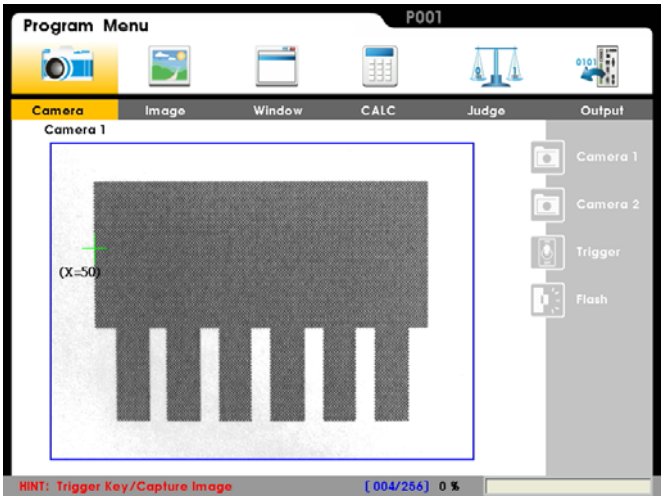
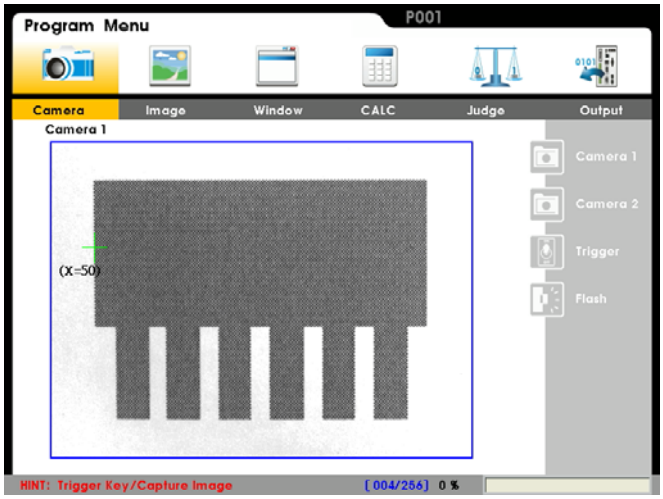
Position output report:

- **"Value" Output**
  - For a 0.30 megapixel camera: (640 * 480)
    X (horizontal) coordinates: 0~639
    Y (vertical) coordinates: 0~479
  - For a 0.80 megapixel camera: (1024 * 768)
    X (horizontal) coordinates: 0~1023
    Y (vertical) coordinates: 0~767

- **"Logic output (OK/NG)"**
  - Detection result:
    A successful detection is 1=OK; otherwise the result is 0=NG.
  - X (horizontal) coordinates: When used with [Limit], the detection result is OK=1 if within the limit; otherwise it will be NG=0.
  - Y (vertical) coordinates: When used with [Limit], the detection result is OK=1 if within the limit; otherwise it will be NG=0.

6.3.3 Example application of [Position]

As shown below, position offset of the object is detected.

(correct position)	(offset position)
	

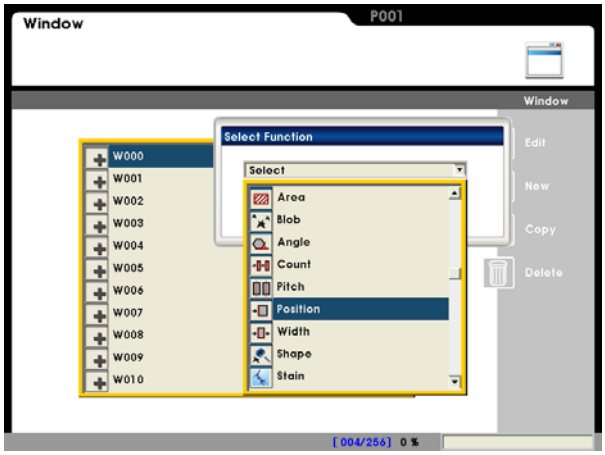
■ **Detection method:**

Edge scan in the X axis from left to right of the image. The detection result is OK if X coordinates fall within the range of limit. Otherwise, the detection result is NG if the range of limit is exceeded; thus the position offset is too large.

The detected Position XY coordinates can be passed onto subsequent programs as reference.

6.3.4 Setup [Position]

■ **From [Select Function], select the [Position] detection function.**



Select [Edit] or [New].
Please set up the following items in this sequence: [Source], [Preprocess], [ROI], [Parameter], [Limit], [Coordinate], and [Execute].

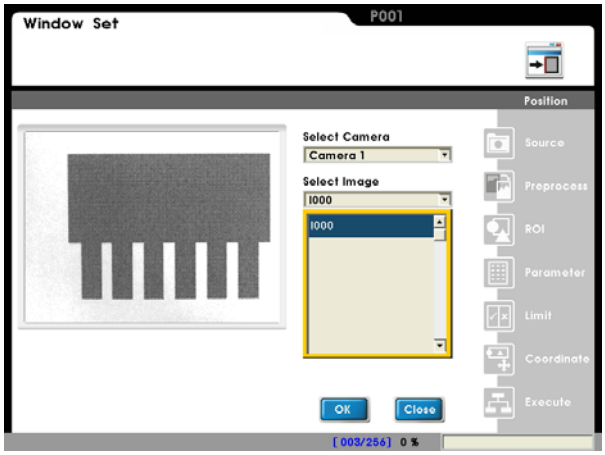
■ **Item 1: [Source]**

Select camera:

Up to two cameras are supported simultaneously. Please select Camera 1 or Camera 2 for this detection.

Select image:

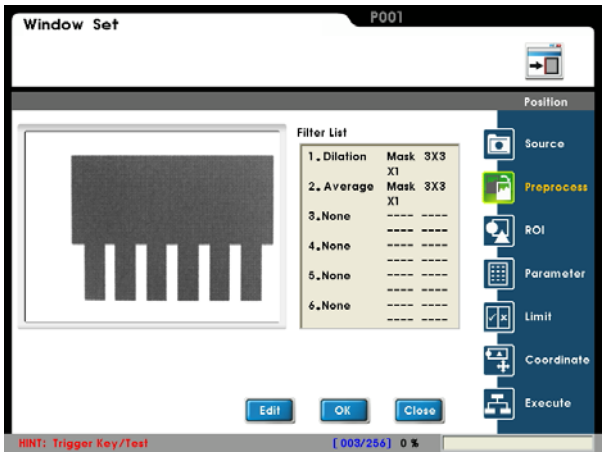
Select a pre-captured image as the reference sample for this detection.



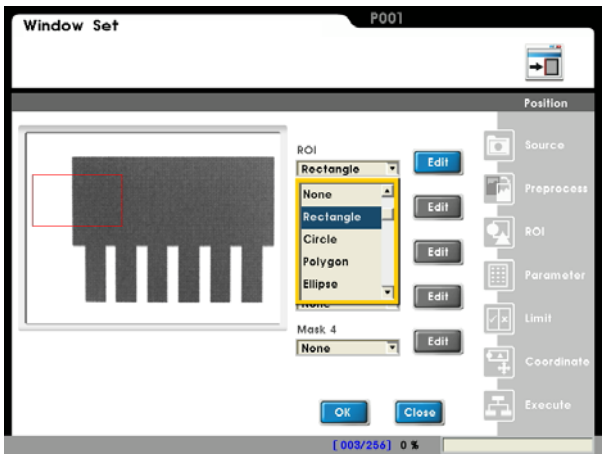
■ **Item 2: [Preprocess]**

A software filter is used to first enhance the image in order to better meet the requirements. Thus, an appropriate preprocess filter can improve accuracy and reliability of the inspection.

More than a dozen preprocess filters are provided, including binarization, dilation, erosion, etc.
Up to six preprocess filters (numbered 1~6) can be applied in order.



Reference For more information about preprocess, please refer to Chapter 10.



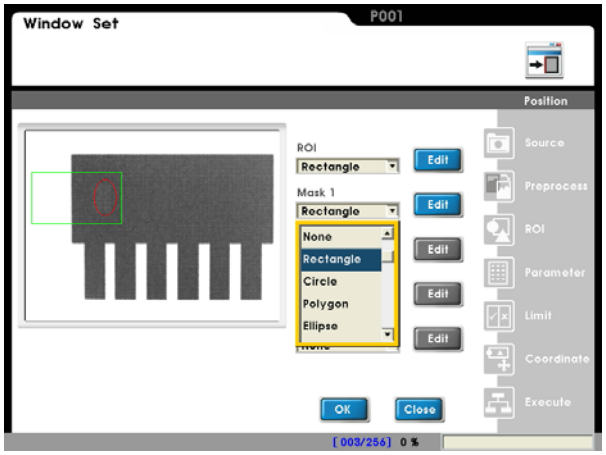
■ Item 3: [ROI]

ROI:

Set the ROI for edge detection.

Different measurement window shapes can be drawn, including rectangles, ellipses, polygons, and circles.

Reference Please refer to Chapter 3.2 [Draw ROI (Region Of Interesting)]



Mask 1~Mask 4:

The mask is the area to be excluded from measurement. A mask can be set within the [ROI] to exclude an area from detection.

In the example to the right, the red circle is a mask.

Up to four masks are supported for one [Window] program.

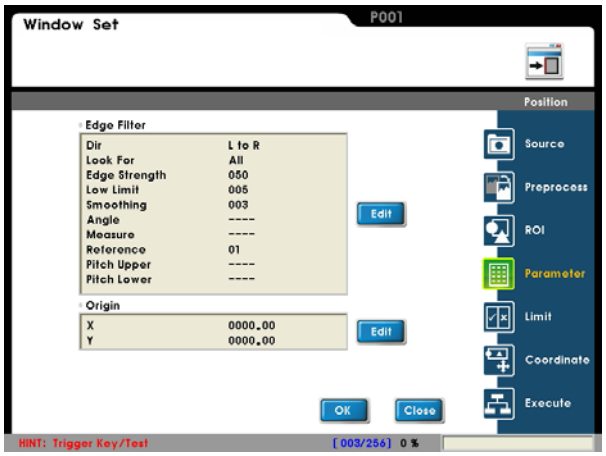
Different mask shapes can be drawn, such as rectangles, ellipses, polygons, and circles.

■ Item 4: [Parameter]

Edge filter:

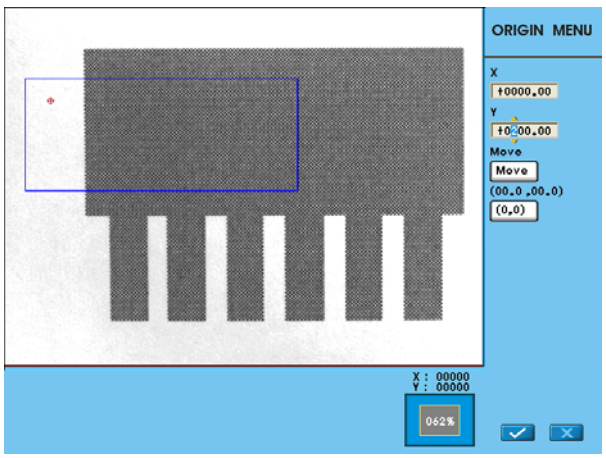
Set the direction for detection search and edge filter parameters.

Observe the waveform to find the optimal parameter settings.



Origin:

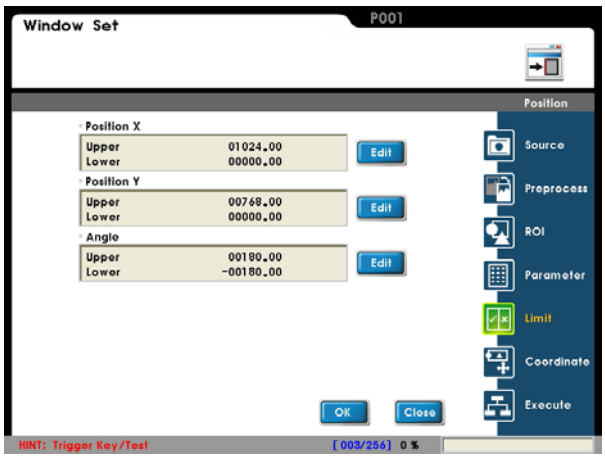
Define the position of the origin.



Set up origin:

Select [Edit] to open the Origin Menu.

■ Item 5: [Limit]



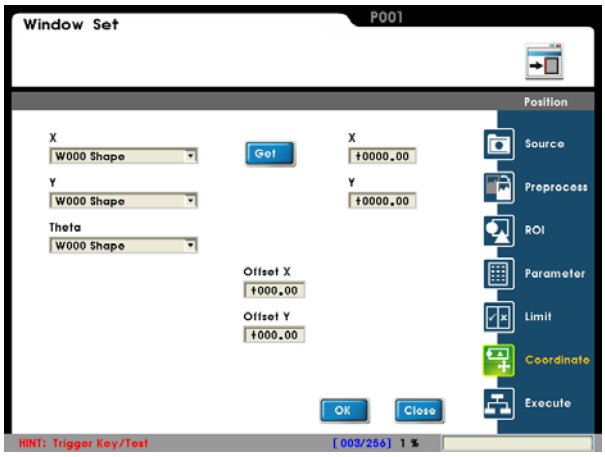
Set the range for OK/NG detection. The result is OK if within the limit and NG otherwise.

Factory defaults to maximum range and thus the result is 1 (OK).

This logic output result of OK=1 and NG=0 can be passed onto the subsequent [Judge] program.

Reference Please refer to Chapter 7 for a detailed description of [Judge]

■ Item 6: [Coordinate]



Specify whether the coordinates (X/Y) and angle (Theta) will be adjusted to match the [Window] result in the [ROI] window. As shown to the right, the window X/Y/θ parameters will be automatically adjusted to the [Shape] detection results.

The [ROI] and [Mask 1]~[Mask 4] can be configured for the detection window.

If [Capture] is selected, the XY coordinates of the position can be used as reference for subsequent programs.

Reference For more information on coordinates, please refer to section 6.8.

■ Item 7: [Execute]

Execute or disable the [Window] function.

[Always Execute]: The current [Window] will always be executed while running.

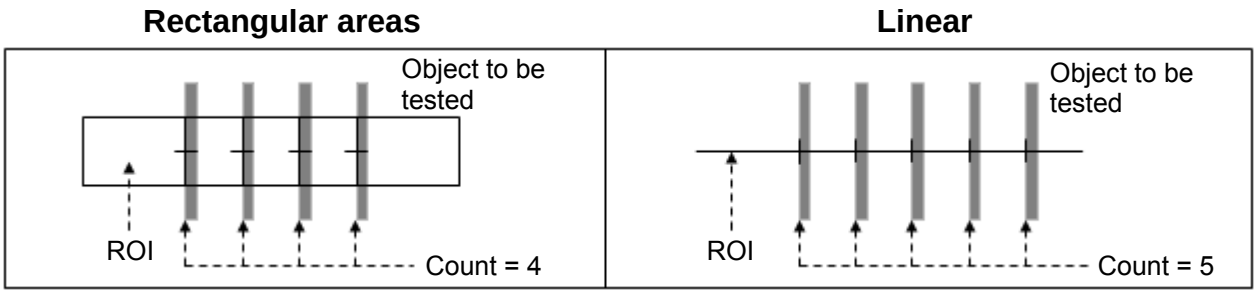
[Never Execute]: The current [Window] will never be executed while running. This is useful during initial testing.

[Reference Execute]: Set the [Reference Window Item] and [Execute Condition] for flow control. Execution of [Window] is determined by the conditions above.

6.4 Count:

6.4.1 What is [Count]

Count is the number of edges where the grayscale gradient is over the threshold in the image. The result is OK if edge count satisfies the limit; otherwise the result is NG.



6.4.2 Detection Result

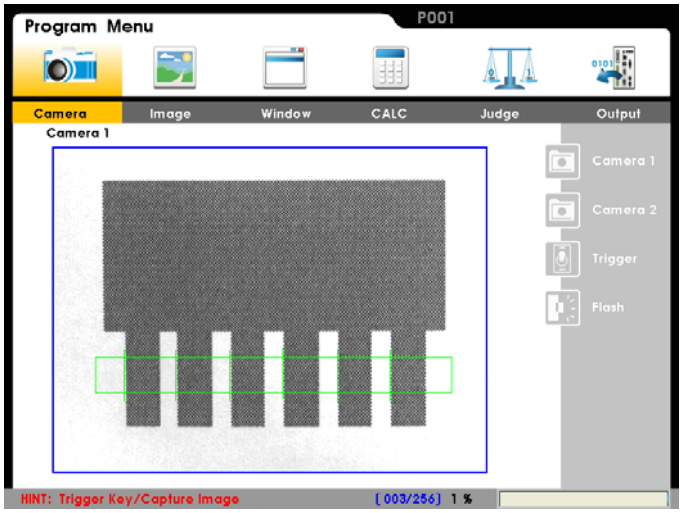
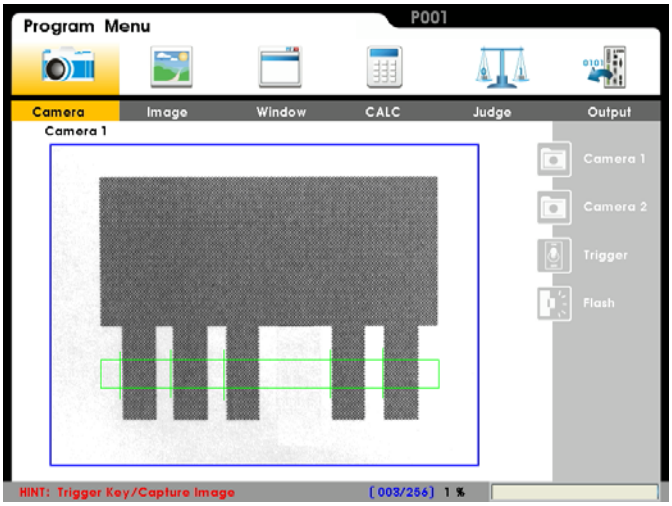
Count output report:

- **"Value" Output**
  - Number of detected edges: Range: 0~999.

- **"Logic output (OK/NG)"**
  - Edge count: When used with [Limit], the detection result is OK=1 if within the limit; otherwise it will be NG=0.

6.4.3 Example application of [Count]

As shown below, the number of detected terminals is counted to ensure accuracy.

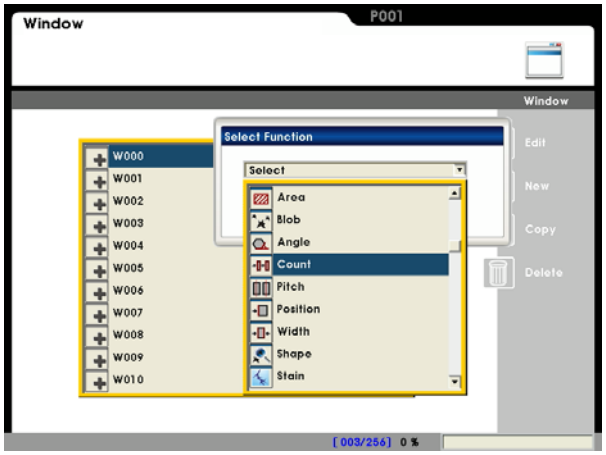
(correct count)	(missing count)
	

■ **Detection method:**

The number of terminals is calculated from the edge count. As shown above when used with a [Limit], the result is OK when edge count is 6. Otherwise, the result is NG when edge count is not 6.

6.4.4 Setup [Count]

■ **From [Select Function], select the [Position] detection function.**



Select [Edit] or [New].
Please set up the following items in this sequence: [Source], [Preprocess], [ROI], [Parameter], [Limit], [Coordinate], and [Execute].

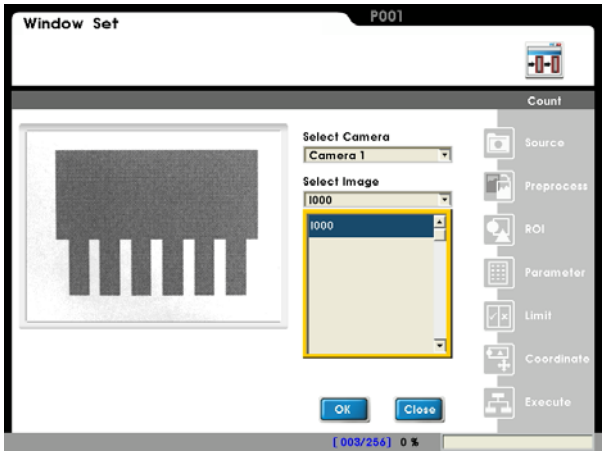
■ **Item 1: [Source]**

Select camera:

Up to two cameras are supported simultaneously. Please select Camera 1 or Camera 2 for this detection.

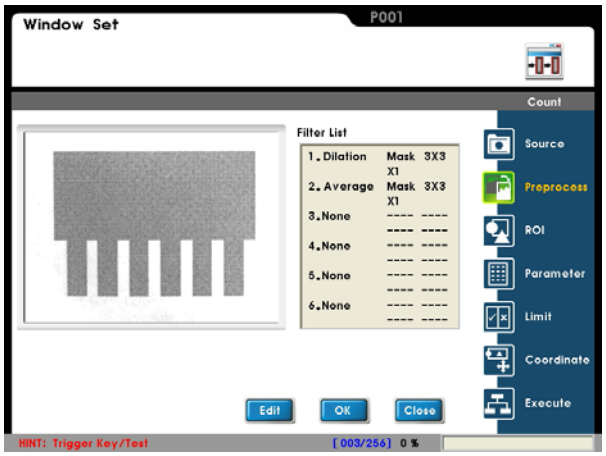
Select image:

Select a pre-captured image as the reference sample for this detection.



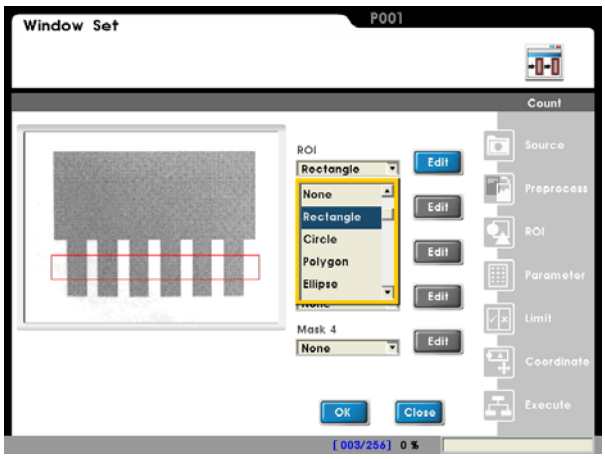
■ **Item 2: [Preprocess]**

A software filter is used to first enhance the image in order to better meet the requirements. Thus, an appropriate preprocess filter can improve accuracy and reliability of the inspection.



More than a dozen preprocess filters are provided, including binarization, dilation, erosion, etc.
Up to six preprocess filters (numbered 1~6) can be applied in order.

Reference For more information about preprocess, please refer to Chapter 10.



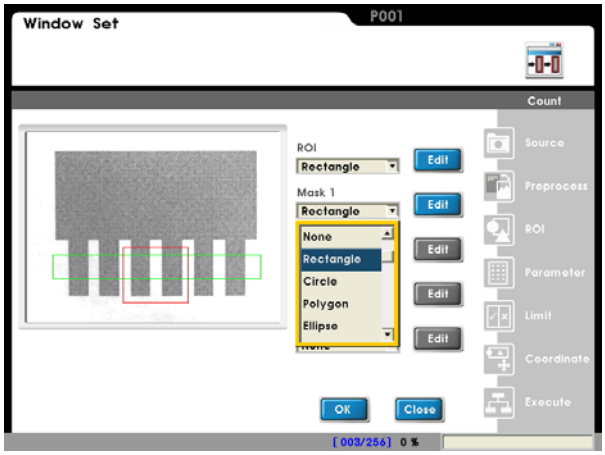
■ **Item 3: [ROI]**

ROI:

Set the ROI for edge detection.

Different measurement window shapes can be drawn, including rectangles, ellipses, polygons, and circles.

Reference Please refer to Chapter 3.2 [Draw ROI (Region Of Interesting)]



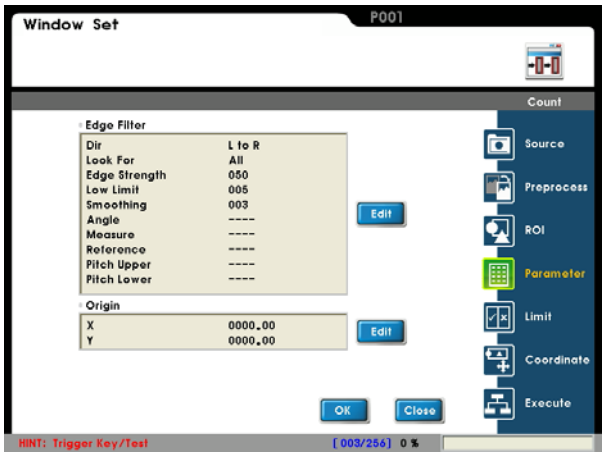
Mask 1~Mask 4:

The mask is the area to be excluded from measurement. A mask can be set within the [ROI] to exclude an area from detection.

In the example to the right, the red rectangle is a mask.

Up to four masks are supported for one [Window] program.

Different mask shapes can be drawn, such as rectangles, ellipses, polygons, and circles.



■ **Item 4: [Parameter]**

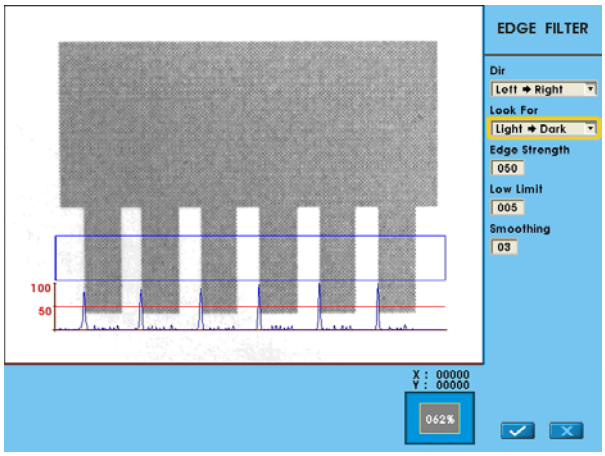
Edge filter:

Set the direction for detection search and edge filter parameters.

Observe the waveform to find the optimal parameter settings.

Origin:

Define the position of the origin.



Direction: Select edge scanning direction.

Look For: Select grayscale gradient type as target edge.

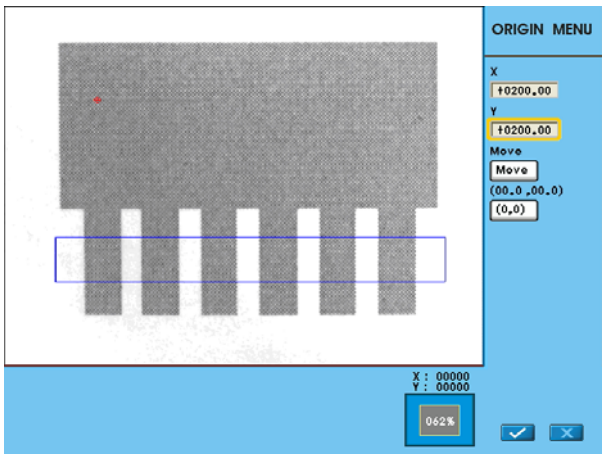
Edge Strength: Set target edge threshold. (Range: 0~100%)

Smoothing: Averages out the edge strength to avoid false positives due to noise.

Reference For more information about edge filter please refer to section 10.2.

Set up origin:

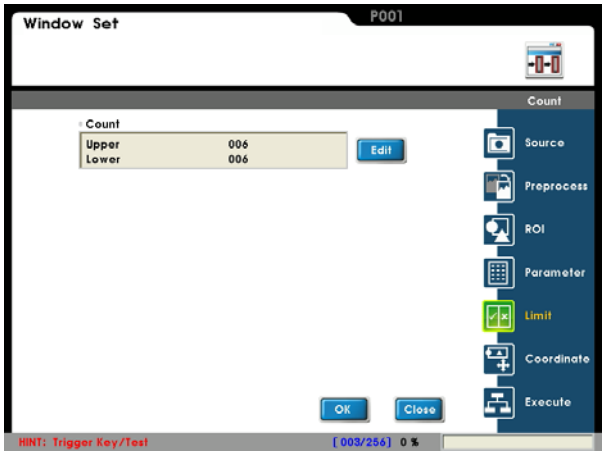
Select [Edit] to open the Origin Menu.



■ Item 5: [Limit]

Set the range for OK/NG detection. The result is OK if within the limit and NG otherwise.

Factory defaults to maximum range and thus the result is 1 (OK).



This logic output result of OK=1 and NG=0 can be passed onto the subsequent [Judge] program.

Reference Please refer to Chapter 7 for a detailed description of [Judge]

■ Item 6: [Coordinate]

Specify whether the coordinates (X/Y) and angle (Theta) will be adjusted to match the [Window] result in the [ROI] window. As shown to the right, the window X/Y/θ parameters will be automatically adjusted to the [Shape] detection results.

The [ROI] and [Mask 1]~[Mask 4] can be configured for the detection window.

Reference For more information on coordinates, please refer to section 6.8.

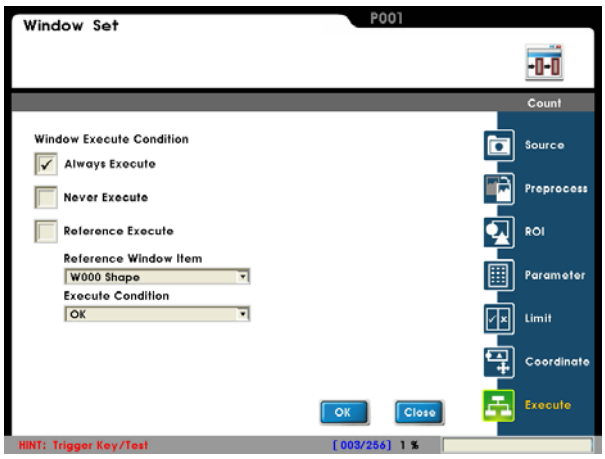
■ Item 7: [Execute]

Execute or disable the [Window] function.

[Always Execute]: The current [Window] will always be executed while running.

[Never Execute]: The current [Window] will never be executed while running. This is useful during initial testing.

[Reference Execute]: Set the [Reference Window Item] and [Execute Condition] for flow control. Execution of [Window] is determined by the conditions above.

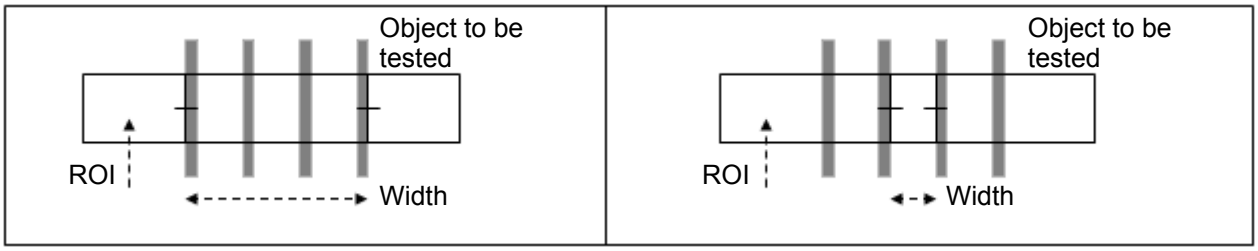


6.5 Width:

6.5.1 What is [Width]

Width is determined by the inner/outer edge-to-edge distance. The measurement result is OK if Width satisfies the limit; otherwise the result is NG.

Outer edge measurement **Inner edge measurement**



6.5.2 Detection Result

Width output report:

- **"Value" Output**
  - Width found: Range: 0~9999
  - Positions of first and second points:

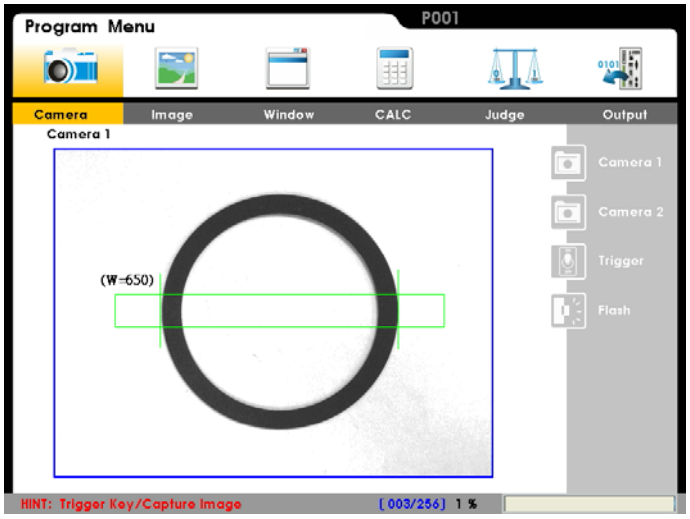
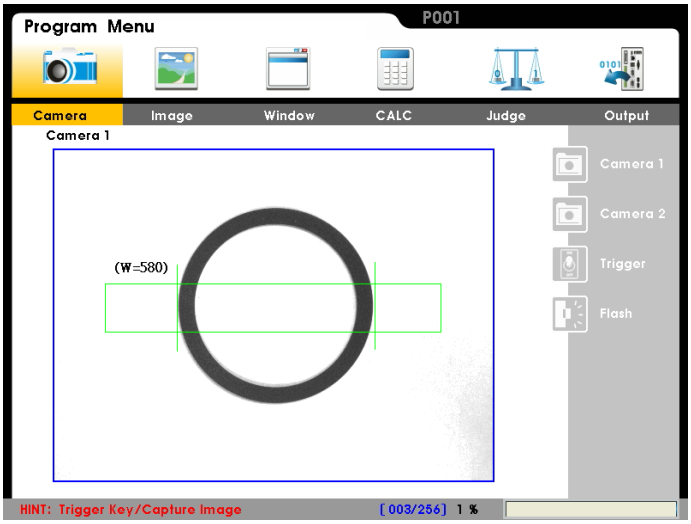
    For a 0.30 megapixel camera: X (horizontal) coordinates: 0~639
    Y (vertical) coordinates: 0~479

    For a 0.80 megapixel camera: X (horizontal) coordinates: 0~1023
    Y (vertical) coordinates: 0~767

- **"Logic output (OK/NG)"**
  - Width: When used with [Limit], the detection result is OK=1 if within the limit; otherwise it will be NG=0.

6.5.3 Example application of [Width]

As shown below, the inner or outer diameter of the O circle is measured.

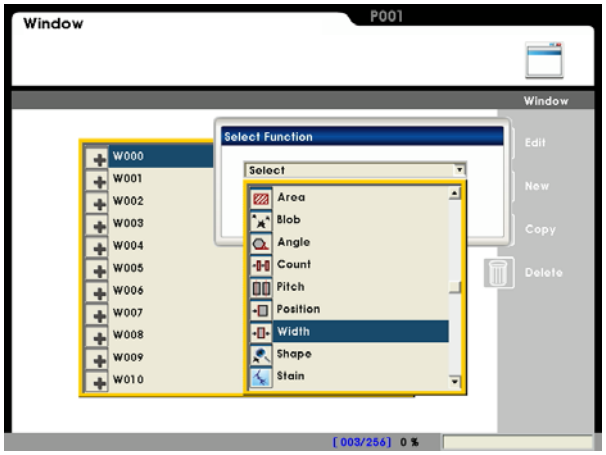
(correct width)	(insufficient width)
	

■ Detection method:

The inner or outer diameter is measured using Width function. As shown above, the result is OK if the outer diameter satisfies the limit; otherwise the result is NG.

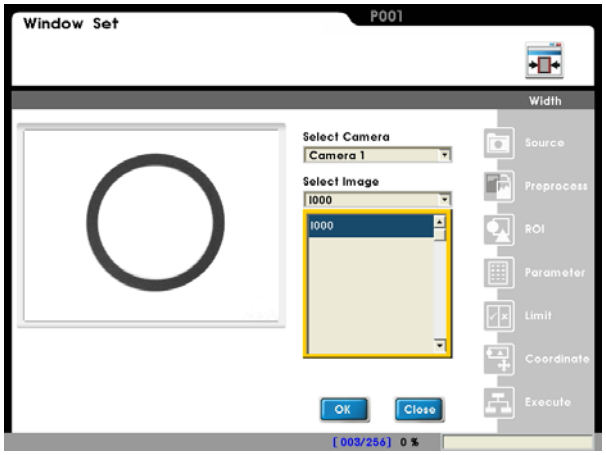
6.5.4 Set up [Width] Detection

■ From [Select Function], select the [Width] detection function



Select [Edit] or [New].
Please set up the following items in this sequence: [Source], [Preprocess], [ROI], [Parameter], [Limit], [Coordinate], and [Execute].

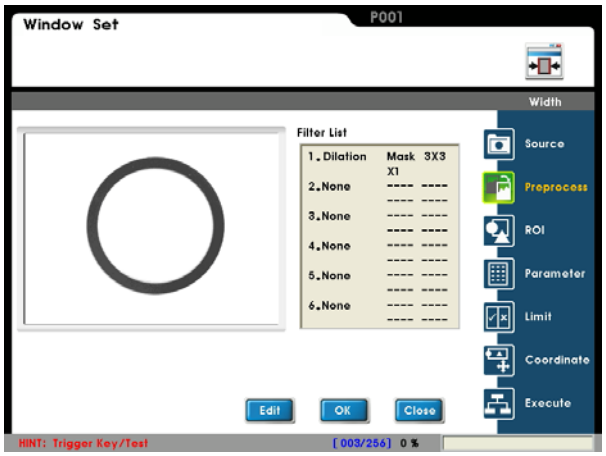
■ Item 1: [Source]



Select camera:
Up to two cameras are supported simultaneously. Please select Camera 1 or Camera 2 for this detection.

Select image:
Select a pre-captured image as the reference sample for this detection.

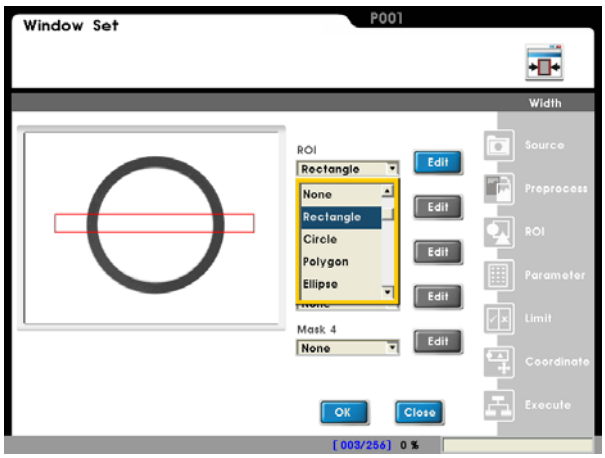
■ Item 2: [Preprocess]



A software filter is used to first enhance the image in order to better meet the requirements. Thus, an appropriate preprocess filter can improve accuracy and reliability of the inspection.

More than a dozen preprocess filters are provided, including binarization, dilation, erosion, etc.
Up to six preprocess filters (numbered 1~6) can be applied in order.

Reference For more information about preprocess, please refer to Chapter 10.



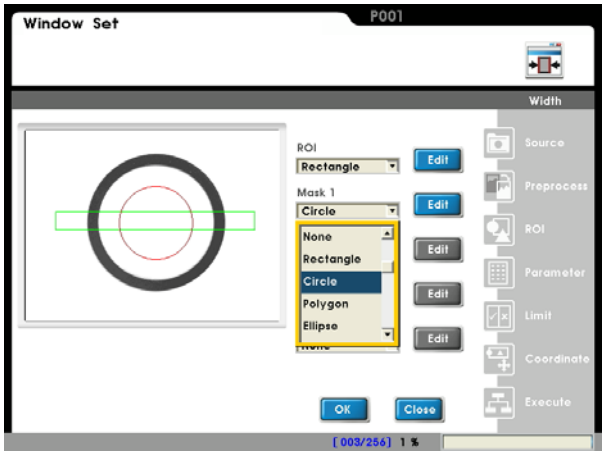
■ Item 3: [ROI]

ROI:

Set the ROI for edge detection.

Different measurement window shapes can be drawn, including rectangles, ellipses, polygons, and circles.

Reference Please refer to Chapter 3.2 [Draw ROI (Region Of Interesting)]



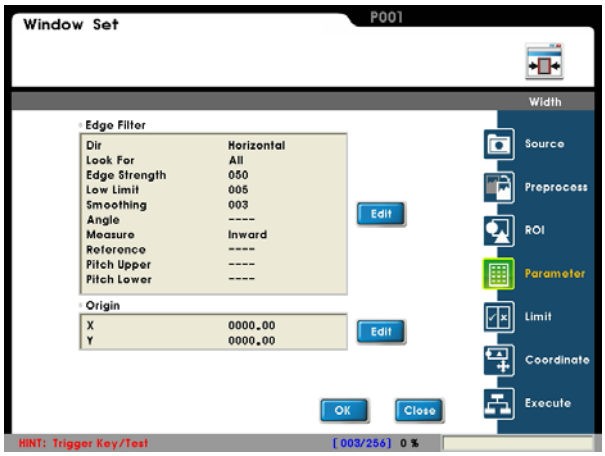
Mask 1~Mask 4:

The mask is the area to be excluded from measurement. A mask can be set within the [ROI] to exclude an area from detection.

In the example to the right, the red circle is a mask.

Up to four masks are supported for one [Window] program.

Different mask shapes can be drawn, such as rectangles, ellipses, polygons, and circles.



■ Item 4: [Parameter]

Edge filter:

Set the direction for detection search and edge filter parameters.

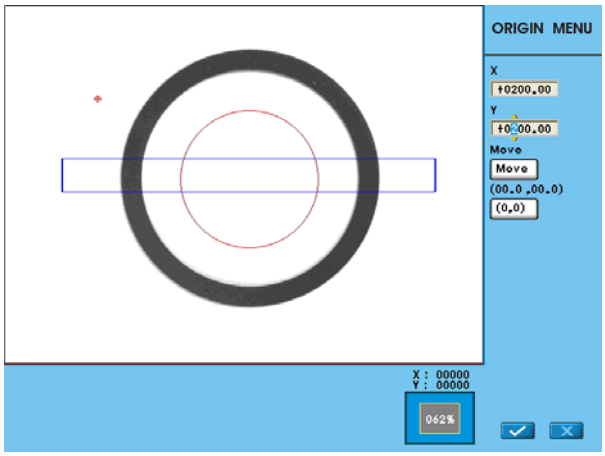
Observe the waveform to find the optimal parameter settings.

Origin:

Define the position of the origin.

Set up origin:

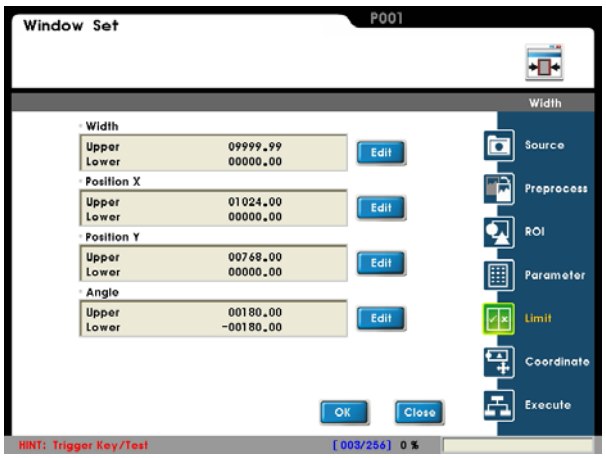
Select [Edit] to open the Origin Menu.



■ Item 5: [Limit]

Set the range for OK/NG detection. The result is OK if within the limit and NG otherwise.

Factory defaults to maximum range and thus the result is 1 (OK).



This logic output result of OK=1 and NG=0 can be passed onto the subsequent [Judge] program.

Reference Please refer to Chapter 7 for a detailed description of [Judge]

■ Item 6: [Coordinate]

Specify whether the coordinates (X/Y) and angle (Theta) will be adjusted to match the [Window] result in the [ROI] window. As shown to the right, the window X/Y/θ parameters will be automatically adjusted to the [Shape] detection results.

The [ROI] and [Mask 1]~[Mask 4] can be configured for the detection window.

Reference For more information on coordinates, please refer to section 6.8.

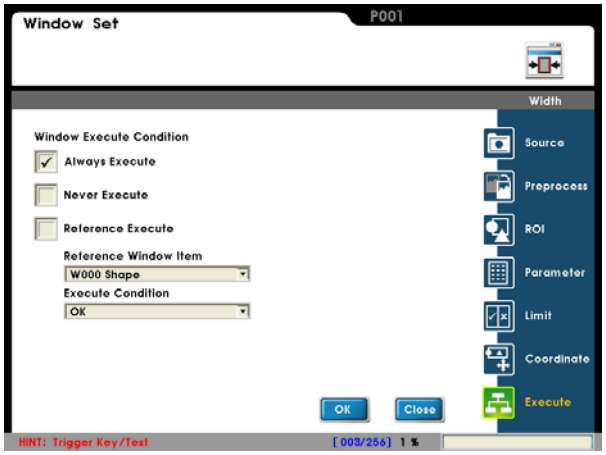
■ Item 7: [Execute]

Execute or disable the [Window] function.

[Always Execute]: The current [Window] will always be executed while running.

[Never Execute]: The current [Window] will never be executed while running. This is useful during initial testing.

[Reference Execute]: Set the [Reference Window Item] and [Execute Condition] for flow control. Execution of [Window] is determined by the conditions above.

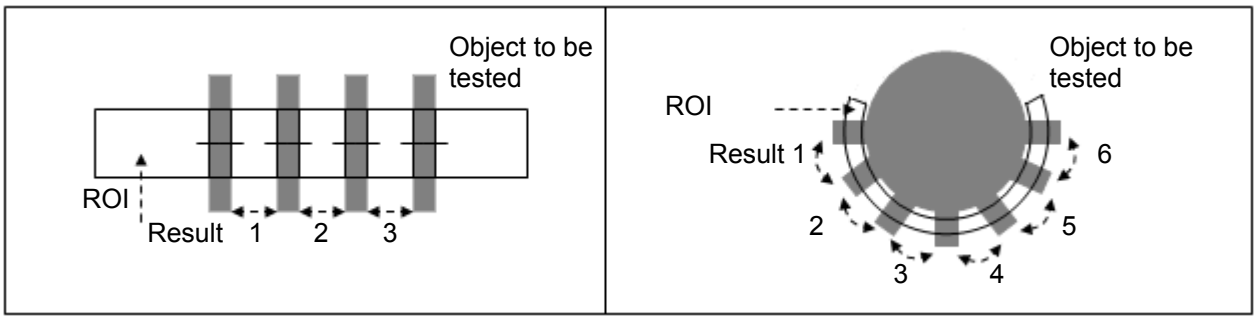


6.6 Pitch:

6.6.1 What is [Pitch]

The Pitch is an enhanced function of Width in the previous section, where multiple widths can be measured instead of just between two edges. The individual width, max width, min width, and average width can be calculated.

Rectangular **Fan**



6.6.2 Detection Result

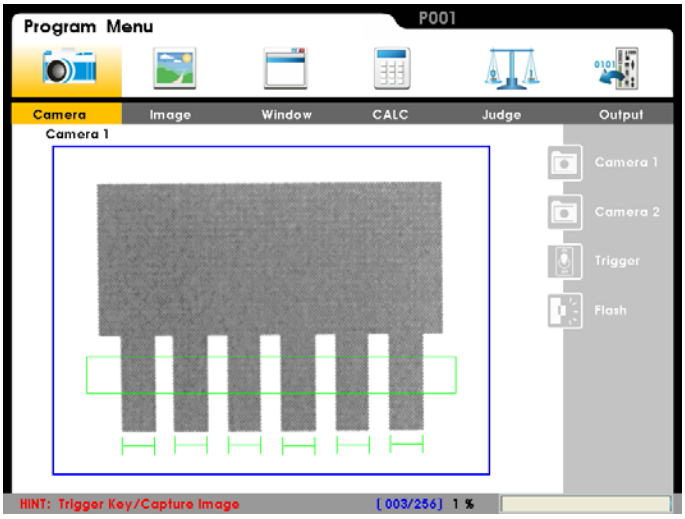
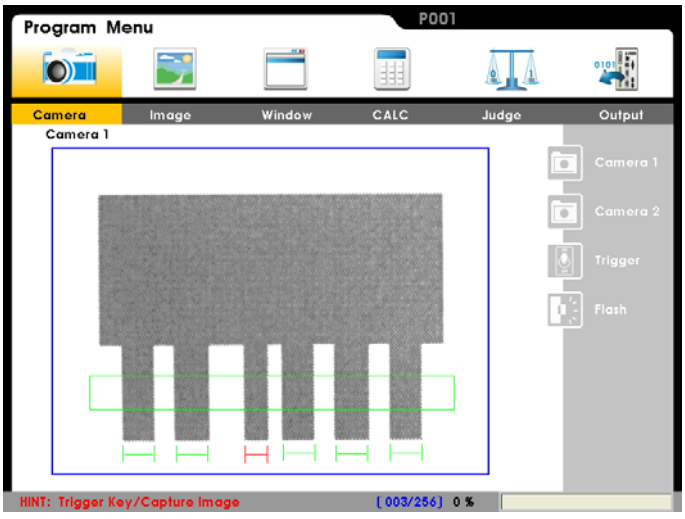
Pitch output report:

- **"Value" Output**
  - Number of widths that fit the limit: Range: 0~999
  - Designated Width: Range: 0~9999
  - Max width: 0~9999
  - Min width: 0~9999
  - Average width: 0~9999
  - Positions of first and second points:
    For a 0.30 megapixel camera: X (horizontal) coordinates: 0~639
    Y (vertical) coordinates: 0~479
    For a 0.80 megapixel camera: X (horizontal) coordinates: 0~1023
    Y (vertical) coordinates: 0~767

- **"Logic output (OK/NG)"**
  - Width count:
  - Designated Width:
  - Max Width:
  - Min Width:
  - Average Width:
    When used with [Limit] for the above, the Detection result is OK=1 if within the limit; otherwise it will be NG=0.

6.6.3 Example application of [Pitch]

As shown below, the width of each terminal is measured.

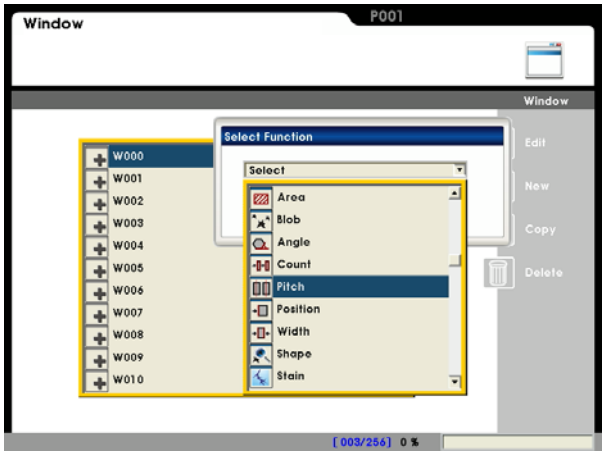
(qualified width)	(insufficient width)
	

■ Detection method:

All terminal widths are automatically measured using the Pitch function; then the results can be filtered out.

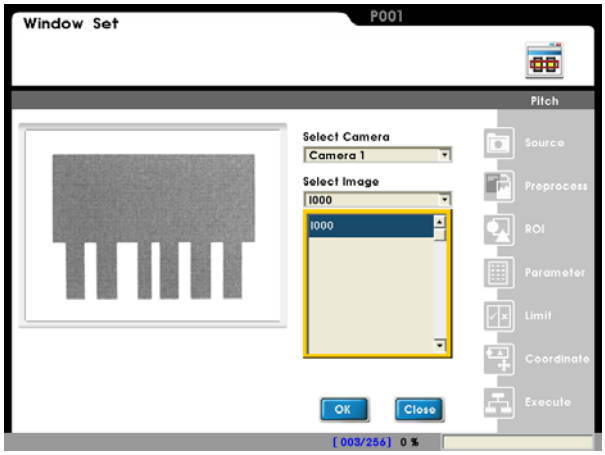
6.6.4 Setup [Pitch]

■ **From [Select Function], select the [Pitch] detection function.**



Select [Edit] or [New].
Please set up the following items in this sequence: [Source], [Preprocess], [ROI], [Parameter], [Limit], [Coordinate], and [Execute].

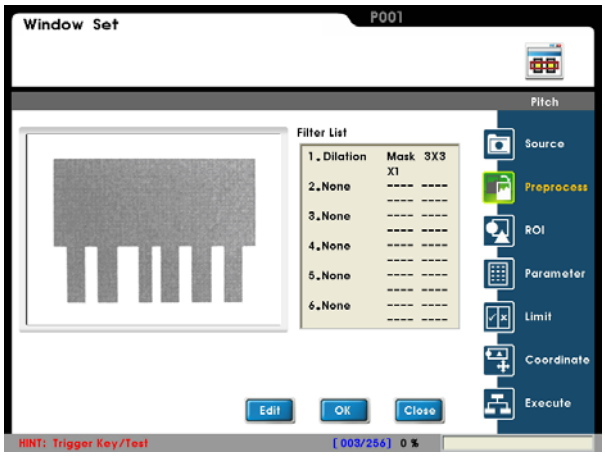
■ **Item 1: [Source]**



Select camera:
Up to two cameras are supported simultaneously. Please select Camera 1 or Camera 2 for this detection.

Select image:
Select a pre-captured image as the reference sample for this detection.

■ **Item 2: [Preprocess]**

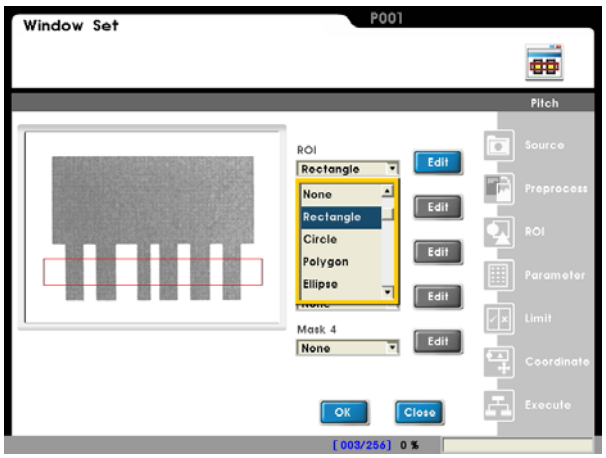


A software filter is used to first enhance the image in order to better meet the requirements. Thus, an appropriate preprocess filter can improve accuracy and reliability of the inspection.

More than a dozen preprocess filters are provided, including binarization, dilation, erosion, etc.
Up to six preprocess filters (numbered 1~6) can be applied in order.

Reference For more information about preprocess, please refer to Chapter 10.

■ Item 3: [ROI]



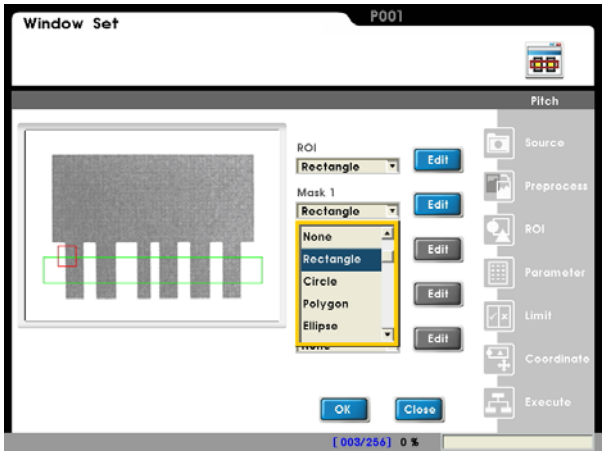
ROI:

Set the ROI for edge detection.

Different measurement window shapes can be drawn, including rectangles, ellipses, polygons, and circles.

Reference Please refer to Chapter 3.2 [Draw ROI (Region Of Interesting)]

Mask 1~Mask 4:



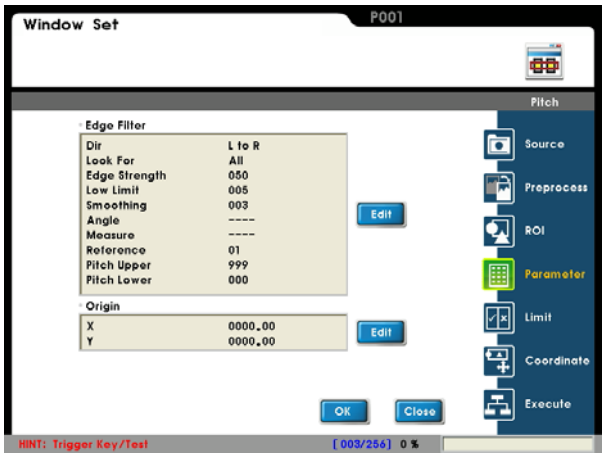
The mask is the area to be excluded from measurement. A mask can be set within the [ROI] to exclude an area from detection.

In the example to the right, the small red rectangle is a mask.

Up to four masks are supported for one [Window] program.

Different mask shapes can be drawn, such as rectangles, ellipses, polygons, and circles.

■ Item 4: [Parameter]



Edge filter:

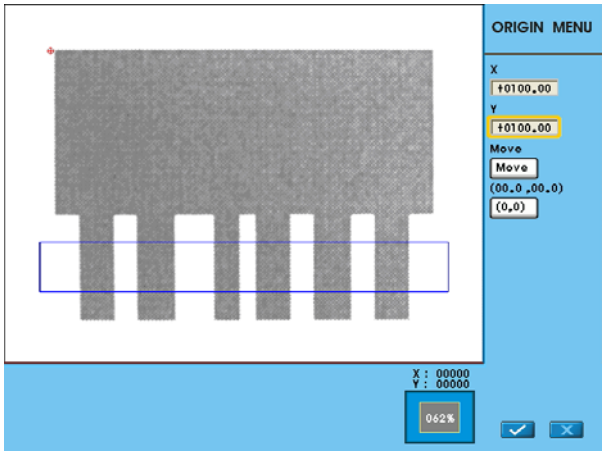
Set the direction for detection search and edge filter parameters.

Observe the waveform to find the optimal parameter settings.

Origin:

Define the position of the origin.

Set up origin:



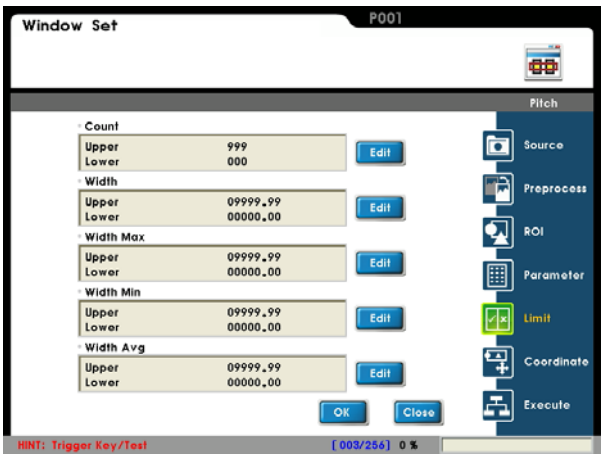
Select [Edit] to open the Origin Menu.

■ Item 5: [Limit]

Set the range for OK/NG detection. The result is OK if within the limit and NG otherwise.

Factory defaults to maximum range and thus the result is 1 (OK).

This logic output result of OK=1 and NG=0 can be passed onto the subsequent [Judge] program.



Reference Please refer to Chapter 7 for a detailed description of [Judge]

■ Item 6: [Coordinate]

Specify whether the coordinates (X/Y) and angle (Theta) will be adjusted to match the [Window] result in the [ROI] window. As shown to the right, the window X/Y/θ parameters will be automatically adjusted to the [Shape] detection results.

The [ROI] and [Mask 1]~[Mask 4] can be configured for the detection window.

Reference For more information on coordinates, please refer to section 6.8.

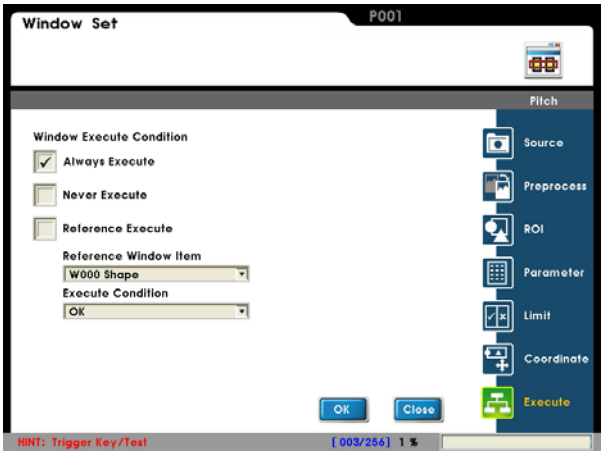
■ Item 7: [Execute]

Execute or disable the [Window] function.

[Always Execute]: The current [Window] will always be executed while running.

[Never Execute]: The current [Window] will never be executed while running. This is useful during initial testing.

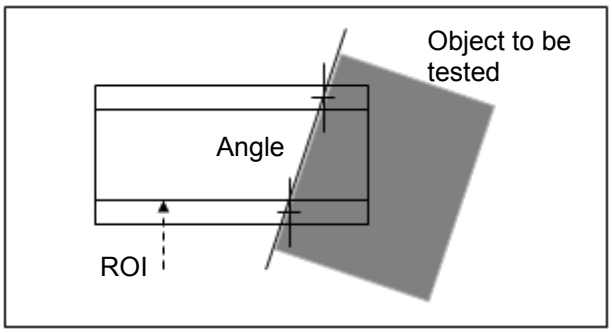
[Reference Execute]: Set the [Reference Window Item] and [Execute Condition] for flow control. Execution of [Window] is determined by the conditions above.



6.7 Angle:

6.7.1 What is [Angle]

A line is drawn through two positions and the angle of the line to the horizontal axis is calculated.



6.7.2 Detection Result

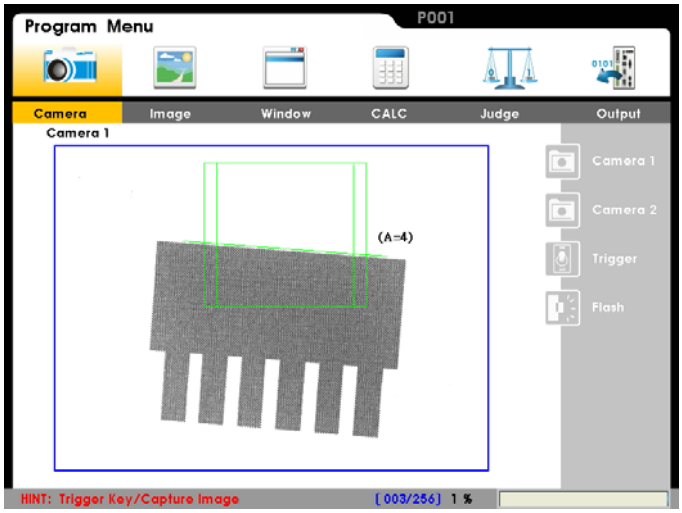
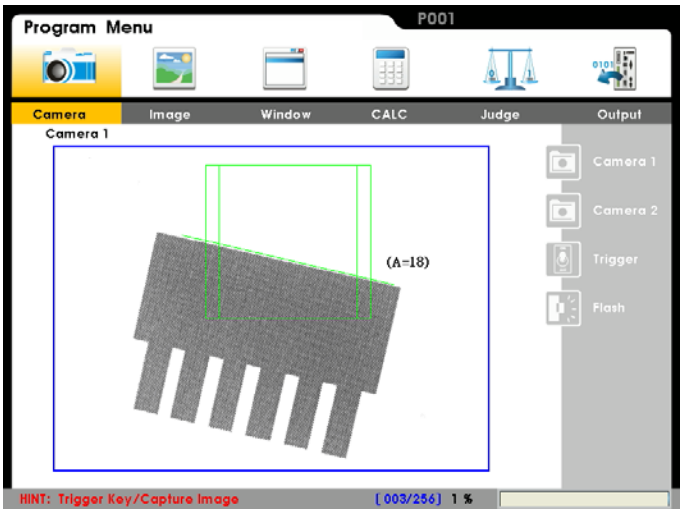
Angle output report:

- **"Value" Output**
  - Angle found: Range: 0~360

- **"Logic output (OK/NG)"**
  - Angle: When used with [Limit], the detection result is OK=1 if within the limit; otherwise it will be NG=0.

6.7.3 Example application of [Angle]

As shown below, the slant angle of the object is measured.

(small angle)	(large angle)
	

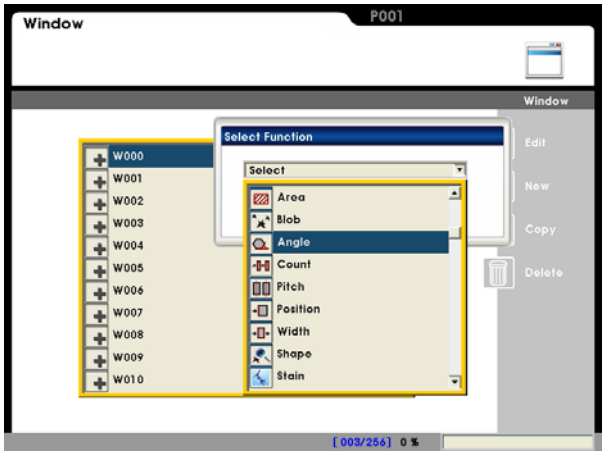
■ Detection method:

Two positions are automatically determined and the angle of the line to the horizontal axis is calculated. The detection result is OK if the angular coordinates fall within the range of limit. Otherwise, the detection result is NG if the range of limit is exceeded; thus the position offset is too large.

Angle can be passed onto subsequent rotation function as reference.

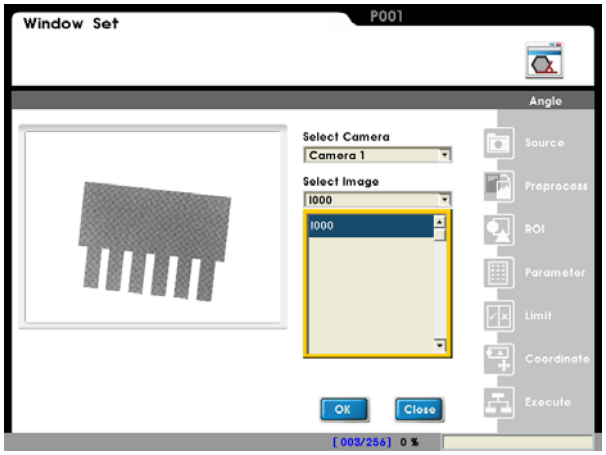
6.7.4 Set up [Angle] Detection

■ From [Select Function], select the [Angle] detection function.



Select [Edit] or [New].
Please set up the following items in this sequence: [Source], [Preprocess], [ROI], [Parameter], [Limit], [Coordinate], and [Execute].

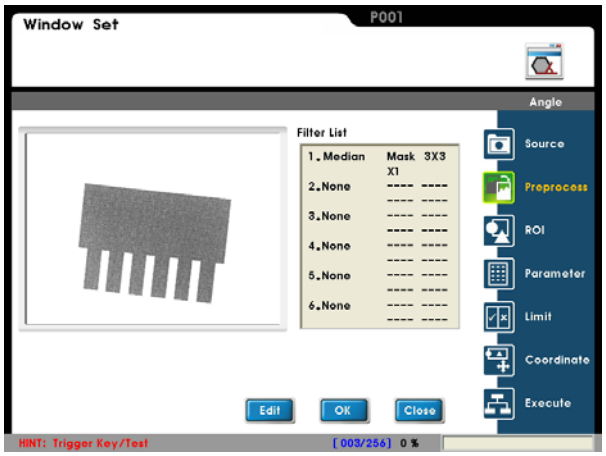
■ Item 1: [Source]



Select camera:
Up to two cameras are supported simultaneously. Please select Camera 1 or Camera 2 for this detection.

Select image:
Select a pre-captured image as the reference sample for this detection.

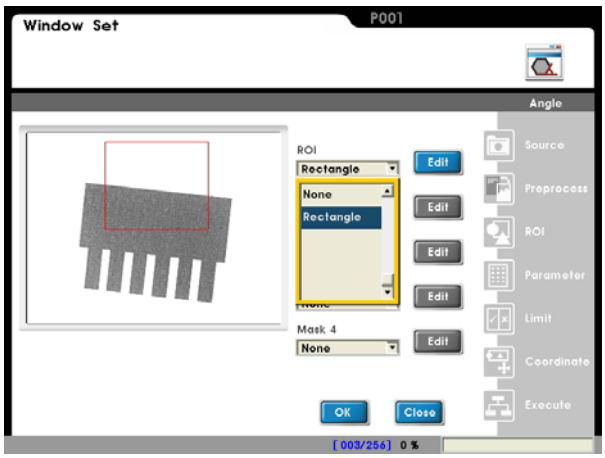
■ Item 2: [Preprocess]



A software filter is used to first enhance the image in order to better meet the requirements. Thus, an appropriate preprocess filter can improve accuracy and reliability of the inspection.

More than a dozen preprocess filters are provided, including binarization, dilation, erosion, etc.
Up to six preprocess filters (numbered 1~6) can be applied in order.

Reference For more information about preprocess, please refer to Chapter 10.



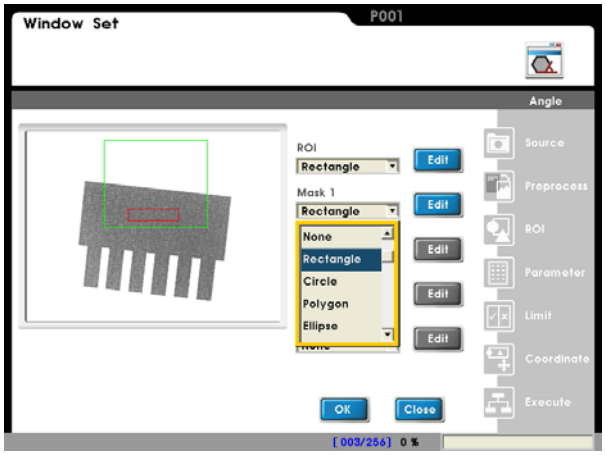
■ Item 3: [ROI]

ROI:

Set the ROI for edge detection.

Angle is only available with the rectangular window.

Reference Please refer to Chapter 3.2 [Draw ROI (Region Of Interesting)]



Mask 1~Mask 4:

The mask is the area to be excluded from measurement.

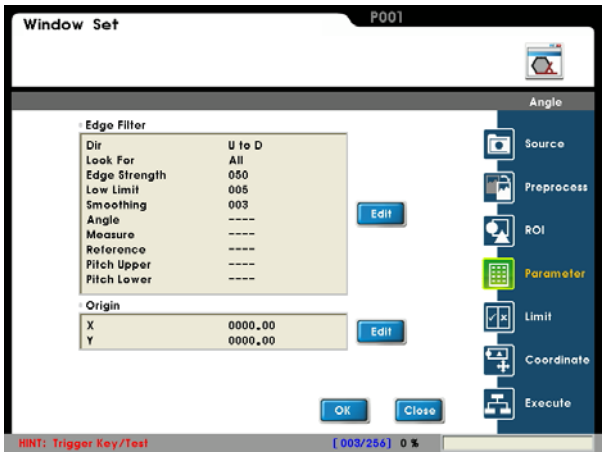
A mask can be set within the [ROI] to exclude an area from detection.

In the example to the right, the red circle is a mask.

Up to four masks are supported for one [Window] program.

Different mask shapes can be drawn, such as rectangles, ellipses, polygons, and circles.

■ Item 4: [Parameter]



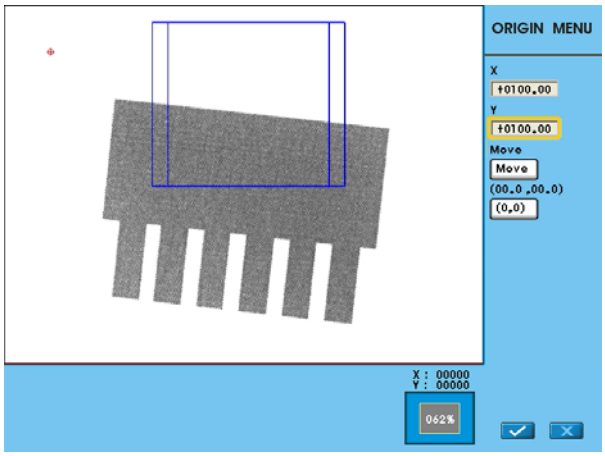
Edge filter:

Set the direction for detection search and edge filter parameters.

Observe the waveform to find the optimal parameter settings.

Origin:

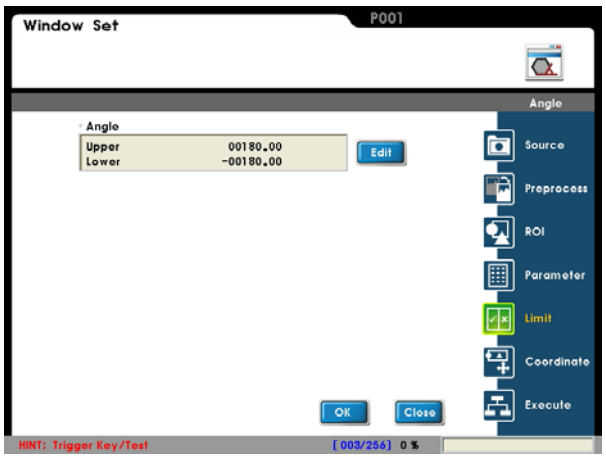
Define the position of the origin.



Set up origin:

Select [Edit] to open the Origin Menu.

■ Item 5: [Limit]

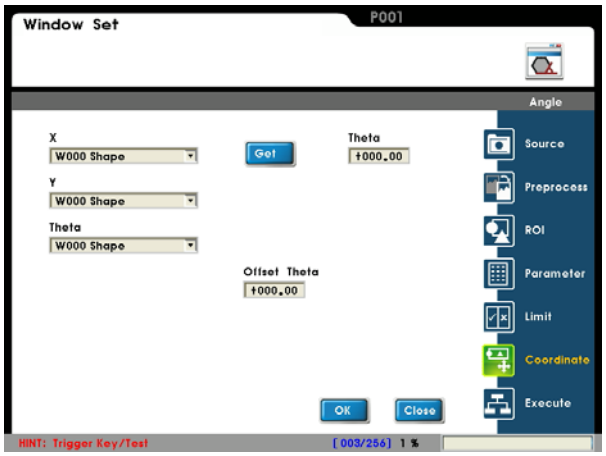


Set the range for OK/NG detection. The result is OK if within the limit and NG otherwise.
Factory defaults to maximum range and thus the result is 1 (OK).

This logic output result of OK=1 and NG=0 can be passed onto the subsequent [Judge] program.

Reference Please refer to Chapter 7 for a detailed description of [Judge]

■ Item 6: [Coordinate]

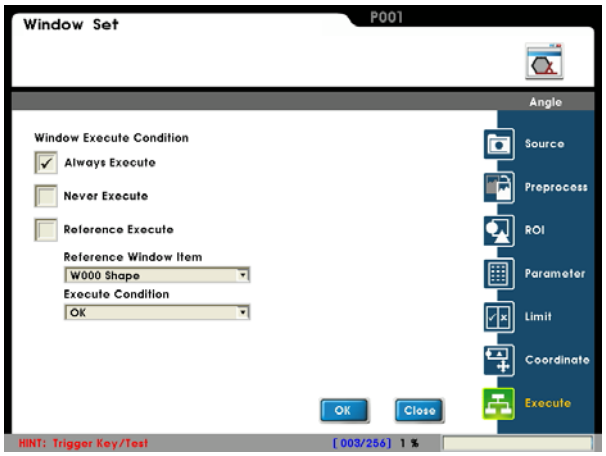


Specify whether the coordinates (X/Y) and angle (Theta) will be adjusted to match the [Window] result in the [ROI] window. As shown to the right, the window X/Y/θ parameters will be automatically adjusted to the [Shape] detection results.
The [ROI] and [Mask 1]~[Mask 4] can be configured for the detection window.

Select [Capture] and the angle (Theta) of the edge can be used as reference for subsequent rotation program.

Reference For more information on coordinates, please refer to section 6.8.

■ Item 7: [Execute]

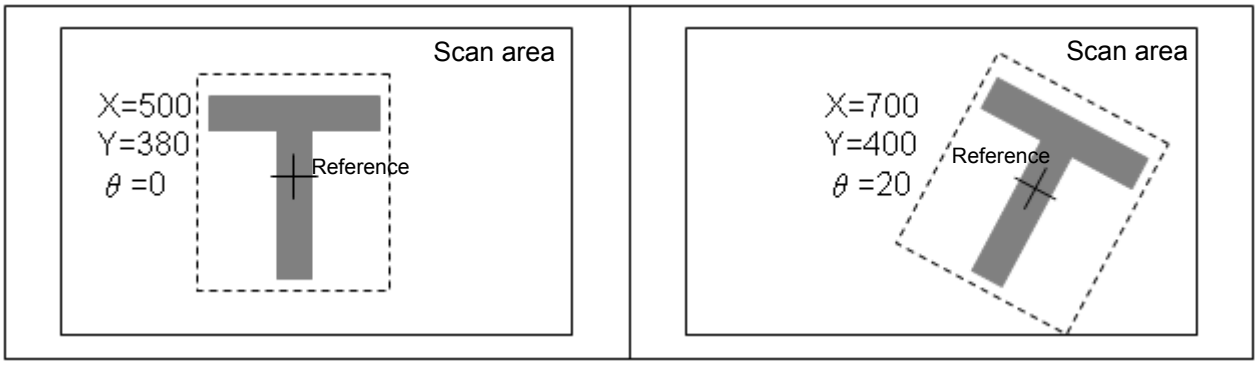


Execute or disable the [Window] function.
[Always Execute]: The current [Window] will always be executed while running.
[Never Execute]: The current [Window] will never be executed while running. This is useful during initial testing.
[Reference Execute]: Set the [Reference Window Item] and [Execute Condition] for flow control. Execution of [Window] is determined by the conditions above.

6.8 Shape:

6.8.1 What is [Shape]

The Shape function uses a reference image scanned from within the designated area to search for the specified shape and will output the XY coordinates and θ angle of the pattern located. Shape is recommended for objects to be tested with offset positions. Then the XYθ parameters can be passed onto subsequent programs for offset calibration.



6.8.2 Detection Result

Shape output report:

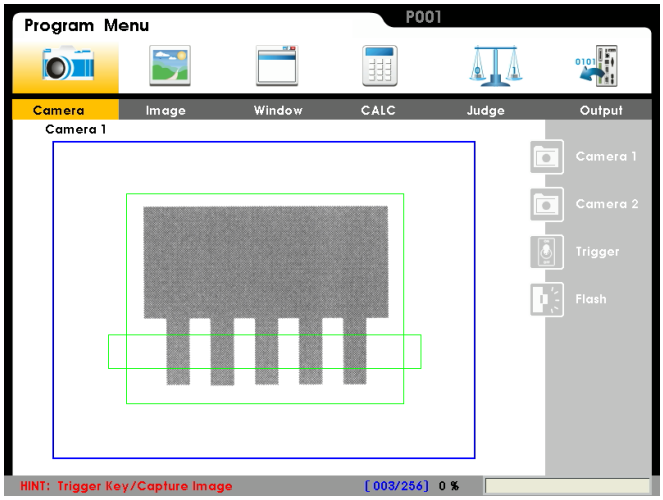
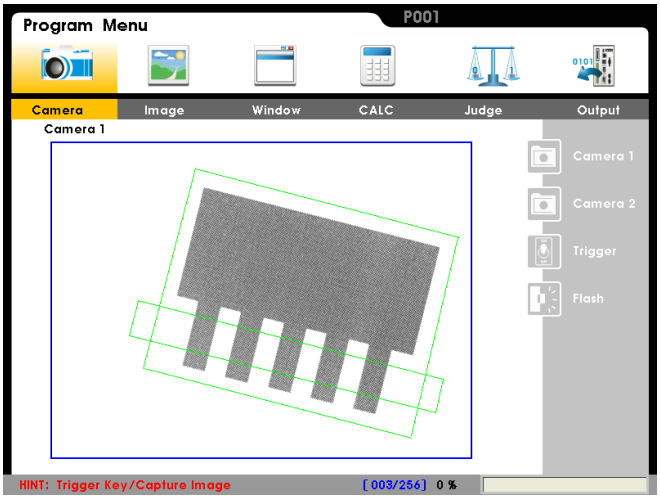
- **"Value" Output**
  - Found: 0~999
  - Similarity: 0~100.00
  - θ (rotation) angle: 0~359.99
  - For a 0.30 megapixel camera: (1024 * 768)
    X (horizontal) coordinates: 0~639.99
    Y (vertical) coordinates: 0~479.99
  - For a 0.80 megapixel camera: (1024 * 768)
    X (horizontal) coordinates: 0~1023.99
    Y (vertical) coordinates: 0~767.99

- **"Logic output (OK/NG)"**
  - Detection result:
    A successful detection is 1=OK; otherwise the result is 0=NG.
  - Found: When used with [Limit], the detection result is OK=1 if within the limit; otherwise it will be NG=0.
  - Similarity: When used with [Limit], the detection result is OK=1 if within the limit; otherwise it will be NG=0.
  - θ (rotation) angle: When used with [Limit], the detection result is OK=1 if within the limit; otherwise it will be NG=0.

- X (horizontal) coordinates: When used with [Limit], the detection result is OK=1 if within the limit; otherwise it will be NG=0.
- Y (vertical) coordinates: When used with [Limit], the detection result is OK=1 if within the limit; otherwise it will be NG=0.

6.8.3 Example application of [Shape]

As shown below, the offset XYθ of the object is passed onto subsequent [Count] as reference.

(standard position)	(offset position coordinates)
	

■ **Detection method:**

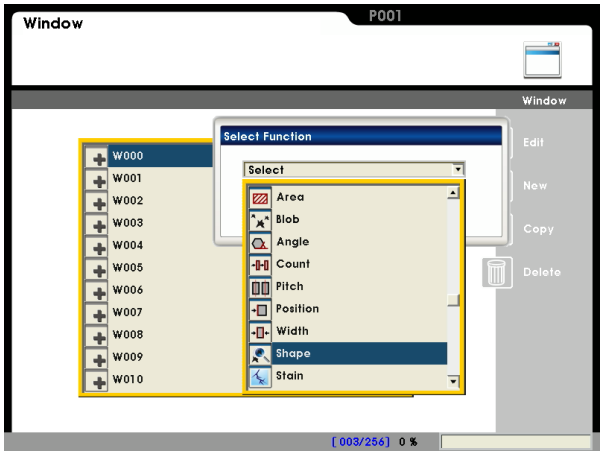
Both the Shape (full rectangle) and count (flat rectangle) detection functions are applied to the standard image; at the same, position of the edge counter is referenced to the Shape parameters. For more reliable results, the counter detection frame offset matches the position offset of the test item.

6.8.4 Set up [Shape] Detection Settings

■ From [Select Function], select [Shape].

Select [Edit] or [New].

Please set up the following items in this sequence: [Source], [Preprocess], [ROI], [Parameter], [Limit], [Coordinate], and [Execute].



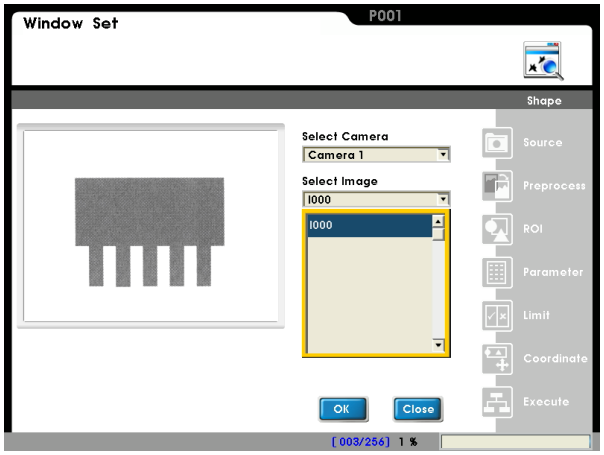
● Item 1: [Source]

Select camera:

Up to two cameras are supported simultaneously. Please select Camera 1 or Camera 2 for this detection.

Select image:

Select a pre-captured image as the reference sample for this detection.

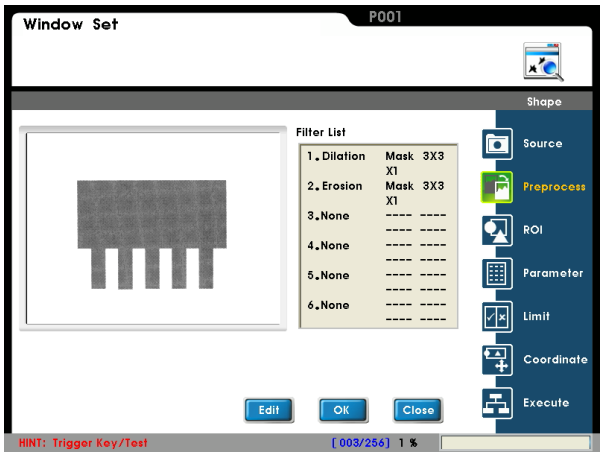


■ Item 2: [Preprocess]

A software filter is used to first enhance the image in order to better meet the requirements. Thus, an appropriate preprocess filter can improve accuracy and reliability of the inspection.

More than a dozen preprocess filters are provided, including binarization, dilation, erosion, etc.

Up to six preprocess filters (numbered 1~6) can be applied in order.



Reference For more information about preprocess, please refer to Chapter 10.

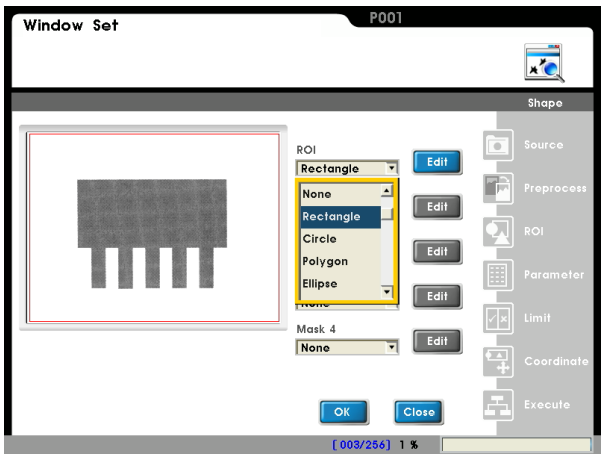
■ Item 3: [ROI]

ROI:

Set the ROI for edge detection.

Different measurement window shapes can be drawn, including rectangles, ellipses, polygons, and circles.

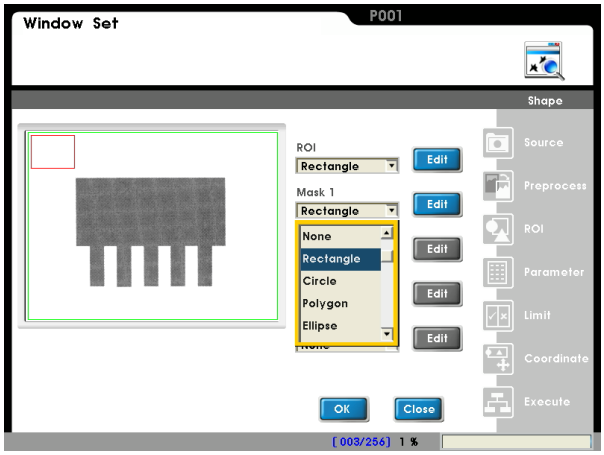
Reference Please refer to Chapter 3.2 [Draw ROI (Region Of Interesting)]



Mask 1~Mask 4:

The mask is the area to be excluded from measurement. A mask can be set within the [ROI] to exclude an area from detection.

In the example to the right, the top left red rectangle is a mask.



Up to four masks are supported for one [Window] program.

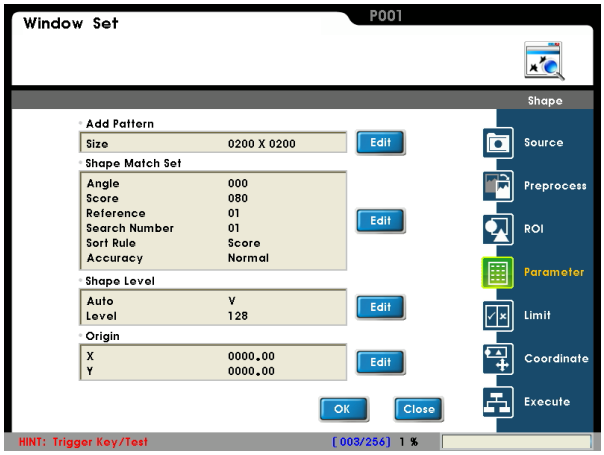
Different mask shapes can be drawn, such as rectangles, ellipses, polygons, and circles.

■ Item 4: [Parameter]

Edge filter:

Set the direction for detection search and edge filter parameters.

Observe the waveform to find the optimal parameter settings.



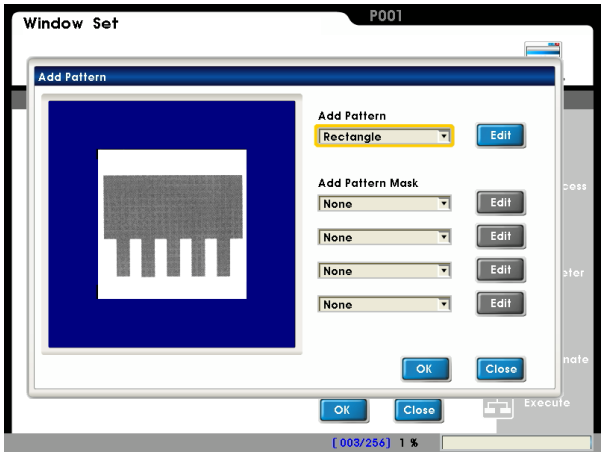
Origin:

Define the position of the origin.

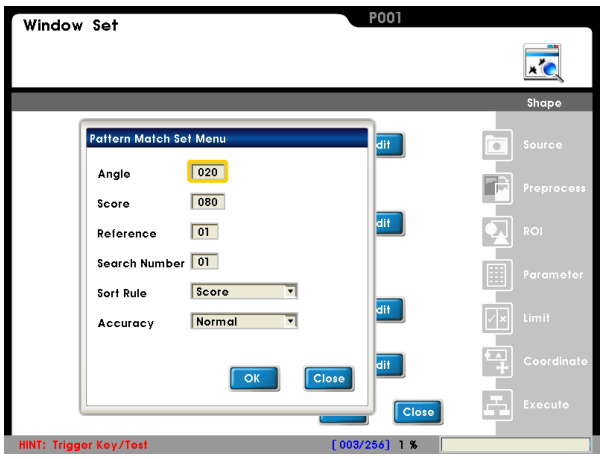
Add Pattern:

As Shape is based on the bright/dark transitional edges, the reference pattern should contain more of these edges to improve the matching reliability.

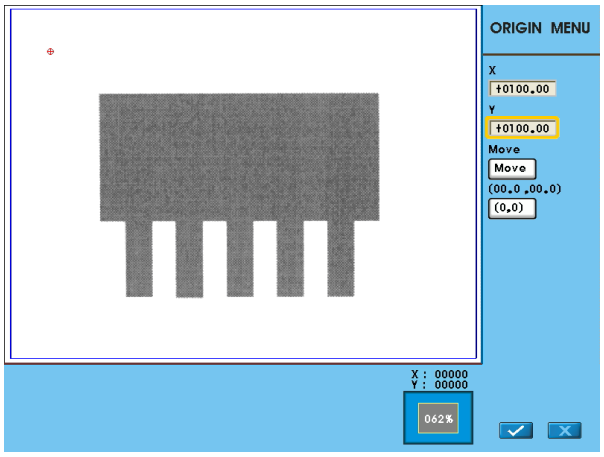
Select [Close] to finish setup.



Angle: Set positive/negative angle range. (a value of 20 indicates -20~+20)
Score: Pattern matching and coordinates are successful if higher than this score.
Reference: Output the n-th result when scanning multiple targets. (must be used with the [Sort Rule] below)
Search Number: Adjust this quantity when scanning multiple targets. However, the scan time will increase if the target is less than the scan quantity.
Sort Rule: Set the sort method for multiple scanned targets. The n-th result from [Reference] will also be changed.
Accuracy: Higher accuracy results in more accurate X/Y/θ parameters, but detection time is also increased.



Set up origin:
Select [Edit] to open the Origin Menu.

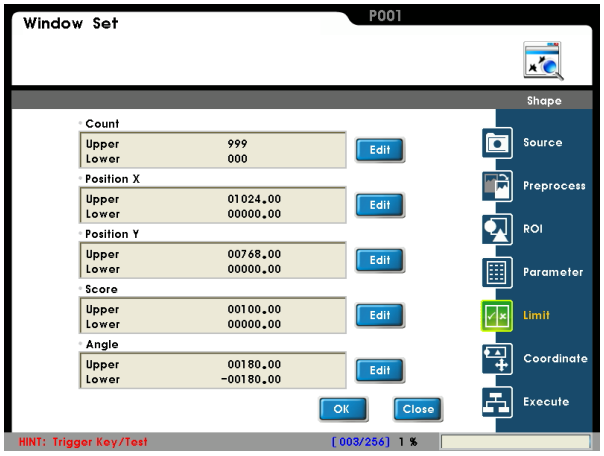


■ Item 5: [Limit]

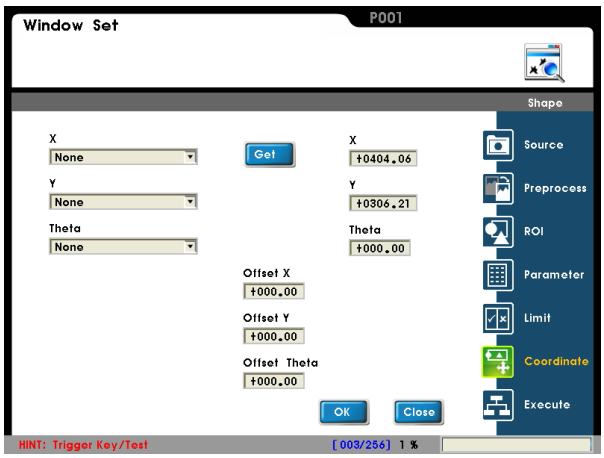
Set the range for OK/NG detection. The result is OK if within the limit and NG otherwise.
Factory defaults to maximum range and thus the result is 1 (OK).

This logic output result of OK=1 and NG=0 can be passed onto the subsequent [Judge] program.

Reference Please refer to Chapter 7 for a detailed description of [Judge]



■ Item 6: [Coordinate]



Specify whether the coordinates (X/Y) and angle (Theta) will be adjusted to match the [Window] result in the [ROI] window. As shown to the right, the window X/Y/θ parameters will be automatically adjusted to the [Shape] detection results.

The [ROI] and [Mask 1]~[Mask 4] can be configured for the detection window.

After selecting [Capture], the X/Y coordinates of the edge position can be used as reference for subsequent programs.

■ Item 7: [Execute]

Execute or disable the [Window] function.

[Always Execute]: The current [Window] will always be executed while running.

[Never Execute]: The current [Window] will never be executed while running. This is useful during initial testing.

[Reference Execute]: Set the [Reference Window Item] and [Execute Condition] for flow control. Execution of [Window] is determined by the conditions above.

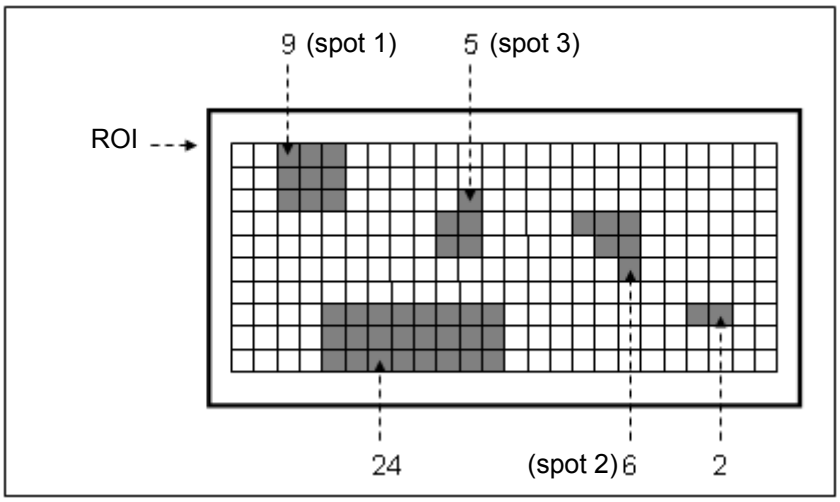
6.9 Blob:

6.9.1 What is [Blob]

Blob detection calculates the black/white pixel clusters. A spot is detected if the cluster satisfies the preset criteria.

As shown below, spot detection is configured for black clusters in sizes of 4~10 pixels. Thus a total of three spots (5, 6, 9-pixel clusters) are found and the 2, 24-pixel clusters are excluded.

The spots are sorted in order of pixel size.



6.9.2 Detection Result

Blob detection output report:

- **"Value" Output**
  - Spots found: Range: 0~999.
  - Sort by horizontal and vertical coordinates.

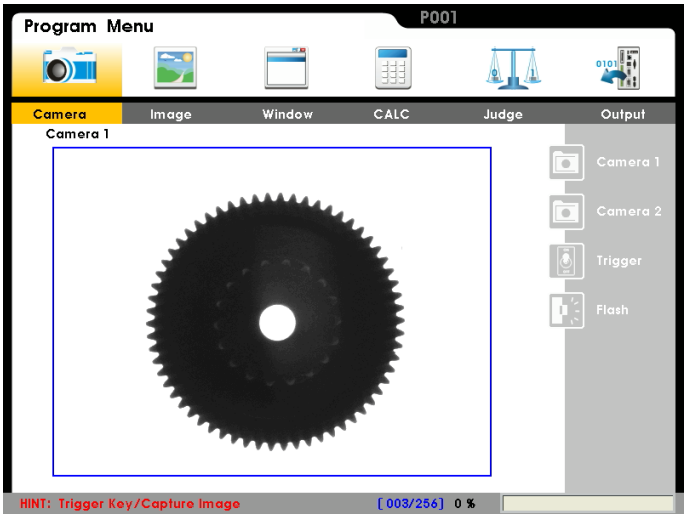
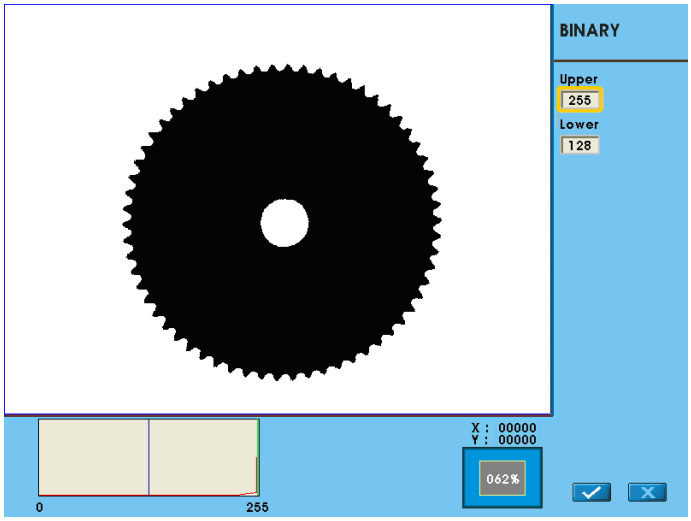
    For a 0.30 megapixel camera: (640 * 480);
    X (horizontal) coordinates: 0~639
    Y (vertical) coordinates: 0~479

    For a 0.80 megapixel camera: (1024 * 768)
    X (horizontal) coordinates: 0~1023
    Y (vertical) coordinates: 0~767
  - Sort by area: Range 0~999999.
  - Sort by circumference: Range 0~999999.

- **"Logic output (OK/NG)"**
  - Spot number, horizontal position, vertical position, area, and circumference.
    When used with [Limit] for the above, the detection result is OK=1 if the limit is satisfied; otherwise it is NG=0.

6.9.3 Example application of [Blob]

As shown below, the center of the gear is measured.

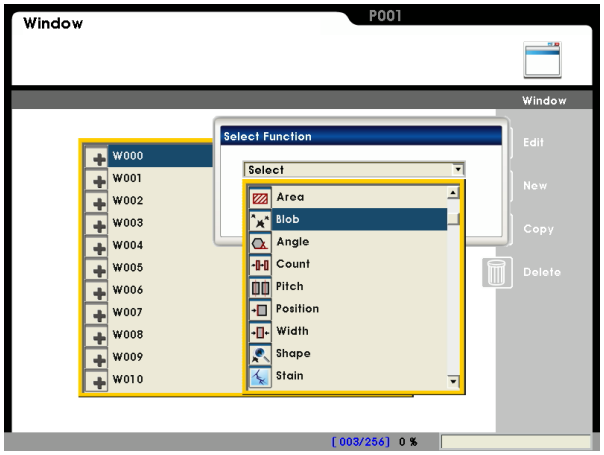
(original image)	(binarized image)
	

■ Detection method:

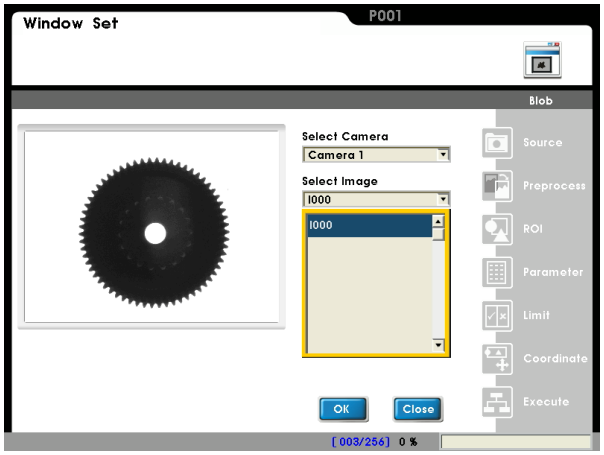
Before Blob detection, the original grayscale image is binarized into black/white pixels. Apply Blob detection on black pixel cluster to obtain the XY coordinates of the center.

6.9.4 Set up [Blob] Detection Settings

■ From [Select Function], select [Blob].



Select [Edit] or [New].
Please set up the following items in this sequence: [Source], [Preprocess], [ROI], [Parameter], [Limit], [Coordinate], and [Execute].



● Item 1: [Source]

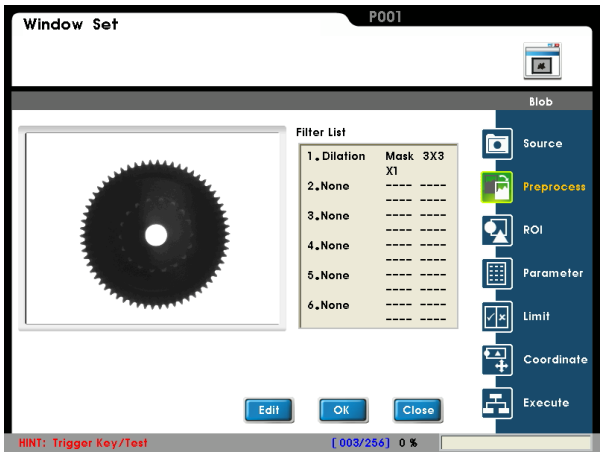
Select camera:

Up to two cameras are supported simultaneously. Please select Camera 1 or Camera 2 for this detection.

Select image:

Select a pre-captured image as the reference sample for this detection.

■ Item 2: [Preprocess]

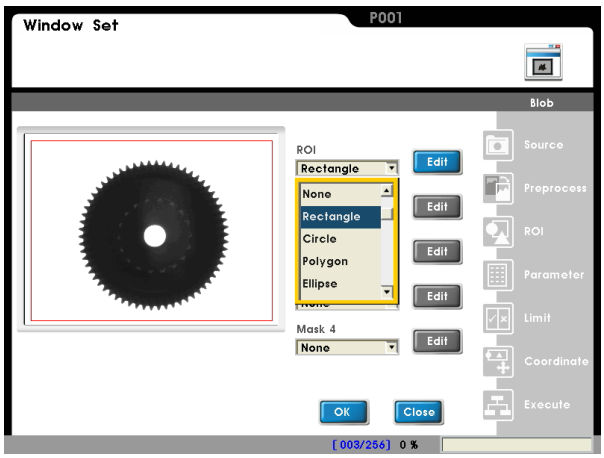


A software filter is used to first enhance the image in order to better meet the requirements. Thus, an appropriate preprocess filter can improve accuracy and reliability of the inspection.

More than a dozen preprocess filters are provided, including binarization, dilation, erosion, etc.
Up to six preprocess filters (numbered 1~6) can be applied in order.

Reference For more information about preprocess, please refer to Chapter 10.

■ Item 3: [ROI]

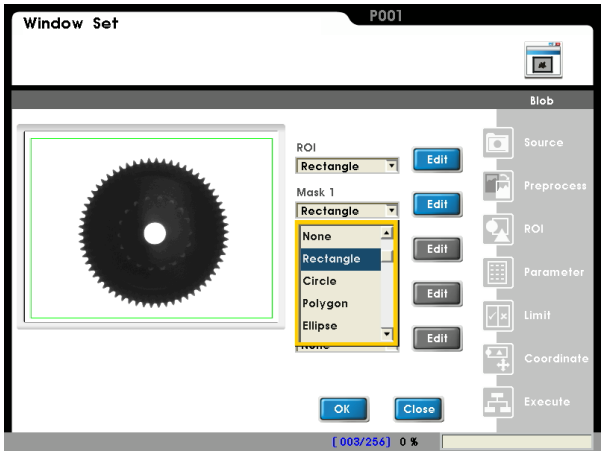


ROI:

A smaller ROI requires less detection time.

Different measurement window shapes can be drawn, including rectangles, ellipses, polygons, and circles.

Reference Please refer to Chapter 3.2 [Draw ROI (Region Of Interesting)]



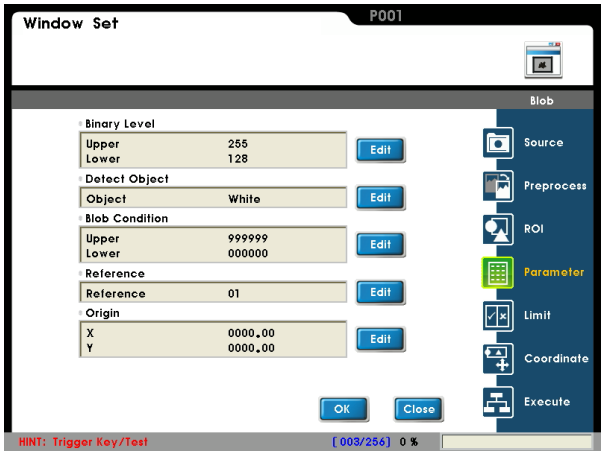
Mask 1~Mask 4:

The mask is the area to be excluded from measurement. A mask can be set within the [ROI] to exclude an area from detection.

Up to four masks are supported for one [Window] program.

Different mask shapes can be drawn, such as rectangles, ellipses, polygons, and circles.

■ Item 4: [Parameter]



Binarization: The grayscale image is binarized into black and white pixels for area inspection.

Detect Object: Count the black pixels or white pixels.

Origin: Define the position of the origin.

Blob Condition: Set the upper/lower limit for number of black pixel cluster.

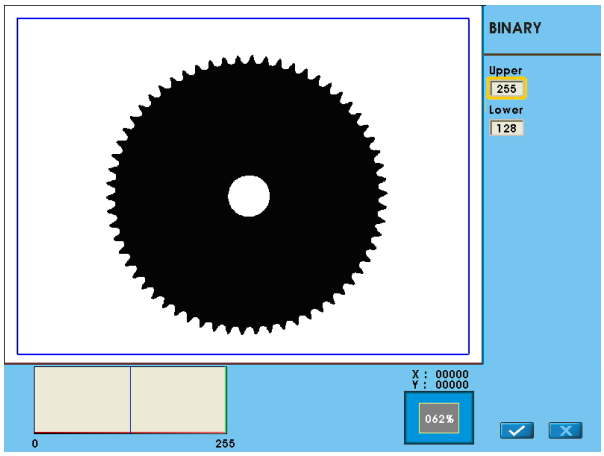
Reference: If multiple spots are found (sorted by descending pixel size), set the n-th result to show as the reference [Limit].

Set up binarization:

Select [Edit] and adjust the upper/lower limits. The resulting image is displayed dynamically.

White pixels indicate the grayscale image inside the ROI, and black pixels are outside the area.

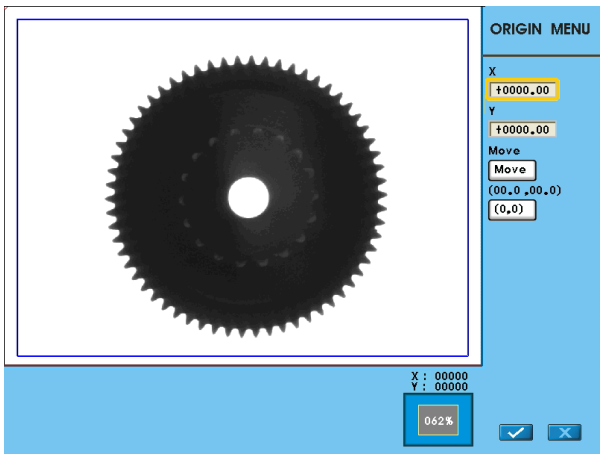
The grayscale level histogram is shown lower left of the screen.



Reference For more information about binarization, refer to Chapter 10.

Set up origin:

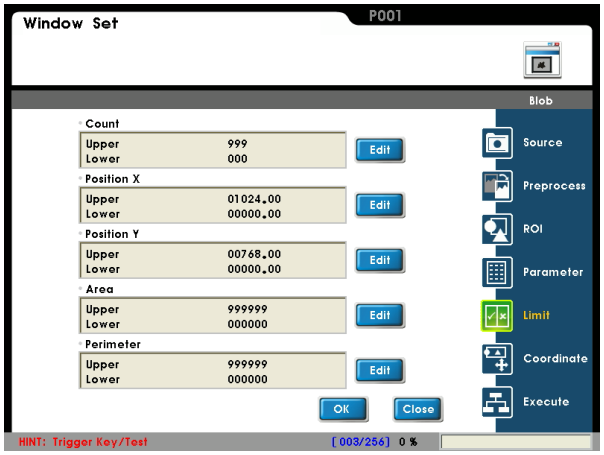
Select [Edit] to open the Origin Menu.



■ Item 5: [Limit]

Set the range for OK/NG detection. The result is OK if within the limit and NG otherwise.

Factory defaults to maximum range and thus the result is 1 (OK).



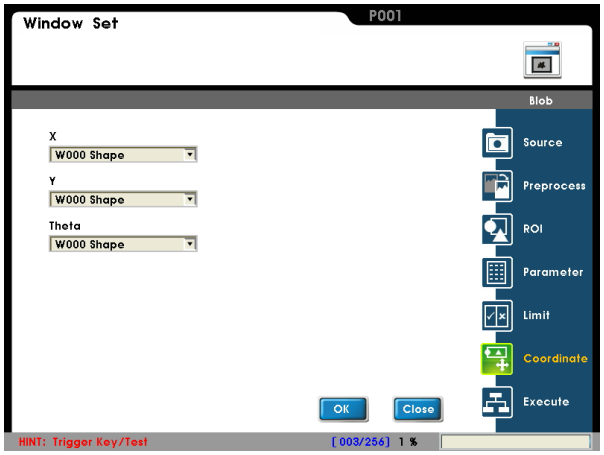
This logic output result of OK=1 and NG=0 can be passed onto the subsequent [Judge] program.

Reference Please refer to Chapter 7 for a detailed description of [Judge]

■ Item 6: [Coordinate]

Specify whether the coordinates (X/Y) and angle (Theta) will be adjusted to match the [Window] result in the [ROI] window. As shown to the right, the window X/Y/θ parameters will be automatically adjusted to the [Shape] detection results.

The [ROI] and [Mask 1]~[Mask 4] can be configured for the detection window.



Reference For more information on coordinates, please refer to section 6.8.

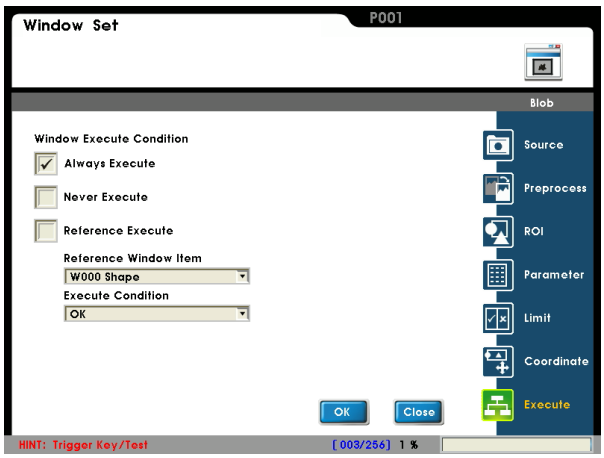
■ Item 7: [Execute]

Execute or disable the [Window] function.

[Always Execute]: The current [Window] will always be executed while running.

[Never Execute]: The current [Window] will never be executed while running. This is useful during initial testing.

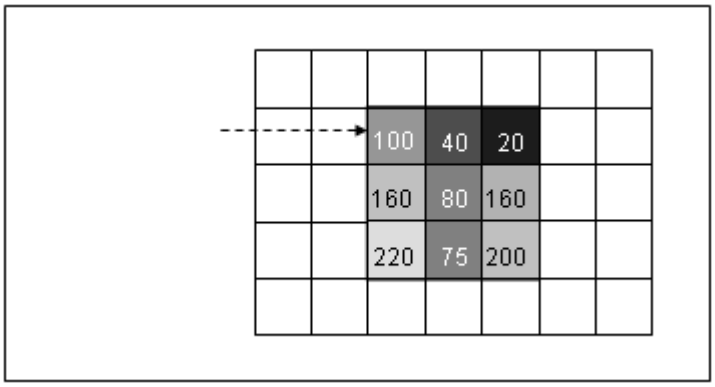
[Reference Execute]: Set the [Reference Window Item] and [Execute Condition] for flow control. Execution of [Window] is determined by the conditions above.



6.10 Intensity:

6.10.1 What is [Intensity]

Intensity is the "max brightness", "min brightness", "average brightness", and "standard deviation" of all grayscale pixels in the ROI.



Max brightness = 220
Min brightness = 20
Average brightness =
(100 + 40 + 20 + 160 + 80 + 160 + 220 + 75 + 200) / 9 = 117.22
Standard deviation = 65.73

6.10.2 Detection Result

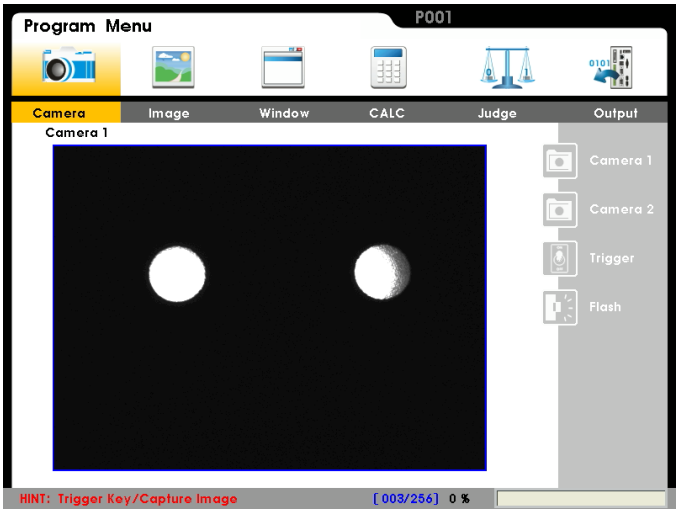
Intensity output report:

- **"Value" Output**
  - Max brightness: range 0.00~255.00
  - Min brightness: range 0.00~255.00
  - Average brightness: range 0.00~255.00
  - Brightness deviation: range 0.00~255.00

- **"Logic output (OK/NG)"**
  - Max brightness, min brightness, average brightness, and brightness deviation.
    When used with [Limit] for the above, the detection result is OK=1 if the limit is satisfied; otherwise it is NG=0.

6.10.3 Example application of [Intensity]

As shown below, the LED is measured for brightness and uniformity.



■ Detection method:

Two image intensity filters are used to measure the brightness and uniformity of the two LEDs side-by-side.

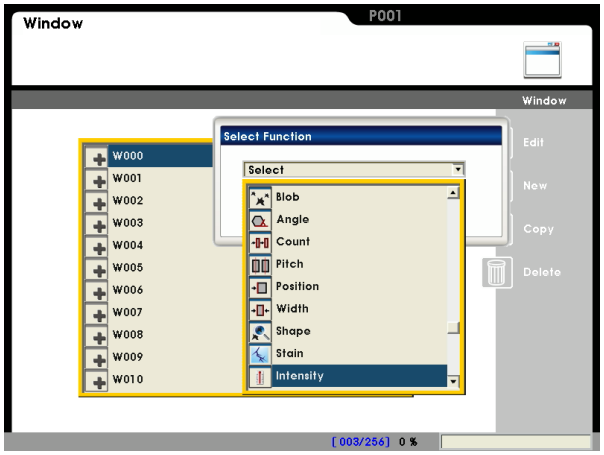
Uniform brightness for the LED on the left, thus "Average brightness=200". “Standard brightness deviation=10”.

The LED on the right shows a shadow, thus "Average brightness=150". "Standard brightness deviation=40”.

Then use the average and standard deviation to check the LED quality.

6.10.4 Set up [Intensity] Detection Settings

■ From [Select Function], select [Intensity].



Select [Edit] or [New].
Please set up the following items in this sequence: [Source], [Preprocess], [ROI], [Parameter], [Limit], [Coordinate], and [Execute].

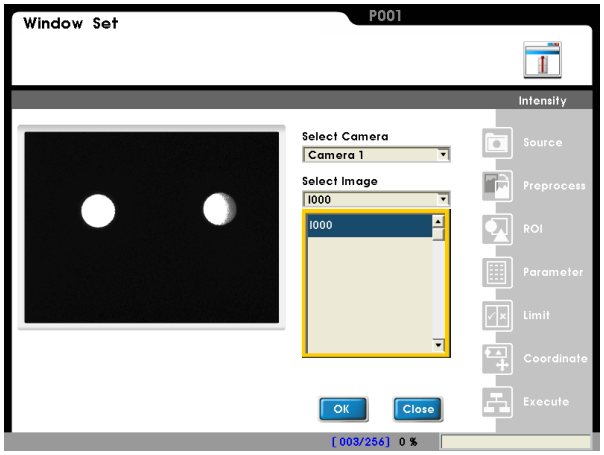
● Item 1: [Source]

Select camera:

Up to two cameras are supported simultaneously. Please select Camera 1 or Camera 2 for this detection.

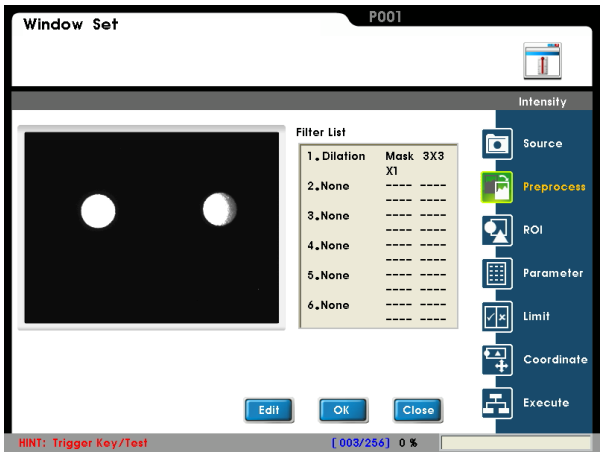
Select image:

Select a pre-captured image as the reference sample for this detection.



■ Item 2: [Preprocess]

A software filter is used to first enhance the image in order to better meet the requirements. Thus, an appropriate preprocess filter can improve accuracy and reliability of the inspection.



More than a dozen preprocess filters are provided, including binarization, dilation, erosion, etc.
Up to six preprocess filters (numbered 1~6) can be applied in order.

Reference For more information about preprocess, please refer to Chapter 10.

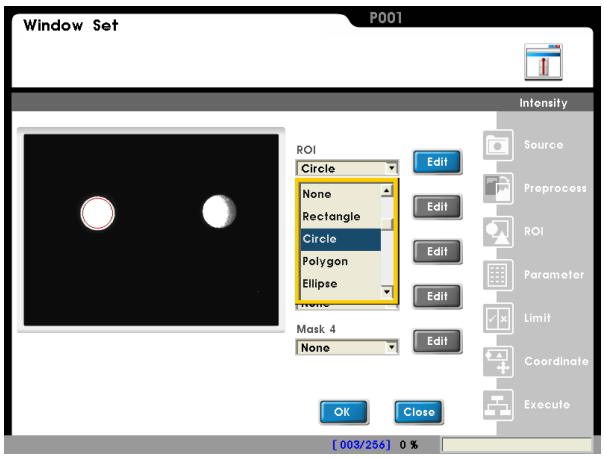
■ Item 3: [ROI]

ROI:

A smaller ROI requires less detection time.

Different measurement window shapes can be drawn, including rectangles, ellipses, polygons, and circles.

Reference Please refer to Chapter 3.2 [Draw ROI (Region Of Interesting)]

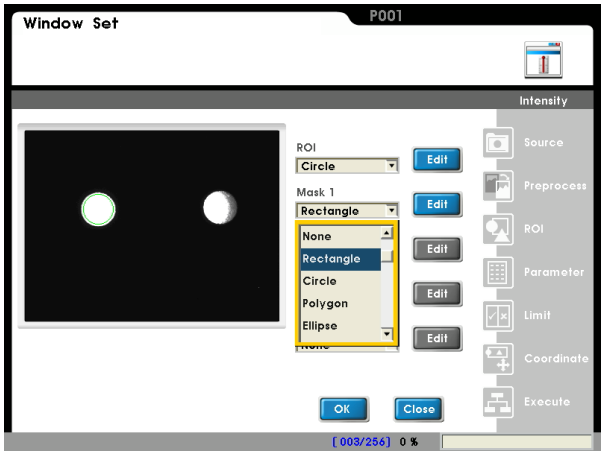


Mask 1~Mask 4:

The mask is the area to be excluded from measurement. A mask can be set within the [ROI] to exclude an area from detection.

Up to four masks are supported for one [Window] program.

Different mask shapes can be drawn, such as rectangles, ellipses, polygons, and circles.



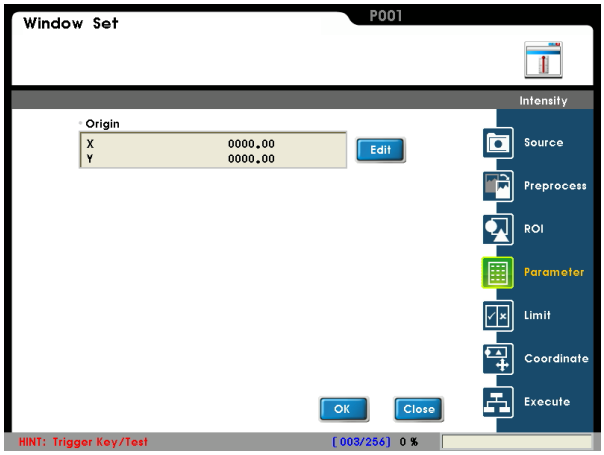
■ Item 4: [Parameter]

Process: Specify a detection result of [Average] or [Standard deviation.

Average: Average grayscale level of all pixels.

Standard deviation: Standard deviation to the average. A large standard deviation indicates that most pixels differ a lot from the average. Conversely, a smaller standard deviation indicates that most pixels are near the average.

Origin: Define the position of the origin.



Set up origin:

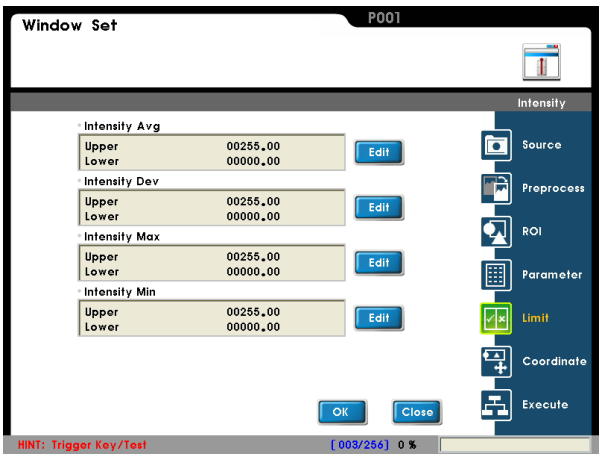
Select [Edit] to open the Origin Menu.

■ Item 5: [Limit]

Set the range for OK/NG detection. The result is OK if within the limit and NG otherwise.

Factory defaults to maximum range and thus the result is 1 (OK).

This logic output result of OK=1 and NG=0 can be passed onto the subsequent [Judge] program.



Reference Please refer to Chapter 7 for a detailed description of [Judge]

■ Item 6: [Coordinate]

Specify whether the coordinates (X/Y) and angle (Theta) will be adjusted to match the [Window] result in the [ROI] window. As shown to the right, the window X/Y/θ parameters will be automatically adjusted to the [Shape] detection results.

The [ROI] and [Mask 1]~[Mask 4] can be configured for the detection window.

Reference For more information on coordinates, please refer to section 6.8.

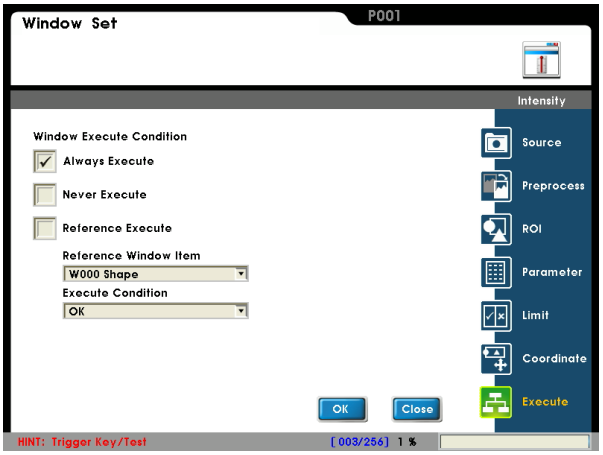
■ Item 7: [Execute]

Execute or disable the [Window] function.

[Always Execute]: The current [Window] will always be executed while running.

[Never Execute]: The current [Window] will never be executed while running. This is useful during initial testing.

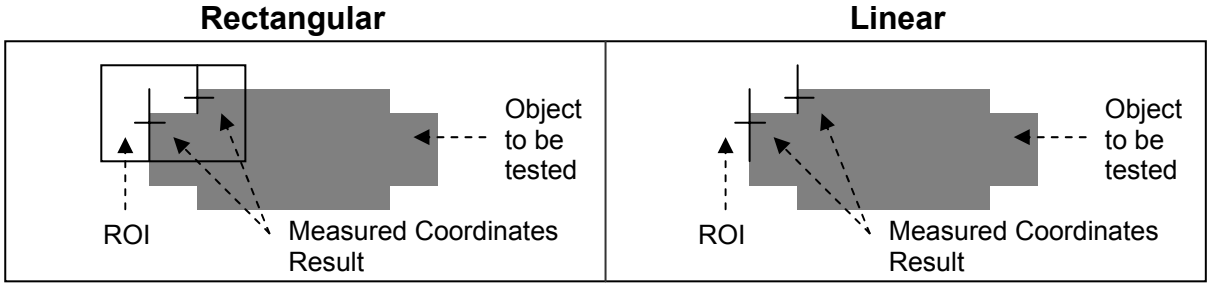
[Reference Execute]: Set the [Reference Window Item] and [Execute Condition] for flow control. Execution of [Window] is determined by the conditions above.



6.11 Position Trace:

6.11.1 What is [Position Trace]

Position Trace detects the XY coordinates where the grayscale level is over the threshold. The result is the max and min edge coordinates.



6.11.2 Detection Result

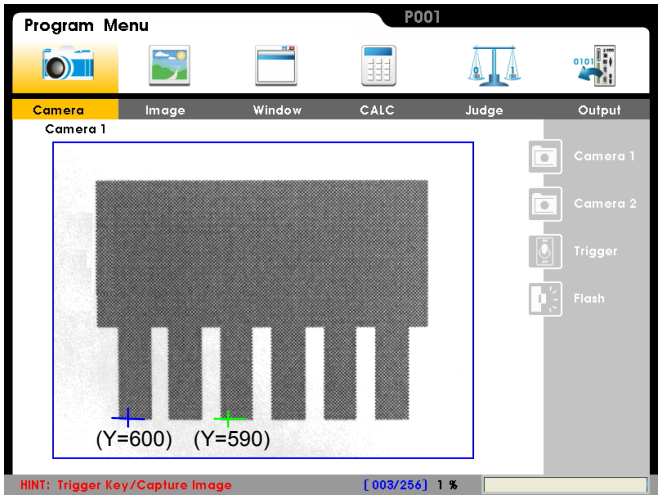
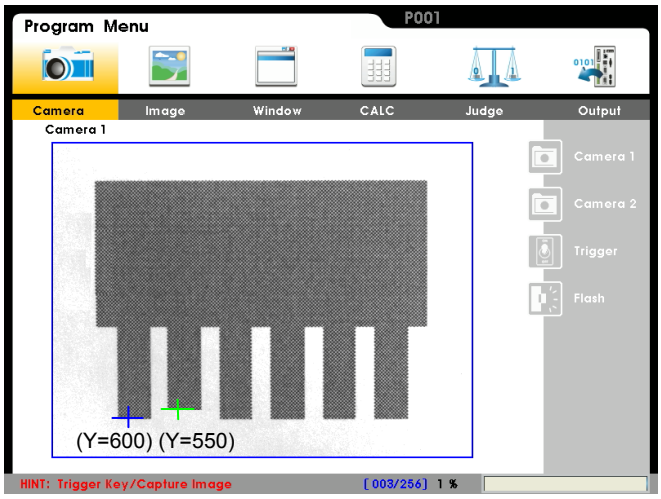
Position Trace output report:

- **"Value" Output**
  - For a 0.30 megapixel camera: (640 * 480)
    X (horizontal) coordinates: 0~639
    Y (vertical) coordinates: 0~479
  - For a 0.80 megapixel camera: (1024 * 768)
    X (horizontal) coordinates: 0~1023
    Y (vertical) coordinates: 0~767

- **"Logic output (OK/NG)"**
  - Detection result:
    A successful detection is 1=OK; otherwise the result is 0=NG.
  - Max/min X (horizontal) coordinates: When used with [Limit], the detection result is OK=1 if within the limit; otherwise it will be NG=0.
  - Max/min Y (vertical) coordinates: When used with [Limit], the detection result is OK=1 if within the limit; otherwise it will be NG=0.

6.11.3 Example application of [Position Trace]

As shown below, the pin lengths are inspected.

(correct position)	(offset position)
	

■ Detection method:

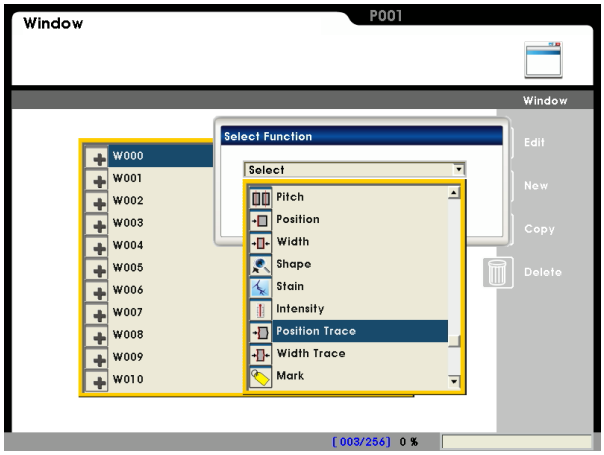
For the edge position detection function, the max and min Y coordinates are scanned from the image from bottom to top. The detection result is OK if Y coordinates fall within the range of the set limit. Otherwise, the detection result will be NG if the range of limit is exceeded, and the offset length is too large.

6.11.4 Set up [Position Trace] Detection Settings

■ From [Select Function], select [Position Trace].

Select [Edit] or [New].

Please set up the following items in sequence: [Source], [Preprocess], [ROI], [Parameter], [Limit], and [Execute].



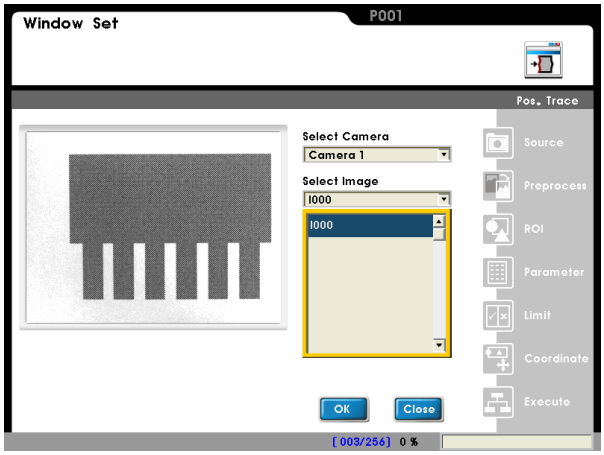
● Item 1: [Source]

Select camera:

Up to two cameras are supported simultaneously. Please select Camera 1 or Camera 2 for this detection.

Select image:

Select a pre-captured image as the reference sample for this detection.

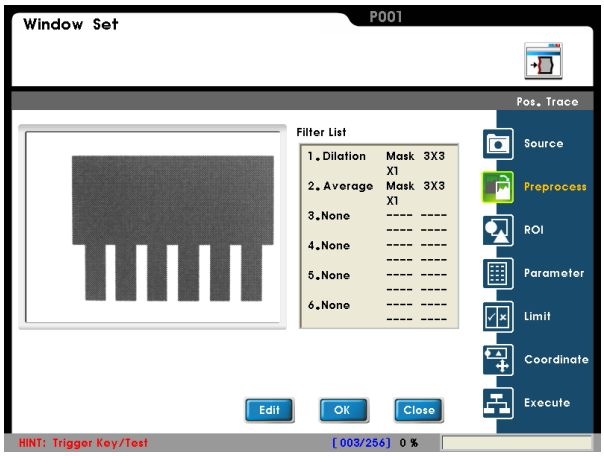


■ Item 2: [Preprocess]

A software filter is used to first enhance the image in order to better meet the requirements. Thus, an appropriate preprocess filter can improve accuracy and reliability of the inspection.

More than a dozen preprocess filters are provided, including binarization, dilation, erosion, etc.

Up to six preprocess filters (numbered 1~6) can be applied in order.



Reference For more information about preprocess, please refer to Chapter 10.

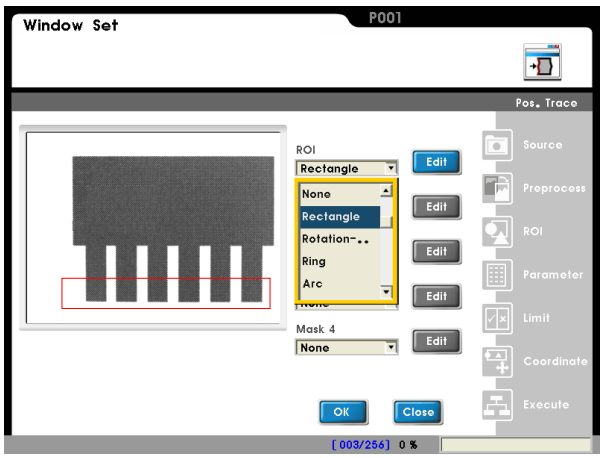
■ Item 3: [ROI]

ROI:

Set the ROI for edge detection.

Different measurement window shapes can be drawn, including rectangles, ellipses, polygons, and circles.

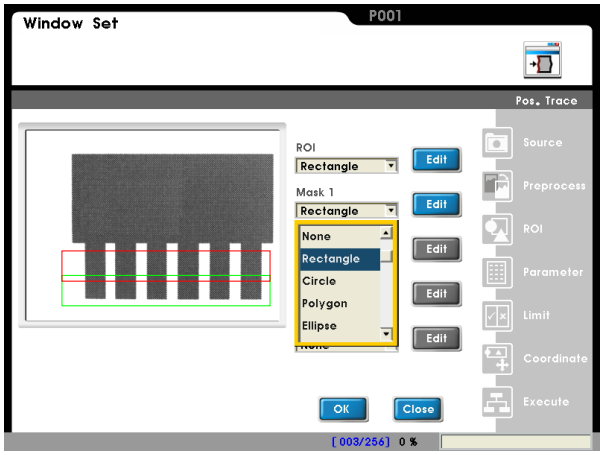
Reference Please refer to Chapter 3.2 [Draw ROI (Region Of Interesting)]



Mask 1~Mask 4:

The mask is the area to be excluded from measurement. A mask can be set within the [ROI] to exclude an area from detection.

In the example to the right, the red rectangle is a mask.



Up to four masks are supported for one [Window] program.

Different mask shapes can be drawn, such as rectangles, ellipses, polygons, and circles.

■ Item 4: [Parameter]

Edge filter:

Set the direction for detection search and edge filter parameters.

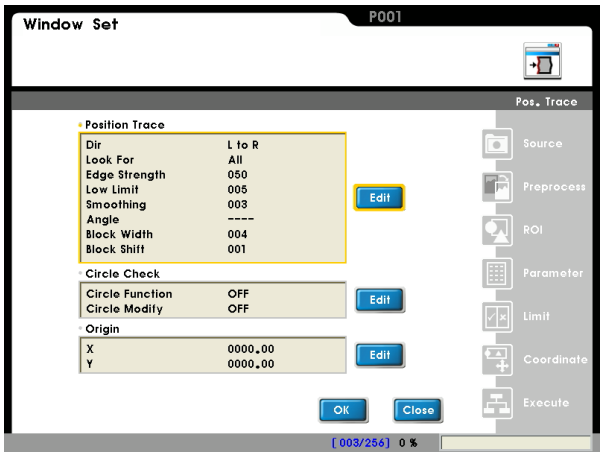
Observe the waveform to find the optimal parameter settings.

Circle Check:

"Circle Function" and "Circle Modify" can be used to enhance edge detection of circular target objects.

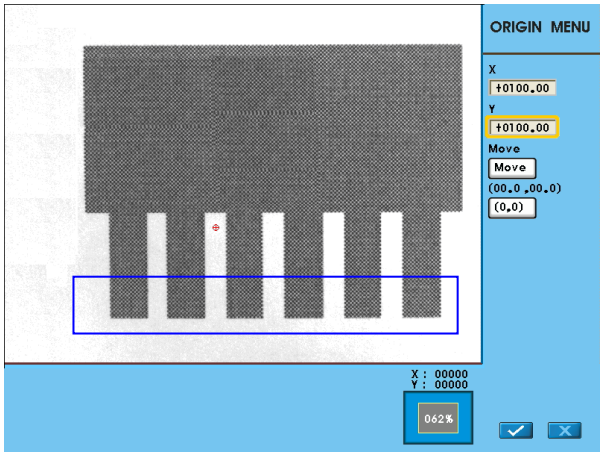
Origin:

Define the position of the origin.

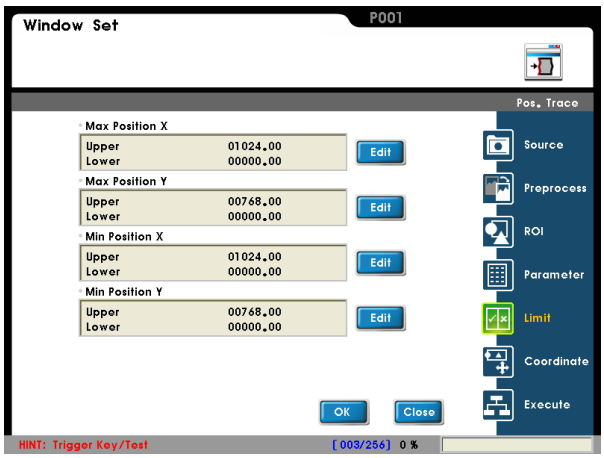


Set up origin:

Select [Edit] to open the Origin Menu.



■ Item 5: [Limit]



Set the range for OK/NG detection. The result is OK if within the limit and NG otherwise.

Factory defaults to maximum range and thus the result is 1 (OK).

This logic output result of OK=1 and NG=0 can be passed onto the subsequent [Judge] program.

Reference Please refer to Chapter 7 for a detailed description of [Judge]

■ Item 6: [Execute]

Execute or disable the [Window] function.

[Always Execute]: The current [Window] will always be executed while running.

[Never Execute]: The current [Window] will never be executed while running. This is useful during initial testing.

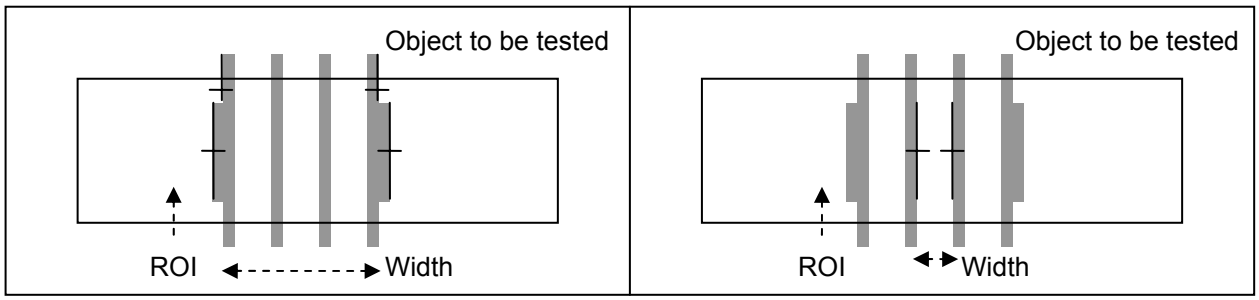
[Reference Execute]: Set the [Reference Window Item] and [Execute Condition] for flow control. Execution of [Window] is determined by the conditions above.

6.12 Width Trace:

6.12.1 What is [Width Trace]

Width Trace detects the distances between all edges (inner or outer). The results are the max and min distances. The result is OK if max and min widths satisfy the limit; otherwise the result is NG.

Outer edge measurement **Inner edge measurement**



6.12.2 Detection Result

Width Trace output report:

- **"Value" Output**
  - Width Trace Values Found: Range: 0~9999
  - Positions of first and second points:

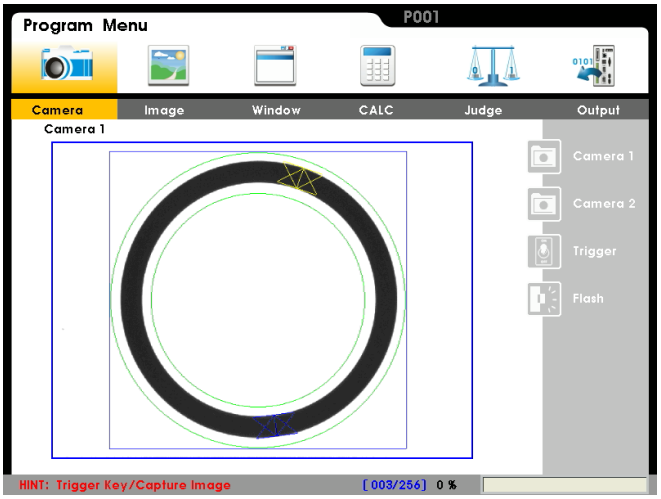
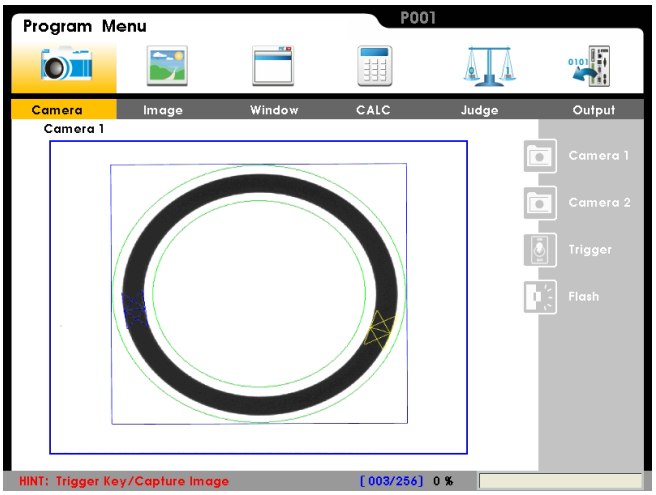
    For a 0.30 megapixel camera: X (horizontal) coordinates: 0~639
    Y (vertical) coordinates: 0~479

    For a 0.80 megapixel camera: X (horizontal) coordinates: 0~1023
    Y (vertical) coordinates: 0~767

- **"Logic output (OK/NG)"**
  - Width Trace: Used with the [Limit], the detection result is OK=1 if max/min widths satisfy the restriction; otherwise the result will be NG=0.

6.12.3 Example application of [Width Trace]

As shown below, the inner/outer width and roundness of the O-circle are measured.

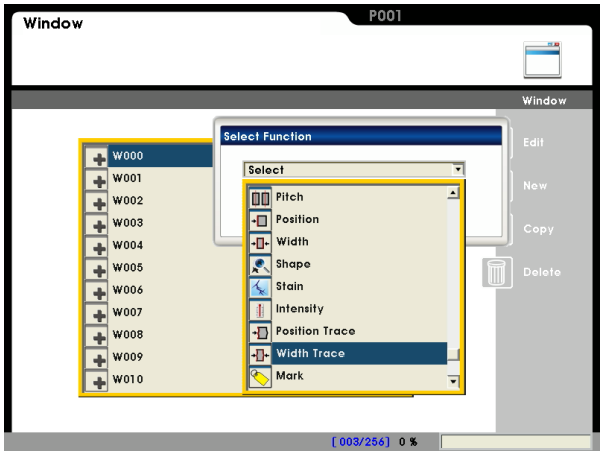
(correct width)	(incorrect width)
	

■ Detection method:

Width Trace measures the widths of the O-circle at different locations while simultaneously detecting the roundness. The result is OK if the widths and roundness satisfy the limit. Otherwise, the result is NG.

6.12.4 Set up [Width Trace] Detection Settings

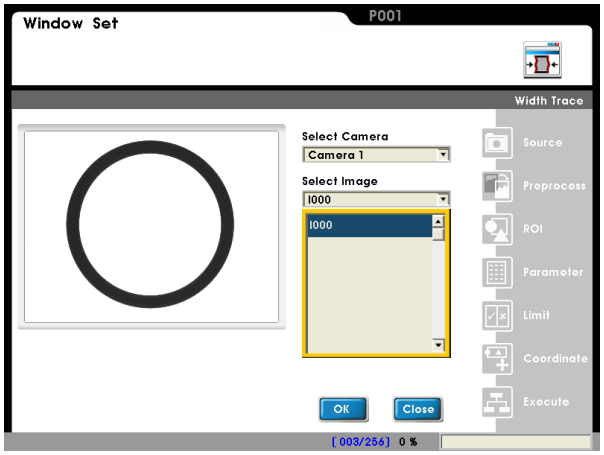
■ From [Select Function], select [Width Trace].



Select [Edit] or [New].

Please set up the following items in sequence: [Source], [Preprocess], [ROI], [Parameter], [Limit], and [Execute].

● Item 1: [Source]



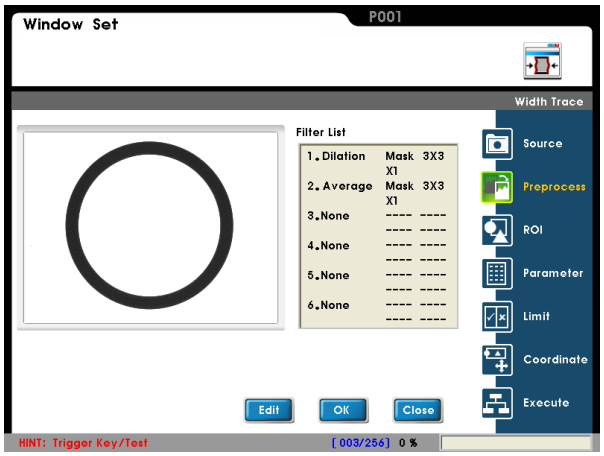
Select camera:

Up to two cameras are supported simultaneously. Please select Camera 1 or Camera 2 for this detection.

Select image:

Select a pre-captured image as the reference sample for this detection.

■ Item 2: [Preprocess]



A software filter is used to first enhance the image in order to better meet the requirements. Thus, an appropriate preprocess filter can improve accuracy and reliability of the inspection.

More than a dozen preprocess filters are provided, including binarization, dilation, erosion, etc.

Up to six preprocess filters (numbered 1~6) can be applied in order.

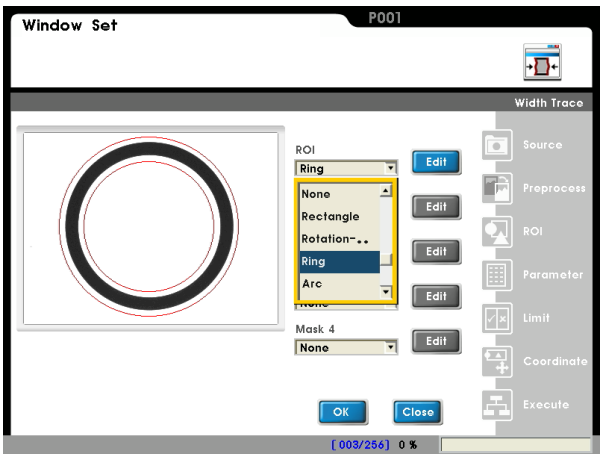
Reference For more information about preprocess, please refer to Chapter 10.

■ Item 3: [ROI]

ROI:

Set the ROI for edge detection.

Different measurement window shapes can be drawn, including rectangles, ellipses, polygons, and circles.

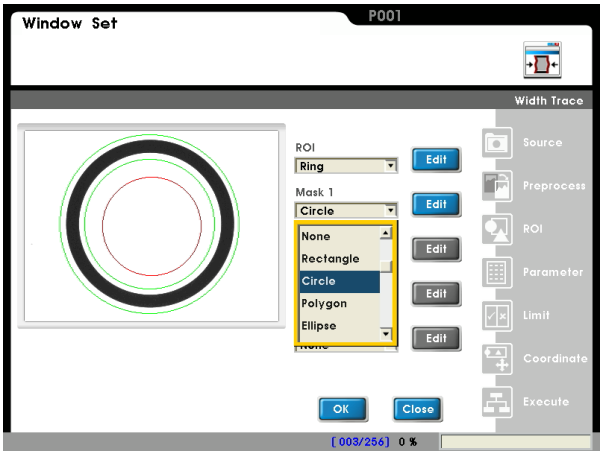


Reference Please refer to Chapter 3.2 [Draw ROI (Region Of Interesting)]

Mask 1~Mask 4:

The mask is the area to be excluded from measurement. A mask can be set within the [ROI] to exclude an area from detection.

In the example to the right, the red rectangle is a mask.



Up to four masks are supported for one [Window] program.

Different mask shapes can be drawn, such as rectangles, ellipses, polygons, and circles.

■ Item 4: [Parameter]

Edge filter:

Set the direction for detection search and edge filter parameters.

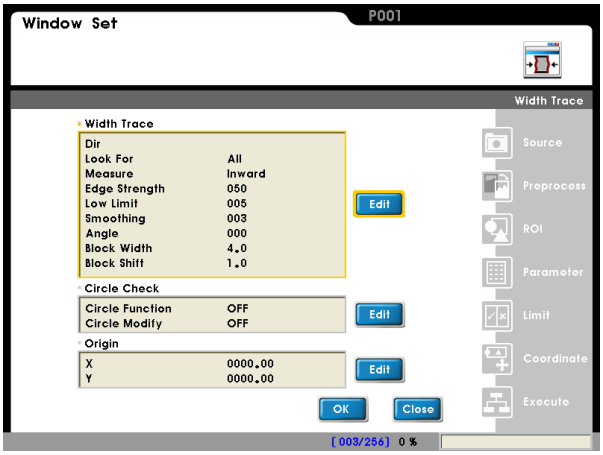
Observe the waveform to find the optimal parameter settings.

Circle Check:

"Circle Function" and "Circle Modify" can be used to enhance edge detection of circular target objects.

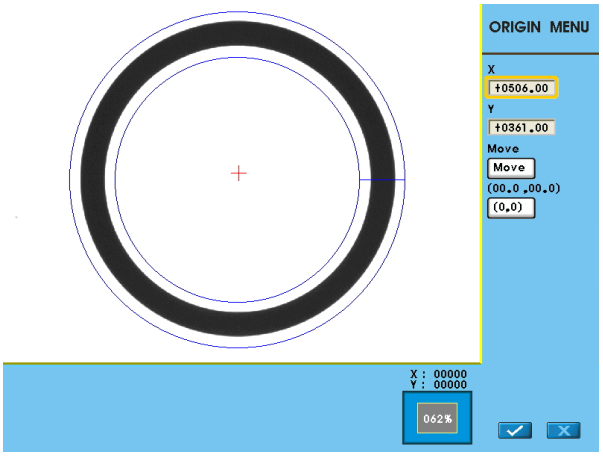
Origin:

Define the position of the origin.



Set up origin:

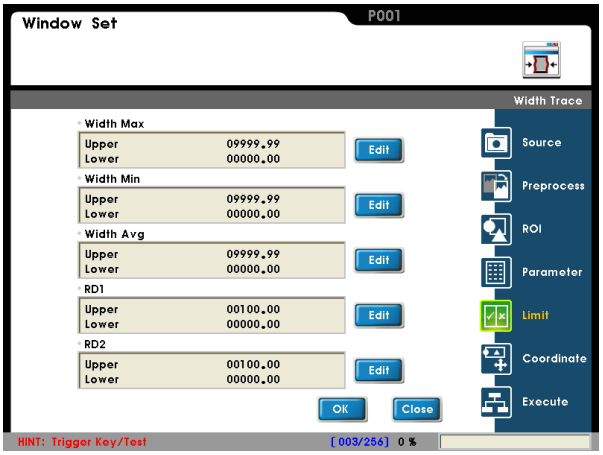
Select [Edit] to open the Origin Menu.



■ Item 5: [Limit]

Set the range for OK/NG detection. The result is OK if within the limit and NG otherwise.

Factory defaults to maximum range and thus the result is 1 (OK).



This logic output result of OK=1 and NG=0 can be passed onto the subsequent [Judge] program.

Reference Please refer to Chapter 7 for a detailed description of [Judge]

■ Item 6: [Execute]

Execute or disable the [Window] function.

[Always Execute]: The current [Window] will always be executed while running.

[Never Execute]: The current [Window] will never be executed while running. This is useful during initial testing.

[Reference Execute]: Set the [Reference Window Item] and [Execute Condition] for flow control. Execution of [Window] is determined by the conditions above.

6.13 Mark:

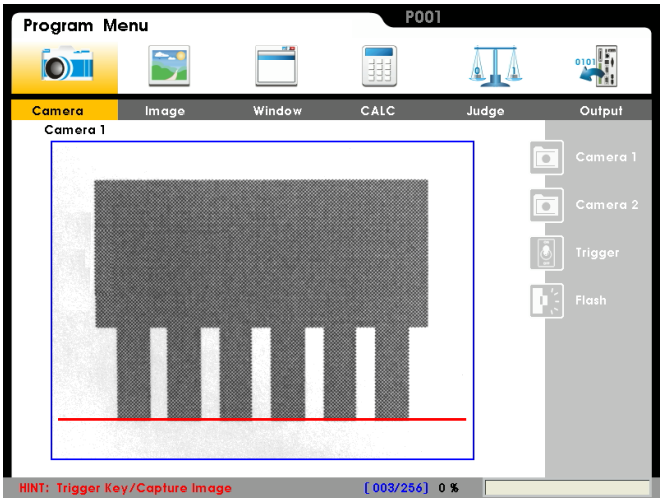
6.13.1 What is [Mark]

Mark overlays the line, pattern, or text information on the detection result screen. The position, size, and color of the mark can be freely selected. This helps make the detection results and differences more easily discernible.

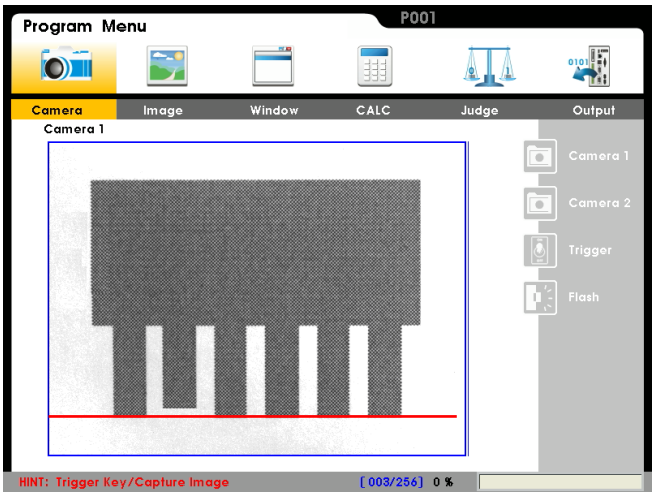
6.13.2 Example application of [Mark]

As shown below, the line across the pins can be used as reference to judge the lengths.

(correct length)



(incorrect length)



■ Application:

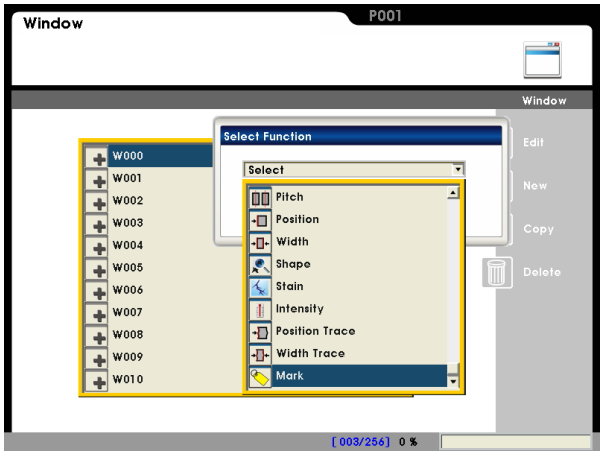
The red line mark is drawn over the test object. The user can easily observe defects not only from the numbers, but also from the display.

6.13.3 Example application of [Mark]

■ From [Select Function], select [Mark].

Select [Edit] or [New].

Please set up the following in sequence: [Source], [Graphic], [Text], and [Execute].



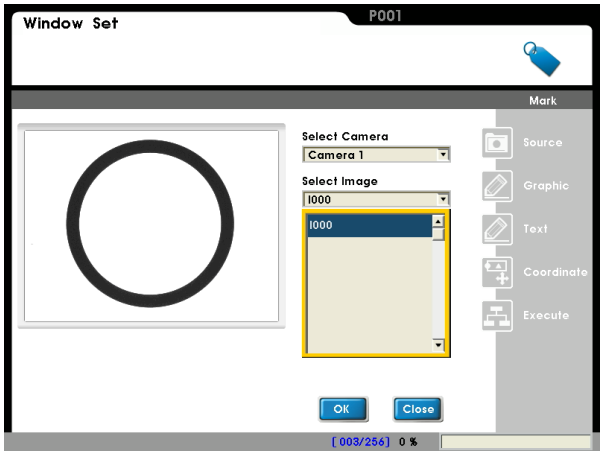
■ Item 1: [Source]

Select camera:

Up to two cameras are supported simultaneously. Please select Camera 1 or Camera 2 for this detection.

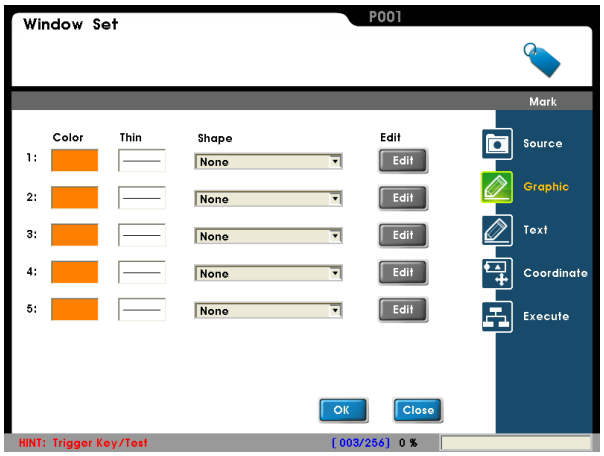
Select image:

Select a pre-captured image as the reference sample for this detection.



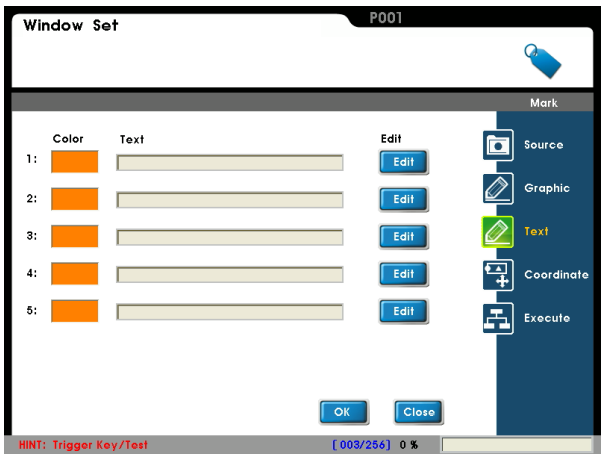
■ Item 2: [Graphic]

Up to five imaging objects can be specified on the detection result screen with custom shape, color, line thickness, and position.



■ Item 3: [Text]

Set the text (alphanumerical only) on the result screen with the custom color and position.



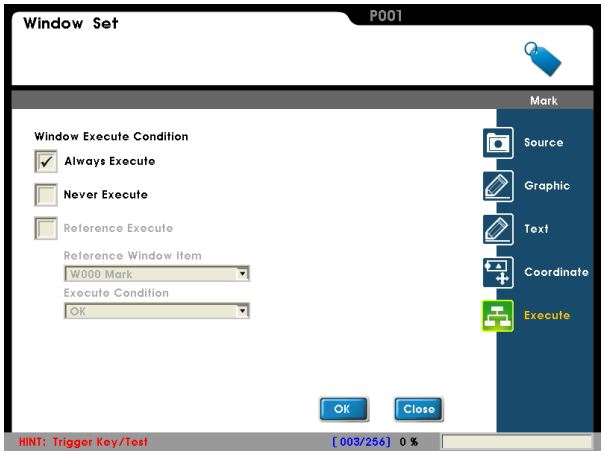
■ Item 4: [Execute]

Execute or disable the [Window] function.

[Always Execute]: The current [Window] will always be executed while running.

[Never Execute]: The current [Window] will never be executed while running. This is useful during initial testing.

[Reference Execute]: Set the [Reference Window Item] and [Execute Condition] for flow control. Execution of [Window] is determined by the conditions above.



Chapter 7 :

Calculator, Judge, and Output

Edit in sequence the [Calculator], [Judge], and [Output] programs under [Window]. Main functions:

- **Calculator:** Apply arithmetic and function calculation on the [Window] data, where this new data can be passed on to the subsequent [Output] program. In addition, the calculator output can be restricted to the upper/lower limits to output a logic flag and passed on to the subsequent [Judge] and [Output] programs.
- **Judge:** Perform Boolean logic on the [Window] and [Calculator] flags and pass on to the subsequent [Output] program.
- **Output:** Data from [Window] and [Calculator] or judgment logic from [Window], [Calculator], and [Judge] can be output to any specific hardware interface.

7.1 What is [Calculator]:

The calculator works with the [Window] results (e.g., quantity, coordinates, angle) through an arithmetic interface. 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. (e.g., sending result 5 to the PC via RS232)

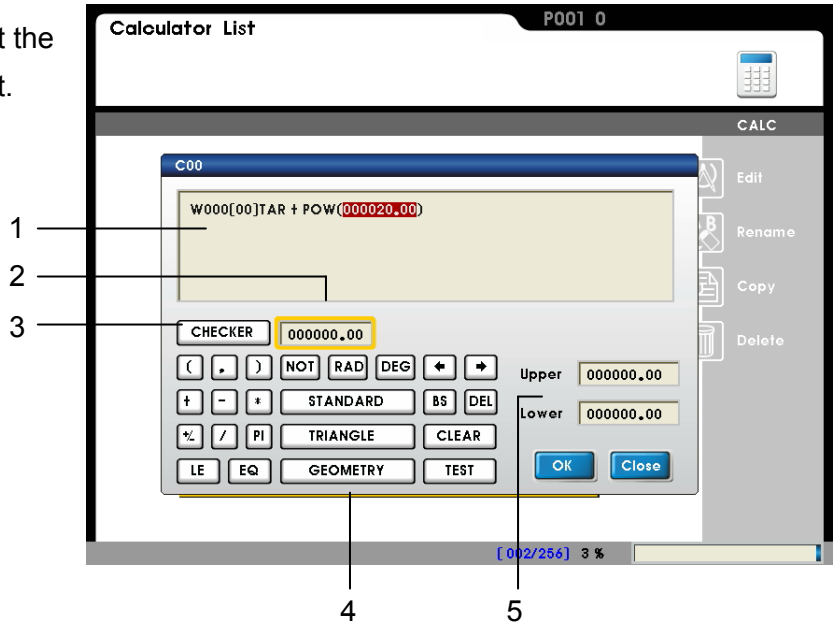
In addition to simple arithmetic, the calculator also provides trigonometry and functions for calculating the distance between coordinates.

Each individual project supports 32 calculators (C00~C31) and each calculator ID can be configured with the upper/lower limits for a logic flag. The results can be passed on to the subsequent [Judge] and [Output] programs. For example, if the standard value is 100 (with +/-1 tolerance) for a size measurement and calculation, 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.

7.2 Edit [Calculator]:

7.2.1 [Calculator] interface

■ Enter the [Program] menu and select the [Calculator] ID to open the editing list.



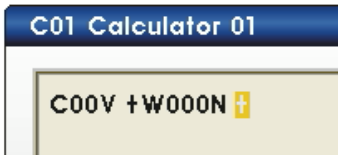
Item	Description
1	Equation display
2	Constant input
3	Select result from [Window], [Previous calc], or [Memory].
4	Built-in functions
5	Upper/lower limit

■ **(Item 1) Equation display:**

Based on the function, approximately 15 entries can be entered to the display area.

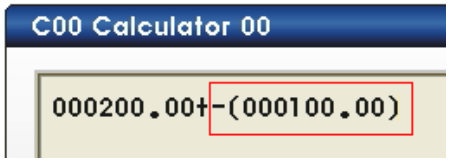
If the equation space is exceeded, please carry over the result to the subsequent calculator ID for more calculations.

As shown to the right, equation space is exceeded for C00 and thus the C00 result 100 is called by C01 for further extension.



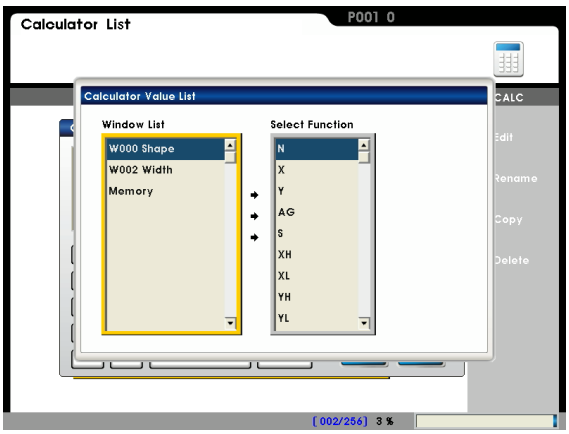
■ **(Item 2) Constant input:**

Use the up / down / left / right keys to adjust the 000000.00 field. Please select the +/- sign and then adjust the value for a negative number.



■ **(Item 3) Select [Window] calculator value List:**

Press the CHECKER button to select the available results from the existing [Window].



Reference Please refer to section 7.2.2 for the list of [Function] codes.

■ **(Item 4) Built-in functions:**

Basic operation unit:

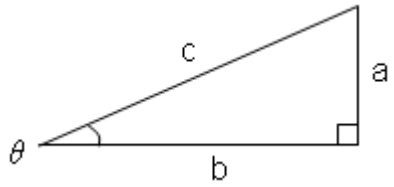
Control unit	Description
BS	Use Backspace to delete the previous field.
DEL	Use Delete to delete the current field.
CLEAR	Use Clear to delete all fields of the calculator.(with a confirmation popup window)
TEST	Get results to test current settings.

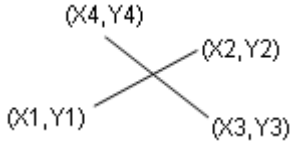
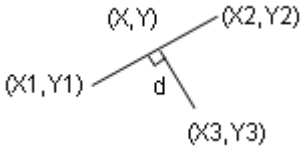
Function unit:

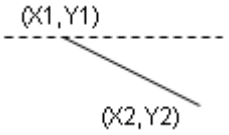
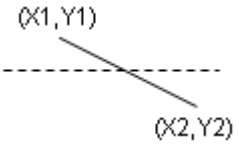
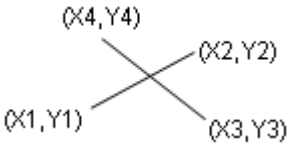
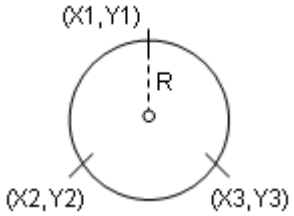
Three functions are supported: [STANDARD], [TRIANGLE], and [GEOMETRY].

[STANDARD] : MAX, BMIN, BAVG, BABS, BMOD, BPOW, BSQR, BSQRT, BINT, BROUND
[TRIANGLE] : SIN, BCOS, BTAN, BASIN, BACOS, BATAN
[GEOMETRY] : DIST, BISECT_X, BISECT_Y, BLINE_DIST, BLINE_DIST_X, BLINE_DIST_Y, BANGLE, BLINE_ANGLE, BD_LINE_ANGLE, BCIRCLE_X, BCIRCLE_Y, BCIRCLE_R

Function	Description	Example	Note:
NOT	Logic function	NOT(2) = 0, BNOT(0) = 1, BNOT(-2) = 0	Returns 1 if input is 0; otherwise 0 is returned;
RAD	Convert to radians	RAD(180) = 3.14	
DEG	Convert to degrees	DEG(3.14) = 179.90	
MAX	Max element	MAX (2,3,4) = 4	Up to 10 input elements
MIN	Min element	MIN (2,3,4) = 2	Up to 10 input elements
AVG	Average	AVG (2,3) = 2.5, B AVG (2,3,4) = 3	Up to 10 input elements
ABS	Absolute value	ABS (-10) = 10	
MOD	Take remainder	MOD (5,2) = 1, B MOD (8,3) = 2	8 / 3 = 2 with remainder 2
POW	Power of N	POW (2,3) = 8, B POW (3,4) = 81	3 * 3 * 3 * 3 = 81
SQR	Root of N	SQR (2) = 4, B SQR (-2) = 4	
SQRT	Square root	SQRT (9) = 3	
INT	Take integer	INT(123.45) = 123	
ROUND	Round up/down first decimal	ROUND(1234.5) = 1235	
PI	π	3.14159	

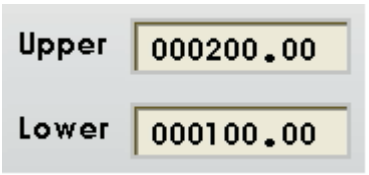
LE	Compare two elements (output 1 if first element is greater than the second)	LE (8,2) = 1 LE (2,8) = 0, BLE (2,2) = 0	8 > 2 2 ≦ 8, 2 ≦ 2 output 0
EQ	Compare two elements (output 1 if equal)	EQ (2,2) =1 EQ (8,2) = 0	Two elements are not equal, output 0
SIN	Sine	SIN (30) = 0.5	SIN(θ)= a / c COS(θ)= b / c TAN(θ)= a / b ASIN(a/c)= θ ACOS(b/c)= θ ATAN(a/c)= θ 
COS	Cosine	COS (30) = 0.866	
TAN	Tangent	TAN (30) = 0.577	
ASIN	Arcsine	ASIN (1) = 90	
ACOS	Arccosine	ACOS (1) = 0	
ATAN	Arctangent	ATAN (1) = 45	

Function	Description	Example	Note:
DIST	Distance between two points	DIST (X1,Y1,X2,Y2) DIST (20,20,30,20) = 10 DIST (20,20,30,30) = 14.14	
ISECT_X	X coordinates of intersection between two lines	ISECT (X1,Y1,X2,Y2,X3,Y3… ISECT_X (0,0,4,4,0,4,4,0) = 2	
ISECT_Y	Y coordinates of intersection between two lines	ISECT (X1,Y1,X2,Y2,X3,Y3… ISECT_Y (0,0,4,4,0,4,4,0) = 2	
LINE_DIST	Min distance (d) to a line	LINE_DIST (X1,Y1,X2,Y2,X3,Y3) LINE_DIST (0,0,4,4,0,4) = 2	
LINE_DIST_X	X coordinates on the line with min distance to a point	LINE_DIST (X1,Y1,X2,Y2,X3,Y3) LINE_DIST_X (0,0,4,4,0,4) = 2	
LINE_DIST_Y	Y coordinates on the line with min distance to a point	LINE_DIST (X1,Y1,X2,Y2,X3,Y3) LINE_DIST_Y (0,0,4,4,0,4) = 2	

ANGLE	Incident angle (at point X1, Y1) of line to horizontal axis in the clockwise direction (range +/-180°)	ANGLE (X1,Y1,X2,Y2) ANGLE (0,0,5,5) = 45 ANGLE (5,5,0,0) = -135	
LINE_ANGLE	Incident angle of line to horizontal axis in the clockwise direction (range +/-90°)	LINE_ANGLE (X1,Y1,X2,Y2) LINE_ANGLE (5,5,0,0) = 45	
D_LINE_ANGLE	Acute angle of two intersecting lines	D_LINE_ANGEL (X1,Y1,X2,Y2… D_LINE_ANGLE (0,0,4,4,0,4,4,0) = 90	
CIRCLE_X	X coordinates of circle formed by three points	CIRCLE_X (X1,Y1,X2,Y2,X3,Y3) CIRCLE_X (-14.6,8.94,-11.64,4.15,-15.61,3.47) = -14	
CIRCLE_Y	Y coordinates of circle formed by three points	CIRCLE_Y (X1,Y1,Y2,Y2,X3,Y3) CIRCLE_Y (-14.6,8.94,-11.64,4.15,-15.61,3.47) = 6	
CIRCLE_R	Radius (R) of circle formed by three points	CIRCLE_R (X1,Y1,X2,Y2,X3,Y3) CIRCLE_R (-14.6,8.94,-11.64,4.15,-15.61,3.47) = 3	

Remark A comma separates the elements. For example: AVG (2,3,4)

■ **(Item 5) Upper/lower limit:**



The calculator results can be restricted by the upper/lower limit with OK/NG logic flag. This flag can be passed on to the subsequent [Judge] and [Output] programs.

As shown in the example to the right, the upper/lower limits are 200 and 100, respectively. The logic flag is OK if calculator result falls within this range; otherwise, the logic flag is NG.

7.2.2 [Calculator] function list:

Data format (Position - X coordinates) using W□□□[△△]X as example.

W□□□: n-th inspection windowFor example: W005 is the 5th window.

[△△]: n-th result as output. For example, if three positions are detected for W005, [△△] = 2 indicates that the second edge result is the output (calculation).

X: X coordinates. Please refer to the following code table.

Function	Syntax	Description	Measure	Calculator data format
Area	TAR	Total area	--	W□□□TAR
Position	N	Quantity	--	W□□□N
	X	X coordinates	[△△]	W□□□[△△]X
	Y	Y coordinates	[△△]	W□□□[△△]Y
	AG	Absolute Angle (horizontal at 0˚) of circle and arc	[△△]	W□□□[△△]AG
	RA	Relative Angle (to initial angle) of circle and arc	[△△]	W□□□[△△]RA
Count	N	Number of edges	--	W□□□N
Width	L	Width (unit: pixels or degrees)	--	W□□□L
	X1	X coordinates of first edge	--	W□□□X1
	Y1	Y coordinates of first edge	--	W□□□Y1
	AG1	Absolute Angle 1 of circle and arc	--	W□□□AG1
	RA1	Relative Angle 1 of circle and arc	--	W□□□RA1
	X2	X coordinates of second edge	--	W□□□X2
	Y2	Y coordinates of second edge	--	W□□□Y2
	AG2	Absolute Angle 2 of circle and arc	--	W□□□AG2
	RA2	Relative Angle 2 of circle and arc	--	W□□□RA2
Pitch	N	Quantity	--	W□□□N
	W	Pitch distance (unit: pixels or degrees)	[△△]	W□□□[△△]W
	WH	Max pitch (unit: pixels or degrees)	--	W□□□WH
	WL	Min pitch (unit: pixels or degrees)	--	W□□□WL
	WA	Average pitch (unit: pixels or degrees)	--	W□□□WA
	XS	X coordinates of first edge	[△△]	W□□□[△△]XS
	YS	Y coordinates of first edge	[△△]	W□□□[△△]YS
	AGS	Absolute Angle 1 of circle and arc	[△△]	W□□□[△△]AGS
	RAS	Relative Angle 1 of circle and arc	[△△]	W□□□[△△]RAS
	XE	X coordinates of second edge	[△△]	W□□□[△△]XE
	YE	Y coordinates of second edge	[△△]	W□□□[△△]YE

	AGE	Absolute Angle 2 of circle and arc	[△△]	W□□□[△△]AGE
	RAE	Relative Angle 2 of circle and arc	[△△]	W□□□[△△]RAE
	X	X coordinates of pitch center	[△△]	W□□□[△△]X
	Y	Y coordinates of pitch center	[△△]	W□□□[△△]Y
	AG	Absolute angle of edge center of circle and arc	[△△]	W□□□[△△]AG
Angle	EAG	Angle (horizontal at 0˚)	--	W□□□EAG
	X1	X coordinates of top Angle	--	W□□□X1
	Y1	Y coordinates of top Angle	--	W□□□Y1
	X2	X coordinates of bottom Angle	--	W□□□X2
	Y2	Y coordinates of bottom Angle	--	W□□□Y2
Intensity	IA	Average brightness	--	W□□□IA
	ID	Standard brightness deviation	--	W□□□ID
	IH	Max brightness	--	W□□□IH
	IL	Min brightness	--	W□□□IL
Shape	N	Quantity	--	W□□□N
	S	Similarity	[△△]	W□□□S
	X	X coordinates of found object	[△△]	W□□□X
	Y	Y coordinates of found object	[△△]	W□□□Y
	XH	Max X coordinates from all objects	--	W□□□XH
	XL	Min X coordinates from all objects	--	W□□□XL
	YH	Max Y coordinates from all objects	--	W□□□YH
	YL	Min Y coordinates from all objects	--	W□□□YL
	AG	Object angle found	[△△]	W□□□AG
Spot	N	Quantity	--	W□□□N
	X	Center X coordinates	[△△]	W□□□[△△]X
	Y	Center Y coordinates	[△△]	W□□□[△△]Y
	XH	Max X coordinates of all spot centers	--	W□□□XH
	XL	Min X coordinates of all spot centers	--	W□□□XL
	YH	Max Y coordinates of all spot centers	--	W□□□YH
	YL	Min Y coordinates of all spot centers	--	W□□□YL
	AR	Spot area	[△△]	W□□□[△△]AR
	ARH	Max area	--	W□□□ARH
	ARL	Min area	--	W□□□ARL
	RD	Roundness	[△△]	W□□□[△△]RD
	RDH	Max roundness	--	W□□□RDH
	RDL	Min roundness	--	W□□□RDL
	AG	Incident clockwise angle of main axis to horizontal axis	[△△]	W□□□[△△]AG

	AGH	Max incident clockwise angle of all main axis to horizontal axis	--	W□□□AGH
	AGL	Min incident clockwise angle of all main axis to horizontal axis	--	W□□□AGL
	PE	Circumference	[△△]	W□□□[△△]PE
	PEH	Max circumference	--	W□□□PEH
	PEL	Min circumference	--	W□□□PEL
	EX	Extension length in X (horizontal) direction	[△△]	W□□□[△△]EX
	EY	Extension length in Y (vertical) direction	[△△]	W□□□[△△]EY
	EXH	Max extension length in X (horizontal) direction	--	W□□□EXH
	EXL	Min extension length in X (horizontal) direction	--	W□□□EXL
	EYH	Max extension length in Y (horizontal) direction	--	W□□□EYH
	EYL	Min extension length in Y (horizontal) direction	--	W□□□EYL
	TLX	Top left X coordinates of extension rectangle	[△△]	W□□□[△△]TLX
	TLY	Top left Y coordinates of extension rectangle	[△△]	W□□□[△△]TLY
	MA	Main axis length	[△△]	W□□□[△△]MA
	MAH	Max length from all main axis	--	W□□□MAH
	MAL	Min length from all main axis	--	W□□□MAL
Stain (defect)	TAR	Total defective area	--	W□□□TAR
	N	Cluster	--	W□□□N
	AR	Defective area	[△△]	W□□□[△△]AR
	ARH	Max defective area	--	W□□□ARH
	ARL	Min defective area	--	W□□□ARL
	X	Center X coordinates of all defects	[△△]	W□□□[△△]X
	Y	Center Y coordinates of all defects	[△△]	W□□□[△△]Y
	XH	Max X coordinates from all defect centers	--	W□□□XH
	XL	Min X coordinates from all defect centers	--	W□□□XL
	YH	Max Y coordinates from all defect centers	--	W□□□YH
	YL	Min Y coordinates from all defect centers	--	W□□□YL
Position Trace	N	Total	--	W□□□N
	X	X coordinates of all edges	[△△]	W□□□[△△]X
	Y	Y coordinates of all edges	[△△]	W□□□[△△]Y
	XH	X coordinates of max outline	--	W□□□XH
	XL	X coordinates of min outline	--	W□□□XL
	YH	Y coordinates of max outline	--	W□□□YH
	YL	Y coordinates of min outline	--	W□□□YL
	XA	Average X coordinates of all outlines	--	W□□□XA
	YA	Average Y coordinates of all outlines	--	W□□□YA
	D	Distances of all outlines	[△△]	W□□□[△△]D

	DH	Max distance from all outlines	--	W□□□DH
	DL	Min distance from all outlines	--	W□□□DL
	DA	Average distance from all outlines	--	W□□□DA
	RD	Roundness	--	W□□□RD
	CX	Centre X coordinates of circle	--	W□□□CX
	CY	Centre Y coordinates of circle	--	W□□□CY
	CRU	circle radius	--	W□□□CRU
Width tracking	N	Total	--	W□□□N
	WH	Max Width	--	W□□□WH
	WL	Min Width	--	W□□□WL
	WA	Average Width	--	W□□□WA
	W	All Widths	[△△]	W□□□[△△]W
	HX1	X1 coordinates of max width	--	W□□□HX1
	HY1	Y1 coordinates of max width	--	W□□□HY1
	HX2	X2 coordinates of max width	--	W□□□HX2
	HY2	Y2 coordinates of max width	--	W□□□HY2
	LX1	X1 coordinates of min width	--	W□□□LX1
	LY1	Y1 coordinates of min width	--	W□□□LY1
	LX2	X2 coordinates of min width	--	W□□□LX2
	LY2	Y2 coordinates of min width	--	W□□□LY2
	XS	X1 coordinates of width across all edges	[△△]	W□□□[△△]XS
	YS	Y1 coordinates of width across all edges	[△△]	W□□□[△△]YS
	XE	X2 coordinates of width across all edges	[△△]	W□□□[△△]XE
	YE	Y2 coordinates of width across all edges	[△△]	W□□□[△△]YE
	RD1	Roundness 1 (inner)	--	W□□□RD1
	CX1	X coordinates of circle 1 center	--	W□□□CX1
	CY1	Y coordinates of circle 1 center	--	W□□□CY1
	CR1	circle 1 radius	--	W□□□CR1
	RD2	Roundness 2 (outer)	--	W□□□RD2
	CX2	Centre X coordinates of circle 2	--	W□□□CX2
	CY2	Centre Y coordinates of circle 2	--	W□□□CY2
	CR2	circle 2 radius	--	W□□□CR2

7.3 What is [Judge]:

The final output is generally determined by multiple inspection results, where the judgment logic OK(1)/NG(0) is processed to generate a composite result.

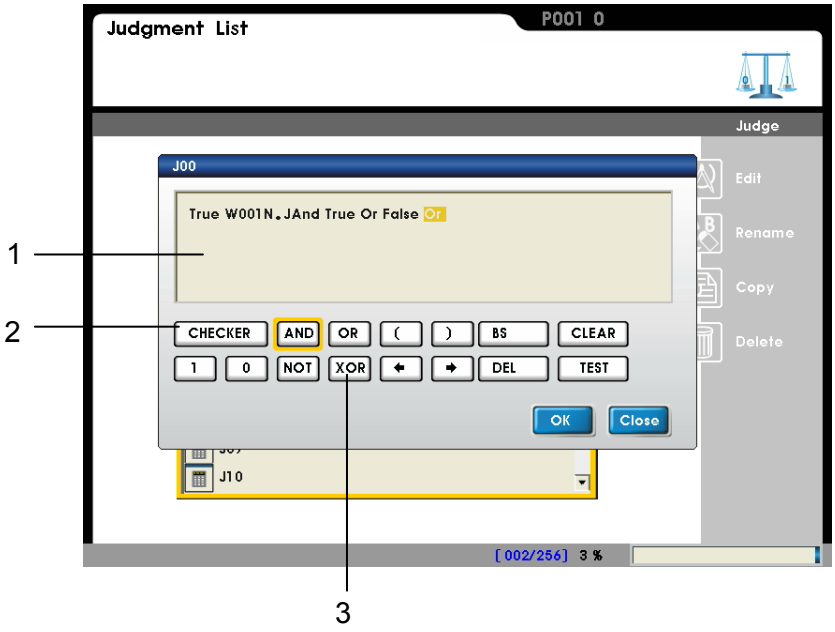
For example, using the AND command on three OK flags to generate the OK result indicates that all three inspection items must be OK. Similarly, using the OR command to three OK flags to generate the OK result indicates that at least one inspection item must be OK.

Each individual project supports 32 judgments (J00~J31) and each judgment ID can be passed on to the subsequent [Output] program.

7.4 Edit [Judge]:

7.4.1 [Judge] interface

■ From [Program], select the [Judge] editing menu.



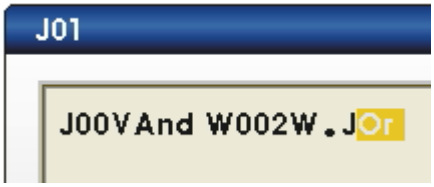
Item	Description
1	Judgment display
2	Select [View] judgment value list
3	Built-in functions

■ **(Item 1) Judgment display:**

Based on the function, approximately 15 entries can be entered to the display area.

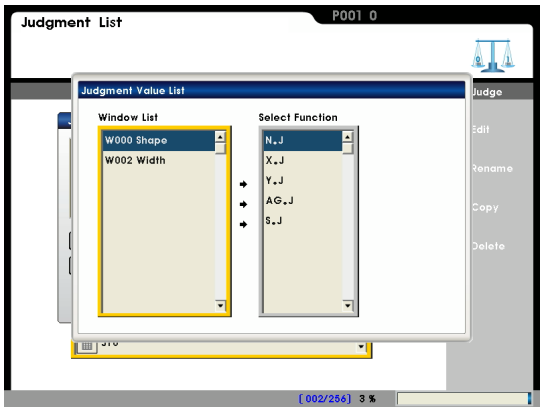
If the judgment space is exceeded, please carry over the result to the subsequent judgment ID for more calculations.

As shown to the right, judgment space is exceeded for J00 and thus the J00 logic flag OK(1)/NG(0) is called by J01 for further extension.



■ **(Item 2) Select [View] judgment value list:**

Press the CHECKER button to select the available results from the existing [Window].



Reference Please refer to section 7.4.2 for the list of [Function] codes.

■ **(Item 3) Built-in functions:**

Basic operation unit:

Control unit	Description
BS	Use Backspace to delete the previous field.
DEL	Use Delete to delete the current field.
CLEAR	Use Clear to delete all fields of the calculator. (with a confirmation popup window)
TEST	Get results to test current settings.

Function unit:

Function	Description	Example	Note:
0	Logical False (NG)		
1	Logical True (OK)		
AND	AND gate	False And True = 0	Output 1 if all inputs are 1.
OR	OR gate	False Or True = 1	Output 1 if any input is 1.
NOT	INV gate	Not (False) = 1	Output 1 if input is 0; output 0 if input is 1.
XOR	XOR gate	False Xor False = 0 True Xor True =0 False Xor Ture =1 True Xor False =1	Output 0 if inputs match; output 1 if inputs differ.

7.4.2 [Judge] Window Functions

Data format (Position - X coordinates) using W□□□X.J as example.

W□□□: n-th inspection window. For example: W005 is the 5th window.

X.J: X coordinates of the judgment result. Please refer to the following code table.

Remark .J is the logic result filtered from the [Limit] parameter.

Function	Syntax	Description	Judge Data format
Area	TAR.J	Total area	W□□□TAR.J
Position	X.J	X coordinates	W□□□X.J
	Y.J	Y coordinates	W□□□Y.J
	AG.J	Absolute Angle (horizontal at 0˚) of circle and arc	W□□□AG.J
Count	N.J	Number of edges	W□□□N.J
Width	W.J	Width (unit: pixels or degrees)	W□□□W.J
	X.J	X coordinates of first edge	W□□□X.J
	Y.J	Y coordinates of first edge	W□□□Y.J
	AG.J	Absolute Angle 1 of circle and arc	W□□□AG.J
Pitch	N.J	Quantity	W□□□N.J
	W.J	Pitch distance (unit: pixels or degrees)	W□□□W.J
	WH.J	Max pitch (unit: pixels or degrees)	W□□□WH.J
	WL.J	Min pitch (unit: pixels or degrees)	W□□□WL.J
	WA.J	Average pitch (unit: pixels or degrees)	W□□□WA.J
Angle	AG.J	Angle (horizontal at 0˚)	W□□□AG.J
Intensity	IA.J	Average brightness	W□□□IA.J
	ID.J	Standard brightness deviation	W□□□ID.J
	IH.J	Max brightness	W□□□IH.J
	IL.J	Min brightness	W□□□IL.J
Shape	N.J	Quantity	W□□□N.J
	X.J	X coordinates of found object	W□□□X.J
	Y.J	Y coordinates of found object	W□□□Y.J
	AG.J	Object angle found	W□□□AG.J
	S.J	Similarity	W□□□S.J
Spot	N.J	Quantity	W□□□N.J
	X.J	Center X coordinates	W□□□X.J
	Y.J	Center Y coordinates	W□□□Y.J
	AR.J	Spot area	W□□□AR.J
	PE.J	Circumference	W□□□PE.J

Stain (defect)	N.J	Cluster	W□□□N.J
	TAR.J	Total defective area	W□□□TAR.J
	AR.J	Defective area	W□□□AR.J
	X.J	Center X coordinates of all defects	W□□□X.J
	Y.J	Center Y coordinates of all defects	W□□□Y.J
Position Trace	XH.J	X coordinates of max outline	W□□□XH.J
	YH.J	Y coordinates of max outline	W□□□YH.J
	XL.J	X coordinates of min outline	W□□□XL.J
	YL.J	Y coordinates of min outline	W□□□YL.J
	RD.J	Roundness	W□□□RD.J
Width tracking	WH.J	Max Width	W□□□WH.J
	WL.J	Min Width	W□□□WL.J
	WA.J	Average Width	W□□□WA.J
	RD1.J	Roundness 1 (inner)	W□□□RD1.J
	RD2.J	Roundness 2 (outer)	W□□□RD2.J

7.5 What is [Output]:

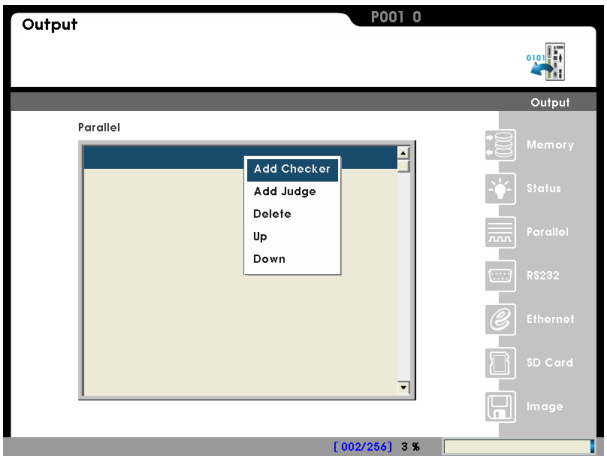
Each inspection result (value and logic from window, calculator, and judgment) can be output to the PC or PLC. The controller supports the following hardware interfaces: [Parallel], [RS232], [Ethernet], [USB], and [SD card]. The user can customize the hardware combination to requirements.
The output 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.

7.6 Edit [Output]:

7.6.1 Setup [Output]

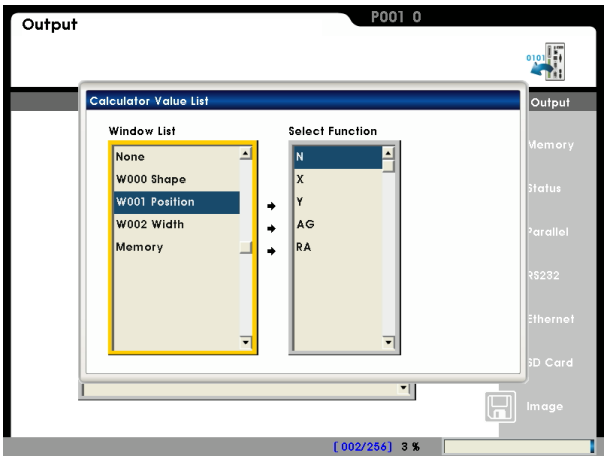
The output interfaces [Parallel], [RS232], [Ethernet], and [SD card] are identically configured as below.

■ Select an output interface as shown to the right.



✧ **Add Checker:** Select item to output.
✧ **Add Judge:** Select judgment (OK/NG) to output.
✧ **Delete:** Delete existing parameter or judgment output.
✧ **Up/Down:** As the output string begins from the first entry, the output sequence can be altered.

■ [Add Checker]:

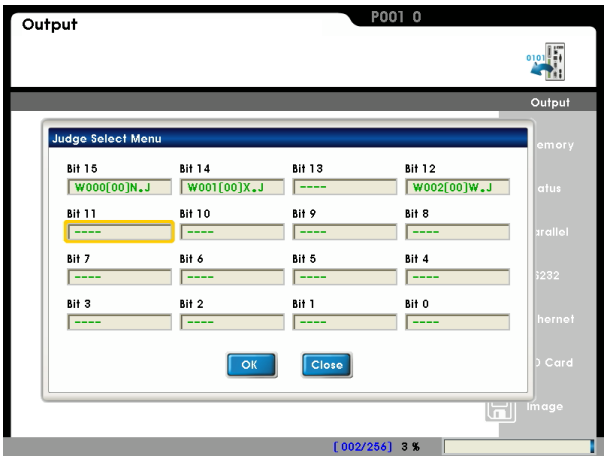


All configured items are shown on the screen after the parameters are added. Please select the output item from the list.
For example: As shown to the right, W001 position > N outputs the number of positions detected by W001.

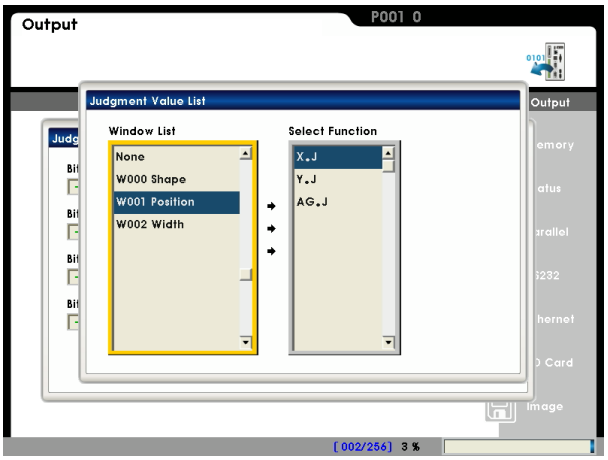
Reference Please refer to section 7.2.2 for the list of [Function] codes.

■ [Add Judge]:

A 16-bit register can store up to 16 OK/NG judgments. The bits can be added out-of-order, as shown to the right, with 3 bits of [bit 15], [bit 14], and [bit 12].



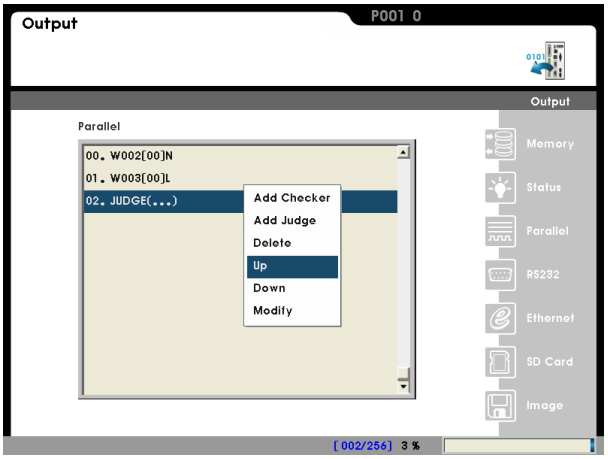
All configured bits are shown on the screen after setup. Please select the output judgment from the list.
For example: As shown to the right, W001 position > X.J outputs the judgment result at X coordinates detected by W001.



Reference Please refer to section 7.4.2 for the list of [Function] codes.

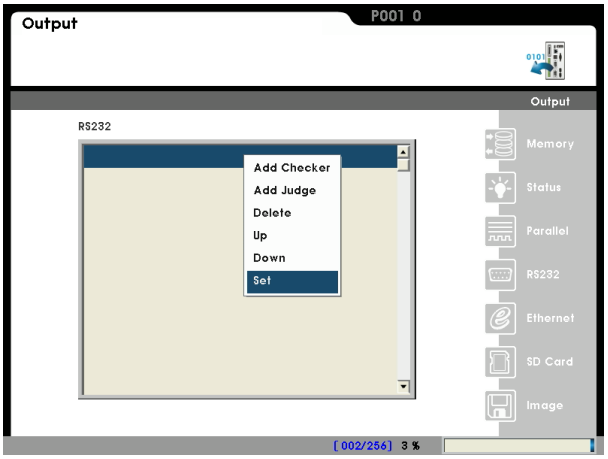
■ [Up/Down]:

As data output begins from the first entry, the output sequence can be altered using the [Up/Down] keys.
As shown to the right, W002N (qty), W003L (width), and JUDGE(…) are output in sequence.
JUDGE(…) can also be modified with the [Modify] option.

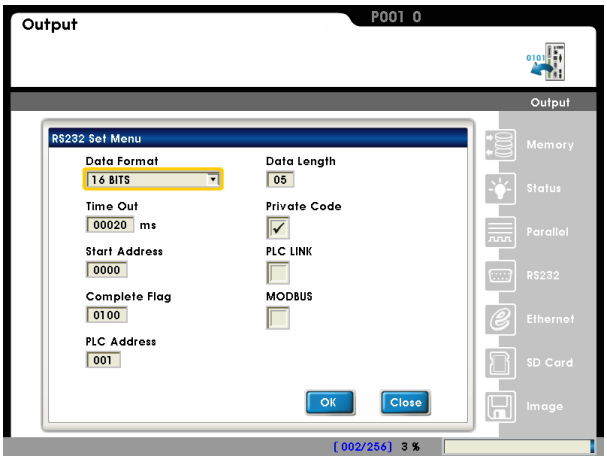


■ [Setup]:

RS232 output interface can be configured with the [Setup] option to use RS232, MODBUS, and PLC LINK modes.

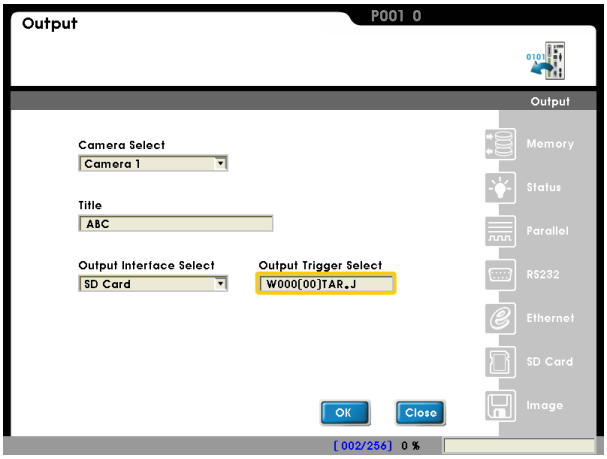


Reference Please refer to sections 9.2 and 9.3



7.6.2 Setup [Image output]

The inspection image can be saved if a program (or comprehensive output) results in NG for further analysis.



■ **Select camera:**

Save image from [Camera 1], [Camera 2], or [All cameras] in the event of NG.

■ **Title:**

Saved filename. For example: The filename format is saved as [Title] = ABC

“ABC20110801_121036_000000001_NG_1.BMP”

✧ 20110801: Date

✧ 121036: Time

✧ 000000001: Sequence number

✧ NG: Save when NG

✧ 1: Camera 1 image

■ **Output Interface Select:**

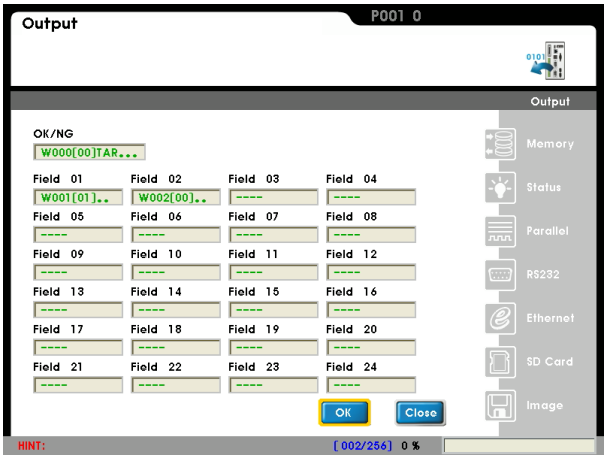
Image can be output from either [Ethernet], [USB], and [SD card].

■ **Output Trigger Select:**

Select source trigger for saving image. For example: W000TAR.J indicates if W000 (area) results in NG, the image is saved.

7.6.3 Setup [Status]:

The status indicators can be custom defined on the execution screen to monitor the OK/NG results. The status indicator includes [OK/NG] and [Field 01~24] types.



■ **OK/NG:**

OK/NG icon is displayed on the top right corner of the execution screen. As shown to the right, W000TAR.J indicates the [Area] result is displayed on the execution screen.

■ **Field 01~24:**

The custom OK/NG icon is displayed on the bottom of the execution screen. As shown to the right, 24 custom definitions are provided.

Remark

After setup, TOUT terminal outputs the ON/OFF state of [OK/NG].
Please use the left / right keys to access [Field 01~24] on the execution screen.

Chapter 8 :

I/O Timing

I/O interface is the main communication channel to the controller with the following functions.

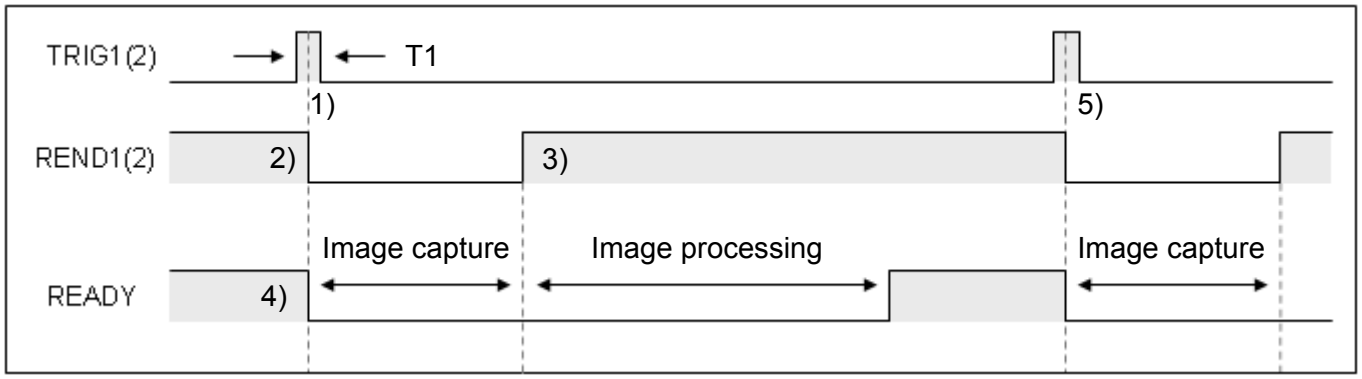
- **Current system state indicator**
  For example: Ready, Error, etc...
- **Camera imaging trigger capture**
  This trigger action can also be issued through the RS232 or Ethernet ports, however the I/O channel is more responsive than the communication channels.
- **Flash output**
  The system parameters control the flash output with the camera shutter action.(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 results OK (1) / NG (0) can be submitted 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.

8.1 I/O Timing:

8.1.1 TRIG (Trigger capture):

■ One Camera coupled with one TRIG signal:

Select either Camera1 or Camera2. (Camera1 is limited to TRIG1, Camera2 is limited to TRIG2)



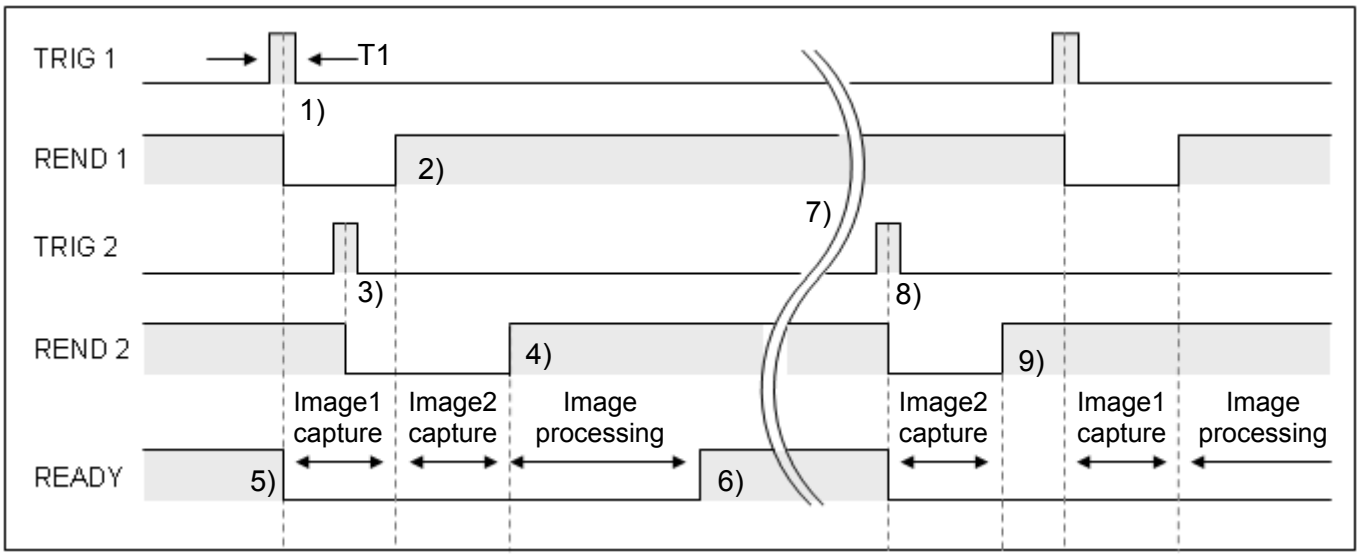
Description:

1) Trigger period T1 must be longer than 1ms.(if T1 is too short, the trigger may be ignored)
2) REND is OFF after triggered.
3) When the image is captured (exposure + transfer), REND signal is ON.
4) READY is OFF after triggered. READY is ON after inspection is complete (capture + processing).
5) Steps 1~4 completes an inspection cycle and the system is ready for the next trigger signal.

TRIG timing depends on the READY signal.
Total period = image capture time + process time

■ Two Cameras coupled with two TRIG signals:

Camera1 works with TRIG1, Camera2 works with TRIG2; TRIG1 and TRIG2 can be triggered in either order.



Description:

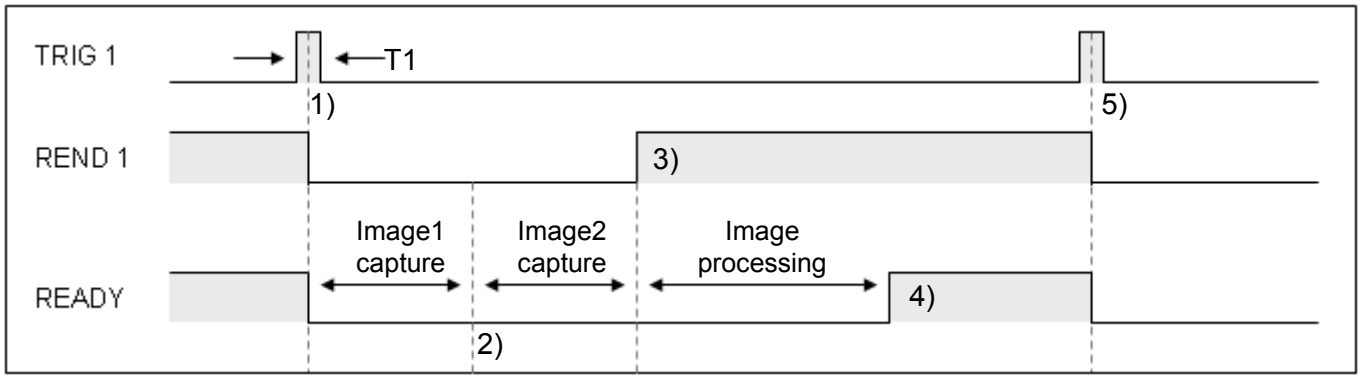
1) Trigger period T1 must be longer than 1ms.(if T1 is too short, the trigger may be ignored)
2) When image1 is captured (exposure + transfer), REND1 signal is ON.
3) If TRIG2 is triggered during the image1 capture cycle, image2 will begin capture after image1 capture cycle is completed.
4) When image2 is captured (exposure + transfer), REND2 signal is ON.
5) READY signal is OFF if TRIG is triggered.
6) READY signal switches ON after image processing is completed.
7) Steps 1~6 completes an inspection cycle and the system is ready for the next trigger signal.
8) TRIG2 can lead TRIG1 or vice versa.
9) In this mode, capture cycles of both TRIG signals must finish before image processing can begin. Therefore, the controller must stay in the trigger standby state before the second TRIG is initialized.

Reference To disable the second trigger standby, please refer to

TRIG1 and TRIG2 timings depend on the READY signal.
Total work cycle = first image capture time + second capture time + process time

- Two Cameras coupled with one TRIG signal: When both Camera1 and Camera2 are triggered by TRIG1.

  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 be ignored)
2) Image1 captured, continue with image 2 capture.
3) REND1 is ON after image1 and image2 are captured.
4) READY is ON after image processing is complete.
5) Steps 1~4 completes an inspection cycle and the system is ready for the next trigger signal.

TRIG1 timing depends on the READY signal.
Total cycle time = image1 capture time + image2 capture time + image processing time

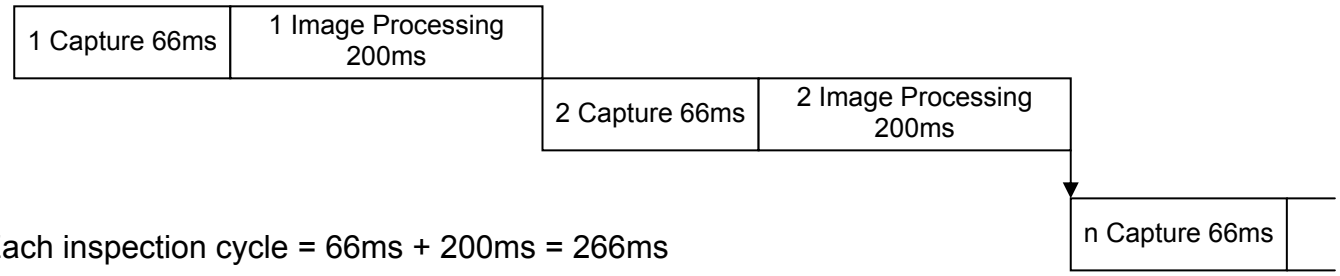
8.1.2 Double buffering TRIG (Trigger) capture:

The controller features a buffer register that saves the next captured image while the current one is being processed. This means that the image capture and processing functions can both be run simultaneously to reduce total cycle time.

Double buffering can be used when the image is captured; the object being inspected can be first moved without waiting for the result output. The overall inspection cycle time can be reduced.

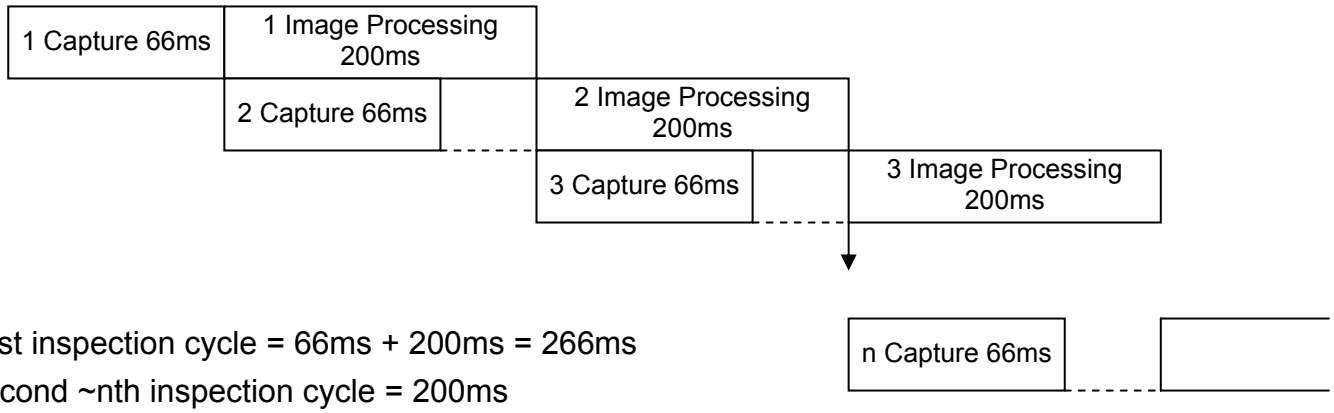
For example: Camera capture time is 66ms and image processing takes 200ms

Traditional method:



Each inspection cycle = 66ms + 200ms = 266ms

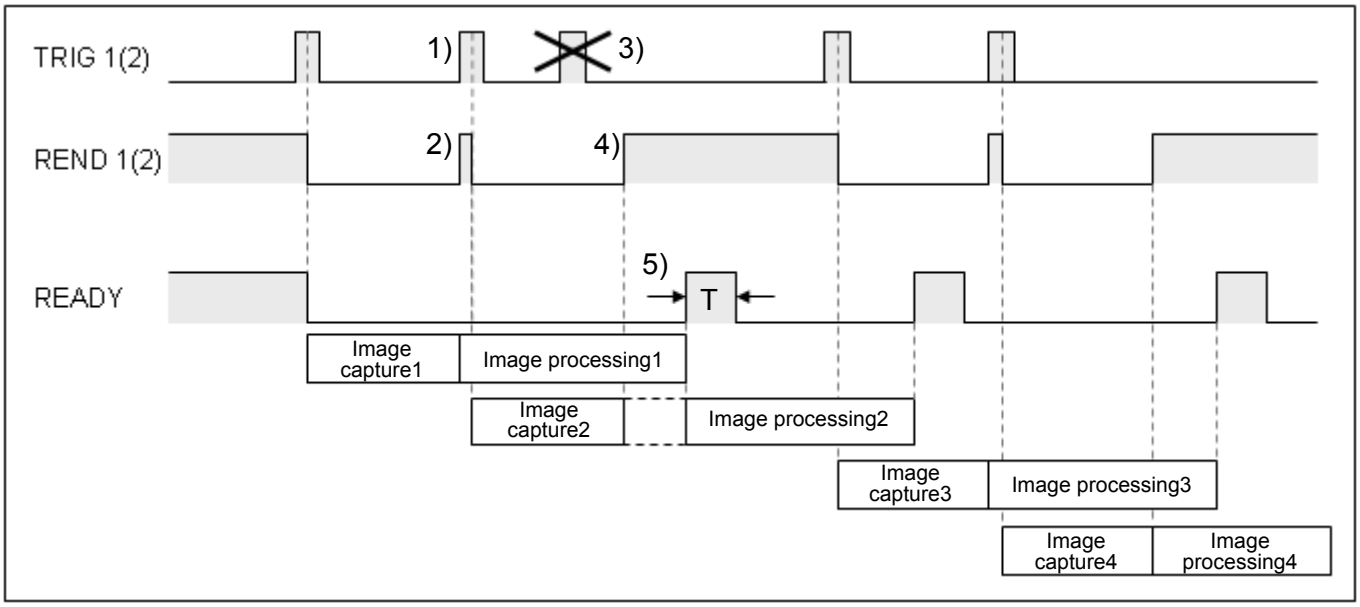
Double buffering:



First inspection cycle = 66ms + 200ms = 266ms

Second ~nth inspection cycle = 200ms

■ (Buffer trigger) One camera coupled with one TRIG signal:



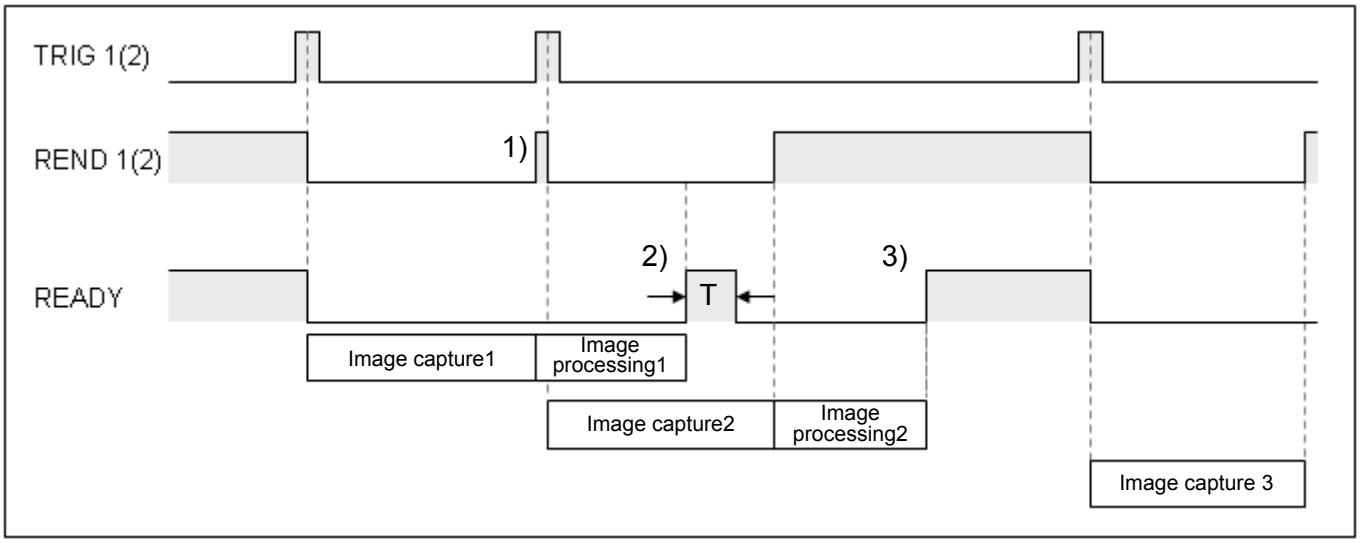
Description:

1) Image capture 2 is buffered at the same time as image processing begins.
2) Buffering is determined by the REND signal.(Enabled when REND is ON)
3) When REND is OFF, TRIG is ignored.
4) When image capture 2 completes, REND is ON to wait for the next trigger.
5) Image is being buffered and processing ends. Output READY signal for T period.(Default T is 10ms and can be changed)

TRIG1 and TRIG2 timings depend on the REND1 and REND2 signals.
The READY signal can be used as the flag to output data. When READY is ON, the output results are ready to be received.

Total cycle time:
First = image capture 1 + image processing 1 (READY OFF to READY ON)
Buffered process = rising-edge of T to next rising-edge of T

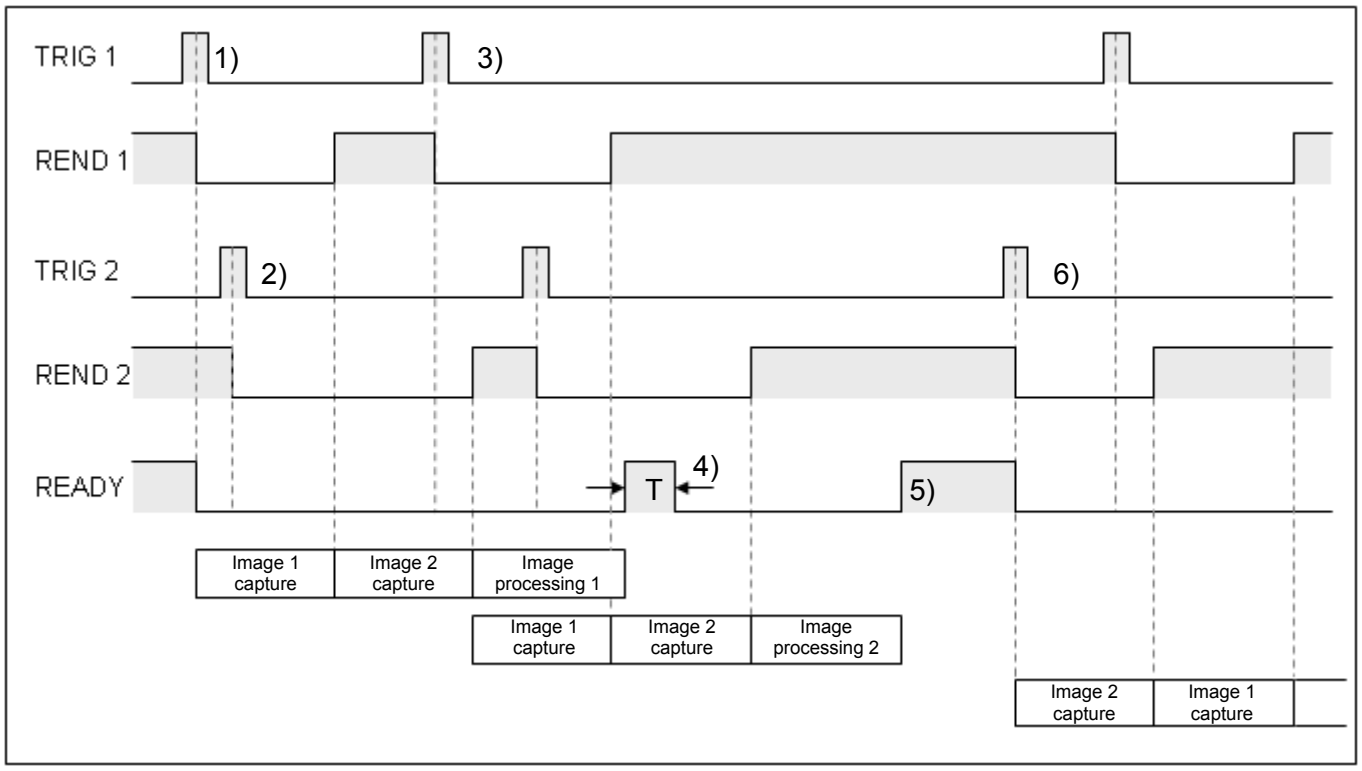
Intermittent buffered processing:



Description:

1) Image capture 1 completes, buffer capture 2 initiates.
2) Buffer capture occurs during image processing 1, READY output is ON for T period after image processing ends.(Default T is 10ms and can be changed)
3) No buffering occurs during image processing 2, READY output follows normal logic when image processing ends.(READY is always ON until the next TRIG signal is triggered)

■ (Double buffer trigger) Two cameras coupled with two TRIG signals:



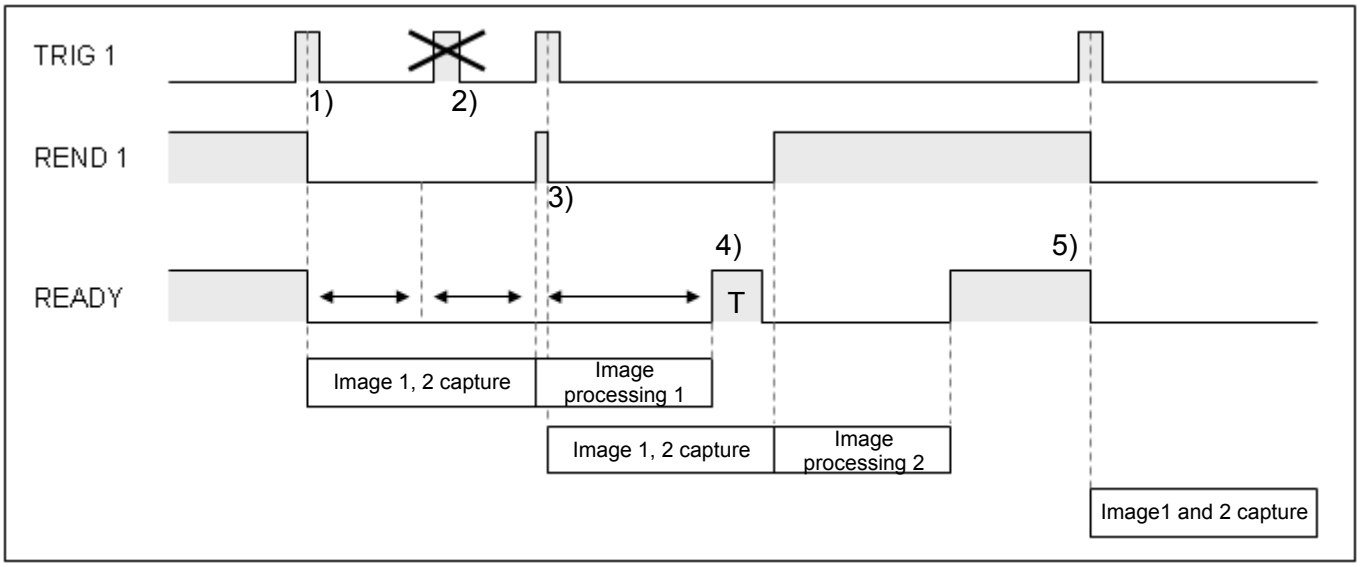
Description:

1) TRIG1 is triggered to begin capturing image1.
2) TRIG2 is triggered to begin capturing image2, but this image2 capture action is delayed because image1 capture is not yet complete.
3) Image1 captured to trigger TRIG1 for double buffering.
4) Double buffering occurs during image processing 1, therefore READY output is ON for T period after image processing ends.(Default T is 10ms and can be changed)
5) No buffering occurs during image processing 2, therefore READY output follows normal logic when image processing ends.(READY is always ON until the next TRIG signal is triggered)
6) Image capture 2 can lead image capture 1 or vice versa.

Remark Image1 is captured by camera1 and image2 is captured by camera2.

■ (Double buffer trigger) Two cameras coupled with one TRIG signal: When both Camera1 and Camera2 are triggered by TRIG1.

TRIG1 initiates the system to automatically capture image1 and image2.



Description:

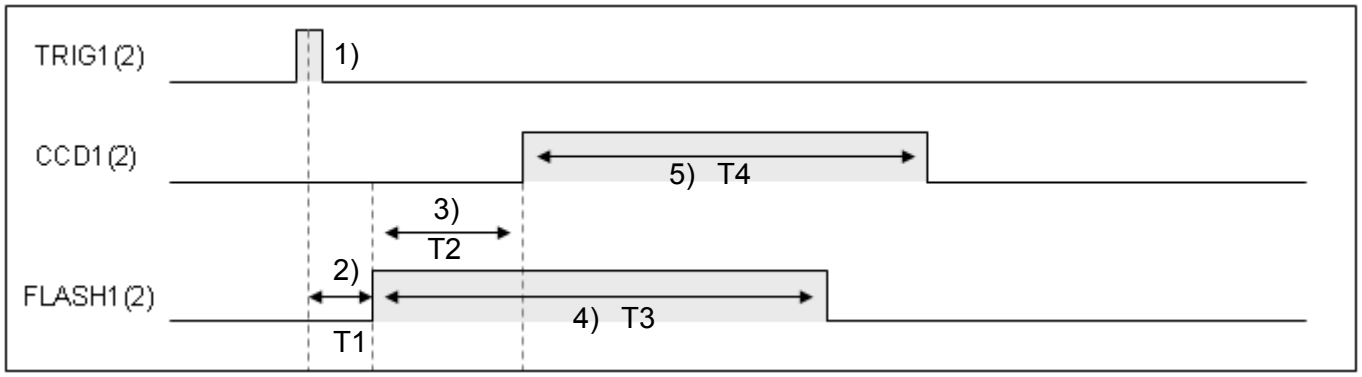
1) TRIG1 is triggered to begin capturing image1 and image2.
2) When capturing an image, TRIG1 is ignored.
3) After capturing image 1 and image 2, REND1 is ON to receive TRIG1 input.
4) Double buffering occurs during image processing 1, therefore READY output is ON for T period after image processing ends.(Default T is 10ms and can be changed)
5) No buffering occurs during image processing 2, therefore READY output follows normal logic when image processing ends.(READY is always ON until the next TRIG signal is triggered)

8.1.3 FLASH timer output:

Proper timing of the light source is crucial to the quality of the image taken. The system supports FLASH1 and FLASH2 outputs to control the peripheral light sources.

Remark The light controller for the light source must have an external trigger input when using the FLASH signal.

- FLASH signal output is enabled before the CCD shutter is activated.



T1: Approximate delay

T2: Setup "Flash action time" (unit: us)

T3: Setup "Flash duration" (unit: 100us)

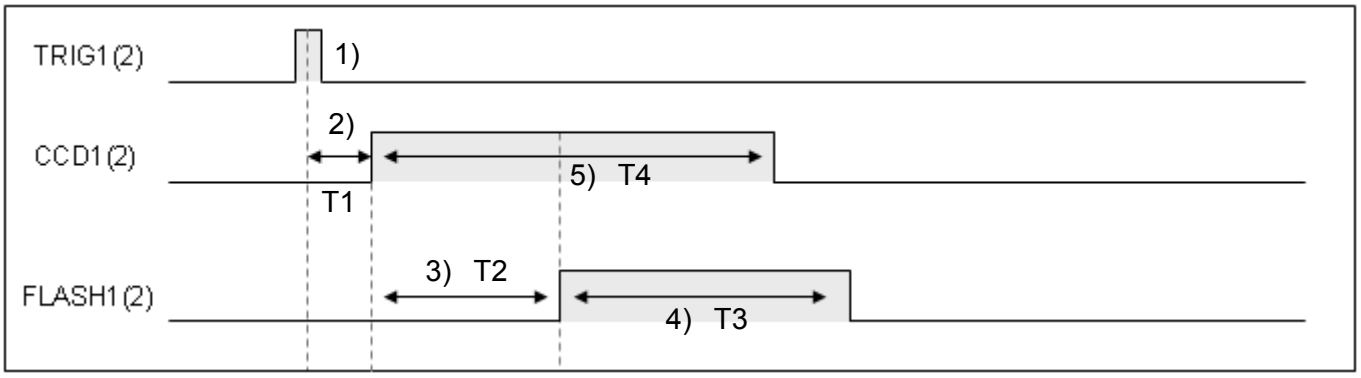
T4: Setup "Shutter setting"

Description:

1) If TRIG is triggered, timed FLASH output is enabled.
2) System delay is handled internally and FLASH output is delayed.
3) CCD shutter is delayed because FLASH output takes place before the CCD shutter is activated.
4) Total FLASH output duration.
5) Shutter duration of the camera.

Remark Because the CCD1 (2) signal is controlled internally in the system, no external signal pins are provided.

■ FLASH signal output is enabled after the CCD shutter.



T1: Approximate delay

T2: Setup "Flash action time" (unit: us)

T3: Setup "Flash duration" (unit: 100us)

T4: Setup "Shutter setting"

Description:

1) If TRIG is triggered, timed FLASH output is enabled.
2) System delay is handled internally and the CCD is delayed after the shutter capture.
3) The FLASH output is delayed because FLASH output comes after CCD shutter activation.
4) Total FLASH output duration.
5) Shutter duration of the camera.

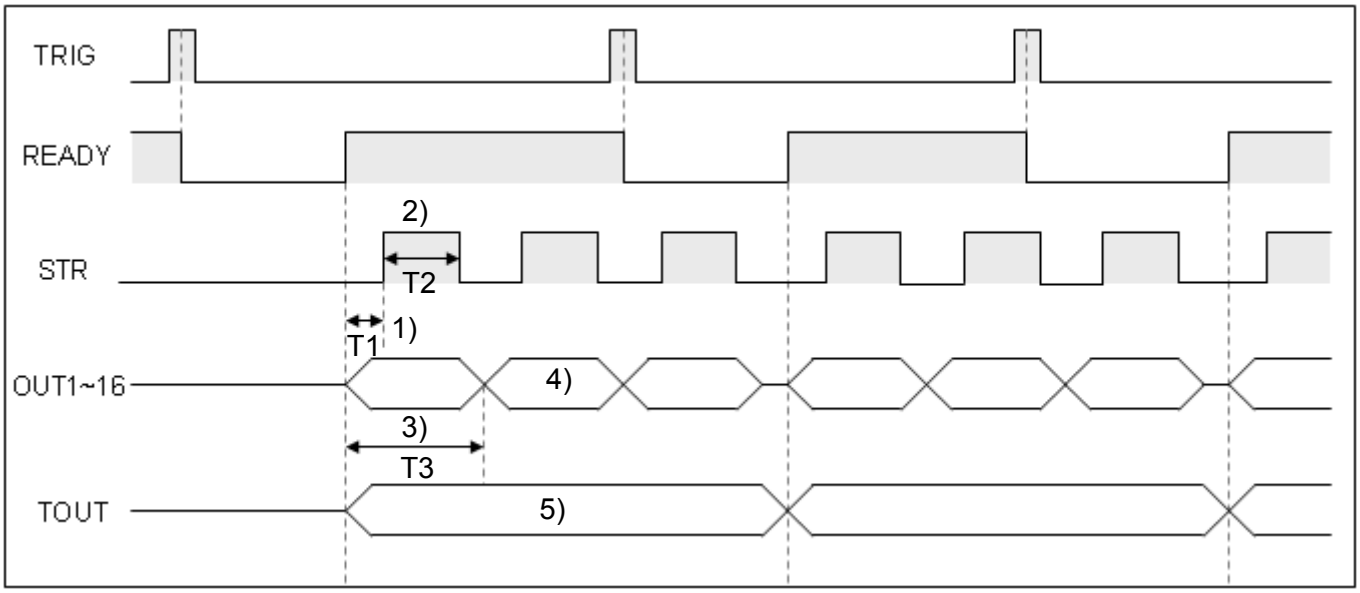
If the flash duration is greater than [shutter duration + frame refresh time + internal processing time], the flash will always remain ON.

If the shutter duration and flash turn on time are in sync and short in length, the flash is constantly turning on and thus will be near-always ON.

8.1.4 Output result:

DMV supports parallel I/O, RS232, USB, Ethernet, PLC, and memory card output methods. Communication may be a combination of the different channels based on the controller hardware or speed requirement.

- Parallel I/O: (no handshaking)
  In addition to the total output (TOUT), there are 16 outputs for status indicator or value output.

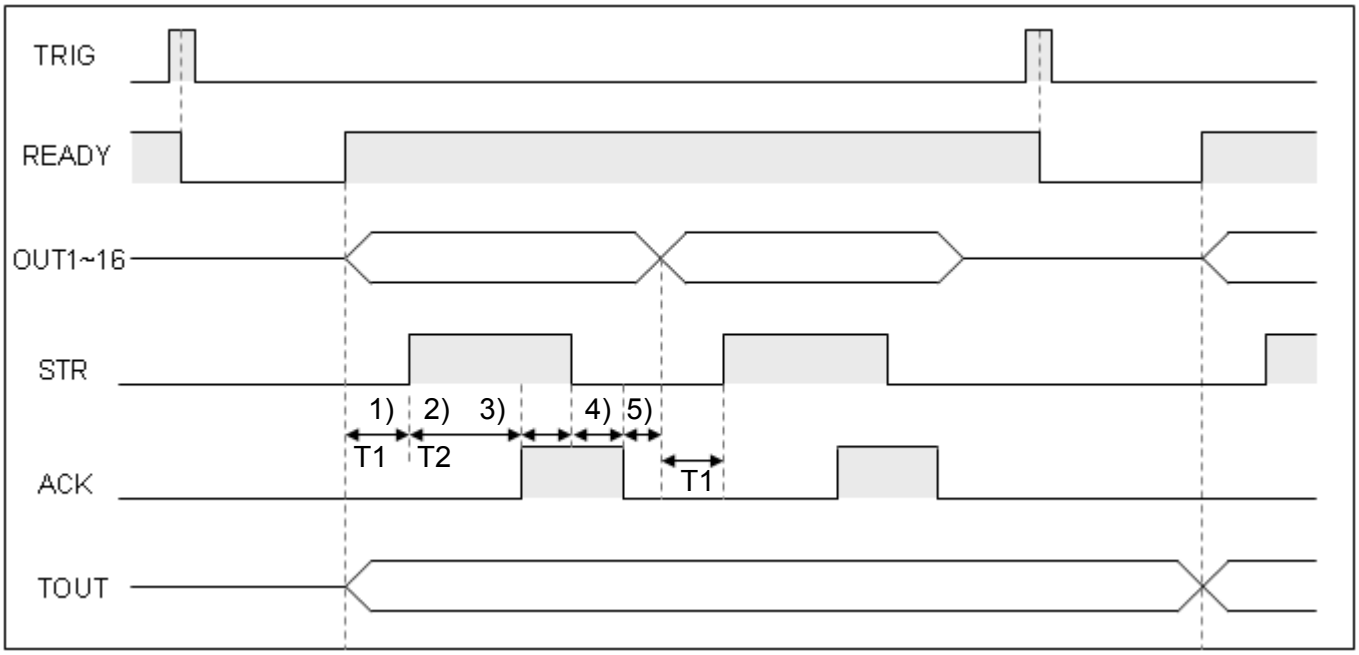


T1: Setup "STR delay" (unit: ms)
T2: Setup "STR duration" (unit: ms)
T3: Setup "Data output duration" (unit: ms)

Description:

1) When READY is ON, delay count begins for STR; STR is outputted after the delay count is reached.
2) The STR output period can be configured with the recommended stable read state on the controller.
3) OUT1~16 output period must satisfy the condition [data output duration ≧ STR delay + STR duration].

■ Parallel I/O: (handshaking)



T1: Setup "STR delay" (unit: ms)

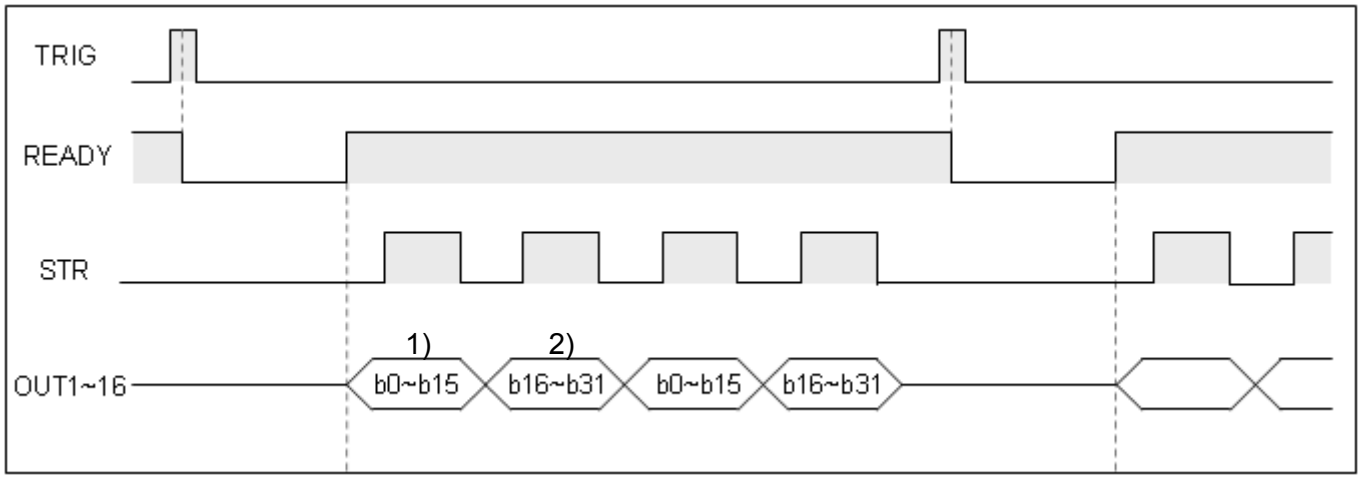
T2: Setup "Communication timeout" (unit: ms)

Description:

1) When READY is ON, delay count begins for STR; STR is outputted after the delay count is reached.
2) After STR is ON, the ACK handshaking signal should respond within the "Communication timeout" period. If not, the output is interrupted, the ERROR signal is sent out and the ERROR indicator light is lit.
3) After STR is output, it will turn OFF after ACK is detected.
4) After STR is OFF, ACK also turns off to enable the next data output.
5) After ACK is off, the next batch of data is output.

■ Parallel I/O: (32-bit format)

In 32-bit output format, every data is divided into two parts to be sent out.



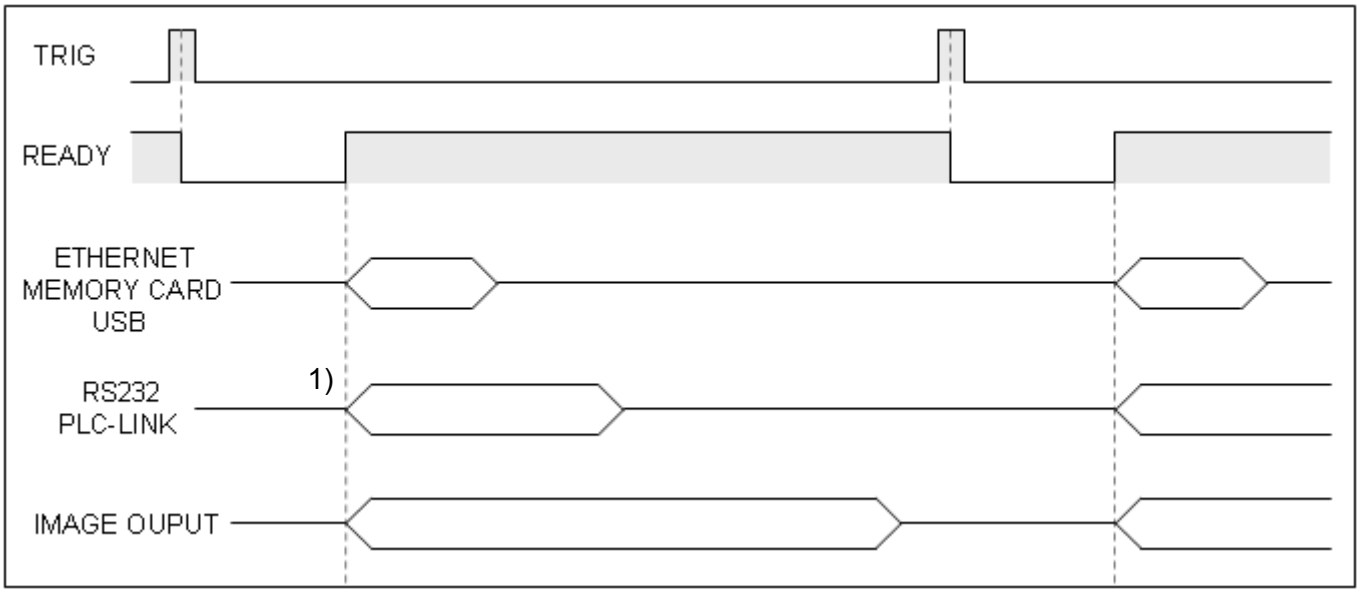
Description:

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) and unsigned binary (0~65535).
32-bit data range: -2147483648~2147483647

■ RS232, USB, ETHERNET, memory card, PLC-Link, and image save output:



Description:

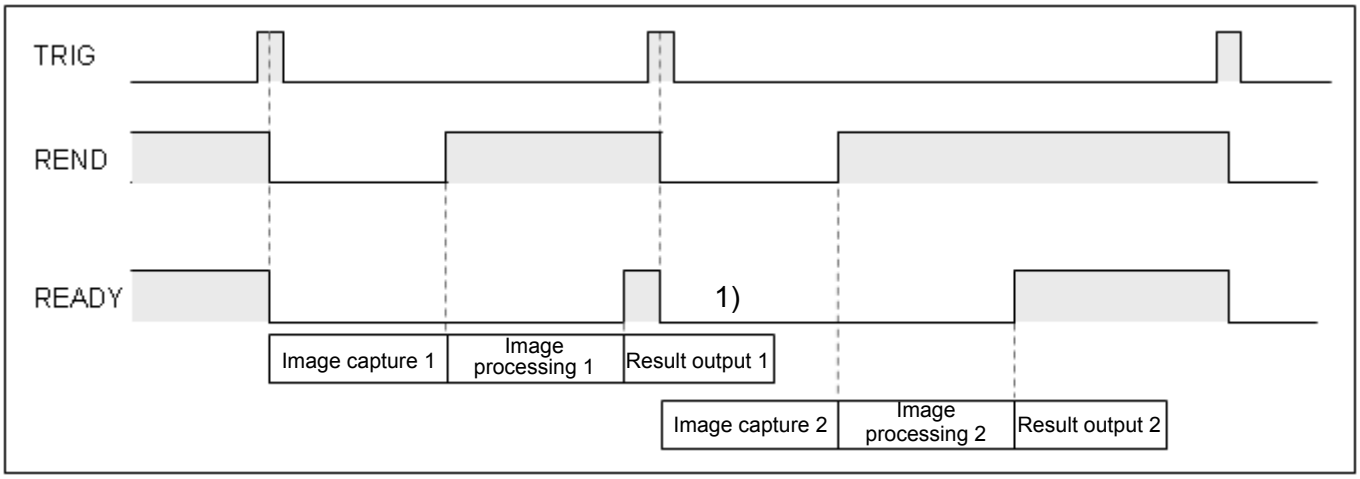
1) The outputs are in sync with the READY ON signal.

Remark Transfer speed: ETHERNET > RS232> IMAGE OUTPUT

8.1.5 Result output time:

Excessively long result output times will prolong the overall inspection time. The following describes the READY signal timing for different length of time in the result output.

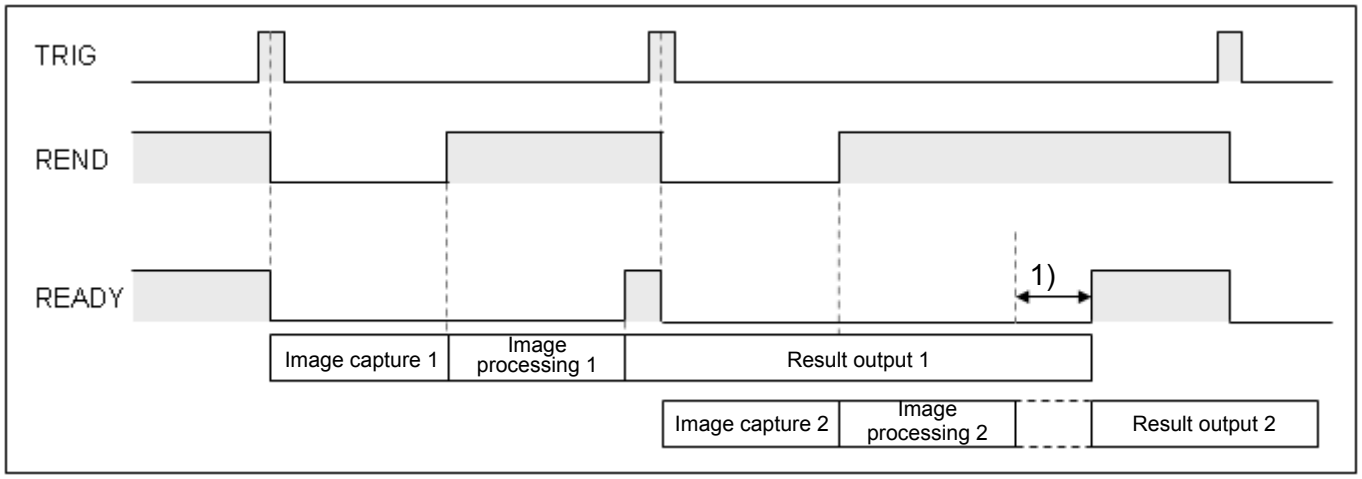
■ Output time is less than inspection time (timing of READY signal)



Description:

1) When result output 1 is shorter than the next inspection time (image capture2 + image processing2), then the output does not affect the next inspection timing cycle.

■ Output time is greater than inspection time (timing of READY signal)



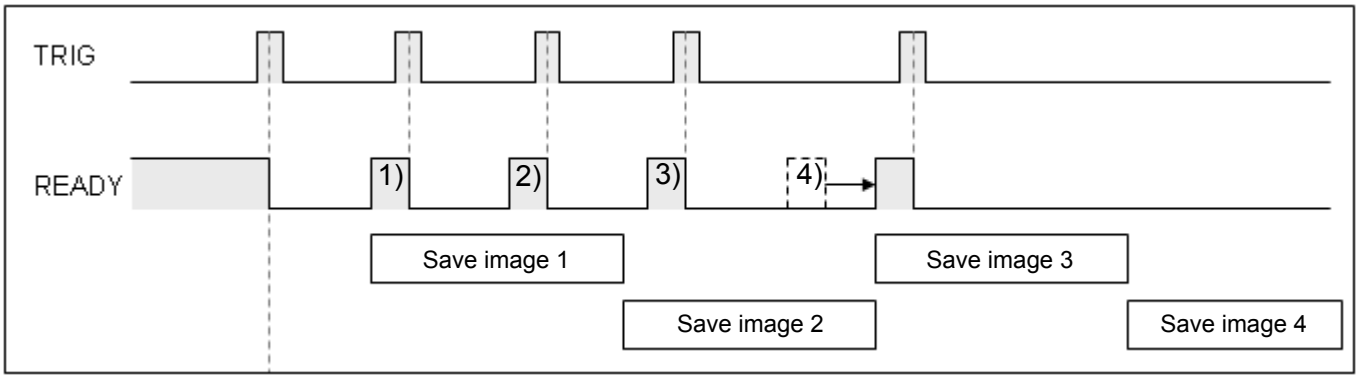
Description:

1) When result output 1 is longer than the next inspection time (image capture2 + image processing2), then the next "result output 2" will be delayed until "result output 1" is finished. As a result, the READY signal timing is also delayed.

8.1.6 (Buffer) Image Save:

Saving the image takes more time and may often exceed the inspection time. The system supports "Delayed save" and "Discard" saving modes.

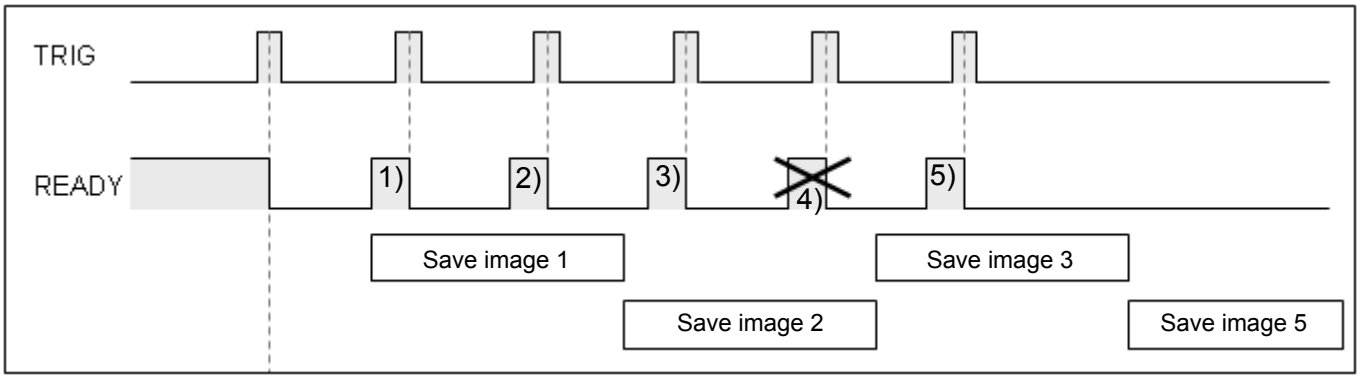
■ Delayed save: (all images must be saved)



Description:

1) After the first inspection cycle, image1 save cycle starts.
2) After the second inspection cycle, image2 is stored to the buffer because image1 is still being saved.
3) After the third inspection cycle, image2 is now saving and image3 is stored to the buffer.
4) At the fourth inspection cycle, image2 is still saving and image3 is still in the buffer. The READY output signal is delayed until after image2 has been saved and then image4 is stored to the buffer.

■ Discard: (discard save when buffer is full)



Description:

1) After the first inspection cycle, image1 save cycle starts.
2) After the second inspection cycle, image2 is stored to the buffer because image1 is still being saved.
3) After the third inspection cycle, image2 is now saving and image3 is stored to the buffer.
4) At the fourth inspection cycle, image2 is still saving and image3 is still in the buffer. The buffer is now full and image4 is discarded.
5) At the fifth inspection cycle, image3 is now saving and image5 is stored to the buffer.

8.1.7 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	Set Value
FNC4	FNC3	FNC2	FNC1		IN8~IN1
OFF	OFF	OFF	OFF	0: Switch process (internal memory)	0~31 (IN5~IN1)
OFF	OFF	OFF	ON	1: Switch process (memory card)	
OFF	OFF	ON	OFF	2: Switch viewing window	0~127 (IN7~IN1)
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 Value Input Conversion Table: (O=ON, X=OFF)

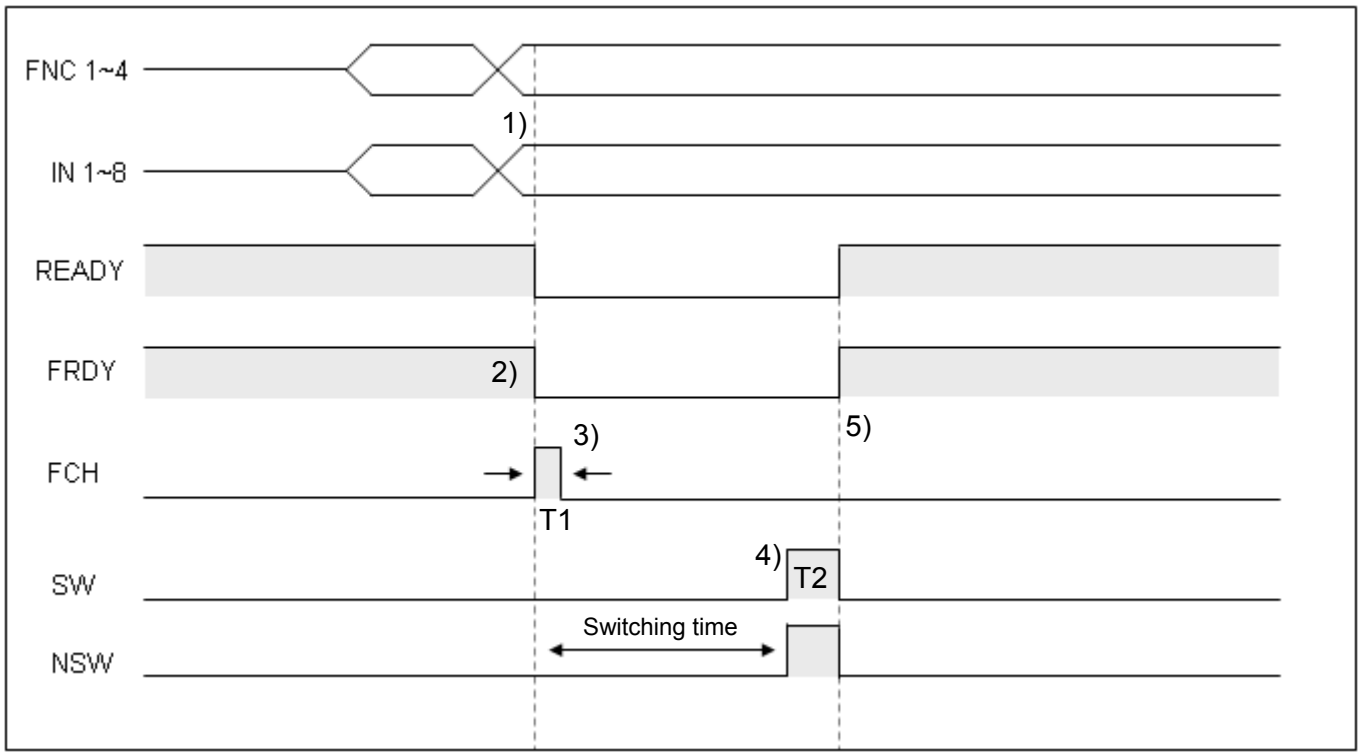
Numerical Value	Switch state							
	IN8	IN7	IN6	IN5	IN4	IN3	IN2	IN1
0	X	X	X	X	X	X	X	X
1	X	X	X	X	X	X	X	O
2	X	X	X	X	X	X	O	X
3	X	X	X	X	X	X	O	O
4	X	X	X	X	X	O	X	X
5	X	X	X	X	X	O	X	O
6	X	X	X	X	X	O	O	X
7	X	X	X	X	X	O	O	O
8	X	X	X	X	O	X	X	X
9	X	X	X	X	O	X	X	O
10	X	X	X	X	O	X	O	X
11	X	X	X	X	O	X	O	O
12	X	X	X	X	O	O	X	X
13	X	X	X	X	O	O	X	O
14	X	X	X	X	O	O	O	X
15	X	X	X	X	O	O	O	O
16	X	X	X	O	X	X	X	X
17	X	X	X	O	X	X	X	O
18	X	X	X	O	X	X	O	X
19	X	X	X	O	X	X	O	O
20	X	X	X	O	X	O	X	X
21	X	X	X	O	X	O	X	O
22	X	X	X	O	X	O	O	X
23	X	X	X	O	X	O	O	O
24	X	X	X	O	O	X	X	X
25	X	X	X	O	O	X	X	O

Numerical Value	Switch state							
	IN8	IN7	IN6	IN5	IN4	IN3	IN2	IN1
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
32	X	X	O	X	X	X	X	X
33	X	X	O	X	X	X	X	O
34	X	X	O	X	X	X	O	X
35	X	X	O	X	X	X	O	O
36	X	X	O	X	X	O	X	X
37	X	X	O	X	X	O	X	O
38	X	X	O	X	X	O	O	X
39	X	X	O	X	X	O	O	O
40	X	X	O	X	O	X	X	X
41	X	X	O	X	O	X	X	O
42	X	X	O	X	O	X	O	X
43	X	X	O	X	O	X	O	O
44	X	X	O	X	O	O	X	X
45	X	X	O	X	O	O	X	O
46	X	X	O	X	O	O	O	X
47	X	X	O	X	O	O	O	O
48	X	X	O	O	X	X	X	X
49	X	X	O	O	X	X	X	O
50	X	X	O	O	X	X	O	X
51	X	X	O	O	X	X	O	O

Numerical Value	Switch state							
	IN8	IN7	IN6	IN5	IN4	IN3	IN2	IN1
52	X	X	O	O	X	O	X	X
53	X	X	O	O	X	O	X	O
54	X	X	O	O	X	O	O	X
55	X	X	O	O	X	O	O	O
56	X	X	O	O	O	X	X	X
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
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

Numerical Value	Switch state							
	IN8	IN7	IN6	IN5	IN4	IN3	IN2	IN1
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
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

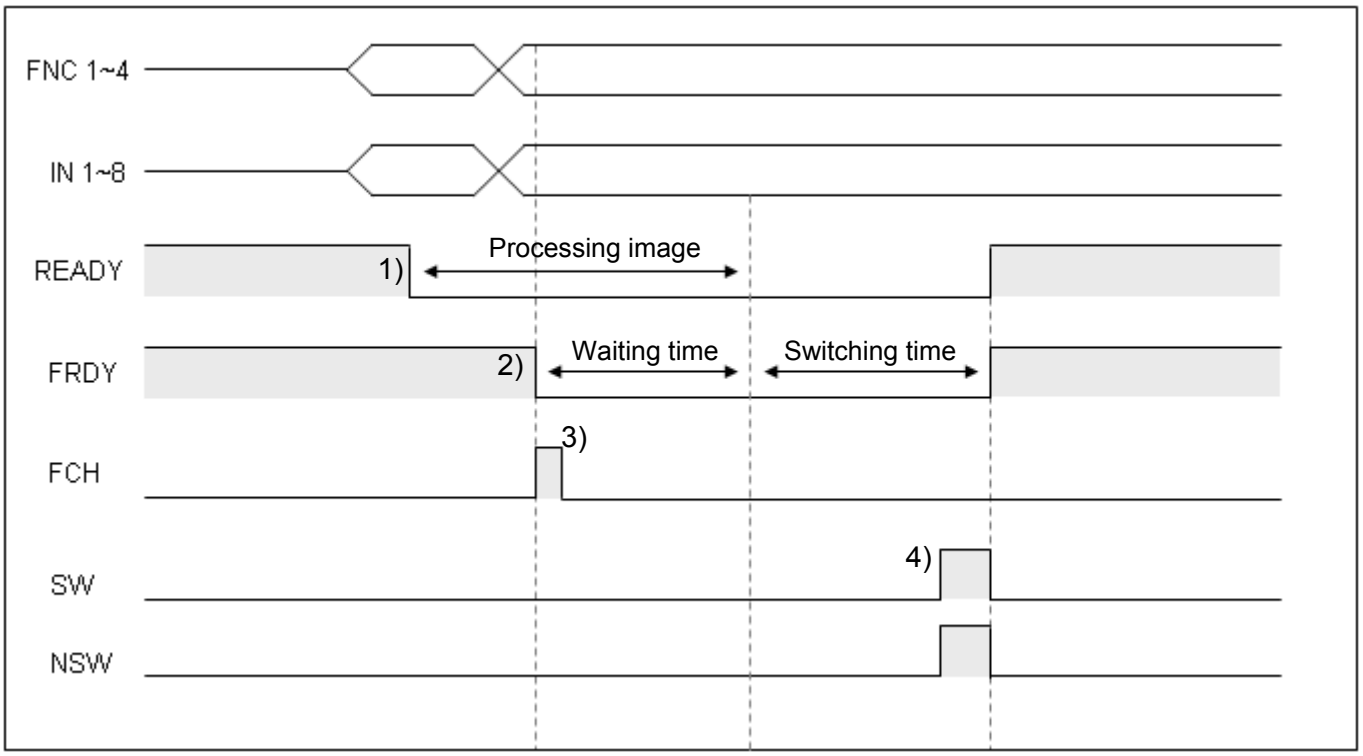
■ Non-imaging mode:



Description:

1) Enable FNC1~4 and IN1~8 to setup the function and parameters.
2) FRDY (Function Ready) is ON to enable function switching.
3) Trigger FCH (Function Change) to execute function switching.(T1 must be longer than 1ms) After FCH is enabled, READY and FRDY are OFF.
4) After the switch is made, the output flags SW (success) or NSW (failed) are set. If switching is disabled or illegal, the NSW flag output is set.
   (T2 is configured in [System] > [Communication] > [External])
5) After SW or NSW outputs are set, READY and FRDY signals return to the ON state.

■ Imaging mode:

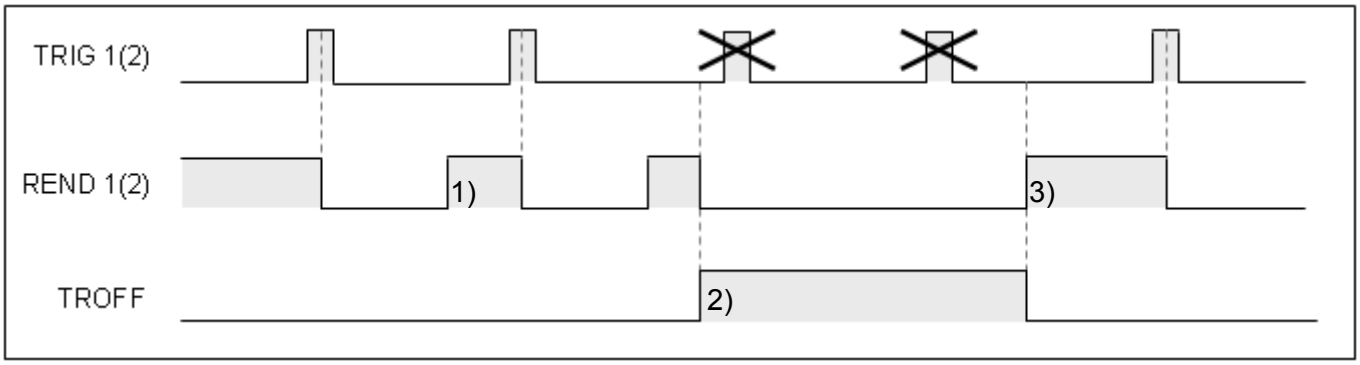


Description:

1) READY is OFF, indicating the system is currently working on the image.
2) FRDY is ON, function switching is enabled.
3) FCH is triggered to initiate function switching (T1 must be longer than 1ms). After FCH is enabled, FRDY is OFF.
   Image processing must be completed before the function can be switched.
4) After the switch is made, the output flags SW (success) or NSW (failed) are set.

8.1.8 Other: TROFF, TEST, PLINK, RESET

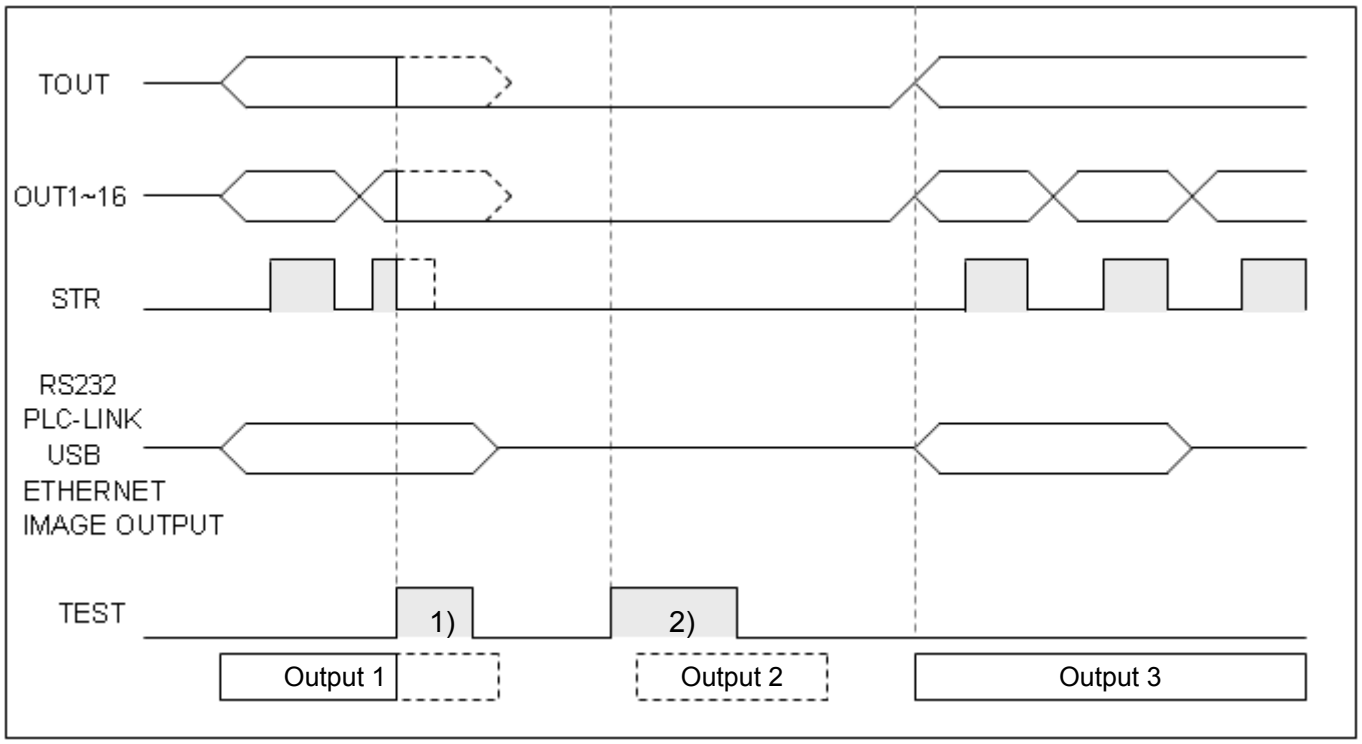
■ TROFF (trigger disabled):



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 is ON before output2 is valid, eternal output terminals and communication are disabled.

■ PLINK (data link to PLC):

This feature is currently being developed.

■ RESET:

When RESET signal input is enabled, all output are disabled.

Chapter 9 :

Serial Communication

9.1 RS232:

The following two types of RS232 communication methods are supported.

1) **RS232 Result output mode:**
   Inspection result is directly output to the RS232 port for the user to decode the data format.
2) **RS232 PLC-LINK mode:**
   Inspection result is automatically written to and then easily accessed from the PLC register. This eliminates the need to decode the data upon reception by the user.
   Auto PLC-LINK is only supported with Delta DVP series.
3) **RS232 Slave mode:**
   The controller automatically switches to the slave mode from "RS232 Result output mode" if no strings are to be output. In this mode, the controller waits for an external serial command to be executed and acknowledged. (please refer to section 9.4 for more information about slave mode commands)
   For example, a serial command is issued to the controller for project switching (in slave mode); the acknowledgement will be returned after the project has been switched.

Remark Both "Result output mode" and "PLC-LINK mode" occupies the RS232 interface and cannot be enabled at the same time. Please select the mode from the settings.

9.2 Result output mode:

■ **Setup protocol:**

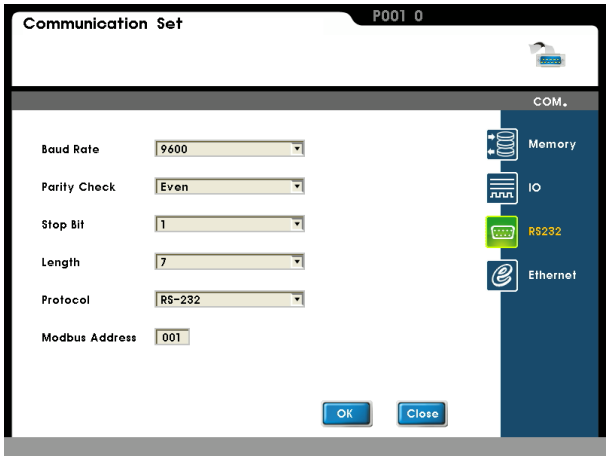
From [System] > [Communication], setup the RS232 communication protocol.

Default baud rate: 9600 (2,400~115,200bps)

Length: 7 (7, 8)

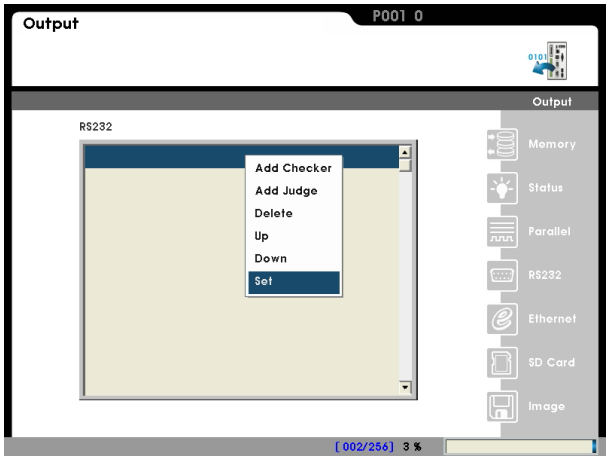
Parity: Even (odd, even, none)

Stop bit: 1 (1, 2)



■ **Output format:**

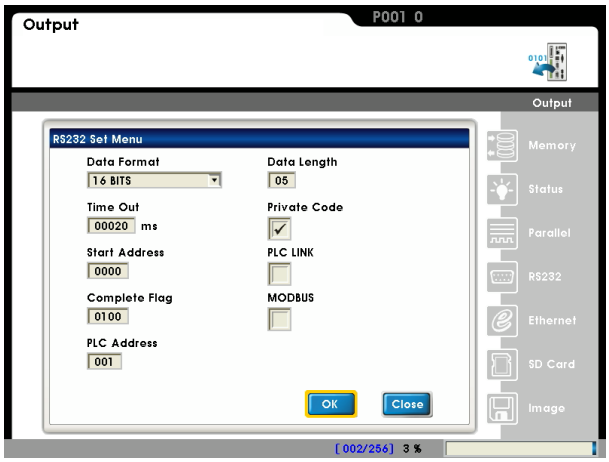
From [Program] > [Output] > [RS232], select [Set] and set the string length for "Result output mode."



■ [RS232] option must be enabled when setting the "Result output mode."

[Data length] is the fixed length of each output data. For example, a output value of 123.45 denotes the RS232 output string of 12345 (decimal point is ignored) requiring at least length of 5; similarly, a minimum length of 4 is required to output 56.78 The negative sign of a number also takes up a character, therefore -123.45 requires at least string length of 6 (-12345 is the output).

- Please set data length to longest valid string of multiple results to ensure a correct output. For example, please set data length to 6 if the output data are 34.56 (length 4), 123 (length 3), 123.45 (length 5), and -123.45 (length 6). As 0's will be appended to the front of shorter lengths, the output string is 003456000123012345-12345



- Judgment output carries only the 0 and 1 flag. As shown to the right, the output string is 001 if bit15=NG(0), bit13=NG(0), and bit12=OK(1).

9.3 PLC-LINK mode:

The inspection result is automatically written 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.

■ **Setup protocol:**

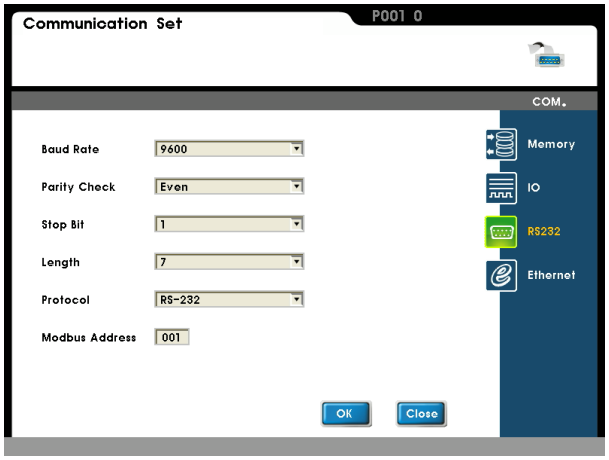
From [System] > [Communication], setup the RS232 communication protocol.

Default baud rate: 9600 (2,400~115,200bps)

Length: 7 (7, 8)

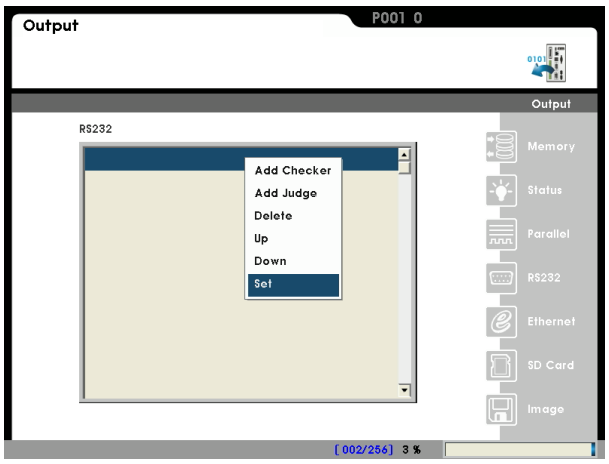
Parity: Even (odd, even, none)

Stop bit: 1 (1, 2)



■ **Output format:**

From [Program] > [Output] > [RS232], select [Set] and set the string length for "Result output mode."

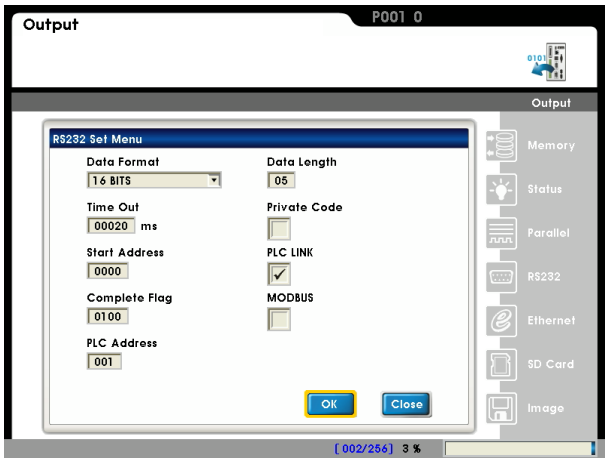


■ [PLC LINK] option must be selected to enable the "PLC LINK mode".

● [Data format]: Please select 32-bit (double word) mode if the output data exceeds the range -32,767~32,768.

■ [Time out]: Timeout between DMV and PLC communication.

■ [Start address]: Starting address to write to PLC. For example, enter 100 to start saving from the D100 register address.



■ [Complete flag]: After all data are written into the PLC register, DMV sets this register to 1 for the PLC to confirm that write access is complete.

After PLC confirms the data write access, please manually set the [Complete flag] register to 0 for the next write access.

■ [PLC Code]: PLC code to connect.

9.4 Slave mode:

While not in the data output state, the controller automatically switches to the slave mode to respond to external commands.

9.4.1 Slave mode command table: (DMV communication format)

	Function	Input string	Return string	Permission	
				Run	Program
1	Trigger 1 action and output	T1 CR	T1 CR T0 + output CR	O	
2	Trigger 2 action and output	T2 CR	T2 CR T0 + output CR	O	
3	Go to run mode	RN CR	RN CR		O
4	Go to program mode	PG CR	PG CR	O	
5	Repeat data output	DQ CR	DQ+ output CR	O	
6	Switch program ID (memory)	PCINnn CR	PC CR	O	
7	Switch program ID (SD card)	PCSDnnnn CR		O	
8	Read program ID	PR CR	PRINnn CR PRSDnnnn CR	O	
9	Switch window ID	WCnnnn CR	WC CR	O	
10	Read window ID	WR CR	WRnnnn CR	O	
11	Capture image	CP CR	CP CR	O	O
12	Enable input trigger	TO CR	TO CR	O	
13	Disable input trigger	TF CR	TF CR	O	
14	Write upper/lower limit (inspection)	LWWmnnnnaaaaaaaabbbbbbbb CR	LW CR	O	
15	Write upper/lower limit (calculator)	LWCAnnaaaaaaaabbbbbbbbCR	LC CR	O	
16	Read upper/lower limit (inspection)	LRWmnnnn CR	LRaaaaaaaabbbbbbbb CR	O	
17	Read upper/lower limit (calculator)	LRCAnn CR	LRaaaaaaaabbbbbbbb CR	O	
18	Save all project settings	SV CR	SV CR		O
19	Set time/date	DWyymmddhhmmss CR	DW CR	O	O
20	Read time/date	DR CR	DRyymmddhhmmss CR	O	O

	Function	Input string	Return string	Permission	
				Run	Program
21	Set camera shutter speed	SHCnmm CR	SH CR	O	
22	Set camera gain and brightness	SECnmmkk CR	SE CR	O	
23	Clear statistics	QC CR	QC CR	O	O
24	System reset	RS CR	RS CR	O	
25	Change password	PSnnnnmmmm CR	PS CR	O	O
26	Simulate keypad input	KYnn CR	KY CR	O	O
27	Write to memory	MWnnaaaaaaaa CR	MW CR	O	O
28	Read from memory	MRnn CR	MRaaaaaaaa CR	O	O

9.4.2 Slave mode commands (DMV communication format)

1) Trigger 1 action and output (RUN mode)

Input string: T1 [CR] Return string: T1 [CR] T0 + output [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] 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: T1 [CR] T01230034500101 [CR]

System returns T1 [CR] upon receiving the command, and then returns the result after inspection completes. Inspection time varies with the inspection item. Please adjust the controller timeout if inspection time is too long.

Remark If both cameras are enabled simultaneously, use [Program] > [Camera] > [Trigger mode] to set the trigger action.

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 decoded)
- E03: READY is not ON and cannot run (please check the I/O status)

2) Trigger 2 action and output (RUN mode)

Input string: T2 [CR] Return string: T2 [CR] T0 + output [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] 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] T01230034500101 [CR]

System returns T2 [CR] upon receiving the command, and then returns the result after inspection completes. Inspection time varies with the inspection item. Please adjust the controller timeout if inspection time is too long.

Remark Please

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 decoded)
- E03: READY is not ON and cannot run (please check the I/O status)

3) To RUN mode (program mode)

Input string: RN [CR] Return string: RN [CR]

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 decoded)
- E04: FRDY (function ready) is not ON and cannot run (please check the I/O status)

4) To Setting Mode (RUN mode)

Input string: PG [CR] Return string: PG [CR]

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 decoded)
- E04: FRDY (function ready) is not ON and cannot run (please check the I/O status)

5) Repeat data output (RUN mode)

Input string: DQ [CR] Return string: DQ + output [CR]

Description: Controller returns the latest inspection result.

Error message is returned if there is no inspection result to return. For example, after 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 decoded)
- E05: No inspection result (data not available)

6) Switch program ID - memory (RUN mode)

Input string: PCINnn [CR] Return string: PC [CR]

Description: nn is the program ID. (valid internal memory P00~P31)

Please enter the string to switch to P03: PCIN03 [CR]

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 decoded)
- E04: FRDY (function ready) is not ON and cannot run (please check the I/O status)
- E06: No program ID (program ID not set)

7) Switch program ID - SD card (RUN mode)

Input string: PCSDnnnn [CR] Return string: PC [CR]

Description: nnnn is the program ID.

Please enter the string to switch to P03: PCSD0003 [CR]

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 decoded)
- E04: FRDY (function ready) is not ON and cannot run (please check the I/O status)
- E06: No program ID (program ID not set)
- E08: No SD card

8) Read program ID (RUN mode)

Input string: PR [CR] Return string: (internal memory) PRINnn [CR]
(SD card) PRSDnn [CR]

Description: nn is the program ID.

Controller returns the string for internal program memory ID P03: PCIN03 [CR]

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 decoded)

9) Switch window ID (RUN mode)

Input string: WCnnn [CR] Return string: WC [CR]

Description: nnn is the window ID. (valid window ID range W00~W127)

Please enter the string to switch to W015: WC015 [CR]

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 decoded)
- E04: FRDY (function ready) is not ON and cannot run (please check the I/O status)
- E07: No window ID (including window ID not set)

10) **Read window ID** (RUN mode)

Input string: WR [CR] Return string: WRnnn [CR]

Description: nnn is the window ID.

Controller returns the string for window ID W020: WR020 [CR]

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 decoded)

11) **Capture image** (RUN/PROG mode)

Input string: CP [CR] Return string: CP [CR]

Description: Copy current screen to SD card. Image is saved as 800*600.

Error handling: Return string

- E02: Incorrect string data. (string length is too long or too short to be decoded)
- E08: No SD card found.
- E09: Insufficient memory or SD card space

12) **Enable input trigger** (RUN mode)

Input string: TO [CR] Return string: TO [CR]

Description: Controller defaults to "trigger enabled" state at each bootup, therefore this can be used with the "disable input trigger" 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 decoded)

13) **Disable input trigger** (RUN mode)

Input string: TF [CR] Return string: TF [CR]

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 decoded)

14) Write upper/lower limit - inspection window (RUN mode)

Input string: LWWmnnnnaaaaaaaabbbbbbbb CR Return string: LW CR

Description: m (data ID), nnnn (window ID), aaaaaaaa (upper limit), bbbbbbbb (lower limit). Upper/lower limits are fixed 8-digit numbers.

To set the upper/lower limits of W015 to 300 and 200 respectively, please enter the string LWW2001500000300000000200 CR

If the upper/lower input limits are coordinates or angle data (hundredth decimal format), the string format is as below:

For upper/lower angle limits of 120.00 and 50.00, please enter LWW2001500012000000005000 CR

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 decoded)
- E04: FRDY (function ready) is not ON and cannot run (please check the I/O status)
- E07: No window ID (including window ID not set)
- E10: Upper/lower limit error (invalid range or upper is less than lower)
- E11: Incorrect data ID (not available from current inspection)

15) Write upper/lower limit - calculator (RUN mode)

Input string: LWCAnnaaaaaaaabbbbbbbb CR Return string: LC CR

Description: nn (calculator ID), aaaaaaaaaa (upper limit), bbbbbbbbbb (lower limit). Upper/lower limits are fixed 8-digit numbers.

To set the calculator's upper/lower limits of C25 to 123.45 and 12.34, please enter the string LWCA2500012345000012345 CR

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 decoded)
- E04: FRDY (function ready) is not ON and cannot run (please check the I/O status)
- E10: Upper/lower limit error (invalid range or upper is less than lower)
- E11: Incorrect data ID (not available from current inspection)

16) Read upper/lower limit - inspection window (RUN mode)

Input string: LRWmnnnn CR Return string: LRaaaaaabbbbbb CR

Description: m (data ID), nnnn (window ID), aaaaaaaa (upper limit), bbbbbbbb (lower limit). Upper/lower limits are fixed 8-digit numbers.

To read the upper/lower limits of W015 from 300 and 200, please enter the string LRW20015 CR

Return string LR0000030000000200 CR

If the upper/lower read limits are coordinates or angle data (hundredth decimal format), the string format is as below:

upper/lower limits are 120.00 and 50.00, the return string is LR0001200000005000 CR

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 decoded)
- E07: No window ID (including window ID not set)
- E11: Incorrect data ID (not available from current inspection)

17) Read upper/lower limit - calculator (RUN mode)

Input string: LRCAnn CR Return string: LRaaaaaaaabbbbbbbb CR

Description: nn (calculator ID), aaaaaaaa (upper limit), bbbbbbbb (lower limit). Upper/lower limits are fixed 8-digit numbers.

To read the calculator's upper/lower limits of C25 from 123.45 and 12.34, the return string is LR0001234500001234 CR

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 decoded)

18) Save all project settings (program mode)

Input string: SV CR Return string: SV CR

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 decoded)
- E08: No SD card found.
- E09: Insufficient memory or SD card space

19) Set time/date (RUN/PROG mode)

Enter string : DWyymmddhhmmss [CR] Return string: DW [CR]

Error handling: Return string

- E02: Incorrect string data. (string length is too long or too short to be decoded)
- E15: Incorrect calendar format.

20) Read time/date (RUN/PROG mode)

Input string: DR [CR] Return string: DRyymmddhhmmss [CR]

Error handling: Return string

- E02: Incorrect string data. (string length is too long or too short to be decoded)

21) Set camera shutter speed (RUN mode)

Input string: SHCnmm [CR] Return string: SH [CR]

Description: Cn (camera ID), mm (shutter speed).

Shutter speed table: (range 01~15)

01= 1 s	05=1/100 s (10ms)	09=1/1000 s (1ms)	13=1/10000 s (0.1ms)
02=1/2 s (500ms)	06=1/120 s (8ms)	10=1/2000 s (0.5ms)	14=1/20000 s (0.05ms)
03=1/15 s (66ms)	07=1/240 s (4ms)	11=1/4000 s (0.25ms)	15= Custom
04=1/30 s (33ms)	08=1/500 s (2ms)	12=1/5000 s (0.2ms)	

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 decoded)
- E12: Incorrect camera settings.

22) Set camera gain and brightness (RUN mode)

Input string: SECnmmkk [CR] Return string: SE [CR]

Description: Cn (camera ID), mm (gain), kk (brightness). (mm and kk are limited to 00~99)

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 decoded)
- E12: Incorrect camera settings.

Remark Higher gain can compensate for insufficient lighting, but may also add noise to the image.

23) Clear statistics (RUN/PROG mode)

Input string: QC [CR] Return string: QC [CR]

Error handling: Return string

- E02: Incorrect string data. (string length is too long or too short to be decoded)

24) Reset system (RUN mode)

Input string: RS [CR] Return string: RS [CR]

Description: The following data will be reset:
Total, NG, defect rate, statistics, output terminals.

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 decoded)

25) Change password (RUN/PROG mode)

Input string: PSnnnnmmmm [CR] Return string: PS [CR]

Description: nnnn (old password), mmmm (new password). Password must be a 4-digit number. (range 0000~9999)

Error handling: Return string

- E02: Incorrect string data. (string length is too long or too short to be decoded)
- E14: Incorrect password (incorrect password or wrong format for new password)

26) Simulate keypad input (RUN/PROG mode)

Input string: KYnn [CR] Return string: KY [CR]

Description: nn (keypad code).

01= Up	05= ENTER	09= FUNCTION
02= Down	06= RUN/STOP	10= DISPLAY
03= Right	07= ESC	11= CUSTOM
04= Left	08= TRIGGER	

Error handling: Return string

- E02: Incorrect string data. (string length is too long or too short to be decoded)
- E13: Incorrect keypad code (range 01~11)

27) Write memory (RUN/PROG mode)

Input string: MWnnaaaaaaaa CR Return string: MW CR

Description: nn (16 memory addresses), aaaaaaaa (write with two decimal digits at the end) (range -9999999~9999999)

Error handling: Return string

- E02: Incorrect string data. (string length is too long or too short to be decoded)

28) Read memory (RUN/PROG mode)

Input string: MRnn CR Return string: MRaaaaaaaa CR

Description: nn (16 memory addresses), aaaaaaaa (read with two decimal digits at the end)

Error handling: Return string

- E02: Incorrect string data. (string length is too long or too short to be decoded)

Error code table:

Error code	Description
E01	Incorrect mode (RUN/PROG mode)
E02	Incorrect string data (string length is too long or too short to be decoded)
E03	READY is not ON and cannot run (please check the I/O status)
E04	FRDY (function ready) is not ON and cannot run (please check the I/O status)
E05	No inspection result (data not available)
E06	No program ID (program ID not set)
E07	No window ID (including window ID not set)
E08	No SD card
E09	Insufficient memory or SD card space
E10	Upper/lower limit error (invalid range or upper is less than lower)
E11	Incorrect data ID (not available from current inspection)
E12	Incorrect camera settings
E13	Incorrect keypad code (range 01~11)
E14	Incorrect password (incorrect password or wrong format for new password)
E15	Incorrect calendar format

9.4.3 Slave mode command table: (Modbus communication format)

Only ASCII mode is supported. Please refer to section 9.5 ASCII table for more information on converting hexadecimal and ASCII.

R is the Read command (03 code up to 64 reads)

W is the Write command (single write: 06 code; multiple writes: 10 code up to 6 writes)

Read 03 command: (read single or multiple data controlled by the [Byte] parameter)

Output format:

:	01	03	1010	0002	DA	CR LF
Header	Device number	Function code (read)	Function address	Data ID	Parity	Suffix

Return format:

:	01	03	04	0010	0015	D8	CR LF
Header	Device number	Function code (read)	Data ID (byte)	Result 1	Result 2	Parity	Suffix

Write 06 single data: (the correctly written data string is returned as is)

Output format:

:	01	06	1000	0001	E8	CR LF
Header	Device number	Function code (write)	Function address	Write data	Parity	Suffix

Return format:

:	01	06	1000	0001	E8	CR LF
Header	Device number	Function code (write)	Function address	Write data	Parity	Suffix

Write 10 multiple data: (up to 6 writes)

Output format:

:	01	10	1070	0002	04	0060	0015	F4	CR LF
Header	Device number	Function code	Function address	Writes	Bytes	Data 1	Data 2	Parity	Suffix

Return format:

:	01	10	1070	0002	6D	CR LF
Header	Device number	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 (last two digits are 0C)

1's complement = FF - 0C = F3 (difference from FF)

2's complement = F3 +1 = F4 (2's complement is 1 added to 1)

Address	Title	Description	Permission	
			Run	Program
1000H (W)	Trigger 1 action	Trigger if Data 1 is written	O	
1001H (W)	Trigger 2 action	Trigger if Data 1 is written	O	
1010H (R) ~ 104FH (R)	Output data (total 64 outputs)	(for more information on the output data, please refer to the description below)	O	
1050H (W)	Switch to RUN mode	Trigger if Data 1 is written		O
1051H (W)	Switch to PROG mode	Trigger if Data 1 is written	O	
1060H (R/W)	Read/switch program ID	0~255 (0~31 on internal memory, 32~255 on SD card)	O	
1062H (R/W)	Read/switch window ID	0~127	O	
1070H (R/W)	Read upper/lower limit (window)	Data ID to read	O	
1071H (R/W)		Window ID to read		
1072H (R)		Read upper limit (Low word)		
1073H (R)		Read upper limit (High word)		
1074H (R)		Read lower limit (Low word)		
1075H (R)		Read lower limit (High word)		
1077H (W)	Write upper/lower limit (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)		
1080H (R/W)	Read upper/lower limit (calculator)	Calculator ID to read	O	
1081H (R/W)		Read upper limit (Low word)		
1082H (R)		Read upper limit (High word)		
1083H (R)		Read lower limit (Low word)		
1084H (R)		Read lower limit (High word)		
1086H (W)	Write upper/lower limit (calculator)	Calculator ID to write		
1087H (W)		Write upper limit (Low word)		
1088H (W)		Write upper limit (High word)		

1089H (W)		Write lower limit (Low word)		
108AH (W)		Write lower limit (High word)		
1090H (R/W)	Read/set date and time	Year (00~99)	O	O
1091H (R/W)		Month (01~12)		
1092H (R/W)		Day (01~31)		
1093H (R/W)		Hour (00~23)		
1094H (R/W)		Minute (00~59)		
1095H (R/W)		Second (00~59)		
10A0H (W)	Set camera shutter speed	Camera ID (1~2)	O	
10A1H (W)		Shutter speed (1~15)		
10A2H (W)	Set camera gain and brightness	Camera ID (1~2)	O	
10A3H (W)		Gain (00~99)		
10A4H (W)		Brightness (00~99)		
10A5H (W)	Change password	Old password (4 digits)	O	O
10A6H (W)		New password (4 digits)		
10B0H (W)	Enable input trigger	Trigger if Data 1 is written	O	
10B1H (W)	Disable input trigger	Trigger if Data 1 is written	O	
10B2H (W)	Save all project settings	Trigger if Data 1 is written		O
10B3H (W)	Capture image	Trigger if Data 1 is written	O	O
10B4H (W)	Clear statistics	Trigger if Data 1 is written	O	O
10B5H (W)	System reset	Trigger if Data 1 is written	O	
10C0H (W)	Simulate keypad input	1~11	O	O
10D0H (R/W)	Internal memory	Memory01	O	O
10D1H (R/W)		Memory02	O	O
10D2H (R/W)		Memory03	O	O
10D3H (R/W)		Memory04	O	O
10D4H (R/W)		Memory05	O	O
10D5H (R/W)		Memory06	O	O
10D6H (R/W)		Memory07	O	O
10D7H (R/W)		Memory08	O	O
10D8H (R/W)		Memory09	O	O
10D9H (R/W)		Memory10	O	O
10DAH (R/W)		Memory11	O	O
10DBH (R/W)		Memory12	O	O
10DCH (R/W)		Memory13	O	O
10DDH (R/W)		Memory14	O	O
10DEH (R/W)		Memory15	O	O
10DFH (R/W)		Memory16	O	O

1) Trigger 1 action 1000H(W) (RUN mode)

Enter 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. If triggered in Modbus mode, the results are not automatically output but saved in the 1010H~104H registers. The inspection results can then be read after Ready is ON.

Error handling: Return string

- : 01860178 [CR] [LF] : Incorrect function code (not 06 Write)
- : 01860376 [CR] [LF] : Incorrect write data length (only one write containing "1" is allowed)
- : 01860475 [CR] [LF] : Cannot run (incorrect system mode)
- : 01861069 [CR] [LF] : Incorrect write parity code
- : 01861168 [CR] [LF] : Cannot run (system is in the Ready state)

2) Trigger 2 action and output 1001H(W) (RUN mode)

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. If triggered in Modbus mode, the results are not automatically output but saved in the 1010H~104H registers. The inspection results can then be read after Ready is ON.

Error handling: Return string

- : 01860178 [CR] [LF] : Incorrect function code (not 06 Write)
- : 01860376 [CR] [LF] : Incorrect write data length (only one write containing "1" is allowed)
- : 01860475 [CR] [LF] : Cannot run (incorrect system mode)
- : 01861069 [CR] [LF] : Incorrect write parity code
- : 01861168 [CR] [LF] : Cannot run (system is in the Ready state)

3) Data output 1010H~104FH(R) (RUN mode)

Output the previous inspection result if there is no inspection program to run.

16-bit (Word) format: To return 50,000 and 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-bit (Double Word) format: To return 400,000 and 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) format: (return bit2=0, bit3=1, bit4=1)

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 with bit2=0, bit3=1, bit4=1 set of judge)
  Read three strings: 010310100003 D9 [CR] [LF] (one data DW and one judge W)
  Returned: 01030600061A8000183E [CR] [LF]

Error handling: Return string

- : 0183017B [CR] [LF] : Incorrect function code (not 03 Write)
- : 0183027A [CR] [LF] : Read length is too long (more than 64)
- : 01830478 [CR] [LF] : Cannot run (incorrect system mode)
- : 0183106C [CR] [LF] : Incorrect read parity code

4) Switch to RUN mode 1050H(W) (PROG mode)

Enter 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

- : 01860178 [CR] [LF] : Incorrect function code (not 06 Write)
- : 01860376 [CR] [LF] : Incorrect write data length (only one write containing "1" is allowed)
- : 01860475 [CR] [LF] : Cannot run (incorrect system mode)
- : 01861069 [CR] [LF] : Incorrect write parity code

5) Switch to PROG mode 1051H(W) (RUN mode)

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

- : 01860178 [CR] [LF] : Incorrect function code (not 06 Write)
- : 01860376 [CR] [LF] : Incorrect write data length (only one write containing "1" is allowed)
- : 01860475 [CR] [LF] : Cannot run (incorrect system mode)
- : 01861069 [CR] [LF] : Incorrect write parity code

6) Read/switch program ID 1060H(R/W) (RUN mode)

Program ID 0~31 saved on internal memory and 32~255 on SD card.

Read program ID: (returns 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 to program ID 20)

Enter 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

- : 0183017B [CR] [LF] : Incorrect function code (not 03 Read or 06 Write)
- : 0183027A [CR] [LF] : Read length is too long (length must be 1)
- : 01830478 [CR] [LF] : Cannot run (incorrect system mode)
- : 0183106C [CR] [LF] : Incorrect read parity code
- : 01860376 [CR] [LF] : Incorrect write data length (only one write is allowed)
- : 01861069 [CR] [LF] : Incorrect write parity code
- : 01861168 [CR] [LF] : Cannot run (invalid program ID)

7) Read/switch program ID 1062H(R/W) (RUN mode)

Read window ID: (returns 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 to window ID 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

- : 0183017B [CR] [LF] : Incorrect function code (not 03 Read or 06 Write)
- : 0183027A [CR] [LF] : Read length is too long (length must be 1)
- : 01830478 [CR] [LF] : Cannot run (incorrect system mode)
- : 0183106C [CR] [LF] : Incorrect read parity code
- : 01860376 [CR] [LF] : Incorrect write data length (only one write is allowed)
- : 01861069 [CR] [LF] : Incorrect write parity code
- : 01861168 [CR] [LF] : Cannot run (invalid window ID)

8) Read upper/lower limit (window) 1070H~1075H (RUN mode)

The following six registers are required to read the [Window] upper/lower limits.

1070H (R/W) – Read/write data ID

1071H (R/W) – Read/write window ID

1072H (R) – Read upper limit (Low word)

1073H (R) – Read upper limit (High word)

1074H (R) – Read lower limit (Low word)

1075H (R) – Read lower limit (High word)

- [1070H data ID] and [1071H window ID] are first written to the registers to be accessed, then data from the 1072H~1075H addresses can be read.

Read upper/lower limit: (for example, data ID =2, window ID = 5, upper/lower limits are 500,000 and 300)

First enter string: 01101070000204000 20005 62 CR LF Return string: 011010700002 6D CR LF

Description: 2(dec) is 0002(hex).
5(dec) is 0005(hex).

Then enter read string: 010310720004 76 CR LF

Return string: 0103080007A1200000012C FF CR LF

Description: 500,000(dec) is 0007A120(hex).
300(dec) is 0000012C(hex).

Upper/lower limits are fixed DW (32bits) format.

Error handling: Return string

- : 0183017B CR LF : Incorrect function code (not 03 Read or 10 Write)
- : 0183027A CR LF : Read length is too long (length must less than be 6)
- : 01830478 CR LF : Cannot run (incorrect system mode)
- : 0183106C CR LF : Incorrect read parity code
- : 01860376 CR LF : Incorrect write data length (only one or two writes are allowed)
- : 01860475 CR LF : Cannot run (incorrect system mode)
- : 01861069 CR LF : Incorrect write parity code
- : 01861168 CR LF : Cannot run (invalid data ID or window ID)

9) Write upper/lower limit (window) 1077H~107CH (RUN mode)

The following six registers are required to write the [Window] upper/lower limits. For writing to the upper/lower limits, the six register writes can be issued at the same time.

1077H (W) – Write data ID

1078H (W) – Write window ID

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)

Write upper/lower limit: (for example, 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: 6(dec) is 0006(hex).
20(dec) is 0014(hex).
600,000(dec) is 000927C0(hex).
400(dec) is 00000190(hex).
Upper/lower limits are fixed DW (32bits) format.

Error handling: Return string

- : 01860178 [CR] [LF] : Incorrect function code (not 10 Multi Write)
- : 01860376 [CR] [LF] : Incorrect write data length (only six writes are allowed)
- : 01860475 [CR] [LF] : Cannot run (incorrect system mode)
- : 01861069 [CR] [LF] : Incorrect write parity code
- : 01861168 [CR] [LF] : Cannot run (invalid data ID or window ID)

10) Read upper/lower limit - calculator 1080H~1084H (RUN mode)

The following five registers are required to read the [Calculator] upper/lower limits.
1080H (R/W) – Read/write calculator ID
1081H (R) – Read upper limit (Low word)
1082H (R) – Read upper limit (High word)
1083H (R) – Read lower limit (Low word)
1084H (R) – Read lower limit (High word)

- [1080H calculator ID] is first written to the register, then data can be accessed from the 1081H~1084H addresses.

Read upper/lower limit: (for example, calculator ID to read is 5, upper/lower limits are 500,000 and 300)

First enter string: 010610800005 64 [CR] [LF] Return string: 010610800005 64 [CR] [LF]
Description: 5(dec) is 0005(hex).
Then enter read string: 010310810004 67 [CR] [LF]
Return string: 0103080007A1200000012C FF [CR] [LF]
Description: 500,000(dec) is 0007A120(hex).
300(dec) is 0000012C(hex).

Upper/lower limits are fixed DW (32bits) format.

Error handling: Return string

- : 0183017B [CR] [LF] : Incorrect function code (not 03 Read or 06 Write)
- : 0183027A [CR] [LF] : Read length is too long (length must less than be 5)
- : 01830478 [CR] [LF] : Cannot run (incorrect system mode)
- : 0183106C [CR] [LF] : Incorrect read parity code
- : 01860376 [CR] [LF] : Incorrect write data length (only one write is allowed)
- : 01860475 [CR] [LF] : Cannot run (incorrect system mode)
- : 01861069 [CR] [LF] : Incorrect write parity code
- : 01861168 [CR] [LF] : Cannot run (invalid calculator ID)

11) Write upper/lower limit (calculator) 1086H~108AH (RUN mode)

The following five registers are required to write the [Calculator] upper/lower limits. For writing to the upper/lower limits, the five register writes can be issued at the same time.

1086H (W) – Write to calculator ID
1087H (W) – Write upper limit (Low word)
1088H (W) – Write upper limit (High word)
1089H (W) – Write lower limit (Low word)
108AH (W) – Write lower limit (High word)

Write upper/lower limit: (for example, Calculator ID to write is 20, upper/lower limits are 600,000 and 400)

Input string: 01**10**1086**00**050A**0014**000927C000000190 B5 [CR] [LF]
Return string: 01**10**1086**0**005 54 [CR] [LF]
Description: 5(dec) is 0005(hex).
20(dec) is 0014(hex).
600,000(dec) is 000927C0(hex).
400(dec) is 00000190(hex).
Upper/lower limits are fixed DW (32bits) format.

Error handling: Return string

- : 01860178 [CR] [LF] : Incorrect function code (not 10 Multi Write)
- : 01860376 [CR] [LF] : Incorrect write data length (only five writes are allowed)
- : 01860475 [CR] [LF] : Cannot run (incorrect system mode)
- : 01861069 [CR] [LF] : Incorrect write parity code
- : 01861168 [CR] [LF] : Cannot run (invalid calculator ID)

12) Read/set time and date 1090H~1095H (RUN/PROG mode)

1090H (R/W) – Year (00~99, without the thousandth and hundredth digits)

1091H (R/W) – Month (01~12)

1092H (R/W) – Day (01~31)

1093H (R/W) – Hour (00~23)

1094H (R/W) – Minute (00~59)

1095H (R/W) – Second (00~59)

Read time/date: (for example, to read 2011/07/22 08:30:58)

Input string: 01031090006 56 [CR] [LF]

Return string: 01030C000B0007 0016 0008 001E 003A 68 [CR] [LF]

Description: 11(dec) is 000B(hex).
07(dec) is 0007(hex).
22(dec) is 0016(hex).
08(dec) is 0008(hex).
30(dec) is 001E(hex).
58(dec) is 003A(hex).

Write time/date: (for example, to write 2011/08/25 12:30:40)

Enter string : 01101090000 60C000B0008 0019 000C 001E 0028 BF [CR] [LF]

Return string: 011000900006 59 [CR] [LF]

Description: 11(dec) is 000B(hex).
08(dec) is 0008(hex).
25(dec) is 0019(hex).
12(dec) is 000C(hex).
30(dec) is 001E(hex).
40(dec) is 0028(hex).

In addition to multi writes to the date/time, single write 06 is also supported.

Error handling: Return string

- : 0183017B [CR] [LF] : Incorrect function code (not 03 Read, 06 Write, or 10 Multi Write)
- : 0183027A [CR] [LF] : Read length is too long (length must less than be 6)
- : 0183106C [CR] [LF] : Incorrect read parity code
- : 01860376 [CR] [LF] : Incorrect write length (length must be 6 for multi write)
- : 01861069 [CR] [LF] : Incorrect write parity code
- : 01861267 [CR] [LF] : Cannot run (illegal write data or out of range)

13) Set camera shutter speed 10A0H~10A1H (RUN mode)

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 (1~15)

01= 1 s	05=1/100 s (10ms)	09=1/1000 s (1ms)	13=1/10000 s (0.1ms)
02=1/2 s (500ms)	06=1/120 s (8ms)	10=1/2000 s (0.5ms)	14=1/20000 s (0.05ms)
03=1/15 s (66ms)	07=1/240 s (4ms)	11=1/4000 s (0.25ms)	15= custom
04=1/30 s (33ms)	08=1/500 s (2ms)	12=1/5000 s (0.2ms)	

Write settings: (for example, set camera2 shutter speed to 0.5ms)

Input string: 011010A00002040002000A 2D [CR] [LF]

Return string: 011010A00002 3D [CR] [LF]

Description: 2(dec) is 0002(hex).

10(dec) is 000A(hex).

Error handling: Return string

- : 01860178 [CR] [LF] : Incorrect function code (not 10 Multi Write)
- : 01860376 [CR] [LF] : Incorrect write data length (only two writes are allowed)
- : 01860475 [CR] [LF] : Cannot run (incorrect system mode)
- : 01861069 [CR] [LF] : Incorrect write parity code
- : 01861267 [CR] [LF] : Cannot run (illegal write data or out of range)

14) Set camera gain and brightness 10A2H~10A4H (RUN mode)

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 (00~99 higher is brighter)

10A4H (W) – Brightness (00~99 higher is brighter)

Write settings: (for example, set camera2 gain and brightness to 50 and 70 respectively)

Enter string: 011010A20003060002003200 46 BA [CR] [LF]

Return string: 011010A20003 3A [CR] [LF]

Description: 2(dec) is 0002(hex).

50(dec) is 0032(hex).

70(dec) is 0046(hex).

Error handling: Return string

- : 01860178 CR LF : Incorrect function code (not 10 Multi Write)
- : 01860376 CR LF : Incorrect write data length (only three writes are allowed)
- : 01860475 CR LF : Cannot run (incorrect system mode)
- : 01861069 CR LF : Incorrect write parity code
- : 01861267 CR LF : Cannot run (illegal write data or out of range)

15) Change password 10A5H~10A6H (RUN/PROG mode)

The following two registers are required to change the password. With multi write, both register writes can be issued at the same time.

10A5H (W) – Old password (4 digits)

10A6H (W) – New password (4 digits)

Write settings: (for example, change the password from 1234 to 5678)

Input string: 011010A500020404D2162E 1A CR LF

Return string: 011010A50002 38 CR LF

Description: 1234(dec) is 04D2(hex).

5678(dec) is 162E(hex).

Error handling: Return string

- : 01860178 CR LF : Incorrect function code (not 10 Multi Write)
- : 01860376 CR LF : Incorrect write data length (only two writes are allowed)
- : 01861069 CR LF : Incorrect write parity code
- : 01861267 CR LF : Cannot run (illegal write data or out of range)
- : 01861366 CR LF : Cannot run (incorrect password)

16) Enable input trigger 10B0H(W) (RUN mode)

Input string: 010610B00001 38 CR LF Return string: 010610B00001 38 CR LF

Description: After a "1" is written, the switch is successful if the string returned is identical.

Error handling: Return string

- : 01860178 CR LF : Incorrect function code (not 06 Write)
- : 01860376 CR LF : Incorrect write data length (only one write containing "1" is allowed)
- : 01860475 CR LF : Cannot run (incorrect system mode)
- : 01861069 CR LF : Incorrect write parity code

17) Disable input trigger 10B1H(W) (RUN mode)

Input string: 010610B10001 37 [CR] [LF] Return string: 010610B10001 37 [CR] [LF]

Description: After a "1" is written, the switch is successful if the string returned is identical.

Error handling: Return string

- : 01860178 [CR] [LF] : Incorrect function code (not 06 Write)
- : 01860376 [CR] [LF] : Incorrect write data length (only one write containing "1" is allowed)
- : 01860475 [CR] [LF] : Cannot run (incorrect system mode)
- : 01861069 [CR] [LF] : Incorrect write parity code

18) Save all project settings 10B2H(W) (program mode)

Input string: 010610B20001 36 [CR] [LF] Return string: 010610B20001 36 [CR] [LF]

Description: After a "1" is written, the switch is successful if the string returned is identical.

Error handling: Return string

- : 01860178 [CR] [LF] : Incorrect function code (not 06 Write)
- : 01860376 [CR] [LF] : Incorrect write data length (only one write containing "1" is allowed)
- : 01860475 [CR] [LF] : Cannot run (incorrect system mode)
- : 01861069 [CR] [LF] : Incorrect write parity code

19) Capture image 10B3H(W) (RUN/PROG mode)

Input string: 010610B30001 35 [CR] [LF] Return string: 010610B30001 35 [CR] [LF]

Description: After a "1" is written, the switch is successful if the string returned is identical.

Error handling: Return string

- : 01860178 [CR] [LF] : Incorrect function code (not 06 Write)
- : 01860376 [CR] [LF] : Incorrect write data length (only one write containing "1" is allowed)
- : 01861069 [CR] [LF] : Incorrect write parity code

20) Clear statistics 10B4H(W) (RUN/PROG mode)

Input string: 010610B40001 34 [CR] [LF] Return string: 010610B40001 34 [CR] [LF]

Description: After a "1" is written, the switch is successful if the string returned is identical.

Error handling: Return string

- : 01860178 [CR] [LF] : Incorrect function code (not 06 Write)
- : 01860376 [CR] [LF] : Incorrect write data length (only one write containing "1" is allowed)
- : 01861069 [CR] [LF] : Incorrect write parity code

21) Reset system 10B5H(W) (RUN mode)

Input string: 010610B50001 33 [CR] [LF] Return string: 010610B50001 33 [CR] [LF]

Description: After a "1" is written, the switch is successful if the string returned is identical.

Error handling: Return string

- : 01860178 [CR] [LF] : Incorrect function code (not 06 Write)
- : 01860376 [CR] [LF] : Incorrect write data length (only one write containing "1" is allowed)
- : 01860475 [CR] [LF] : Cannot run (incorrect system mode)
- : 01861069 [CR] [LF] : Incorrect write parity code

22) Simulate keypad input 10C0H(W) (RUN/PROG mode)

Single write (1~11) value as below.

01= Up	05= ENTER	09= FUNCTION
02= Down	06= RUN/STOP	10= DISPLAY
03= Right	07= ESC	11= CUSTOM
04= Left	08= TRIGGER	

For example, please write 10 to the register to communicate the [Display] keypad command.

Input string: 010610C0000A 1F [CR] [LF] Return string: 010610C0000A 1F [CR] [LF]

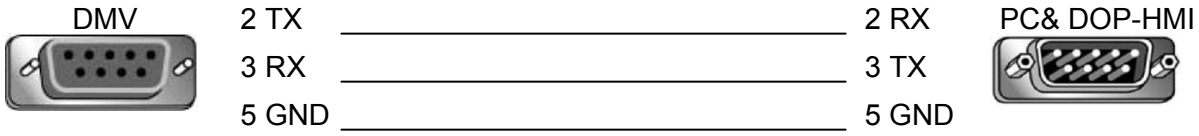
Description: 10(dec) is 000A(hex).

Error handling: Return string

- : 01860178 [CR] [LF] : Incorrect function code (not 06 Write)
- : 01860376 [CR] [LF] : Incorrect write data length (only one write is allowed)
- : 01861069 [CR] [LF] : Incorrect write parity code

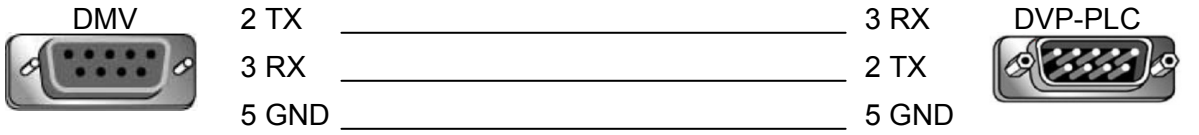
9.5 RS232 pin definition:

The DMV can directly connect to the PC master while in slave mode.



However, RX and TX must be reversed between DMV and PLC as both are configured to connect in slave modes.

To achieve normal operations, when connecting DMV(RS232) to PLC RS485, in addition to using the RS232-to-RS485 adaptor, RX and TX must be reversed.



9.6 ASCII Table:

The bolded characters are currently used by DMV. (HEX is 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

9.7 Communication formatting:

As DMV communicates in the ASCII format, therefore the ASCII data must be converted to decimal for HMI and PLC. The example below applies to the Delta HMI (DOP series) and PLC (DVP series). If HMI and/or PLC being used are those of other suppliers, this protocol conversion format can be referenced and the directions provided from the aforesaid suppliers should be followed to complete the process.

9.7.1 Delta HMI (DOP) data conversion:

For example: DMV output result: T012340555 CR (data length set at 4).
T0 begins result TX, 1234 is the first data, 0555 is the second data, and CR is the suffix.

1) Use INITCOM to set HMI port parameters.

Command	INITCOM
Variable 1	$10
Variable 2	0, 0, 0, 2, 0, 6, 0
Variable 3	Var3
Variable 4	Var4

⇨

COM Port	COM1
Interface	RS232
Data Bits	7 Bits
Parity	Even
Stop Bits	1 Bits
Baud Rate	9600
Flow Control	No Flow Control

2) Use SELECTCOM to set TX port. (0 for COM1 and 1 for COM2)

Command	SELECTCOM
Variable 1	0
Variable 2	Var2

4) Use PUTCHARS for TX string.
Variable1: TX status (0 for failed and 1 for success)
Variable2: TX start address
Variable3: TX string length (variable, where one character represents one length)
Variable4: Timeout (or variable, unit: milliseconds)

Command	PUTCHARS
Variable 1	$20
Variable 2	$21
Variable 3	4
Variable 4	300

5) Use GETCHARS for RX.
Variable1: RX status (0 for failed and 1 for success)
Variable2: RX start address
Variable3: RX string length (variable, where one character represents one length)
Variable4: RX timeout (or variable, unit: milliseconds)

Command	GETCHARS
Variable 1	$30
Variable 2	$31
Variable 3	10
Variable 4	300

6) As above, RX string is saved at $31. In the following example for a string T012340555, it is converted into the decimal results 1234 and 555 then saved to the register.

- Use B2W to save each character into a register.

Command	B2W
Variable 1	$200
Variable 2	$31
Variable 3	10
Variable 4	Var4

Register	HEX	Register	HEX
$200	54 (T)	$205	34 (4)
$201	30 (0)	$206	30 (0)
$202	31 (1)	$207	35 (5)
$203	32 (2)	$208	35 (5)
$204	33 (3)	$209	35 (5)

- Use A2H to convert register characters into a register.

Command	A2H
Variable 1	$300
Variable 2	$202

Register	Hexadecimal
$300	1234
$301	0555

Command	A2H
Variable 1	$301
Variable 2	$206

- Use BIN to convert hexadecimal into decimal for each register.

Command	BIN
Variable 1	$400
Variable 2	$300

Register	Decimal
$400	1234
$401	0555

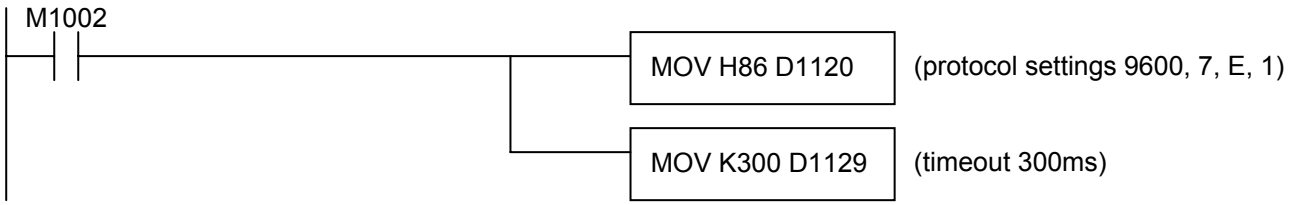
Command	BIN
Variable 1	$401
Variable 2	$301

7) A2H applies to 4-character numbers. Please adhere to the following for other than 4-character numbers.
   - Less than 4 characters:
     - For example: To extract 34 from $400=1234
       Divide by 100 using [Take remainder] to get 34.
     - For example: To extract 123 from $400=1234
       Use [Divide] to divide by 10 and take the quotient (123).
   - More than 4 characters:
     - For example: To extract 12340555 from $400=1234 and $401=555
       [Multiple] $400=1234 by 10000 and then add 555 to get 12340555.
     - For example: To extract 340555 from $400=1234 and $401=555
       Divide the numerical value $400=1234 by 100 using [Take remainder] to get 34.
       Then [Multiple] 34 by 10000 and then add 555 to get 340555.
     - For example: To extract 123405 from $400=1234 and $401=555
       [Divide] $401= 555 by 100 and take the quotient to get 05.
       Then [Multiple] $400=1234 by 100 and then add 05 to get 123405.

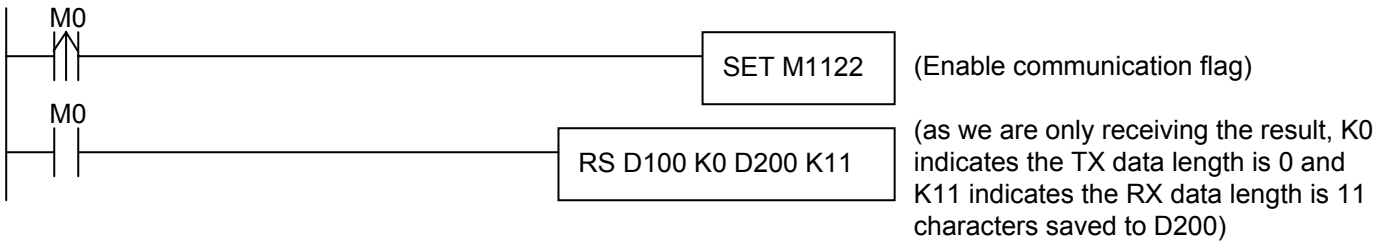
9.7.2 Delta PLC (DVP) data conversion:

For example: DMV output result: T012340555 [CR] (data length set at 4).
T0 begins result TX, 1234 is the first data, 0555 is the second data, and [CR] is the suffix.

1) Set PLC protocol and timeout.



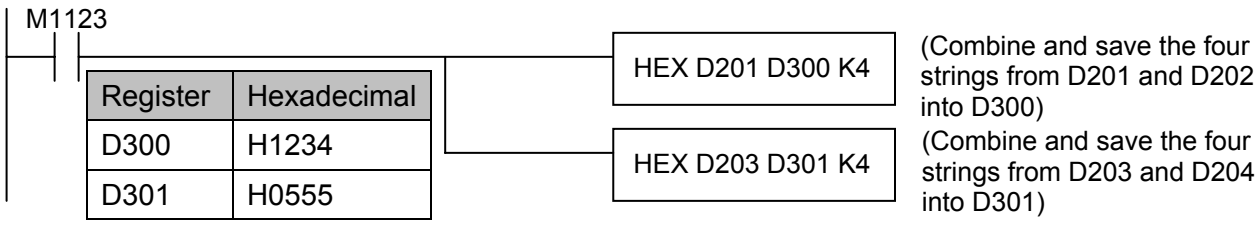
2) Use RS to receive 11 characters including the [CR] suffix. (for example, M0 as the trigger flag)



3) Observe the contents of D200~D205 (6 registers).

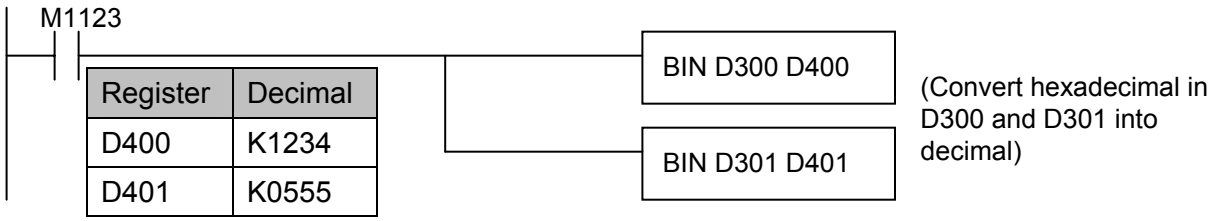
Register	Hexadecimal	Register	Hexadecimal
D200	H3054 (0T)	D203	H3530 (50)
D201	H3231 (21)	D204	H3535 (55)
D202	H3433 (43)	D205	HD ([CR])

4) Use M1123 flag (RX done) to convert data.
   - HEX D201 D300 K4
   - HEX D203 D301 K4
   - M1123
   - Use HEX to combine and save the string (as hexadecimal) to the register.



Register	Hexadecimal
D300	H1234
D301	H0555

   - Combine and save the string (as hexadecimal) to the register.



Register	Decimal
D400	K1234
D401	K0555

5) HEX applies to 4-character numbers. Please adhere to the following for other than 4-character numbers.
   - Less than 4 characters:
     - ◆ For example: To extract 34 from D400=1234
       [Divide] by 100 and take the quotient to get 34.
     - ◆ For example: To extract 123 from D400=1234
       Use [Divide] to divide by 10 and take the quotient (123).
   - More than 4 characters:
     - ◆ For example: To extract 12340555 from D400=1234 and D401=555
       [Multiple] D400=1234 by 10000 and then add 555 to get 12340555.
     - ◆ For example: To extract 340555 from D400=1234 and D401=555
       [Divide] D400= 1234 by 100 and take the remainder to get 34.
       Then [Multiple] 34 by 10000 and then add 555 to get 340555.
     - ◆ For example: To extract 123405 from D400=1234 and D401=555
       [Divide] D401= 555 by 100 and take the quotient to get 05.
       Then [Multiple] D400=1234 by 100 and then add 05 to get 123405.

Remark HEX command in DVP PLC supports 1~16 characters. Please refer to the PLC operating manual for more information.

Chapter 10:

Appendix

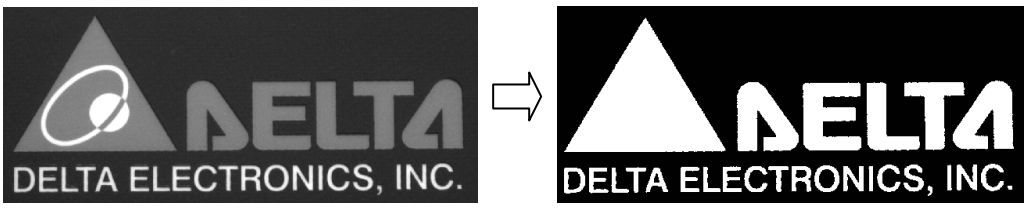
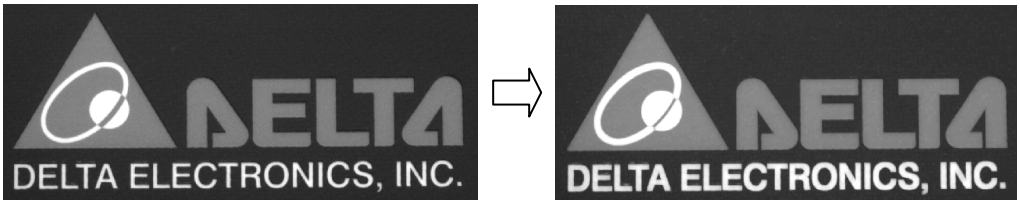
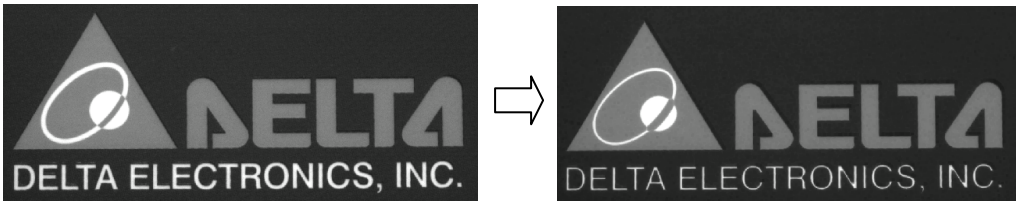
10.1 Pre-processing:

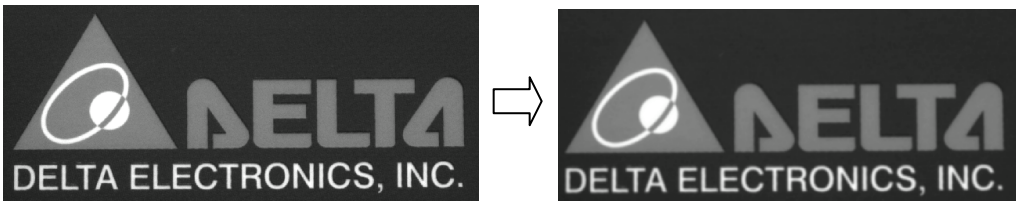
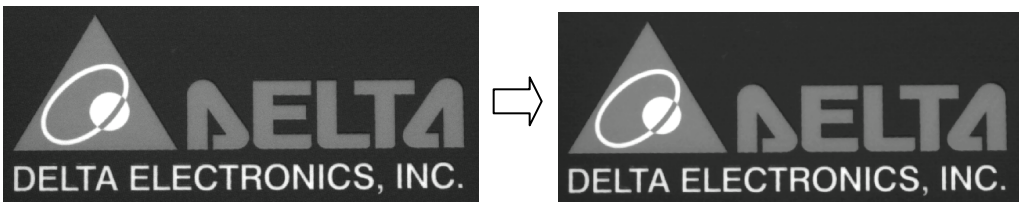
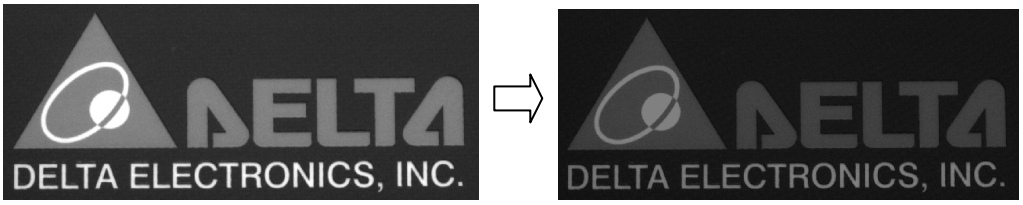
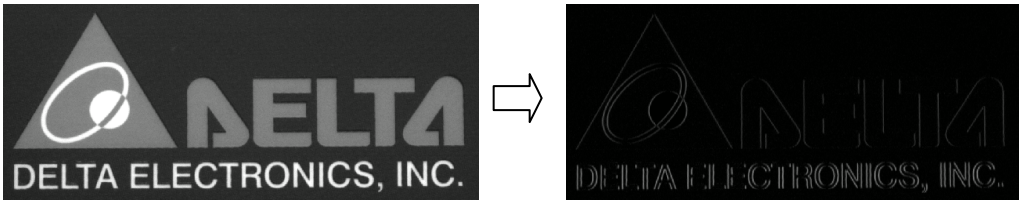
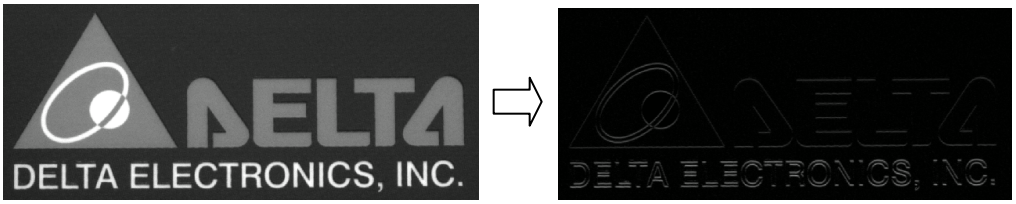
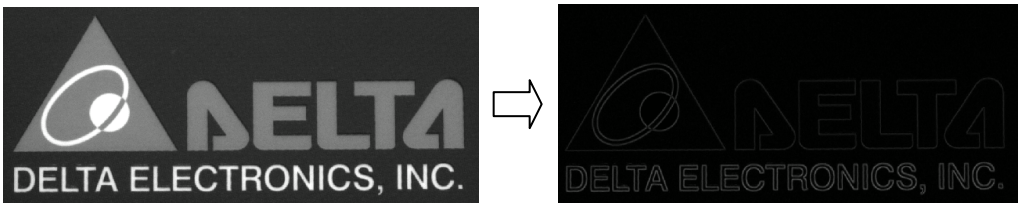
10.1.1 What is Pre-processing

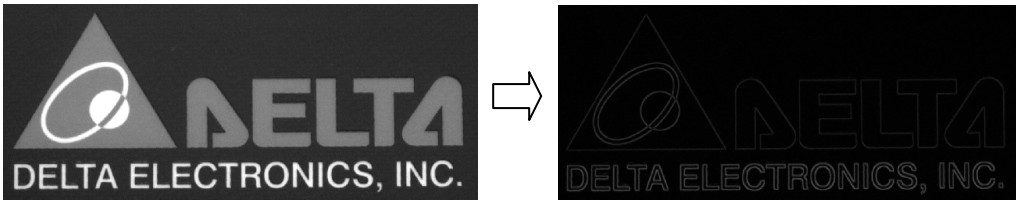
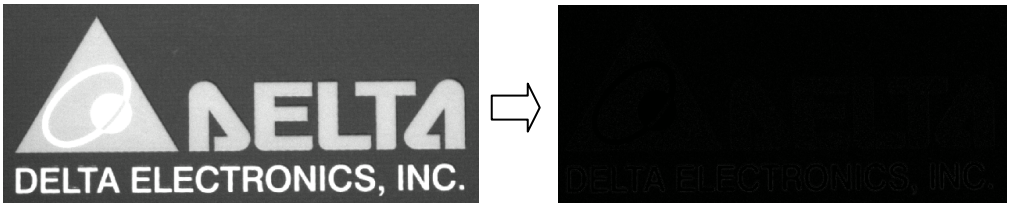
The original captured image can be applied with software pre-processing filters built into the controller. The original image can first be softened, edge detected, blurred, and so on to assist in subsequent inspection cycles. DMV1000 currently supports 12 pre-processing filters with 1~6 custom slots for a single inspection cycle. The pre-processing filter characteristics and common combinations are described in the following section.

10.1.2 Pre-processing Functions

The 12 pre-processing filters are described below.

Serial No.	Function	Description
	None	No pre-processing
1	Gray Cut	Convert grayscale into black or white pixels. 
2	Dilation	Dilation (expand) the white pixels. 
3	Erosion	Shrink the white pixels. 

4	Average	Take the Average with surrounding pixels to blur the image and reduce noise. 
5	Median	Take the median with surrounding pixels to reduce noise without blurring the image. 
6	Sharpen	Strengthen the contrast of edge transitions in the grayscale image; the overall grayscale level will decrease. 
7	Sobel X	Extract edge in the X direction 
8	Sobel Y	Extract edge in the Y direction 
9	Sobel	Extract edge in the XY directions 

10	Prewitt	Edge extraction in the XY direction with similar effects as Sobel. 
11	Roberts	Edge extraction in the XY direction achieves a similar effect as Sobel, but the edge lines are fainter. 
12	Laplacian	Edge extraction in the XY direction has a similar effect as Sobel, but the lines are thinner with stronger results at high contrasting edges. 
13	Subtract	

■ **Composite pre-processing:**

Each inspection supports up to 6 pre-processing combinations. As shown to the right, the pre-processing filters [Erosion], [Dilation], and [Median] are applied to the image in order.

The processed result is shown immediately to the user when each pre-processing function is selected.

■ **Upper right**  **(show all) function:**

✧ Checked: Three pre-processing filters are used as shown to the right.

Regardless where the [Target window] is located, the final image will be shown with the 3 applied pre-processing filters.

✧ Unchecked: Show image inside [Target window].As shown to the right, [Filter 3] shows the final processed result from pre-processing 1+2+3.[Filter 2] shows the processed result from pre-processing 1+2. The [Target window] can be moved around to inspect the results of pre-processing filters on different layers beforehand.

■ **Repetition and mask 3*3 (5*5) selection:**

The repetition and mask parameters can be edited for each pre-processing filter.

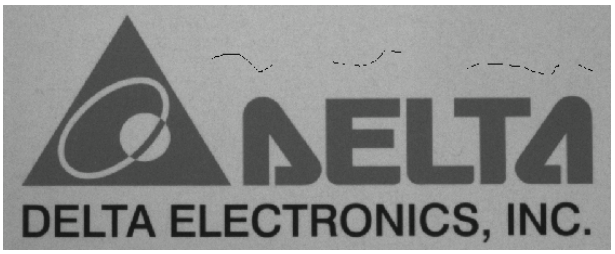
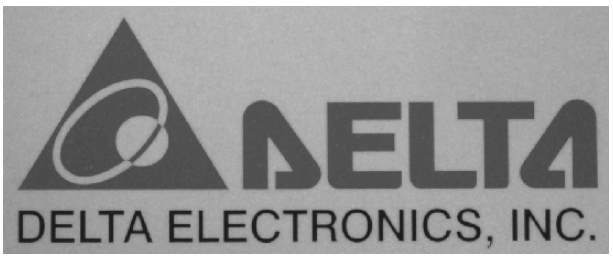
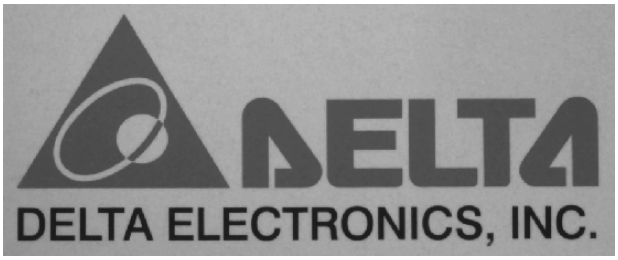
✧ For example, to apply the [Erosion] filter 2 times continuously, simply set the repetition count to 2 (instead of setting 2 individual [Erosion] filters back-to-back).

✧ Setting the mask parameter to work on 5*5 pixels will achieve more distinct results than 3*3.

	Gray Cut	Dilation	Erosion	Average	Median	Sharpen
Repetition		◎	◎	◎	◎	◎
Mask		◎	◎			

	Sobel X	Sobel Y	Sobel	Prewitt	Roberts	Laplacian	Subtract
Repetition	◎	◎	◎	◎	◎	◎	◎
Capture							◎

■ **Example of composite pre-processing:**

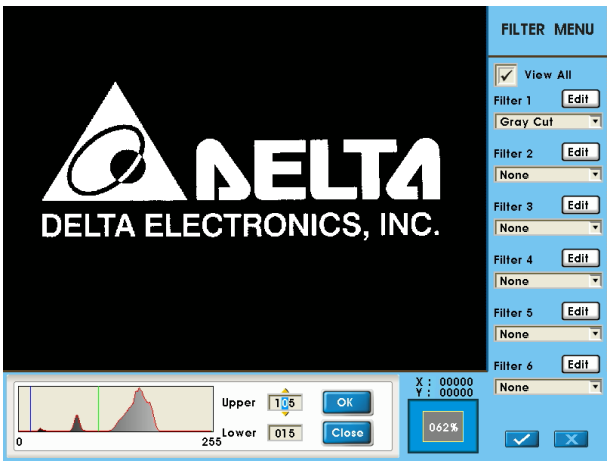
Steps	Filtered image	Description
1 (original image)		This is the original image. Please follow the steps below to filter out the noise and retrieve the clear text from the image.
2 (Dilation)		Use [Dilation] (white spreading) to remove the smaller dark noise. Note that the black text is also reduced.
3 (Dilation) + (Erosion)		Use [Erosion] (eroding into the white) after [Dilation] to restore the black text.
4 (Dilation) + (Erosion) + (Gray Cut)		Use [Gray Cut] on the noiseless image to retrieve the clear text image.

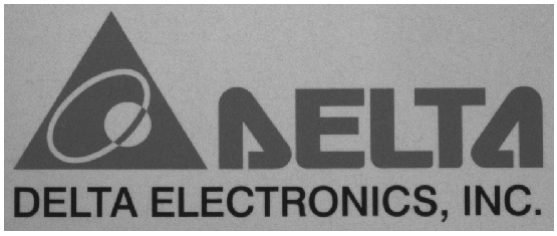
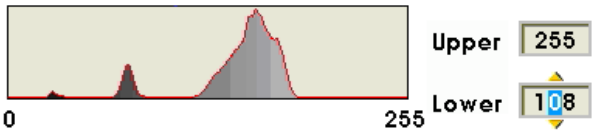
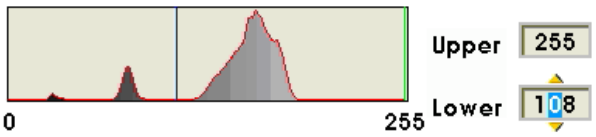
■ **Gray Cut instructions:**

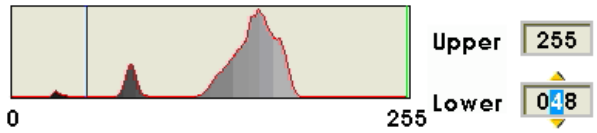
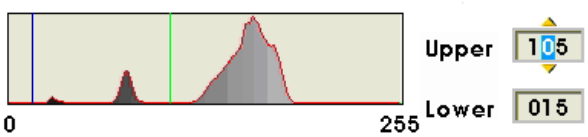
The Gray Cut pre-processing filter quantizes the grayscale levels into either black or white.

If a grayscale pixel falls in between two threshold grayscale levels, the pixel is set to white (grayscale 255).If a grayscale pixel falls outside (less than lower bound or higher than upper bound) the two threshold grayscale levels, the pixel is set to black (grayscale 0).

The grayscale histogram will be shown in the lower left when using the Gray Cut filter. The Gray Cut results can be observed on the display by adjusting the [Upper bound] and [Lower bound] values.



	Resulting image	Grayscale histogram and parameters
Original image		
Description:	There are three grayscale levels in the original image. 1) Background color: Lightest grayscale level (closest to 255) 2) Logo color: Medium grayscale level 3) Text color: Darkest grayscale level (closest to 0) The grayscale histogram displays three major distributions of pixels, with the largest block of the pixels in the background color.	
Delete background		
Description:	Keep the upper bound at 255 and modify the lower bound to 108. Now that the background grayscale pixels are in between the two thresholds (white), the background will be removed to give emphasis to the logo and text.	

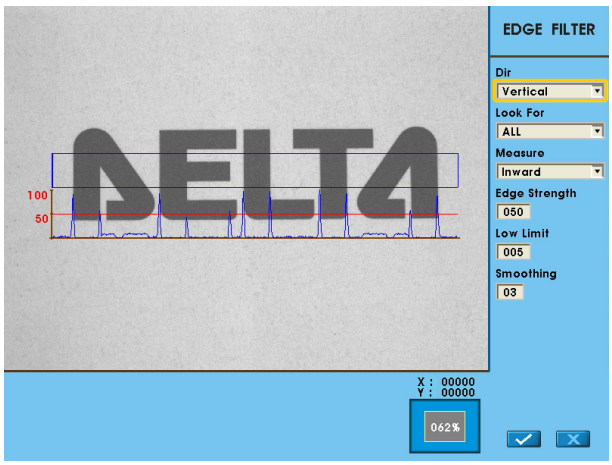
Keep text	DELTA ELECTRONICS, INC.	
Description:	Keep the upper bound at 255 and modify the lower bound to 48. Now that the logo grayscale pixels are in between the two thresholds (white), the logo will be removed to give emphasis to the text.	
Invert image	DELTA ELECTRONICS, INC.	
Description:	Modify the upper bound to 105 and lower bound to 15. Now that the logo and text grayscale pixels are in between the two thresholds (white) and the background grayscale images are outside (black), the image can be inverted.	

10.2 Edge filtering settings:

10.2.1 What is Edge Filtering

[Edge position], [Edge count], [Edge width], [Edge pitch], [Edge angle], [Edge tracking], and [Width tracking] functions are based on the results from edge detection.

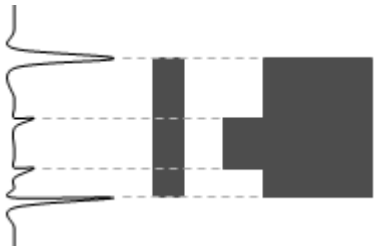
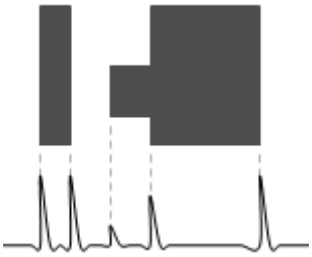
As shown to the right, each inspection function provides the user settings of [Parameters] > [Edge filter].The edge transition waveform is also displayed during the setup to find the appropriate threshold values for stable edge detection.



10.2.2 Edge Filtering Details

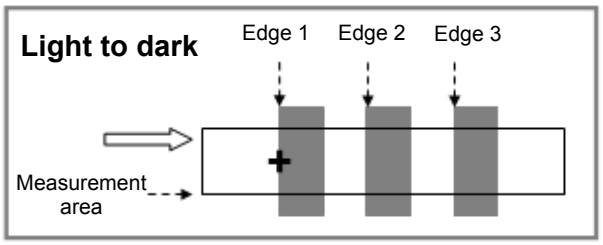
Edge filtering settings include [Direction], [Look for], [Edge strength], [Lower limit], [Smoothing], [Measure], [Reference], [Pitch upper] and [Pitch lower].The settings are described in this section.

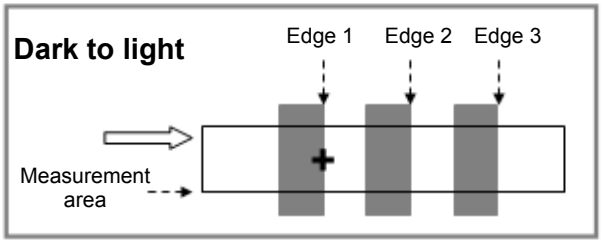
■ **Direction:**

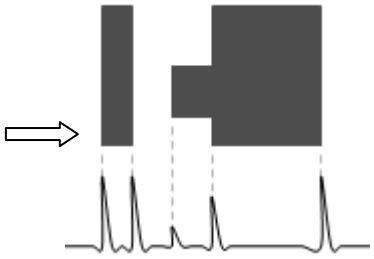
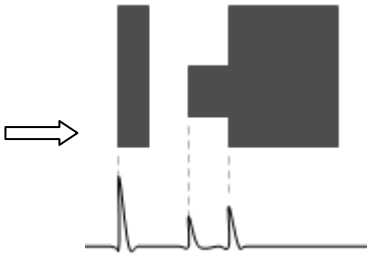
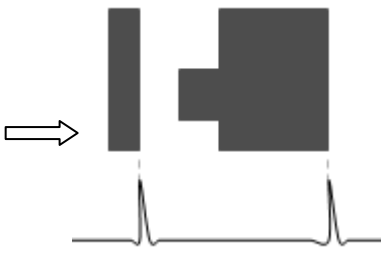
Top to bottom, bottom to top	Left to right, right to left
	
Description: Edge detection waveform is based on the grayscale gradient in the image. A larger grayscale gradient results in the higher peak to indicate a more distinct edge. The waveform will automatically orient itself with the [Direction] of edge scanning.	

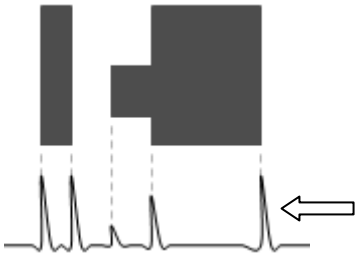
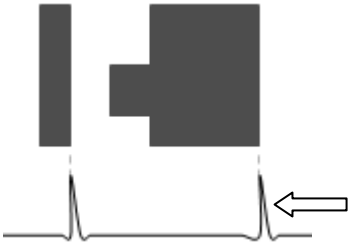
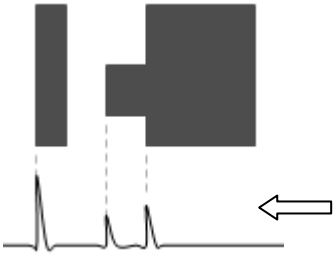
■ **Find:**

- ✧ Light to dark: Found 3 edges from bright to dark.
- ✧ Dark to light: Found 3 edges from dark to bright.
- ✧ All edges: Found total 6 edges.





All edges (scan from left to right)	Light to dark (scan from left to right)	Dark to light (scan from left to right)
		
Description: When scanning from left to right, [Light to dark] finds the edges in between white and black; [Dark to light] finds the edges in between black and white.[All edges] finds all edges with [Light to dark] and [Dark to light].		

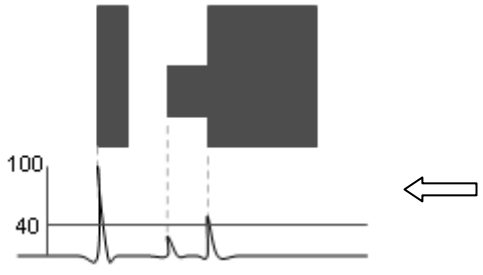
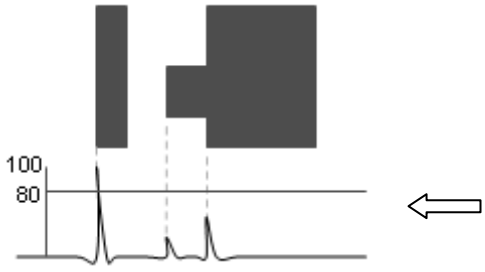
All edges (scan from right to left)	Bright to dark (scan from right to left)	Dark to bright (scan from right to left)
		
Description: Results for [Light to dark] and [Dark to light] will be reversed if the scanning direction is changed.		

■ **Edge strength: (default=50%)**

[Edge strength] is the peak threshold for determining the edge. As shown below, although there are three different peaks, the [Edge strength] threshold filters out the two lower peaks and detects the highest peak as an edge.

With grayscale gradient of 0~255, the maximum edge gradient is 255 when going from pure black to pure white and vice versa. The minimum and maximum grayscale gradient levels will be automatically detected and mapped by the system to 0~100% for the [Edge strength].If the grayscale gradient levels fall between 50~150, a 50% edge intensity indicates a threshold of (150-50)/2+50=100 (grayscale 0~255).

This percentage (%) is used to stabilize the edge detection even if the brightness of the light source changes. If the grayscale gradient levels become 50~250 due to a change in the external light source (with this new range still mapped to 0~100%), the same 50% edge intensity results in the (250-50)/2+50=150 (grayscale 0~255) threshold level. In effect, the threshold is automatically adjusted when the histogram changes due to external light source without sacrificing the edge detection performance.

Dark to light, scan from right to left (edge strength=40)	Dark to light, scan from right to left (edge strength=80)
	
Description: As shown to the left, 40% [Edge strength] results in 2 edges from the first and third peaks. As shown to the right, 80% [Edge strength] results in 1 edge from the third peak.	

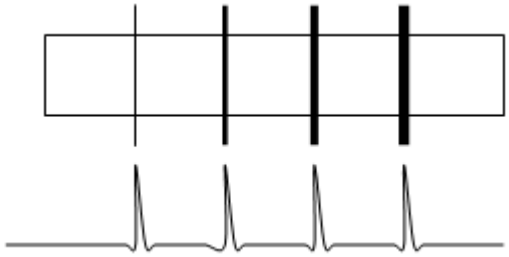
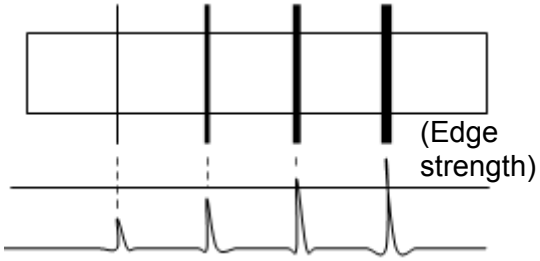
■ **Lower limit: (default=05)**

The [Edge strength] function automatically maps grayscale gradient levels of 0~255 to 0~100%, which stabilizes the edge detection under a variable light source.

[Lower limit] sets the absolute grayscale gradient level. A value of 80 (0~255) means that any peak under 80 will be filtered out and ignored.

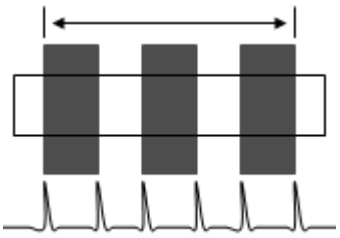
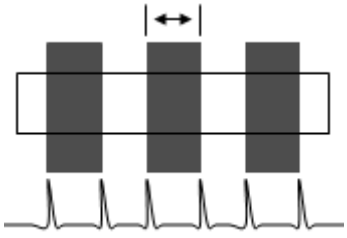
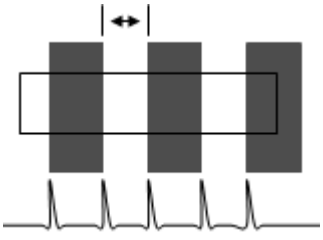
- **Smoothing: (default=03)**

[Smoothing] controls the noise filter performance where a higher value denotes more surrounding pixels are being used to average out the current pixel grayscale. The waveform is smoothed out before edge detection is performed. Conversely, thinner edges require smaller [Smoothing] values so as to not deteriorate the edge details.

Smoothing=1	Smoothing=6
	
Description: Four different edge widths are as shown. To the left, [Smoothing=1] disables the pixel averaging filter and therefore the peaks are identical for the 4 lines. To the right, [Smoothing=6] enables the pixel averaging filter and therefore the thinner line results in a lower peak. Using peak levels coupled with [Edge strength] to filter out edges 1 and 2, leaving the intended edges 3 and 4.	

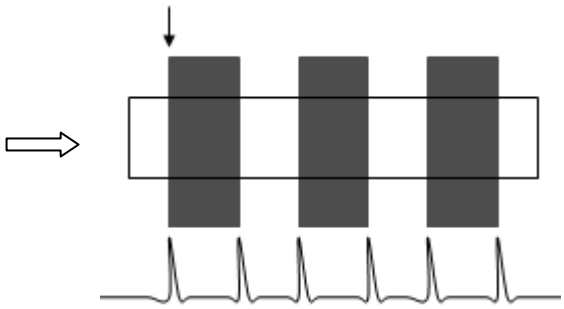
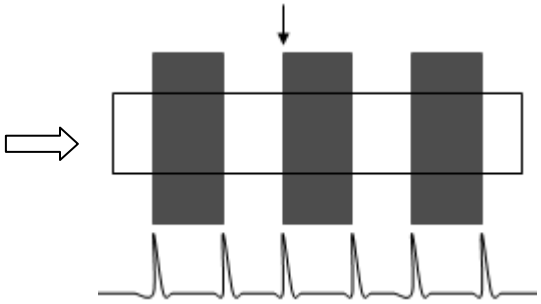
- **Measure: (for edge width and width tracking only)**

Select the [Inward] or [Outward] method for measuring the width.

Inward	Outward (even number of edges)	Outward (odd number of edges)
		
Description: Most common three measurements of edge width as shown. Inward: The 2 outer most edges are referenced to calculate the edge distance. Outward (even number of edges): The 2 inner most edges are referenced to calculate the edge distance. Outward (odd number of edges): As the number of edges is not symmetric, the inner most left edge is referenced to calculate the distance between the two edges.		

■ **Reference: (for edge position and edge pitch only)**

Select n-th edge for inspection.

Reference=1	Reference=3
	
Description: To the left (reference=1), the first edge is referenced as output for the detection. To the right (reference=3), the third edge is referenced as output for the detection.	

■ **Pitch upper/pitch lower: (for edge pitch only)**

The pitch width can be filtered using the [Pitch upper] and [Pitch lower] parameters.

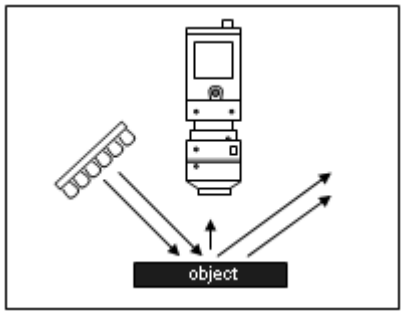
For example: Four pitch widths of 40, 60, 80, and 100 are detected from [Edge strength] filtering. With the [Pitch upper] is set to 90 and [Pitch lower] set to 50, pitch widths outside this range will be filtered out and therefore 2 widths (60 and 80) will be the result.

10.3 Lighting:

10.3.1 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.

1. **Dark field lighting:** Smooth surfaces appear darker
   The CCD camera does not fall on the same axis as the lens and the angle is not perpendicular. Light hitting the smooth surface on the object will reflect away from the camera 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.

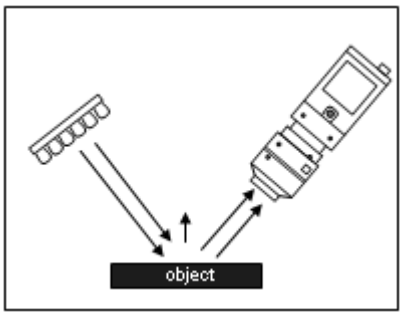


■ Raised text on black plastic

(test item)

(dark field lighting)

2. **Bright field lighting:** Smooth surfaces appear brighter
   The CCD camera and lens fall on the same axis as the light source, and the angle is perpendicular. Light is directly reflected off the smooth surface on the object into the CCD. As a result, the smooth surfaces appear brighter and the rough areas scatter light away from the CCD to appear darker. Bright field and dark field lighting are inversely related in the resulting image, but excessive glare should also be avoided in bright field lighting.



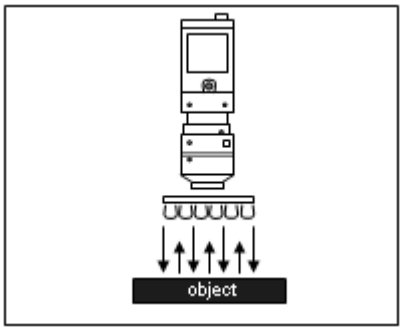
■ Raised text on black plastic

(test item)

(bright field lighting)

3. Front lighting:

Front lighting is a commonly used technique, with ring or strip light source, for imaging objects. As the ring light is installed at a different angle, it casts a different shadow effect. For highly reflective objects, the diffuser or soft light series can be used to obtain a clear imaging.

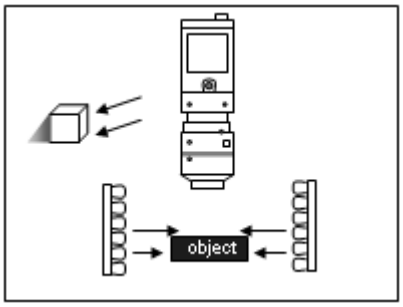


■ Lighting on flat text

4. Oblique lighting:

Oblique lighting creates horizontal 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°, 90° used for ring lighting, 0° and 30° can be used for oblique lighting.

To reduce errors caused by the shadowing, oblique lighting should be avoided in edge detection.



■ Printed text on the fuse

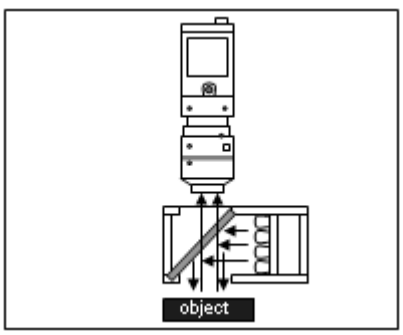
(test item)

General Ring lighting

Low angle Ring lighting

5. Coaxial lighting:

The light source can be either inside or outside the lens. 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.

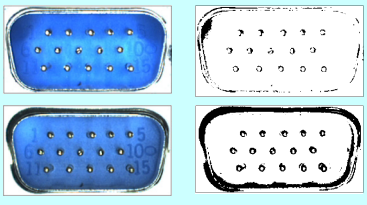


■ Measuring a pin connector

(test item)

(general lighting)

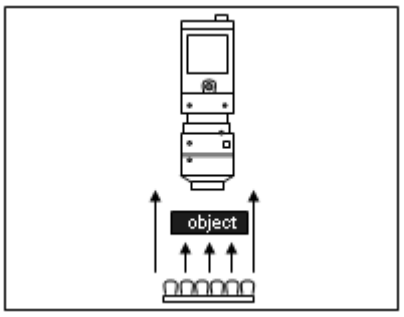
(coaxial lighting)



6. 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.

Back lighting includes:



■ Measuring bore holes and diameters

(test item)

(general ring lighting)

(back lighting)