

## Datasheet

No revision without agency approval.

To view or download the latest technical information about this product, including specifications, dimensions, accessories, and wiring, see [www.bannerengineering.com](http://www.bannerengineering.com).



SMI91 Series sensor, with C13RC2 current amplifier module (left) and intrinsic safety barrier (right)

- Offers economy, performance and reliability in a rugged housing
- Provides standard limit-switch mounting hole spacing
- Use with approved intrinsically safety barriers and Banner MAXI-AMP™ model C13RC2 current trip point amplifier
- Certified for use in hazardous locations as defined by Article 500 of the National Electrical Code when used with approved I.S. barriers
- Provides 10 to 30 V dc supply voltage with NPN output
- Features a light- or dark-operate selection switch
- Available in opposed, polarized and non-polarized retroreflective, diffuse, convergent, and glass or plastic fiber optic sensing modes
- Ranges up to 60 meters
- Integral 3-pin Mini-style QD fitting; QD cordset required, see *Accessories*

## Models

Sensing Mode	Models	Range	
<p>OPPOSED</p>	Long-range opposed, 880 nm Effective Beam: 13 mm (0.5 in)	SMI91EQD Emitter SMI91RQD Receiver	60 m (200 ft)
	Short-range opposed, 880 nm Effective Beam: 3.5 mm (0.14 in)	SMI91ESRQD Emitter SMI91RSRQD Receiver	
<p>RETRO</p>	Non-polarized retroreflective, 650 nm Visible Red	SMI912LVQD	150 mm to 9 m (6 in to 30 ft) <sup>1</sup>
<p>POLAR RETRO</p>	Polarized retroreflective, 650 nm Visible Red	SMI912LVAGQD	300 mm to 4.5 m (1 to 15 ft) <sup>1</sup>
<p>DIFFUSE</p>	Long-range diffuse, 880 nm Infrared	SMI912DQD	760 mm (30 in)
	Short-range diffuse, 880 nm Infrared	SMI912DSRQD	380 mm (15 in)
<p>CONVERGENT VISIBLE RED</p>	Convergent, 650 nm Visible Red	SMI912CVQD	Focus at: 38 mm (1.5 in) Spot Size at Focus: 1.5 mm (0.06 in)
<p>PLASTIC FIBER</p>	Plastic fiber optic, 650 nm Visible Red	SMI912FPQD	See performance curves
<p>GLASS FIBER</p>	Glass fiber optic, 880 nm Infrared	SMI912EFQD Emitter SMI912RFQD Receiver	
	Glass fiber optic, 880 nm Infrared	SMI912FQD	

<sup>1</sup> Performance based on use of a model BRT-3 retroreflector (3-inch diameter). Actual sensing range may be more or less than specified, depending on the efficiency and reflective area of the retroreflector used.



**WARNING: Not To Be Used for Personnel Protection**

Never use this device as a sensing device for personnel **protection**. Doing so could lead to serious injury or death. This device does not include the self-checking redundant circuitry necessary to allow its use in personnel safety applications. A sensor failure or malfunction can cause either an energized or de-energized sensor output condition.

## Overview

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VALU-BEAM SMI91 Series sensors are designed for intrinsically safe operation in hazardous atmospheres. They are certified (see Specifications) as being intrinsically safe when used with approved intrinsic safety barriers.

SMI91 Series sensors may be wired for either two- or three-wire current-sinking operation. In the three-wire hookup, which requires a dual intrinsic-safety barrier or two intrinsic-safety barriers, the sink current is 15 mA. The two-wire hookup, which requires one barrier, sinks  $\leq 10$  mA (OFF state) and  $\geq 20$  mA (ON state). (See [Wiring Connections](#) on page 3.)

SMI91 Series sensors feature rugged, encapsulated construction, along with adjustable sensitivity and switchable light or dark operate. They also include Banner's exclusive Alignment Indicating Device system, which lights an indicator LED whenever the sensor "sees" its modulated light source, and pulses at a rate proportional to the received light signal strength.

Intrinsic safety barriers and current trip point amplifier model CI3RC2 are also available (see [Accessories](#) on page 8).

## Installation Instructions

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### Ex/HazLoc Applications

**WARNING:**

- Explosive Atmospheres/Hazardous **Locations**
- The user has the responsibility to ensure that all local, state, and national laws, rules, codes, or regulations relating to the installation and use of this Banner device in any particular application are satisfied. This Banner device must be installed by Qualified Persons, in accordance with this document and applicable regulations.
- A Qualified Person is a person who, by possession of a recognized degree or certificate of professional training, or who, by extensive knowledge, training and experience, has successfully demonstrated the ability to solve problems relating to the subject matter and work.

**WARNING:**

- Explosion Hazard
- Do not disconnect equipment unless the power has been switched off or the area is known to be non-hazardous.

**CAUTION: Electrostatic Discharge (ESD)**

Special **Conditions** for Safe Use. Parts of the enclosure are non-conducting and may generate an ignition-capable level of ESD. Cleaning of the equipment shall be done only with a damp cloth.

#### General Notes and **Conditions** for Safe Use:

- See Specifications and Wiring Diagrams for important information concerning entity parameters, permissible locations, electrical connections and certifications.
- In addition to the warning above concerning user responsibility, the installation must comply with the following:
  - All installations must comply with all manufacturer's instructions.
  - U.S. Installations: The relevant requirements of the National Electrical Code® (ANSI/NFPA-70 (NEC®) and when appropriate ANSI/ISA-RP12.06.01 Installation of Intrinsically Safe Systems for Hazardous (Classified) Locations.
  - Canadian Installations: The relevant requirements of the Canadian Electrical Code (CSA C22.1).
  - ATEX and IECEx Installations: The relevant requirements of EN 60079-14 and applicable National regulations.
- Do not attempt any repairs to this Banner device; it contains no field-replaceable parts or components. Tampering and/or replacement with non-factory components may adversely affect the safe use of the system.
- Barrier entity parameters must meet the following requirements:
  - $V_{oc}$  or  $V_t \leq V_{max}$   $C_a \geq C_i + C_{cable}$
  - $I_{sc}$  or  $I_t \leq I_{max}$   $L_a \geq L_i + L_{cable}$
- If barriers with Volt/Ohm parameters are used, the following parameters shall apply:
  - One Single-Channel Barrier Systems—one 28 V (max), 300  $\Omega$  (min)
  - Two Single-Channel Barrier or One Dual-Channel Systems
    - two 28 V (max), 600  $\Omega$  (min)
    - one 28 V (max), 300  $\Omega$  (min) and one 10 V (max), 50  $\Omega$  (min)
    - one 28 V (max), 300  $\Omega$  (min) and one 28 V diode return
- Sensor Entity Parameters
  - $V_{max}(U_i) \leq 30V$  dc

- $I_{max}(I_i) \leq 350 \text{ mA}$
- $P_i \leq 750 \text{ mW}$
- $C_i = 0 \text{ }\mu\text{F}$
- $L_i = 0 \text{ mH}$
- The ambient operating temperature range of the sensors is  $-40 \text{ }^\circ\text{C}$  to  $+70 \text{ }^\circ\text{C}$  ( $-40 \text{ }^\circ\text{F}$  to  $+158 \text{ }^\circ\text{F}$ ).
- The sensors are suitable for installation without barriers in Class I Div. 2 Groups A, B, C, D; Class II Div. 2 Group G; and Class III Div. 2, when installed in (or through the wall of) a suitable enclosure with provision for connection of rigid metal conduit per the National Electrical Code, as acceptable to the local inspection authority having jurisdiction. In Div. 2 installations (without barriers), observe Explosion Hazard warning at the beginning of this section.
- The sensors are suitable for installation without barriers in Class I Div. 2 Groups A, B, C, D when installed in (or through the wall of) a suitable enclosure with provision for connection of rigid metal conduit per the Canadian Electrical Code, as acceptable to the local inspection authority having jurisdiction. In Div. 2 installations (without barriers), observe Explosion Hazard warning at the beginning of this section.
- Control (Installation) Drawing p/n 13321 has been replaced by this document.

## Wiring Connections

SMI91 Series sensors are intrinsically safe ONLY when used with certified energy-limiting intrinsically safe barriers. Banner does not manufacture such barriers; however, our applications engineers can refer you to suppliers of certified barriers that will interface with Banner sensors. SMI91 Series sensors may be wired using Banner Current Amplifier Control Module CI3RC2. Note from the wiring diagrams that the installation may be made with either a single barrier (2-wire hookup) or with a double barrier (3-wire hookup). Emitter-only units (SMI91EQD, ESRQD, and EFQD) use the 2-wire hookup; all other models use either 2- or 3-wire hookup.

In the 2-wire configuration, the sensor will act as a current sink, drawing less than 10 mA in the OFF state and more than 20 mA in the ON state. The user must provide a current sensing device ("current sensor" in the diagram) to convert the current to a logic level. In the 3-wire configuration, the output may be used directly to control loads of less than 15 mA.

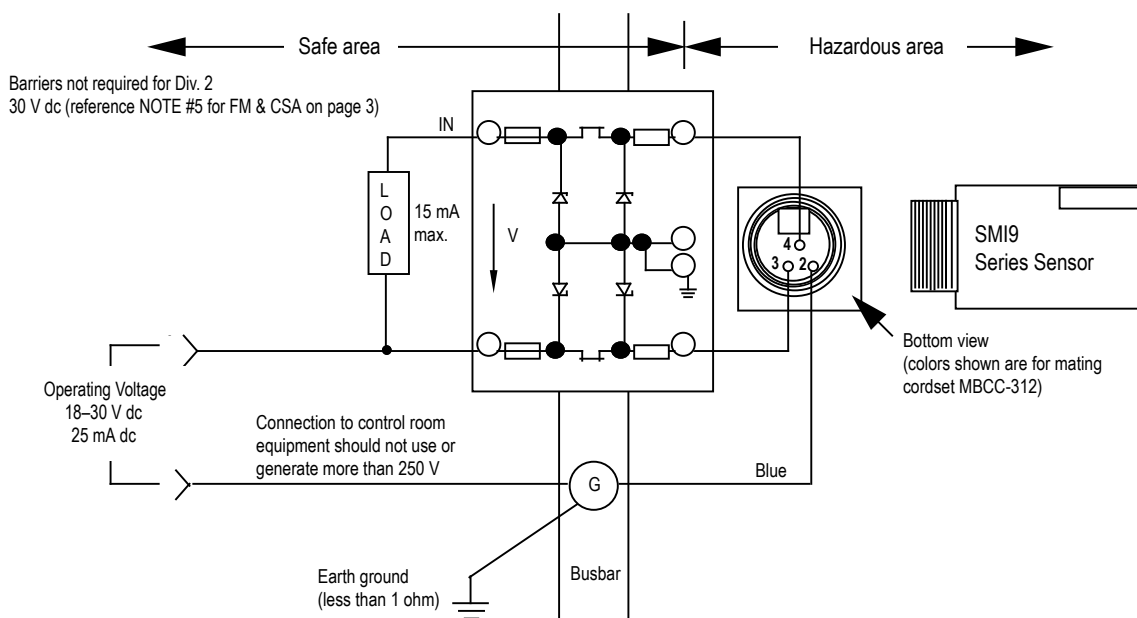
In selecting the barrier, it is important to consider the barrier's resistance. The sensor must have at least 10 volts across the brown and blue power leads for proper operation, and the barrier will cause a voltage drop due to its resistance. The formula that determines how much resistance is allowed is:  $R = 40 (\text{supply voltage} - 10 \text{ volts})$ .

If the supply voltage is 24 V dc, then the maximum resistance is 560 ohms. If the supply voltage is 18 V dc, then the maximum resistance is 320 ohms. This includes the resistance of any current sensing device used (in the 2-wire configuration), so the barrier resistance must be further reduced by the current sensor resistance.

Note that, in the 3-wire hookup, the positive load barrier is in series with the load. This will result in an apparent saturation voltage of the output that is higher than the sensor output by the amount of  $I \times R$  (current times resistance) drop through the barrier.

A "positive input" barrier is required for both supply and for load. The sensor's blue (negative supply) lead is normally connected to the ground terminal of the barrier.

The user is responsible for proper installation and maintenance of this equipment, and must conform with the certification requirements relating to barriers and to maximum allowable capacitance and inductance of the field wiring. If in doubt about these requirements, our applications engineers can refer you to the appropriate authority.



Note: Emitters have no output connection (no connection to black wire)

Figure 1. Wiring for 3-Wire Connections

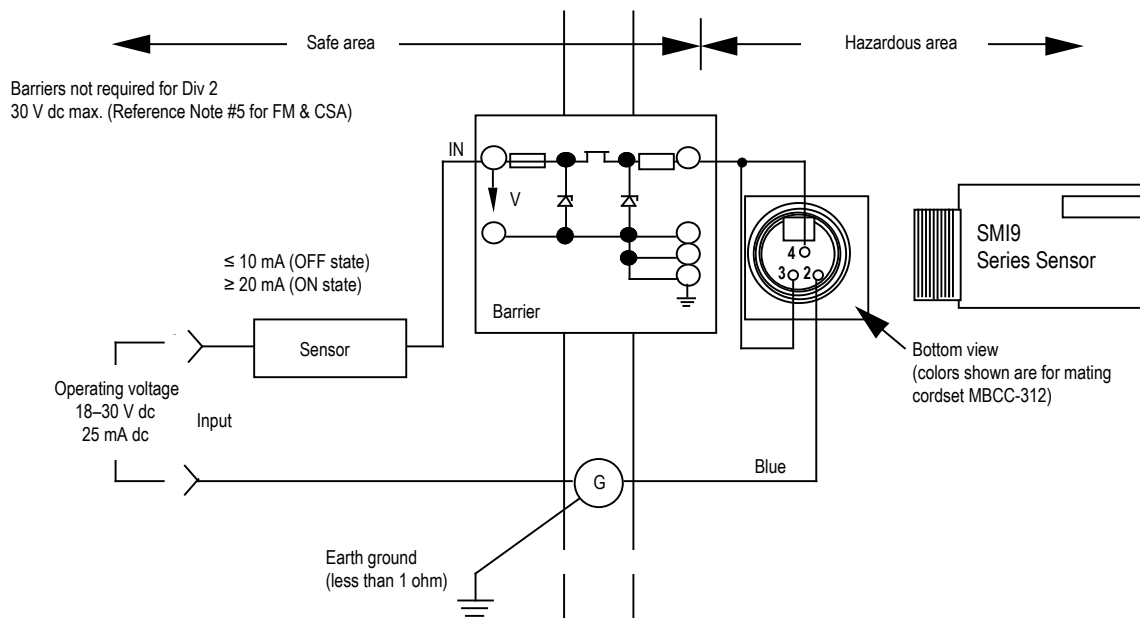


Figure 2. Wiring for 2-Wire Connections

## Specifications

### Supply Voltage and Current

Sensor only: requires 10 to 30 V dc, 25 mA maximum

### Sensing Beam

Infrared (880 nm) or visible red (650 nm), depending on model

### Adjustments

Light/Dark Operate select switch on rear of sensor  
Sensitivity control on rear of sensor allows precise gain setting (turn clockwise to increase gain)

### Indicators

Sensors include Banner's exclusive Alignment Indicating Device (AID™) system, which lights a top-mounted red indicator LED whenever the sensor "sees" its modulated light source, and pulses the LED at a rate proportional to the received light signal strength.

### Construction

Housing: reinforced PBT, totally encapsulated  
Lenses: molded acrylic  
Hardware: stainless steel

### Connections

Supplied with integral 3-pin Mini-style QD fitting; requires cordset model MBCC (see *Accessories*), purchased separately.

### Output Configuration

Current sinking NPN open-collector transistor

### Output Rating

Three-wire hookup sinks 15 mA maximum, continuous (10 to 30 V dc)  
Two-wire hookup sinks  $\leq 10$  mA (OFF state) and  $\geq 20$  mA (ON state), 10 to 30 V dc.  
Outputs are short-circuit protected.

### Application Note

Special Conditions for Safe Use: Parts of the enclosure are non-conducting and may generate an ignition-capable level of ESD. Cleaning of the equipment must be done only with a damp cloth.

### Output Response Time

Opposed-mode receivers: 8 milliseconds ON/4 milliseconds OFF; independent of signal strength  
All other models: 4 milliseconds ON and OFF  
100 millisecond delay on power-up (output does not conduct during this time).

### Repeatability

Opposed mode: 1.0 millisecond  
All other modes: 1.3 milliseconds  
Repeatability is independent of signal strength.

### Environmental Ratings

Banner tested to NEMA standards 1, 2, 3, 3S, 4, 4X, 12, and 13, IEC IP66

### Operating Conditions

Temperature:  $-20$  °C to  $+70$  °C ( $-4$  °F to  $+158$  °F)  
Max. Relative Humidity: 90% @  $50$  °C (non-condensing)

### Certifications



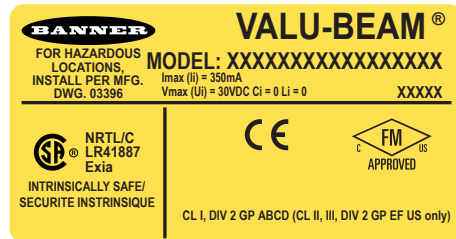
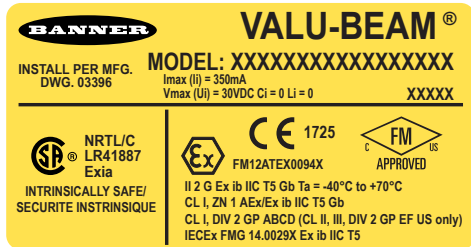
IEC IECEx FMG 14.0029X  
ATEX FM12ATEX0094X  
FM CoC 0003046293 (US)  
FM CoC 0003046293C (CAN)

## Design Standards

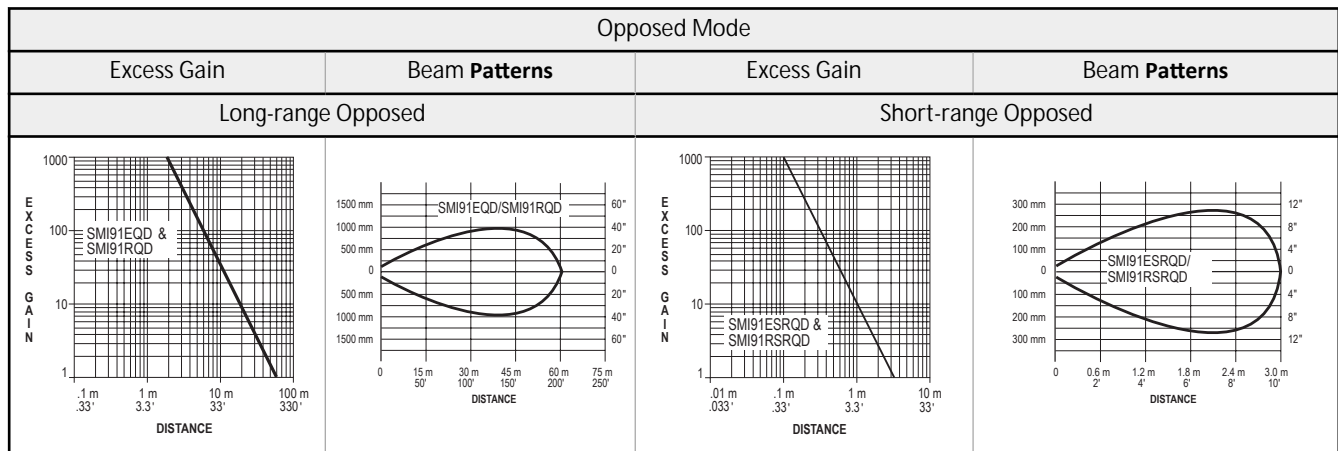
ATEX (European)	EN 60079-0, EN 60079-11, EN 60079-26
Canadian	CAN/CSA C22.2, No. 142-M1987, No. 157-92, No. 1010.1, E60079-0, E60079-11
United States	FM Class 3600, 3610, and 3810, ANSI/ISA 61010-1 (82.02.01), ANSI/ISA 60079-0, and 60079-11.
IECEX	IEC 60079-0 (Ed.6.0); IEC 60079-11 (Ed. 6.0)

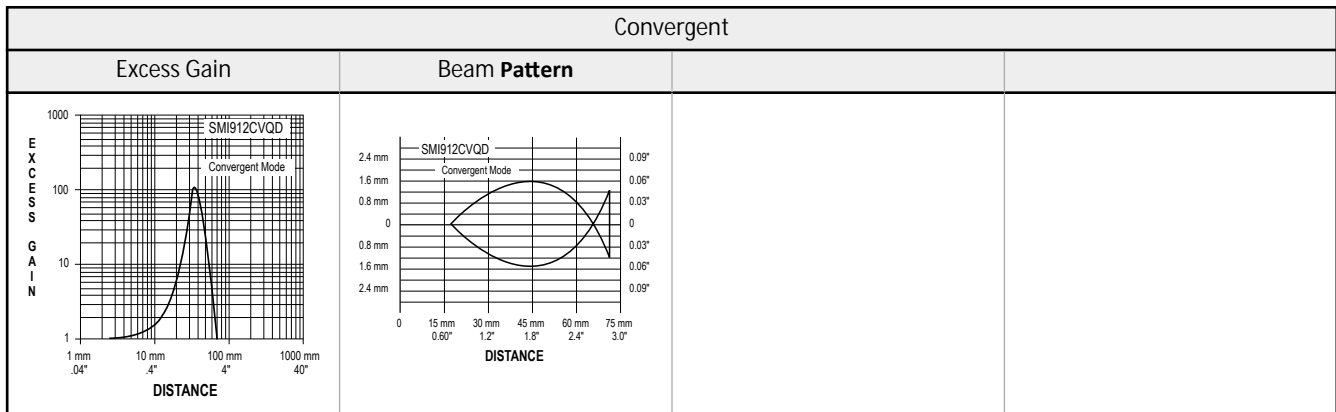
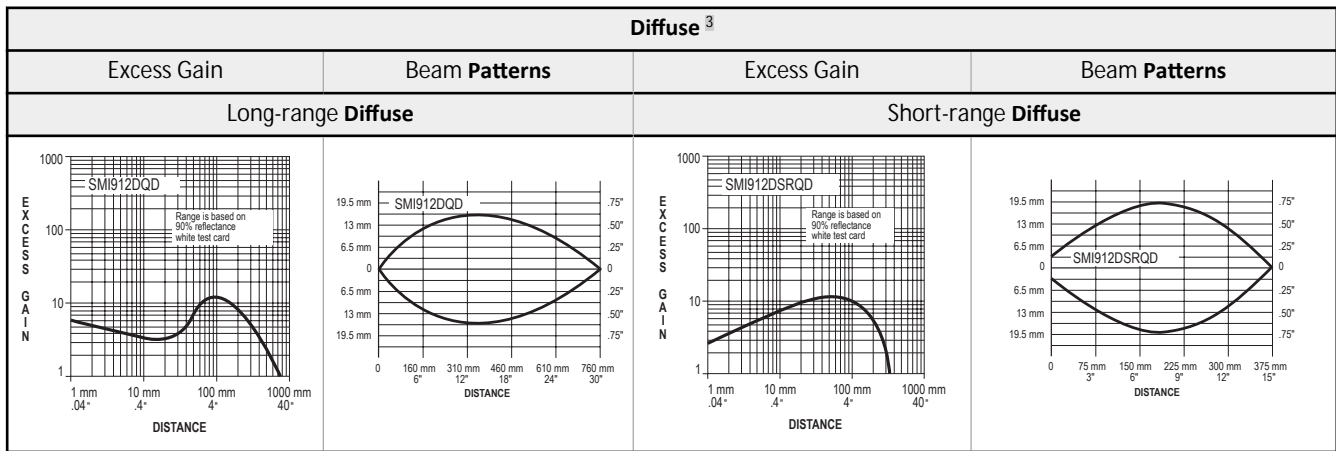
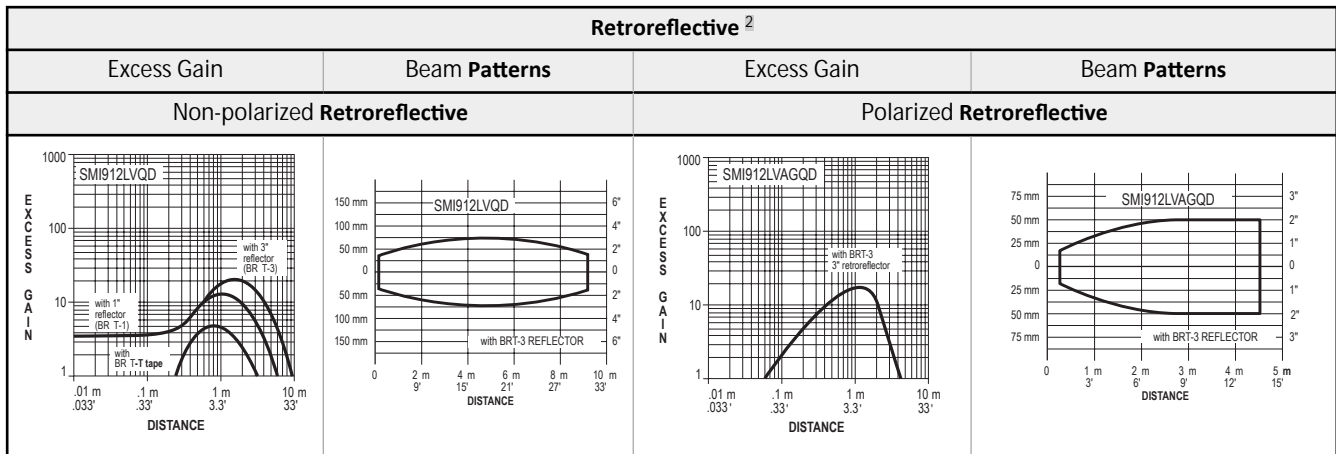
Approvals

ATEX (European)	SMI91(b) II 2 G Ex ib IIC T5 Ta = -40 °C to 70 °C - 03396; Entity Entity Parameters: V <sub>Max</sub> = 30 V, I <sub>Max</sub> = 350 mA, P <sub>i</sub> = 750 mW, C <sub>i</sub> = 0 μF, L <sub>i</sub> = 0 mH. b = RQD, RSRQD, RFQD, EQD, ESRQD or EFQD.
Canadian	SMI91(a) Non-incendive for Class I, Division 2, Groups A, B, C and D, T5 Ta = -40 °C to 70 °C a = 2LVQD, 2DQD, 2DSRQD, 2FQD, 2CVQD, 2LVAGQD or 2FPQD.
	SMI91(b) Non-incendive for Class I, Division 2, Groups A, B, C and D, T5 Ta = -40 °C to 70 °C Intrinsically safe for Class I, Zone 1 Ex ib Group IIC T5 Ta = -40 °C to 70 °C; - 03396, Entity Entity Parameters: V <sub>Max</sub> = 30 V, I <sub>Max</sub> = 350 mA, P <sub>i</sub> = 750 mW, C <sub>i</sub> = 0 μF, L <sub>i</sub> = 0 mH. b = RQD, RSRQD, RFQD, EQD, ESRQD or EFQD.
United States	SMI91(a) Non-incendive for Class I, Division 2, Groups A, B, C and D, T5 Ta = -40 °C to 70 °C Suitable for Class II and III, Division 2, Group G, T5 Ta = -40 °C to 70 °C a = 2LVQD, 2DQD, 2DSRQD, 2FQD, 2CVQD, 2LVAGQD or 2FPQD.
	SMI91(b) Non-incendive for Class I, Division 2, Groups A, B, C and D, T5 Ta = -40 °C to 70 °C Suitable for Class II and III, Division 2, Group G, T5 Ta = -40 °C to 70 °C Intrinsically safe for Class I, Zone 1 AEx ib Group IIC T5 Gb Ta = -40 °C to 70 °C - 03396; Entity Entity Parameters: V <sub>Max</sub> = 30 V, I <sub>Max</sub> = 350 mA, P <sub>i</sub> = 750 mW, C <sub>i</sub> = 0 μF, L <sub>i</sub> = 0 mH. b = RQD, RSRQD, RFQD, EQD, ESRQD or EFQD.
IECEX	SMI91(b) Ex ib IIC T5 Ta = -40 °C to +70 °C - 03396; Entity Entity Parameters: V <sub>Max</sub> = 30 V, I <sub>Max</sub> = 350 mA, C <sub>i</sub> = 0 μF, L <sub>i</sub> = 0 mH b = RQD, RSRQD, RFQD, EQD, ESRQD or EFQD.

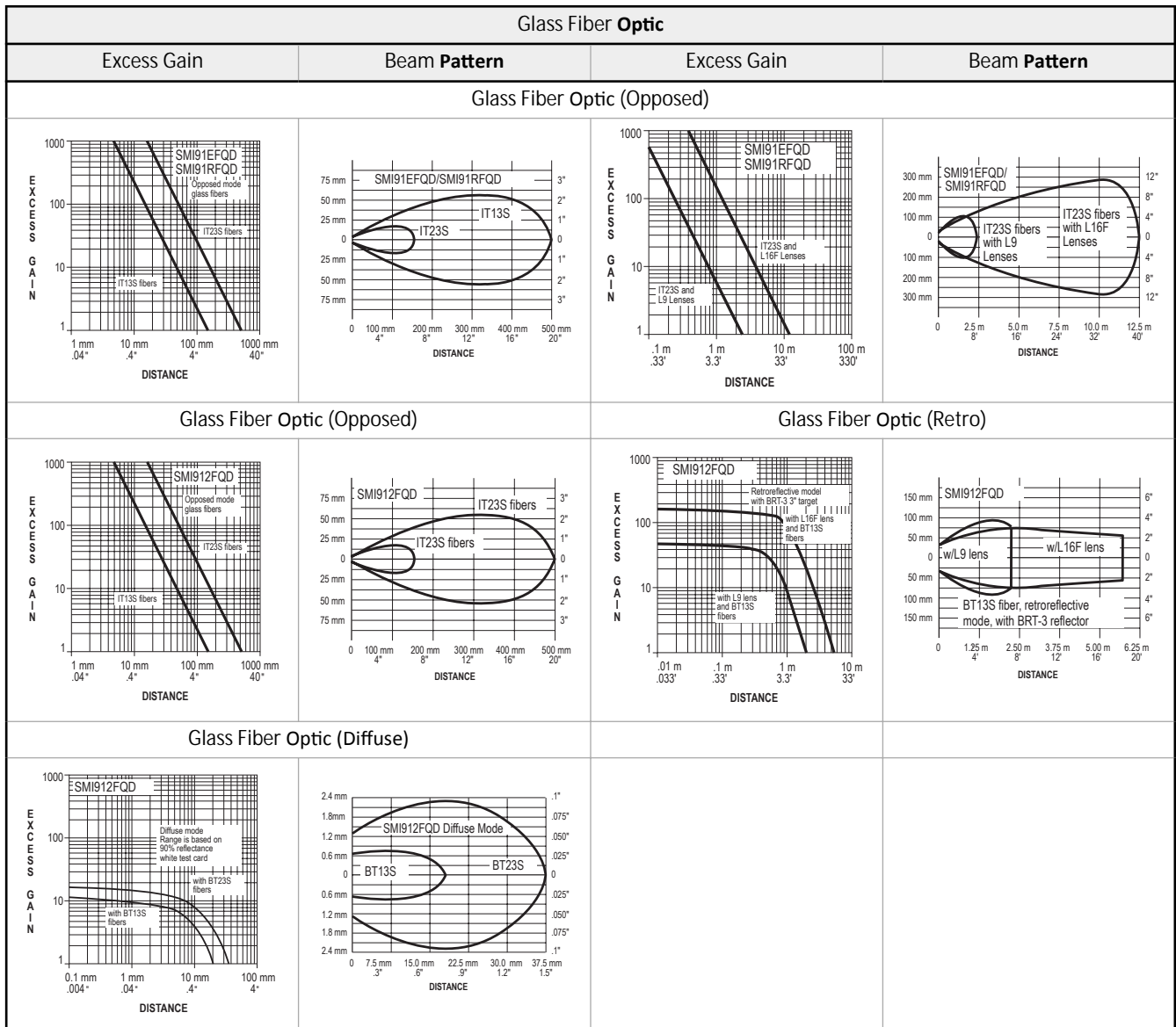
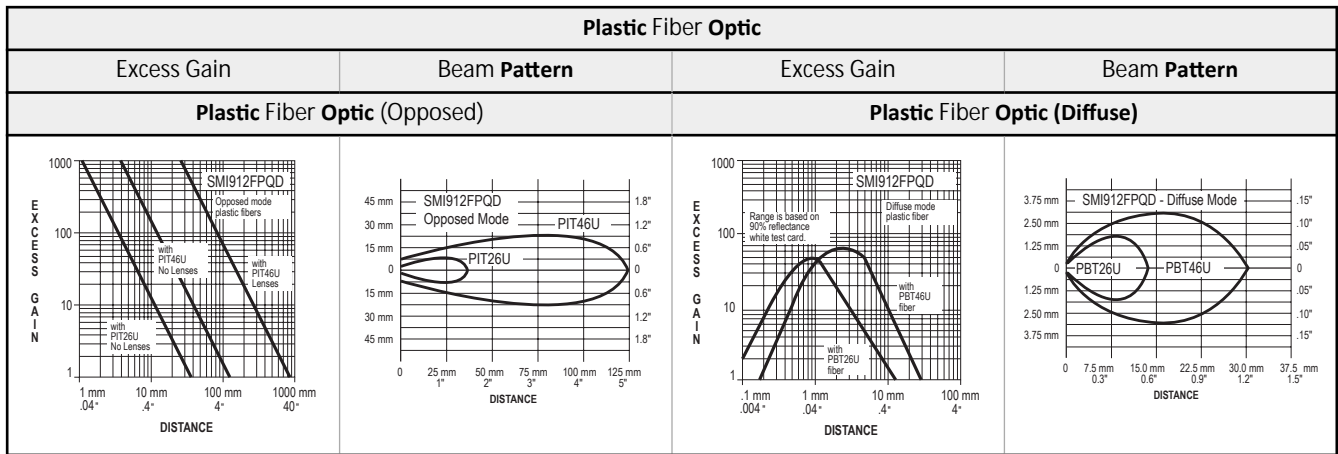


Performance Curves

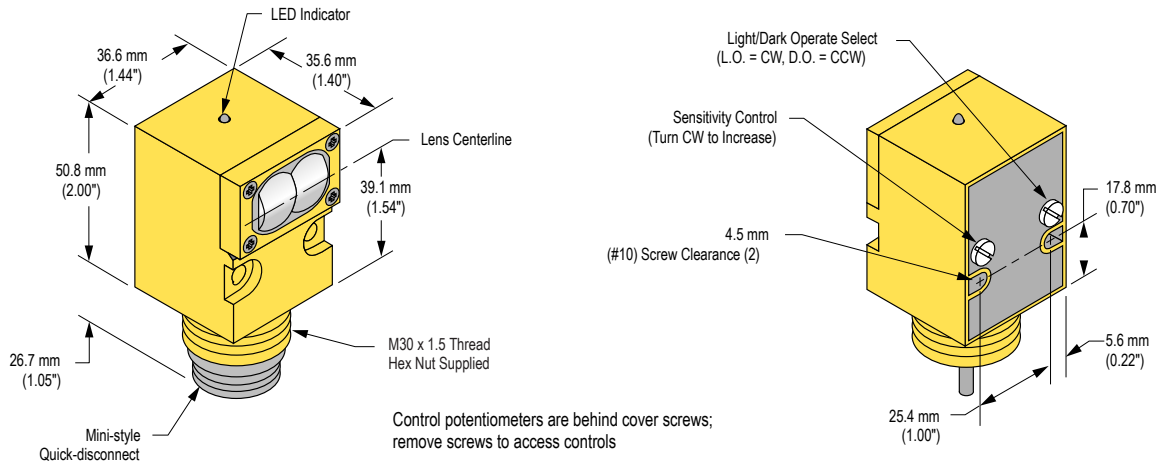




<sup>2</sup> Retroreflective performance based on use of a model BRT-3 retroreflector (3" diameter). Actual sensing range may be more or less than specified, depending on the efficiency and reflective area of the retroreflector used.  
<sup>3</sup> Diffuse mode performance based on use of 90% reflectance white test card.



## Dimensions



## Accessories

The following accessories are for the VALU-BEAM SMI91x series of sensors.

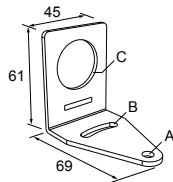
### Cordsets

3-Pin Mini-Style Cordsets						
Model	Length	Style	Dimensions	Pinout (Female)		
MBCC-306	1.83 m (6.5 ft)	Straight		<p>1 = Black 2 = Brown 3 = Blue</p>		
MBCC-312	3.66 m (12 ft)					
MBCC-330	9.14 m (30 ft)					
SMICC-306	1.83 m (6.5 ft)	Straight				<p>1 = Red/Black 2 = Red/White 3 = Green</p>
SMICC-312	3.66 m (12 ft)					
SMICC-330	9.14 m (30 ft)					
SM30CC-306	1.83 m (6.5 ft)	Straight		<p>1 = Red/Black 2 = Red/White 3 = Green</p>		
SM30CC-312	3.66 m (12 ft)					

## Mounting Brackets

### SMB30A

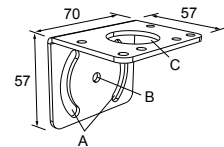
- Right-angle bracket with curved slot for versatile orientation
- Clearance for M6 (¼ in) hardware
- Mounting hole for 30 mm sensor
- 12-ga. stainless steel



Hole center spacing: A to B=40  
Hole size: A=ø 6.3, B= 27.1 x 6.3, C=ø 30.5

### SMB30MM

- 12-ga. stainless steel bracket with curved mounting slots for versatile orientation
- Clearance for M6 (¼ in) hardware
- Mounting hole for 30 mm sensor

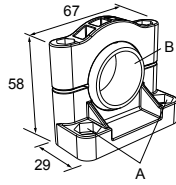


Hole center spacing: A = 51, A to B = 25.4  
Hole size: A = 42.6 x 7, B = ø 6.4, C = ø 30.1



SMB30SC

- Swivel bracket with 30 mm mounting hole for sensor
- Black reinforced thermoplastic polyester
- Stainless steel mounting and swivel locking hardware included



Hole center spacing: A=Ø 50.8  
 Hole size: A=Ø 7.0, B=Ø 30.0

### Current Trip-Point Module CI3RC2

- Self-contained module converts the SMI91 sensor's current output signal to a trip point switch.
- SPDT electromechanical relay switches loads that draw up to 5 amps. The SPST solid-state relay can switch a dc load of up to 30 V dc, max.; 20 mA max.
- Powered by either 105 to 130 V ac or 210 to 250 V ac.
- Supplies dc power to operate a single sensor or both the emitter and receiver of one SMI Series opposed-mode sensor pair. The sensor's input to the CI3RC2 is protected against short circuits. Built-in circuit diagnostics indicate an input overload by flashing an LED status light.
- Module has two isolated output switches, a 5-amp rated SPDT electromechanical relay and a solid-state transistor switch used for logic-level interfaces.
- May be ordered either alone or as a part of a kit.

Supply Voltage

105 to 130 V ac or 210 to 250 V ac, 50/60 Hz (8 VA)

Output **Configuration** (Solid-state dc relay)

SPST optically-coupled transistor; 30 V dc maximum, 20 mA maximum.

**Emitter** Power

+24 V dc at 25 mA maximum available at module pin #3

Inputs

Trip point for output "OFF": ≤ 10 mA  
 Trip point for output "ON": ≥ 20 mA  
 Trip point range for input overload indication: 30 mA ≤ I ≤ 80 mA

Indicators

Status Indicators for OUTPUT "ON" and INPUT overload/short

Output **Configuration** (SPDT electromechanical relay)

Contact rating: 250 V ac maximum, 24 V dc maximum, 5 amps maximum (resistive load), 1/10 HP at 240 V ac. Install transient suppressor (MOV) across contacts which switch inductive loads. Min. load: 12 V dc, 0.1 A.  
 Closure time: 10 milliseconds maximum.  
 Release time: 10 milliseconds maximum.  
 Maximum switching speed: 20 operations/second.  
 Mechanical life: 20,000,000 operations

**Construction**

Housing: rugged polyphenylene oxide (PPO®) 1.6" × 2.3" × 4"  
 Standard round-pin 11-pole base. Use RS-11 socket or equivalent.

**Operating Conditions**

Temperature: 0 °C to +50 °C (+32 °F to +122 °F)

### Intrinsic Safety Barriers

Model (Barrier Only)	Barrier <b>Description</b>	Kit Model	Kit <b>Description</b>
CI2B-1	Single-channel intrinsically safe barrier	CI2BK-1	Includes CI3RC2 current amplifier, one RS-11 socket, one DIN-rail mount, one single-channel intrinsically safe barrier
CI2B-1	Dual-channel intrinsically safe barrier (typically used in opposed-mode applications)	CI2BK-2	Includes CI3RC2 current amplifier, one RS-11 socket, one DIN-rail mount, one dual-channel intrinsically safe barrier

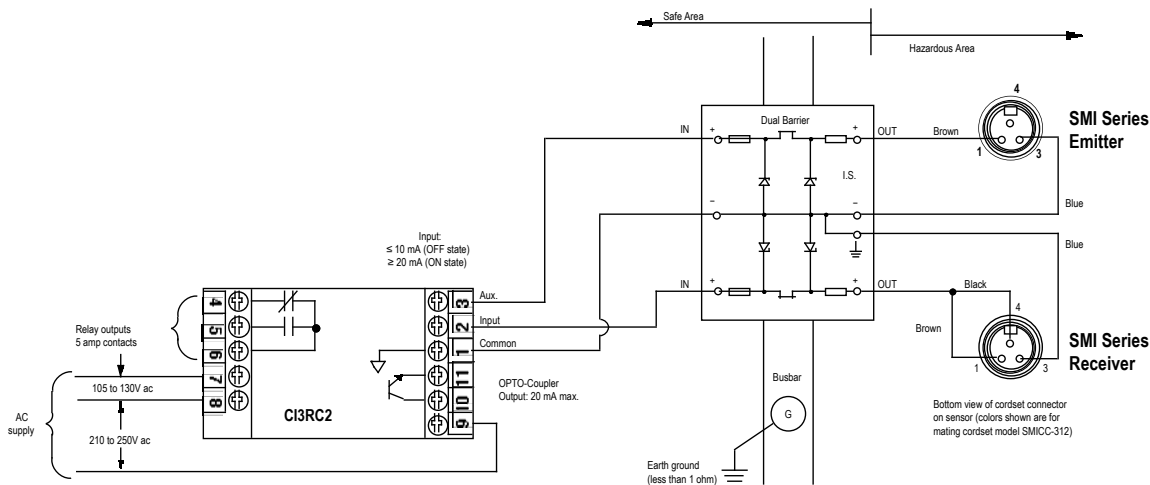


Figure 3. Wiring Connections - SMI91 Series Opposed Mode Emitters and Receivers

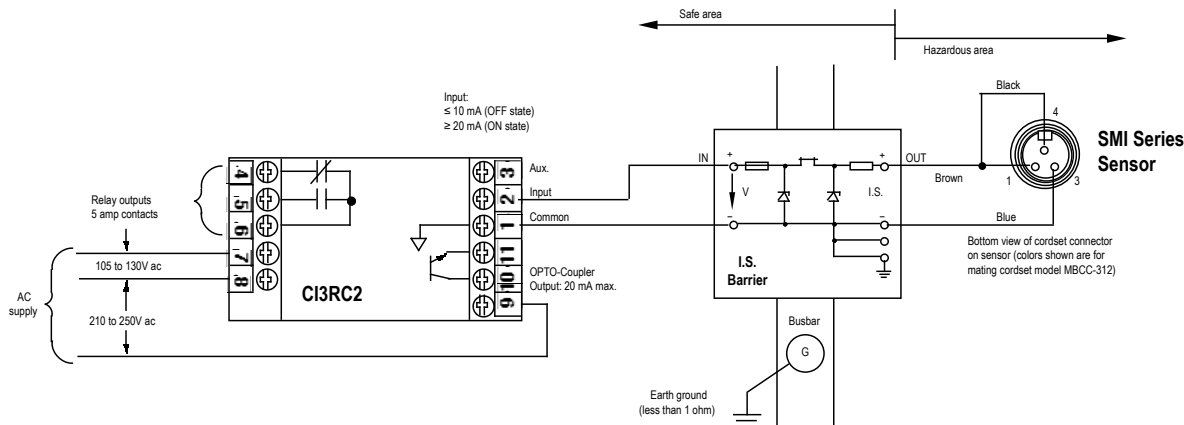


Figure 4. Wiring Connections - All Other SMI91 Series Sensors

## Repairs and Translations

Obtain assistance with product repairs by contacting your local Banner Engineering Corp distributor or by calling Banner directly at (763) 544-3164. Access literature translated into your native language on the Banner website at [www.bannerengineering.com](http://www.bannerengineering.com) or contact Banner directly at (763) 544-3164.

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