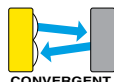




Features

- Outstanding color contrast sensitivity; detects 16 levels of gray scale.
- Reliable detection of the toughest color mark contrasts, including 20% yellow against white
- Three sensing beam colors: blue, green and white, depending on model
- Fast, 50-microsecond response
- Easy-to-set automatic *Expert*-style configuration options: Static and Dynamic TEACH and Window SET, plus Manual Adjust for fine tuning via push button or remote input
- Non-volatile memory
- Ten-element light bar for clear display of received signal strength
- Fixed-convergent sensing at 10 ±3 mm (0.39" ±0.12")
- Rectangular 1.2 mm x 3.8 mm (0.05" x 0.15") sensing image at 10 mm from the lens
- Horizontal or vertical sensing image, depending on model (see table below)
- Rugged zinc alloy die-cast housing with high-quality acrylic lens suitable for food processing applications; rated IP67, NEMA 6
- Bipolar (NPN/PNP) discrete outputs with three delay settings (0, 20 or 40 ms)
- 0 to 10 mA analog output; value provides an indication of signal strength.
- Integral cable or QD connector, depending on model



Models

Models	Beam Color	Cable*	Focus	Supply Voltage	Output Type	Sensing Image Orientation
R55ECG1	Green	6-wire 2 m (6.5')	10 mm (0.39")	10-30V dc	Bipolar NPN/PNP and Analog 0-10 mA	Parallel to sensor length
R55ECG1Q	525 nm	6-pin Euro-Style QD				
R55ECB1	Blue	6-wire 2 m (6.5')				
R55ECB1Q	475 nm	6-pin Euro-Style QD				
R55ECW1	White	6-wire 2 m (6.5')				
R55ECW1Q	450-650 nm	6-pin Euro-Style QD				
R55ECG2	Green	6-wire 2 m (6.5')				Perpendicular to sensor length
R55ECG2Q	525 nm	6-pin Euro-Style QD				
R55ECB2	Blue	6-wire 2 m (6.5')				
R55ECB2Q	475 nm	6-pin Euro-Style QD				
R55ECW2	White	6-wire 2 m (6.5')				
R55ECW2Q	450-650 nm	6-pin Euro-Style QD				

* 9 m (30') cables are available by adding suffix "W/30" to the model number of the cabled version (e.g., **R55ECG1 W/30**). A model with a QD connector requires an accessory mating cable. See page 12.

R55 Expert™ Color Mark Sensors

Overview

R55 Expert (R55E) offers maintenance-free, solid-state reliability for all color contrasts found in common product and material registration applications. Fast 50-microsecond sensing response produces excellent registration repeatability, even in ultra-high-speed applications. This fast response, coupled with the small 1.2 x 3.8 mm (0.05" x 0.15") sensing image, allows color marks to be made small and inconspicuous, while being reliably sensed.

The construction of the R55E is extremely robust, with a die-cast metal housing, plastic optics, and IP67 and NEMA 6 leakproof design for harsh sensing environments. The sensor's 10-segment bargraph display and the individual indicator LEDs provide easy configuration and status monitoring.

Indicators

The LED indicators (see Figure 1) operate as follows in RUN mode (normal operation):

Output Conducting LED: ON when outputs are active

Delay Configuration Indicator LED: OFF No OFF-delay is programmed
ON 20- or 40-ms OFF-delay is programmed

Light Operate LED: ON to indicate Light Operate configuration

Dark Operate LED: ON to indicate Dark Operate configuration

(NOTE: Since either one of these is always ON when the sensor is operating, the combined Light/Dark Operate LEDs also provide a functional Power-ON indication.)

10-Segment Bargraph Display: indicates signal strength, with respect to the sensing threshold ("switchpoint").

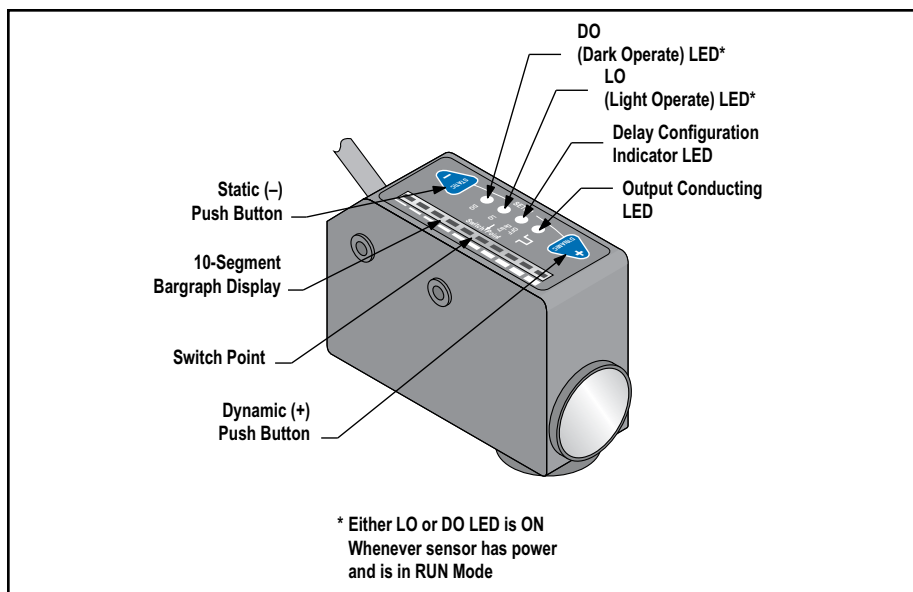


Figure 1. R55E Series sensor features

Sensor Configuration

Sensor configuration is accomplished via TEACH, SET and SETUP modes. After the sensing parameters are defined (using either TEACH or SET mode), SETUP mode may be used to enable the delay or to change the light/dark operate status. Manual Adjust may be used to fine-tune the thresholds (see page 7). Two push buttons, Dynamic (+) and Static (-), or the remote wire, may be used to access and set the sensing parameters. The ten-element signal strength bargraph display clearly displays the relative received signal strength.

Sensor sensitivity may be configured using any of three methods. A single switching threshold may be achieved using either Dynamic (on-the-fly) or Static TEACH, or Window SET may be used to define a sensing window, centered on a single sensing condition.

The discrete bipolar (one NPN and one PNP) outputs may be programmed in SETUP mode to include a 20- or 40-millisecond pulse stretcher (OFF-delay), if required. A third, dedicated, 0 to 10 milliamp analog output may be used for applications such as measuring or monitoring of surface brightness or texture.

Both sensing sensitivity and output setup are accomplished either by using the sensor push buttons, or by supplying input pulses via the remote input.

Remote Configuration

The remote configuration function may be used to configure the sensor remotely or to disable the push buttons for security. Connect the gray wire of the sensor to ground (0V dc), with a remote programming switch connected between them. Pulse the remote line according to the diagrams in the configuration procedures. The duration of the individual pulses is equal to the value T:

$$0.04 \text{ seconds} \leq T \leq 0.8 \text{ seconds}$$

Returning to RUN Mode

Some TEACH and SET modes may be exited after the 90-second time-out or by exiting the process:

- In Static TEACH or Window SET mode, press and hold the Static (-) button (or hold the remote line) for 2 seconds. The sensor returns to RUN mode without saving any new settings.

SETUP mode may be exited after the 30-second time-out or by exiting the process:

- In SETUP mode, press and hold both the Static (-) and Dynamic (+) buttons (or hold the remote line) for 2 seconds. The sensor returns to RUN mode and saves the current setting.

R55 Expert™ Color Mark Sensors

Static TEACH

- Establishes a single switching threshold
- Threshold position is adjustable using “+” and “-” buttons (Manual Adjust)

Static TEACH is the traditional setup method, used when two conditions can be presented by the user. The sensor locates a single sensing threshold (the switchpoint) midway between the two taught conditions, with the Output ON condition on one side, and the Output OFF condition on the other (see Figure 2).

The first condition taught is the ON condition. The Output ON and OFF conditions can be reversed by changing Light/Dark Operate status in SETUP mode (see page 7).

Static TEACH and Manual Adjust

Using Manual Adjust with Static TEACH moves the switching threshold. Sensitivity may be adjusted at any time when the sensor is in RUN mode by clicking the “+” and “-” buttons. Each click translates to 1/2 segment on the signal strength light bar. For best sensing reliability, the light and dark conditions should register equally distant from the switchpoint on the bargraph display.

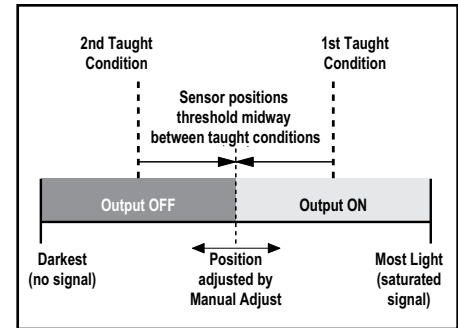


Figure 2. Static TEACH (Light Operate shown)

	Push Button 0.04 seconds ≤ “Click” ≤ 0.8 seconds	Remote Line 0.04 seconds ≤ T ≤ 0.8 seconds	Result
Access TEACH Mode	Press and hold Static button ≥ 2 seconds until LO and DO indicators alternately flash, then release button. 	No action required; sensor is ready for 1st TEACH condition.	Push Button TEACH only: LO and DO: Alternately flash green  : ON yellow (ready to teach output ON condition) Light Bar: Goes OFF
TEACH Output ON Condition	- Present the output ON sensing condition. - Single-click Static button. 	- Present output ON sensing condition. - Single-pulse the remote line. 	LO and DO: Alternately flash green  : OFF (ready to teach output OFF condition) Light Bar: Remains OFF
TEACH Output OFF Condition	- Present the output OFF sensing condition. - Single-click Static button. 	- Wait 0.8 seconds. - Present the output OFF sensing condition. - Single-pulse the remote line. 	Contrast accepted: One light bar segment flashes for three seconds to indicate relative contrast, and then sensor enters RUN mode. Contrast too low: Every other segment flashes for three seconds to indicate low contrast, and the sensor returns to TEACH Output ON Condition.

NOTES:

- The sensor will return to RUN mode if either TEACH condition is not registered within 90 seconds. Also, TEACH mode may be cancelled by pressing and holding the push button for ≥ 2 seconds. In either case, the sensor will revert to the previous conditions taught (i.e., exit without save).
- If the sensing conditions are accepted at the end of TEACH Output OFF Condition, the signal strength light bar flashes one of its ten segments for three seconds to indicate relative sensing contrast. The higher the flashing segment, the higher the measured sensing contrast. High contrast relates directly to sensing reliability. High-contrast sensing applications are most tolerant of sensing variables, such as web flutter or variations in color mark color or print density.

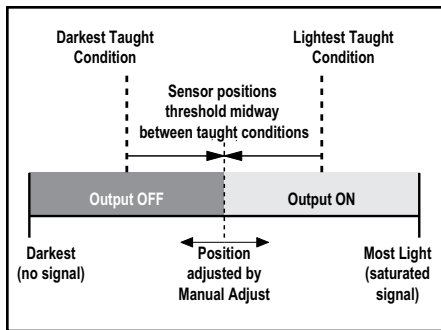


Figure 3. Dynamic TEACH (Light Operate shown)

Dynamic TEACH

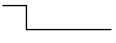
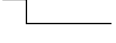
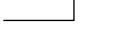
- Teach on-the-fly
- Establishes a single switching threshold
- Threshold position is adjustable using “+” and “-” buttons (Manual Adjust)

Dynamic TEACH is used to configure the switching threshold during actual sensing conditions. During Dynamic TEACH, the R55E takes multiple samples of the color mark against its background material and automatically sets the threshold at the optimum level. Dynamic TEACH activates the sensor’s adaptive threshold system, which continuously tracks minimum and maximum signal levels, and automatically maintains centering of the switchpoint between the light and dark conditions. The adaptive threshold system remains in effect during RUN mode to automatically adjust for changes in the light or the dark conditions. The adaptive routine saves to non-volatile memory at least once per hour.

When Dynamic TEACH mode is used to configure sensitivity, the output ON state (light or dark operate) will remain as it was last programmed. To change to either the light or the dark condition, use SETUP mode (see page 7).

Dynamic TEACH and Manual Adjust

Sensitivity may be adjusted at any time when the sensor is in RUN mode by clicking the “+” and “-” buttons. However, when a manual adjustment is made, the adaptive threshold system is disabled (cancelled).

	Push Button	Remote Line	Result
Access TEACH Mode	Press and hold Dynamic button ≥ 2 seconds until LO and DO indicators alternately flash. 	Hold remote line low (to ground) > 2 seconds. 	LO and DO: Alternately flash green  : OFF Light Bar: Remains OFF
TEACH Output ON and OFF Condition	Continue depressing the Dynamic button while sampling light and dark sensing conditions. 	- Present Output ON and OFF sensing conditions. - Continue to hold remote line low. 	LO and DO: Alternately flash green  : OFF Light Bar: Remains OFF
Return to Run Mode	Release the Dynamic button when finished sampling light and dark sensing conditions. 	Release remote line switch. 	Contrast accepted: One light bar segment flashes for three seconds to indicate relative contrast, and then sensor enters RUN mode. Contrast too low: Every other segment flashes for three seconds to indicate low contrast, and the sensor reverts to the previously taught conditions.

NOTE: If the sensing conditions are accepted at the end of Dynamic TEACH, the signal strength light bar flashes one of its ten segments for three seconds to indicate relative sensing contrast. The higher the flashing segment, the higher the measured sensing contrast. High contrast relates directly to sensing reliability. High contrast sensing applications are most tolerant of sensing variables, such as web flutter or variations in color mark color or print density.

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Window SET

- Establishes a single ON condition
- All other conditions (lighter or darker) result in OFF output
- Sensing window size (sensitivity) is adjustable using “+” and “-” buttons (Manual Adjust)

The R55 Expert sensor also may be configured for a single specific target. Window SET is most useful when a product may not always appear in the same place, or when other signals may appear. Window SET designates a sensing window, with the Output ON condition inside the window, and the Output OFF conditions outside the window (see Figure 4). The sensor accepts a single sensing condition and adds switching thresholds above and below that condition to create a sensing window. Output ON and OFF conditions can be reversed by changing Light/Dark Operate status in SETUP mode.

Window SET and Manual Adjust

Using Manual Adjust with Window SET expands or contracts the size of the window. The lighted LEDs on the light bar separate to a greater or lesser extent to exhibit the relative sensing window size.

Manually adjust the sensitivity by clicking either the “+” or “-” button; the bar graph will flash two segments centered about the sensing point. If the sensitivity is increased (-), the two lighted segments will become closer together, and farther apart if the sensitivity decreased (+). If segments do not flash while the sensitivity is being adjusted, the setting has reached its maximum and cannot be adjusted further.

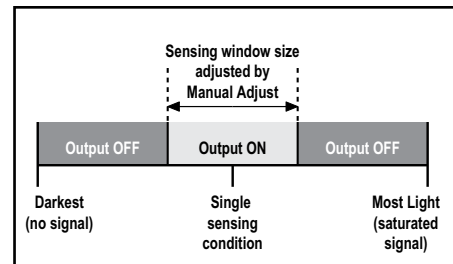
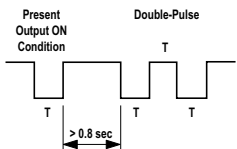


Figure 4. Window SET (Light Operate shown)

	Push Button 0.04 seconds ≤ “Click” ≤ 0.8 seconds	Remote Line 0.04 seconds ≤ T ≤ 0.8 seconds	Result
Access SET Mode	• Press and hold Static button ≥ 2 seconds until LO and DO indicators alternately flash. • Release button. 	• No action required; sensor is ready for sensing condition to be presented.	LO and DO: Alternately flash green □ : ON yellow (indicating ready to teach Output ON condition) Light Bar: Goes OFF
Learn Switchpoint (Output ON Condition)	• Present the Output ON sensing condition. • Double-click Static button. 	• Present the target (output ON) condition. • Single-pulse the remote wire. • Wait ≥ 0.8 second, then double-pulse the remote wire. 	LO and DO: ON depending on condition taught □ : OFF Light Bar: Two center segments are lit if TEACH was successful.

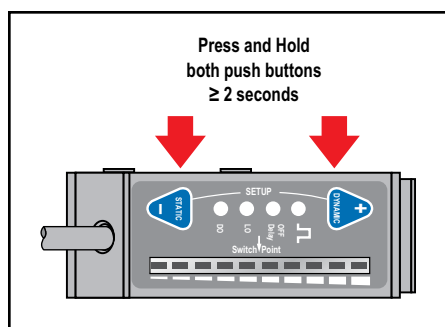


Figure 5. SETUP Mode

SETUP Mode

SETUP mode is used to configure discrete sensor output response for:

- Light or Dark operate
- 20- or 40-millisecond pulse stretcher (OFF-delay), if required.

It will be necessary to access SETUP mode only if the settings that result from TEACH mode are not the settings required for the application. The status LEDs indicate the output response configuration when the sensor is in RUN mode (see table below).

To change the output response settings;

1. Press and hold both push buttons for at least two seconds (or double-pulse the remote line), until the signal strength light bar turns OFF.
2. Click either push button (or pulse the remote line) to toggle through the six possible settings, indicated as follows:

Output Configuration	Delay Indicator	LO Indicator	DO Indicator
Light operate with no delay	OFF	ON	OFF
Light operate with 20 ms delay	Flashing	ON	OFF
Light operate with 40 ms delay	ON	ON	OFF
Dark operate with no delay	OFF	OFF	ON
Dark operate with 20 ms delay	Flashing	OFF	ON
Dark operate with 40 ms delay	ON	OFF	ON

3. Press and hold both push buttons (or hold the remote line) until the signal strength light bar turns ON, indicating return to RUN mode.

NOTE: If SETUP mode configuration is interrupted and remains inactive for 30 seconds, the sensor returns to RUN mode with the most recent settings (i.e., exits and saves current selection).

Locking Out (Disabling) the Push Buttons

In addition to its configuration function, the remote input may be used to disable the push buttons for security. Disabling the push buttons prevents undesired tampering with the configuration settings. Connect the gray wire of the sensor as described on page 3, and four-pulse to either enable or disable the push buttons:



NOTE: Push buttons can be disabled/enabled from the remote line only.

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Installation Notes

Lens Location

The lens of the R55E may be installed at either of two lens ports (see Figure 6). The lens and the lens port cap are both threaded and may be exchanged by hand; no tools are required. The lens and cap both include an o-ring seal.

NOTE: Lens port cap must be installed for reliable operation.

Mounting the Sensor

The R55E includes a total of eight M5 threaded holes used for mounting (see dimension drawing on page 10). These threaded holes are positioned to match the mounting hole patterns common to other color mark sensors. The R55E includes four M5 x 0.8 x 6 mm stainless steel cap screws and a hex key wrench.

The R55E focus is located at 10 mm (0.39") ahead of the lens surface. The R55E must be mounted within 3 mm (0.12") of this distance from the surface of the material for reliable sensing (Figure 7).

Mounting Considerations

1. Whenever possible, it is a good idea to sense a web material at a location where it passes over a tension bar or roller, to minimize the adverse effects of web "flutter" or sag (Figure 7).
2. When sensing a color mark on a reflective (shiny) material, mount the R55E at an angle that places the lens centerline at approximately 15° off perpendicular to the material's surface (see Figure 8). This "skew angle" will minimize strong direct reflections (which tend to overwhelm the sensor), and allow the sensor to discern the relatively small optical contrast offered by difference in colors.
3. Clear materials are poor reflectors of light. When sensing a mark printed on a clear poly web, position a reflective surface directly behind the clear material that will return light to the R55E. The printed mark, regardless of its color, then becomes the dark condition, as it blocks the light from reaching the reflective surface. Most clear materials are also shiny; it is important also to include a 15° skew angle when sensing clear materials (Figure 8).

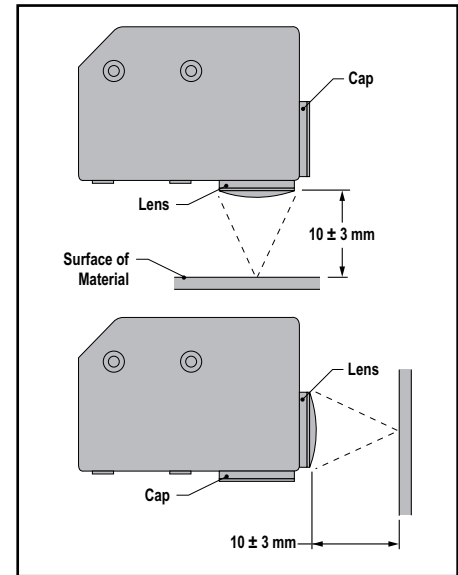


Figure 6. R55E Lens Positions

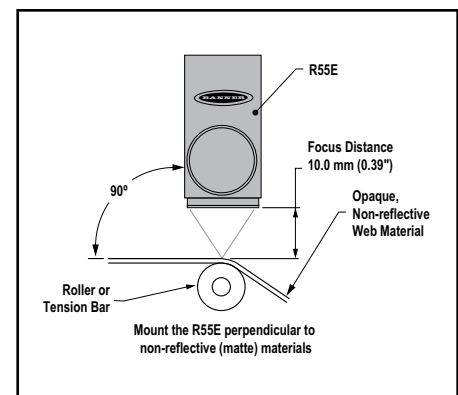


Figure 7. Mounting for sensing opaque non-reflective materials

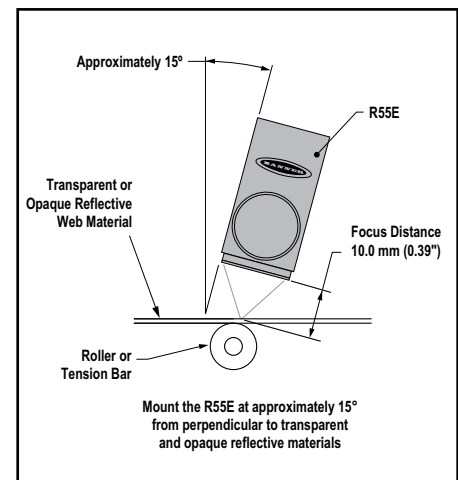


Figure 8. Mounting for sensing opaque reflective and transparent materials

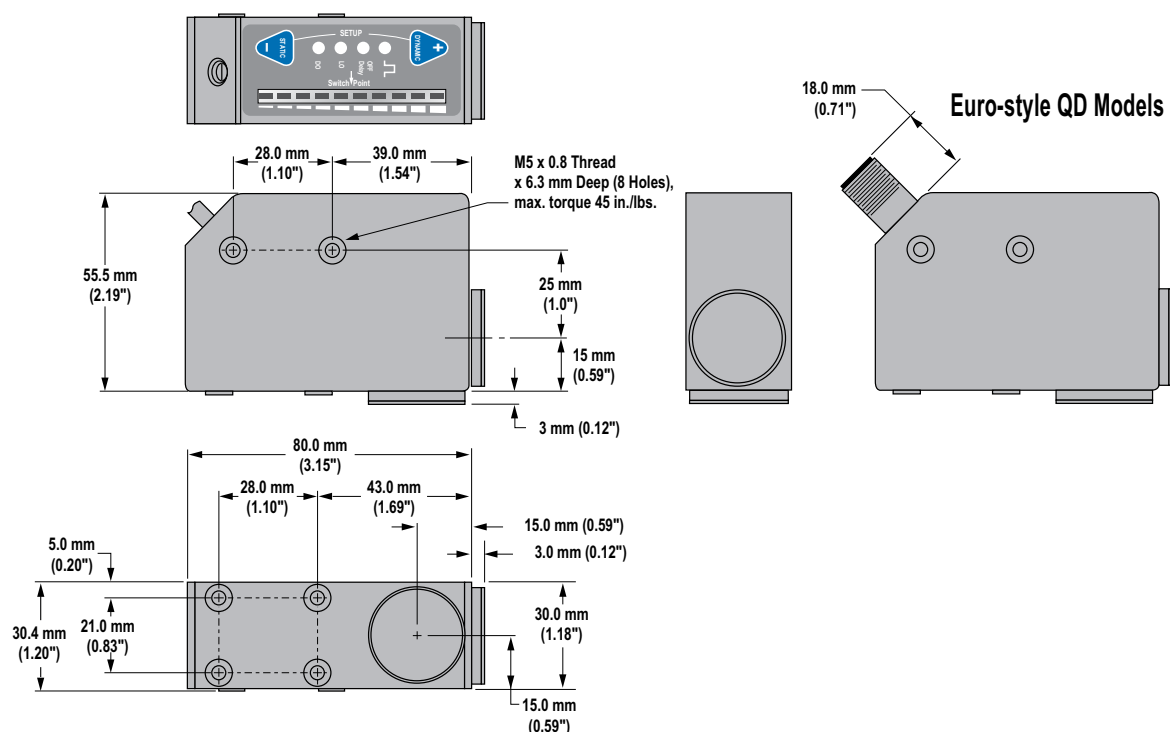
R55 Expert™ Color Mark Sensors

Specifications

Supply Input	10 to 30V dc (10% maximum ripple) at less than 80 mA, exclusive of load.								
Supply Protection Circuitry	Protected against reverse polarity and transient voltages.								
Output Configuration	Digital outputs: Bipolar. One current sourcing (PNP) and one current sinking (NPN) open-collector transistor Analog output: Current source proportional to the received light level, updated in real time (every 50 microseconds)								
Output Rating	Digital outputs are 100 mA maximum (each) Off-state leakage current < 10 microamps at 30V dc Saturation voltage (NPN output) < 1.5V at 150 mA dc Saturation voltage (PNP output) < 2.0V at 150 mA dc Current Sourcing Analog output: 0 to 10 mA Maximum load voltage drop is ≤ 2 volts								
Output Protection	Protected against false pulse on power-up and continuous overload or short-circuit of outputs.								
Output Response	50 microseconds NOTE: 1 second delay on power-up; outputs do not conduct during this time.								
Adjustments (see pages 3–7)	Using push buttons (“+” Dynamic and “-” Static): Manually adjust discrete output switchpoint using “+” or “-” buttons Dynamic TEACH (teach on-the-fly) sensitivity adjustment Static TEACH sensitivity adjustment Light operate/Dark operate OFF-delay select: 0 milliseconds, 20 milliseconds or 40 milliseconds Using Remote TEACH input (gray wire): Dynamic TEACH (teach on-the-fly) sensitivity adjustment Static TEACH sensitivity adjustment Light operate/Dark operate OFF-delay select: 0 milliseconds, 20 milliseconds or 40 milliseconds Lockout of push buttons for security								
Indicator LEDs	10-segment (green) light bar indicates signal strength Light Operate: green Dark Operate: green Outputs Conducting: yellow OFF-Delay (green): <table> <tr> <td>SETUP Mode</td> <td>RUN Mode</td> </tr> <tr> <td>OFF — no delay</td> <td>OFF — no delay</td> </tr> <tr> <td>Flashing — 20 ms delay</td> <td>ON — 20 or 40 ms Delay</td> </tr> <tr> <td>ON — 40 ms delay</td> <td></td> </tr> </table>	SETUP Mode	RUN Mode	OFF — no delay	OFF — no delay	Flashing — 20 ms delay	ON — 20 or 40 ms Delay	ON — 40 ms delay	
SETUP Mode	RUN Mode								
OFF — no delay	OFF — no delay								
Flashing — 20 ms delay	ON — 20 or 40 ms Delay								
ON — 40 ms delay									
Construction	Zinc alloy die-cast and steel housing with black acrylic polyurethane finish Lens and lens port cap are o-ring sealed Lens is acrylic Lens port cap and lens holder are ABS								
Environmental Rating	IEC IP67; NEMA 6								
Connections	PVC-jacketed 6-conductor 2 m (6.5') or 9 m (30') attached cable with internal strain relief, or 6-pin Euro-style quick-disconnect. Mating QD cables are purchased separately. See Cables, page 10.								
Operating Conditions	Temperature: -10° to +55° C (+14° to 131° F) Maximum Relative Humidity: 90% at 50° C (non-condensing)								
Vibration and Mechanical Shock	All models meet IEC 68-2-6 and IEC 68-2-27 testing criteria.								
Application Notes	- Do not mount the sensor directly perpendicular to shiny surfaces; position it at approximately a 15° angle in relation to the sensing target (see page 8). - Minimize web or product “flutter” whenever possible to maximize sensing reliability. - The analog output is proportional to the received light signal. The analog output is unaffected by + or – manual sensitivity adjustments.								

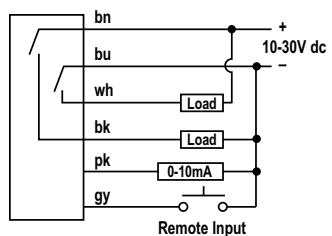
R55 Expert™ Color Mark Sensors

Dimensions

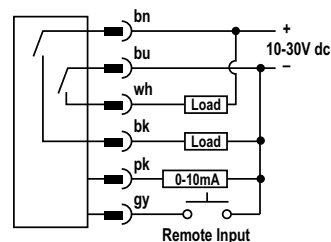


Hookups

Cabled Models



Quick-Disconnect Models



Quick-Disconnect (QD) Cables

Style	Model	Length	Dimensions	Pinout
6-Pin Euro-Style Straight	MQDC-606 MQDC-615 MQDC-630	2 m (6.5') 5 m (15') 9 m (30')		
6-Pin Euro-Style Right-Angle	MQDC-606RA MQDC-615RA MQDC-630RA	2 m (6.5') 5 m (15') 9 m (30')		

R55 Expert™ Color Mark Sensors

Accessory Mounting Brackets

SMB55A	• 15° offset bracket • 12-gauge stainless steel	SMB55F	• Flat mount bracket • 12-gauge stainless steel
shown with R58 sensor	shown with R58 sensor		
SMB55RA	• Right-angle bracket • 12-gauge stainless steel	SMB55S	• 15° offset bracket • 12-gauge stainless steel
shown with R58 sensor	shown with R58 sensor		

Replacement Lens

Models	Description
UC-R55	Replacement lens for R55E 

R55 Expert™ Color Mark Sensors



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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