SA1C-FK: Fiber Optic Analog Photoelectric Sensors

- High-speed, miniature photoelectric sensors with analog (4mA to 20mA) and digital output
- Senses gradual color changes
- Available in both red and green LEDs
- Through-beam and reected-light sensing available
- Ideal for either color mark applications or simple presence and absence applications requiring analog output
- Compact size allows for DIN rail mounting
- Dozens of coordinating ber optic units available to address specic application needs
- Simple to install and program
- IP66 protection rating

CE

General Specifications

	SA1C-FK3	SA1C-FK3G
Light Source Element	Red LED	Green LED
Sensing Distance	Depends on the ber unit (see pages 72–74)	
Power Voltage	12 to 24V DC (Operating voltage: 10 to 30V DC) ripple 10% maximum	
Current Draw	80mA maximum	
Analog Current Output	4 to 20mA, 5V DC maximum	
Digital Output	NPN open collector 30V DC, 100mA maximum,1.5V maximum with short circuit protection	
Operation Mode	Dark ON (connect MODE line to GND line); Light ON (connect MODE line to power line)	
Response	0.5ms maximum	
Indicator	Operation LED: Red, Stable LED: Green	
Detectable Object	Translucent object, opaque object	
Hysteresis	20% maximum (using reex ber unit)	
Sensitivity	4-turn adjustment	
Operation Point Control	1 turn	
Receiver Element	Photo diode	
Operating Temperature	–25 to +55˚C (performance will be adversely affected if the sensor becomes coated with ice)	
Storage Temperature	–30 to +70˚C (performance will be adversely affected if the sensor becomes coated with ice)	
Operating Humidity	35 to 85% RH (avoid condensation)	
Extraneous Light Immunity	Sunlight: 10,000 lux maximum; Incandescent light: 3,000 lux (at the receiver)	
Noise Resistance	Normal mode: 500V (50ns to 1µs, 100Hz: Using a noise simulator) Common mode: 300V (50ns to 1µs, 100Hz: Using a noise simulator)	
Insulation Resistance	Between live and dead parts: 20MΩ minimum, with 500V DC megger	
Dielectric Strength	Between live and dead parts: 1,000V, 1 minute	
Vibration Resistance	Damage limits: 10 to 55Hz; Single amplitude: 0.75mm 20 cycles in each of 3 axes	
Shock Resistance	Damage limits: 500 m/sec^2 10 cycles in each of 3 axes	
Degree of Protection	IP66 — IEC Pub 529	
Cable	Cable type: Ø4.4mm 5-core vinyl cabtyre cable 0.2mm^2, 6'–6-3/4" (2m) long	
Material	Housing: Polybuthylenterephtalate (PBT)	
Accessories	Mounting bracket, adjusting screwdriver, load resistor (249Ω) for converting analog amperage to voltage (1 to 5V)	
Interference Prevention	Up to 2 units can be installed in close proximity. For analog output, interference prevention is not possible.	
Weight	Approximately 75g	

1. *Analog current output specification is based on the power voltage range from 12 to 24V DC (±10%).*
2. *Use the attached resistor (249Ω, 1/4W) as a load resistance for converting analog output to voltage.*
3. *Response time for analog current output is between 10% and 90% of the rise or fall of the voltage signal when using a 249Ω resistor.*

Part Numbers: SA1C-FK Sensors

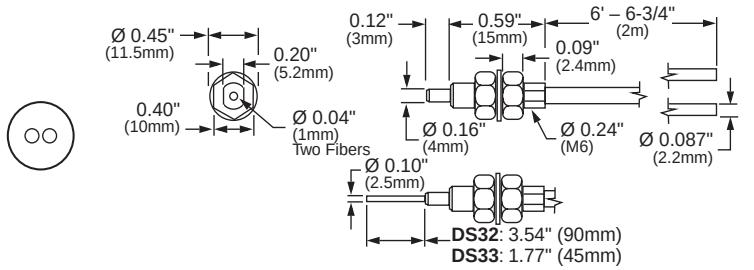
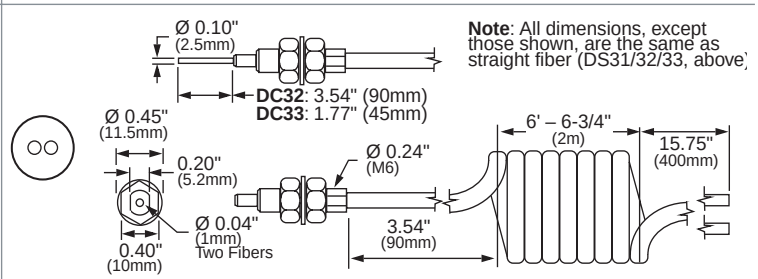
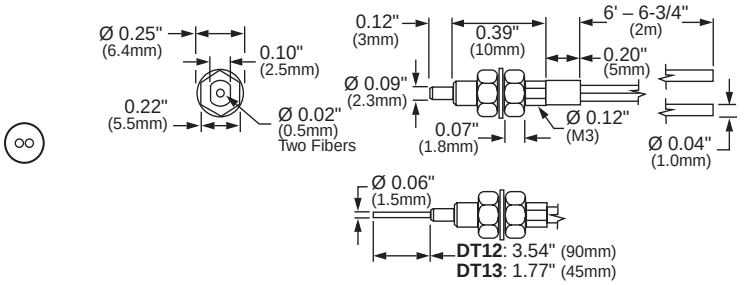
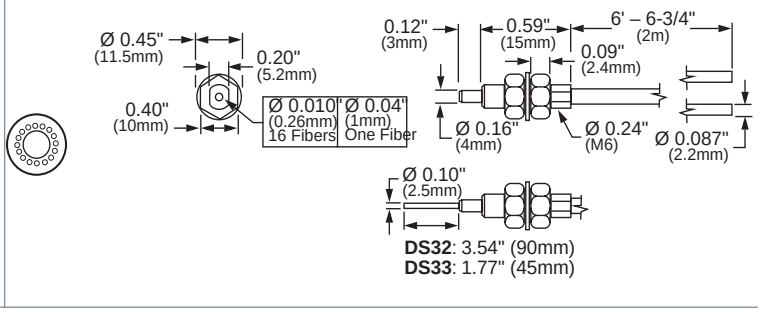
Part Number	Light Source Element	Output
SA1C-FK3	Red LED	Analog output + NPN output (with short-circuit)
SA1C-FK3G	Green LED	

Ordering Details

The SA1C-FK series consists of the amplier/receiver only . Fiber optic units must be ordered separately using part numbers beginning with SA9F. SA1C-FK amplier/receivers can be used with either through-beam or diffuse-reected ber optic units.

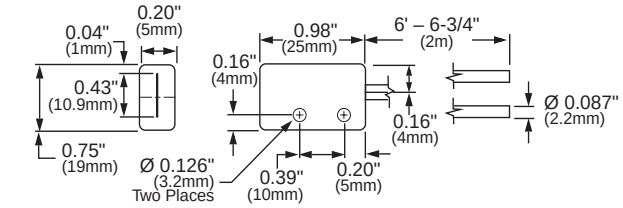
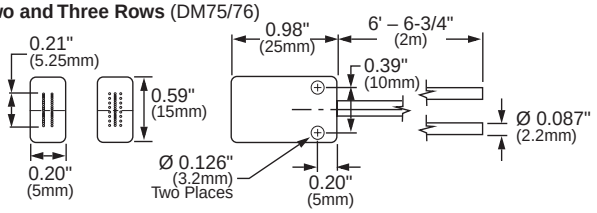
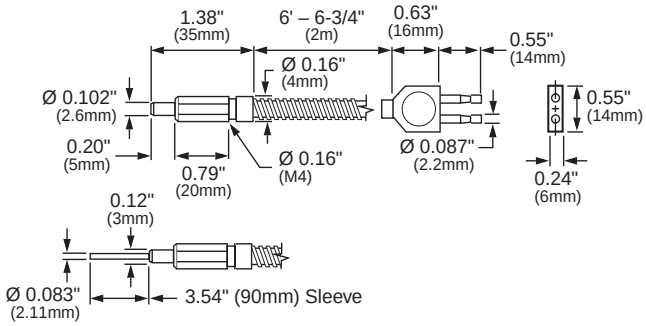
The ber optic cord is 6'–6-3/4" (2m) long. Fiber optic cords can be cut to the desired length using a ber cutter , except for heat-resistant glass ber cords. A ber cutter is included with ber optic units (order SA9Z-F01 separately for replacement). A set of two easy-insert adaptors is included with the following ber optic units: SA9F-TT , SA9F-TL, SA9F-DT, and SA9F-DL (order SA9Z-F02 for replacement set).

Part Numbers: SA9F Diffuse-Reect ed Light Fiber Optic Units

Part Number	Description	Amplifier	Range	Dimensions
SA9F-DS31 No sleeve **SA9F-DS32** 3.54" (90mm) sleeve **SA9F-DS33** 1.77" (45mm) sleeve	Straight: Two bers Ø 0.04" (1mm) Threaded mount: Ø 0.24" (M6) Detects: Ø 0.0012" (0.03mm) minimum object	SA1C-FK3 SA1C-FK3G	2.36" (60mm) 0.28" (7mm)	
SA9F-DC31 No sleeve **SA9F-DC32** 3.54" (90mm) sleeve **SA9F-DC33** 1.77" (45mm) sleeve (All three not compatible with green LED)	Coiled: Two bers Ø 0.04" (1mm) Threaded mount: Ø 0.24" (M6) Detects: Ø 0.0012" (0.03mm) minimum object	SA1C-FK3 SA1C-FK3G	0.98" (25mm) —	
SA9F-DT11 No sleeve **SA9F-DT12** 3.54" (90mm) sleeve **SA9F-DT13** 1.77" (45mm) sleeve (All three not compatible with green LED)	Straight: Two bers Ø 0.02" (0.5mm) Threaded mount: Ø 0.12" (M3) Detects: Ø 0.0012" (0.03mm) minimum object	SA1C-FK3 SA1C-FK3G	0.78" (20mm) —	
SA9F-DD31	Coaxial: Core Ø 0.04" (1mm) + 16 bers: Ø 0.01" (0.26mm) Threaded mount: Ø 0.24" (M6) Detects: Ø 0.0012" (0.03mm) minimum object	SA1C-FK3 SA1C-FK3G	2.36" (60mm) 0.28" (7mm)	

(continued on following page)

Part Numbers: SA9F Diffuse-Reect ed Light Fiber Optic Units, continued

Part Number	Description	Amplifier	Range	Dimensions
SA9F-DM74 1 row = 32 fibers **SA9F-DM75** 2 rows = 16 each (Not compatible with green LED) **SA9F-DM76** 3 rows = 16 center + 8 fibers each side (Not compatible with green LED)	Multicore: 32 bers Ø 0.010" (0.26mm) Detects: Ø 0.0024" (0.06mm) minimum object	SA1C-FK SA1C-FK3G (not compatible with SA9F-DM75, SA9F-DM76)	2.36" (60mm) 0.16" (4mm)	**One Row** (DM74)  **Two and Three Rows** (DM75/76) 
SA9F-DH21 No sleeve **SA9F-DH22** 3.54" (90mm) sleeve (Both not compatible with green LED)	Heat-resistant glass: Two fibers Ø 0.03" (0.7mm) Threaded mount: Ø 0.16" (M4) Detects: Ø 0.0012" (0.03mm) minimum object	SA1C-FK3 SA1C-FK3G	1.06" (27mm) —	 

Measuring Conditions

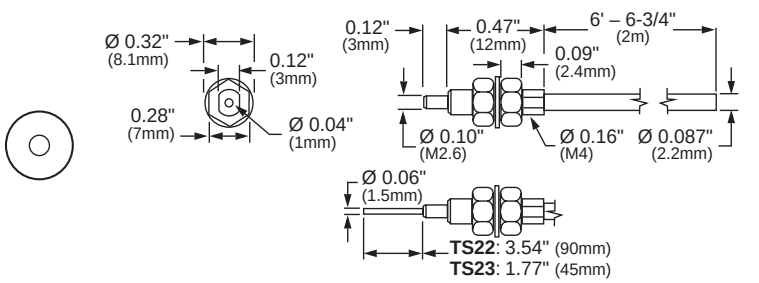
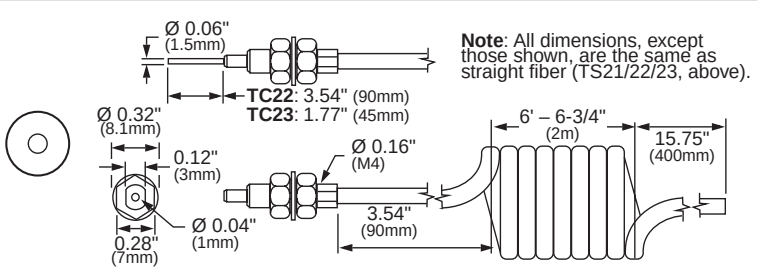
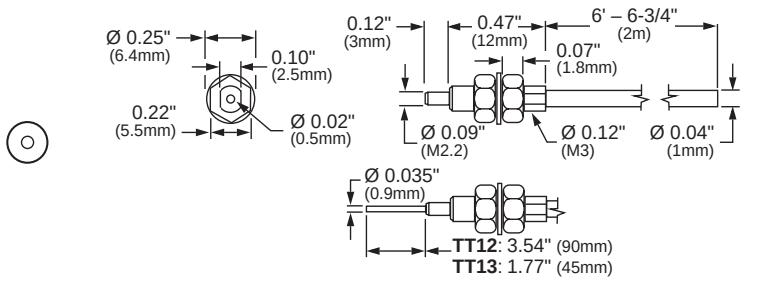
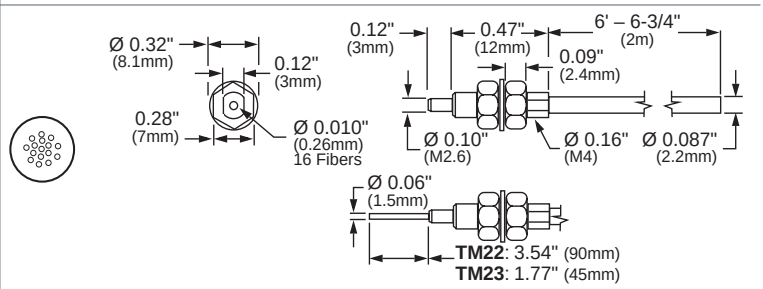
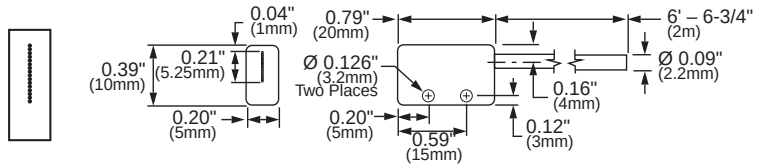
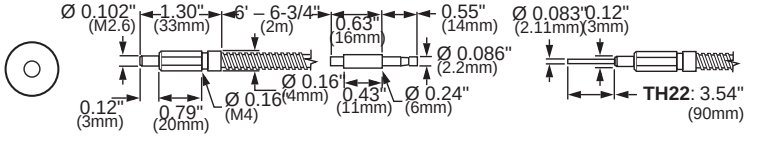
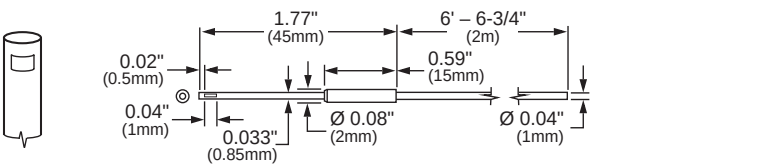
Amplier = Applicable Amplier

Range = Sensing Range
Sensing a 50 x 50mm piece of white paper

Minimum detectable object:
Sensing a copper-stranded wire with the SA1C-FK3

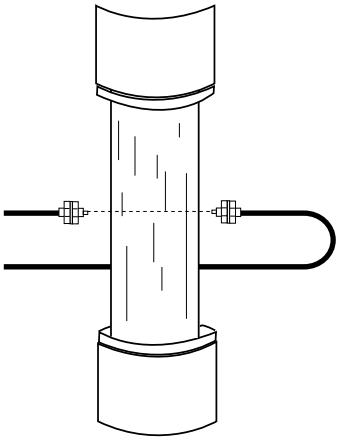
The sensing range varies depending upon the sensing conditions.

Part Numbers: SA9F Through-Beam Fiber Optic Units

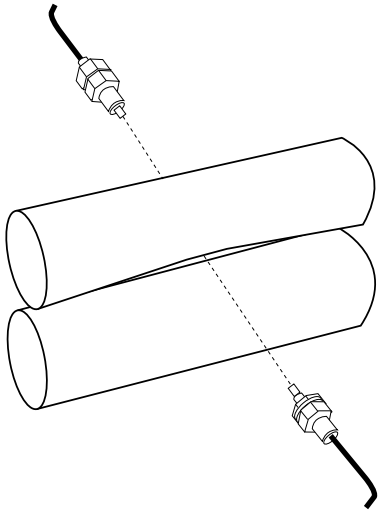
Part Number	Description	Amplifier	Range	Dimensions
SA9F-TS21 No sleeve **SA9F-TS22** 3.54" (90mm) sleeve **SA9F-TS23** 1.77" (45mm) sleeve	Straight ber: Ø 0.04" (1mm) Threaded mount: Ø 0.16" (M4) Detects: Ø 0.012" (0.3mm) minimum object	SA1C-FK3 SA1C-FK3G	7.09" (180mm) 0.63" (16mm)	
SA9F-TC21 No sleeve **SA9F-TC22** 3.54" (90mm) sleeve **SA9F-TC23** 1.77" (45mm) sleeve	Coiled ber: Ø 0.04" (1mm) Threaded mount: Ø 0.16" (M4) Detects: Ø 0.012" (0.3mm) minimum object	SA1C-FK3 SA1C-FK3G	5.91" (150mm) 0.55" (14mm)	
SA9F-TT11 No sleeve **SA9F-TT12** 3.54" (90mm) sleeve **SA9F-TT13** 1.77" (45mm) sleeve	Straight ber: Ø 0.02" (0.5mm) Threaded mount: Ø 0.12" (M3) Detects: Ø 0.006" (0.15mm) minimum object	SA1C-FK3 SA1C-FK3G	1.97" (50mm) 0.2" (5mm)	
SA9F-TM21 No sleeve **SA9F-TM22** 3.54" (90mm) sleeve **SA9F-TM23** 1.77" (45mm) sleeve	Multicore: 16 bers (cluster) Ø 0.010" (0.26mm) Threaded mount: Ø 0.16" (M4) Detects: Ø 0.012" (0.3mm) minimum object	SA1C-FK3 SA1C-FK3G	5.91" (150mm) 0.55" (14mm)	
SA9F-TM74 16 fibers in one row	Multicore: 16 bers (one row) Ø 0.010" (0.26mm) Detects: Ø 0.0024" (0.06mm) minimum object	SA1C-FK3 SA1C-FK3G	5.91" (150mm) 0.55" (14mm)	
SA9F-TH21 No sleeve **SA9F-TH22** 3.54" (90mm) sleeve	Heat-resistant glass ber: Ø 0.04" (1mm) Threaded mount: Ø 0.16" (M4) Detects: Ø 0.012" (0.3mm) minimum object	SA1C-FK3 SA1C-FK3G	3.94" (100mm) 0.31" (8mm)	
SA9F-TL53 (Not compatible with green LED)	Side view: one ber 0.02" (0.5mm) Optical axis at 90 Detects: Ø 0.0024" (0.06mm) minimum object	SA1C-FK3 SA1C-FK3G	1.57" (40mm) —	

Applications

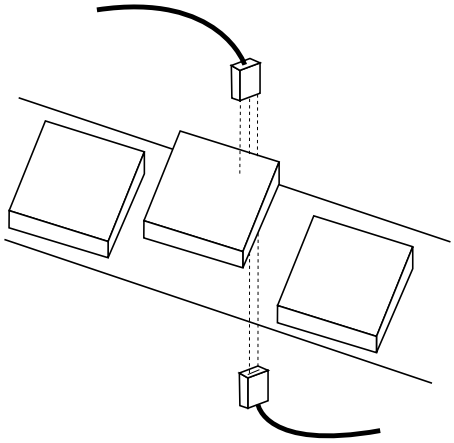
Monitoring the gradual change in liquid densities



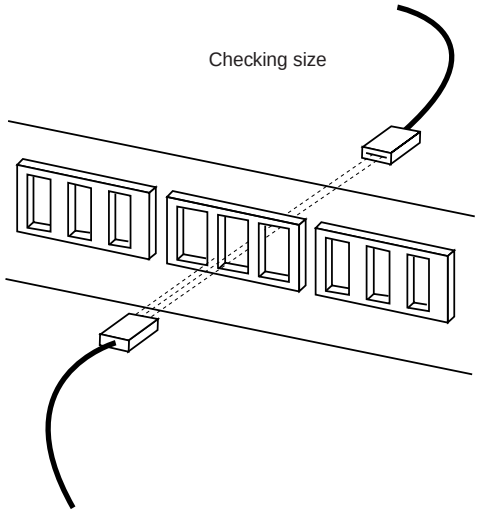
Detecting the roundness of rollers



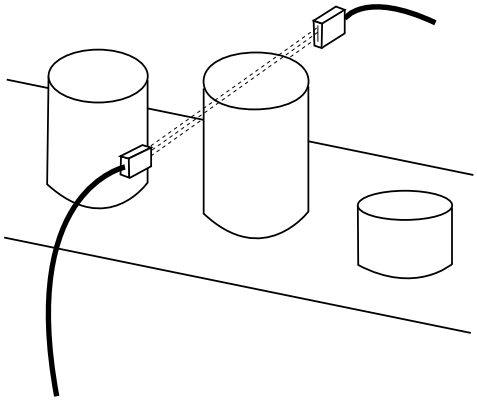
Sensing position or alignment



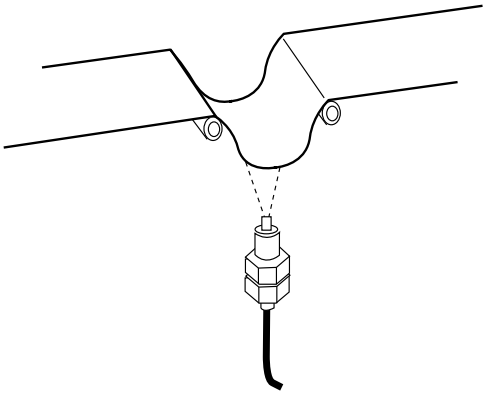
Checking size



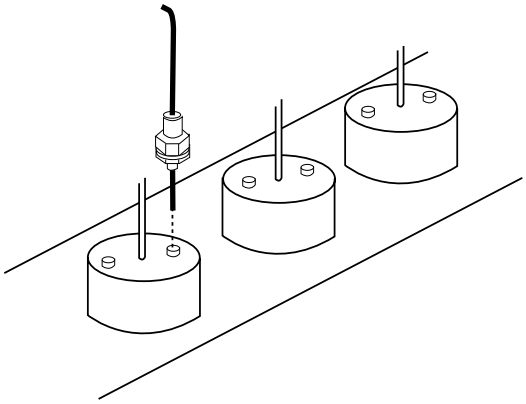
Checking height



Controlling web tension



Sensing color marks



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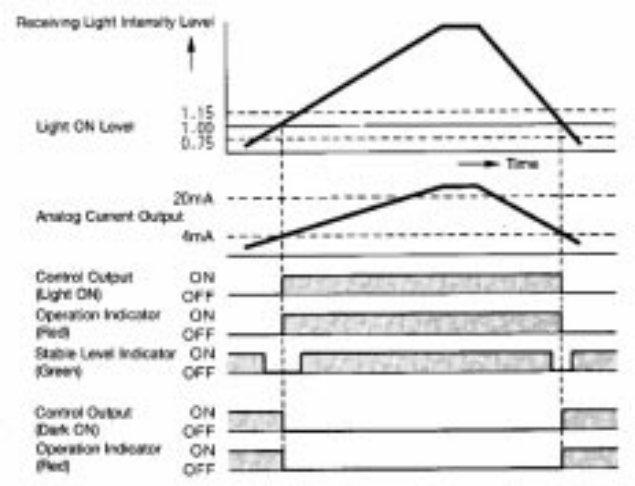
Operation

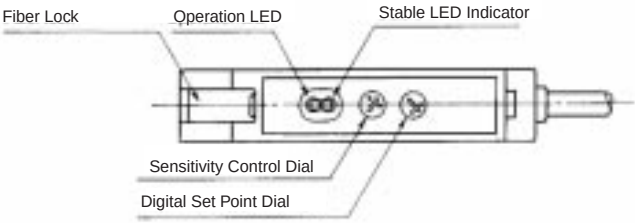
See page H-112 for general sensor instructions. Below are considerations specic to SA1C-FK photoelectric sensors.

The control output and red operation LED turn on when an object is detected (light on) or turn off when no object is detected (dark on).

Operation Chart



Indicators



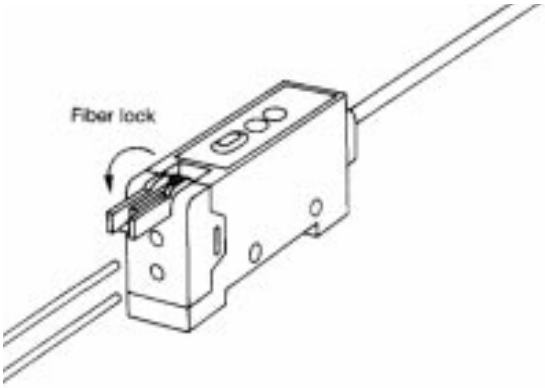
Operation and Stable Level Indicator

The operation LED and stable LED operate according to the intensity level of received light described below. Use the sensor in the stable incident or stable interruption mode.

			Light On	Dark On
Receiving Light Intensity Level	**Mode**	**Stable (Green)**	**Operational (Red)**	
Light ON Level ▶ 1.15	Stable incident	ON	ON	OFF
Light ON Level ▷ 1.00	Unstable incident	OFF		
Light ON Level ▶ 0.75	Unstable interruption		OFF	ON
	Stable interruption	ON		

Installation

Connecting Fiber Unit to Amplier



To install the ber unit: 1. Lift the ber lock using the attached screwdriver. 2. Then insert the ber unit into the amplier unit. 3. Lock the ber into place by pushing down the ber lock.

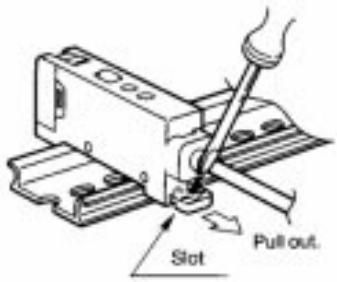
To remove the ber unit: Lift the ber lock, and pull the ber unit out.

To insert a coaxial b er unit, connect the ø 1-core ber to the pr ojector (lower) hole of the amplier unit.

Installing the Amplier Unit

The amplier unit can either be installed to the attached mounting bracket or a 35mm-wide DIN rail. Amplier units can be installed adjacently.

Removing the Amplier Unit



Insert a screwdriver into the slot in the spring latch, and pull the latch out. When installing the amplier unit using the mounting holes in the housing, the tightening torque should range from 0.5 to 0.8Nm (5 to 8kgfcm).

Installation, continued

Optical Alignment

When the analog output is used, install the ber unit in a position in which the analog value is equivalent to your desired value.

When digital output is used, follow the installation procedures below. (The optical alignment described below is for the light ON mode.)

Though-Beam Type
Face the emitter and receiver toward each other, and ensure proper alignment. When the emitter and receiver are aligned correctly, the operation LED (Red) turns ON.

When the receiving light intensity level is over 2.0, the stable LED (Green) turns on. When the receiving light intensity level is between 1.15 and 2.0, the stable LED ashes.

While monitoring the stable LED, mount the photoelectric sensor. Make sure that the operation LED turns OFF and the stable LED ashes at interruption.

Diffuse-Reex T ype
While detecting an object, ensure proper alignment between the sensor and the object. When the sensor and the object are aligned correctly, the operation LED (Red) turns ON.

When the receiving light intensity level is over 2.0, the stable LED (Green) turns on.

When the receiving light intensity level is between 1.15 and 2.0, the stable LED ashes. While monitoring the stable LED, mount the photoelectric sensor .

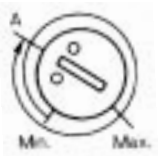
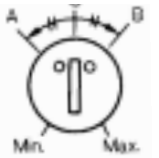
Make sure that the operation LED turns OFF and the stable LED ashes when an object is removed.

Sensitivity Adjustment

Analog Output
Analog output exceeding 20mA causes saturation. Too much received light impairs the relationship between the received light level and the analog output. To avoid this, turn the sensitivity control toward Min. to set your desired current value within 20mA.

Digital Output
When the reex type is affected by the background or when the through-beam type detects translucent or small objects, adjust the sensitivity as shown in the gure below . The sensitivity adjustment described below is for light ON mode. The sensitivity control dial has four degrees of sensitivity.

1. The SA1C-FK is initially set to the maximum sensitivity (4).

Step	Switch Status	Sensitivity Control	Adjustment Procedure
1	Receiving the Light Through-beam: Without object Reex: Without object		First, when receiving the light, turn the sensitivity control clockwise from the Min. position until the operation LED (Red) turns ON (Point A).
2	Not Receiving the Light Through-beam: With object Reex: Without object		Second, in the interruption status, turn the sensitivity control further clockwise until the operation LED (Red) turns on again (Point B).
3	—		Last, set the sensitivity control in the middle between A and B.

Digital Set Point Control

Digital output can be turned ON or OFF using the digital set point control dial according to the analog output. The digital set point control dial is initially set to Min. To change the analog current from 4mA to 20mA, turn the dial clockwise.

Power and Wiring

Use a power supply with minimal noise and inrush. Ensure that the ripple factor is within allowable limits.

When using a switching power supply, be sure to ground the FG (frame ground) terminal. If the FG terminal is not grounded, high-frequency noise will affect the photoelectric switch.

Wiring cable color conforms to IEC standard. Before wiring, verify that the cable colors conform to the connection diagram on the following page.

Parallel wiring with high-voltage or power lines in the same conduit is not recommended because of induction noise. When wiring is long, use a separate conduit.

Installation Notes

For digital output, two units can be installed in close proximity without interference. However, for analog output, close mounting is not possible. Allow sufcient clearance between units.

Do not use photoelectric switches in extremely dusty areas or areas subject to strong shocks or vibrations. In addition, do not use the sensor near the following:

- Induction machines and heat sources
- Oil and chemicals
- Corrosive gasses
- Water (for a long period of time)

Do not tighten the mounting screws excessively. Recommended tightening torque ranges from 0.5 to 0.8Nm (5 to 8kgfcm).

To ensure stable analog output, run a test operation for approximately 30 minutes. When the analog current exceeds 20mA, use the attached resistor (249Ω) or a 250Ω resistor with 1/4W or more allowable loss.

If the ber optic is damaged, cut the ber optic using a ber cutter or replace.

Do not use the switch in the transient state when turning power on (for 70ms).

The receiver should not be exposed to light from incandescent lamps.

Use a soft cloth dipped in alcohol to remove dust from the sensing area on the front of the sensor.

Make sure that vibration and shock do not exceed the rated range.

Turn power off before installation, removal, wiring, and maintenance.

Wiring

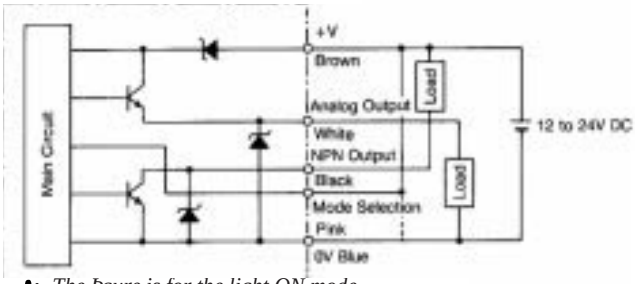
Follow the wiring procedure below for mode selection:

For light ON, connect the lead wire (pink) to +V (brown).

For dark ON, connect the lead wire (pink) to GND 0V (blue).

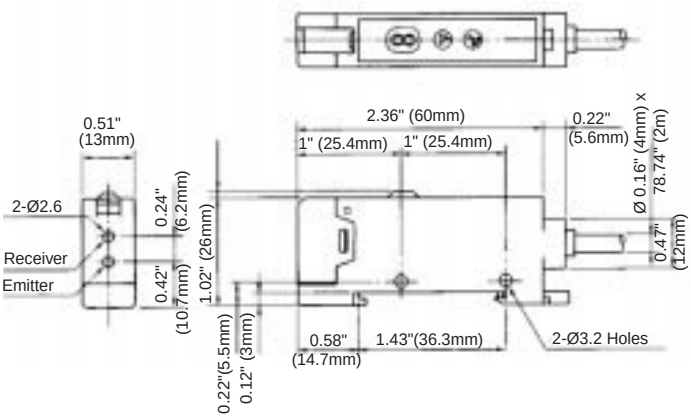
Schematics

Output Circuit & Connection Diagram
Analog Output + Digital Output (NPN Output)

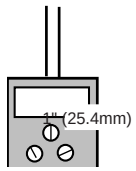


The figure is for the light ON mode.

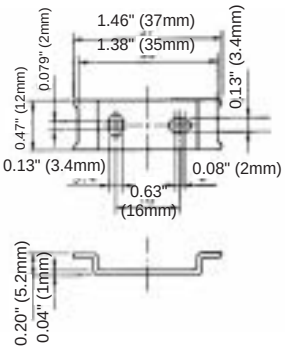
Dimensions



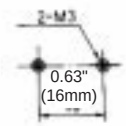
Mounting Hole Layout



Mounting Bracket (attachment)
Not Required for DIN Rail Mounting



Mounting Hole Layout

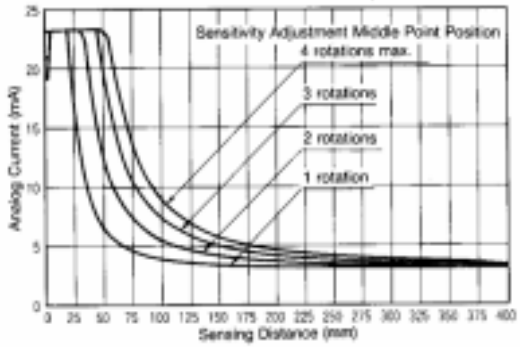


(when using a mounting bracket)

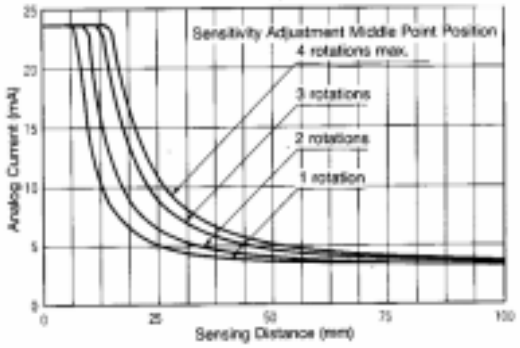
Sensing Characteristics

(1) Fiber unit: SA9F-TS21 (without a detected object)

SA1C-FK3 (Red LED)

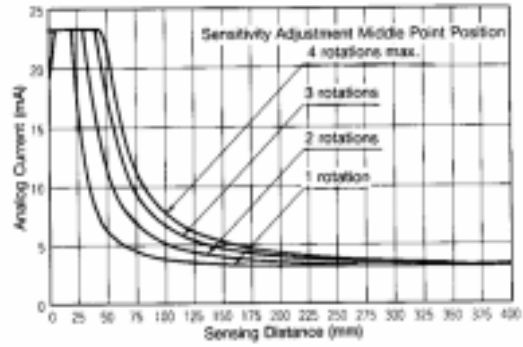


SA1C-FK3G (Green LED)

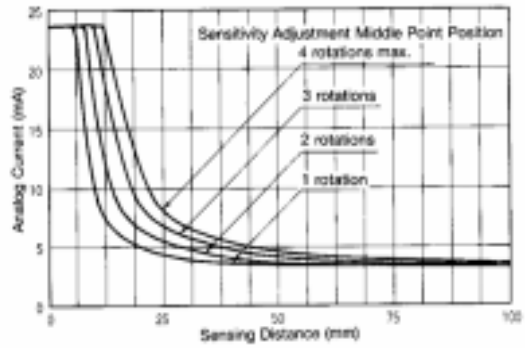


(2) Fiber unit: SA9F-TC21 (without detected object)

SA1C-FK3 (Red LED)

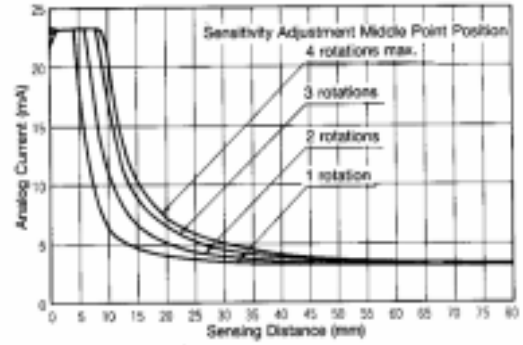


SA1C-FK3G (Green LED)

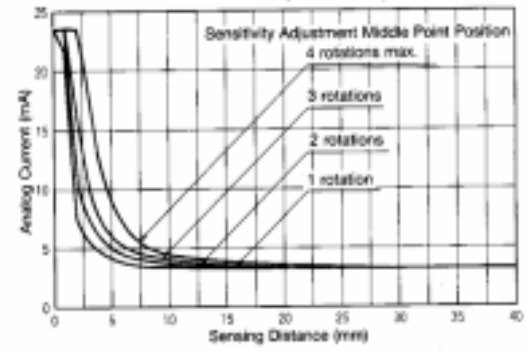


(3) Fiber unit: SA9F-TT12 (without detected object)

SA1C-FK3 (Red LED)

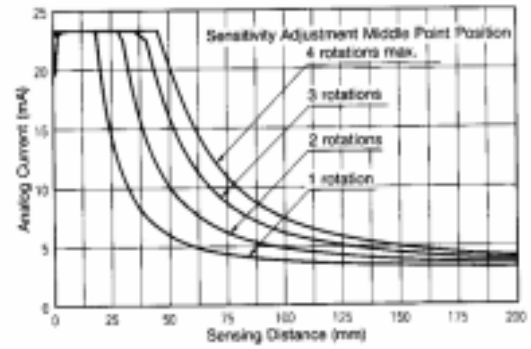


SA1C-FK3G (Green LED)

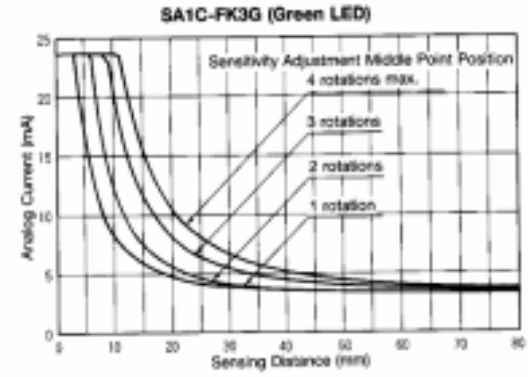


(4) Fiber unit: SA9F-TM74 (without detected object)

SA1C-FK3 (Red LED)



SA1C-FK3G (Green LED)

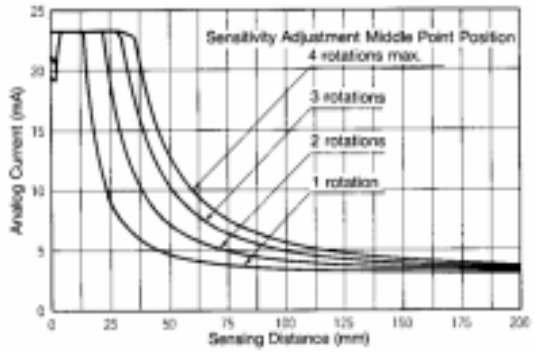


1. *Performance can be changed by a combination of amplier units and ber units.*
2. *Absolute value of analog output to sensing range cannot be ensured.*
3. *Measurement conditions—power voltage: 12V, operating temperature:25˚C, attached resistor (249Ω) is used.*

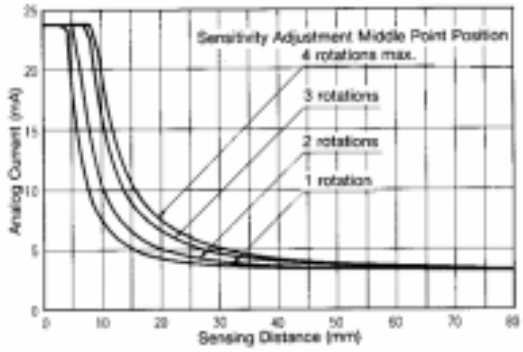
Sensing Characteristics, continued

(5) Fiber unit: SA9F-TH21 (without a detected object)

SA1C-FK3 (Red LED)

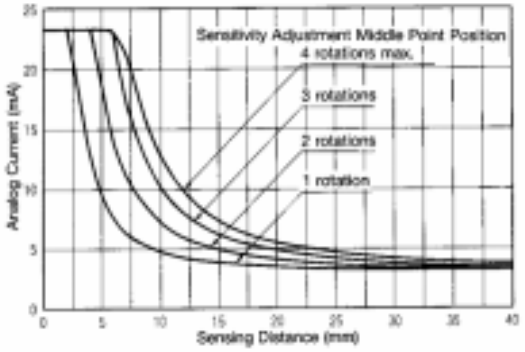


SA1C-FK3G (Green LED)

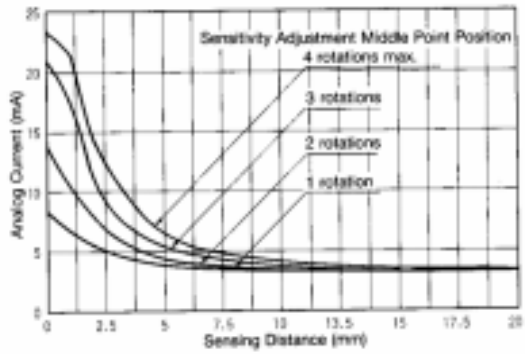


(6) Fiber unit: SA9F-TL53 (without a detected object)

SA1C-FK3 (Red LED)

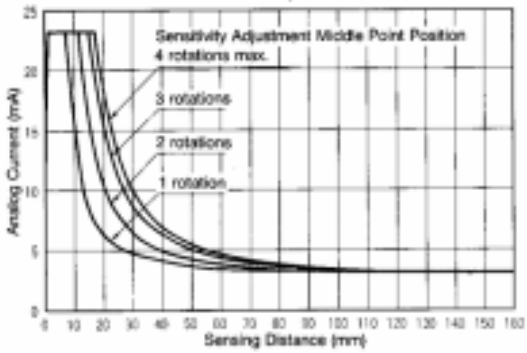


SA1C-FK3G (Green LED)

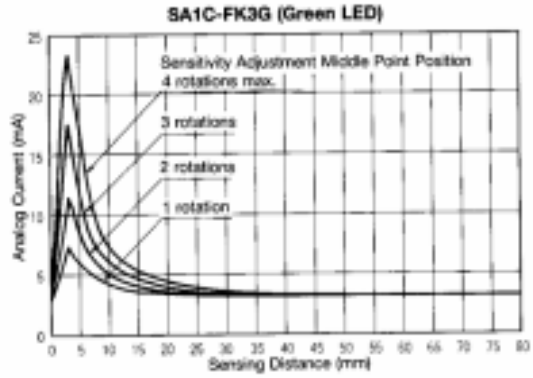


(7) Fiber unit: SA9F-DS31 (without detected object)

SA1C-FK3 (Red LED)

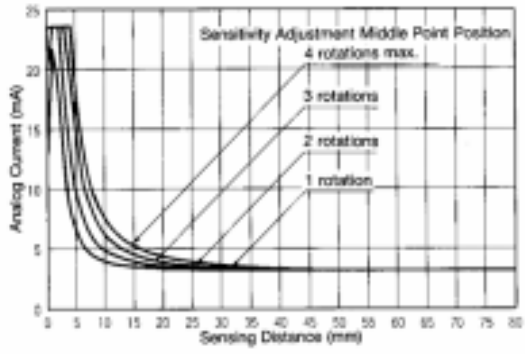


SA1C-FK3G (Green LED)



(8) Fiber unit: SA9F-DD31 (without detected object)

SA1C-FK3 (Red LED)



SA1C-FK3G (Green LED)