BANNER®
the photoelectric specialist

D10 *Expert*™ – Analog and Discrete Outputs

Advanced sensor for use with plastic fiber optics

D10 *Expert* Features

- Easy-to-set automatic Expert-style TEACH options* including static, dynamic, and single-point programming plus manual adjustment for fine-tuning
- 16-bit microcontroller and 12-bit Analog-to-Digital converter for high-performance, low-contrast sensing
- Easy-to-read 4-digit display for TEACH and signal strength readout, plus indicators for a continuous readout of operating status (user configurable)
- Models available with one scalable Analog output (4-20 mA or 0-10V) and one Discrete output (PNP or NPN)
- Four-mode power and speed selection with automatic cross-talk avoidance circuitry
- Selectable OFF-delay options
- Gate input wire can be used to selectively inhibit sensor outputs from switching
- Models available with visible red (680 nm) or visible green (525 nm) sensing beam
- Models available with 2 m or 9 m (6.5' or 30') cable or integral quick-disconnect
- Sleek, ultra-slim 10 mm housing, mounts to a standard 35 mm DIN rail

* U.S. Patent #5,808,296

D10 *Expert* Models

Models		Cables*	Discrete Output	Analog Output
Red Beam	Green Beam			
D10INFP	**D10INFPG**	2 m (6.5') Cable	NPN	4-20 mA
D10INFPQ	**D10INFPGQ**	6-pin Pico-style QD		
D10IPFP	**D10IPFPG**	2 m (6.5') Cable	PNP	
D10IPFPQ	**D10IPFPGQ**	6-pin Pico-style QD		
D10UNFP	**D10UNFPG**	2 m (6.5') Cable	NPN	0-10V
D10UNFPQ	**D10UNFPGQ**	6-pin Pico-style QD		
D10UPFP	**D10UPFPG**	2 m (6.5') Cable	PNP	
D10UPFPQ	**D10UPFPGQ**	6-pin Pico-style QD		

*9 m (30') cables are available by adding suffix "**W/30**" to the model number of any cabled sensor (e.g., **D10INFP W/30**). A model with a QD connector requires a mating cable (see page 14).

D10 *Expert* Description

The D10 *Expert* Sensor is a high-performance plastic fiber-optic sensor whose many configuration (TEACH-mode) options make it suitable for demanding applications. Even with all its features, it is extremely easy to use. Advanced 16-bit microcontroller technology makes this possible.

The D10 *Expert* provides high-performance sensing in low-contrast applications, with its *Expert* TEACH setup with static, dynamic and single-point programming plus manual fine adjustment, remote programming and lockout. Its slender, stylized housing has a large digital display visible beneath a clear cover for easy programming and status monitoring during operation. The sensor mounts directly to standard 35 mm DIN rail or using the supplied mounting bracket. (Mount in a protected area free from excess vibration and wash-down.)

The sensor features two outputs with independent set-points: one of two analog choices, depending on model, and one discrete (NPN or PNP, also depending on model). Built-in crosstalk avoidance protocol provides trouble-free operation for multiple sensors in one area.

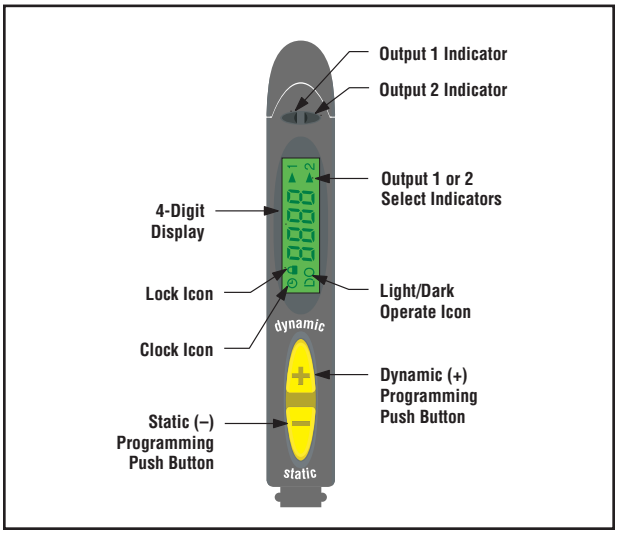

Figure 1. D10 indicators

D10 Specifications

Required Fiber-Optic Cable	Banner P-Series plastic fibers	
Sensing Beam	Visible red, 680 nm, or Visible green, 525 nm, depending on model	
Supply Voltage and Current	**4-20 mA Analog Models:** 12-24V dc (10% maximum ripple) at less than 65 mA exclusive of load **0-10V dc Analog Models:** 15-24V dc (10% maximum ripple) at less than 70 mA exclusive of load	
Supply Protection Circuitry	Protected against reverse polarity and transient voltage.	
Output Configuration	**2 independently configurable outputs, depending on model:** NPN w/analog (4-20 mA or 0-10V) or PNP w/analog (4-20 mA or 0-10V)	
Output Rating	**Discrete Output:** 150 mA, maximum load **OFF-state leakage current:** < 10µA at 24V dc **ON-state saturation voltage:** **NPN** < 1.5V dc @ 150 mA **PNP** < 2.5V dc @ 150 mA	**Analog Output:** 4-20 mA or 0-10V dc **Load:** **4-20 mA Models:** 100Ω maximum impedance **0-10V dc Models:** 1 MΩ maximum impedance
Output Protection Circuitry	Protected against false pulse on power-up and continuous short-circuit	
Output Response Time	**Discrete Output:** Programmable, 50 microseconds, 200 microseconds, 1 millisecond, 2.5 milliseconds **Analog Output:** 1 millisecond NOTE: 150 millisecond delay on power-up; outputs do not conduct during this time.	
Adjustments	Push-button or remote programming of response time, OFF-delay, light-dark operate, and display	
Indicators	Four-digit digital display plus LCD indicators for active channel, push-button lockout, OFF-delay and light/dark operate selection. LCD backlight (red for Program mode or green for Run mode) indicates Power ON. Two amber output indicators	
Construction	Black ABS/polycarbonate alloy (UL94 V-0 rated) housing, clear polycarbonate cover.	
Environmental Rating	NEMA 1, IEC IP50	
Connections	PVC-jacketed 2 m or 9 m (6.5' or 30') 6-wire integral cable or integral 6-pin Pico-style quick-disconnect	
Operating Conditions	**Temperature:** -20° to +55°C (-4° to +131°F) **Storage Temperature:** -20° to +80°C (-4° to +175°F) **Max. Rel. Humidity:** 90% @ 50°C (non-condensing)	

Number of Devices, Stacked	Ambient Temperature Rating	Load Specification (discrete output)
3	55°C	150 mA
7	50°C	50 mA
10	45°C	50 mA

Installation	35 mm DIN rail or included mounting bracket
Certifications	CE c UL us

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Programming Options

Light/Dark Operate Selection			Toggle to select the condition for which each output will conduct: when the target is present or when the target is absent.			
OFF-Delay Timing Selection			Programmable OFF-delay pulse stretcher: 0, 2, 5, 10, 15, 20, 30, 40, 60, 80, or 100 milliseconds **Analog Outputs:** Off-delay acts as a smoothing function			
Display Selection			**Discrete Output:** Raw signal value or % excess signal **Analog Output:** Raw signal value or analog value (0-10V dc or 4-20 mA)			
Power Level/Speed Selection			**Super High-Speed SHS**	**High-Speed HS**	**High-Power HP**	**Super High-Power SHP**
Discrete Response			50 µs	200 µs	1 ms	2.5 ms
Repeatability			25 µs	50 µs	75 µs	100 µs
Maximum Range*	**Color**	**Fiber**				
	680 nm Red	PIT16U	20 mm	30 mm	55 mm	90 mm
		PIT26U	100 mm	150 mm	250 mm	400 mm
		PIT46U	300 mm	550 mm	1000 mm	1200 mm
		PIT66U	600 mm	1000 mm	1700 mm	2400 mm
		PBT16U	6 mm	10 mm	18 mm	30 mm
		PBT26U	30 mm	50 mm	100 mm	150 mm
		PBT46U	100 mm	175 mm	250 mm	300 mm
		PBT66U	175 mm	250 mm	400 mm	475 mm
	525 nm Green	PIT16U	9 mm	9 mm	13 mm	16 mm
		PIT26U	40 mm	40 mm	55 mm	70 mm
		PIT46U	100 mm	100 mm	160 mm	180 mm
		PIT66U	180 mm	180 mm	280 mm	320 mm
		PBT16U	**	**	3 mm	3.5 mm
		PBT26U	12 mm	12 mm	20 mm	25 mm
		PBT46U	30 mm	30 mm	42 mm	60 mm
		PBT66U	55 mm	55 mm	80 mm	100 mm
Tracking Feature			Sets Output 2 to identical settings as Output 1; Output 2 settings can then be revised as desired. (See Advanced Setup procedure, page 11.)			
Factory Default Settings			The following settings are preset at the factory; revert sensor to factory defaults using Advanced Setup procedure (page 8). • Light operate (lo) • No OFF delay (t 0) • Raw signal value (1234) • Output 1 displayed • High Speed (HS); 200 µs response • Maximum power setting • Analog: full scale • Discrete: switch-point positioned at middle of range			

* Diffuse mode performance based on 90% reflectance white test card.

** ø0.010" bifurcated fiber not recommended in these speed settings. Contact Banner Applications for more information.

D10 Programming

Programming Procedures

Two push buttons, Dynamic (+) and Static (-), may be used to access and set programming parameters. For remote programming, connect a switch or digital input to the gray wire; length of the individual pulses is equal to the value T:

0.04 seconds ≤ T ≤ 0.8 seconds

Returning to RUN Mode

TEACH and SETUP modes each may be exited in one of two ways: by exercising the 60-second time-out, or by cancelling out of the process. In TEACH mode, the sensor will return to RUN mode without saving any of the new settings; in SETUP mode, the sensor will return to RUN mode but save all of the settings. To cancel out of TEACH mode, press and hold the Static (-) button for 2 seconds; to cancel out of SETUP mode, press and hold both the Static (-) and Dynamic (+) buttons for 2 seconds.

Output 2

The set-point(s) for each output can be set independently of one another. However, the functional range available for output 2 is dictated by the automatic power and gain settings established for output 1. Whenever output 1 is taught, output 2 also must be retaught. Applications hint: teach the weakest signal on output 1 first.

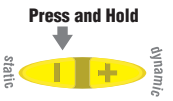
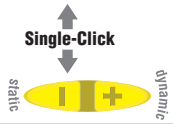
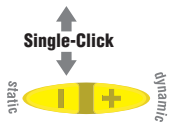
Active Channel Select

Selects which channel to teach and displays channel configuration information.

	Action		Display Shows
Push Button		Single-click both Dynamic (+) and Static (-) buttons concurrently.	**Pointer icon:** moves to the other channel indicator  
Remote		Triple-pulse the remote line.	

Static TEACH

Two-point TEACH to set a single threshold. Threshold is adjustable using the "–" and "+" buttons (see Manual Adjust, page 6).

	Action		Display Shows
Push Button		Press and hold Static (-) button.	• LCD flashes "**1st**" • LCD background turns red 
Remote		No action required; sensor is automatically ready for 1st TEACH condition.	
Push Button		Present Output ON target. Click Static button.	• LCD flashes "**2nd**" 
Remote		Present Output ON target. Single-pulse the remote line.	
Push Button		Present Output OFF target. Click Static button.	**TEACH conditions acceptable:** • LCD background turns green • LCD flashes "**pass,**" followed by a number (denoting contrast); see table at right. • Sensor returns to RUN mode with new settings. 
Remote		Present Output OFF target. Single-pulse the remote line.	**TEACH conditions unacceptable:** • LCD flashes "**fail**" and returns to "**1st**" • LCD background remains red • After 60 seconds, sensor returns to RUN mode (LCD background turns green) without changing settings. 

Contrast Values	
500 +	Excellent
100 - 500	Good
32 - 99	Low
0 - 31	Marginal

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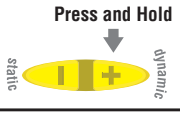
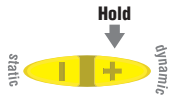
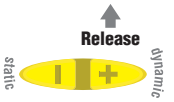
Dynamic TEACH

TEACH on-the-fly; sets a single threshold. Threshold is adjustable using the "+" and "-" buttons (see Manual Adjust, page 6).

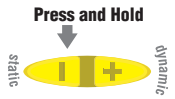
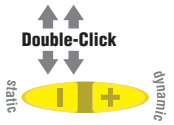
Action			Display Shows
Push Button		Press and hold Dynamic (+) button.	• LCD shows "**dyn**" • LCD background turns red 
Remote		Hold remote line low (to ground).	
Push Button		Present Output ON/OFF conditions. Continue to hold Dynamic button.	
Remote		Present Output ON/OFF conditions. Continue to hold remote line low (to ground).	
Push Button		Release Dynamic button.	**TEACH conditions acceptable:** • LCD background turns green • LCD flashes "**pass,**" followed by a number (denoting contrast); see table at left. • Sensor returns to RUN mode with new settings. 
Remote		Release remote line/switch.	**TEACH conditions unacceptable:** • LCD flashes "**fail**" • LCD background remains red • Sensor returns to RUN mode (LCD background turns green) without changing settings. 

Contrast Values

500 +	Excellent
100 - 500	Good
32 - 99	Low
0 - 1	Marginal

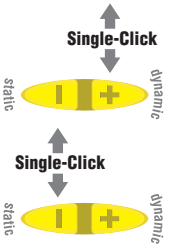
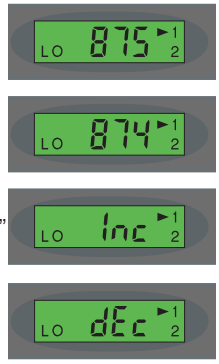
Single-Point Static TEACH

Used to set a single ON condition. All other conditions (both lighter and darker) will result in an OFF output. Target ON condition sensitivity is adjustable using the "+" and "-" buttons (see Manual Adjust, page 6).

Action			Display Shows
Push Button		Press and hold Static (-) button.	• LCD flashes "**1st**" • LCD background turns red 
Remote		Present target to learn, single-pulse remote line.	• LCD flashes "**2nd**" • LCD background turns red 
Push Button		Present target to learn, double-click Static button.	**TEACH conditions acceptable:** • LCD background turns green • LCD flashes "**sngl**," then "**pt**" twice • Sensor returns to RUN mode with new settings. 
Remote		Double-pulse the remote line.	**TEACH conditions unacceptable:** • LCD flashes "**fail**" and returns to "**1st**" • LCD background remains red • After 60 seconds, sensor returns to RUN mode (LCD background turns green) without changing settings. 

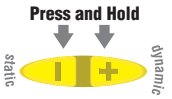
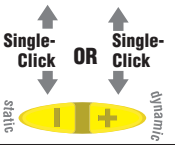
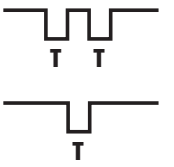
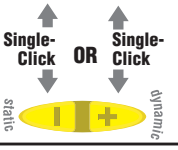
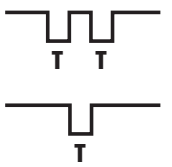
Manual Adjust

May be used at any time sensor is in RUN mode, to adjust the sensing thresholds or to adjust sensitivity to the single-point target conditions.

Action			Display Shows
Push Button		• Click "+" to increase, or click "-" to decrease, threshold set-point value. or • Click "+" to increase, or or click "-" to decrease, the tolerance to the single-point target condition.	• LCD display briefly flashes the threshold set-point value as it is being changed or • LCD display flashes "**inc**" or "**dec**" as single-point tolerance is adjusted 
Remote		Not available with remote programming.	

Setup

Configure sensor display and operating parameters. Click Dynamic (+) or double-pulse remote line to select an option. Click Static (-) or single-pulse remote line to advance. Changes are updated instantly.

Action			Display Shows
Push Button		Press and hold both Dynamic (+) and Static (-) buttons concurrently.	• LCD background turns red
Remote		Double-pulse remote line.	
Select Light/Dark Operate			
Push Button		• Click Dynamic to toggle between selections. • Click Static to advance to "OFF-Delay."	**Light Operate:** • LCD display flashes "**lo**" • LO icon  **Dark Operate:** • LCD display flashes "**do**" • DO icon 
Remote		• Double-pulse remote line to toggle between selections. • Single-pulse remote line to advance to "OFF-Delay."	
Select OFF-Delay Timing Enable			
Push Button		• Click Dynamic to toggle between selections. • Click Static to advance to "Display."	**OFF (No OFF-Delay):** • "**t 0**" • Clock icon OFF  **2 to 100 ms OFF-Delay:** • "**t 2**," "**t 5**," "**t 10**," "**t 15**," "**t 20**," "**t 30**," "**t 40**," "**t 60**," "**t 80**," or "**t100**" • Clock icon ON 
Remote		• Double-pulse remote line to toggle between selections. • Single-pulse remote line to advance to "Display."	

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Setup (continued)

Action			Display Shows
Select Display Parameters			
Push Button	Single-Click OR Single-Click; static / dynamic	• Click Dynamic (+) to toggle between selections. • Click Static (-) to advance to "Power/Speed."	**Raw signal value:** • 1234 **Discrete Channels only:** **Percent of excess signal** • 123P **Voltage-output channels only:** **0 to 10 Volt analog value** • 10 U **Current-output channels only:** **4 to 20 mA analog value** • 20 A
Remote	T T T	• Double-pulse remote line to toggle between selections. • Single-pulse remote line to advance to "Power/Speed."	
Select Power and Speed Combination			
Push Button	Single-Click OR Single-Click; static / dynamic	• Click Dynamic (+) to toggle between selections. • Click Static (-) to return to RUN mode.	**Super-high-speed (50-µs response)** • SHS **High-speed (200-µs response)** • HS **High-power (1-ms response)** • HP **Super-high-power** **(2.5-ms response)** • SHP
Remote	T T T	• Double-pulse remote line to toggle between selections. • Single-pulse remote line to return to RUN mode.	

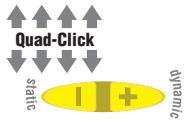
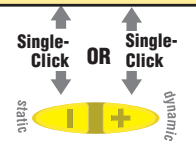
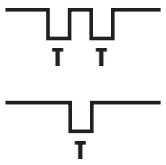
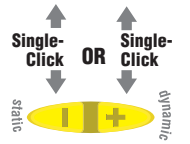
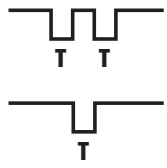
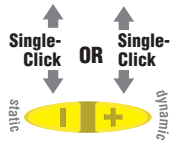
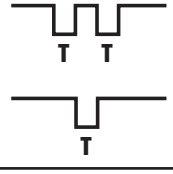
Push-Button Lockout

Prevents unwanted adjustments or tampering of the push buttons. Push buttons can be enabled or disabled only from the remote line and only during normal RUN mode.

Action			Display Shows
Push Button		Not available with push-button programming.	**Push Buttons Disabled:** • LCD flashes "**loc**" • Padlock icon appears • Sensor remains in RUN mode **Push Buttons Enabled:** • LCD flashes "**uloc**" • Padlock icon disappears • Sensor remains in RUN mode
Remote	T T T T	Quad-pulse remote line while in RUN mode to toggle between selectons.	

Advanced Setup

Advanced adjustments to previously configured sensor display and operating parameters. ***Quad-click Static (-) or quad-pulse remote line before exiting "Power and Speed" settings to enter this mode.*** *Click Dynamic (+) or double-pulse remote line to select an option. Click Static or single-pulse remote line to advance. Changes are updated instantly.*

Action			Display Shows
Enter SETUP Mode (from "Power and Speed" mode)			• LCD background remains red and displays "Tracking Enable" option
Push Button		Quad-click Static (-) button.	
Remote		Quad-pulse remote line.	
Tracking Enable (sets output 2 identical to output 1)			**Tracking disabled:** • LCD display shows "**tr n**"  **Tracking enabled:** • LCD display shows "**tr y**" 
Push Button		• Click Dynamic (+) to toggle between selections. • Click Static (-) to advance to "Factory Default."	
Remote		• Double-pulse remote line to toggle between selections. • Single-pulse remote line to advance to "Factory Default."	
Factory Default Settings (returns sensor to factory default settings)			**Factory Default Settings Not Selected:** • LCD display shows "**fd n**"  **Factory Default Settings Selected:** • LCD display shows "**fd y**" 
Push Button		• Click Dynamic (+) to toggle between selections. • Click Static (-) to advance to "Display Orientation."	
Remote		• Double-pulse remote line to toggle between selections. • Single-pulse remote line to advance to "Display Orientation."	
Display Orientation (inverts display to read "upside-down")			**Normal:** • For example: 1234  **Inverted**: • For example: 1234  NOTE: Icons and channel indicators do not invert
Push Button		• Click Dynamic (+) to toggle between selections. • Click Static (-) to return to RUN mode.	
Remote		• Double-pulse remote line to toggle between selections. • Single-pulse remote line to return to RUN mode.	

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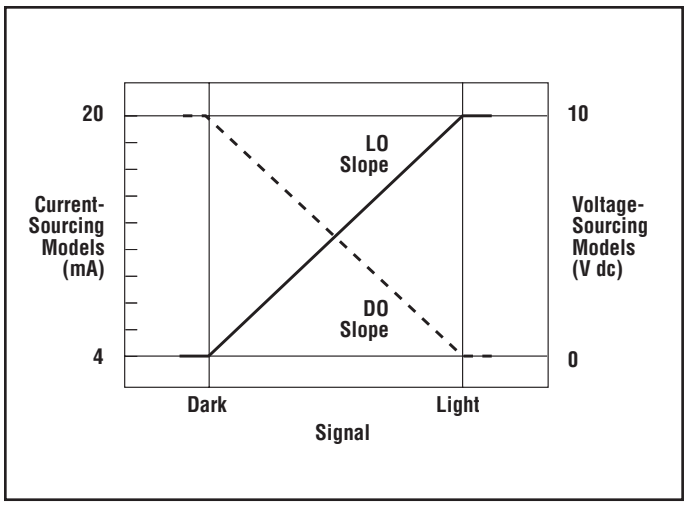

Figure 2. Analog output as a function of target position – two set-points (static or dynamic)

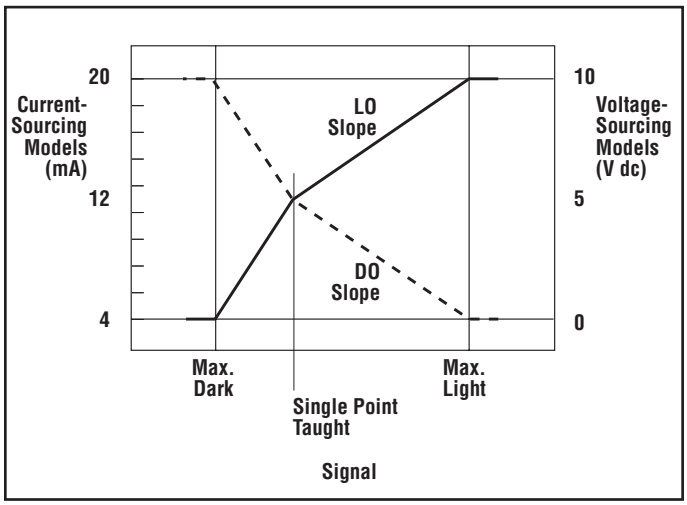

Figure 3. Analog output as a function of target position – single-point TEACH

Analog Outputs

Output 1 is configured for either 4 to 20 mA or 0 to 10V dc analog output, depending on the model. The sensor may be programmed using the two-point TEACH (either static or dynamic) or single-point static teach.

Teaching two set-points (static or dynamic): The sensor sets the first taught condition to the highest output level (either 20 mA or 10V), and the second taught condition to the lowest level (either 4 mA or 0V), and scales between these points. If the first condition taught has more returned light, the sensor will be in Light Operate mode (LO). If the first taught condition is darker, the sensor will be in Dark Operate mode (DO). To change the slope of the analog output (refer to Figure 2), toggle LO/DO in Setup (page 6).

Single-point (static) Teach: The sensor sets the taught condition to the mid-point of its range (12 mA or 5V, depending on the model). For Light Operate mode, the sensor will automatically scale up to 20 mA (or 10V) for maximum light condition (the maximum possible received signal) and down to 4 mA (or 0V) for maximum dark condition (no signal), and vice-versa for Dark Operate mode. To change the slope of the analog output (refer to Figure 3), toggle LO/DO in Setup (page 6).

An OFF-delay enabled for the analog output acts as an averaging function. During the OFF-delay period, the sensor will take multiple analog readings and average the result before changing the analog value. This acts to reduce the effects of major spikes in the analog system, in effect “smoothing” the output reading.

NOTE: Depending on the application configuration and fibers used, the analog function may or may not behave linearly. The received light intensity will be dictated by the inverse square properties of light.

Dynamic TEACH and Adaptive Thresholds

Dynamic TEACH is used to program sensitivity during actual machine run conditions. During Dynamic TEACH, the D10 takes multiple samples of the light and dark conditions and automatically sets the sensitivity at the optimum level. For the discrete output, Dynamic TEACH activates the sensor's adaptive threshold system, which continuously tracks minimum and maximum signal levels, and automatically maintains centering of the switch point between the light and dark conditions. The adaptive threshold system remains in effect during RUN mode to automatically adjust for changes in the light or the dark conditions. The adaptive routine saves to non-volatile memory at least once per hour.

When Dynamic TEACH mode is used to program sensitivity, the output ON state (light or dark operate) will remain as it was last programmed. To change to either light or dark operate, use the SETUP mode (see page 6).

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

Self-Diagnostic Error Modes

In the unlikely event that the setup parameters are lost or become corrupt, the display will continuously scroll: "E2 Error." Reteach the sensor to recover. If the problem persists, contact your Banner representative for further information.

Gate Input

The D10's pink wire is configured as a gate input. When this wire is pulled low (i.e., to the sensor ground), it inhibits the discrete output from switching, while all other D10 functions continue to be enabled. This feature is useful for controlling when the outputs are allowed to change states. Gate input function response time is 1 millisecond. While the gate is enabled, the analog output holds the last value.

Repairs

NOTE: Do not attempt any repairs to the D10. It contains no field-replaceable components. Return the sensor to the factory for warranty repair or replacement.

If it ever becomes necessary to return a D10 to the factory, please do the following:

1) Contact the Banner Factory Application Engineering Group at the address or at the numbers listed at the bottom of the back page. They will attempt to troubleshoot the system from your description of the problem. If they conclude that a component is defective, they will issue an RMA (Return Merchandise Authorization) number for your paperwork, and give you the proper shipping address.

2) Pack the D10 carefully. Damage which occurs in return shipping is not covered by warranty.

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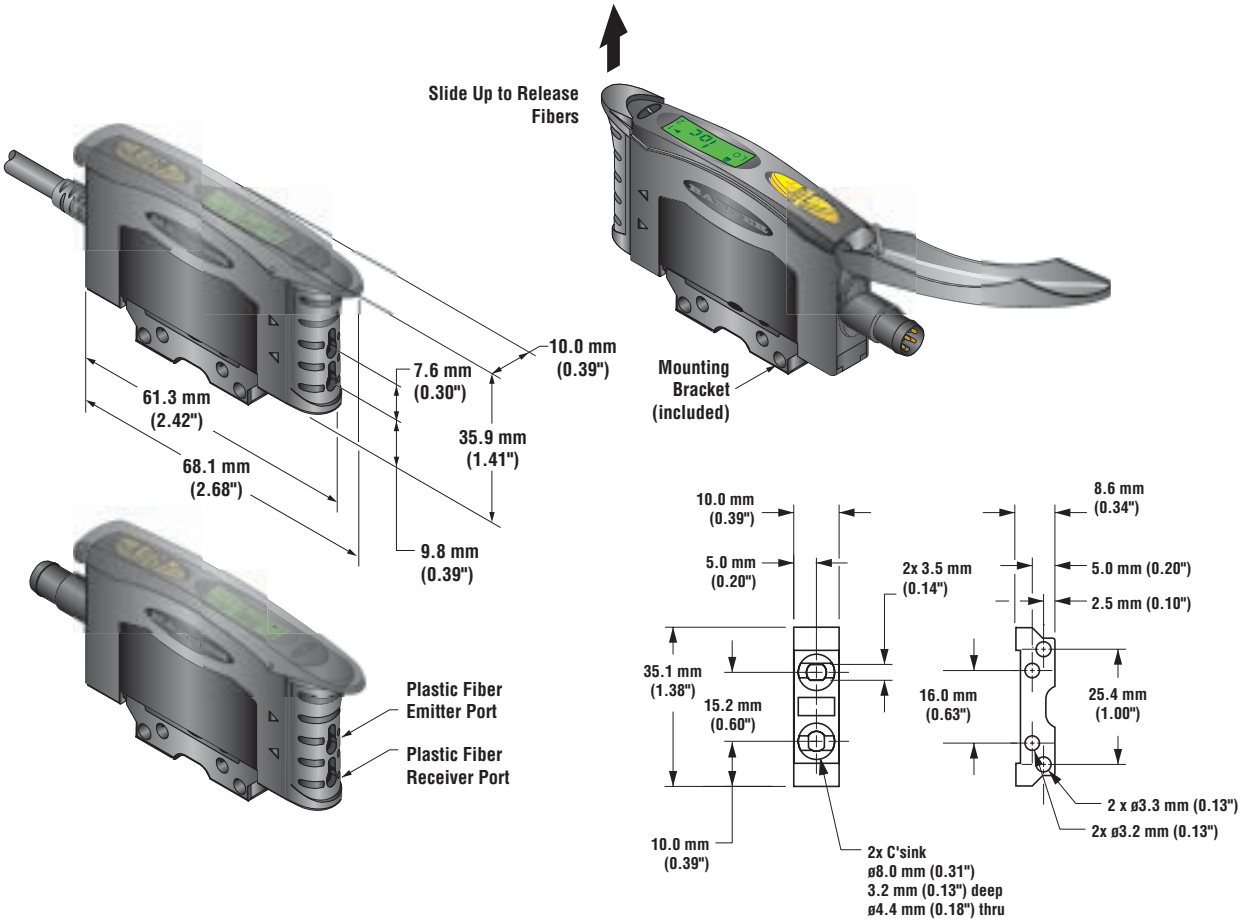
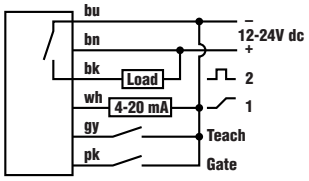
Dimensions

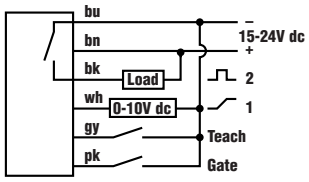


Hookups

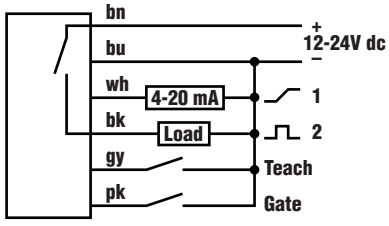
D10INFP(Q)



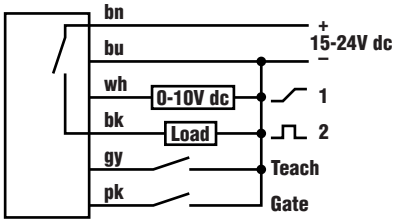
D10UNFP(Q)



D10IPFP(Q)



D10UPFP(Q)

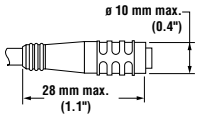
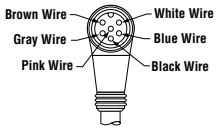
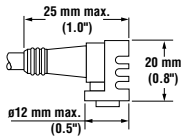


NOTE: QD Hookups are identical.

D10 Accessories

Pico-Style Quick-Disconnect Cables

Cable: PUR jacket, polyurethane connector body, POM snap-lock coupling
Conductors: 26 or 24 AWG high-flex stranded, gold-plated contacts
Temperature: -40° to +90°C (-40° to +194°F)
Voltage Rating: 30V ac/36V dc

Style	Model	Length	Dimensions	Pin-out
6-Pin Straight	**PKG6Z-2**	2 m (6.5')		
	PKG6Z-9	9 m (30')		
6-Pin Right-angle	**PKW6Z-2**	2 m (6.5')		
	PKW6Z-9	9 m (30')		

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WARNING . . . Not To Be Used for Personnel Protection

Never use this product as a sensing device for personnel protection. Doing so could lead to serious injury or death.

This product 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. Consult your current Banner Safety Products catalog for safety products which meet OSHA, ANSI and IEC standards for personnel protection.

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.