SA1C-F: High-Speed, Miniature Photoelectric Sensors with Fiber Optics

- Ideal for remote sensing applications
- Featuring quick-connect cable and easy-insert ber optic units for simple installation
- Through-beam and reected-light sensing available
- Sensing range up to 7.09" (180mm) for through-beam sensors
- Dual outputs: Select NPN and PNP transistor outputs or NPN transistor output combined with a self-diagnostic output
- Outputs selectable for light on or dark on
- High-speed, 50µs response time
- Featuring variable off-delay (0 to 100 ms) and ne-tune sensitivity adjustment
- Stable LED makes alignment easy
- Red or green LEDs available for detecting color marks
- Mount on a 1.378" (35mm) DIN rail
- Protection rated IP66

CE

General Specifications

Power Voltage	12V to 24V DC
Operating Voltage	10V to 30V DC, ripple 10% (maximum)
Current Draw	Standard speed: 30mA (maximum) High-speed: 40mA (maximum)
Operating Temperature	Amplier only: –25 to +55C Fiber optic cords (except heat-resistant types): –40 to +70C Heat-resistant ber optic cords: –40C to +350C (avoid ice coating)
Operating Humidity	35 to 85% RH (avoid condensation)
Extraneous Light Immunity	Sunlight: 10,000 lux (maximum); Incandescent light: 3,000 lux (maximum) on receiver surface— dened as incident or unwanted light received by a sensor , unrelated to the presence or absence of the intended object
Material	Amplier only: PBT resin (housing) with polycarbonate lens Fiber optic cords (except heat-resistant types): Nickel-plated brass (sensing head), polyethylene-covered PMMA (cord), and SUS304 stainless (sleeve) Heat-resistant ber optic cords: SUS 304 stainless (sensing head) and SUS spiral tube around glass ber cord
Degree of Protection	IP66 — IEC Pub 529, sensors rated IP66 are dust-tight, water-resistant, and perform best when not subjected to heavy particle or water blasts
Cable	Cable type: 0.2mm^2; Vinyl cabtyre cable #24 AWG, 6'–6-3/4' (2m) long Connector type: Ø 0.31" (8mm) 3- or 4-pin connector (cable ordered separately for quick connect sensors)
Light Source	Red or green LED (pulse-modulated)
Output	NPN transistor: 30V DC (1.2V residual), 100mA (maximum) PNP transistor: 30V DC (2.0V residual), 200mA (maximum) Self-diagnostic: 30V DC (1.2V residual), 50mA (maximum)
Response	Standard-speed: 0.5ms (maximum) High-speed: 50µs (maximum)
Off Delay	0 to 100 ms (adjustable)
Sensitivity	4-turn adjustment
Minimum Bending Radius	Fiber optic cord (except SA9F-TT, -DT, -TL, and -DL): 1"R (25mm); Sleeve: 0.39"R (10mm) SA9F-TT and -DT: 0.59"R (15mm); Sleeve: 0.39"R (10mm) SA9F-TL and DL: 0.59"R (15mm); Sleeve: Unbendable

Function Specifications

	SA1C-FN, -FD (standard speed)	**SA1C-F1N, -F1D (high-speed)**
Operation Mode	Light on or dark on (selectable by switch on amplier)	
Indicator	Operation indicator: Red LED (out) Stable level indicator: Green LED (stable)	
Noise Resistance	Normal mode: 500V Common mode: 300V Pulse width: 50ns –1us, 100Hz (using a noise simulator)	Normal mode: 300V Common mode: 150V Pulse width: 50ns –1us, 100Hz (using a noise simulator)
Storage Temperature	–30 to +70C (avoid freezing)	
Insulation Resistance	20M minimum with 500V DC megger (between live and dead parts)	
Dielectric Strength	1000V, 1 minute (between live and dead parts)	
Vibration Resistance	Damage limits: 10 – 55Hz Amplitude: 1.5mm p-p, 20 cycles in each of 3 axes crossed (one cycle = 5 minutes)	
Shock Resistance	Damage limits: 500m/S2 (approximately 49G), 10 shocks in each of 3 axes	
Weight	Cable type: Approximately 75g Quick-connect type: Approximately 30g	

Part Numbers: SA1C-F Fiber Optic Sensors

Amplifier Part Number	Output	Light Source	Response	Through-Beam Units Part Number	Range	Diffuse-Reflected Units Part Number	Range
SA1C-FN3E (Cable) **SA1C-FN3EC** (Quick-Connect)	30V DC NPN transistor: 100mA (maximum) Self-diagnostic: 50mA (maximum)	Red LED	Standard speed: 0.5 ms	**SA9F-TS**: Ø 0.16" (M4) Straight **SA9F-TC**: Ø 0.16" (M4) Coiled **SA9F-TT**: Ø 0.12" (M3) Straight **SA9F-TM**: Ø 0.16" (M4) Multicore **SA9F-TH**: Heat-resistant glass ber **SA9F-TL**: Side view	7.09" (180mm) 5.91" (150mm) 1.97" (50mm) 5.91" (150mm) 3.94" (100mm) 1.57" (40mm)	**SA9F-DS**: Ø 0.24" (M6) Straight **SA9F-DC**: Ø 0.24" (M6) Coiled **SA9F-DD**: Ø 0.24" (M6) Coaxial **SA9F-DT**: Ø 0.12" (M3) Straight **SA9F-DM**: Ø 0.01" (0.26mm) Multicore **SA9F-DH**: Heat-resistant glass ber **SA9F-DL**: Side view	2.36" (60mm) 0.98" (25mm) 2.36" (60mm) 0.79" (20mm) 2.36" (60mm) 1.06" (27mm) 0.39" (10mm)
SA1C-FD3F (Cable) **SA1C-FD3FC** (Quick-Connect)	30V DC NPN transistor: 100mA (maximum) PNP transistor: 200mA (maximum)						
SA1C-FN3EG (Cable) **SA1C-FN3EGC** (Quick-Connect)	30V DC NPN transistor: 100mA (maximum) Self-diagnostic: 50mA (maximum)	Green LED	Standard speed: 0.5 ms	**SA9F-TS**: Ø 0.16" (M4) Straight **SA9F-TC**: Ø 0.16" (M4) Coiled **SA9F-TT**: Ø 0.12" (M3) Straight **SA9F-TM**: Ø 0.16" (M4) Multicore **SA9F-TH**: Heat-resistant glass ber **SA9F-TL**: Incompatible with green LED	0.63" (16mm) 0.55" (14mm) 0.20" (5mm) 0.55" (14mm) 0.31" (8mm) N/A	**SA9F-DS**: Ø 0.24" (M6) Straight **SA9F-DC**: Incompatible with green LED **SA9F-DD**: Ø 0.24" (M6) Coaxial **SA9F-DT**: Incompatible with green LED **SA9F-DM**: Ø 0.01" (0.26mm) Multicore **SA9F-DH**: Incompatible with green LED **SA9F-DL**: Incompatible with green LED	0.28" (7mm) N/A 0.28" (7mm) N/A 0.16" (4mm) N/A N/A
SA1C-FD3FG (Cable) **SA1C-FD3FGC** (Quick-Connect)	30V DC NPN transistor: 100mA (maximum) PNP transistor: 200mA (maximum)						
SA1C-F1N3E (Cable) **SA1C-F1N3EC** (Quick-Connect)	30V DC NPN transistor: 100mA (maximum) Self-diagnostic: 50mA (maximum)	Red LED	High-speed: 50 µs	**SA9F-TS**: Ø 0.16" (M4) Straight **SA9F-TC**: Ø 0.16" (M4) Coiled **SA9F-TT**: Ø 0.12" (M3) Straight **SA9F-TM**: Ø 0.16" (M4) Multicore **SA9F-TH**: Heat-resistant glass ber **SA9F-TL**: Side view	1.97" (50mm) 1.57" (40mm) 0.59" (15mm) 1.57" (40mm) 1.18" (30mm) 0.51" (13mm)	**SA9F-DS**: Ø 0.24" (M6) Straight **SA9F-DC**: Ø 0.24" (M6) Coiled **SA9F-DD**: Ø 0.24" (M6) Coaxial **SA9F-DT**: Ø 0.12" (M3) Straight **SA9F-DM**: Ø 0.01" (0.26mm) Multicore **SA9F-DH**: Heat-resistant glass ber **SA9F-DL**: Side view	0.79" (20mm) 0.28" (7mm) 0.79" (20mm) 0.24" (6mm) 0.71" (18mm) 0.28" (7mm) 0.12" (3mm)
SA1C-F1D3F (Cable) **SA1C-F1D3FC** (Quick-Connect)	30V DC NPN transistor: 100mA (maximum) PNP transistor: 200mA (maximum)						

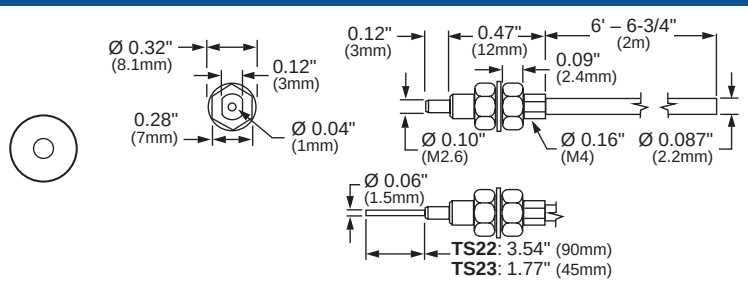
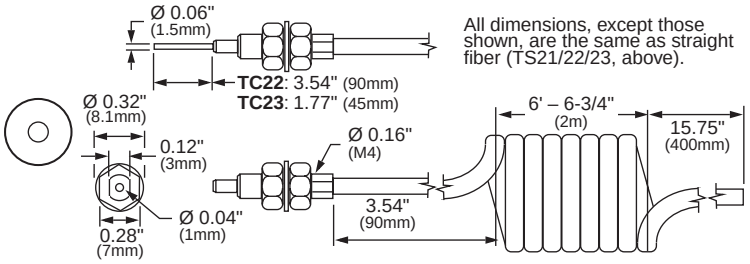
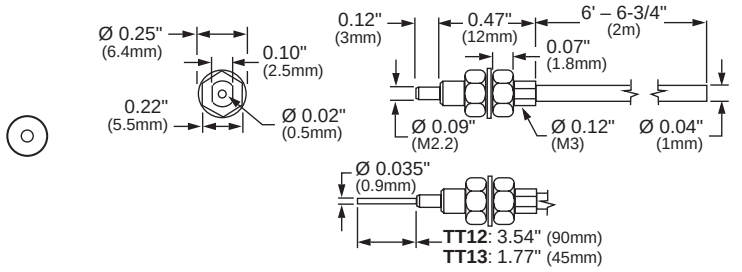
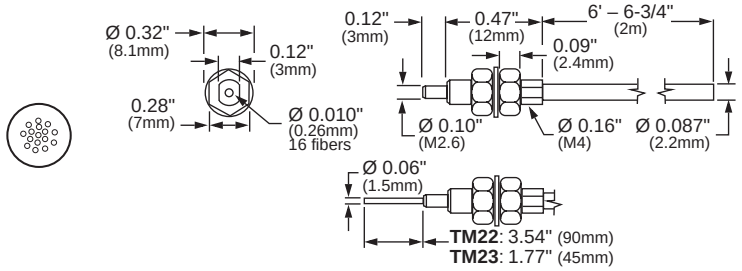
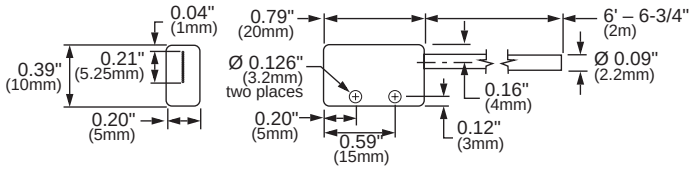
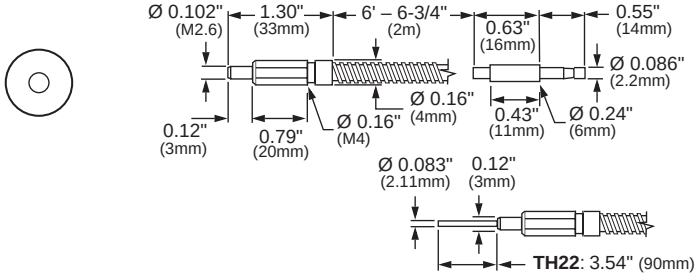
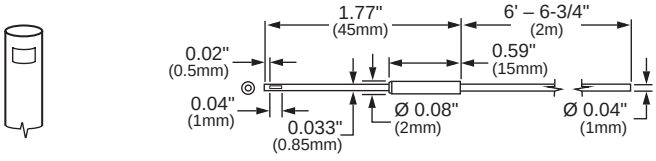
Ordering Details

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

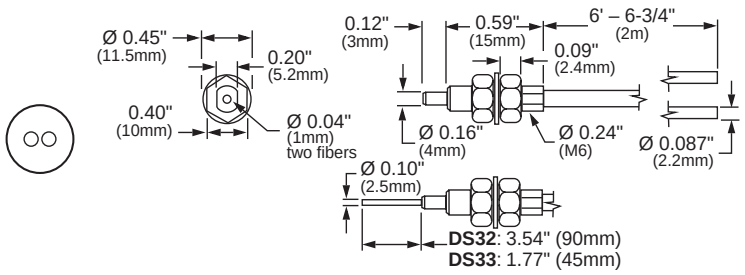
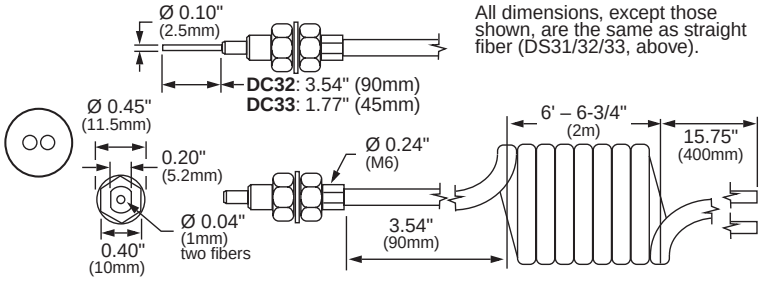
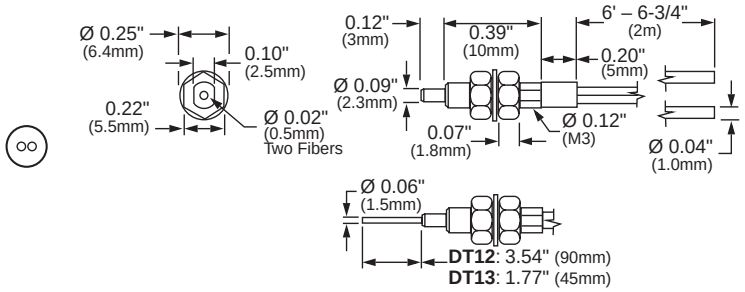
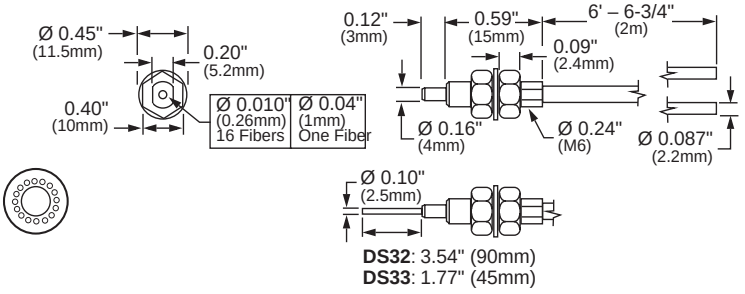
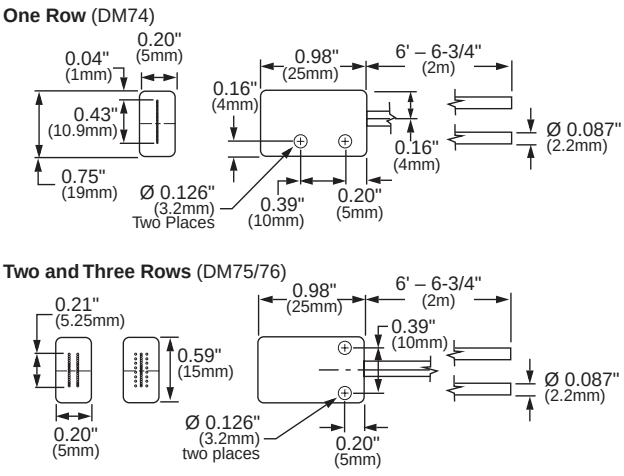
Amplier/receiver units include a mounting bracket, screws, and a screwdriver . Cables for quick-connect sensors are ordered separately. Optional attachments, available for modifying beam size of through-beam sensors, are also ordered separately.

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

Part Numbers: SA9F Through-Beam Fiber Optic Units

Part Number	Description	Dimensions	Appearance
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		
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		
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		
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		
SA9F-TM74 16 bers in one row	Multicore: 16 bers (one row) Ø 0.010" (0.26mm) Detects: Ø 0.0024" (0.06mm) minimum object		
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		
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		

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

Part Number	DESCRIPTION	Dimensions	Appearance
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		
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		
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		
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		
SA9F-DM74 1 row = 32 bers **SA9F-DM75** 2 rows = 16 each (Not compatible with green LED) **SA9F-DM76** 3 rows = 16 center + 8 bers each side (not compatible with green LED)	Multicore: 32 bers Ø 0.010" (0.26mm) Detects: Ø 0.0024" (0.06mm) minimum object		

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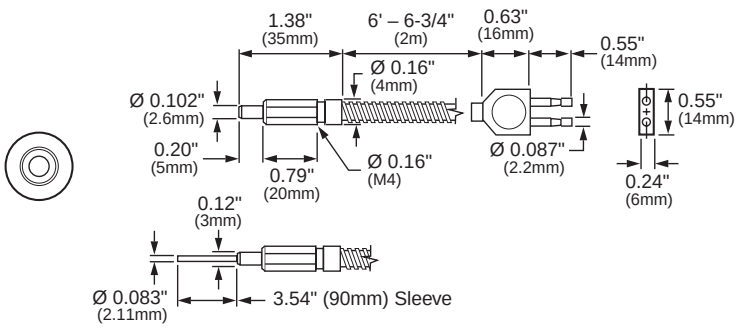
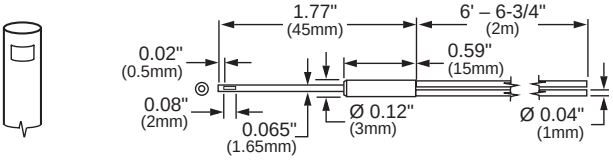
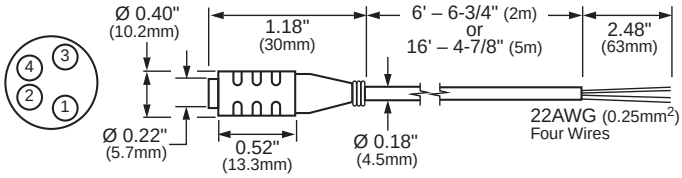
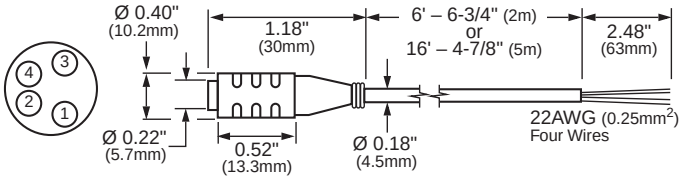
Part Numbers: SA9F Diffuse-Reect ed Light Fiber Optic Units, continued

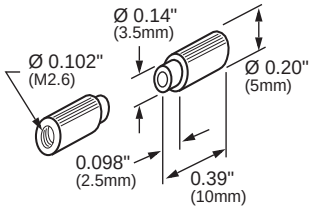
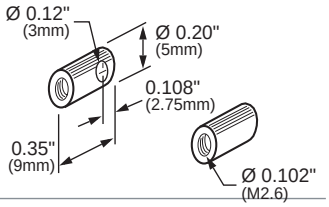
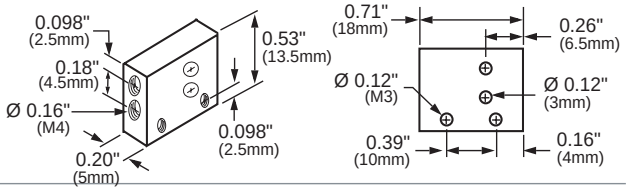
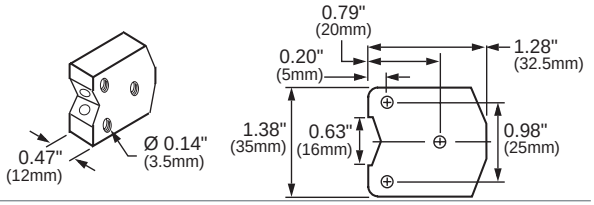
Part Number	Description	Dimensions	Appearance
SA9F-DH21 No sleeve **SA9F-DH22** 3.54" (90mm) sleeve (both not compati- ble with green LED)	Heat-resistant glass: Two fibers Ø 0.03" (0.7mm) Threaded mount: Ø 0.16" (M4) Detects: Ø 0.0012" (0.03mm) minimum object		
SA9F-DL63 (not compatible with green LED)	Side view: Two bers Ø 0.02" (0.5mm) Optical axis at 90 Detects: Ø 0.0012" (0.03mm) minimum object		

Part Numbers: Accessories

Part Number	Description	Used With	Dimensions
SA9C-CA4D2	4-core cable with connector 6'–6-3/4" (2m)	SA1C-F quick-connect only, NPN and PNP outputs	
SA9C-CA4D5	4-core cable with connector 16'–4-7/8" (5m)		
SA9C-CA4D2S	4-core cable with connector 6'–6-3/4" (2m)	SA1C-F quick-connect only, NPN and self-diagnostic outputs	
SA9C-CA4D5S	4-core cable with connector 16'–4-7/8" (5m)		
SA9Z-F01	Fiber cutter	All ber units except heat resistant	HxLxD: 0.91" x 1.77" x 0.31" (23x 45 x 8Dmm) Included with ber units; order replacement only
SA9Z-F02	Set of 2 easy-insert adaptors	SA9F-TT, SA9F-TL, SA9F-DT, and SA9F-DL	Ø 0.087" (OD) x 0.945" long (Ø 2.2mm x 24mm) Included with applicable ber optic units; order replacement set only

(continued on following page)

Part Numbers: Accessories, continued

Part Number	Description	Used With	Dimensions
SA9Z-F11	Lens attachment for long-range detection of opaque objects, minimum size: Ø 0.14" (3.5mm)	SA1C-F through-beam ber unit only Sensing ranges: Standard speed red LED: SA9F-TS21: 4' – 3-3/16" (1.3m) 5.31" (0.135m) SA9F-TC21: 3' – 3-3/8" (1m) 3.94" (0.1m) SA9F-TM21: 3' – 5-3/8" (1.05m) 5.12" (0.13m) Sensing ranges: Standard speed green LED: SA9F-TS21: 5.31" (0.135m) SA9F-TC21: 3.94" (0.1m) SA9F-TM21: 5.12" (0.13m) Sensing ranges:High-speed red LED: SA9F-TS21: 5.75" (0.4m) SA9F-TC21: 1.81" (0.3m) SA9F-TM21: 4.96" (0.38m)	
SA9Z-F12	Side view attachment to rotate axis by 90 for detection of opaque objects, minimum size: Ø 0.14" (3.5mm)	SA1C-F through-beam ber unit only Sensing ranges: Standard speed red LED: SA9F-TS21: 7.87" (200mm) SA9F-TC21: 5.12" (130mm) SA9F-TM21: 6.30" (160mm) Sensing ranges: High-speed red LED: SA9F-TS21: 1.97" (50mm) SA9F-TC21: 1.38" (35mm) SA9F-TM21: 1.57" (40mm)	
SA9Z-F13	Side-on attachment for narrow clearance, Range: 1.26" (32mm), for detection of transparent or opaque objects	SA1C-F diffuse-reected light ber unit only Sensing ranges: Standard speed red LED: SA9F-TS21: 1.38" (35mm) SA9F-TC21: 1.81" (30mm) SA9F-TM21: 1.38" (35mm)	
SA9Z-F14	Attachment for high-accuracy: Range: 0.4" ± 0.04" (10mm ± 1mm), for detection of transparent or opaque objects	SA1C-F through-beam ber unit only Sensing ranges: Standard speed red LED: SA9F-TS21: SA9F-TC21: SA9F-TM21: 0.394" ± 0.039" (10mm ± 1mm)	

Detecting Color Marks

Color of Mark	Background Color										
❑ = Use Red LED ☆ = Use Green LED ◆ = Use Red or Green LED — = Not Detectable	White	Yellow	Chartreuse	Orange	Red	Magenta	Turquoise	Blue	Violet	Green	Black
White	—	☆	◆	☆	☆	◆	◆	◆	◆	◆	◆
Yellow	☆	—	◆	☆	☆	☆	◆	◆	◆	◆	◆
Chartreuse	◆	◆	—	❑	❑	☆	❑	◆	☆	◆	◆
Orange	☆	☆	❑	—	—	☆	❑	◆	◆	◆	◆
Red	☆	☆	❑	—	—	❑	❑	◆	◆	◆	◆
Magenta	◆	☆	☆	☆	❑	—	❑	❑	—	❑	◆
Turquoise	◆	◆	❑	❑	❑	❑	—	❑	◆	☆	◆
Blue	◆	◆	◆	◆	◆	❑	❑	—	❑	❑	❑
Violet	◆	◆	☆	◆	◆	—	◆	❑	—	❑	❑
Green	◆	◆	◆	◆	◆	❑	☆	❑	❑	—	❑
Black	◆	◆	◆	◆	◆	◆	◆	❑	❑	❑	—

Operation Principle

SA1C-F: Through-Beam and Diffuse-Reect ed Light Sensors

The SA1C-F series features red or green LEDs — also useful for color mark detection as outlined in the table on page H-86.

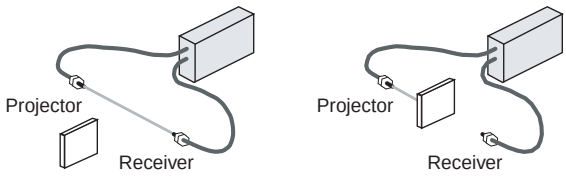
Through-beam sensors transmit light from the projector to the receiver. Through-beam sensors provide the most reliable detection of opaque objects. The output is selectable:

- In the presence of an object → dark on
- In the absence of an object → light on

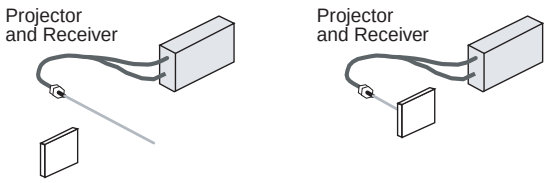
Diffuse-reected light sensors feature a built-in projector and receiver . The sensor detects scattered light reected from an object. This makes it perfect for detecting transparent objects. Since a separate receiver or reective backplate is not required, wiring is reduced and installation is simplied. The output is selectable:

- In the presence of an object → light on
- In the absence of an object → dark on

Through-Beam Sensors



Diffuse-Reflected Light Sensors



Operation

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

Control output and red operation LED turn on when an object is detected (light on) or turn off when not detected (dark on).

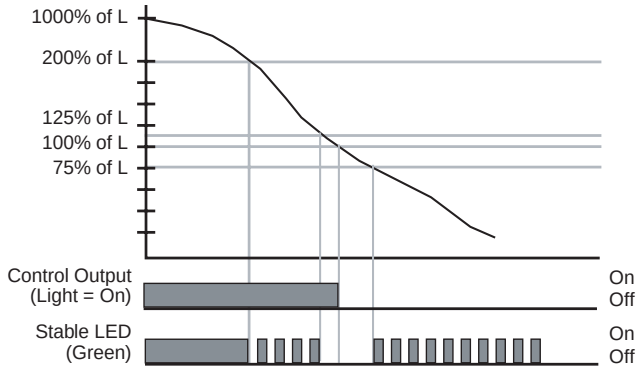
Do not operate the sensor for approximately 20ms after turning the power on to prevent a transient state.

Green stable LED ashes when incident light is stable, without interruption, and is less than 75% of the light-on level. When incident light becomes unstable, uctuates, or exceeds 115% of the light-on level, the stable LED turns off. Whenever the light intensity received exceeds 200% of the light-on level, the stable LED turns on and stays on as long as this condition exists.

When a unit includes a self-diagnostic output, the output turns on when unstable incident light continues for 0.3 second or more after the stable LED turns off. The self-diagnostic output can be used as an alert to adverse effects resulting from a dirty lens, optical misalignment, and background changes. The self-diagnostic output turns off when stable operation resumes (stable LED on).

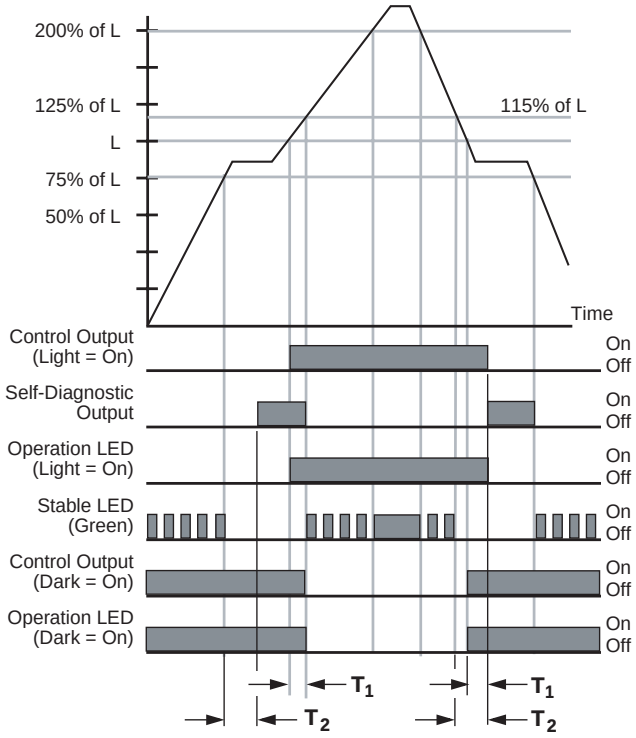
Intensity Monitor for Light Received

L = Light-on level



Timing Diagram

T_1: Off-delay time (adjustable, 0 to 100ms)
T_2: 0.3 sec or more (self-diagnostic output only)
L = Light-on level



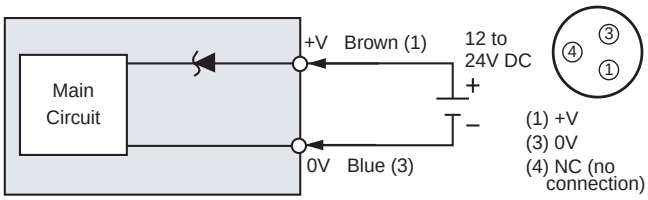
Installation

See page H-113 for general sensor instructions. Below are considerations specic to SA1C-F photoelectric sensors.

Schematics: Through-Beam Sensors

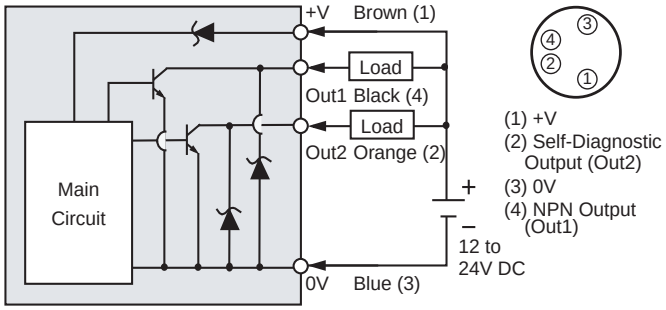
The schematics for the through-beam sensor (below), applies to NPN, PNP, and self-diagnostic outputs.

Either Combination of Outputs

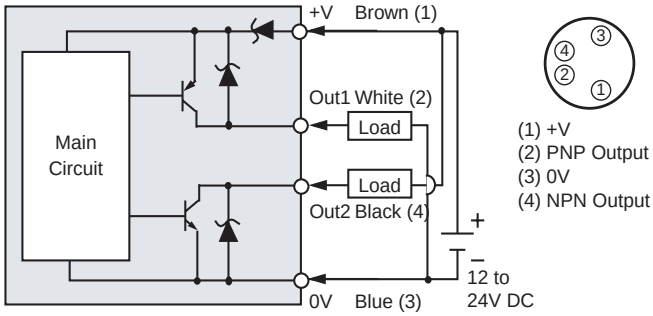


Schematics: Reect ed-Light Sensors

NPN and Self-Diagnostic Outputs

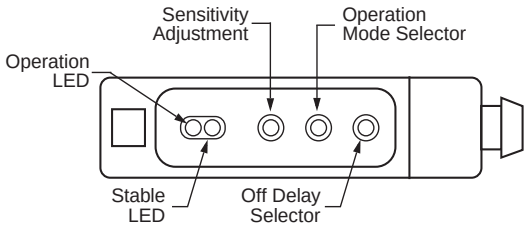


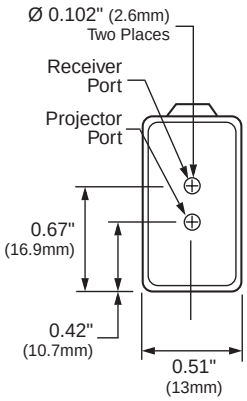
NPN and PNP Outputs



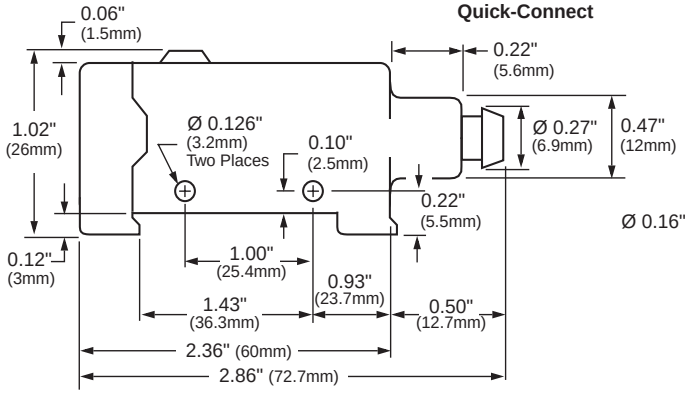
Dimensions

SA1C-F Series Amplifier Unit

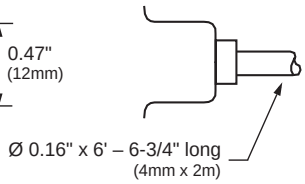




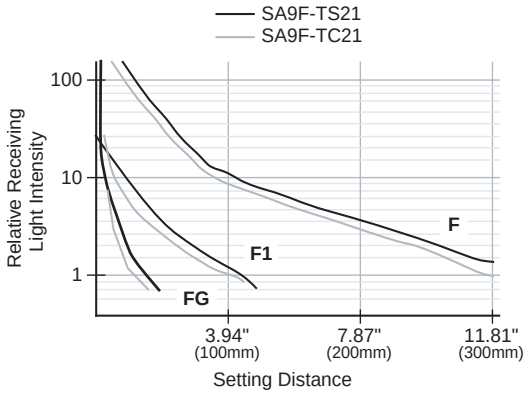
Quick-Connect



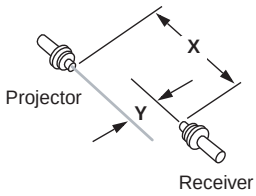
Cable Style



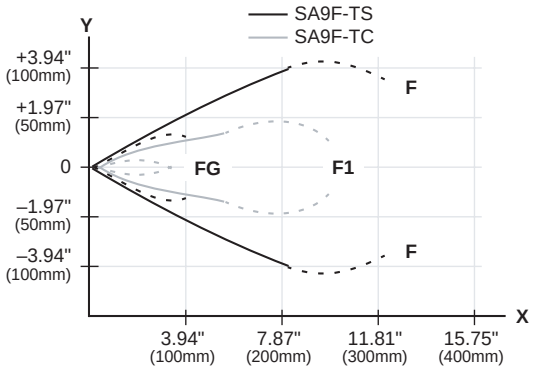
Sensing Characteristics: Through-Beam Fiber Optic Sensors

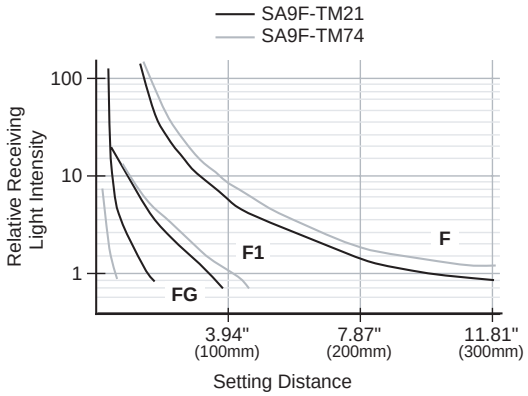


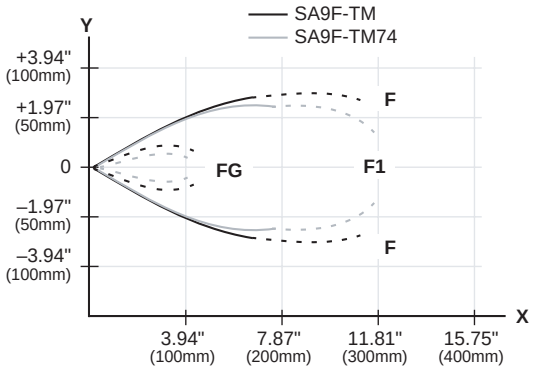
Alignment

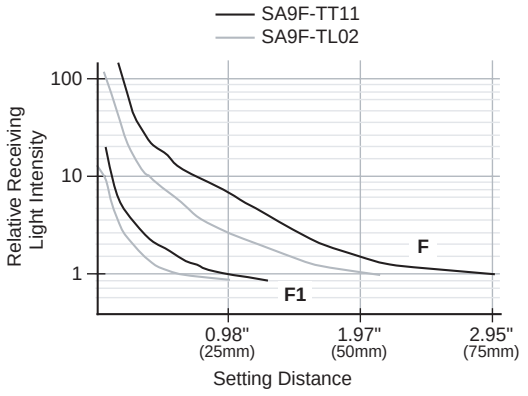


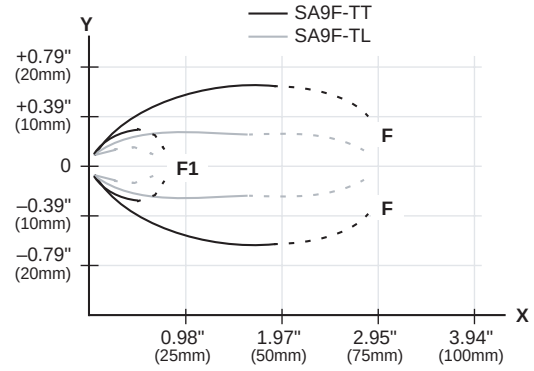
F	Standard Speed Red LED
FG	Standard Speed Green LED
F1	High-Speed Red LED

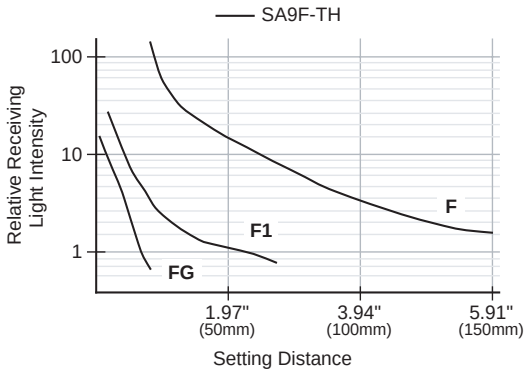


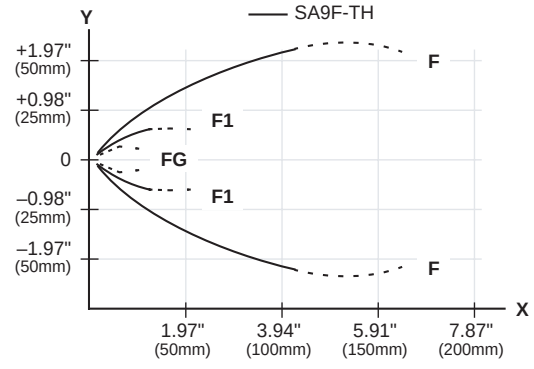




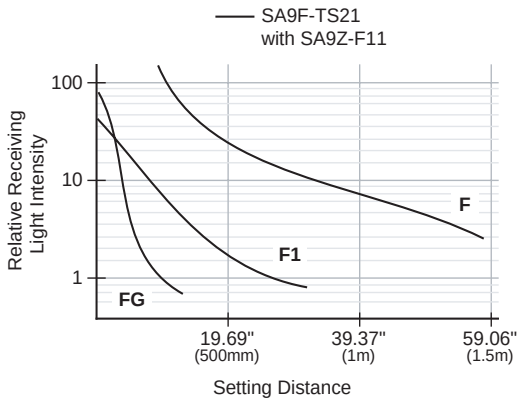




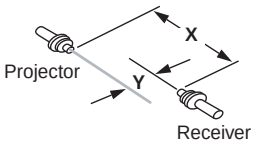




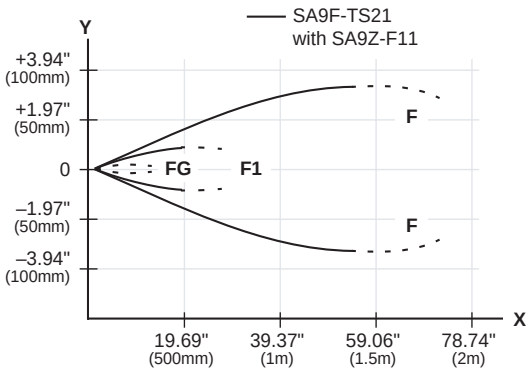
Sensing Characteristics: Through-Beam Fiber Optics with Attachments

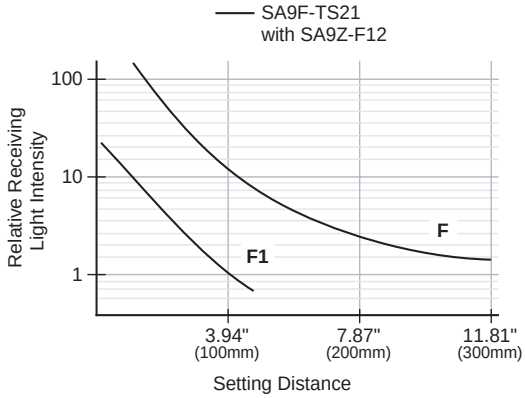


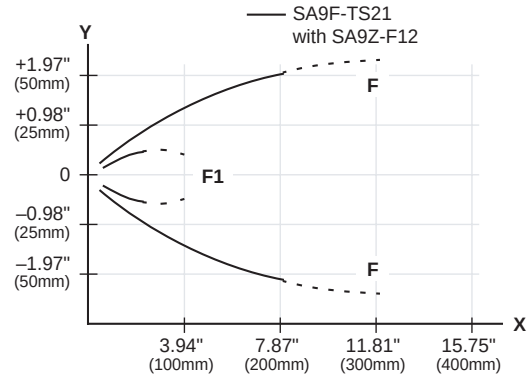
Alignment

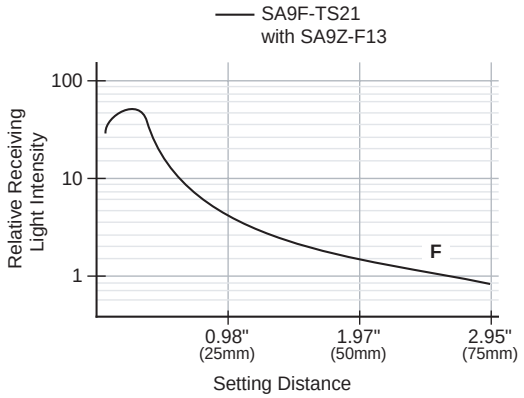


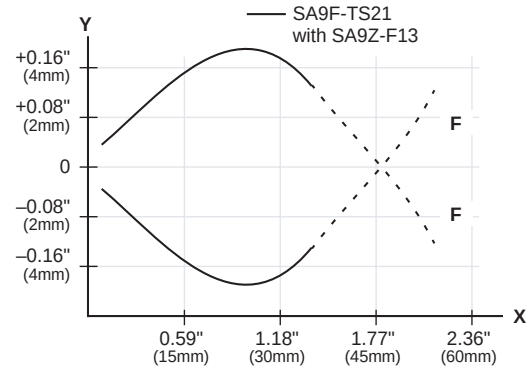
F	Standard Speed Red LED
FG	Standard Speed Green LED
F1	High-Speed Red LED

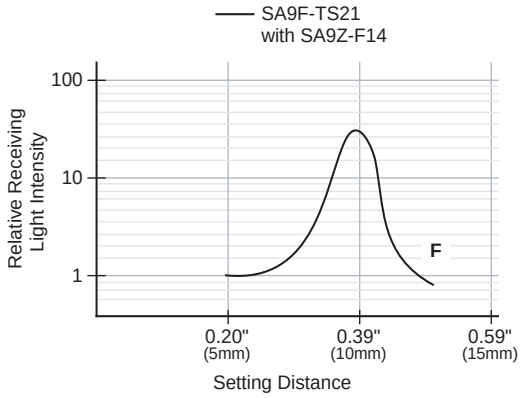




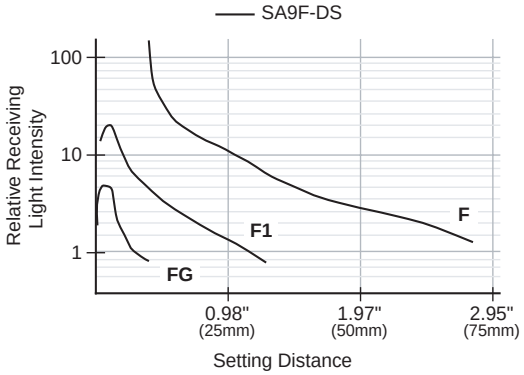


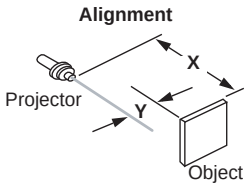






Sensing Characteristics: Diffuse-Reect ed Light Fiber Optic Units





F	Standard Speed Red LED
FG	Standard Speed Green LED
F1	High-Speed Red LED