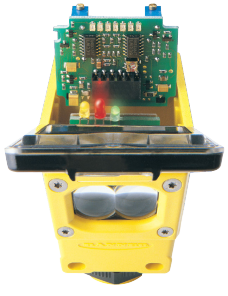
Datasheet

Plug-In Logic and Display Modules for Q45 Series Sensors



Module Model Number	Output Timing		7-Segment Signal Strength Display
	ON/OFF Delay	One-Shot/Delayed One-Shot	
45LM5	x		
45LM8		x	
45LM8M1		x	
45LM5D	x		x
45LM8D		x	x
45LM8DM1		x	x
45LMD			x

WARNING:

- **Do not use this device for personnel protection**
- Using this device for personnel protection could result in serious injury or death.
- This device does not include the self-checking redundant circuitry necessary to allow its use in personnel safety applications. A device failure or malfunction can cause either an energized (on) or de-energized (off) output condition.

Overview

Q45 Series sensors easily accept the addition of timing and signal strength display functions. Seven plug-in modules are available to provide various combinations of these features. All modules install easily under the sensor's black inner cover. Modules interconnect to the sensor circuitry without wires. Timing adjustments are easily accessible.

Timing Logic Functions

Programming of output timing on those models which feature logic functions is done using a bank of 4 DIP switches located on the module. These modules feature 15-turn clutched potentiometers for accurate timing adjustments. See Programming of Output Timing Functions on p. 2 for timing ranges and logic settings.

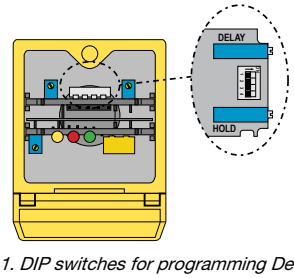


Figure 1. DIP switches for programming Delay logic

LED Signal Strength Display Function

Modules with the 7-element display of relative signal strength give a more precise indication of excess gain than does the AID™ system LED[1] (standard on all Q45 sensors); see Measuring Excess Gain and Contrast on p. 4 for more information. This feature is valuable for sensor setup and alignment, for critical evaluation of alternative sensing schemes, and for close monitoring of sensing performance over time (that is, dirt build-up or progressive misalignment). The more LEDs that are lit, the stronger the light signal being received by the sensor. Three segments lit indicate an excess gain of approximately 1x.

[1] U.S. Patent no. 4356393

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Install or Remove a Q45X Series Module

CAUTION:
- Shock Hazard
- An electrical shock hazard exists inside the device whenever power is applied. Failure to remove power when the device is open could result in injury.
- Remove all power to the device (and to the load) whenever the device will be opened.

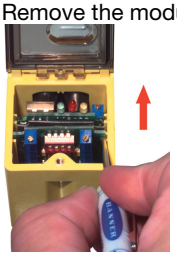
Note: It is not necessary to remove power to adjust the Sensitivity or Timing controls, as long as the black inner cover remains in place.

Modules (expansion cards) are installed and removed through the top of the sensor.

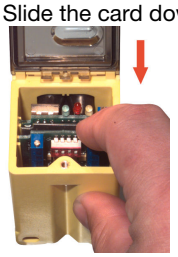
1. Remove power from the sensor and load.
2. Loosen the top cover screw.
3. Raise the cover. The cover is hinged at the front.
4. Insert a small screwdriver into one of the slots of the black inner cover, lift up, and remove the black inner cover.



5. If needed, remove a module.
   a) Insert a small, flat blade screwdriver or similar tool into the lift slot on the edge of the module to be removed.
   b) Gently pry up to disconnect the card and to raise it until you can grasp it with your fingers.
   c) Remove the module.



6. If needed, insert a module.
   a) Insert a module in the expansion slot so that the connector receptacles on the card align with the connector pins inside the sensor.
   b) Slide the card down into the slot until the connectors are fully engaged.



7. Reinstall the black inner cover.

Note: Some expansion cards are supplied with a new (replacement) black inner cover.

8. Close and secure the top cover.
9. Reapply power as desired.

Programming of Output Timing Functions

Plug-in module models 45LM5 and 45LM5D may be programmed for ON-Delay, OFF-Delay, or combined ON/OFF-Delay timing functions. Either delay may be programmed independently for a short time range (up to 1 second) or for a long time range (up to 15 seconds). A 15-turn potentiometer is dedicated to each delay to allow precise adjustment of the delay within the selected time range.

Note: The ON-Delay timer adjustment is labeled DELAY and the OFF-Delay timer adjustment is labeled HOLD.

Plug-in module models 45LM8, 45LM8M1,45LM8D,and 45LM8DM1 may be programmed for either a One-Shot output pulse or a Delayed One-Shot timer. For models 45LM8 and 45LM8D, the pulse and delay may be programmed independently for a short time range (up to 1 second) or for a long time range (up to 15 seconds). For models 45LM8M1 and 45LM8DM1, the pulse and delay may be programmed independently for a short time range (up to 0.1 second) or for a long time range (up to 1.5 seconds). A 15-turn potentiometer is dedicated to each delay to allow precise adjustment of the delay within the selected time range.

Note: The Delay timer adjustment is labeled DELAY and the Pulse timer adjustment is labeled HOLD.

45LM5 and 45LM5D

45LM5 and 45LM5D Timing Logic Function and Timing Range(s)		Switch Positions			
		#1	#2	#3	#4
ON-Delay	1 second maximum	ON	OFF	OFF	OFF
	15 seconds maximum	OFF	ON	OFF	OFF
OFF-Delay	1 second maximum	OFF	OFF	ON	OFF
	15 seconds maximum	OFF	OFF	OFF	ON
ON-Delay and OFF-Delay	1 second maximum 1 second maximum	ON	OFF	ON	OFF
	1 second maximum 15 seconds maximum	ON	OFF	OFF	ON
	15 seconds maximum 1 second maximum	OFF	ON	ON	OFF
	15 seconds maximum 15 seconds maximum	OFF	ON	OFF	ON

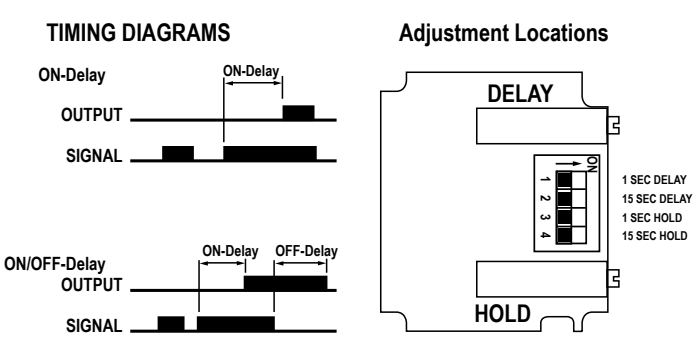


Figure 2. Timing Diagrams and Adjustment Locations

Note:

1. If both ranges of either delay function are selected (both 1 second and 15 second switches are ON), the delay time range becomes 16 seconds, maximum.
2. With switches #1 and #2 OFF (no ON-Delay programmed), ON-Delay is adjustable from negligible up to 100 milliseconds, maximum.
3. With switches #3 and #4 OFF (no OFF-Delay programmed), OFF-Delay is adjustable from negligible up to 100 milliseconds, maximum.

45LM8(M1) and 45LM8D(M1)

45LM8(M1) and 45LM8D(M1) Timing Logic Function and Timing Ranges[2]		Switch Positions			
		#1	#2	#3	#4[3]
One-Shot	1 second maximum pulse (0.1)	OFF	OFF	OFF	–
	15 seconds maximum pulse (1.5)	OFF	OFF	ON	–
Delayed One-Shot	1 second maximum delay (0.1) 1 second maximum pulse (0.1)	ON	OFF	OFF	–
	1 second maximum delay (1.5) 15 seconds maximum pulse (0.1)	OFF	ON	OFF	–

2 Maximum times for models 45LM8M1 and 45LM8DM1 are in parentheses.
3 For normal output (output conducts during pulse time), turn switch #4 OFF To invert the output, turn switch #4 ON.

45LM8(M1) and 45LM8D(M1) Timing Logic Function and Timing Ranges[2]		Switch Positions			
		#1	#2	#3	#4[3]
	15 seconds maximum delay (0.1) 1 second maximum pulse (1.5)	ON	OFF	ON	–
	15 seconds maximum delay (1.5) 15 seconds maximum pulse (1.5)	OFF	ON	ON	–

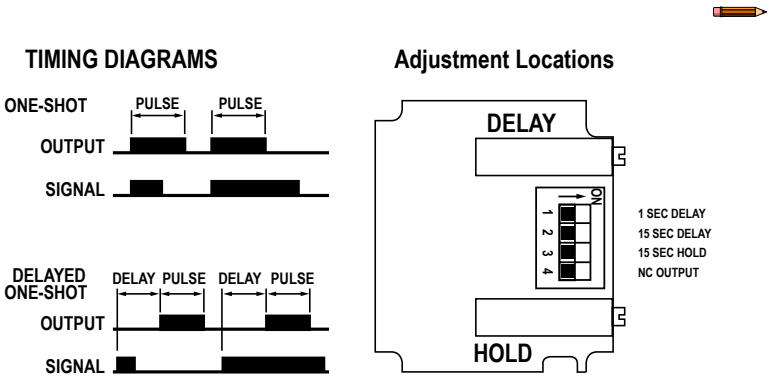


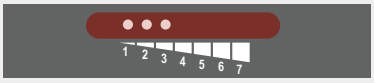
Figure 3. Timing Diagrams and Adjustment Locations

Note:

1. Delay is non-retriggerable. Pulse is retriggerable if the Delay time is less than the One-Shot pulse time.
2. If both ranges of the delay function are selected (both 1 second and 15 second switches are ON) the delay time range becomes 16 seconds, maximum.
3. With switches #1 and #2 OFF (no delay programmed), delay is adjustable from negligible up to 10 milliseconds, maximum.

Measuring Excess Gain and Contrast

Table 1: The 7-segment LED array and its corresponding Excess Gain Values



LED Number	Approximate Gain
#1	0.25×
#2	0.5×
#3	1.0×
#4	2.0×
#5	4.0×
#6	6.0×
#7	8.0×

The Q45's optional seven-element LED array may be used to measure the excess gain and contrast in any sensing situation and during sensor installation and maintenance.

Excess gain is a measurement of the amount of light energy falling on the receiver of a photoelectric sensor over and above the minimum amount necessary to operate the sensor's amplifier. Excess gain is expressed as a ratio:

`Excess gain (E.G.) = light energy falling on receiver/amplifier threshold`

The amplifier threshold is the point at which the sensor's output switches. The Q45's threshold corresponds to the #3 level of the LED array. That is, when LEDs #1 through #3 are lit, the excess gain of the received light signal is about 1×.

Table 1 on p. 4 shows how excess gain relates to the LED array indicator.

Contrast is the ratio of the amount of light falling on the receiver in the light state as compared to the dark state. Contrast is also referred to as light-to-dark ratio. Optimizing the contrast in any sensing situation increases the reliability of the sensing system. Contrast may be calculated if excess gain values are known for both the light and dark conditions:

`Contrast = Excess gain (light condition)/Excess gain (dark condition)`

To determine the contrast for any sensing application, present both the light and dark conditions to the Q45, and read the signal for each. Take the ratio of the two numbers (from Table 1 on p. 4) that correspond to the highest LED numbers registered for the light and dark conditions.

For example, if LEDs #1 through #6 turn ON in the light condition and LEDs #1 and #2 turn ON in the dark condition, the contrast is calculated as follows:

`Contrast = 6×/0.5× = 12`

This value is expressed as 12:1 or twelve-to-one.

2 Maximum times for models 45LM8M1 and 45LM8DM1 are in parentheses.
3 For normal output (output conducts during pulse time), turn switch #4 OFF To invert the output, turn switch #4 ON.

The best sensor adjustment causes all seven LEDs to turn ON for the light condition, and causes no LEDs to turn ON in the dark condition. In this situation (such as an application in which a box breaks the beam of an opposed mode emitter and receiver):

`Contrast is greater than 8×/0.25× = 32:1`

It is not always possible to adjust a sensor to maintain this much contrast. However, it is important to always adjust a sensor for the greatest amount of contrast possible for any sensing situation. The LED signal strength indicator array makes this easy. The following table gives general guidelines for contrast values.

Table 2: Contrast values and corresponding guidelines

Contrast Ratio	Recommendation
1.2 or less	Unreliable. Use an alternative sensing scheme.
1.2 to 2	Poor contrast. Minor sensing system variables will affect sensing reliability.
2 to 3	Low contrast. Sensing environment must remain perfectly clean and all other sensing variables must remain stable.
3 to 10	Good contrast. Minor sensing system variables will not affect sensing reliability.
10 or greater	Excellent contrast. Sensing should remain reliable as long as the sensing system has enough excess gain for operation.

Specifications

Timing Adjustments
Two 15-turn clutched potentiometers with brass elements, accessible from outside at the top of sensor, beneath an o-ring sealed polycarbonate cover

Timing Repeatability
±2% of the timing range (maximum); assumes conditions of constant temperature and power supply

Useful Time Range
From maximum time down to 10% of maximum
When the timing potentiometer is set fully counterclockwise, time is approximately 1% of maximum

Response time
A disabled timing function adds no measurable sensing response time

LED Display
Seven-element LED display, visible through transparent top sensor cover. The more LEDs that are lit, the stronger is the received light signal. Three LEDs lit is equivalent to an excess gain of about 1x

Operating Temperature
–40 °C to +70 °C (–40 °F to +158 °F)

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