

\* Read this manual through for proper operation before use.  
\* After understanding, keep this manual so it is available whenever necessary.  
\* This product is not designed to be used as a safety device to protect human body.

## 1 Before use

### What is Timing Comparator?

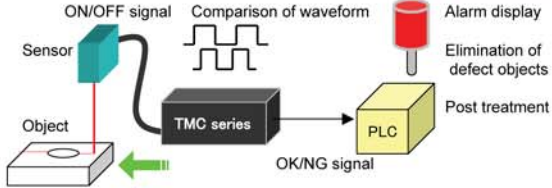
This is a brand new sensor signal processing unit to detect the sensor output signal by using not only ON/OFF but "time" including width and position. By combining the sensor, it enables easy detection of object presence, object direction, and wrong type object.

**Simple operation** - Completes registration with a single teaching.

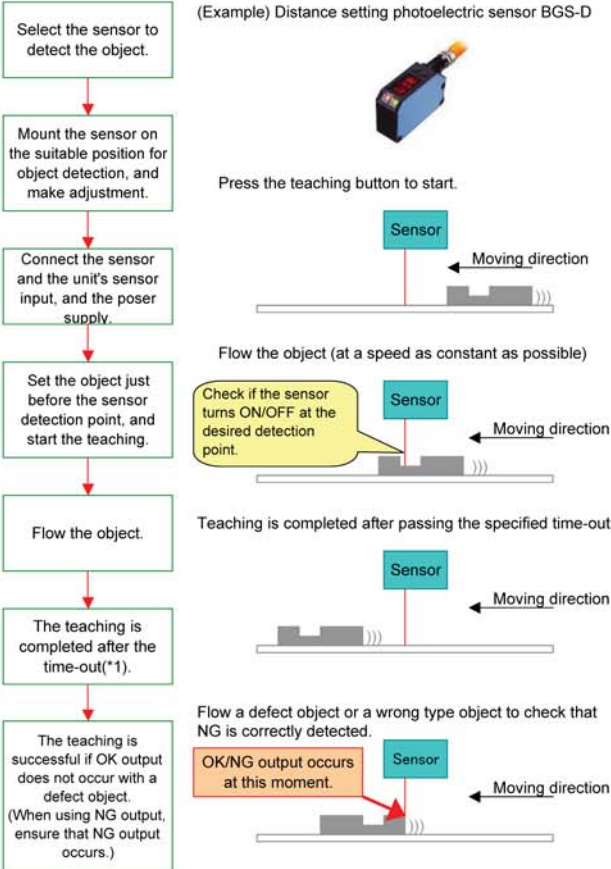
**High speed process** - With 5 μs of sampling cycle, detects the sensor signal with high accuracy.

**Stable detection** - Enables to follow the speed-up/slowdown of object speed, since the width of ON/OFF signal is detected with "ratio" of time.

International  
PATENT PENDING



### Setup flow

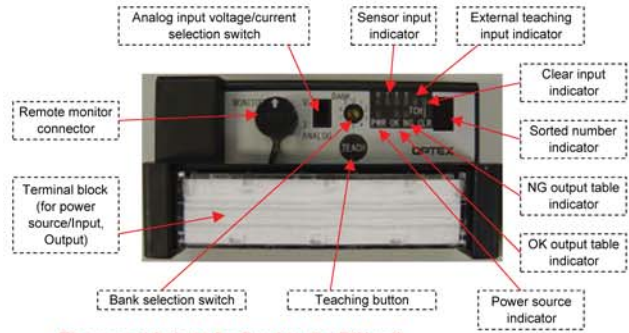


\* Refer to the page 4 for details.

## ? Important remark on TMC

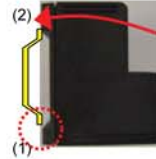
- Any sensor can be connected as long as it is an open collector output sensor such as NPN and PNP.
- A NPN sensor and a PNP cannot be connected together.
- To detect the object moving at a high speed, using the sensor with rapid response speed improves accuracy. (Reduce the value of IN FILT setting value.)

## Buttons and functions



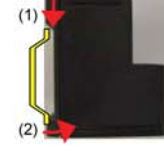
The rear side is to be fixed to the DIN rail.

How to fix



- Hook the lower claw to the DIN rail.
- Press the upper claw inside.

How to remove



- Press from above.
- The lower claw is removed.

## Alignment of terminal blocks and functions

	IN0	IN1	IN2	IN3	AIN	CLR	BK0	BK2	OK	NG
+1	-1	+2	-2	+3	-4	TCH	BK1	BK2	-3	+4

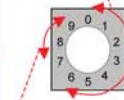
Terminal	Name	Function
IN0	Sensor input 0	The sensor input to detect the object. Connect with the sensor output wires. Functions as the preset input of analog input (for rising) when selected in PRESETIN as a setting value.
IN1	Sensor input 1	
IN2	Sensor input 2	
IN3	Sensor input 3	
AIN	Analog input	Analog input + side. Accepts the 0 to 5 V and 0 to 20mA input.
-A	Analog input common	Analog input - side. Internally connected with -1, -2, and -3 terminals.
CLR	Clear input	The input to turn OFF the OK, NG, and BK 0 to 2 output as well as to clear the current value of OK counter. Operates at rising.
TCH	Teaching input	External teaching input. Teaching starts at rising.
BK0	Bank input/output 0	The input to externally switch the bank number. Or the output of the sorted bank number. Functions as input when SORTING is set to OFF.
BK1	Bank input/output 1	
BK2	Bank input/output 2	
OK	OK output	The output to turn on when the concordance rate is the OK LEVEL setting value or more.
NG	NG output	The output to turn on when the concordance rate is below the OK LEVEL setting value and is the NG LEVEL setting value or more.
+1	Power supply +	Power supply + side (12 to 24 V DC). All are internally connected and used for sensor power supply.
+2		
+3		
+4		
-1	Power supply -	Power supply - side. All are internally connected and used for sensor power supply.
-2		
-3		

## Bank selection table

Parameter BANK	Bank selection switch	BK 0 Terminal	BK 1 Terminal	BK 2 Terminal	Bank Number	
BK0-2 (SWTCH)	0 - 6	Invalid	Invalid	Invalid	0 - 6	
		0			0	
		1			1	
		2			2	
		3			3	
		4			4	
		5			5	
		6			6	
		7 - 9	OFF	OFF	OFF	0
			ON	OFF	OFF	1
			OFF	ON	OFF	2
			ON	ON	OFF	3
			OFF	OFF	ON	4
	ON		OFF	ON	5	
		OFF	ON	ON	6	
		ON	ON	ON	0	

Specified by the setting value.

Specified by the switch.

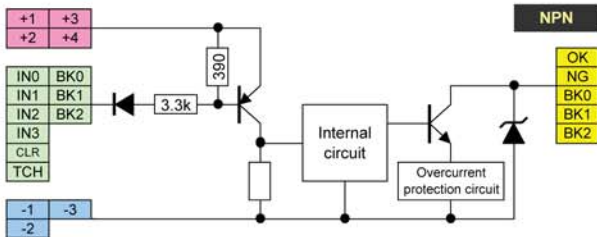


Specified by the external input.

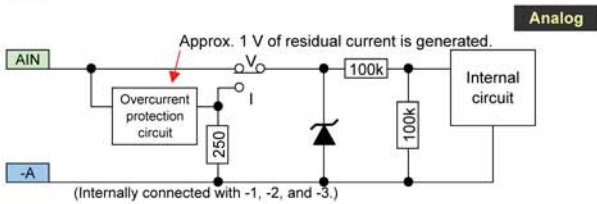
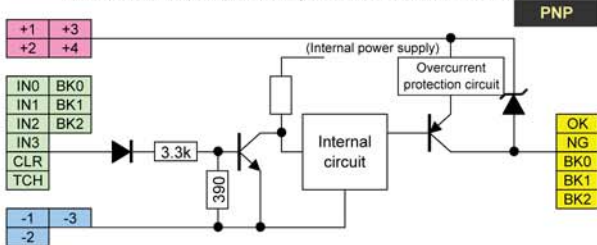
Setting value SORTING	BK 0 Terminal	BK 1 Terminal	BK 2 Terminal	Selectable bank range
OFF		Input		0 - 6
2	Output	Input		0, 2, 4, 6
3, 4	Output	Input		0, 4
5~7		Output		0

\* When using BK0-2 terminal switched to output as Bank selection input, the input is regarded as "OFF."

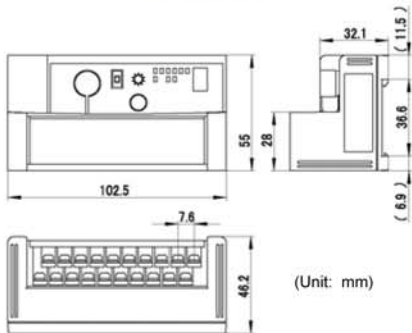
## Input/Output circuit



\* The input and output are internally connected in BK0-2 terminal.



## Dimensions



## Specification

Type	TMC-N11	TMC-P11
Supply voltage	12 - 24 DC V $\pm$ 10%	
Current consumption	Max. 80 mA / 24 V DC	
Input signal	No insulation source (NPN)	No insulation sink (PNP)
Sensor input	4	
Teaching/Clear input	1 for each	
Bank selection	3 (7 types with binary format)	
Input ON voltage	Min. 7.8 V	
Input OFF current	Max. 1.0 mA	
Input current	Typ. 7.1 mA / 24 V DC	
Input impedance, Input voltage range	3.3k ohm, 0 - Supply voltage (AIN excluded) 200k ohm, 0 - 6.5 V (AIN voltage input) 250 ohm, 0 - 26 mA (AIN current input)	
Input response time	5 $\mu$ s - 25.6 ms	
Output signal	No insulation NPN Open collector	No insulation PNP Open collector
OK/NG output	1 for each	
Sorting output	3 (7 types with binary format) Used together with Bank selection input	
Maximum open/close capacity	Max. 100 mA	
Output leakage current	Max. 100 $\mu$ A	
Output residual voltage	Max. 0.8 V	Max. 1.8 V
Output response time	Max. 5 $\mu$ s	
Analog resolution	10 bit (1 bit = 6.45 mV / 25.8 $\mu$ A)	
Accuracy	$\pm$ 0.2 % of F.S. (F.S. = 6.6 V / 26.4 mA)	
Linearity	$\pm$ 0.2 % of F.S.	
Temperature coefficient	$\pm$ 80 ppm/ $^{\circ}$ C	
Operating temperature	0 - 55 $^{\circ}$ C	
Operating humidity	35 - 85 %/RH	
Storage temperature	-20 - 70 $^{\circ}$ C	
Storage humidity	25 - 95 %/RH	
Anti-vibration	10 - 55 Hz Amplitude 1.5 mm	
Anti-impact	5 G (10 times)	
Housing material	ABS	
Protection category	IP00	
Weight	Approx. 130 g	

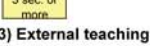
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## 2 Teaching

### How to perform teaching

#### (1) Remote monitor (CVS-M1)

Depress 3 sec. or more on the monitor display.



#### (2) Teaching button of TMC

Press the teaching button on the main unit. \*



#### (3) External teaching

Turn ON the TCH terminal. \*



\* Executing once again cancels the request.

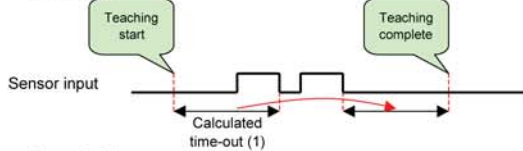
## Pattern registration by teaching

### When only one object flows:

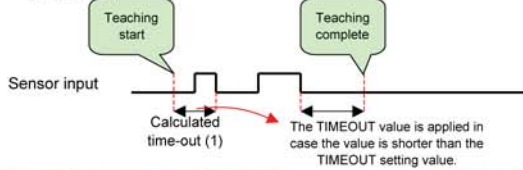
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Teaching automatically completes some time after input stops changing. The time from stopping changing to terminating (1) is called as "the time out." The duration of time out is from teaching start up to the 2nd change of the sensor input, and it is always longer than the TIMEOUT setting value (initial value: 2 sec.).

#### (Example 1)



#### (Example 2)



### When objects continuously flow:

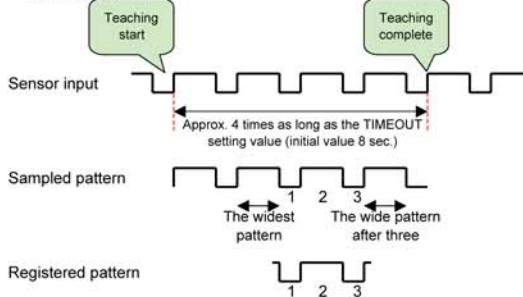
PATENT PENDING

When objects flow continuously, teaching cannot complete by the time-out due to continuous input changing. In this case, teaching can complete with either of the following conditions:

- (1) The time approx. 4 times as long as the TIMEOUT setting value has passed.
- (2) The sampled pattern counts are 255 or more.

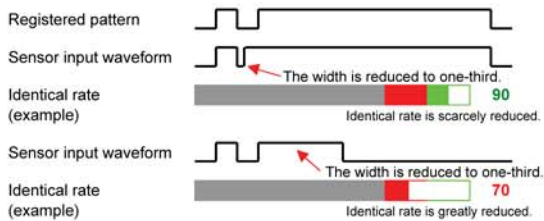
For registration, find the widest pattern first, and register the wide patterns (of more than 95% of the widest pattern) after three patterns (see the following figures).

#### (Example 3)

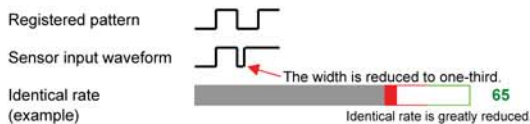


## How to compare patterns

"Time weighing" is performed for comparing waveforms. The identical rate of narrow parts among registered ones are reduced less than that of the wider parts.



Perform teaching of the thin parts for strict comparison of thin parts. (Manually move the object to make the wide parts timed-out during detection.)

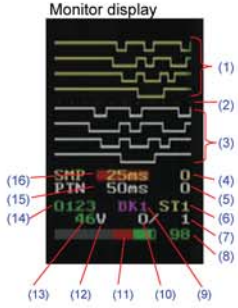


- \* Detects 4 sensor input points as one pattern.
- \* Counts as a pattern when a point of sensor inputs changes.
- \* Performs pattern comparison at the moment the last ON/OFF status registered in teaching and the sensor input is identical.

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### 3 Detail and operation of remote monitor display

TMC series allow operation only by the main unit. For easier operation, however, connection of optional remote monitor (CVS-M1) is recommended to modify various setting values and to check the waveforms. (It can be removed during operation.) The description below is for the remote monitor display and its operation.



- (1) **Sensor input waveform**  
From top to bottom, sensor input 0, 1, 2, and 3. The right side is the new pattern.  
Green: OK-judged pattern position  
Red: NG-judged pattern position
- (2) **Time axis of waveform**  
Clearance between red points is the time displayed on (15) and (16).
- (3) **Registered pattern waveform**  
Displays the waveform teaching has been performed.
- (4) **Input waveform display starting pattern count**  
In displaying the input waveform, starts from the last patterns by specified counts. (0 - 255)

(12) **Analog input selection status**  
Displays the analog input voltage/current selection switch status.  
V: Voltage input I: Current input

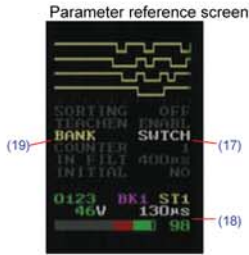
(13) **Analog input value**  
Displays the value after offset/span conversion as 0 - 9999.  
Displays FFFF when inputting overvoltage.

(14) **Sensor input ON/OFF status**  
0 - 3: Turned ON.  
(Number in accordance with IN0 - IN3)  
- : Turned OFF.  
X : Masked.

(15) **Registered pattern waveform display time**  
Time axis that the registered pattern waveform displays (the time between the red marks).

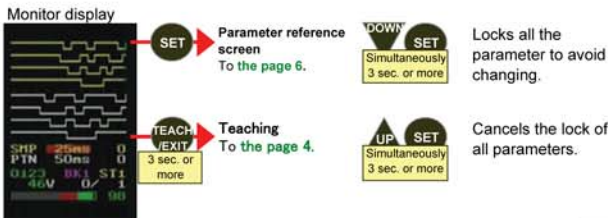
(16) **Sensor input waveform display time**  
Time axis that the sensor input waveform displays (the time between the red marks).

- (5) **Registered waveform display starting pattern count**  
In displaying the registered waveform, starts from the last patterns by specified counts. (0 - 251)
- (6) **Sorted result**  
Displays the sorted bank number. (0 - 6: Bank number, -: Without)
- (7) **OK counter setting value**  
Displays the COUNTER setting value. Displays A00 when the setting value is
- (8) **Concordance rate**  
Concordance rate when comparing the patterns. (0 - 100)
- (9) **Bank number**  
Displays the current bank number. (0 - 6)
- (10) **Actual OK counter value**  
Displays the actual OK counter value. (0 - 999)
- (11) **Concordance rate bar graph**  
Gray: Without object (less than NG LVL)  
Red: NG (less than OK LVL)  
Green: OK (OK LVL or more)



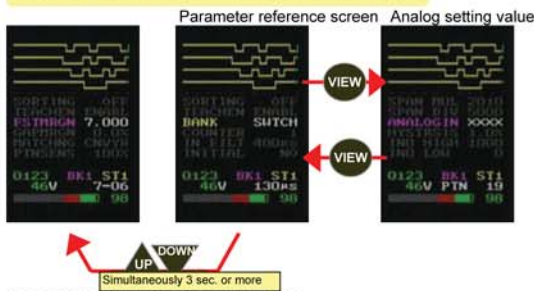
- (17) **Setting value**  
Displays the setting value of menu.
- (18) **Processing time**  
Time to detect the concordance rate with the registered pattern.
- (19) **Menu**  
Yellow: Common to the all banks  
Purple: The setting value switches according to each bank.  
Blue: Locked

#### Operation of monitor display



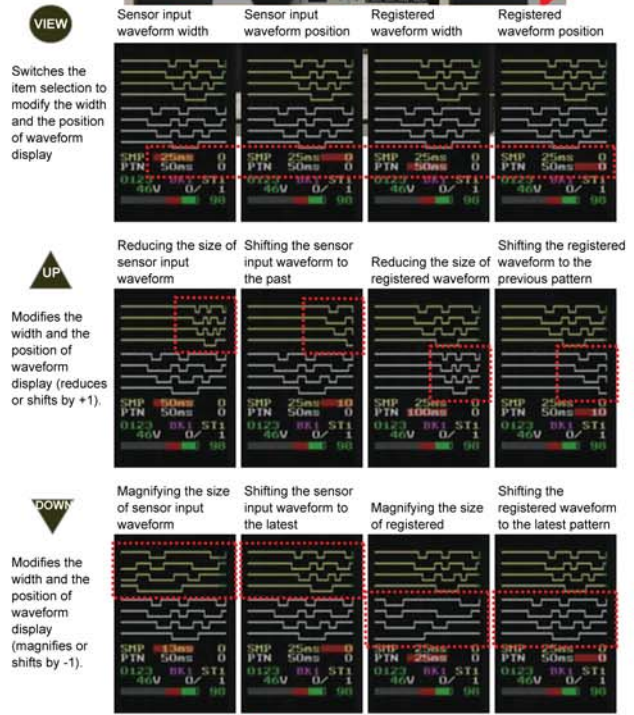
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#### Selecting analog setting value/expert setting value

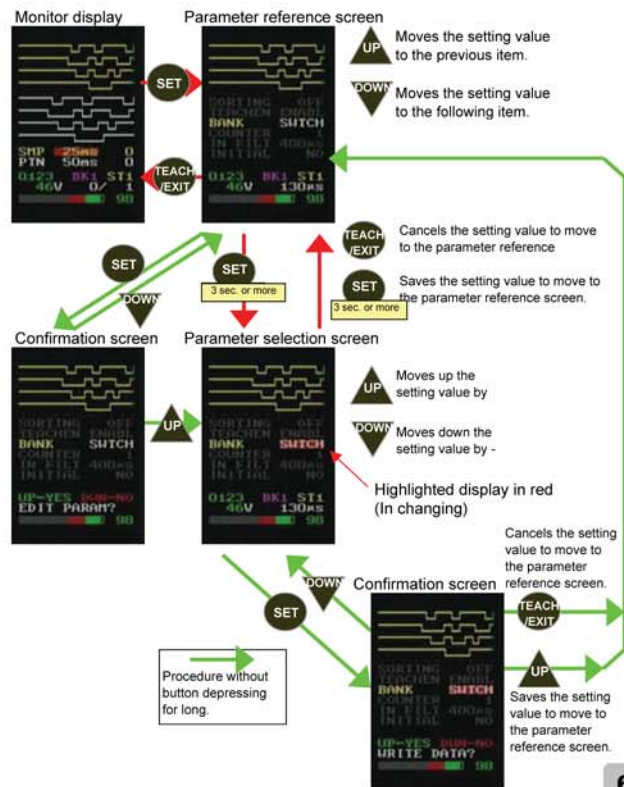


The expert setting value is displayed, too. (It is hidden when switched to the analog setting value.)

#### Operation of waveform display



#### Operation of parameter reference/selection screen



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## 4 Settings

**LCD display** Settings in yellow are common to all banks  
**LCD display** Settings in purple switch to the individual bank value  
 Letters in blue: Describes when to be set

### Standard settings

Parameter <b>LCD display</b>	Setting range (Default)	Description
Bank selection <b>BANK</b>	0 - 6, BK0-2* (BK0-2*)	Specifies the bank number. <b>0 - 6:</b> Switch to the bank number 0 to 6. <b>BK0-2</b> or <b>SWTCH:</b> Specifies the bank number by the bank input terminal (BK0 to 2) or the bank selection switch. * Displayed as <b>SWTCH</b> when the bank selection switch is 0 to 6, and as <b>BK0-2</b> when it is 7 to 9.
OK counter setting value <b>COUNTER</b>	1 - 1000 (1)	Selects the count value of OK counter. When OK counter reaches the setting value or more, OK output is turned ON and OK counter is cleared. If the OK counter is below the setting value, OK output is not turned ON. In NG judgment, however, NG output is turned ON. Even under Sorting Function a common counter is used. (Output from either bank increases the count.)
Filter time to eliminate input noise <b>IN FILT</b>	0 $\mu$ s - 25.6 m (400 $\mu$ s)	Selects the filter time to eliminate the chattering and noise of sensor input. Selectable value: <b>0 <math>\mu</math>s, 12 <math>\mu</math>s, 25 <math>\mu</math>s, 50 <math>\mu</math>s, 100 <math>\mu</math>s, 200 <math>\mu</math>s, 400 <math>\mu</math>s, 800 <math>\mu</math>s, 1.6 m, 3.2 m, 6.4 m, 12.8 m, 25.6 m.</b> Extends the time within the range which does not deteriorate the response when the sensor input (IN0 - IN3) are instable for chattering.
Initialization <b>INITIAL</b>	NO, YES (NO)	Initializes the setting values. <b>NO:</b> No initialization <b>YES:</b> Enter this setting to initialize all settings. (The display disappears and restart after approximately a second.)
Input mask <b>MASKING</b>	0123, X123 - OXXX (0123)	Selects ENABL/PRHBT of the sensor input (IN0 - 3). <b>0123:</b> All inputs are valid. <b>X123:</b> IN0 becomes invalid. <b>OX23:</b> IN1 becomes invalid. <b>XX23:</b> IN0 and IN1 become invalid. Hereinafter, the part of X shows invalid input and the part of number shows valid input. Prohibits the specified input to protect malfunction in case the sensor input signal used at the other bank has negative effect.
NG output level <b>NG LVL</b>	0 - 100 (60)	Selects the lower limit value to turn ON NG output. Set the value satisfying the following conditions: equal to or less than the identical rate at the defect object detection, and more than the identical rate at the irrelevant parts detection. Setting is necessary only when NG output is used.
OK output level <b>OK LVL</b>	0 - 100 (80)	Selects the lower limit value to turn ON OK output. Set the intermediate value satisfying the following conditions: below the concordance rate obtained at the conforming object detection, and equal to or more than the concordance rate obtained at the defect object detection.
Output holding, OFF <b>OFF DLY</b>	HOLD, CONT, 0.01m - 5.00 s (50.0 m)	Selects the output holding function and OFF delay time of OK/NG Bank output. <b>HOLD:</b> Holds the output when turned ON. CLR input turns the output OFF. If NG judgment occurs during OK output, the output switches to NG output. (The opposite pattern does not occur.) <b>CONT:</b> Holds the output when turned ON, and switches to updated judgment output when it exceeds NG LVL or OK LVL. <b>0.01 m - 5.00 s:</b> Specifies OFF delay time.
ON delay <b>ON DLY</b>	0.00m - 5.00 s (0.00 m)	Selects the ON delay time of OK/NG Bank output. <b>0.00 m - 5.00 s:</b> Specifies ON delay time. Set the ON delay time to the same width as the object to avoid incorrect output when incorrect OK/NG output occurs while the object is passing.
Sorting number <b>SORTING</b>	OFF, 2 - 7 (OFF)	Compares the multiple bank patterns sequentially, and outputs the bank number of the highest concordance rate. The processing time becomes longer as the number of sorted banks increases. <b>OFF:</b> Sorting function is deactivated. (Compares the selected bank pattern only.) <b>2:</b> Includes the next bank pattern and compares the two bank patterns in total. For example, when "1" is set for bank "1," the patterns of bank "1" and "2" are compared. For the number over bank "7," the setting is ignored. <b>3 - 7:</b> As the setting "2," compares the successive banks. (When "3" is selected, three banks in total, and when "7," seven banks in total.) * To use the sorting function, ensure that the banks have the same sensor input status (ON/OFF) at teaching completion. To use analog input, set the upper and lower limit values such as IN0 HIGH, IN0 LOW to the same value as for all the banks.
Teaching ON/OFF selection <b>TEACHEN</b>	ENABL, PRHBT (ENABL)	<b>ENABL:</b> Teaching ON <b>PRHBT:</b> Teaching OFF (excluding external teaching)

### Analog settings

Parameter <b>LCD display</b>	Setting range (Default)	Description
Analog input selection <b>ANALOGIN</b>	XXXX, OXXX - 0123 (XXXX)	Specifies the sensor input (IN0 to IN3) to switch the signal that is turned ON/OFF between/outside the analog input upper/lower limit values. "0" to "3": sensor input. <b>XXXX:</b> Detects by ON/OFF input of IN0 to IN3. <b>OXXX:</b> Switches IN0 to the detection result of analog input (turns ON when is equal or less than IN0 HIGH and when the lower limit value is equal to or more than IN0 LOW in AIN analog input). <b>X1XX:</b> Switches IN1 to the detection result of analog input (turns ON when is equal or less than IN1 HIGH and when the lower limit value is equal to or more than IN1 LOW in AIN analog input). <b>01XX:</b> Switches IN0 and IN1 to the detection result of analog input. .... <b>0123:</b> Switches all to the analog input.
Hysteresis <b>HYSTRSIS</b>	0.0 % - 6.3 % (1.0 %)	Specifies hysteresis of the analog upper/lower limit values. The setting value is ratio to the full scale (6.6 V / 26.4 mA).
Input 0 upper limit value <b>IN0 HIGH</b>	0 - 9999 (1000)	Specifies the analog input upper limit value when switching the sensor input IN0 to analog input. IN0 is judged as ON when between the specified upper limit value and the lower limit value (IN0 LOW).
Input 0 lower limit value <b>IN0 LOW</b>	0 - 9999 (0)	Specifies the analog input lower limit value when switching the sensor input IN0 to analog input.
Input 1 upper limit value <b>IN1 HIGH</b>	0 - 9999 (2000)	Specifies the analog input upper limit value when switching the sensor input IN1 to analog input.
Input 1 lower limit value <b>IN1 LOW</b>	0 - 9999 (1000)	Specifies the analog input lower limit value when switching the sensor input IN1 to analog input.
Input 2 upper limit value <b>IN2 HIGH</b>	0 - 9999 (3000)	Specifies the analog input upper limit value when switching the sensor input IN2 to analog input.
Input 2 lower limit value <b>IN2 LOW</b>	0 - 9999 (2000)	Specifies the analog input lower limit value when switching the sensor input IN2 to analog input.
Input 3 upper limit value <b>IN3 HIGH</b>	0 - 9999 (4000)	Specifies the analog input upper limit value when switching the sensor input IN3 to analog input.
Input 3 lower limit value <b>IN3 LOW</b>	0 - 9999 (3000)	Specifies the analog input lower limit value when switching the sensor input IN3 to analog input.
Analog input offset <b>OFFSET</b>	-5000 - 5000 (0)	Specifies the analog input offset value. Adds the specified value to the input value (full scale 0 to 5000) before span correction.
Analog input preset <b>PRESET</b>	0 - 9999 (2500)	Specifies so that the analog input value becomes the preset value when any input of IN0 to IN3 rises. (Specifies IN0 to IN3 in PRESETIN.)
Preset control input selection <b>PRESETIN</b>	OFF, IN0 - IN3 (OFF)	Specifies the input to start the analog input preset function. Normally select the sensor input switched to analog input in ANALOGIN. Turns OFF when unused. The preset function is cancelled by power on or by switching the bank.
Input span (multiplier) <b>SPAN MUL</b>	0 - 9999 (5000)	Specifies the coefficient (numerator) to be multiplied after deducting the analog input offset value. The multiplied value is the solution of (SPAN MUL $\times$ SPAN DIV).
Input span (divisor) <b>SPAN DIV</b>	0 - 9999 (5000)	Specifies the coefficient (denominator) to be multiplied after deducting the analog input offset value.

### Expert settings

Parameter <b>LCD display</b>	Setting range (Default)	Description
Allowable object speed (High-speed) <b>FSTMRGN</b>	1,000 - 84.33 (7,000)	To specify the maximum speed allowable for correct detection, select the value to multiply the setting pattern time by the unit of multiplier.
Tolerable time deviation <b>GAPMRGN</b>	0.0 % - 49.6 % (0.0 %)	Specifies the rate to ignore the time deviation of pattern. When lower than the specified rate against the average time, the time deviation is ignored. Set it higher when the sensor input ON/OFF width of conforming products varies to a certain degree.
Matching mode <b>MATCHING</b>	DIRCT, ABSNC, CNVYR (CNVYR)	Selects the mode to compare the ON/OFF patterns. <b>DIRCT:</b> Calculates the concordance rate from the value with the largest time or pattern deviation. Use to detect the only partial deviation. (For detection of orientation direction and wrong type objects) <b>ABSNC:</b> Averages the total of time and pattern deviation. Use to ignore the slight deviation. (For detection of presence) <b>CNVYR:</b> Same as DIRCT setting. Accepts the gradual change of object moving speed to allow the correct detection while the conveyor
Coincidence influence on the different patterns <b>PTNSENS</b>	0 % - 196 % (100 %)	When deviation from the registered pattern exists, specifies the rate to reflect it in the coincidence. <b>0 %:</b> The concordance rate is not lowered even when the ON/OFF patterns are different. <b>100 %:</b> When the ON/OFF patterns are different, the coincidence is lowered by the same rate as when the pattern width rate is different in 100%. It is ignored when using only one sensor input.
Allowable object speed (Low-speed) <b>SLWMRGN</b>	1,000 - 84.33 (50.20)	Low speed version of FSTMRGN setting. Enables to specify the lowest speed allowable for correct detection by the unit of divisor.
Minimum teaching time out <b>TIMEOUT</b>	1 s - 20 s (2 s)	Specifies the minimum time out in teaching. Sampling time in teaching the cyclic pattern takes 4 times as long as the setting value.

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