

## 45LM Series Modules

Plug-in Logic and Display Modules for Q45 Series Sensors



### 45LM Series Description

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; see Figure 1. 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 (see Figure 1) is done via a bank of 4 DIP switches located on the module. These modules feature 15-turn clutched potentiometers for accurate timing adjustments. See page 2 for timing ranges and logic settings.

### 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\* (standard on all Q45 sensors); see page 3 for more information. This feature is extremely valuable for sensor setup and alignment, for critical evaluation of alternative sensing schemes, and for close monitoring of sensing performance over time (i.e., 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.)

\*U.S. Patent no. 4356393

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

Figure 1. 45LM Series Module

### 45LM Series Modules Specifications

Operating Temperature	-40 to +70°C (-40 to +158°F)
Timing Adjustments	Two 15-turn clutched potentiometers with brass elements, accessible from outside at the top of sensor, beneath an o-ring sealed Lexan® cover.
Timing Repeatability	Plus or minus 2% of the timing range (maximum); assumes conditions of constant temperature and power supply.
Useful Time Range	Useful time range is from maximum time down to 10% of maximum. When the timing potentiometer is set fully counterclockwise, time will be 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 (see page 3).

# 45LM Series Modules

## 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."

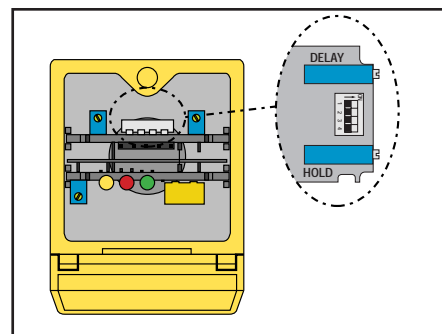
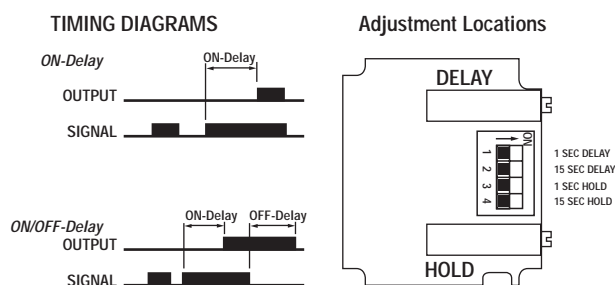


Figure 2. DIP switches for programming Delay logic

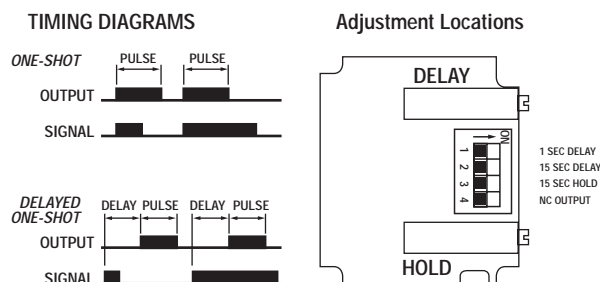
45LM5 and 45LM5D Timing Logic Function and Timing Range(s)		Switch Positions			
		#1	#2	#3	#4
ON-Delay	1 second max.	ON	OFF	OFF	OFF
	15 seconds max.	OFF	ON	OFF	OFF
OFF-Delay	1 second max.	OFF	OFF	ON	OFF
	15 seconds max.	OFF	OFF	OFF	ON
ON-Delay & OFF-Delay	1 second max. 1 second max.	ON	OFF	ON	OFF
	1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

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

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



- 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.



- 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

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:

$$\text{Excess gain (E.G.)} = \frac{\text{light energy falling on receiver}}{\text{amplifier threshold}}$$

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 "1x."

The table at left (Figure 3) 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 will increase the reliability of the sensing system. Contrast may be calculated if excess gain values are known for both the light and dark conditions:

$$\text{Contrast} = \frac{\text{Excess gain (light condition)}}{\text{Excess gain (dark condition)}}$$

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 Figure 3) that correspond to the highest LED numbers registered for the "light" and "dark" conditions.

For example, if LEDs #1 through #6 come ON in the "light" condition and LEDs #1 and #2 come ON in the "dark" condition, the contrast (referring to Figure 2) is calculated as follows:


$$\text{Contrast} = \frac{6x}{0.5x} = 12$$

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

The best sensor adjustment will cause all seven LEDs to come ON for the "light" condition, and will cause no LEDs to come 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):

$$\text{Contrast is greater than } \frac{8x}{0.25x} = 32:1$$

Of course, 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. Figure 4 gives general guidelines for contrast values.



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

Figure 3. The 7-segment LED array and its corresponding Excess Gain Values

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

Figure 4. Contrast values and corresponding guidelines

# 45LM Series Modules

## Removing and Installing the Plug-In Modules



### CAUTION . . . Electrical Shock Hazard

An electrical shock hazard exists inside the sensor whenever power is applied.

**Remove all power to the sensor (and to the load) whenever the transparent top cover will be raised and the black inside cover will be removed.**

Failure to remove power while these covers are removed could result in injury.

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

To remove or install any of the 45LM modules (done through the top of the sensor), perform the following steps:

- 1) Remove all power from the sensor and load.
- 2) Loosen the top cover hold-down screw and raise the transparent cover (it is hinged).
- 3) Insert a small screwdriver into one of the slots at the front of the black inner cover, lift and remove (Figure 5).
- 4) Insert a small screwdriver into one of the slots at the side of the module to be removed and pry it up until you can grasp it with your fingers and remove (Figure 6).
- 5) Press the new module into place (Figure 7).
- 6) Replace the black cover, then the transparent hinged cover, and tighten the hold-down screw.
- 7) Reapply power as desired.

NOTE: If only installing a new module (and not removing an old one), skip step 4.



Figure 5. Insert a small screwdriver into the slot and lift the black cover to remove.

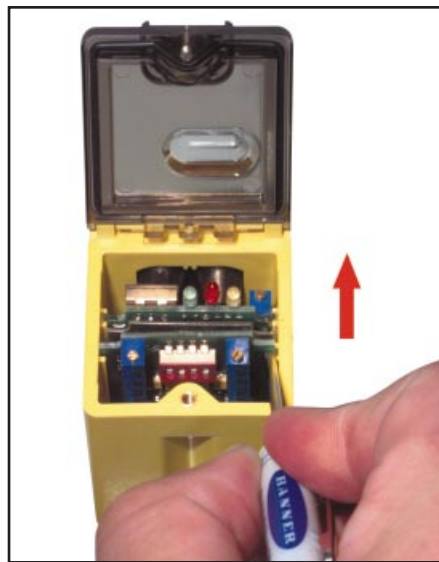


Figure 6. Using the small screwdriver in the module slot if necessary to nudge the module loose, lift the module up and out.

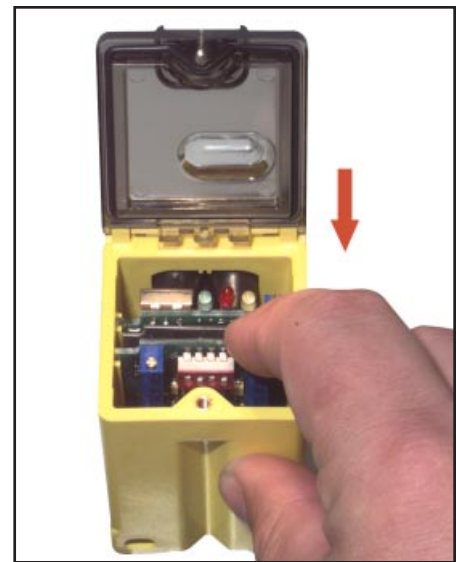


Figure 7. Slide the new module into place, pressing until it fits snugly.



### WARNING . . . Not To Be Used for Personnel Protection

Never use these products as sensing devices for personnel protection. Doing so could lead to serious injury or death.

These sensors do NOT include the self-checking redundant circuitry necessary to allow their use in personnel safety applications. A sensor failure or malfunction can cause either an energized or de-energized sensor output condition. Consult your current Banner Safety Products catalog for safety products which meet OSHA, ANSI and IEC standards for personnel protection.

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