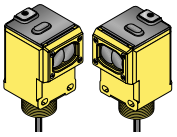
Q45BB6 Series Sensors

10 to 30V dc photoelectric sensors with sinking and sourcing solid-state outputs

*U.S. Patent no. 4356393

Q45BB6 Series Features

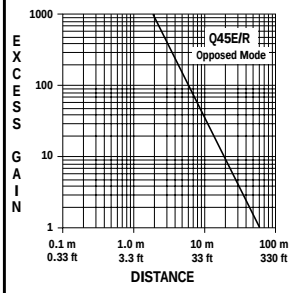
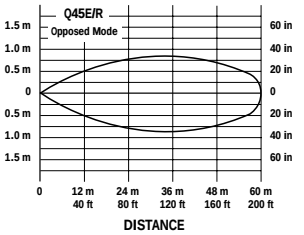
- Advanced one-piece photoelectric sensors with outstanding optical performance and extremely rugged design
- Operate from: 10 to 30V dc
- Bipolar NPN (sinking)/PNP (sourcing) outputs on all models
- Multiple sensing modes include: opposed, diffuse, retroreflective and convergent, plus glass and plastic fiber optic models
- Switchable light/dark operate
- Highly visible Power, Signal (AID™ System*), and Output indicator LEDs
- Versatile plug-in modules available for pulse or delay timing logic and/or signal strength display
- Choice of prewired 2 m (6.5') or 9 m (30') unterminated cable, plus Mini-style or Euro-style quick-disconnect fittings
- Versatile mounting options
- Designed to withstand 1200 psi washdown; exceeds its NEMA 6P and IEC IP67 rating



Because of their extremely high excess gain, these opposed-mode sensors are an excellent option for sensing in contaminated or dirty areas, and are also the best choice for long-range sensing.

Infrared, 880 nm

Q45BB6 Series Opposed-Mode Emitter (E) and Receiver (R) Models

Models	Range	Cable	Supply Voltage	Output Type	Excess Gain	Beam Pattern
Q456E Emitter **Q45BB6R** Receiver	60 m (200')	2-wire 2m (6.5') 4-wire 2m (6.5')	10 to 30V dc	Bipolar NPN/PNP		**Effective Beam: 13 mm** 
Q456EQ Emitter **Q45BB6RQ** Receiver		4-Pin Mini-style QD				
Q456EQ5 Emitter **Q45BB6RQ5** Receiver		4-Pin Euro-style QD				

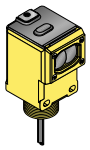
NOTES: i) 9 m (30') cables are available by adding suffix "W/30" to the model number of any cabled sensor (e.g., **Q456E W/30**)

ii) A model with a QD connector requires a mating cable; see page 14.

IMPORTANT: SEE SAFETY USE WARNING ON BACK PAGE

Printed in USA P/N 36578I8B

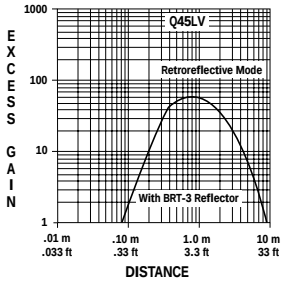
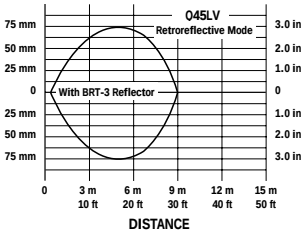
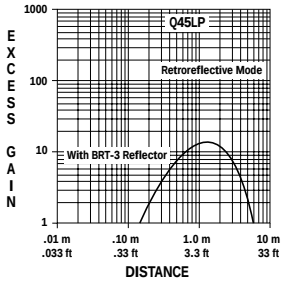
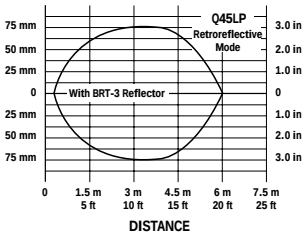
Q45BB6 Series



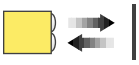
The visible red sensing beam of these sensors makes them very easy to align. Model Q45BB6LP polarizes the emitted light and filters out unwanted reflections, making sensing possible in applications otherwise considered unsuited to retroreflective sensing. Specified using the model BRT-3 3" reflector (see the Accessories section of your current Banner Photoelectric Sensors catalog for further information).

Visible red, 680 nm
Non-Polarized *Polarized*

Q45BB6 Series Retroreflective-Mode Models

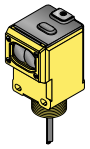
Models	Range	Cable	Supply Voltage	Output Type	Excess Gain	Beam Pattern
Non-Polarized						
Q45BB6LV **Q45BB6LVQ** **Q45BB6LVQ5**	0.08 to 9 m (3" to 30')	4-wire 2 m (6.5') 4-Pin Mini-style QD 4-Pin Euro-style QD	10 to 30V dc	Bipolar NPN/PNP		
Polarized						
Q45BB6LP **Q45BB6LPQ** **Q45BB6LPQ5**	0.15 to 6 m (6" to 20')	4-wire 2 m (6.5') 4-Pin Mini-style QD 4-Pin Euro-style QD	10 to 30V dc	Bipolar NPN/PNP		

NOTES:
i) 9 m (30') cables are available by adding suffix "W/30" to the model number of any cabled sensor (e.g., **Q45BB6LV W/30**)
ii) A model with a QD connector requires a mating cable; see page 14.

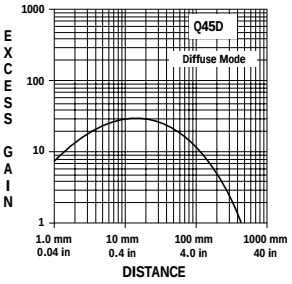
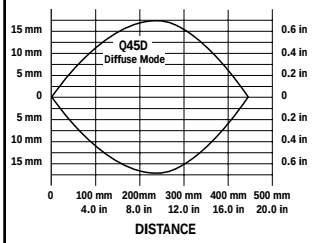
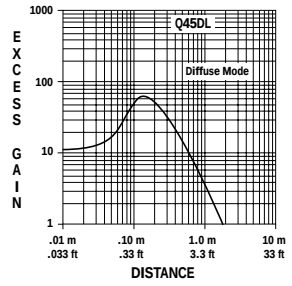
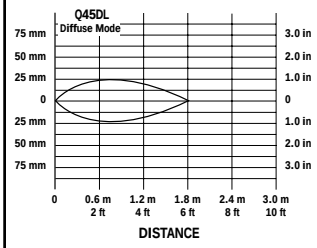
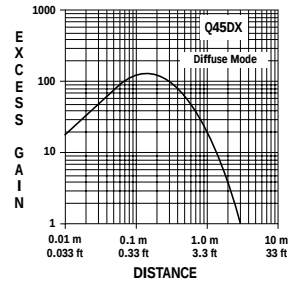
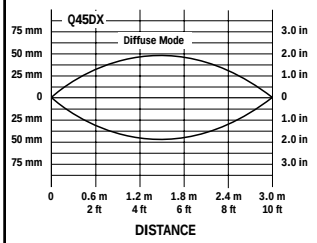


Infrared, 880 nm

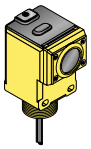
These diffuse-mode models detect objects by sensing the reflection of their own emitted light. Ideal for use when the reflectivity and profile of the object to be sensed are sufficient to return a large percentage of emitted light back to the sensor. Model Q45BB6DX is the first choice for diffuse-mode applications when there are no background objects to falsely return light.



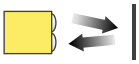
Q45BB6 Series Diffuse-Mode Models

Models	Range	Cable	Supply Voltage	Output Type	Excess Gain	Beam Pattern
					Performance based on 90% reflectance white test card	
Short Range						
Q45BB6D **Q45BB6DQ** **Q45BB6DQ5**	45 cm (18")	4-wire 2 m (6.5') 4-Pin Mini-style QD 4-Pin Euro-style QD	10 to 30V dc	Bipolar NPN/PNP		
Long Range						
Q45BB6DL **Q45BB6DLQ** **Q45BB6DLQ5**	1. 8 m (6')	4-wire 2 m (6.5') 4-Pin Mini-style QD 4-Pin Euro-style QD	10 to 30V dc	Bipolar NPN/PNP		
High Power						
Q45BB6DX **Q45BB6DXQ** **Q45BB6DXQ5**	3 m (10')	4-wire 2 m (6.5') 4-Pin Mini-style QD 4-Pin Euro-style QD	10 to 30V dc	Bipolar NPN/PNP		

Q45BB6 Series

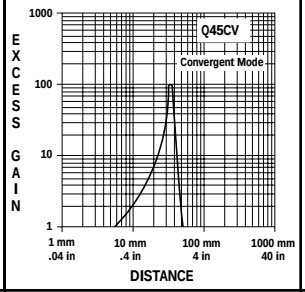
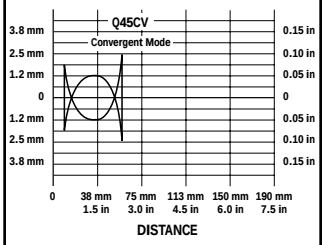
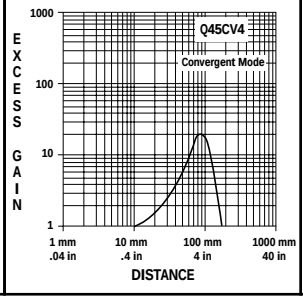
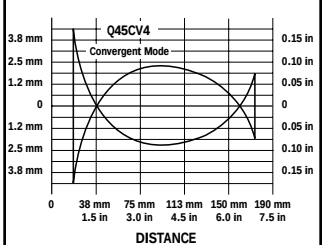


These sensors are ideal for reflective sensing of very small parts or profiles, and can accurately sense the position of parts approaching from the side. Will ignore all but highly reflective objects that are outside the sensing range.



Visible red. 680 nm

Q45BB6 Series Convergent-Mode Models

Models	Focus	Cable	Supply Voltage	Output Type	Excess Gain	Beam Pattern
					Performance based on 90% reflectance white test card	
Q45BB6CV **Q45BB6CVQ** **Q45BB6CVQ5**	38 mm (1.5") **Spot Size at Focus:** 1.3 mm (0.05")	4-wire 2 m (6.5') 4-Pin Mini-style QD 4-Pin Euro-style QD	10 to 30V dc	Bipolar NPN/PNP		
Q45BB6CV4 **Q45BB6CV4Q** **Q45BB6CV4Q5**	100 mm (4") **Spot Size at Focus:** 1.5 mm (0.06")	4-wire 2 m (6.5') 4-Pin Mini-style QD 4-Pin Euro-style QD	10 to 30V dc	Bipolar NPN/PNP		

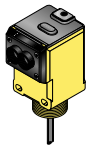
NOTES:

i) 9 m (30') cables are available by adding suffix "W/30" to the model number of any cabled sensor (e.g., **Q45BB6CV W/30**)

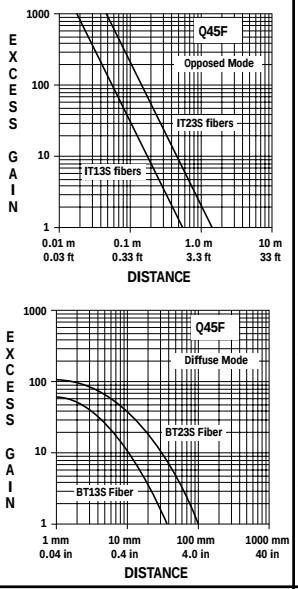
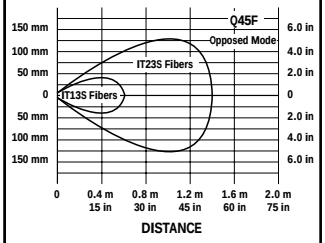
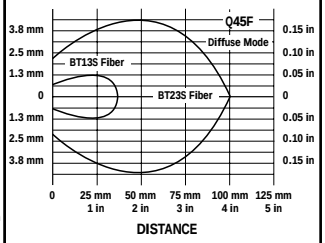
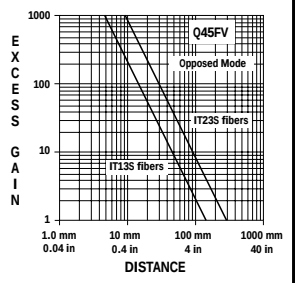
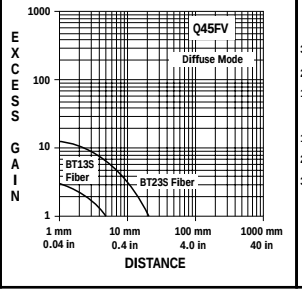
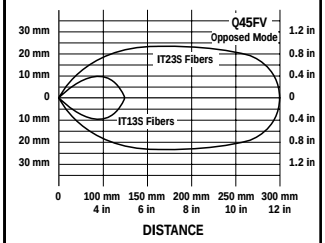
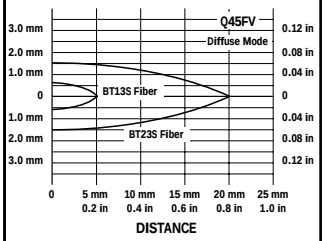
ii) A model with a QD connector requires a mating cable; see page 14.

Infrared, 880 nm and Visible red, 650 nm

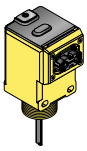
These models are an excellent choice for glass fiber optic applications where faster sensor response is not important. Their high excess gain means that opposed individual fibers can operate reliably in many very hostile environments. Also, special miniature bifurcated fiber optic assemblies with bundle sizes as small as .5 mm (.020") dia. may be used successfully for diffuse-mode sensing when using sensor model Q45BB6F(Q). For more information on compatible glass fiber optics, refer to your current Banner Photoelectric Sensors catalog.



Q45BB6 Series Glass Fiber-Optic Models

Models	Range	Cable	Supply Voltage	Output Type	Excess Gain	Beam Pattern
					Diffuse mode performance based on 90% reflectance white test card	
Infrared, 880 nm						
Q45BB6F **Q45BB6FQ** **Q45BB6FQ5**	Range varies by sensing mode and fiber optics used	4-wire 2 m (6.5') 4-Pin Mini-style QD 4-Pin Euro-style QD	10 to 30V dc	Bipolar NPN/PNP	 	 
Visible Red, 650 nm						
Q45BB6FV **Q45BB6FVQ** **Q45BB6FVQ5**	Range varies by sensing mode and fiber optics used	4-wire 2 m (6.5') 4-Pin Mini-style QD 4-Pin Euro-style QD	10 to 30V dc	Bipolar NPN/PNP	 	 

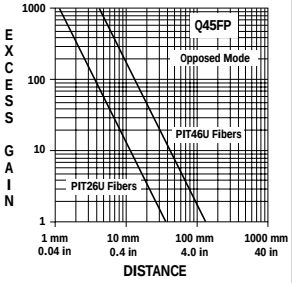
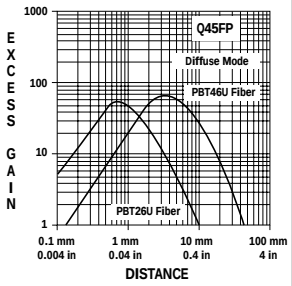
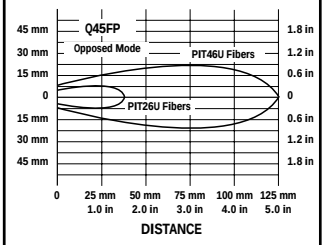
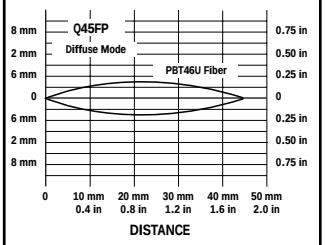
Q45BB6 Series



Lower in cost than glass fiber optics, plastic fiber optics are ideal for use in situations where environmental conditions allow (for example, low levels of acids, alkalis, and solvents). Most are easily cut to length in the field, and are available in a variety of sensing end styles. For more information on compatible plastic fiber optics, refer to your current Banner Photoelectric Sensors catalog.

Visible red, 660 nm

Q45BB6 Series Plastic Fiber-Optic Models

Models	Range	Cable	Supply Voltage	Output Type	Excess Gain	Beam Pattern
					Diffuse mode performance based on 90% reflectance white test card	
Q45BB6FP **Q45BB6FPQ** **Q45BB6FPQ5**	Range varies by sensing mode and fiber optics used	4-wire 2 m (6.5') 4-Pin Mini-style QD 4-Pin Euro-style QD	10 to 30V dc	Bipolar NPN/PNP	 	 

NOTES:

i) 9 m (30') cables are available by adding suffix "W/30" to the model number of any cabled sensor (e.g., **Q45BB6FP W/30**)

ii) A model with a QD connector requires a mating cable; see page 14.

Q45BB6 Series Specifications

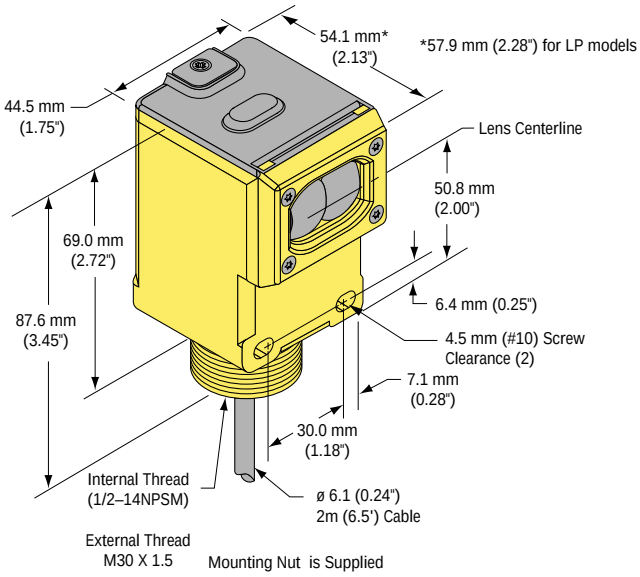
Supply Voltage and Current	10 to 30V dc (10% maximum ripple), at less than 50 mA (exclusive of load)
Supply Protection Circuitry	Protected against reverse polarity and transient voltages
Output Configuration	Bipolar: one current sourcing (PNP) and one current sinking (NPN) open-collector transistor
Output Rating	250mA maximum each output up to 50°C, derated to 150 mA at 70°C (derate 5 mA/°C) **Off-state leakage** current less than 1 microamp **Output saturation voltage** (both outputs) less than 1 volt at 10 mA and less than 2 volts at 250 mA
Output Protection Circuitry	Protected against false pulse on power-up and continuous overload or short circuit of outputs
Output Response Time	**Opposed mode:** 2 milliseconds ON and 1 millisecond OFF; **All other sensing modes:** 2 milliseconds ON/OFF (NOTE: 100 millisecond delay on power-up: outputs are non-conducting during this time)
Repeatability	**Opposed mode:** 0.25 milliseconds **All other sensing modes:** 0.5 milliseconds Response time and repeatability specifications are independent of signal strength.
Adjustments	**Beneath sensor's transparent cover:** Light/Dark Operate select switch and multi-turn Sensitivity control (allows precise sensitivity setting – turn clockwise to increase gain). Optional logic and logic/display modules have adjustable timing functions (see page 10).
Indicators	Indicator LEDs are clearly visible beneath a raised transparent Lexan® dome on top of the sensor. **Power (green) LED** lights whenever 10 to 30V dc power is applied, and flashes to indicate output overload or output short circuit **Signal (red) AID™ System LED** lights whenever the sensor sees its modulated light source, and pulses at a rate proportional to the strength of the received light signal **Load (yellow) LED** lights whenever the output relay is energized **Optional 7-element LED** signal strength display modules
Construction	Molded reinforced thermoplastic polyester housing, o-ring-sealed transparent Lexan® cover, molded acrylic lenses, and stainless steel hardware. Q45s are designed to withstand 1200 psi washdown. The base of cabled models has a 1/2" NPS integral internal conduit thread.
Environmental Rating	NEMA 6P, IEC IP67
Connections	PVC-jacketed 2 m (6.5') or 9 m (30') cables, or 4-pin Mini-style ("Q" suffix models) or 4-pin Euro-style ("Q5" suffix models) quick disconnect (QD) fittings are available. QD cables are ordered separately. See page 14.
Operating Conditions	**Temperature:** -40° to +70° C (-40° to +158°F) **Maximum relative humidity:** 90% at 50°C (non-condensing)
Application Notes	Optional output timing modules are available. See pages 10 through 14 for more information.
Certifications	CE SP® NRTL/C

Lexan® is a registered trademark of General Electric Co.

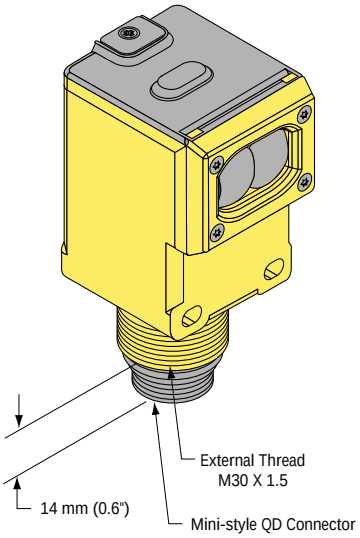
Q45BB6 Series Dimensions

Opposed, Retro, and Diffuse Sensing Modes (model suffix E, R, D, DL, DX, LP & LV)

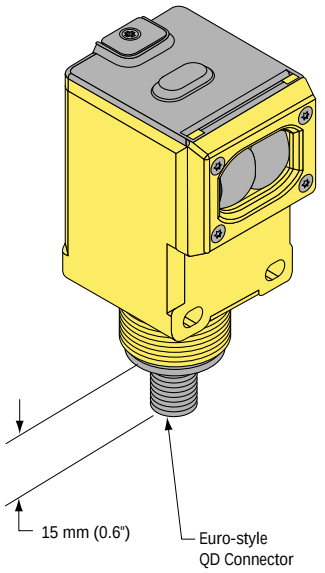
Cabled



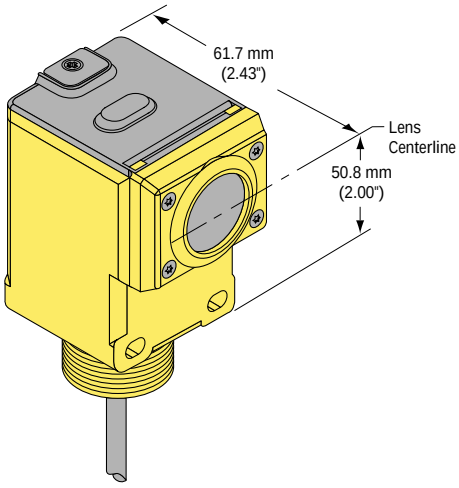
Mini-style Quick-Disconnect



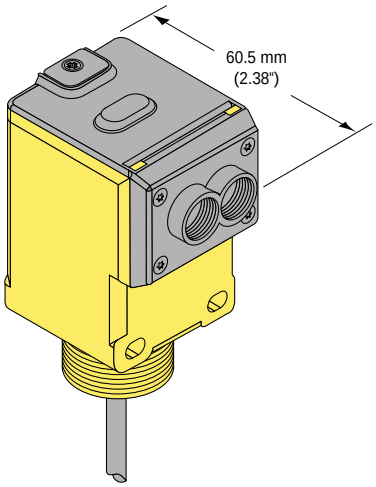
Euro-style Quick-Disconnect



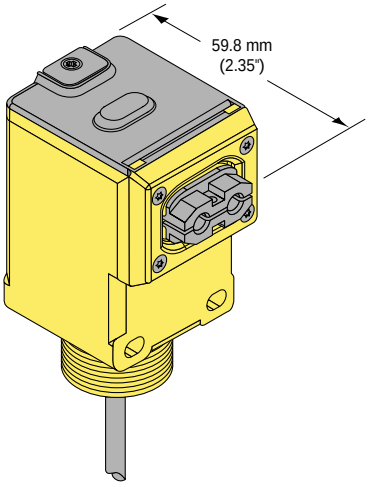
Convergent Sensing Mode (model suffix CV & CV4)



Glass Fiber Optic (model suffix F and FV)



Plastic Fiber Optic (model suffix FP)



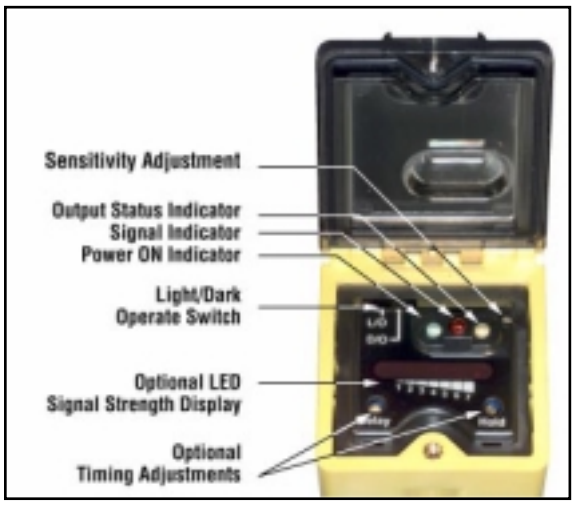


Figure 1. Indicators and controls on the Q45BB6 Series Sensors

Q45BB6 Series Indicators and Controls

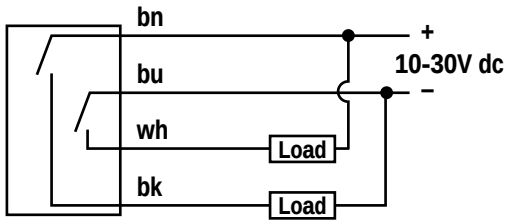
Status indicator LEDs for Power, Signal and Output are clearly visible beneath a raised dome in the sensor's transparent o-ring-sealed Lexan® cover. The Power indicator lights whenever power is applied to the sensor. The Signal LED lights whenever the sensor sees its modulated light source, and pulses at a rate proportional to the strength of the received light signal; this is the AID™ Alignment Indicating Device*. The Output indicator lights whenever the sensor's outputs are conducting. This indicator is especially useful when a timing logic module is used and Signal and Output conditions are not concurrent.

Also located beneath the sensor's o-ring-sealed cover are controls for light/dark operate selection and Sensitivity adjustment.

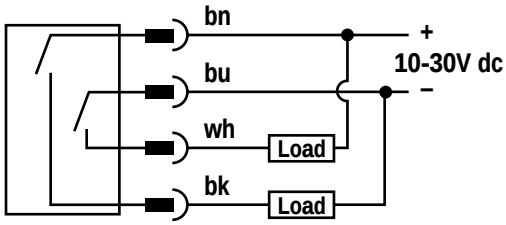
* US patent no. 4356393

Q45BB6 Series Hookups

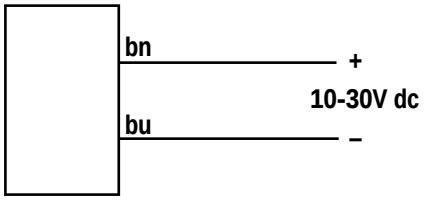
Q45BB6 Sensors with Attached Cable



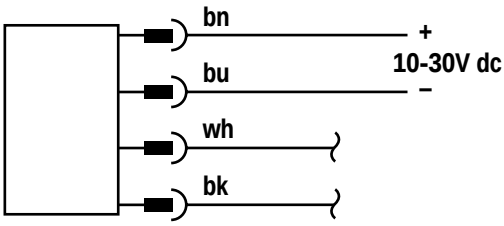
Q45BB6 Sensors with Quick-Disconnect 4-Pin Mini-Style or 4-Pin Euro-style ((model suffix Q and Q5)



Q456E Emitters with Attached Cable



Q456E Emitters with Quick-Disconnect 4-Pin Mini-Style or 4-Pin Euro-style (model suffix Q and Q5)



Quick-Disconnect (QD) Option

DC Q45BB6 Series sensors are sold with either a 2 m (6.5') or a 9 m (30') PVC-covered unterminated cable, or with a 4-pin Mini-style or 4-pin Euro-style Quick-Disconnect (QD) cable fitting.

Mini-style QD sensors are identified by the suffix "Q" in their model number suffix and Euro-style sensors are identified by the suffix "Q5." Mating cables required for QD Q45BB6 sensors are specified on page 14.

Optional Plug-In Output Timing Logic and Display Modules for the Q45BB6 Series

Q45BB6 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 chart at right.

Module Model Number	Output Timing Logic		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

Timing Logic Functions

Programming of output timing on those models which feature logic functions (see chart at right) 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 12 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). 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.)

All modules install easily under the sensor's black inner cover. Modules interconnect to the sensor circuitry without wires. Timing adjustments are easily accessible.

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.

45LM Series Modules Specifications

Operating Temperature	-40 to +70°C (-40 to +158°F)
Models with Timing Logic	45LM5, 45LM5D, 45LM8, 45LM8D, 45LM8M1, 45LM8DM1
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.
Models with LED Signal Strength Display	45LMD, 45LM5D, 45LM8D, 45LM8DM1
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 13).

Lexan® is a registered trademark of General Electric Co.

Removing and Installing the Plug-In Modules

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 2).
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 3).
5) Press the new module into place (Figure 4).
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 2. Insert a small screwdriver into the slot and lift the black cover to remove.

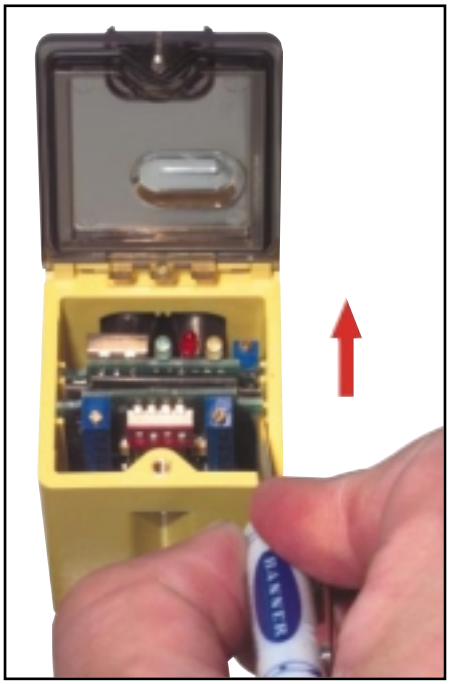


Figure 3. Using the small screwdriver in the module slot if necessary to nudge the module loose, lift the module up and out.

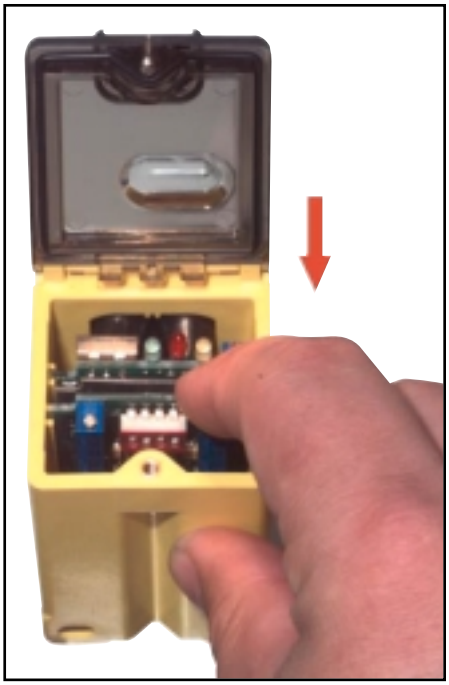


Figure 4. Slide the new module into place, pressing until it fits snugly.

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."

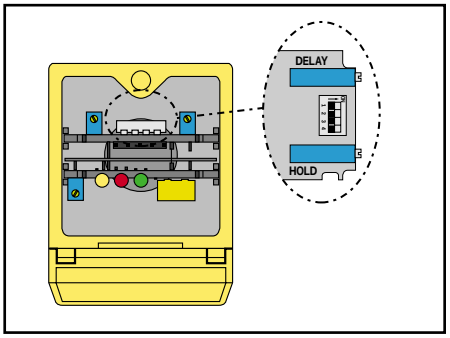
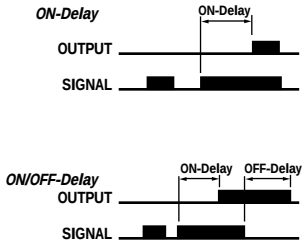


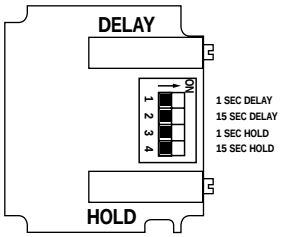
Figure 5. DIP switches for programming Delay logic

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**

TIMING DIAGRAMS



Adjustment Locations



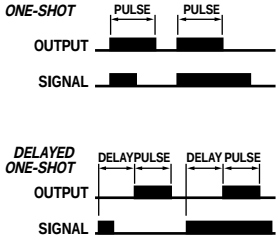
NOTE:
1) If both ranges of either delay function are selected (both 1 second and 15 second switches are ON), the delay time range becomes 16 seconds, maximum.
2) With switches #1 and #2 OFF (no ON-Delay programmed), ON-Delay is adjustable from "negligible" up to 100 milliseconds, maximum.
3) With switches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

45LM8(M1) and 45LM8D(M1) 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) 15 seconds max. pulse (1.5)	**ON**	OFF	**ON**	–
	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**	–

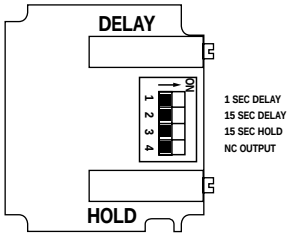
* Maximum times for models 45LM8M1 and 45LM8DM1 are in parentheses.

** For normal output (output conducts during pulse time), turn switch #4 OFF
To invert the output, turn switch #4 **ON**

TIMING DIAGRAMS



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

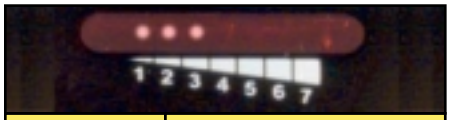
The Q45's optional seven-element LED array may be used to measure the excess gain and contrast in any sensing situation and during sensor installation and maintenance.

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 6) shows how excess gain relates to the LED array indicator.



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

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 6) 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 6) 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 7 gives general guidelines for contrast values.

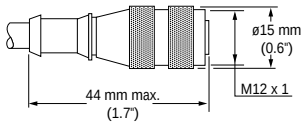
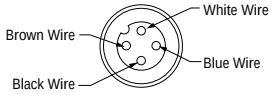
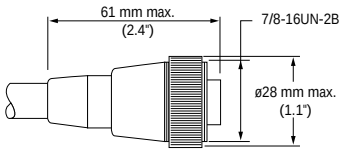
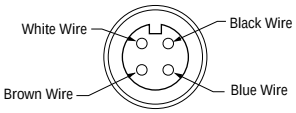
Contrast Ratio	Recommendation
1.2 or less	***Unreliable.*** Use an alternative sensing scheme.
1.2 to 2	***Poor contrast.*** Minor sensing system variables will affect sensing reliability.
2 to 3	***Low contrast.*** Sensing environment must remain perfectly clean and all other sensing variables must 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.

Figure 7. Contrast values and corresponding guidelines

Accessories

Quick-Disconnect Cables

Cable: PVC jacket; polyurethane connector body; nylon coupling nut (Mini), chrome-plated brass coupling nut (Euro)
Conductors: 18 AWG (Mini), 22 or 20 AWG (Euro) high-flex stranded, PVC insulation, gold-plated contacts
Temperature: -40° to +80°C (-40° to +176°F) (Mini); -48° to +90°C (-40° to +194 F) (Euro)
Voltage Rating: 250V ac/300V dc

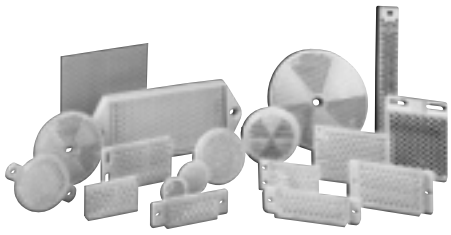
Style	Model	Length	Dimensions	Pin-out
4-Pin Euro-style Straight	**MQDC-406** **MQDC-415** **MQDC-430**	2 m (6.5') 5 m (15') 10 m (30')		
4-Pin Mini-style Straight	**MBCC-406** **MBCC-412** **MBCC-430**	2 m (6.5') 4 m (12') 9 m (30')		

Contact factory for right-angle connectors.

Retroreflective Targets

Banner offers a wide selection of high-quality retroreflective targets. See the Accessories section of your current Banner Photoelectric Sensors catalog for complete information.

NOTE: Polarized sensors require corner cube type retroreflective targets only. Non-polarized sensors may use any retroreflective targets.

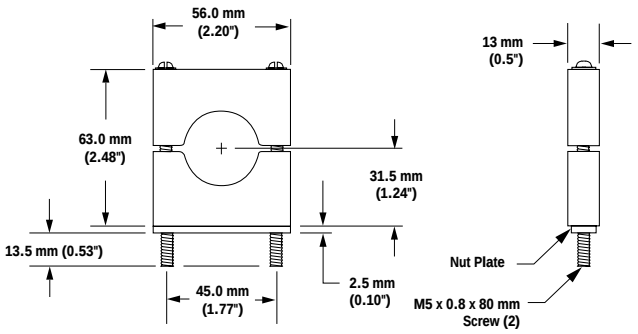
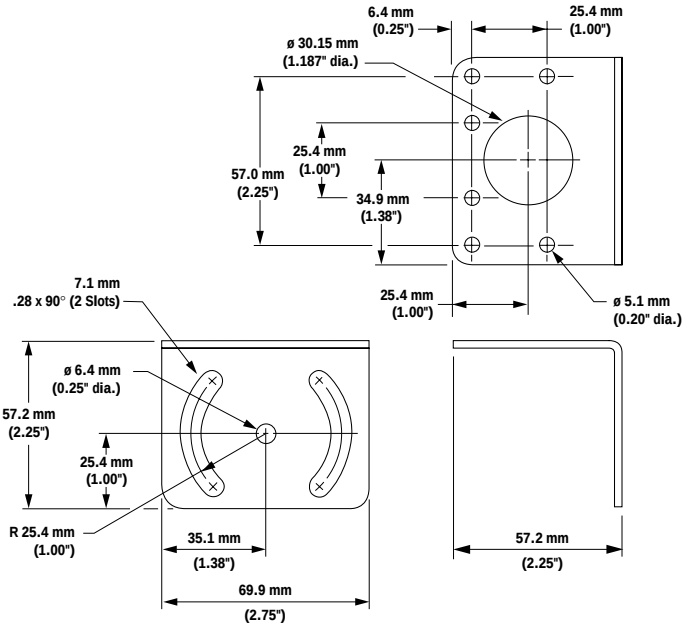
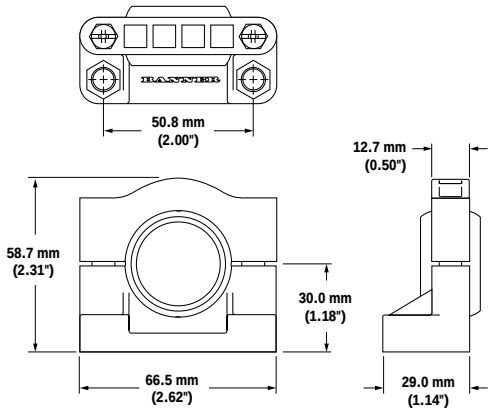


Output Timing Logic and Signal Strength Display Modules

Q45 sensors easily accept the addition of output timing logic and signal strength display functions. Display modules have a seven-element display which gives a “finer” indication of excess gain than does the AID™ system LED that is standard on Q45 sensors. The modules listed below may be used with all Q45BB6 sensors.

Model	Logic and/or Display Function
45LM5	Delay logic: on-delay, off-delay, or on/off-delay (15 secs. max.)
45LM8	Pulse logic: one-shot or delayed one-shot (15 secs. max.)
45LM8M1	Pulse logic: one-shot or delayed one-shot (1.5 sec. max.)
45LM5D	Delay logic plus signal strength display (15 secs. max.)
45LM8D	Pulse logic plus signal strength display (15 secs. max.)
45LM8DM1	Pulse logic plus signal strength display (1.5 sec. max.)
45LMD	Signal strength display only (no timing function)

Mounting Brackets

Model	Description	Dimensions
SMB30C	• 30 mm split clamp, black reinforced thermoplastic polyester bracket • Stainless steel mounting hardware included	
SMB30MM	• 30 mm, 11-gauge, stainless steel bracket with curved mounting slots for versatility and orientation • Clearance for M6 (1/4") hardware	
SMB30SC	• 30 mm swivel, black reinforced thermoplastic polyester bracket • Stainless steel mounting hardware included	

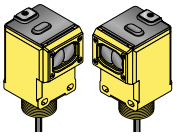
Q45VR2 Series Sensors

90 to 250V ac photoelectric sensors with electromechanical relay output

*U.S. Patent no. 4356393

Q45VR2 Series Features

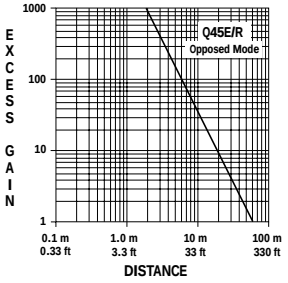
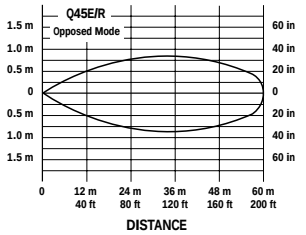
- Advanced one-piece photoelectric sensors with outstanding optical performance and extremely rugged design
- Operate from 90 to 250V ac (50/60Hz)
- SPDT electromechanical relay output for economical, high-capacity switching and immunity to electrical noise
- Multiple sensing modes include: opposed, diffuse, retroreflective and convergent, plus glass and plastic fiber optic models
- Switchable light/dark operate
- Versatile plug-in modules available for pulse or delay timing logic and/or signal strength display
- Highly visible Power, Signal (AID™ System*), and Output indicator LEDs
- Choice of prewired 2 m (6.5') or 9 m (30') unterminated cable or Mini-style quick-disconnect fitting
- Versatile mounting options
- Designed to withstand 1200 psi washdown; exceeds its NEMA 6P and IEC IP67 rating



Because of their extremely high excess gain, these opposed-mode sensors are an excellent option for sensing in contaminated or dirty areas, and are also the best choice for long-range sensing.

Infrared, 880 nm

Q45VR2 Series Opposed-Mode Emitter (E) and Receiver (R) Models

Models	Range	Cable	Supply Voltage	Output Type	Excess Gain	Beam Pattern
Q452E Emitter **Q45VR2R** Receiver	60 m (200')	2-wire 2m (6.5') 5-wire 2m (6.5')	90 to 250V ac	SPDT Electro-mechanical Relay		**Effective Beam: 13 mm** 
Q452EQ Emitter **Q45VR2RQ** Receiver		3-Pin Mini-style QD 5-Pin Mini-style QD				

NOTES: i) 9 m (30') cables are available by adding suffix "W/30" to the model number of any cabled sensor (e.g., **Q452E W/30**)

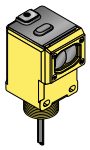
ii) A model with a QD connector requires a mating cable; see page 14.

IMPORTANT: SEE SAFETY USE WARNING ON BACK PAGE

Printed in USA

P/N 36339I8B

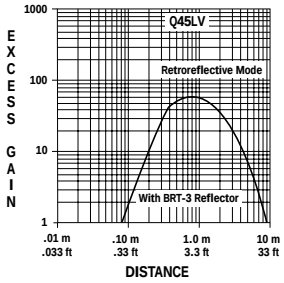
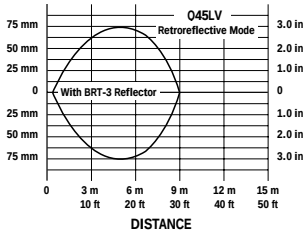
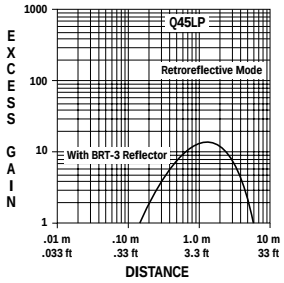
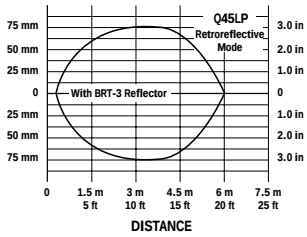
Q45VR2 Series



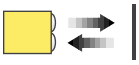
The visible red sensing beam of these sensors makes them very easy to align. Model Q45VR2LP polarizes the emitted light and filters out unwanted reflections, making sensing possible in applications otherwise considered unsuited to retroreflective sensing. Specified using the model BRT-3 3" reflector (see the Accessories section of your current Banner Photoelectric Sensors catalog for further information).

Visible red, 680 nm
Non-Polarized *Polarized*

Q45VR2 Series Retroreflective-Mode Models

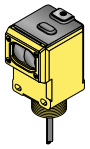
Models	Range	Cable	Supply Voltage	Output Type	Excess Gain	Beam Pattern
Non-Polarized						
Q45VR2LV **Q45VR2LVQ**	0.08 to 9 m (3" to 30')	5-wire 2 m (6.5') 5-Pin Mini-style QD	90 to 250V ac	SPDT Electro-mechanical Relay		
Polarized						
Q45VR2LP **Q45VR2LPQ**	0.15 to 6 m (6" to 20')	5-wire 2 m (6.5') 5-Pin Mini-style QD	90 to 250V ac	SPDT Electro-mechanical Relay		

NOTES:
i) 9 m (30') cables are available by adding suffix "W/30" to the model number of any cabled sensor (e.g., **Q45VR2LV W/30**)
ii) A model with a QD connector requires a mating cable; see page 14.

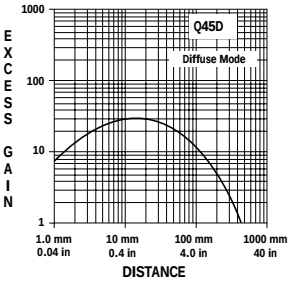
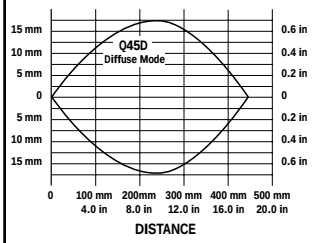
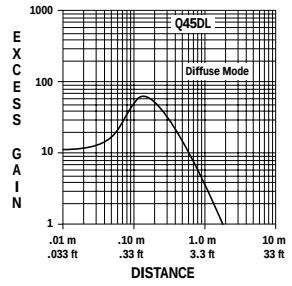
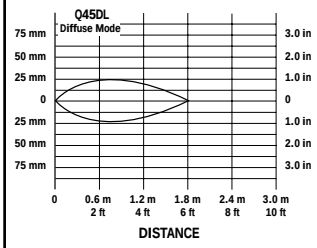
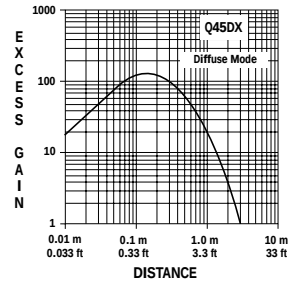
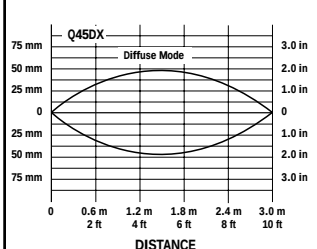


Infrared, 880 nm

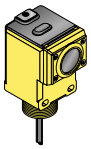
These diffuse-mode models detect objects by sensing the reflection of their own emitted light. Ideal for use when the reflectivity and profile of the object to be sensed are sufficient to return a large percentage of emitted light back to the sensor. Model Q45VR2DX is the first choice for diffuse-mode applications when there are no background objects to falsely return light.



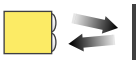
Q45VR2 Series Diffuse-Mode Models

Models	Range	Cable	Supply Voltage	Output Type	Excess Gain	Beam Pattern
					Performance based on 90% reflectance white test card	
Short Range						
Q45VR2D **Q45VR2DQ**	45 cm (18")	5-wire 2 m (6.5') 5-Pin Mini-style QD	90 to 250V ac	SPDT Electro-mechanical Relay		
Long Range						
Q45VR2DL **Q45VR2DLQ**	1. 8 m (6')	5-wire 2 m (6.5') 5-Pin Mini-style QD	90 to 250V ac	SPDT Electro-mechanical Relay		
High Power						
Q45VR2DX **Q45VR2DXQ**	3 m (10')	5-wire 2 m (6.5') 5-Pin Mini-style QD	90 to 250V ac	SPDT Electro-mechanical Relay		

Q45VR2 Series

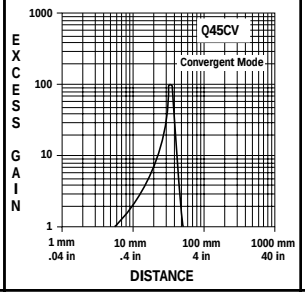
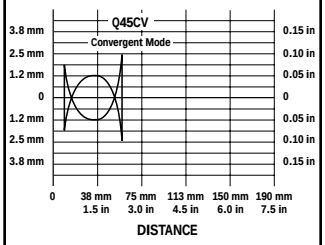
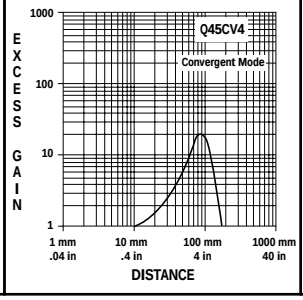
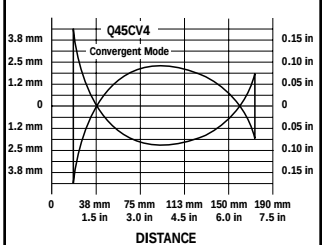


These sensors are ideal for reflective sensing of very small parts or profiles, and can accurately sense the position of parts approaching from the side. Will ignore all but highly reflective objects that are outside the sensing range.



Visible red. 680 nm

Q45VR2 Series Convergent-Mode Models

Models	Focus	Cable	Supply Voltage	Output Type	Excess Gain	Beam Pattern
					Performance based on 90% reflectance white test card	
Q45VR2CV **Q45VR2CVQ**	38 mm (1.5") **Spot Size at Focus:** 1.3 mm (0.05")	5-wire 2 m (6.5') 5-Pin Mini-style QD	90 to 250V ac	SPDT Electro-mechanical Relay		
Q45VR2CV4 **Q45VR2CV4Q**	100 mm (4") **Spot Size at Focus:** 1.5 mm (0.06")	5-wire 2 m (6.5') 5-Pin Mini-style QD	90 to 250V ac	SPDT Electro-mechanical Relay		

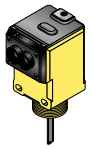
NOTES:

i) 9 m (30') cables are available by adding suffix "W/30" to the model number of any cabled sensor (e.g., **Q45VR2CV W/30**)

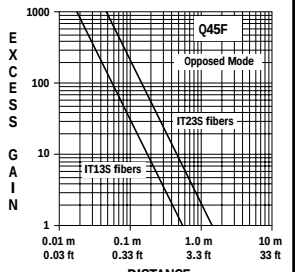
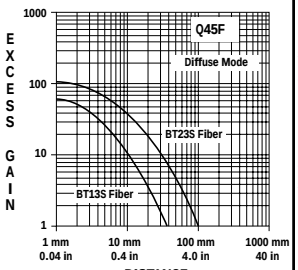
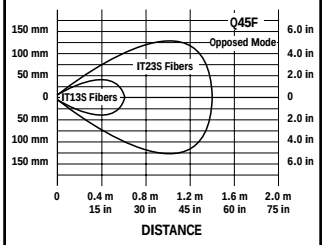
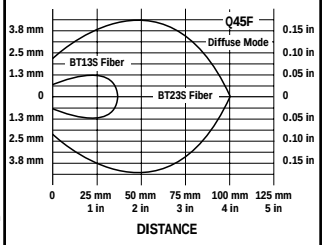
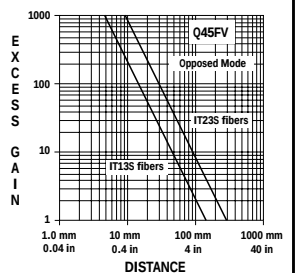
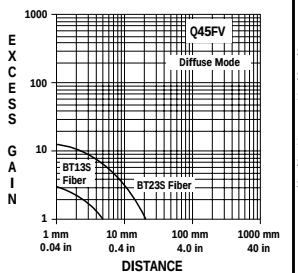
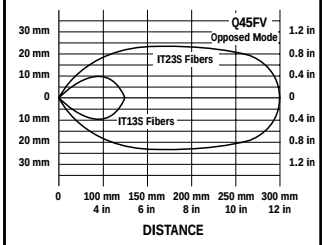
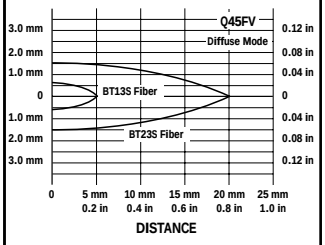
ii) A model with a QD connector requires a mating cable; see page 14.

Infrared, 880 nm and Visible Red, 650 nm

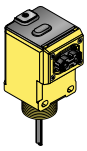
These models are an excellent choice for glass fiber optic applications where faster sensor response is not important. Their high excess gain means that opposed individual fibers can operate reliably in many very hostile environments. Also, special miniature bifurcated fiber optic assemblies with bundle sizes as small as .5 mm (.020") dia. may be used successfully for diffuse-mode sensing when using sensor model Q45VR2F(Q). For more information on compatible glass fiber optics, refer to your current Banner Photoelectric Sensors catalog.



Q45VR2 Series Glass Fiber-Optic Models

Models	Range	Cable	Supply Voltage	Output Type	Excess Gain	Beam Pattern
					Diffuse mode performance based on 90% reflectance white test card	
Infrared, 880 nm						
Q45VR2F **Q45VR2FQ**	Range varies by sensing mode and fiber optics used	5-wire 2 m (6.5') 5-Pin Mini-style QD	90 to 250V ac	SPDT Electro-mechanical Relay	 	 
Visible Red, 650 nm						
Q45VR2FV **Q45VR2FVQ**	Range varies by sensing mode and fiber optics used	5-wire 2 m (6.5') 5-Pin Mini-style QD	90 to 250V ac	SPDT Electro-mechanical Relay	 	 

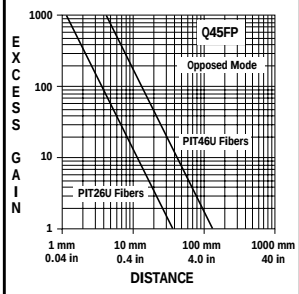
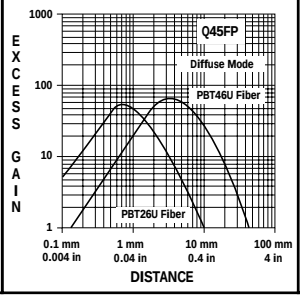
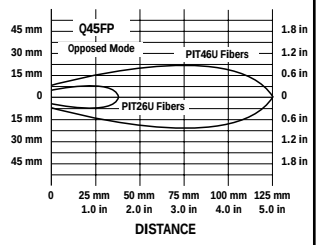
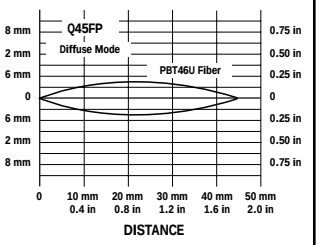
Q45VR2 Series



Lower in cost than glass fiber optics, plastic fiber optics are ideal for use in situations where environmental conditions allow (for example, low levels of acids, alkalis, and solvents). Most are easily cut to length in the field, and are available in a variety of sensing end styles. For more information on compatible plastic fiber optics, refer to your current Banner Photoelectric Sensors catalog.

Visible red, 660 nm

Q45VR2 Series Plastic Fiber-Optic Models

Models	Range	Cable	Supply Voltage	Output Type	Excess Gain	Beam Pattern
					Diffuse mode performance based on 90% reflectance white test card	
Q45VR2FP **Q45VR2FPQ**	Range varies by sensing mode and fiber optics used	5-wire 2 m (6.5') 5-Pin Mini-style QD	90 to 250V ac	SPDT Electro-mechanical Relay	 	 

NOTES:

i) 9 m (30') cables are available by adding suffix “W/30” to the model number of any cabled sensor (e.g., **Q45VR2FP W/30**)

ii) A model with a QD connector requires a mating cable; see page 14.

Q45VR2 Series Specifications

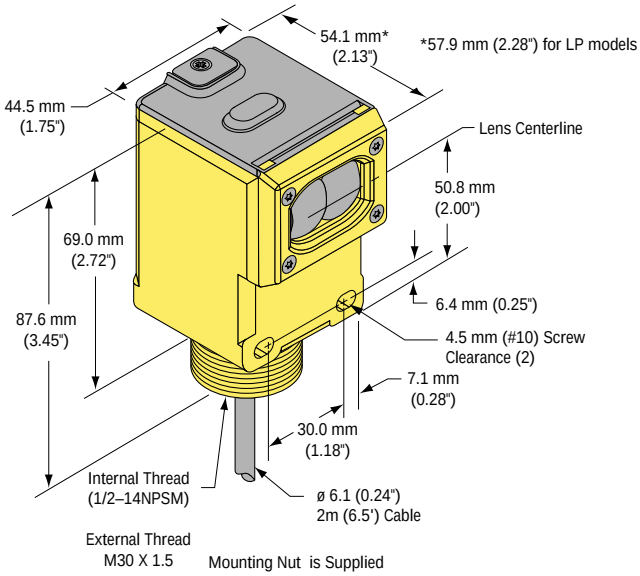
Supply Voltage and Current	90 to 250V ac (50/60 Hz). Average current 20 mA. Peak current 500 mA at 120V ac, 750 mA at 250V ac.
Supply Protection Circuitry	Protected against transient voltages.
Output Configuration	SPDT (Single-Pole, Double-Throw) electromechanical relay output. All models except emitters.
Output Rating	**Max. switching power (resistive load):** 150W, 600VA **Max. switching voltage (resistive load):** 250V ac, 30V dc **Max. switching current (resistive load):** 5A @ 250V ac **Min. voltage and current:** 5V dc, 0.1mA **Mechanical life of relay:** 10,000,000 operations **Electrical life of relay at full resistive load:** 100,000 operations
Output Protection Circuitry	Protected against false pulse on power-up
Output Response Time	15 milliseconds ON and OFF (NOTE: 100 millisecond delay on power-up. Relay is de-energized during this time.)
Repeatability	**Opposed mode:** 0.25 milliseconds **All other sensing modes:** 0.5 milliseconds Response time and repeatability specifications are independent of signal strength.
Adjustments	**Beneath sensor's transparent cover:** Light/Dark Operate select switch and multi-turn Sensitivity control (allows precise sensitivity setting – turn clockwise to increase gain). Optional logic and logic/display modules have adjustable timing functions (see page 10).
Indicators	Indicator LEDs are clearly visible beneath a raised transparent Lexan® dome on top of the sensor. **Power (green) LED** lights whenever 90 to 250V ac power is applied **Signal (red) AID™ System LED** lights whenever the sensor sees its modulated light source, and pulses at a rate proportional to the strength of the received light signal **Load (yellow) LED** lights whenever the output relay is energized **Optional 7-element LED** signal strength display module
Construction	Molded reinforced thermoplastic polyester housing, o-ring-sealed transparent Lexan® cover, molded acrylic lenses, and stainless steel hardware. Q45s are designed to withstand 1200 psi washdown. The base of cabled models has a 1/2" NPS integral internal conduit thread.
Environmental Rating	NEMA 6P, IEC IP67
Connections	PVC-jacketed 2-wire (emitters) or 5-wire (all others) 2 m (6.5') or 9 m (30') unterminated cables, or 3-pin (emitters) or 5-pin (all others) Mini-style quick-disconnect (QD) fittings are available ("Q"- suffix models). QD cables are ordered separately. See page 14.
Operating Conditions	**Temperature:** -40° to +70° C (-40° to +158°F) **Maximum relative humidity:** 90% at 50°C (non-condensing)
Application Notes	Transient suppression is recommended for contacts switching inductive loads. Optional output timing modules are available. See pages 10 through 14 for more information.
Certifications	CE CSA® NRTL/C

Lexan® is a registered trademark of General Electric Co.

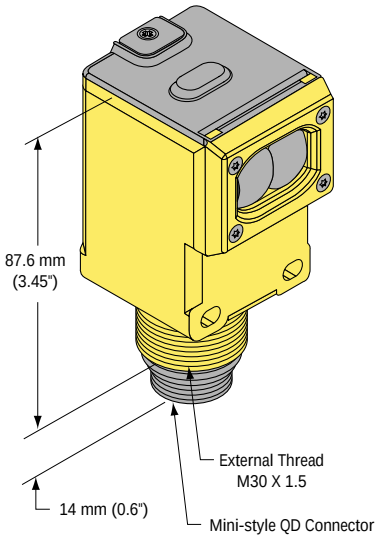
Q45VR2 Series Dimensions

Opposed, Retro, and Diffuse Sensing Modes (model suffix E, R, D, DL, DX, LP & LV)

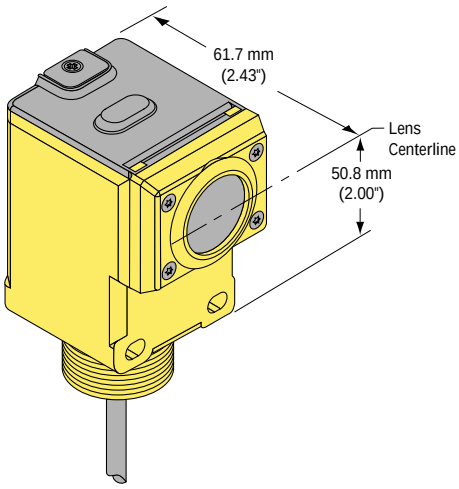
Cabled



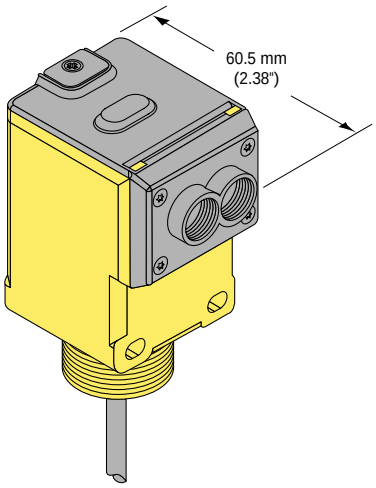
Quick-Disconnect



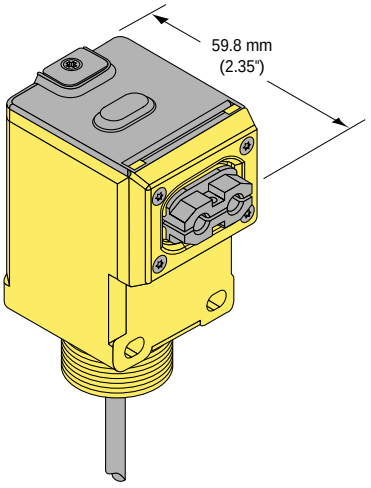
Convergent Sensing Mode (model suffix CV & CV4)



Glass Fiber Optic (model suffix F and FV)



Plastic Fiber Optic (model suffix FP)



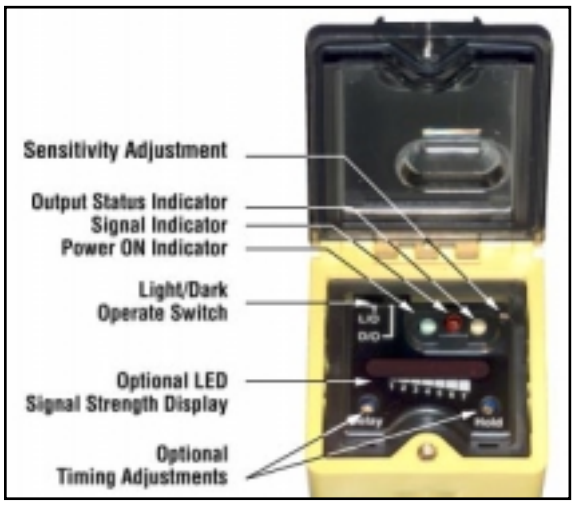


Figure 1. Indicators and controls on the Q45VR2 Series Sensors

Q45VR2 Series Indicators and Controls

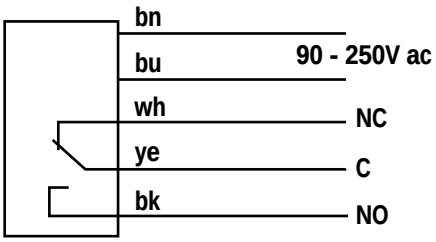
Status indicator LEDs for Power, Signal and Output are clearly visible beneath a raised dome in the sensor's transparent o-ring-sealed Lexan® cover. The Power indicator lights whenever power is applied to the sensor. The Signal LED lights whenever the sensor sees its modulated light source, and pulses at a rate proportional to the strength of the received light signal; this is the AID™ Alignment Indicating Device*. The Output indicator lights whenever the sensor's output relay is energized. This indicator is especially useful when a timing logic module is used and Signal and Output conditions are not concurrent.

Also located beneath the sensor's o-ring-sealed cover are controls for light/dark operate selection and Sensitivity adjustment.

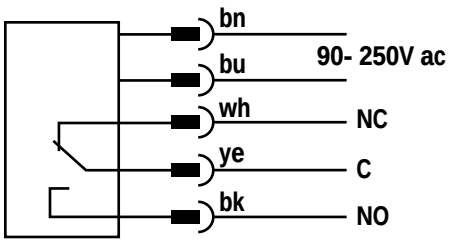
* US patent no. 4356393

Q45VR2 Series Hookups

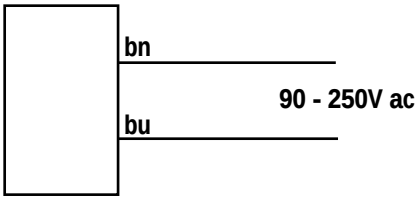
Q45VR2 Sensors with Attached Cable



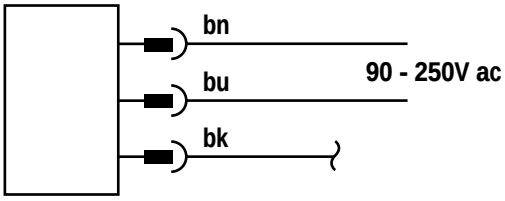
Q45VR2 Sensors with Quick-Disconnect 5-Pin Mini-Style (model suffix Q)



Q452E Emitters with Attached Cable



Q452E Emitters with Quick-Disconnect 3-Pin Mini-Style (model suffix Q)



Quick-Disconnect (QD) Option

AC Q45VR2 Series sensors are sold with either a 2 m (6.5') or a 9 m (30') PVC-covered unterminated cable, or with a 3-pin Mini-style (opposed mode emitter) or 5-pin Mini-style Quick-Disconnect (QD) cable fitting.

Mini-style QD sensors are identified by the suffix "Q" in their model number. Mating cables for QD Q45VR2 sensors are specified on page 14.

Optional Plug-In Output Timing Logic and Display Modules for the Q45VR2 Series

Q45VR2 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 chart at right.

Module Model Number	Output Timing Logic		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

Timing Logic Functions

Programming of output timing on those models which feature logic functions (see chart at right) 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 12 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). 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.)

All modules install easily under the sensor's black inner cover. Modules interconnect to the sensor circuitry without wires. Timing adjustments are easily accessible.

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.

45LM Series Modules Specifications

Operating Temperature	-40 to +70°C (-40 to +158°F)
Models with Timing Logic	45LM5, 45LM5D, 45LM8, 45LM8D, 45LM8M1, 45LM8DM1
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.
Models with LED Signal Strength Display	45LMD, 45LM5D, 45LM8D, 45LM8DM1
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 13).

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Removing and Installing the Plug-In Modules

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 2).
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 3).
5) Press the new module into place (Figure 4).
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 2. Insert a small screwdriver into the slot and lift the black cover to remove.

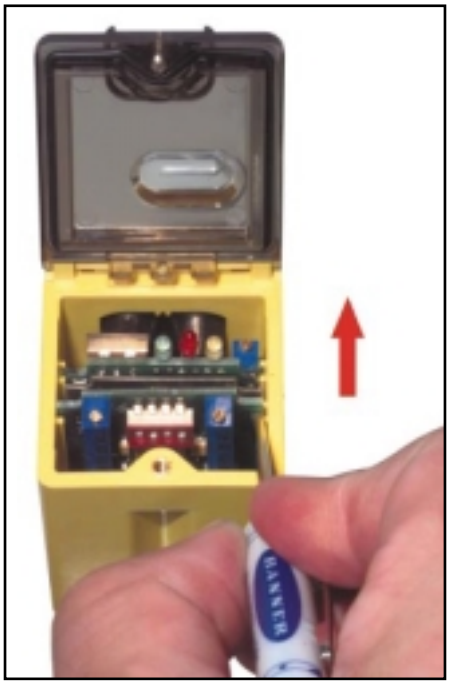


Figure 3. Using the small screwdriver in the module slot if necessary to nudge the module loose, lift the module up and out.

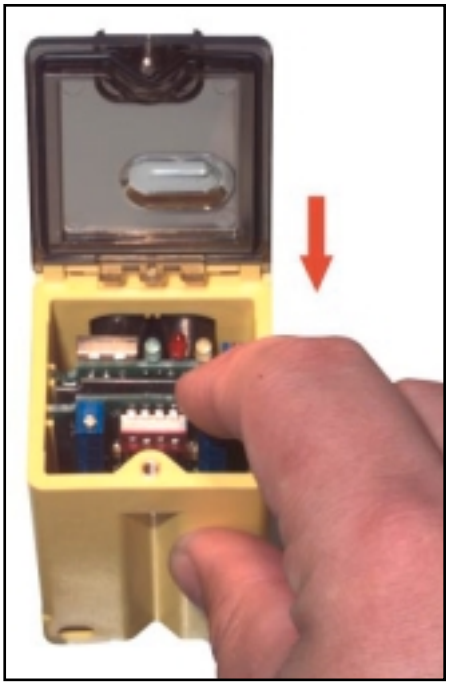


Figure 4. Slide the new module into place, pressing until it fits snugly.

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."

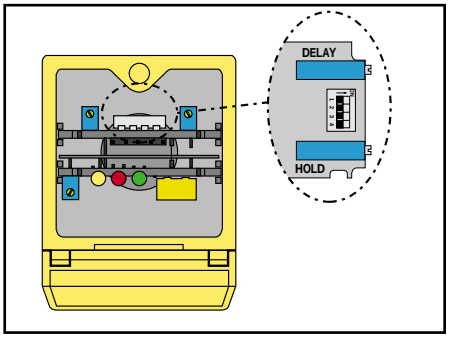
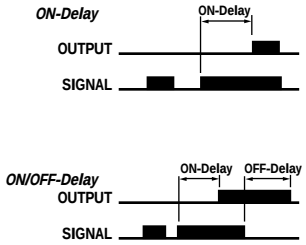


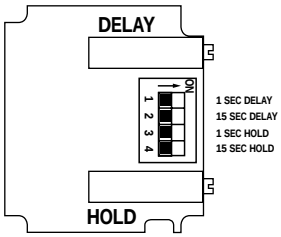
Figure 5. DIP switches for programming Delay logic

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**

TIMING DIAGRAMS



Adjustment Locations



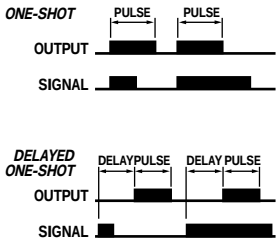
NOTE:
1) If both ranges of either delay function are selected (both 1 second and 15 second switches are ON), the delay time range becomes 16 seconds, maximum.
2) With switches #1 and #2 OFF (no ON-Delay programmed), ON-Delay is adjustable from "negligible" up to 100 milliseconds, maximum.
3) With switches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

45LM8(M1) and 45LM8D(M1) 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) 15 seconds max. pulse (1.5)	**ON**	OFF	**ON**	–
	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**	–

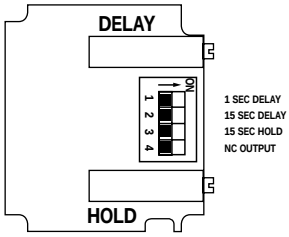
* Maximum times for models 45LM8M1 and 45LM8DM1 are in parentheses.

** For normal output (output conducts during pulse time), turn switch #4 OFF
To invert the output, turn switch #4 **ON**

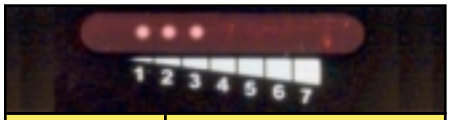
TIMING DIAGRAMS



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.



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

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.

Figure 7. Contrast values and corresponding guidelines

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 6) 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 6) 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 6) 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):

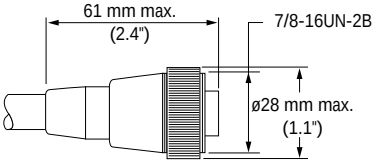
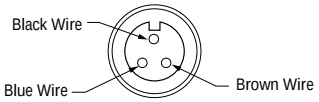
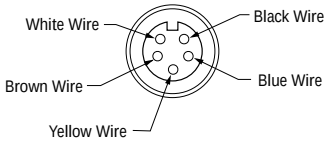
$$\text{Contrast is greater than } \frac{8x}{0.25x} = 32:1$$

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 7 gives general guidelines for contrast values.

Accessories

Mini-Style Quick-Disconnect Cables

Cable: PVC jacket, polyurethane connector body, nylon coupling nut
Conductors: 18 AWG high-flex stranded, PVC insulation, gold plated contacts
Temperature: -40° to +80°C (-40° to +176°F)
Voltage Rating: 250V ac/300V dc

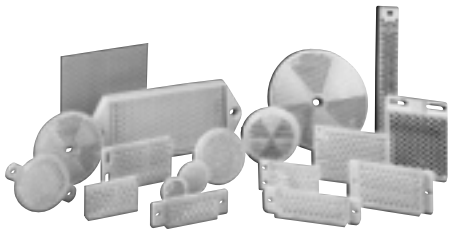
Style	Model	Length	Dimensions	Pin-out
3-Pin Female Pin-out Straight	**MBCC-306** **MBCC-312** **MBCC-330**	2 m (6.5') 4 m (12') 9 m (30')		
5-Pin Female Pin-out Straight	**MBCC-506** **MBCC-512** **MBCC-530**	2 m (6.5') 4 m (12') 9 m (30')		

Contact factory for right-angle connectors.

Retroreflective Targets

Banner offers a wide selection of high-quality retroreflective targets. See the Accessories section of your current Banner Photoelectric Sensors catalog for complete information.

NOTE: Polarized sensors require corner cube type retroreflective targets only. Non-polarized sensors may use any retroreflective targets.

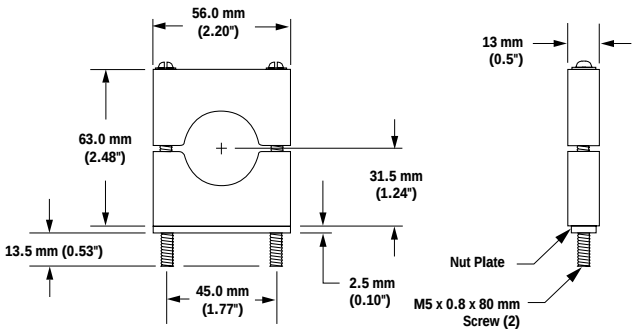
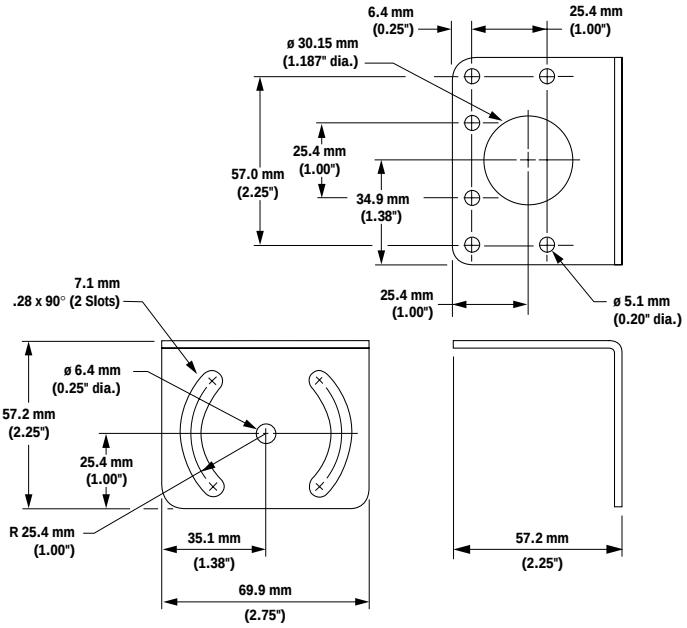
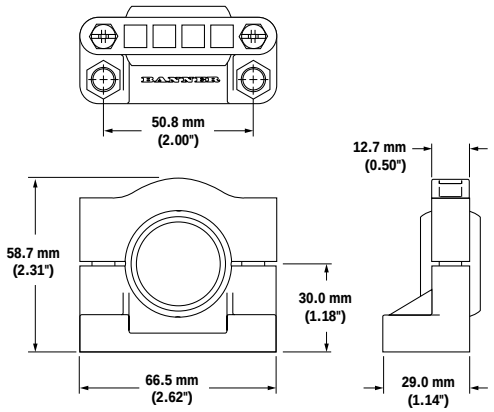


Output Timing Logic and Signal Strength Display Modules

Q45 sensors easily accept the addition of output timing logic and signal strength display functions. Display modules have a seven-element display which gives a “finer” indication of excess gain than does the AID™ system LED that is standard on Q45 sensors. The modules listed below may be used with all Q45VR2 sensors.

Model	Logic and/or Display Function
45LM5	Delay logic: on-delay, off-delay, or on/off-delay (15 secs. max.)
45LM8	Pulse logic: one-shot or delayed one-shot (15 secs. max.)
45LM8M1	Pulse logic: one-shot or delayed one-shot (1.5 sec. max.)
45LM5D	Delay logic plus signal strength display (15 secs. max.)
45LM8D	Pulse logic plus signal strength display (15 secs. max.)
45LM8DM1	Pulse logic plus signal strength display (1.5 sec. max.)
45LMD	Signal strength display only (no timing function)

Mounting Brackets

Model	Description	Dimensions
SMB30C	• 30 mm split clamp, black reinforced thermoplastic polyester bracket • Stainless steel mounting hardware included	
SMB30MM	• 30 mm, 11-gauge, stainless steel bracket with curved mounting slots for versatility and orientation • Clearance for M6 (1/4 in) hardware	
SMB30SC	• 30 mm swivel, black reinforced thermoplastic polyester bracket • Stainless steel mounting hardware included	

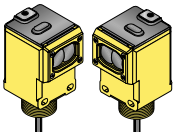
Q45BW22 Series Sensors

90 to 250V ac photoelectric sensors with protected solid-state relay output

*U.S. Patent no. 4356393

Q45BW22 Series Features

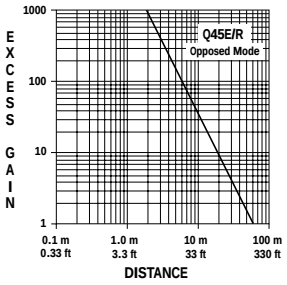
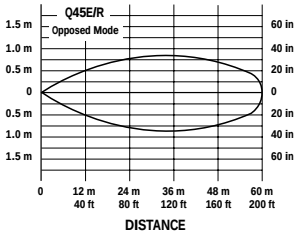
- Advanced one-piece photoelectric sensors with outstanding optical performance and extremely rugged design
- 90 to 250V ac
- Protected solid-state relay output; 300 mA max. load at up to 250V ac
- Multiple sensing modes include: opposed, diffuse, retroreflective and convergent, plus glass and plastic fiber optic models
- Switchable light/dark operate
- Versatile plug-in modules available for pulse or delay timing logic and/or signal strength display
- Highly visible Power, Signal (AID™ System*), and Output indicator LEDs
- Choice of prewired 2 m (6.5') or 9 m (30') unterminated cable, plus Mini-style or Micro-style quick-disconnect fittings
- Versatile mounting options
- Designed to withstand 1200 psi washdown; exceeds its NEMA 6P and IEC IP67 rating



Because of their extremely high excess gain, these opposed-mode sensors are an excellent option for sensing in contaminated or dirty areas, and are also the best choice for long-range sensing.

Infrared, 880 nm

Q45BW22 Series Opposed-Mode Emitter (E) and Receiver (R) Models

Models	Range	Cable	Supply Voltage	Output Type	Excess Gain	Beam Pattern
Q452E Emitter **Q45BW22R** Receiver	60 m (200')	2-wire 2m (6.5') 3-wire 2m (6.5')	90 to 250V ac	SPST Solid-state Relay		**Effective Beam: 13 mm** 
Q452EQ Emitter **Q452EQ1** Emitter **Q45BW22RQ** Receiver **Q45BW22RQ1** Receiver		3-Pin Mini-style QD 4-Pin Micro-style QD 3-Pin Mini-style QD 4-Pin Micro-style QD				

NOTES: i) 9 m (30') cables are available by adding suffix "W/30" to the model number of any cabled sensor (e.g., **Q452E W/30**)

ii) A model with a QD connector requires a mating cable; see page 14.

IMPORTANT: SEE SAFETY USE WARNING ON BACK PAGE

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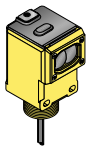
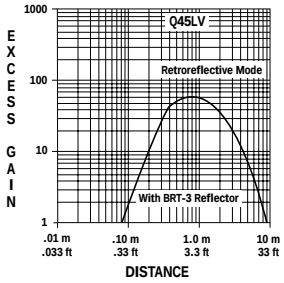
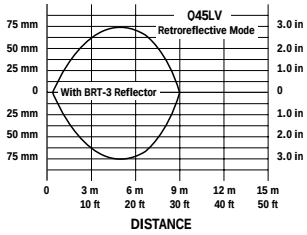
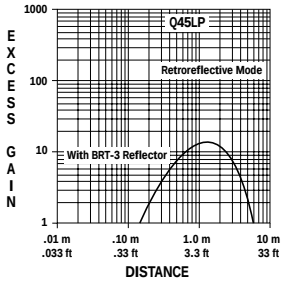
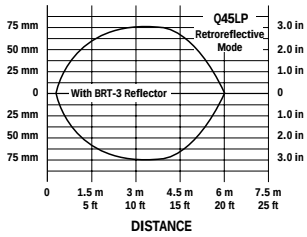
Q45BW22 Series



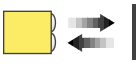
The visible red sensing beam of these sensors makes them very easy to align. Model Q45BW22LP polarizes the emitted light and filters out unwanted reflections, making sensing possible in applications otherwise considered unsuited to retroreflective sensing. Specified using the model BRT-3 3" reflector (see the Accessories section of your current Banner Photoelectric Sensors catalog for further information).

Visible red, 680 nm
Non-Polarized *Polarized*

Q45BW22 Series Retroreflective-Mode Models

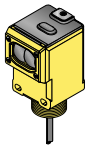
Models	Range	Cable	Supply Voltage	Output Type	Excess Gain	Beam Pattern
Non-Polarized						
Q45BW22LV **Q45BW22LVQ** **Q45BW22LVQ1**	0.08 to 9 m (3" to 30')	3-wire 2 m (6.5') 3-Pin Mini-style QD 4-Pin Micro-style QD	90 to 250V ac	SPST Solid-state Relay		
Polarized						
Q45BW22LP **Q45BW22LPQ** **Q45BW22LPQ1**	0.15 to 6 m (6" to 20')	3-wire 2 m (6.5') 3-Pin Mini-style QD 4-Pin Micro-style QD	90 to 250V ac	SPST Solid-state Relay		

NOTES:
i) 9 m (30') cables are available by adding suffix "W/30" to the model number of any cabled sensor (e.g., **Q45BW22LV W/30**)
ii) A model with a QD connector requires a mating cable; see page 14.

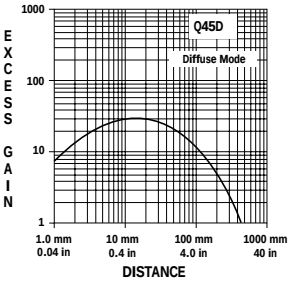
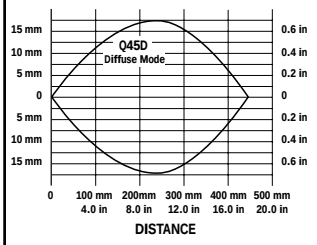
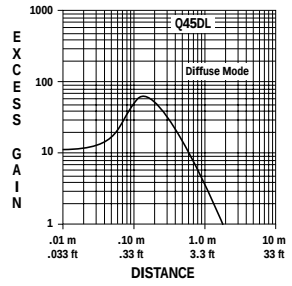
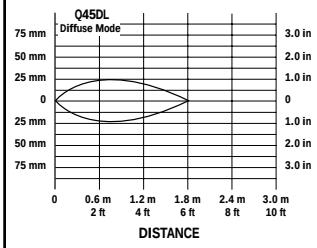
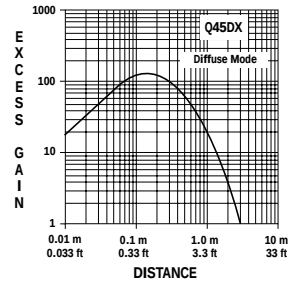
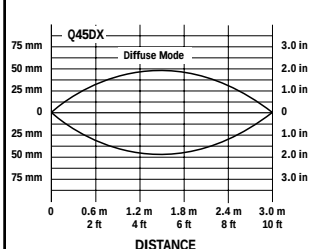


Infrared, 880 nm

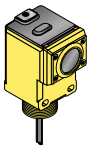
These diffuse-mode models detect objects by sensing the reflection of their own emitted light. Ideal for use when the reflectivity and profile of the object to be sensed are sufficient to return a large percentage of emitted light back to the sensor. Model Q45BW22DX is the first choice for diffuse-mode applications when there are no background objects to falsely return light.



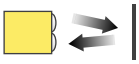
Q45BW22 Series Diffuse-Mode Models

Models	Range	Cable	Supply Voltage	Output Type	Excess Gain	Beam Pattern
					Performance based on 90% reflectance white test card	
Short Range						
Q45BW22D **Q45BW22DQ** **Q45BW22DQ1**	45 cm (18")	3-wire 2 m (6.5') 3-Pin Mini-style QD 4-Pin Micro-style QD	90 to 250V ac	SPST Solid-state Relay		
Long Range						
Q45BW22DL **Q45BW22DLQ** **Q45BW22DLQ1**	1. 8 m (6')	3-wire 2 m (6.5') 3-Pin Mini-style QD 4-Pin Micro-style QD	90 to 250V ac	SPST Solid-state Relay		
High Power						
Q45BW22DX **Q45BW22DXQ** **Q45BW22DXQ1**	3 m (10')	3-wire 2 m (6.5') 3-Pin Mini-style QD 4-Pin Micro-style QD	90 to 250V ac	SPST Solid-state Relay		

Q45BW22 Series

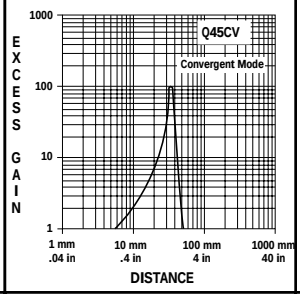
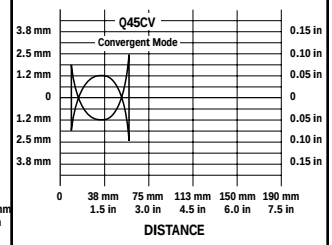
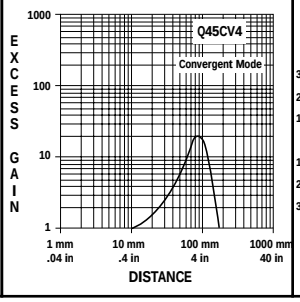
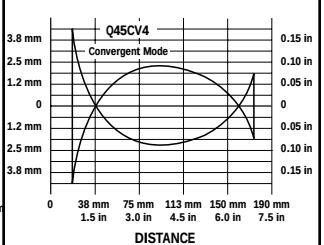


These sensors are ideal for reflective sensing of very small parts or profiles, and can accurately sense the position of parts approaching from the side. Will ignore all but highly reflective objects that are outside the sensing range.



Visible red. 680 nm

Q45BW22 Series Convergent-Mode Models

Models	Focus	Cable	Supply Voltage	Output Type	Excess Gain	Beam Pattern
					Performance based on 90% reflectance white test card	
Q45BW22CV **Q45BW22CVQ** **Q45BW22CVQ1**	38 mm (1.5") **Spot Size at Focus:** 1.3 mm (0.05")	3-wire 2 m (6.5') 3-Pin Mini-style QD 4-Pin Micro-style QD	90 to 250V ac	SPST Solid-state Relay		
Q45BW22CV4 **Q45BW22CV4Q** **Q45BW22CV4Q1**	100 mm (4") **Spot Size at Focus:** 1.5 mm (0.06")	3-wire 2 m (6.5') 3-Pin Mini-style QD 4-Pin Micro-style QD	90 to 250V ac	SPST Solid-state Relay		

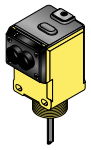
NOTES:

i) 9 m (30') cables are available by adding suffix "W/30" to the model number of any cabled sensor (e.g., **Q45BW22CV W/30**)

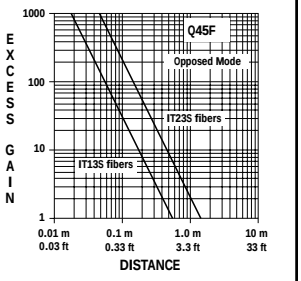
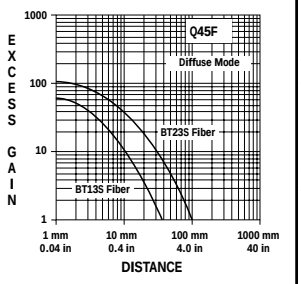
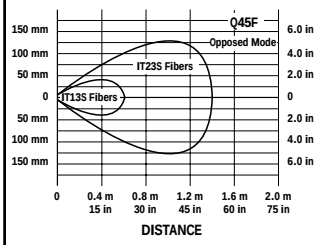
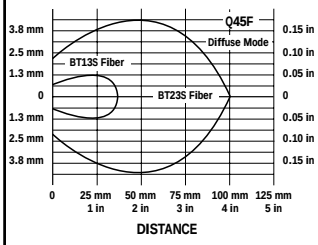
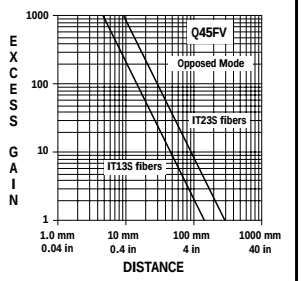
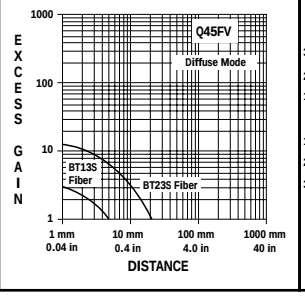
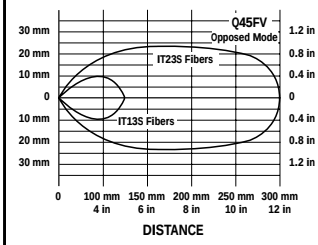
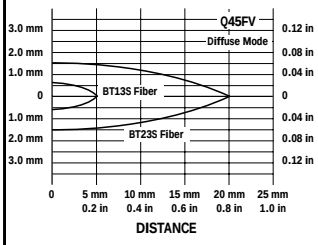
ii) A model with a QD connector requires a mating cable; see page 14.

Infrared, 880 nm and Visible Red, 650 nm

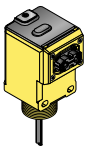
These models are an excellent choice for glass fiber optic applications where faster sensor response is not important. Their high excess gain means that opposed individual fibers can operate reliably in many very hostile environments. Also, special miniature bifurcated fiber optic assemblies with bundle sizes as small as .5 mm (.020") dia. may be used successfully for diffuse-mode sensing when using sensor model Q45BW22F(Q). For more information on compatible glass fiber optics, refer to your current Banner Photoelectric Sensors catalog.



Q45BW22 Series Glass Fiber-Optic Models

Models	Range	Cable	Supply Voltage	Output Type	Excess Gain	Beam Pattern
					Diffuse mode performance based on 90% reflectance white test card	
Infrared, 880 nm						
Q45BW22F **Q45BW22FQ** **Q45BW22FQ1**	Range varies by sensing mode and fiber optics used	3-wire 2 m (6.5') 3-Pin Mini-style QD 4-Pin Micro-style QD	90 to 250V ac	SPST Solid-state Relay	 	 
Visible Red, 650 nm						
Q45BW22FV **Q45BW22FVQ** **Q45BW22FVQ1**	Range varies by sensing mode and fiber optics used	3-wire 2 m (6.5') 3-Pin Mini-style QD 4-Pin Micro-style QD	90 to 250V ac	SPST Solid-state Relay	 	 

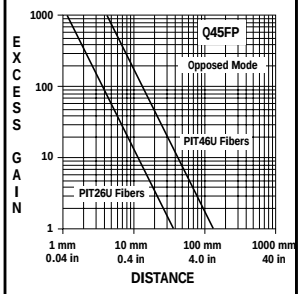
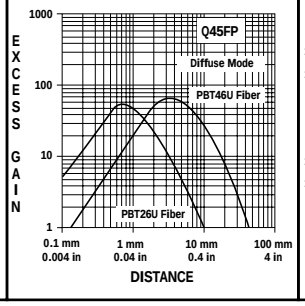
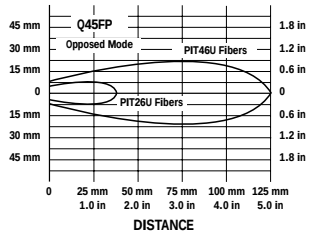
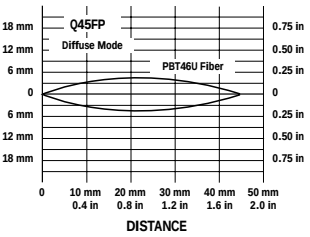
Q45BW22 Series



Lower in cost than glass fiber optics, plastic fiber optics are ideal for use in situations where environmental conditions allow (for example, low levels of acids, alkalis, and solvents). Most are easily cut to length in the field, and are available in a variety of sensing end styles. For more information on compatible plastic fiber optics, refer to your current Banner Photoelectric Sensors catalog.

Visible red, 660 nm

Q45BW22 Series Plastic Fiber-Optic Models

Models	Range	Cable	Supply Voltage	Output Type	Excess Gain	Beam Pattern
					Diffuse mode performance based on 90% reflectance white test card	
Q45BW22FP **Q45BW22FPQ** **Q45BW22FPQ1**	Range varies by sensing mode and fiber optics used	3-wire 2 m (6.5') 3-Pin Mini-style QD 4-Pin Micro-style QD	90 to 250V ac	SPST Solid-state Relay	 	 

NOTES:

i) 9 m (30') cables are available by adding suffix "W/30" to the model number of any cabled sensor (e.g., **Q45BW22FP W/30**)

ii) A model with a QD connector requires a mating cable; see page 14.

Q45BW22 Series Specifications

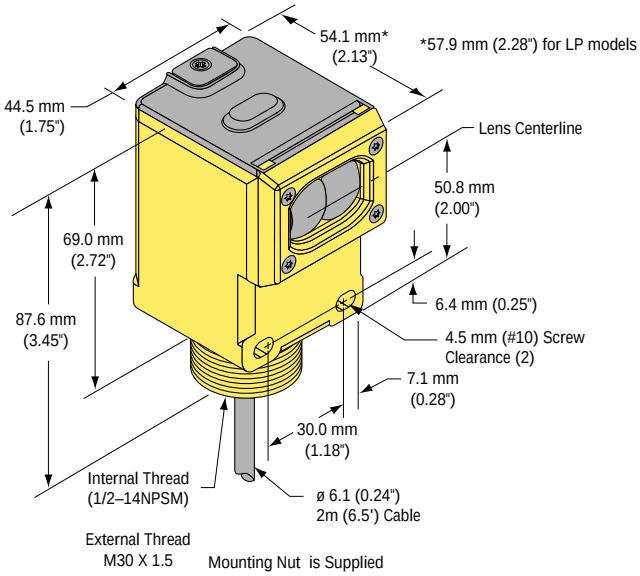
Supply Voltage and Current	90 to 250V ac (50 - 60 Hz). Average current 20 mA. Peak current 500 mA at 120V ac, 750 mA at 250V ac.
Supply Protection Circuitry	Protected against transient voltages.
Output Configuration	Short circuit/overload protected FET solid-state relay
Output Rating	**Continuous current** 300 mA max. to 50°C (derate to 200 mA at 70°C, 5 mA/°C) **Inrush current** 3A max. for 100 milliseconds, 5A max. for 1 millisecond **Off-state leakage current** <100 microamps **Saturation voltage** <3V at 300 mA
Output Protection Circuitry	Manually-resettable output latch-out trips in the event of an output overload or short circuit condition. The green Power LED flashes to indicate the latch-out. To reset the output, remove power to the sensor and load for 5 seconds, then restore power.
Output Response Time	**Opposed mode:** 2 milliseconds ON, 1 millisecond OFF **All other sensing modes:** 2 milliseconds ON/OFF (NOTE: 100 millisecond delay on power-up. Output is non-conducting during this time.)
Repeatability	**Opposed mode:** 0.25 milliseconds **All other sensing modes:** 0.5 milliseconds Response time and repeatability specifications are independent of signal strength.
Adjustments	**Beneath sensor's transparent cover:** Light/Dark Operate select switch and multi-turn Sensitivity control (allows precise sensitivity setting – turn clockwise to increase gain). Optional logic and logic/display modules have adjustable timing functions (see page 10).
Indicators	Indicator LEDs are clearly visible beneath a raised transparent Lexan® dome on top of the sensor. **Power (green) LED** lights whenever 90 to 250V ac power is applied, and flashes to indicate output overload or output short circuit **Signal (red) AID™ System LED** lights whenever the sensor sees its modulated light source, and pulses at a rate proportional to the strength of the received light signal **Load (yellow) LED** lights whenever the output relay is energized **Optional 7-element LED** signal strength display modules
Construction	Molded reinforced thermoplastic polyester housing, o-ring-sealed transparent Lexan® cover, molded acrylic lenses, and stainless steel hardware. Q45s are designed to withstand 1200 psi washdown. The base of cabled models has a 1/2" NPS integral internal conduit thread.
Environmental Rating	NEMA 6P, IEC IP67
Connections	PVC-jacketed 2 m (6.5') or 9 m (30') cables, or 3-pin Mini-style ("Q" suffix models) or 4-pin Micro-style ("Q1" suffix models) quick disconnect (QD) fittings are available. QD cables are ordered separately. See page 14.
Operating Conditions	**Temperature:** -40° to +70°C (-40° to +158°F) **Maximum relative humidity:** 90% at 50°C (non-condensing)
Application Notes	Optional output timing modules are available. See pages 10 through 14 for more information.
Certifications	CE NRTL/C

Lexan® is a registered trademark of General Electric Co.

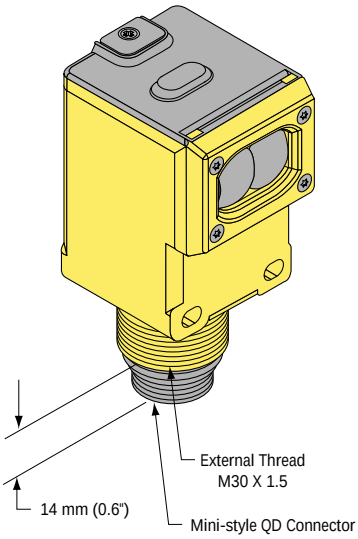
Q45BW22 Series Dimensions

Opposed, Retro, and Diffuse Sensing Modes (model suffix E, R, D, DL, DX, LP & LV)

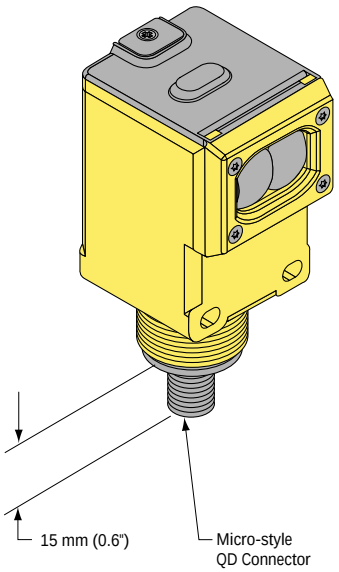
Cabled



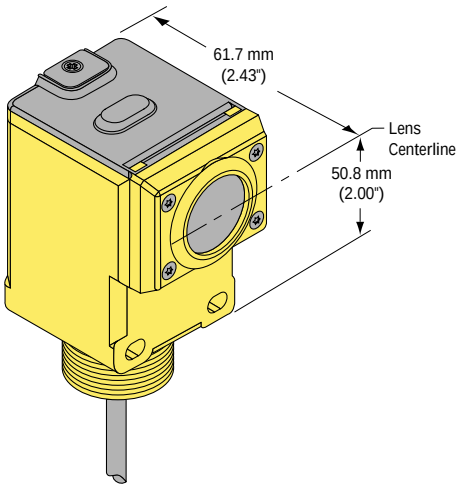
Mini-style Quick-disconnect



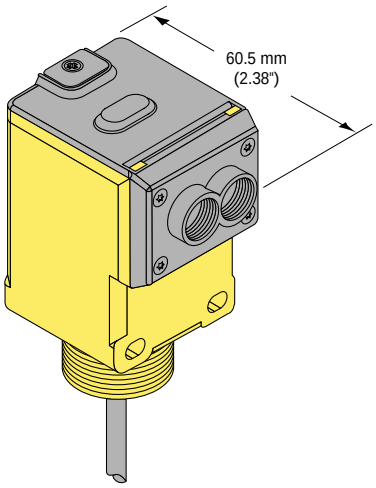
Micro-style Quick-disconnect



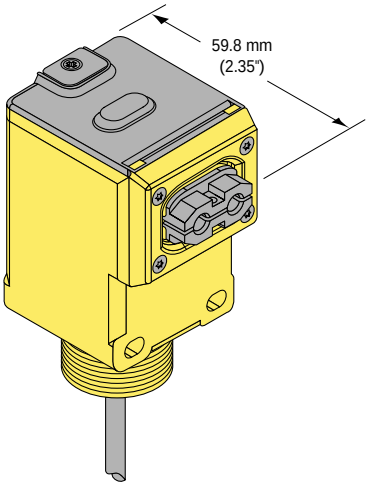
Convergent Sensing Mode (model suffix CV & CV4)



Glass Fiber Optic (model suffix F and FV)



Plastic Fiber Optic (model suffix FP)



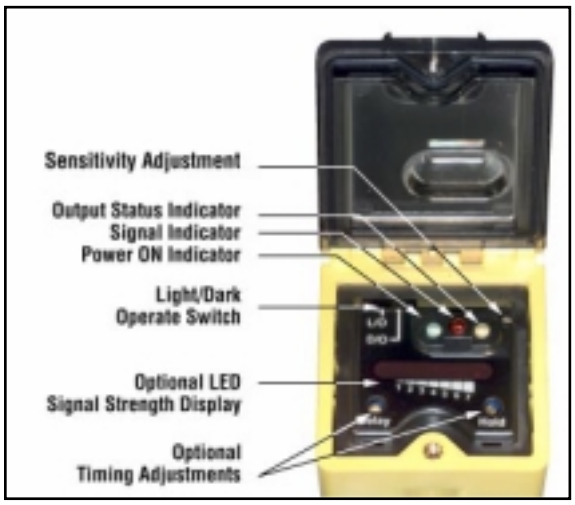


Figure 1. Indicators and controls on the Q45BW22 Series Sensors

Q45BW22 Series Indicators and Controls

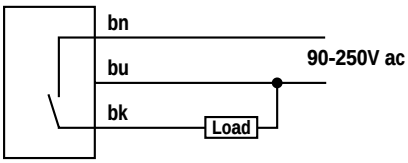
Status indicator LEDs for Power, Signal and Output are clearly visible beneath a raised dome in the sensor's transparent o-ring-sealed Lexan® cover. The Power indicator lights whenever power is applied to the sensor. The Signal LED lights whenever the sensor sees its modulated light source, and pulses at a rate proportional to the strength of the received light signal; this is the AID™ Alignment Indicating Device*. The Output indicator lights whenever the sensor's output is conducting. This indicator is especially useful when a timing logic module is used and Signal and Output conditions are not concurrent.

Also located beneath the sensor's o-ring-sealed cover are controls for light/dark operate selection and Sensitivity adjustment.

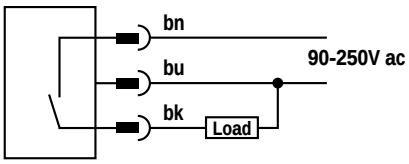
* US patent no. 4356393

Q45BW22 Series Hookups

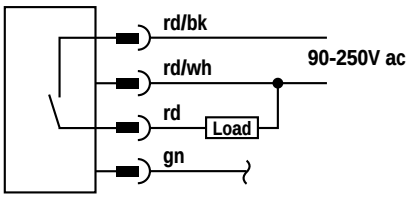
Q45BW22 Sensors with Attached Cable



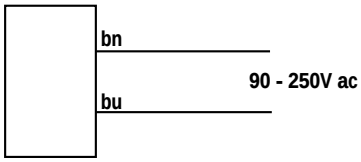
Q45BW22 Sensors with Quick-Disconnect 3-Pin Mini-Style (model suffix Q)



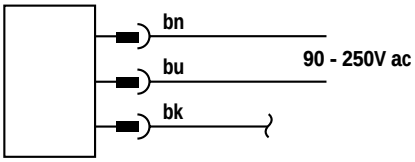
Q45BW22 Sensors with Quick-Disconnect 4-Pin Micro-Style (model suffix Q1)



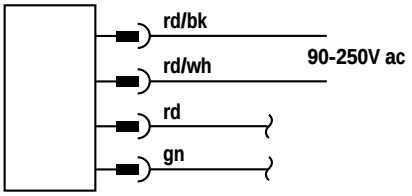
Q452E Emitter with Attached Cable



Q452E Emitter with Quick-Disconnect 3-Pin Mini-Style (model suffix Q)



Q452E Emitter with Quick-Disconnect 4-Pin Micro-Style (model suffix Q1)



Quick Disconnect (QD) Option

AC Q45BW22 Series sensors are sold with either a 2 m (6.5') or a 9 m (30') PVC-covered unterminated cable, or with a 3-pin Mini-style or 4-pin Micro-style QD cable fitting.

AC 3-pin Mini-style QD sensors are identified by the letter "Q" in their model number suffix and 4-pin Micro-style are identified by "Q1". Mating cables for QD Q45BW22 sensors are specified on page 14.

Optional Plug-In Output Timing Logic and Display Modules for the Q45BW22 Series

Q45BW22 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 chart at right.

Module Model Number	Output Timing Logic		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

Timing Logic Functions

Programming of output timing on those models which feature logic functions (see chart at right) 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 12 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). 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.)

All modules install easily under the sensor's black inner cover. Modules interconnect to the sensor circuitry without wires. Timing adjustments are easily accessible.

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.

45LM Series Modules Specifications

Operating Temperature	-40 to +70°C (-40 to +158°F)
Models with Timing Logic	45LM5, 45LM5D, 45LM8, 45LM8D, 45LM8M1, 45LM8DM1
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.
Models with LED Signal Strength Display	45LMD, 45LM5D, 45LM8D, 45LM8DM1
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 13).

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Removing and Installing the Plug-In Modules

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 2).
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 3).
5) Press the new module into place (Figure 4).
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 2. Insert a small screwdriver into the slot and lift the black cover to remove.

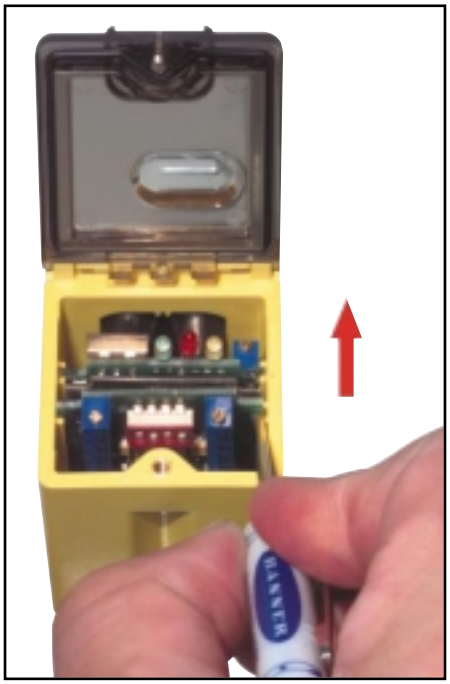


Figure 3. Using the small screwdriver in the module slot if necessary to nudge the module loose, lift the module up and out.

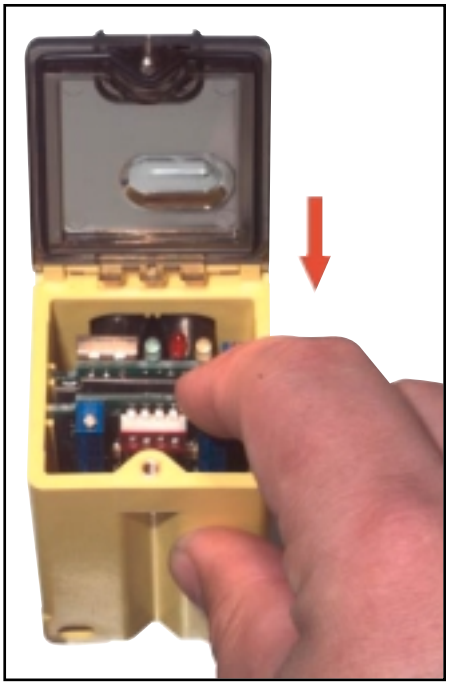


Figure 4. Slide the new module into place, pressing until it fits snugly.

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."

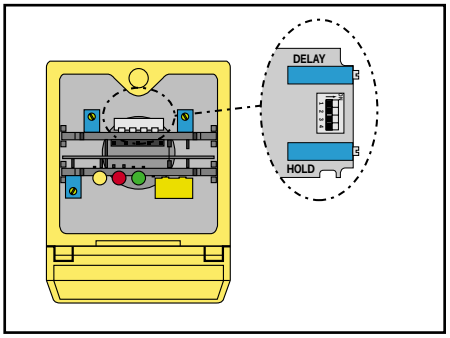
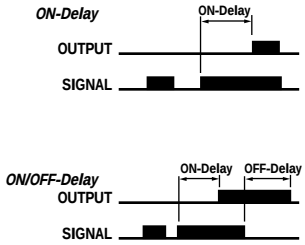


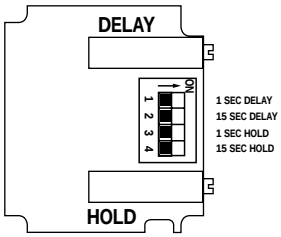
Figure 5. DIP switches for programming Delay logic

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**

TIMING DIAGRAMS



Adjustment Locations



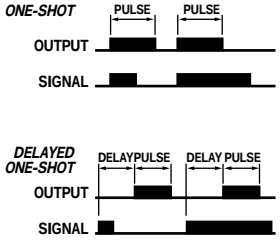
NOTE:
1) If both ranges of either delay function are selected (both 1 second and 15 second switches are ON), the delay time range becomes 16 seconds, maximum.
2) With switches #1 and #2 OFF (no ON-Delay programmed), ON-Delay is adjustable from "negligible" up to 100 milliseconds, maximum.
3) With switches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

45LM8(M1) and 45LM8D(M1) 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) 15 seconds max. pulse (1.5)	**ON**	OFF	**ON**	–
	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**	–

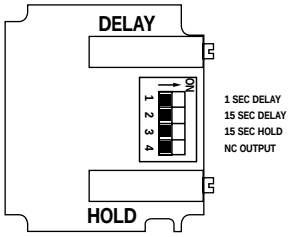
* Maximum times for models 45LM8M1 and 45LM8DM1 are in parentheses.

** For normal output (output conducts during pulse time), turn switch #4 OFF
To invert the output, turn switch #4 **ON**

TIMING DIAGRAMS



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

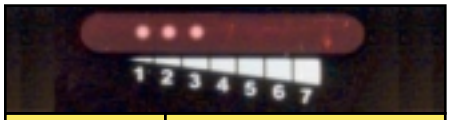
The Q45's optional seven-element LED array may be used to measure the excess gain and contrast in any sensing situation and during sensor installation and maintenance.

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 6) shows how excess gain relates to the LED array indicator.



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

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 6) 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 6) 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 7 gives general guidelines for contrast values.

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.

Figure 7. Contrast values and corresponding guidelines

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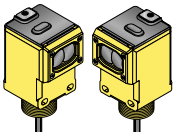
Q45VR3 Series Sensors

Universal voltage photoelectric sensors with electromechanical relay output

Q45VR3 Series Features

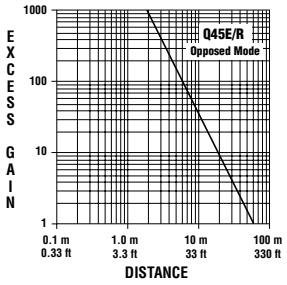
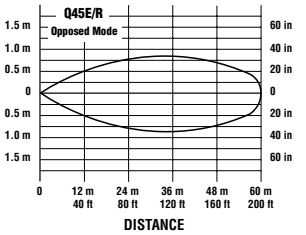
- Advanced one-piece photoelectric sensors with outstanding optical performance and extremely rugged design
- Universal supply voltage: 12 to 250V dc or 24 to 250V ac
- Electromechanical relay for economical, high-capacity switching and immunity to electrical noise
- Full line includes opposed, diffuse, retroreflective, convergent, and glass and plastic fiber optic sensing modes
- Switchable light/dark operate
- Versatile plug-in modules available for pulse or delay timing logic and/or signal strength display
- Highly visible Power, Signal (AID™ System), and Output indicator LEDs
- Choice of prewired 2 m (6.5') or 9 m (30') unterminated cable or Mini-style quick-disconnect fitting
- Versatile mounting options
- Designed to withstand 1200 psi washdown; exceeds its NEMA 6P and IEC IP67 rating



Because of their extremely high excess gain, these opposed-mode sensors are an excellent option for sensing in contaminated or dirty areas, and are also the best choice for long-range sensing.

Infrared, 880 nm

Q45VR3 Series Opposed-Mode Emitter (E) and Receiver (R) Models

Models	Range	Cable	Supply Voltage	Output Type	Excess Gain	Beam Pattern
Q453E Emitter **Q45VR3R** Receiver	60 m (200')	2-wire 2m (6.5') 5-wire 2m (6.5')	Universal 12 - 250V dc or 24 - 250V ac	SPDT Electro-mechanical Relay		**Effective Beam: 13 mm** 
Q453EQ Emitter **Q45VR3RQ** Receiver		3-Pin Mini-style QD 5-Pin Mini-style QD				

NOTES: i) 9 m (30') cables are available by adding suffix "W/30" to the model number of any cabled sensor (e.g., **Q453E W/30**)

ii) A model with a QD connector requires a mating cable; see page 14.

IMPORTANT: SEE SAFETY USE WARNING ON BACK PAGE

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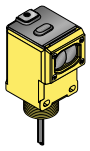
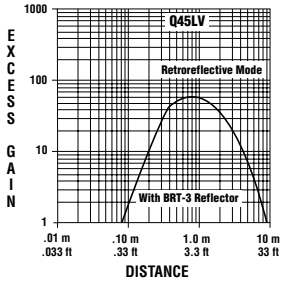
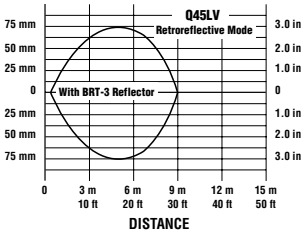
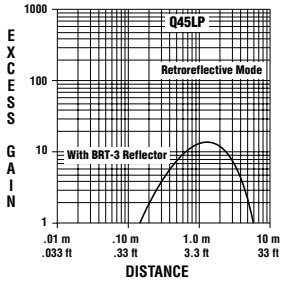
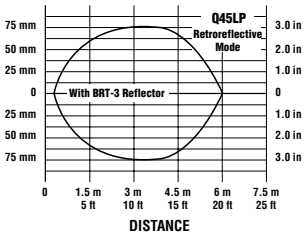
Q45VR3 Series



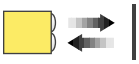
The visible red sensing beam of these sensors makes them very easy to align. Model Q45VR3LP polarizes the emitted light and filters out unwanted reflections, making sensing possible in applications otherwise considered unsuited to retroreflective sensing. Specified using the model BRT-3 3" reflector (see the Accessories section of your current Banner Photoelectric Sensors catalog for further information).

Visible red, 680 nm
Non-Polarized *Polarized*

Q45VR3 Series Retroreflective-Mode Models

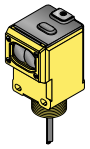
Models	Range	Cable	Supply Voltage	Output Type	Excess Gain	Beam Pattern
Non-Polarized						
Q45VR3LV **Q45VR3LVQ**	0.08 to 9 m (3" to 30')	5-wire 2 m (6.5') 5-Pin Mini-style QD	Universal 12 - 250V dc or 24 - 250V ac	SPDT Electro- mechanical Relay		
Polarized						
Q45VR3LP **Q45VR3LPQ**	0.15 to 6 m (6" to 20')	5-wire 2 m (6.5') 5-Pin Mini-style QD	Universal 12 - 250V dc or 24 - 250V ac	SPDT Electro- mechanical Relay		

NOTES:
i) 9 m (30') cables are available by adding suffix "W/30" to the model number of any cabled sensor (e.g., **Q45VR3LV W/30**)
ii) A model with a QD connector requires a mating cable; see page 14.

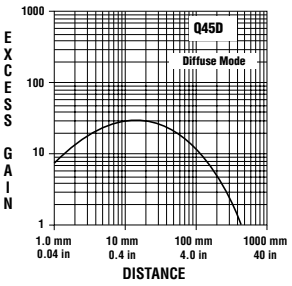
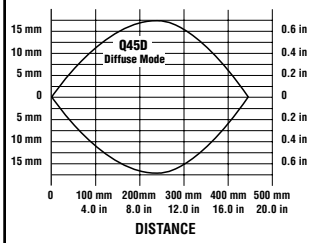
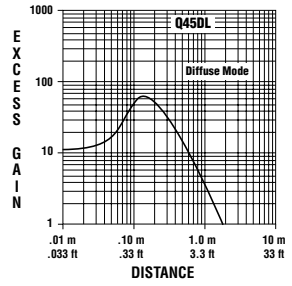
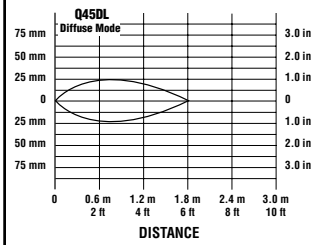
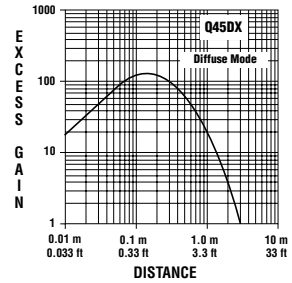
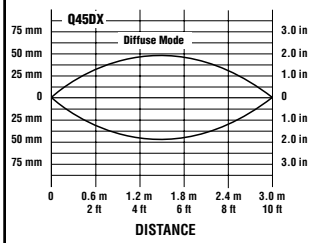


Infrared, 880 nm

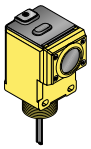
These diffuse-mode models detect objects by sensing the reflection of their own emitted light. Ideal for use when the reflectivity and profile of the object to be sensed are sufficient to return a large percentage of emitted light back to the sensor. Model Q45VR3DX is the first choice for diffuse-mode applications when there are no background objects to falsely return light.



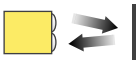
Q45VR3 Series Diffuse-Mode Models

Models	Range	Cable	Supply Voltage	Output Type	Excess Gain	Beam Pattern
					Performance based on 90% reflectance white test card	
Short Range						
Q45VR3D **Q45VR3DQ**	45 cm (18")	5-wire 2 m (6.5') 5-Pin Mini-style QD	Universal 12 - 250V dc or 24 - 250V ac	SPDT Electro-mechanical Relay		
Long Range						
Q45VR3DL **Q45VR3DLQ**	1. 8 m (6')	5-wire 2 m (6.5') 5-Pin Mini-style QD	Universal 12 - 250V dc or 24 - 250V ac	SPDT Electro-mechanical Relay		
High Power						
Q45VR3DX **Q45VR3DXQ**	3 m (10')	5-wire 2 m (6.5') 5-Pin Mini-style QD	Universal 12 - 250V dc or 24 - 250V ac	SPDT Electro-mechanical Relay		

Q45VR3 Series

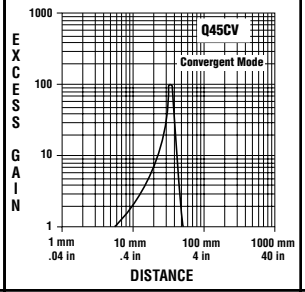
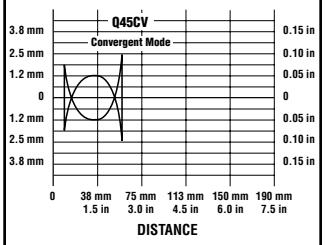
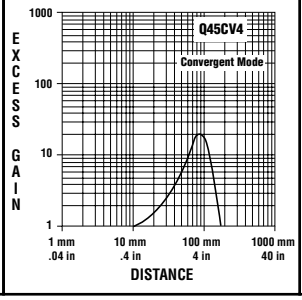
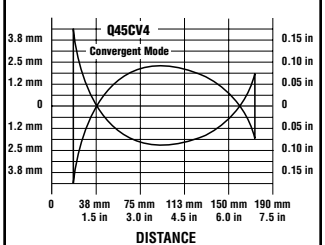


These sensors are ideal for reflective sensing of very small parts or profiles, and can accurately sense the position of parts approaching from the side. Will ignore all but highly reflective objects that are outside the sensing range.



Visible red. 680 nm

Q45VR3 Series Convergent-Mode Models

Models	Focus	Cable	Supply Voltage	Output Type	Excess Gain	Beam Pattern
					Performance based on 90% reflectance white test card	
Q45VR3CV **Q45VR3CVQ**	38 mm (1.5") **Spot Size at Focus:** 1.3 mm (0.05")	5-wire 2 m (6.5') 5-Pin Mini-style QD	Universal 12 - 250V dc or 24 - 250V ac	SPDT Electro-mechanical Relay		
Q45VR3CV4 **Q45VR3CV4Q**	100 mm (4") **Spot Size at Focus:** 1.5 mm (0.06")	5-wire 2 m (6.5') 5-Pin Mini-style QD	Universal 12 - 250V dc or 24 - 250V ac	SPDT Electro-mechanical Relay		

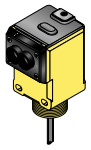
NOTES:

i) 9 m (30') cables are available by adding suffix "W/30" to the model number of any cabled sensor (e.g., **Q45VR3CV W/30**)

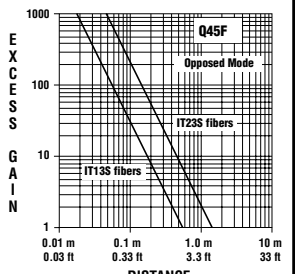
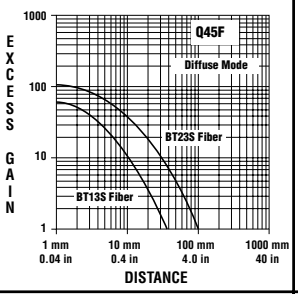
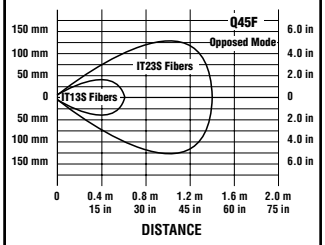
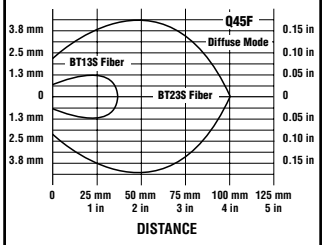
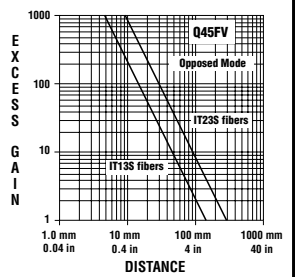
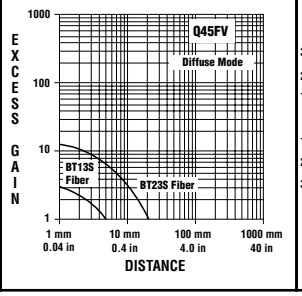
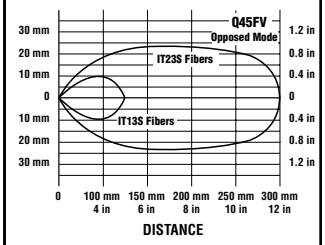
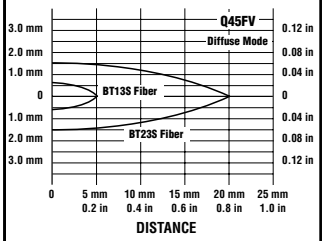
ii) A model with a QD connector requires a mating cable; see page 14.

Infrared, 880 nm and Visible Red, 650 nm

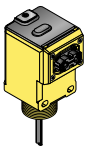
These models are an excellent choice for glass fiber optic applications where faster sensor response is not important. Their high excess gain means that opposed individual fibers can operate reliably in many very hostile environments. Also, special miniature bifurcated fiber optic assemblies with bundle sizes as small as .5 mm (.020") dia. may be used successfully for diffuse-mode sensing when using sensor model Q45VR3F(Q). For more information on compatible glass fiber optics, refer to your current Banner Photoelectric Sensors catalog.



Q45VR3 Series Glass Fiber-Optic Models

Models	Range	Cable	Supply Voltage	Output Type	Excess Gain	Beam Pattern
					Diffuse mode performance based on 90% reflectance white test card	
Infrared, 880 nm						
Q45VR3F **Q45VR3FQ**	Range varies by sensing mode and fiber optics used	5-wire 2 m (6.5') 5-Pin Mini-style QD	Universal 12 - 250V dc or 24 - 250V ac	SPDT Electro-mechanical Relay	 	 
Visible Red, 650 nm						
Q45VR3FV **Q45VR3FVQ**	Range varies by sensing mode and fiber optics used	5-wire 2 m (6.5') 5-Pin Mini-style QD	Universal 12 - 250V dc or 24 - 250V ac	SPDT Electro-mechanical Relay	 	 

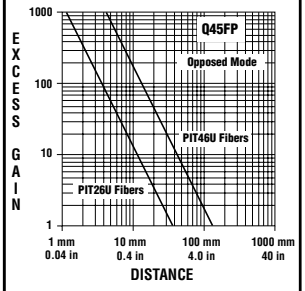
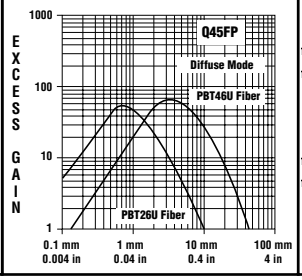
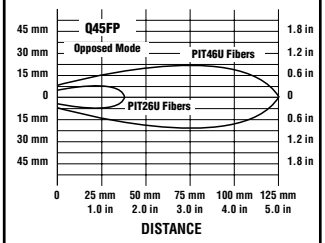
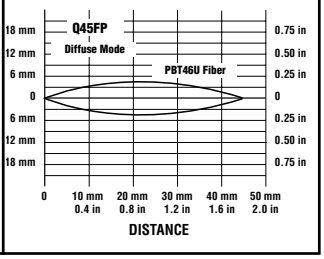
Q45VR3 Series



Lower in cost than glass fiber optics, plastic fiber optics are ideal for use in situations where environmental conditions allow (for example, low levels of acids, alkalis, and solvents). Most are easily cut to length in the field, and are available in a variety of sensing end styles. For more information on compatible plastic fiber optics, refer to your current Banner Photoelectric Sensors catalog.

Visible red, 660 nm

Q45VR3 Series Plastic Fiber-Optic Models

Models	Range	Cable	Supply Voltage	Output Type	Excess Gain	Beam Pattern
					Diffuse mode performance based on 90% reflectance white test card	
Q45VR3FP **Q45VR3FPQ**	Range varies by sensing mode and fiber optics used	5-wire 2 m (6.5') 5-Pin Mini-style QD	Universal 12 - 250V dc or 24 - 250V ac	SPDT Electro-mechanical Relay	 	 

NOTES:

i) 9 m (30') cables are available by adding suffix "W/30" to the model number of any cabled sensor (e.g., **Q45VR3FP W/30**)

ii) A model with a QD connector requires a mating cable; see page 14.

Q45VR3 Series Specifications

Supply Voltage and Current	Universal voltage: 24 to 250V ac, 50/60 Hz or 12 to 250V dc (1.5 watts maximum)
Supply Protection Circuitry	Protected against transient voltages. DC hookup is without regard to polarity.
Output Configuration	SPDT (Single-Pole, Double-Throw) electromechanical relay output. All models except emitters.
Output Rating	**Max. switching power (resistive load):** 1250VA, 150W **Max. switching voltage (resistive load):** 250V ac, 125V dc **Max. switching current (resistive load):** 5A @ 250V ac, 5A @ 30V dc derated to 200 mA @ 125V dc **Min. voltage and current:** 5V dc, 10mA **Mechanical life of relay:** 50,000,000 operations **Electrical life of relay at full resistive load:** 100,000 operations
Output Protection Circuitry	Protected against false pulse on power-up
Output Response Time	15 milliseconds ON and OFF (NOTE: 100 millisecond delay on power-up. Relay is de-energized during this time.)
Repeatability	**Opposed mode:** 0.25 milliseconds **All other sensing modes:** 0.5 milliseconds Response time and repeatability specifications are independent of signal strength.
Adjustments	Light/Dark Operate select switch; and multi-turn Sensitivity control on top of sensor beneath a transparent o-ring-sealed Lexan® cover, allows precise sensitivity setting (turn clockwise to increase gain). Optional logic and logic/display modules have adjustable timing functions (see page 10).
Indicators	Indicator LEDs are clearly visible beneath a raised transparent Lexan® dome on top of the sensor. **Power (green) LED** lights whenever 24 to 250V ac, or 12 to 250V dc power is applied **Signal (red) AID™ System LED** lights whenever the sensor sees its modulated light source, and pulses at a rate proportional to the strength of the received light signal **Load (yellow) LED** lights whenever the output relay is energized Optional 7-element LED signal strength display module
Construction	Molded VALOX® thermoplastic polyester housing, o-ring-sealed transparent Lexan® cover, molded acrylic lenses, and stainless steel hardware. Q45s are designed to withstand 1200 psi washdown. The base of cabled models has a 1/2" NPS integral internal conduit thread.
Environmental Rating	NEMA 6P, IEC IP67
Connections	PVC-jacketed 2 m (6.5') or 9 m (30') unterminated cables, or Mini-style quick-disconnect (QD) fittings are available ("Q"- suffix models). QD cables are ordered separately. See page 14.
Operating Conditions	**Temperature:** -25° to +55° C (-13° to +131°F) **Maximum relative humidity:** 90% at 50°C (non-condensing)
Application Notes	Transient suppression is recommended for contacts switching inductive loads. Optional output timing modules are available. See pages 10 and 14 for more information.

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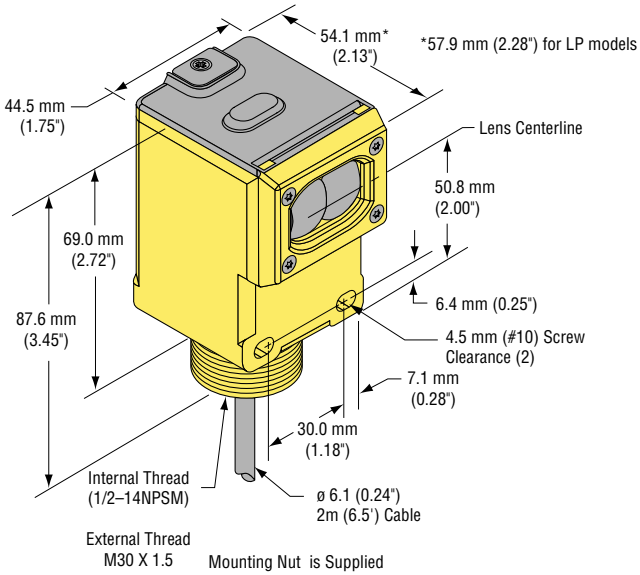
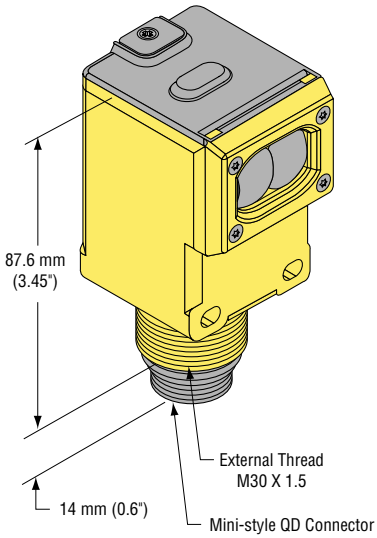
Q45VR3 Series Dimensions

Q45VR3 Series Sensors – Opposed, Retro, and Diffuse Sensing Modes (model suffix E, R, D, DL, DX, LP & LV)

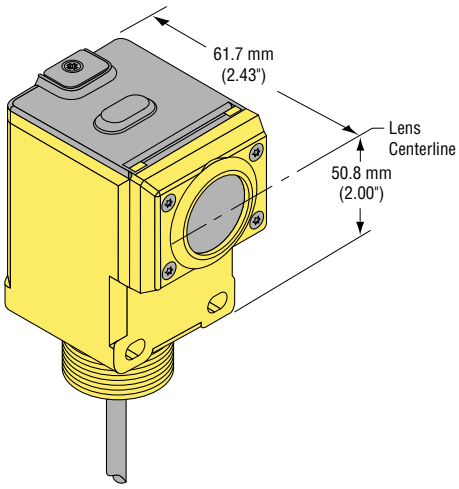
Cabled



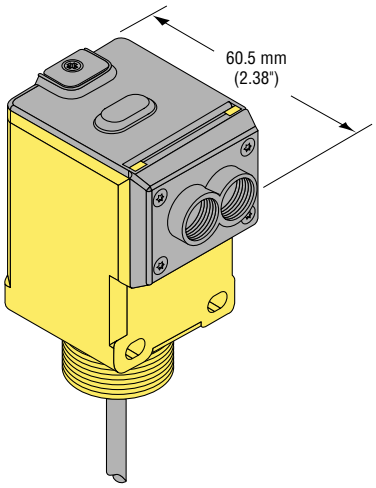
Quick-Disconnect



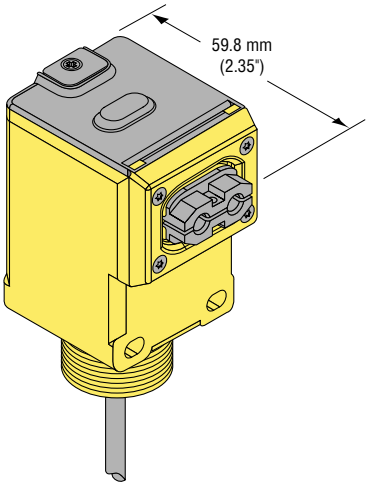
Convergent Sensing Mode (model suffix CV & CV4)



Glass Fiber Optic (model suffix F and FV)



Plastic Fiber Optic (model suffix FP)



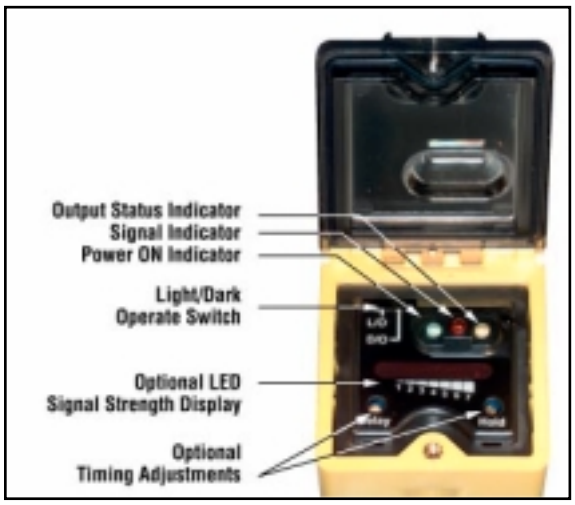


Figure 1. Indicators and controls on the Q45VR3 Series Sensors

Q45VR3 Series Indicators and Controls

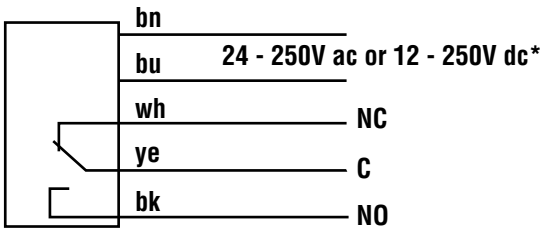
Status indicator LEDs for Power, Signal and Output are clearly visible beneath a raised dome in the sensor's transparent o-ring-sealed Lexan® cover. The Power indicator lights whenever power is applied to the sensor. The Signal LED lights whenever the sensor sees its modulated light source, and pulses at a rate proportional to the strength of the received light signal; this is the AID™ Alignment Indicating Device*. The Output indicator lights whenever the sensor's output relay is energized. This indicator is especially useful when a timing logic module is used and Signal and Output conditions are not concurrent.

Also located beneath the sensor's o-ring-sealed cover are controls for light/dark operate selection and Sensitivity adjustment.

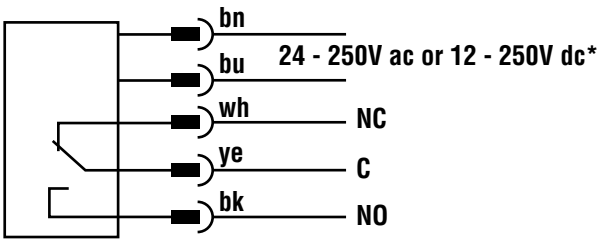
* US patent no. 4356393

Q45VR3 Series Hookups

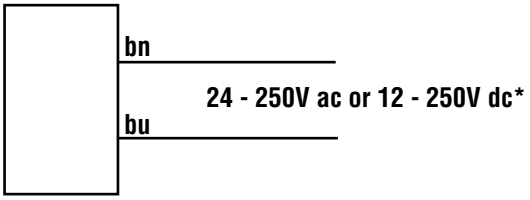
Q45VR3 Sensors with Attached Cable



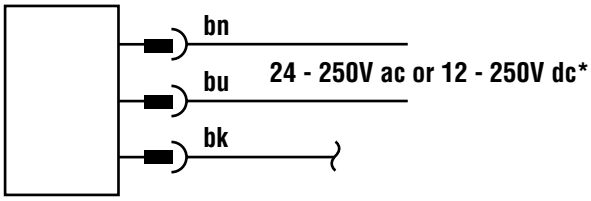
Q45VR3 Sensors with Quick-Disconnect 5-Pin Mini-Style (model suffix Q)



Q453E Emitters with Attached Cable



Q453EQ Emitters with Quick-Disconnect 3-Pin Mini-Style



*NOTE: Connection of dc power is without regard to polarity.

Quick-Disconnect (QD) Option

AC Q45VR3 Series sensors are sold with either a 2 m (6.5') or a 9 m (30') attached PVC-covered cable, or with a 3-pin Mini-style (opposed mode emitter) or 5-pin Mini-style Quick-Disconnect (QD) cable fitting.

Mini-style QD sensors are identified by the suffix "Q" in their model number suffix. Mating cables for QD Q45VR3 sensors are specified on page 14.

Optional Plug-In Output Timing Logic and Display Modules for the Q45VR3 Series

Q45VR3 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 chart at right.

Module Model Number	Output Timing Logic		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

Timing Logic Functions

Programming of output timing on those models which feature logic functions (see chart at right) 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 12 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). 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.)

All modules install easily under the sensor's black inner cover. Modules interconnect to the sensor circuitry without wires. Timing adjustments are easily accessible.

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 Gain or Timing controls, as long as the black inside cover remains in place.

45LM Series Modules Specifications

Operating Temperature	-40 to +70ºC (-40 to +158ºF)
Models with Timing Logic	45LM5, 45LM5D, 45LM8, 45LM8D, 45LM8M1, 45LM8DM1
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
Models with LED Signal Strength Display	45LMD, 45LM5D, 45LM8D, 45LM8DM1
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 13)

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Removing and Installing the Plug-In Modules

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 2).
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 3).
5) Press the new module into place (Figure 4).
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 2. Insert a small screwdriver into the slot and lift the black cover to remove.

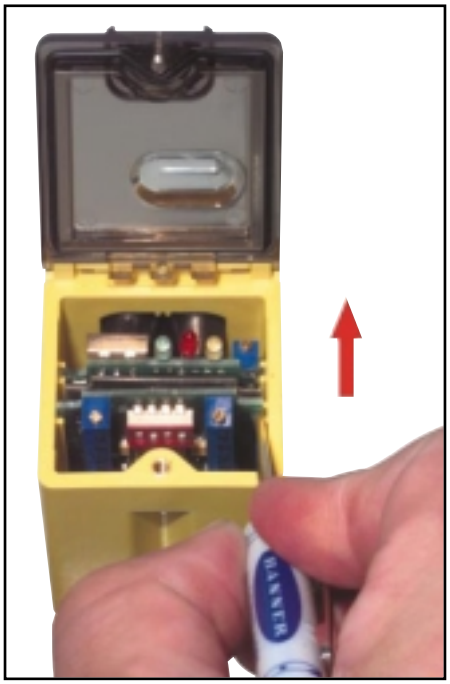


Figure 3. Using the small screwdriver in the module slot if necessary to nudge the module loose, lift the module up and out.

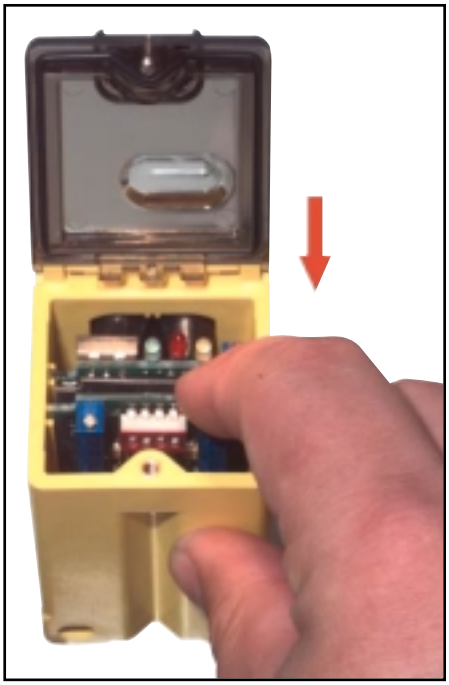


Figure 4. Slide the new module into place, pressing until it fits snugly.

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."

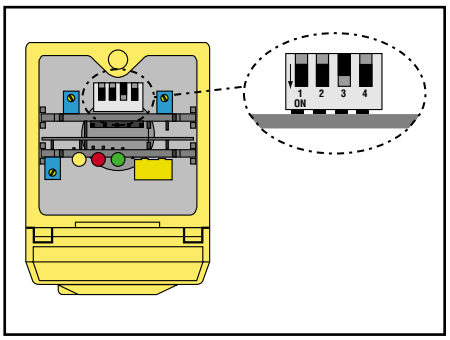
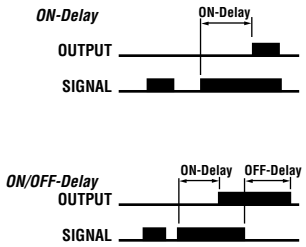


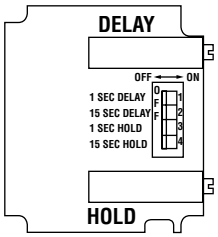
Figure 5. DIP switches for programming Delay logic

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**

TIMING DIAGRAMS



Adjustment Locations



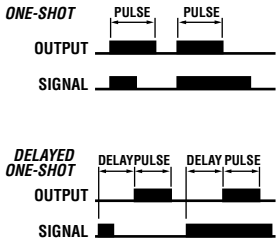
NOTE:
1) If both ranges of either delay function are selected (both 1 second and 15 second switches are ON), the delay time range becomes 16 seconds, maximum.
2) With switches #1 and #2 OFF (no ON-Delay programmed), ON-Delay is adjustable from "negligible" up to 100 milliseconds, maximum.
3) With switches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

45LM8(M1) and 45LM8D(M1) 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) 15 seconds max. pulse (1.5)	**ON**	OFF	ON	–
	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**	–

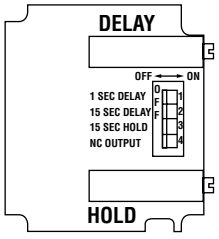
* Maximum times for models 45LM8M1 and 45LM8DM1 are in parentheses.

** For normal output (output conducts during pulse time), turn switch #4 OFF To invert the output, turn switch #4 **ON**

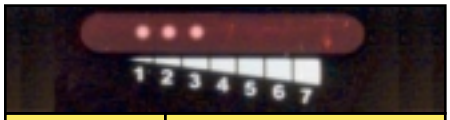
TIMING DIAGRAMS



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.



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

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.

Figure 7. Contrast values and corresponding guidelines

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 6) 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 6) 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 6) 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):

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

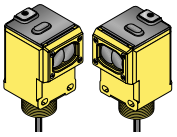
Of course, it is not always possible to adjust a sensor to maintain this much contrast. However, it is important to always adjust a sensor for the greatest amount of contrast possible for any sensing situation. The LED signal strength indicator array makes this easy. Figure 7 gives general guidelines for contrast values.

Q45BW13 Series Sensors

Universal voltage photoelectric sensors with isolated solid-state output

Q45BW13 Series Features

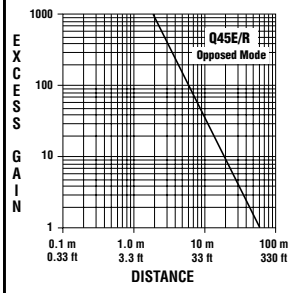
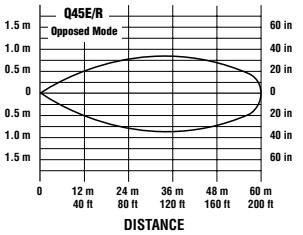
- Advanced one-piece photoelectric sensors with outstanding optical performance and extremely rugged design
- Universal supply voltage: 12 to 250V dc or 24 to 250V ac
- Opto-isolated solid-state relay output; 300 mA max. load at up to 250V ac, 250V dc
- Full line includes opposed, diffuse, retroreflective, convergent, and glass and plastic fiber optic sensing modes
- Switchable light/dark operate
- Versatile plug-in modules available for pulse or delay timing logic and/or signal strength display
- Highly visible Power, Signal (AID™ System), and Output indicator LEDs
- Choice of prewired 2 m (6.5') or 9 m (30') unterminated cable or Mini-style quick-disconnect fitting
- Versatile mounting options
- Designed to withstand 1200 psi washdown; exceeds its NEMA 6P and IEC IP67 rating



Because of their extremely high excess gain, these opposed-mode sensors are an excellent option for sensing in contaminated or dirty areas, and are also the best choice for long-range sensing.

Infrared, 880 nm

Q45BW13 Series Opposed-Mode Emitter (E) and Receiver (R) Models

Models	Range	Cable	Supply Voltage	Output Type	Excess Gain	Beam Pattern
Q453E Emitter **Q45BW13R** Receiver	60 m (200')	2-wire 2m (6.5') 4-wire 2m (6.5')	Universal 12 - 250V dc or 24 - 250V ac	Isolated SPST Solid-state Switch		**Effective Beam: 13 mm** 
Q453EQ Emitter **Q45BW13RQ** Receiver		3-Pin Mini-style QD 4-Pin Mini-style QD				

NOTES: i) 9 m (30') cables are available by adding suffix "W/30" to the model number of any cabled sensor (e.g., **Q453E W/30**)

ii) A model with a QD connector requires a mating cable; see page 14.

IMPORTANT: SEE SAFETY USE WARNING ON BACK PAGE

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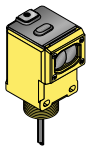
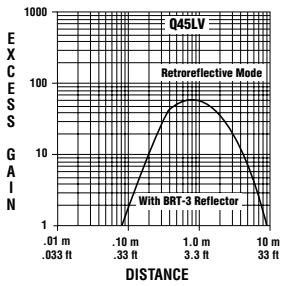
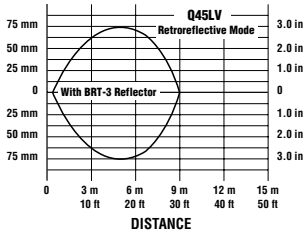
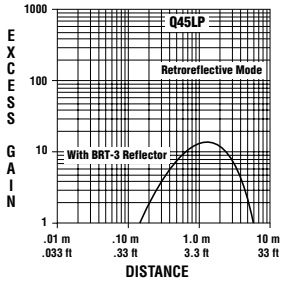
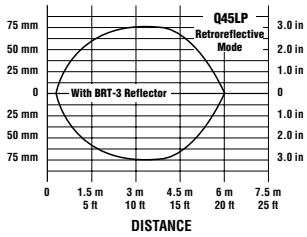
Q45BW13 Series



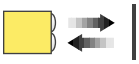
The visible red sensing beam of these sensors makes them very easy to align. Model Q45BW13LP polarizes the emitted light and filters out unwanted reflections, making sensing possible in applications otherwise considered unsuited to retroreflective sensing. Specified using the model BRT-3 3" reflector (see the Accessories section of your current Banner Photoelectric Sensors catalog for further information).

Visible red, 680 nm
Non-Polarized *Polarized*

Q45BW13 Series Retroreflective-Mode Models

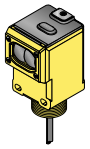
Models	Range	Cable	Supply Voltage	Output Type	Excess Gain	Beam Pattern
Non-Polarized						
Q45BW13LV **Q45BW13LVQ**	0.08 to 9 m (3" to 30')	4-wire 2 m (6.5') 4-Pin Mini-style QD	Universal 12 - 250V dc or 24 - 250V ac	Isolated SPST Solid-state Switch		
Polarized						
Q45BW13LP **Q45BW13LPQ**	0.15 to 6 m (6" to 20')	4-wire 2 m (6.5') 4-Pin Mini-style QD	Universal 12 - 250V dc or 24 - 250V ac	Isolated SPST Solid-state Switch		

NOTES:
i) 9 m (30') cables are available by adding suffix "W/30" to the model number of any cabled sensor (e.g., **Q45BW13LV W/30**)
ii) A model with a QD connector requires a mating cable; see page 14.

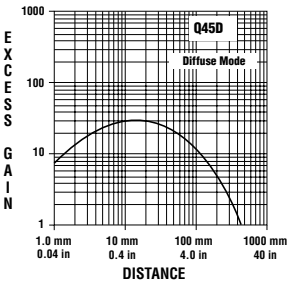
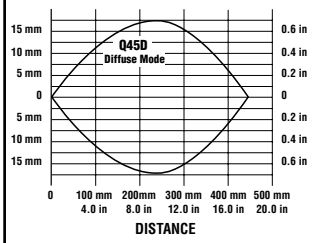
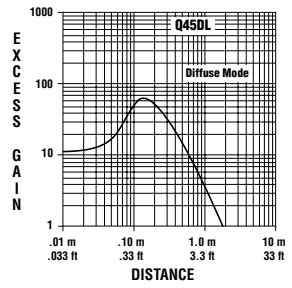
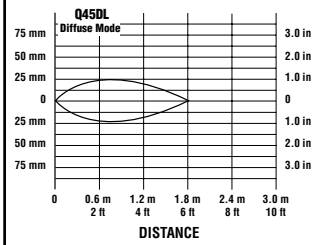
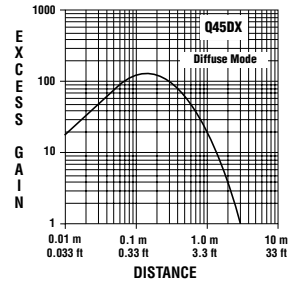
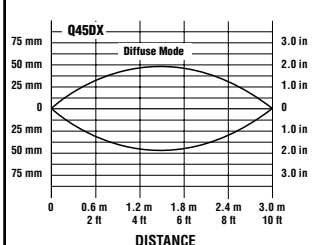


Infrared, 880 nm

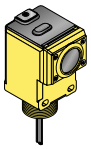
These diffuse-mode models detect objects by sensing the reflection of their own emitted light. Ideal for use when the reflectivity and profile of the object to be sensed are sufficient to return a large percentage of emitted light back to the sensor. Model Q45BW13DX is the first choice for diffuse-mode applications when there are no background objects to falsely return light.



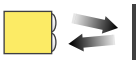
Q45BW13 Series Diffuse-Mode Models

Models	Range	Cable	Supply Voltage	Output Type	Excess Gain	Beam Pattern
					Performance based on 90% reflectance white test card	
Short Range						
Q45BW13D **Q45BW13DQ**	45 cm (18")	4-wire 2 m (6.5') 4-Pin Mini-style QD	Universal 12 - 250V dc or 24 - 250V ac	Isolated SPST Solid-state Switch		
Long Range						
Q45BW13DL **Q45BW13DLQ**	1. 8 m (6')	4-wire 2 m (6.5') 4-Pin Mini-style QD	Universal 12 - 250V dc or 24 - 250V ac	Isolated SPST Solid-state Switch		
High Power						
Q45BW13DX **Q45BW13DXQ**	3 m (10')	4-wire 2 m (6.5') 4-Pin Mini-style QD	Universal 12 - 250V dc or 24 - 250V ac	Isolated SPST Solid-state Switch		

Q45BW13 Series

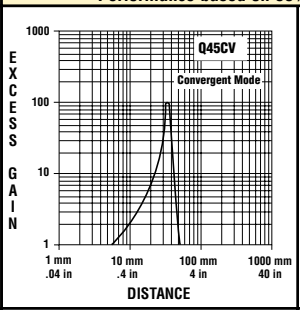
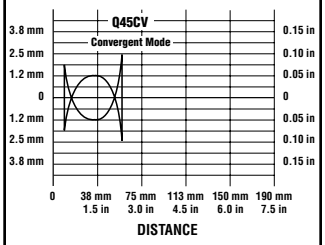
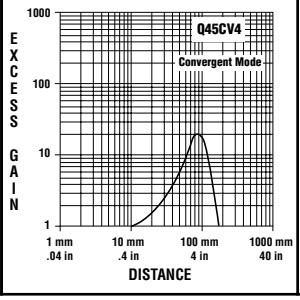
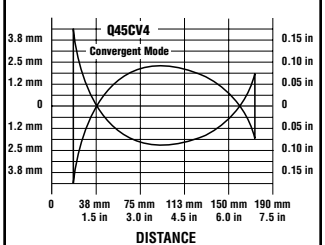


These sensors are ideal for reflective sensing of very small parts or profiles, and can accurately sense the position of parts approaching from the side. Will ignore all but highly reflective objects that are outside the sensing range.



Visible red. 680 nm

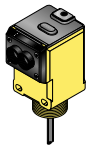
Q45BW13 Series Convergent-Mode Models

Models	Focus	Cable	Supply Voltage	Output Type	Excess Gain	Beam Pattern
					Performance based on 90% reflectance white test card	
Q45BW13CV **Q45BW13CVQ**	38 mm (1.5") **Spot Size at Focus:** 1.3 mm (0.05")	4-wire 2 m (6.5') 4-Pin Mini-style QD	Universal 12 - 250V dc or 24 - 250V ac	Isolated SPST Solid-state Switch		
Q45BW13CV4 **Q45BW13CV4Q**	100 mm (4") **Spot Size at Focus:** 1.5 mm (0.06")	4-wire 2 m (6.5') 4-Pin Mini-style QD	Universal 12 - 250V dc or 24 - 250V ac	Isolated SPST Solid-state Switch		

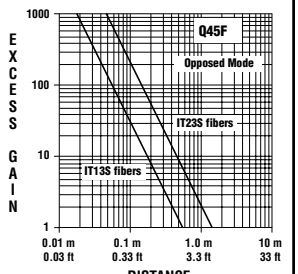
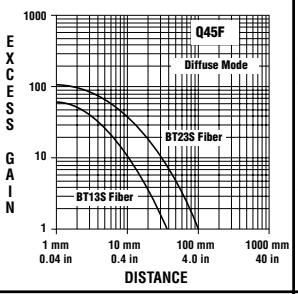
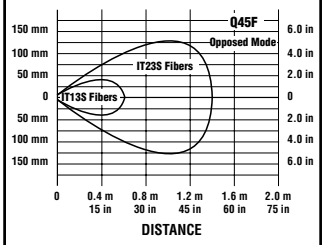
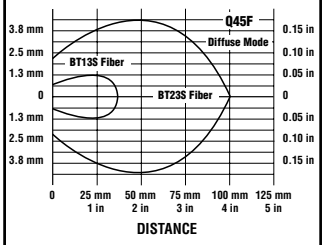
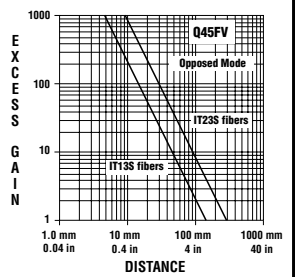
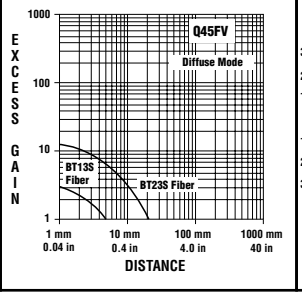
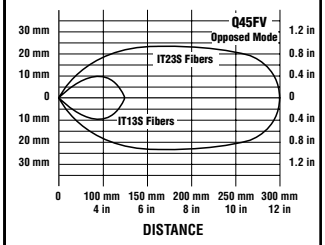
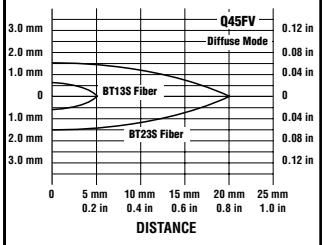
NOTES:
i) 9 m (30') cables are available by adding suffix "W/30" to the model number of any cabled sensor (e.g., **Q45BW13CV W/30**)
ii) A model with a QD connector requires a mating cable; see page 14.

Infrared, 880 nm and Visible Red, 650 nm

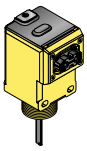
These models are an excellent choice for glass fiber optic applications where faster sensor response is not important. Their high excess gain means that opposed individual fibers can operate reliably in many very hostile environments. Also, special miniature bifurcated fiber optic assemblies with bundle sizes as small as .5 mm (.020") dia. may be used successfully for diffuse-mode sensing when using sensor model Q45BW13F(Q). For more information on compatible glass fiber optics, refer to your current Banner Photoelectric Sensors catalog.



Q45BW13 Series Glass Fiber-Optic Models

Models	Range	Cable	Supply Voltage	Output Type	Excess Gain	Beam Pattern
					Diffuse mode performance based on 90% reflectance white test card	
Infrared, 880 nm						
Q45BW13F **Q45BW13FQ**	Range varies by sensing mode and fiber optics used	4-wire 2 m (6.5') 4-Pin Mini-style QD	Universal 12 - 250V dc or 24 - 250V ac	Isolated SPST Solid-state Switch	 	 
Visible Red, 650 nm						
Q45BW13FV **Q45BW13FVQ**	Range varies by sensing mode and fiber optics used	4-wire 2 m (6.5') 4-Pin Mini-style QD	Universal 12 - 250V dc or 24 - 250V ac	Isolated SPST Solid-state Switch	 	 

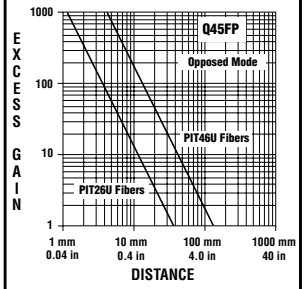
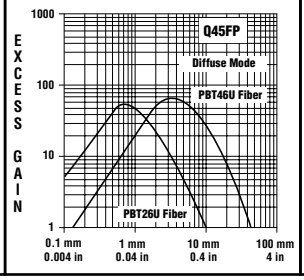
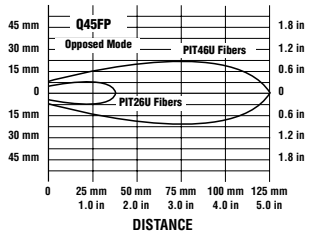
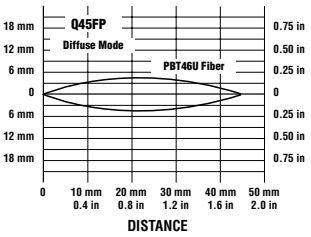
Q45BW13 Series



Lower in cost than glass fiber optics, plastic fiber optics are ideal for use in situations where environmental conditions allow (for example, low levels of acids, alkalis, and solvents). Most are easily cut to length in the field, and are available in a variety of sensing end styles. For more information on compatible plastic fiber optics, refer to your current Banner Photoelectric Sensors catalog.

Visible red, 660 nm

Q45BW13 Series Plastic Fiber-Optic Models

Models	Range	Cable	Supply Voltage	Output Type	Excess Gain	Beam Pattern
					Diffuse mode performance based on 90% reflectance white test card	
Q45BW13FP **Q45BW13FPQ**	Range varies by sensing mode and fiber optics used	4-wire 2 m (6.5') 4-Pin Mini-style QD	Universal 12 - 250V dc or 24 - 250V ac	Isolated SPST Solid-state Switch	 	 

NOTES:

i) 9 m (30') cables are available by adding suffix "W/30" to the model number of any cabled sensor (e.g., **Q45BW13FP W/30**)

ii) A model with a QD connector requires a mating cable; see page 14.

Q45BW13 Series Specifications

Supply Voltage and Current	Universal voltage: 24 to 250V ac, 50/60 Hz or 12 to 250V dc (1.5 watts maximum)
Supply Protection Circuitry	Protected against transient voltages. DC hookup is without regard to polarity.
Output Configuration	**All models except emitters:** Optically isolated SPST solid-state switch
Output Rating	250V ac, 250V dc, 300 mA **Output saturation voltage:** 3V at 300 mA, 2V at 15 mA **Off-state leakage current:** <50 microamps **Inrush current:** 1 amp for 20 milliseconds, non-repetitive
Output Protection Circuitry	Protected against false pulse on power-up
Output Response Time	**Opposed mode:** 2 milliseconds on, 1 millisecond off **All other sensing modes:** 2 milliseconds on/off (NOTE: 100 millisecond delay on power-up. Output is non-conducting during this time.)
Repeatability	**Opposed mode:** 0.25 milliseconds **All other sensing modes:** 0.5 milliseconds Response time and repeatability specifications are independent of signal strength.
Adjustments	Light/Dark Operate select switch; and multi-turn Sensitivity control on top of sensor beneath a transparent o-ring-sealed Lexan® cover, allows precise sensitivity setting (turn clockwise to increase gain). Optional logic and logic/display modules have adjustable timing functions (see page 10).
Indicators	Indicator LEDs are clearly visible beneath a raised transparent Lexan® dome on top of the sensor. **Power (green) LED** lights whenever 24 to 250V ac, or 12 to 250V dc power is applied **Signal (red) AID™ System LED** lights whenever the sensor sees its modulated light source, and pulses at a rate proportional to the strength of the received light signal **Load (yellow) LED** lights whenever the output relay is energized Optional 7-element LED signal strength display module
Construction	Molded VALOX® thermoplastic polyester housing, o-ring-sealed transparent Lexan® cover, molded acrylic lenses, and stainless steel hardware. Q45s are designed to withstand 1200 psi washdown. The base of cabled models has a 1/2" NPS integral internal conduit thread.
Environmental Rating	NEMA 6P, IEC IP67
Connections	PVC-jacketed 2 m (6.5') or 9 m (30') unterminated cables, or Mini-style quick-disconnect (QD) fittings are available ("Q"- suffix models). QD cables are ordered separately. See page 14.
Operating Conditions	**Temperature:** -25° to +55° C (-13° to +131°F) **Maximum relative humidity:** 90% at 50°C (non-condensing)
Application Notes	Optional output timing modules are available. See pages 10 and 14 for more information. Output is not short-circuit protected. Exercise care when making wiring connections.

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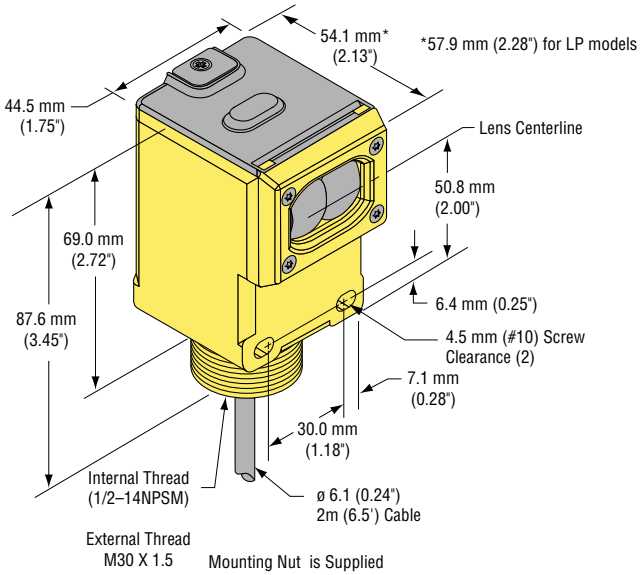
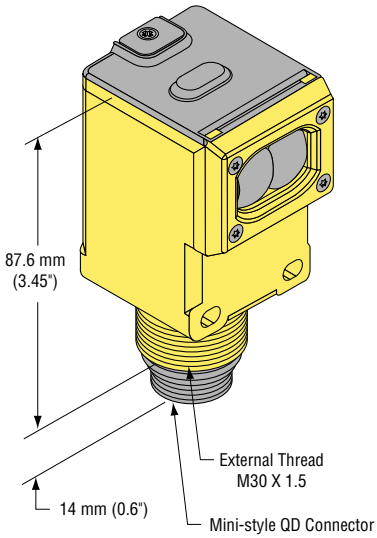
Q45BW13 Series Dimensions

Q45BW13 Series Sensors – Opposed, Retro, and Diffuse Sensing Modes (model suffix E, R, D, DL, DX, LP & LV)

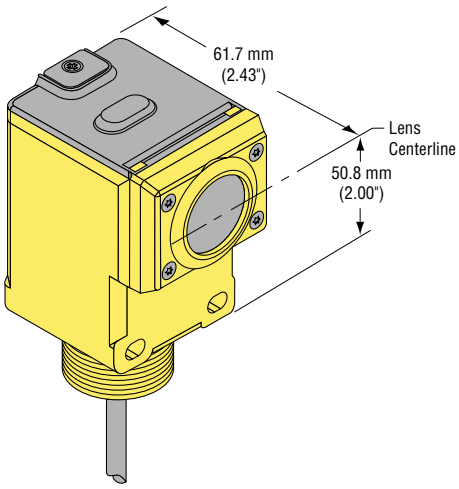
Cabled



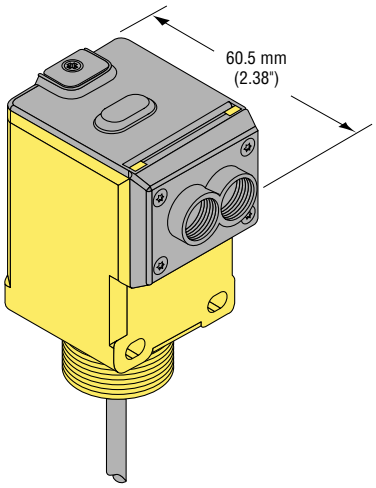
Quick-Disconnect



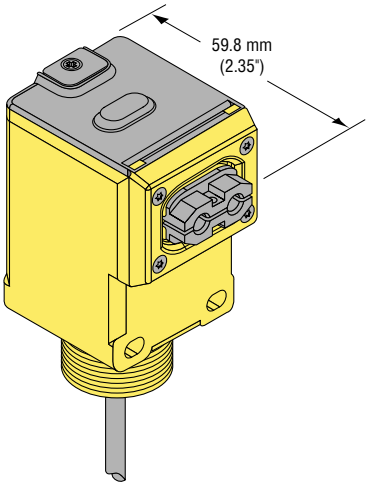
Convergent Sensing Mode (model suffix CV & CV4)



Glass Fiber Optic (model suffix F and FV)



Plastic Fiber Optic (model suffix FP)



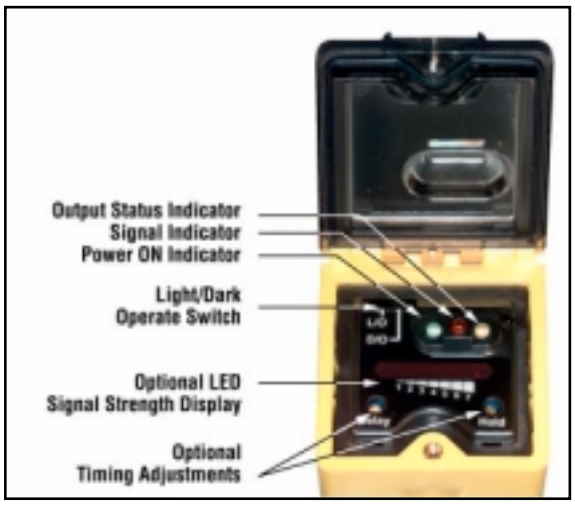


Figure 1. Indicators and controls on the Q45BW13 Series Sensors

Q45BW13 Series Indicators and Controls

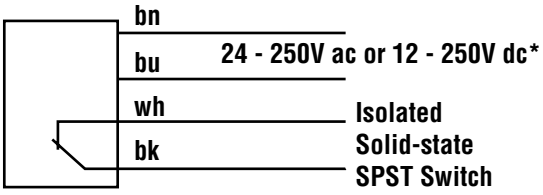
Status indicator LEDs for Power, Signal and Output are clearly visible beneath a raised dome in the sensor's transparent o-ring-sealed Lexan® cover. The Power indicator lights whenever power is applied to the sensor. The Signal LED lights whenever the sensor sees its modulated light source, and pulses at a rate proportional to the strength of the received light signal; this is the AID™ Alignment Indicating Device*. The Output indicator lights whenever the sensor's output relay is energized. This indicator is especially useful when a timing logic module is used and Signal and Output conditions are not concurrent.

Also located beneath the sensor's o-ring-sealed cover are controls for light/dark operate selection and Sensitivity adjustment.

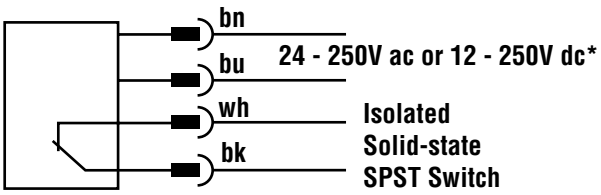
* US patent no. 4356393

Q45BW13 Series Hookups

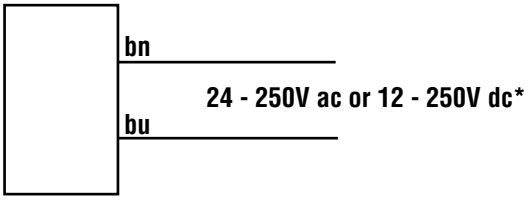
Q45BW13 Sensors with Attached Cable



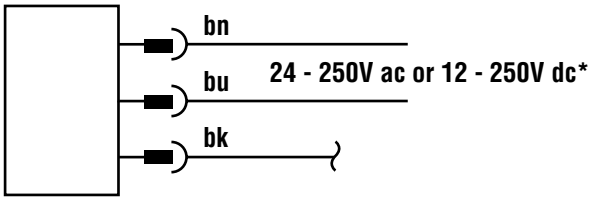
Q45BW13 Sensors with Quick-Disconnect 4-Pin Mini-Style (model suffix Q)



Q453E Emitter with Attached Cable



Q453EQ Emitter with Quick-Disconnect 3-Pin Mini-Style



*NOTE: Connection of dc power is without regard to polarity.

Quick-Disconnect (QD) Option

AC Q45BW13 Series sensors are sold with either a 2 m (6.5') or a 9 m (30') attached PVC-covered cable, or with a 3-pin Mini-style (opposed mode emitter) or 4-pin Mini-style Quick-Disconnect (QD) cable fitting.

Mini-style QD sensors are identified by the suffix "Q" in their model number suffix. Mating cables for QD Q45BW13 sensors are specified on page 14.

Optional Plug-In Output Timing Logic and Display Modules for the Q45BW13 Series

Q45BW13 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 chart, at right.

Module Model Number	Output Timing Logic		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

Timing Logic Functions

Programming of output timing on those models which feature logic functions (see chart at right) 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 12 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). 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.)

All modules install easily under the sensor's black inner cover. Modules interconnect to the sensor circuitry without wires. Timing adjustments are easily accessible.

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 Gain or Timing controls, as long as the black inside cover remains in place.

45LM Series Modules Specifications

Operating Temperature	-40 to +70ºC (-40 to +158ºF)
Models with Timing Logic	45LM5, 45LM5D, 45LM8, 45LM8D, 45LM8M1, 45LM8DM1
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
Models with LED Signal Strength Display	45LMD, 45LM5D, 45LM8D, 45LM8DM1
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 13)

Removing and Installing the Plug-In Modules

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 2).
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 3).
5) Press the new module into place (Figure 4).
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 2. Insert a small screwdriver into the slot and lift the black cover to remove.

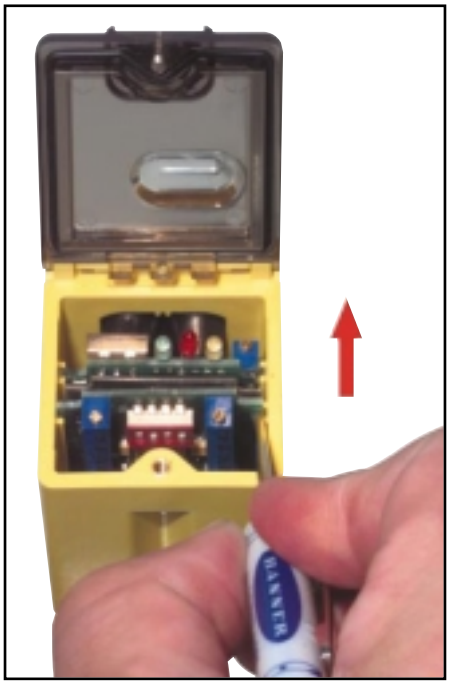


Figure 3. Using the small screwdriver in the module slot if necessary to nudge the module loose, lift the module up and out.

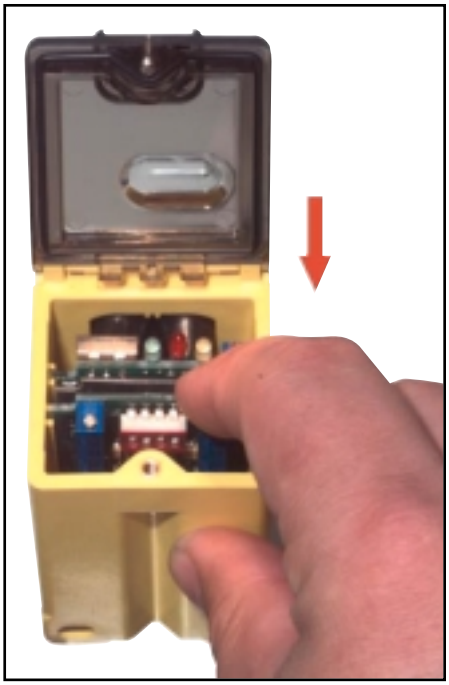


Figure 4. Slide the new module into place, pressing until it fits snugly.

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."

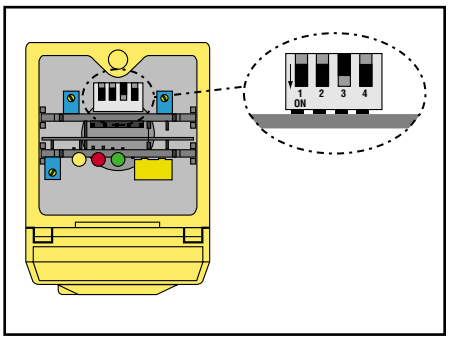
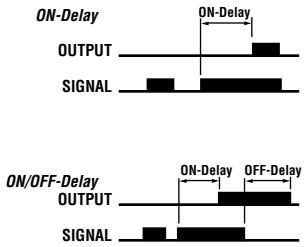


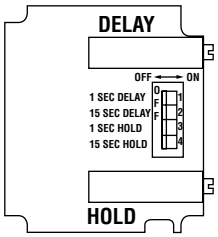
Figure 5. DIP switches for programming Delay logic

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**

TIMING DIAGRAMS



Adjustment Locations



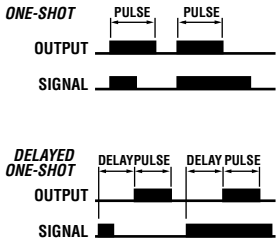
NOTE:
1) If both ranges of either delay function are selected (both 1 second and 15 second switches are ON), the delay time range becomes 16 seconds, maximum.
2) With switches #1 and #2 OFF (no ON-Delay programmed), ON-Delay is adjustable from "negligible" up to 100 milliseconds, maximum.
3) With switches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

45LM8(M1) and 45LM8D(M1) 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) 15 seconds max. pulse (1.5)	**ON**	OFF	ON	–
	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**	–

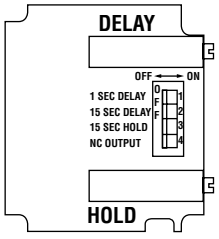
* Maximum times for models 45LM8M1 and 45LM8DM1 are in parentheses.

** For normal output (output conducts during pulse time), turn switch #4 OFF
To invert the output, turn switch #4 **ON**

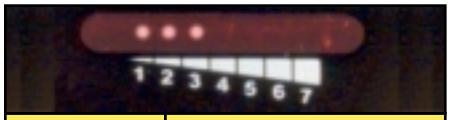
TIMING DIAGRAMS



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.



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

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.

Figure 7. Contrast values and corresponding guidelines

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 6) 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 6) 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 6) 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 7 gives general guidelines for contrast values.

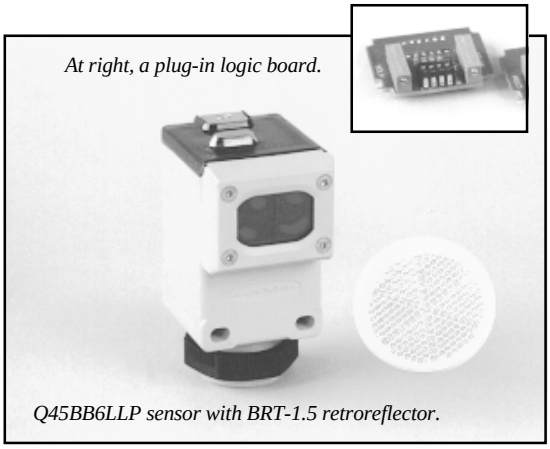
Q45BB6 Series Laser-diode Retroreflective Sensors

Very long-range retroreflective sensors for 10-30V dc

BANNER® the photoelectric specialist

- **Operate from 10 to 30V dc, retro and polarized retro modes; Class II laser diode light source, sensing range 100' (30 m)**
- **NPN (sinking) and PNP (sourcing) solid-state outputs, switchable light- and dark-operate; 250 mA maximum load**
- **Highly-visible top-mounted POWER, SIGNAL, and OUTPUT indicator LEDs**
- **Optional PULSE or DELAY timing logic and display modules**
- **Choice of prewired 6-1/2 ft. or 30 ft. cable**
- **Designed to withstand 1200 psi washdown; versatile mounting options**

ISO9002 DOCUMENTED QUALITY



Q45BB6LLP sensor with BRT-1.5 retroreflector.

Banner Q45BB6 Series laser diode long-range polarized retroreflective sensors are self-contained sensor designed for applications where high sensing power and a small beam size are important. Q45BB6 laser-diode retroreflective sensors operates over sensing ranges that are typically accomplished only by conventional opposed mode photoelectrics. Models Q45BB6LL and Q45BB6LLQ are standard retroreflective mode sensors. Models Q45BB6LLP and Q45BB6LLPQ use a special lens which polarizes the emitted light and filters out unwanted reflections, making these sensors useful in many applications previously considered unsuited to retroreflective mode sensing. Sensing range is specified at 150 ft (50 m) for the LL Series and 100 ft. (30 m) for the LLP Series. Actual range is dependent upon the efficiency and size of the retroreflective target. See page 2 for a listing of available sensor models.

All models have one sinking (NPN) and one sourcing (PNP) solid-state output, and operate from 10 to 30V dc. Outputs are light operate/dark operate switchable.

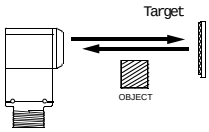
Sensors are designed to withstand 1200 psi washdown to far exceed their NEMA 6P (IEC IP 67) rating.

Highly-visible status indicator LEDs for POWER, SIGNAL, and OUTPUT are located beneath a raised dome in

(continued on page 2)

Caution... Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

Specifications



Supply Voltage: +10 to 30V dc.

Supply Current: 50 milliamps.

Hookup: **Brown wire** +10 to 30V dc
Blue wire dc common
Yellow wire (laser attenuator wire):
connect to dc common for normal laser operation, or
connect to +10 to 30V dc to extinguish laser diode
White wire sinking (NPN) output
Black wire sourcing (PNP) output

Delay at Power-up: 1 second.

Output Configuration: Bipolar. One current sinking (NPN) and one current sourcing (PNP) open-collector transistor.

Output Rating:
250 mA max. (each) up to 50°C. Output leakage <1 µA (off-state). Output saturation voltage (both outputs) <1V at 10 mA and <2V at 250 mA.

Indicators: Highly visible; located beneath a raised transparent Lexan® dome on top of the sensor.
POWER (green) LED lights whenever 10 to 30V dc power is applied and the yellow "inhibit" wire is connected to dc common, and flashes to indicate an output overload or output short circuit. *A steady green LED also indicates that laser emission is "on" (laser light is being emitted).*
SIGNAL (AID™ system, U.S. patent #4356393) LED (red) lights whenever the sensor sees its modulated light source, and pulses at a rate proportional to the strength of the received light signal.
LOAD (yellow) LED lights whenever an output is conducting.
Optional 7-element LED signal strength display module (pages 3-5).

Timing Logic: Optional logic timing modules available (pages 3-4).

Sensing Beam and Range: 670 nm visible red (temperature coefficient .2 nm/°C). Range to 150' (50 m) for LL Series and 100 feet (30 m) for LLP Series.

Beam Diameter at Aperture: 2.5 mm collimated ellipse.

Beam Divergence: Approximately 0.5 mrad (milliradians).

Peak Output Power: Less than 3 milliwatts.

Laser Classification: Class II laser product. US Safety Standards 21 CFR 1040.10 and 1040.11; European Standards EN 60825 and IEC 60825.

Pulse Width: 10 microseconds.

Rep Rate: 500 microseconds.

Operating Temperature: -10 to 40°C (+14 to 122°F).

Construction: Molded VALOX® thermoplastic polyester housing. Molded acrylic lenses, stainless steel hardware. O-ring sealed transparent Lexan® top cover. NEMA 6P (IEC IP 67) rated. Q45 sensors are designed to withstand 1200 psi washdown.

Cable: Attached 5-conductor PVC-covered cable, 6-1/2 feet (2 m) long; models with 30-foot (10 m) cable also available. Quick disconnect models with integral 5-pin mini-style quick disconnect fitting (designated by "Q" model suffix) are also available.

Compatible Retroreflective Targets: See page 6.

Printed in USA P/N 38244

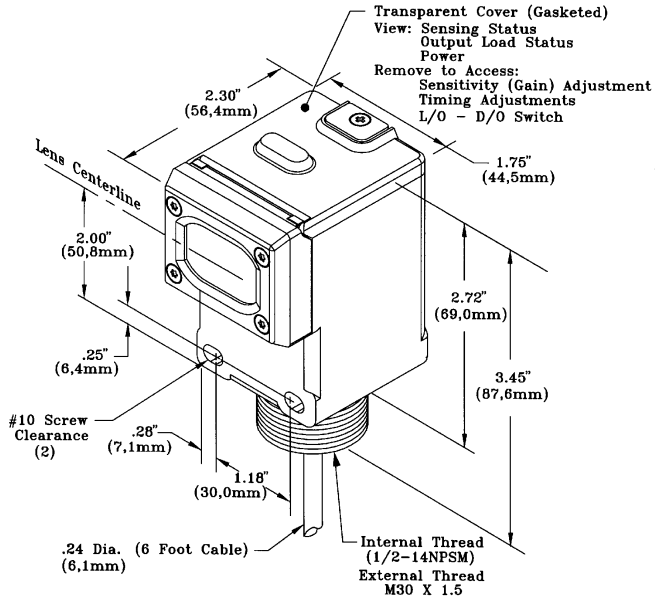
Q45BB6LL

the sensor's transparent o-ring sealed LEXAN® cover. The POWER indicator lights whenever dc power is applied to the sensor, and flashes in the event of an output overload or output short-circuit. The SIGNAL LED lights whenever the sensor sees the reflection of its modulated laser light source, and pulses at a rate proportional to the strength of the received light signal. The OUTPUT indicator lights whenever the sensor's output is conducting. This indicator is especially useful when a timing logic module is used and SIGNAL and OUTPUT conditions are not concurrent.

Also located beneath the sensor's o-ring sealed top cover are controls for light/dark operate selection and SENSITIVITY adjustment. Optional logic, signal strength display, and logic/display modules (pages 3-5) slip easily into the top of the sensor and provide adjustable delay or adjustable pulse timer logic and/or received light signal strength display.

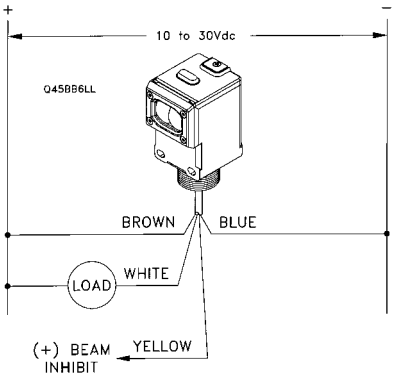
The variety of mounting options available with Q45 Series sensors makes them ideal for conveyor and other production line applications. The Q45's two through-mounting holes have standard limit-switch spacing. Q45s may also be mounted using their 30mm threaded base mounting hub. A versatile 2-axis stainless steel mounting bracket (model SMB30MM), a VALOX® split clamp bracket (model SMB30C), and a VALOX® swivel-mount bracket (model SMB30S) are available (see page 5). All models are housed in tough, molded, o-ring sealed VALOX® housings designed to withstand 1200 psi washdown.

Dimensions Models Q45BB6LL & Q45BB6LLP



Hookup (all models)

NPN (current sinking) hookup, 250 mA max.

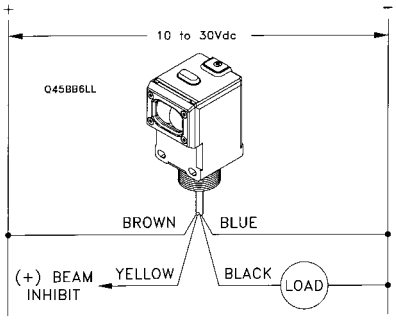


NOTES:

1) The YELLOW wire must be connected to +Vdc for normal operation. Connect the YELLOW wire to -Vdc to interrupt (extinguish) the laser light source.

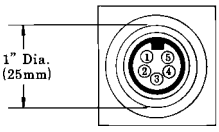
2) The two sensor outputs may be used simultaneously.

PNP (current sourcing) hookup, 250 mA max.



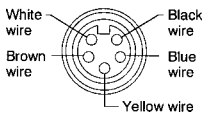
Quick Disconnect Information: Q45BB6LLQ and Q45BB6LLPQ

Sensor base (male pins)

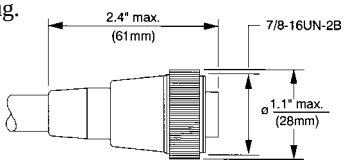


These sensors require model MBCC-512 mini-style quick-disconnect cable (p/n 25496).

Mini-style cable connector (female). Side view below.



Side view of MBCC-512 quick-disconnect cable plug.



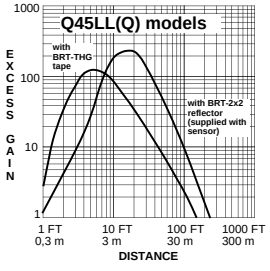
Model listing

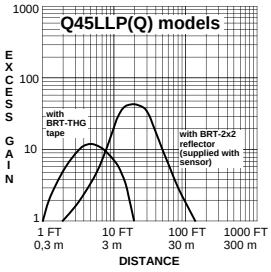
Non-polarized models:

Q45BB6LL	p/n xxxxx	6-foot attached cable
Q45BB6LL w/30	p/n xxxxx	30-foot attached cable
Q45BB6LLQ	p/n xxxxx	5-pin mini-style quick-disconnect fitting

Polarized models:

Q45BB6LLP	p/n xxxxx	6-foot attached cable
Q45BB6LLP w/30	p/n xxxxx	30-foot attached cable
Q45BB6LLPQ	p/n xxxxx	5-pin mini-style quick-disconnect fitting

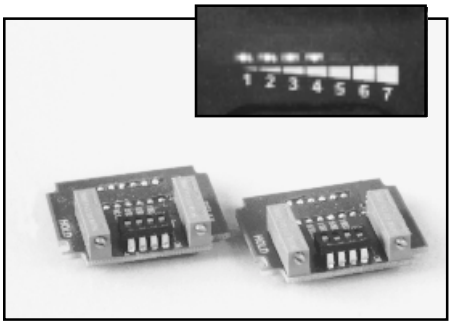




45LM Series Modules

Plug-in Logic and Display Modules

Main photo: 45LM5 and 45LM8 logic boards. Inset photo: LED Signal Strength Display, included on boards: 45LMD, 45LM5D, and 45LM8D; shown with 4 LEDs lit.



Q45 sensors easily accept the addition of timing logic and signal strength display functions. Five plug-in modules are available:

Model number	P/N	Function
45LM5	35495	On-delay or off-delay or on/off delay logic
45LM8	35496	One-shot or delayed one-shot logic
45LM5D	36591	On-delay or off-delay or on/off delay logic plus seven-element LED signal strength display
45LM8D	36593	One-shot or delayed one-shot logic plus seven-element LED signal strength display
45LMD	35497	Seven-element LED signal strength display, no logic

Models with timing logic functions: Programming of the output logic function, the timing range, and the output state on these modules (45LM5, 45LM5D, 45LM8, 45LM8D) is done via a set of four switches located on the module. These modules feature 15-turn clutched potentiometers for accurate timing adjustments. See the next page for timing ranges and logic settings.

Models with LED signal strength display function: These modules (45LMD, 45LM5D, 45LM8D) have a seven-element LED indicator array for display of relative signal strength. The seven-element display gives a "finer" indication of excess gain than does the AID™ system LED that is standard on all Q45 sensors. 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 buildup, progressive misalignment, etc.). The more LEDs that are lit, the stronger is the light signal that is being received by the sensor. Three array LEDs lit indicates an excess gain of approximately 1x.

All modules easily install under the sensor's transparent, hinged, o-ring sealed Lexan® top cover. Modules interconnect to the sensor circuitry without wires. Timing adjustments are easily accessible. Q45 sensors with covers properly fastened are rated NEMA 6P. Module installation and removal information is given below. Specifications are given on the next page.

Installation and Removal, 45LM Series Plug-in Modules

Installation

Modules are installed through the top of the sensor. The procedure is as follows:

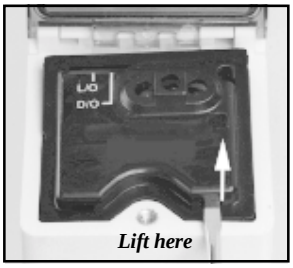
1) Remove all power from the sensor and load.
2) Loosen the top cover hold-down screw and raise the cover. The cover is hinged at the front.
3) Using a small screwdriver inserted into one of the slots at the rear of the inside black cover, lift up and remove the black inside cover (Photo 1).
4) Hold the logic module with the printed side facing you and the brass potentiometer screws pointing upward. Look down at the top of the sensor from the rear, and slide the board into the closest slot until it is snug (Photo 2).
5) Replace the black inside cover with the new one supplied with the module.

Removal

Modules are removed through the top of the sensor. The procedure is as follows:

1) Remove all power from the sensor and load.
2) Loosen the top cover hold-down screw and raise the cover. The cover is hinged at the front.
3) Using a small screwdriver inserted into one of the slots at the rear of the inside black cover, lift up and remove the black inside cover (Photo 1).
4) Insert a small, flat bladed screwdriver or similar tool into the lift slot on the edge of the module board (Photo 3). Gently lift the module out.

Photo 1.



Lift here

Photo 2.

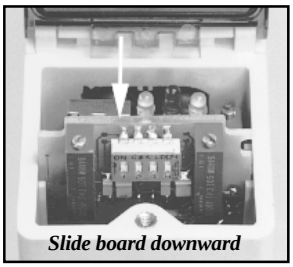
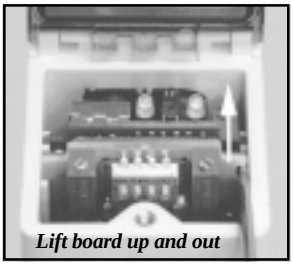

Slide board downward

Photo 3.


Lift board up and out

45LM Series Modules

45LM Series Plug-in Module Specifications

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

Models with Timing Logic
(45LM5, 45LM5D, 45LM8, 45LM8D)

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.

Model Summary, 45LM Series Modules

45LM5	Delay logic, no display
45LM8	One-shot pulse logic, no display
45LM5D	Delay logic, with display
45LM8D	One-shot pulse logic, with display
45LMD	Display only, no logic

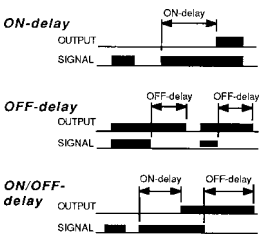
Models with LED Signal Strength Display
(45LMD, 45LM5D, 45LM8D)

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.

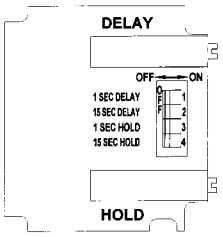
45LM5 and 45LM5D (Delay Timer Logic)

Models **45LM5 and 45LM5D** are programmable for ON-DELAY *or* OFF-DELAY *or* ON/OFF DELAY timing functions. Each delay function may be independently adjusted and separately programmed for either a long or short adjustment range.

Logic Diagrams



Adjustment Locations



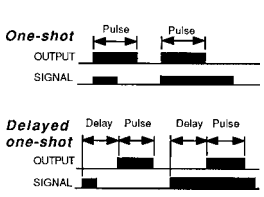
Timing Logic Function and Timing Range(s)		#1	#2	#3	#4
ON-DELAY	1 second maximum	**ON**	OFF	OFF	OFF
ON-DELAY	15 seconds maximum	OFF	**ON**	OFF	OFF
OFF-DELAY	1 second maximum	OFF	OFF	**ON**	OFF
OFF-DELAY	15 seconds maximum	OFF	OFF	OFF	**ON**
ON-DELAY & **OFF-DELAY**	1 second maximum 1 second maximum	**ON**	OFF	**ON**	OFF
ON-DELAY & **OFF-DELAY**	1 second maximum 15 seconds maximum	**ON**	OFF	OFF	**ON**
ON-DELAY & **OFF-DELAY**	15 seconds maximum 1 second maximum	OFF	**ON**	**ON**	OFF
ON-DELAY & **OFF-DELAY**	15 seconds maximum 15 seconds maximum	OFF	**ON**	OFF	**ON**

NOTE 1: if both ranges of either delay function are selected (i.e., if both 1 second and 15 second switches are "on"), the delay time range becomes 16 seconds, maximum.
NOTE 2: with switches #1 and #2 "off" (no ON-DELAY programmed), ON-DELAY is adjustable from "negligible" up to 100 milliseconds, maximum.
NOTE 3: with switches #3 and #4 "off" (no OFF-DELAY programmed), OFF-DELAY is adjustable from "negligible" up to 100 milliseconds, maximum.

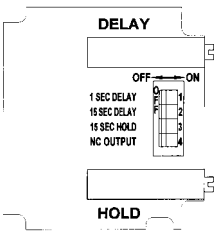
45LM8 and 45LM8D (Pulse Timer Logic)

Models **45LM8 and 45LM8D** are programmable for either a ONE-SHOT ("single-shot") pulse timer or a DELAYED ONE-SHOT logic timer. DELAY and PULSE times may be independently adjusted and separately programmed for either a long or short adjustment range.

Logic Diagrams



Adjustment Locations



Logic Function and Timing Ranges:		#1	#2	#3	#4*
ONE-SHOT	1 second maximum pulse	OFF	OFF	OFF	-----
ONE-SHOT	15 seconds maximum pulse	OFF	OFF	**ON**	-----
DELAYED **ONE-SHOT**	1 second maximum delay 1 second maximum pulse	**ON**	OFF	OFF	-----
DELAYED **ONE-SHOT**	15 seconds maximum delay 1 second maximum pulse	OFF	**ON**	OFF	-----
DELAYED **ONE-SHOT**	1 second maximum delay 15 seconds maximum pulse	**ON**	OFF	**ON**	-----
DELAYED **ONE-SHOT**	15 seconds maximum delay 15 seconds maximum pulse	OFF	**ON**	**ON**	-----
*For normal outputs (n.o. output conducts during pulse time), turn switch #4					OFF
To reverse the normal n.o./n.c. relationship of outputs, turn switch #4					**ON**

NOTE 1: DELAY is non-retriggerable. PULSE is retriggerable if the DELAY time is less than the ONE-SHOT pulse time.
NOTE 2: if both ranges of the delay function are selected (i.e., if both 1 second and 15 second switches are "on"), the delay time range becomes 16 seconds, maximum.
NOTE 3: with switches #1 and #2 "off" (no DELAY programmed), DELAY is adjustable from "negligible" up to 10 milliseconds, maximum.

45LM Series Modules, Mounting Brackets

Measuring Excess Gain and Contrast

The Q45's seven-element LED array may be used to measure the *excess gain* and *contrast* in any sensing situation and during 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 the right ***(Excess Gain and LED Array Lights)*** shows how excess gain relates to LED array indication.

Excess Gain and LED Array Lights

D.A.T.A. light LED number	Approx. Gain
#1	0.25x E.G.
#2	0.5x
#3	1.0x
#4	2.0x
#5	4.0x
#6	6.0x
#7	8.0x

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 the table above) that correspond to the highest light 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 the table at the top of this page) 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):

Contrast Values and Corresponding Guidelines

Contrast Ratio	Recommendation
1.2 or less	***Unreliable.*** Evaluate alternative sensing schemes.
1.2 to 2	***Poor contrast.***
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.

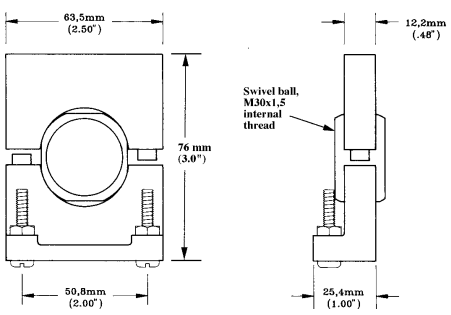
$$\text{Contrast is } \textit{greater} \text{ than } \frac{8x}{0.25x} = 32{:}1$$

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. The ***Contrast Values and Corresponding Guidelines*** table (above) gives general guidelines for contrast values.

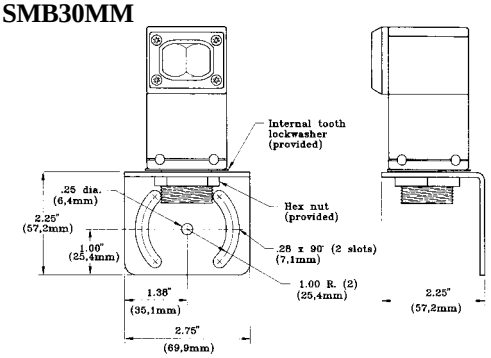
Mounting Brackets

Accessory mounting bracket model **SMB30S** (33204) is a swivel mount bracket whose swivel ball locks in place when its two clamping bolts are tightened. Bracket material is black VALOX®. Hardware is stainless steel, and mounting bolts are included. This bracket may be used with Q45s and other sensors having M30 x 1,5 threads. Bracket dimensions are given below.

SMB30S



SMB30MM



Model **SMB30C** (32636) split clamp bracket is similar, but without the adjustable swivel ball. Bracket material is black VALOX®.

Mounting bracket **SMB30MM** (27162) has curved mounting slots for versatility in mounting and orientation.

The sensor mounts to the SMB30MM by its threaded base, using a jam nut and lock washer (supplied).

The curved mounting slots have clearance for 1/4-inch hardware. Dimensions are given at the left.

Q45BB6LL

Alignment Information

Conventional infrared modulated LED photoelectric sensors have beam divergence angles of several degrees. As a result, they are easily aligned by simple line-of-sight methods.

In sharp contrast, the Q45BB6LL laser-diode retroreflective sensor has a beam divergence of only 0.5 milliradians, or .06 degrees (see Figure 1). This translates, for example, to a beam diameter of only 0.x inches at a distance of 20 feet. Consequently, there is very little forgiveness for angular misalignment between the sensor and the retroreflective target. (NOTE: The laser beam cross section is slightly elliptical, but can be regarded as circular for this discussion.)

The effective beam is equal to the minimum opaque object profile required to reliably block the light beam. The beam size at the sensor is 0.x inch (x,x mm) diameter. The effective beam expands according to the following formula:

$$W = 0.1 \text{ inch} + 2X(\tan 0.029°) = 0.1 \text{ inch} + X(0.001)$$

where: W = Effective beam diameter (beam width)
X = Distance from sensor in inches.

Alignment Tips

Any Banner retroreflective target may be used with these sensors, with the exception of model BRT-THG Series tape with LLP (polarized) sensors. Also, round targets with center mounting holes may not work well at ranges of less than 50 feet. **Do not use a mirror!... see WARNING, above.** The larger the target, the easier alignment will be. For small targets at medium or long sensing ranges, it may be useful to mount vertical and horizontal strips of reflective tape, with the intended target mounted at the intersection of the tape strips.

The visible red beam of the laser diode is easily seen in normal room lighting. Sight along the beam, toward the retroreflector, from directly behind the sensor. Roughly align the sensor housing to the target, then "scan" the laser beam across the tape. Once the beam is "found", adjust the sensor mounting until the red image (dot of red light) is centered exactly in the center of the reflector. Remove the tape strips and check the response of the sensor to the object to be detected.

WARNING: Never stare directly into the sensor lens. Laser light can damage your eyes.
Avoid placing any mirror-like object in the beam.
Never use a mirror as a retroreflective target.

Consider the use of Banner sensor mounting bracket model SMB30S (see page 5). This is a swivel bracket that can greatly simplify multiple-axis alignment.

WARNING These photoelectric presence sensors do NOT include the self-checking redundant circuitry necessary to allow their use in personnel safety applications. A sensor failure or malfunction can result in *either* an energized or a de-energized sensor output condition.

Never use these products as sensing devices for personnel protection. Their use as safety devices may create an unsafe condition which could lead to serious injury or death.

Only MACHINE-GUARD and PERIMETER-GUARD Systems, and other systems so designated, are designed to meet OSHA and ANSI machine safety standards for point-of-operation guarding devices. No other Banner sensors or controls are designed to meet these standards, and they must NOT be used as sensing devices for personnel protection.

45LM Series Modules

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

Figure 1. 45LM Series Module

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

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).

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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.”

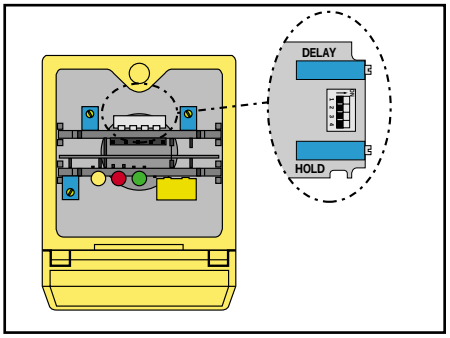


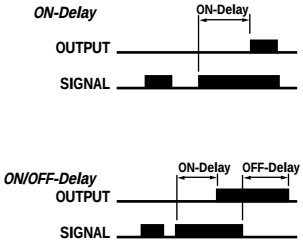
Figure 2. DIP switches for programming Delay logic

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.

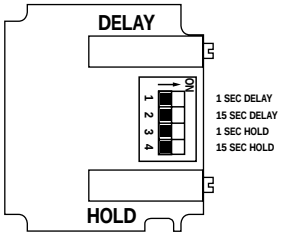
NOTE: The Delay timer adjustment is labeled “DELAY” and the Pulse timer adjustment is labeled “HOLD.”

45LM5 and 45LM5D 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**

TIMING DIAGRAMS



Adjustment Locations



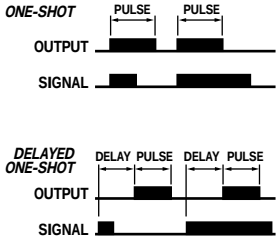
NOTE:
1) If both ranges of either delay function are selected (both 1 second and 15 second switches are ON), the delay time range becomes 16 seconds, maximum.
2) With switches #1 and #2 OFF (no ON-Delay programmed), ON-Delay is adjustable from “negligible” up to 100 milliseconds, maximum.
3) With switches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

45LM8(M1) and 45LM8D(M1) 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**	–

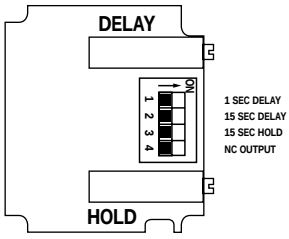
* Maximum times for models 45LM8M1 and 45LM8DM1 are in parentheses.

** For normal output (output conducts during pulse time), turn switch #4 OFF To invert the output, turn switch #4 **ON**

TIMING DIAGRAMS



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

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.

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 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.

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.

Figure 4. Contrast values and corresponding guidelines

45LM Series 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.

Removing and Installing the Plug-In Modules

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.

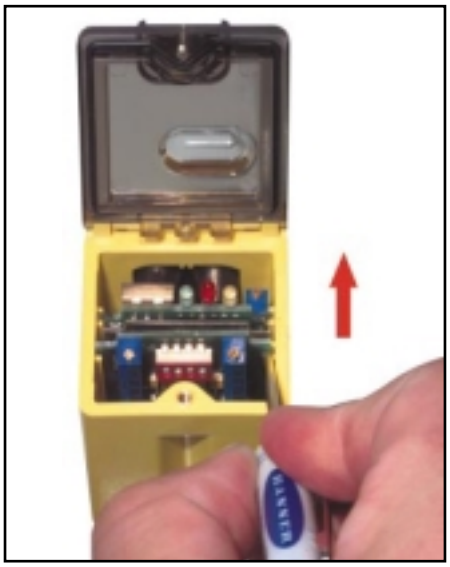


Figure 6. Using the small screwdriver in the module slot if necessary to nudge the module loose, lift the module up and out.

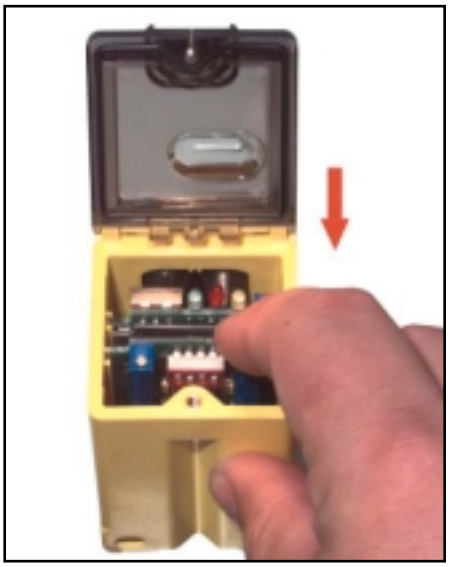


Figure 7. Slide the new module into place, pressing until it fits snugly.

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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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