R58E Series Expert™ Register Mark Sensors

Registration Mark Sensor with Three-Color Light Source

Features

- Ultra-fast 10 kHz switching frequency
- Sensor automatically selects red, green, or blue LED during TEACH to optimize application contrast
- Outstanding color contrast sensitivity; detects 16 levels of gray scale
- Smart gain-control algorithm to maximize performance in low-contrast or high-gloss applications
- Easy-to-set, automatic Expert-style TEACH options include Static and Dynamic programming plus manual adjustment for fine tuning
- Easy-to-read 8-segment light bar indicator for TEACH and signal strength readout, plus indicators for continuous readout of output status and setup
- Fixed-convergent sensing at 10 mm ±3 mm (0.39" ±0.12")
- Models available with either parallel or perpendicular sensing image (see below)
- Rugged zinc alloy die-cast housing with high-quality acrylic lens suitable for food processing applications; rated IP67, NEMA 6
- LO / DO operation, 30 ms pulse stretcher (OFF-delay), and 30 ms ON-delay are easily selected via push buttons or a remote input wire
- Bipolar discrete outputs; one current sourcing (PNP) and one current sinking (NPN)
- Models available with integral cable or Euro-style quick-disconnect pigtail

Models

<table>
<thead>
<tr>
<th>Models</th>
<th>Cable*</th>
<th>Focus</th>
<th>Supply Voltage</th>
<th>Output Type</th>
<th>Sensing Image Orientation</th>
</tr>
</thead>
<tbody>
<tr>
<td>R58ECRGB1</td>
<td>5-wire 2 m (6.5')</td>
<td>10 mm (0.39&quot;)</td>
<td>10 to 30V dc</td>
<td>Bipolar NPN/PNP</td>
<td>Parallel to sensor length</td>
</tr>
<tr>
<td>R58ECGB1Q</td>
<td>5-pin Euro-style QD pigtail</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R58ECRGB2</td>
<td>5-wire 2 m (6.5')</td>
<td></td>
<td></td>
<td>Bipolar NPN/PNP</td>
<td>Perpendicular to sensor length</td>
</tr>
<tr>
<td>R58ECRGB2Q</td>
<td>5-pin Euro-style QD pigtail</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* 9 m cables are available by adding suffix “W/30” to the model number of any cabled sensor (e.g., R58ECRGB1 W/30).
A model with a QD connector requires a mating cable; see page 10.

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.
Overview

R58 Expert (R58E) sensors offer 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 register marks to be made small and inconspicuous.

R58E sensors feature TEACH mode sensitivity adjustment by presenting the output ON and output OFF sensing conditions to the sensor. TEACH mode has two options: Static TEACH and Dynamic TEACH. Static TEACH is used to manually set the two sensing conditions individually. Dynamic TEACH provides a means for teaching a series of conditions on-the-fly; the R58E samples the sensing events and automatically sets the switch point between the lightest and darkest conditions. The sensor determines whether the lightest or darkest condition is present for the shortest time and sets the output ON condition and LO/DO for the shortest-duration event sensed. The sensor uses a tri-color LED during Static and Dynamic TEACH and automatically selects red, green, or blue, based on the contrast between the register mark and the background.

Sensitivity may be fine-tuned at any time by simply clicking the “+” or “-” buttons on the sensor. The eight-element signal strength light bar clearly displays the relative received signal strength.

The discrete bipolar (one NPN and one PNP) outputs may be programmed in SETUP mode to include a 30-millisecond ON and/or OFF-delay, if required.

Both Static and Dynamic TEACH and output SETUP are accomplished either by using the push buttons on the sensor, or by supplying input pulses via the Remote TEACH input.

The construction of the R58E is extremely robust, with a die-cast metal housing, plastic optics, and IP67 and NEMA 6 leakproof design for harsh sensing environments.
Sensor Programming

The R58E is pre-set to power up in RUN mode and sense the most recently taught register mark. The sensitivity of the R58E may be quickly optimized by using one of two available TEACH modes: Static TEACH or Dynamic TEACH.

- **Static TEACH:** Both the output ON and output OFF conditions are presented, and sensitivity can be adjusted manually via the push buttons.
- **Dynamic TEACH:** The register mark is presented during actual run conditions, and the sensitivity can be adjusted manually via the push buttons.

Remote TEACH

The sensor may be programmed either via its push buttons, or via a remote switch. Remote programming also may be used to enter SETUP mode to set ON and OFF-delay, and to disable the push buttons to prevent unauthorized adjustment of the programming settings. To access this feature, connect the gray wire of the sensor to 0V dc, with a remote programming switch between the sensor and OV dc.

Programming is accomplished by following the sequence of input pulses (see following programming procedures). The duration of each pulse (corresponding to a push button “click”), and the period between multiple pulses, are defined as “T”:

\[
0.04 \text{ seconds} < T < 0.8 \text{ seconds}
\]

Status Indicators

<table>
<thead>
<tr>
<th>LED</th>
<th>Indicates</th>
</tr>
</thead>
</table>
| Power             | **ON Green:** RUN mode  
                        **OFF:** TEACH or SETUP mode                                         |
| Output            | **ON Yellow:** Output is conducting, or TEACH output ON condition  
                        **OFF:** Output is not conducting, or TEACH output OFF condition     |
| Light Operate     | **ON Green:** Light Operate (LO) operation                                 |
| Dark Operate      | **ON Green:** Dark Operate (DO) operation                                  |
| OFF-Delay         | **ON Green:** 30-ms pulse stretcher (OFF-delay) is active                 |
| ON-Delay          | **ON Green:** 30 ms ON-delay is active                                    |
| 8-Segment Light Bar | **ON Red:** Indicates signal strength with respect to the sensing threshold (Switch Point); higher segment number for higher sensing contrast  
                        **OFF:** Sensor programming active                                  |
**Static TEACH**

In Static TEACH mode, the sensor learns the output ON and output OFF conditions after each is presented one time. Sensitivity is automatically set to place the switch point midway between the two conditions. See Figure 2.

NOTE: The sensor will return to RUN mode if either TEACH condition is not registered within 60 seconds. TEACH mode may be cancelled by pressing and holding the Static push button for \( \geq 2 \) seconds. In either case, the sensor will revert to the previous conditions taught (i.e., exit without save).

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 switch point on the signal strength light bar.

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<table>
<thead>
<tr>
<th>Procedure</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Programming Mode</strong></td>
<td></td>
</tr>
</tbody>
</table>
  - Push and hold the Static push button for \( \geq 2 \) seconds  
  - No action required; sensor is ready for the Output ON condition |
| **Teach Output ON Condition** |  
  - Present the Output ON condition  
  - Present the Output ON condition  
  - “Click” the Static push button  
  - Single-pulse the remote line  
  - Wait at least 0.8 seconds  
  - LO and DO: Alternately flash Green  
  - Output: ON Yellow (indicating ready to teach output ON condition)  
  - Light Bar: Goes OFF |
| **Teach Output OFF Condition** |  
  - Present the Output OFF condition  
  - Present the Output OFF condition  
  - “Click” the Static push button  
  - Single-pulse the remote line  
  - LO and DO: Alternately flash Green  
  - Output: OFF (indicating ready to teach output OFF condition)  
  - Light Bar: Remains OFF |

**Teach Accepted**  
- 8-Segment Light Bar flashes one segment for three seconds to indicate relative contrast (see contrast table on page 5)  
- Sensor enters RUN mode

**Teach Not Acceptable**  
- Every other segment flashes for three seconds to indicate low contrast  
- Sensor returns to TEACH output ON condition

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**Figure 2. Static and Dynamic TEACH (Light Operate shown)**
Dynamic TEACH

Dynamic TEACH is used to program sensitivity during actual machine run conditions. During Dynamic TEACH, the R58E takes multiple samples of the register mark against its background material and automatically sets the sensitivity at the optimum level. See Figure 2.

NOTE: The register mark must be presented at least two times during Dynamic TEACH.

When Dynamic TEACH mode is used to program sensitivity, the output ON state will be the shortest-duration event sensed, and LO/DO will be set accordingly. To change the output state, change to either LO or DO in SETUP mode (see page 6), or pulse the remote line three times (see page 7).

Maximum Feed Rate

In order to optimize performance and ensure that all LED color and gain combinations are evaluated during Dynamic TEACH, the register mark must encompass the 1.2 mm dimension of the 1.2 mm x 3.8 mm sensing image for at least 0.002 seconds. Therefore, the maximum feed rate can be determined with the following formula:

\[
\text{Maximum Feed Rate in mm/sec.} = \frac{(\text{register mark width in mm} - 1.2)}{0.002}
\]

Example with a 5 mm register mark:

\[
\text{Maximum Feed Rate} = \frac{(5 \text{ mm} - 1.2)}{0.002} = 1900 \text{ mm/sec.}
\]

NOTE: Register marks narrower than the 1.2 mm sensing image width can be detected at feed rates less than 600 mm/sec, but the contrast will be reduced due to averaging of the background and the register mark.

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 switch point on the signal strength light bar.

### Procedure

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Push Button</th>
<th>Remote Line</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Programming Mode</strong></td>
<td>• Press and hold the Dynamic push button for &gt; 2 seconds</td>
<td>• Hold the remote line low for &gt; 2 seconds</td>
</tr>
<tr>
<td></td>
<td>• Continue pressing the Dynamic push button while sampling the Output ON and Output OFF conditions</td>
<td>• Continue holding the remote line low while sampling the Output ON and Output OFF conditions</td>
</tr>
<tr>
<td><strong>Teach Conditions</strong></td>
<td>• Release the Dynamic push button when finished sampling the Output ON and Output OFF conditions</td>
<td>• Open remote switch when finished sampling the Output ON and Output OFF conditions</td>
</tr>
<tr>
<td></td>
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</tr>
</tbody>
</table>
SETUP mode is used to configure discrete sensor output response for:

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

It will be necessary to access SETUP mode only if the settings which result from TEACH mode programming are not the settings required for the application or if a delay is required. The status LEDs indicate the output response configuration when the sensor is in RUN mode, as follows:

- LO indicator ON = output is light operate
- DO indicator ON = output is dark operate
- OFF-delay indicator ON = 30 millisecond OFF-delay is active
- ON-delay indicator ON = 30 millisecond ON-delay is active

Change the output response settings as shown in Figure 3.

**NOTE:** If SETUP mode programming is interrupted and remains inactive for 60 seconds, the sensor returns to RUN mode with the most recent settings (i.e., exits and saves current selection).
Remote SETUP Mode

1. To enter SETUP mode, pulse the remote line once, wait 0.04 to 0.8 seconds, then pulse again. See Figure 4.
2. Wait > 0.8 seconds, then enter sequential pulses to toggle between the eight output configuration choices; single-click to increment, and double-click to decrement (see table on page 6). Spacing between sequential pulses must be > 0.8 seconds.
3. To exit SETUP mode, hold the TEACH input low for > 2 seconds. The sensor will return to RUN mode with the most recent settings (i.e., exits and saves current selection).

Toggling Between Light Operate (LO) and Dark Operate (DO)

NOTE: Remote line only
Pulse the remote line three times to toggle between LO and DO. See Figure 5.

Locking Out (Disabling) the Push Buttons

Pulse four times to disable (or to re-enable) the push buttons.
NOTE: Push buttons can be disabled/enabled from the remote line only. See Figure 6.

Lens Location

The lens may be installed at either of two lens ports (see Figure 7). 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. Fully seat the lens cap to ensure a liquid-tight seal.
Mounting

The R58E includes a total of eight size 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 register mark sensors. The R58E includes four M5 x 0.8 x 6 mm stainless steel cap screws and a hex key wrench.

The R58E focus is 10 mm (0.39") from the lens surface. The R58E must be mounted within 3 mm (0.12") of this distance from the surface of the material for reliable sensing (Figure 7). Consider the following when mounting the R58E:

• 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 8).

• When sensing a register mark on a reflective (shiny) material, mount the R58E at an angle which places the lens centerline at approximately 15° off perpendicular to the material’s surface (Figure 9). 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 differences in colors.

• Clear materials are poor reflectors of light. When sensing a mark printed on a clear material (e.g., a clear poly web), position a reflective surface directly behind the clear material to return light to the R58E. 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 to include a 15° skew angle when sensing clear materials (Figure 9).

![Figure 8. Mounting for sensing opaque non-reflective materials](image1)

![Figure 9. Mounting for sensing opaque reflective and transparent materials](image2)
## Specifications

| **Supply Voltage and Current** | 10 to 30V dc (10% max. ripple);  
Supply current (exclusive of load current): 75 mA @ 10V dc  
35 mA @ 30V dc |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Supply Protection Circuitry</strong></td>
<td>Protected against reverse polarity and transient voltages</td>
</tr>
<tr>
<td><strong>Output Configuration</strong></td>
<td>Outputs are bipolar: one current sourcing (PNP) and one current sinking (NPN) open-collector transistor</td>
</tr>
</tbody>
</table>
| **Output Rating** | 100 mA max. (each output);  
OFF-state leakage current: NPN < 200 microamps; PNP < 10 microamps  
NPN saturation: < 200 mV @ 10 mA and < 1V @ 100 mA  
PNP saturation: < 1.2V @ 10 mA and < 1.6V @ 100 mA |
| **Output Protection Circuitry** | Protected against false pulse on power-up and continuous overload or short-circuit of outputs. |
| **Output Response Time** | 50 microseconds  
NOTE: 1 second delay on power-up; outputs do not conduct during this time. |
| **Repeatability** | 15 µs |
| **Tri-Color LED Sensing Image** | Rectangular: 1.2 mm x 3.8 mm (0.05" x 0.15") at 10 mm (0.39") from face of lens; image oriented either parallel or perpendicular to sensor length, depending on model (see page 1).  
Red: 636 nm  
Green: 525 nm  
Blue: 472 nm |
| **Adjustments** | Using push buttons ("+" Dynamic and "+-" Static):  
Manually adjust discrete output Switch Point using "+" or "+-" buttons  
Dynamic TEACH (teach on-the-fly) sensitivity adjustment  
Static TEACH sensitivity adjustment  
Light operate/Dark operate  
OFF-delay/ON-delay  
Using Remote TEACH input (gray wire):  
Dynamic TEACH (teach on-the-fly) sensitivity adjustment  
Static TEACH sensitivity adjustment  
Light operate/Dark operate  
OFF-delay/ON-delay  
Lockout of push buttons for security |
| **Indicators** | 8-segment Light Bar: Red signal strength indicator relative to taught signal level; higher segment number for higher sensing contrast  
Light Operate: Green  
Dark Operate: Green  
Outputs Conducting: Yellow  
OFF-Delay: Green  
ON-Delay: Green  
Power/Run Mode: Green |
| **Construction** | Zinc alloy die-cast and steel housing with black painted finish and o-ring sealed lens and lens port cap.  
Lens: Acrylic  
Lens port cap and lens holder: ABS  
Push buttons: Thermoplastic elastomer  
Labels: Polycarbonate |
| **Environmental Rating** | IEC IP67; NEMA 6 |
| **Connections** | PVC-jacketed 5-conductor 2 m (6.5’) or 9 m (30’) attached cable with internal strain relief, or 150 mm (6”) pigtail with 5-pin Euro-style QD fitting. Mating QD cables are purchased separately. See Quick-Disconnect cables on page 10. |
| **Operating Conditions** | Temperature: -10° to +55° C (+14° to 131° F)  
Storage Temperature: -20° to +80° C (-4° to +185° 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. |
R58E Expert™ Register Mark Sensors

Dimensions

Cabled Models

Quick-Disconnect Models

Accessories

Quick-Disconnect Cables

<table>
<thead>
<tr>
<th>Style</th>
<th>Model</th>
<th>Length</th>
<th>Dimensions</th>
<th>Pinout</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-pin Euro-style</td>
<td>MQDEC2-506</td>
<td>2 m (6.5')</td>
<td><img src="image" alt="Dimensions" /></td>
<td>White</td>
</tr>
<tr>
<td>straight, with</td>
<td>MQDEC2-515</td>
<td>5 m (15')</td>
<td></td>
<td>Blue</td>
</tr>
<tr>
<td>shield</td>
<td>MQDEC2-530</td>
<td>9 m (30')</td>
<td></td>
<td>Black</td>
</tr>
</tbody>
</table>
## Accessories, continued

### Mounting Brackets

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<tr>
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<th>SMB55F</th>
</tr>
</thead>
<tbody>
<tr>
<td>• 15° offset bracket</td>
<td>• Flat mount bracket</td>
</tr>
<tr>
<td>• 12-gauge stainless steel</td>
<td>• 12-gauge stainless steel</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SMB55RA</th>
<th>SMB55S</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Right-angle bracket</td>
<td>• 15° offset bracket</td>
</tr>
<tr>
<td>• 12-gauge stainless steel</td>
<td>• 12-gauge stainless steel</td>
</tr>
</tbody>
</table>

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**SMB55A**

- 15° offset bracket
- 12-gauge stainless steel

**SMB55F**

- Flat mount bracket
- 12-gauge stainless steel

**SMB55RA**

- Right-angle bracket
- 12-gauge stainless steel

**SMB55S**

- 15° offset bracket
- 12-gauge stainless steel
R58E Expert™ Register Mark Sensors

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>UC-R55</td>
<td>Replacement lens for R58E</td>
</tr>
</tbody>
</table>

**WARRANTY:** Banner Engineering Corp. warrants its products to be free from defects for one year. Banner Engineering Corp. will repair or replace, free of charge, any product of its manufacture found to be defective at the time it is returned to the factory during the warranty period. This warranty does not cover damage or liability for the improper application of Banner products. This warranty is in lieu of any other warranty either expressed or implied.