MULTI-BEAM®

3- & 4-wire Convergent Mode Scanner Blocks for MULTI-BEAM® Modular Photoelectric Sensors

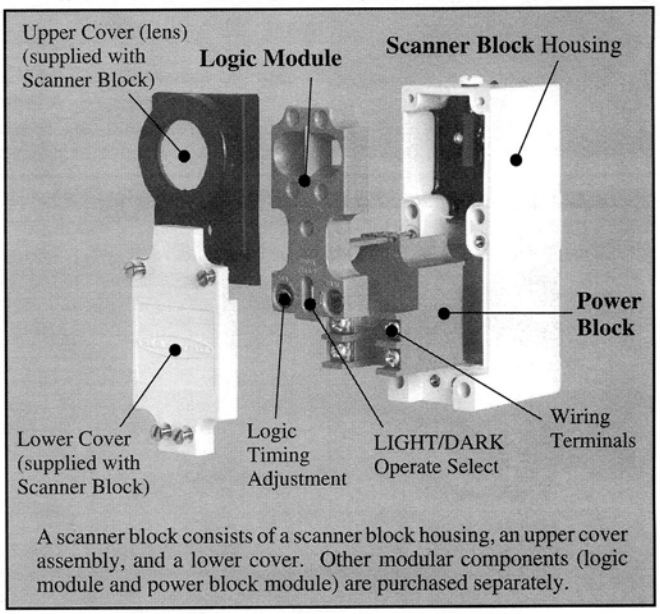
BANNER® the photoelectric specialist

A Banner MULTI-BEAM Sensor is a compact *modular* self-contained photoelectric switch consisting of three components: a scanner block, a power block, and a logic module. The *scanner block*, described in this data sheet, comprises the housing for the sensor and contains a complete modulated photoelectric amplifier, the emitter and receiver optoelements, lenses, and space for the other modules.

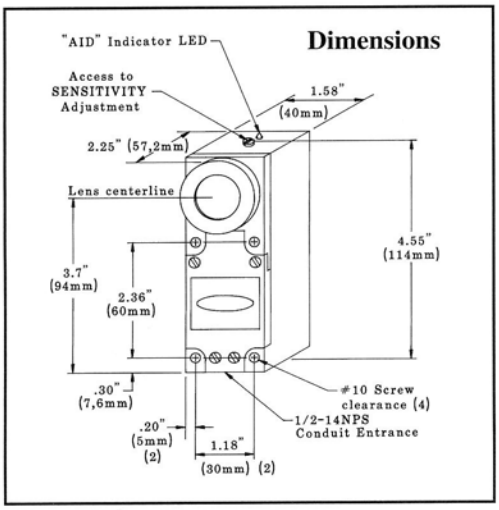
The *power block module* provides the interface between the scanner block and the external circuit. It contains a power supply for the MULTI-BEAM plus a switching device to interface the sensor to the circuit to be controlled. 3- and 4-wire dc power block modules operate from dc voltages and are discussed in data sheet 03499. 3- and 4-wire ac power blocks operate from ac voltages and are covered in data sheet 03501. The *logic module* (data sheet 03304) interconnects the power block and scanner block both electrically and mechanically. It provides the desired timing logic function (if any) plus the ability to program the output for either light- or dark-operate.

Power block and logic modules are purchased separately. This modular design, with field-replaceable power block and logic modules, permits a large variety of sensor configurations, resulting in exactly the right sensor for any convergent mode photoelectric application.

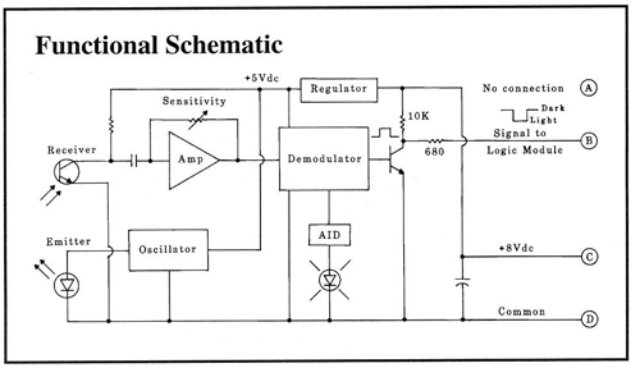
MULTI-BEAM 3- and 4-wire convergent mode scanner blocks include eight different standard models. The high power models (those with 10 millisecond response time) offer the greatest optical sensing power of any industrial convergent mode sensor.



A scanner block consists of a scanner block housing, an upper cover assembly, and a lower cover. Other modular components (logic module and power block module) are purchased separately.



The circuitry of all MULTI-BEAM components is encapsulated within rugged, corrosion-resistant VALOX® housings that meet or exceed NEMA 1, 3, 12, and 13 ratings. MULTI-BEAM 3- and 4-wire convergent mode scanner blocks include Banner's exclusive, patented* Alignment Indicating Device (AID™) system, which lights a top-mounted LED when the sensor sees its modulated light source and pulses at a rate proportional to the strength of the received light signal.



All MULTI-BEAM scanner blocks are totally solid-state for unlimited life.

***US patent 4356393.**

Specifications (see also "Modifications", page 2)

Supply Voltage: Input power and output connections are made via 3- or 4-wire power blocks. See data sheet 03499 (DC Power Blocks) or 03501 (AC Power Blocks), or refer to the Banner product catalog.

Response Time: 1 millisecond "on" and "off"; high-gain models ("X" model suffix) 10 milliseconds "on" and "off"; independent of signal strength.

Repeatability of Response: 0.3 milliseconds (1.5 milliseconds for "X" models); independent of signal strength.

Sensitivity Adjustment: Easily-accessible, located on top of scanner block beneath o-ring gasketed nylon screw cover. 15-turn clutched control; rotate clockwise to increase sensitivity.

Alignment Indicator: Red LED on top of scanner block. Banner's exclusive, patented Alignment Indicating Device (AID™) circuit lights the LED whenever the sensor detects it's own modulated light source, and pulses the LED at a rate proportional to the received light level.

Construction: Reinforced VALOX® housing; components totally encapsulated. Stainless steel hardware. Meets NEMA standards 1, 3, 12, and 13.

Operating Temperature Range: -40 to +70° C (-40 to +158° F).

WARNING These photoelectric presence sensors do NOT include the self-checking redundant circuitry necessary to allow their use in personnel safety applications. A sensor failure or malfunction can result in *either* an energized or a de-energized sensor output condition.

Never use these products as sensing devices for personnel protection. Their use as safety devices may create an unsafe condition which could lead to serious injury or death.

Only MACHINE-GUARD and PERIMETER-GUARD Systems, and other systems so designated, are designed to meet OSHA and ANSI machine safety standards for point-of-operation guarding devices. No other Banner sensors or controls are designed to meet these standards, and they must NOT be used as sensing devices for personnel protection.

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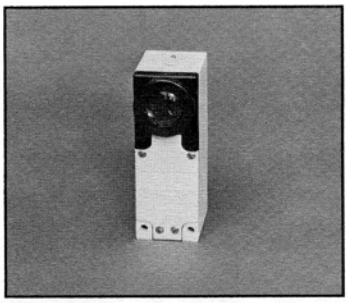
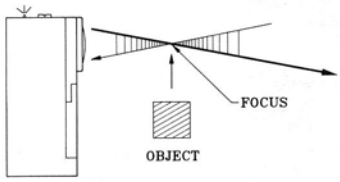
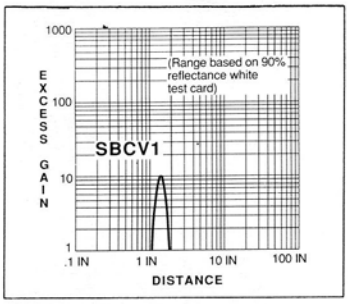
CONVERGENT MODE Scanner Blocks

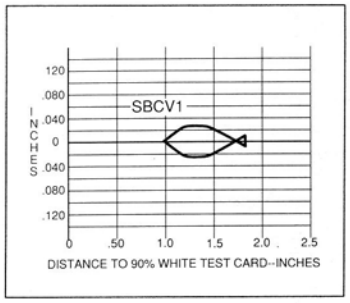




Convergent mode MULTI-BEAMs combine emitter and receiver into one unit. Optics produce a sensing "spot" at fixed distance (focus point) in front of the lens. Convergent mode sensing is an ideal choice for position control of transparent products and for detecting products which are only a fraction of an inch away from another reflective surface. Convergent sensing is also a good second choice (after opposed mode sensing) for precise position control of opaque materials. All models have Banner's exclusive AID™ alignment system.

VISIBLE RED SENSING SPOT - GENERAL APPLICATION

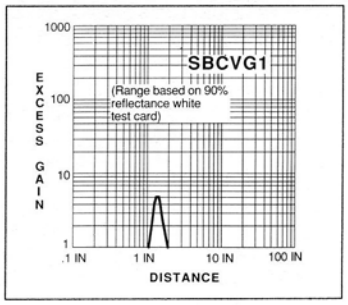


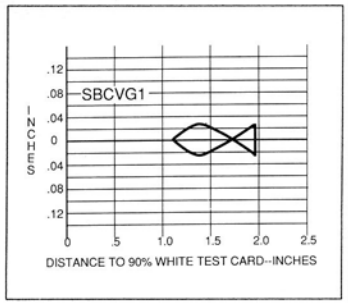


Model
SBCV1
Focus at: 1.5 inch (38mm)
Response: 1ms on/off
Beam: visible red, 650nm

SBCV1: .06-inch (1,5mm) dia. visible red spot, for precise positioning, edge-guiding, and small parts detection. Some products ≥1" tall may be sensed against immediate background, like parts on a conveyor. Excellent for high-contrast registration-sensing applications (except red-on-white). Use with LM6-1 logic module for speed detection sensing of gear teeth, pulley hubs, or chain links.

VISIBLE GREEN SENSING SPOT - COLOR SENSING

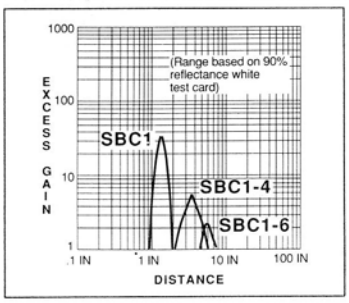


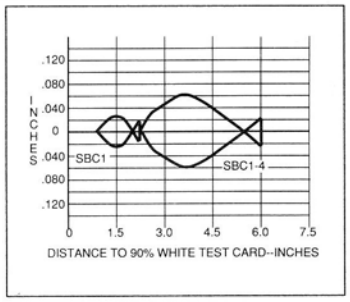


Model
SBCVG1
Focus at: 1.5 in. (38mm)
Response: 1ms on/off
Beam: visible green, 560nm

SBCVG1: .12-inch (3mm) diameter visible green spot. Use to detect color differences (e.g. color registration marks), including red-on-white combinations.

INFRARED SENSING SPOT - GENERAL APPLICATION





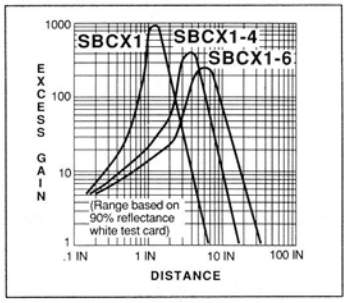
Models
SBC1
Focus at: 1.5 inch (38mm)

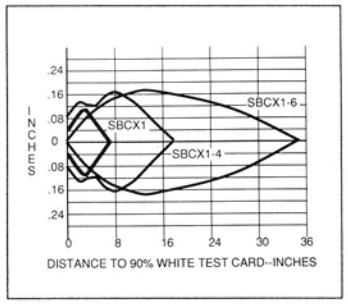
SBC1-4
Focus at: 4 inches (10cm)

SBC1-6
Focus at: 6 inches (15cm)
Response: 1 ms on/off
Beam: infrared, 940nm

SBC1, SBC1-4, SBC1-6: infrared LED light source provides higher gain for reliable sensing of products of low reflectivity, while controlling sensing depth of field. Does not offer the same precision possible with visible light models. Good for sensing clear materials within the sensor's depth of field, and for reliably counting the flow of radiused products which are kept at a fixed distance from the sensor (e.g. bottles against conveyor guide rail).

HIGH GAIN INFRARED - NONREFLECTIVE MATERIALS





Models
SBCX1
Focus at: 1.5 inch (38mm)

SBCX1-4
Focus at: 4 inches (10cm)

SBCX1-6
Focus at: 6 inch (15cm)
Response: 10ms on/off
Beam: infrared, 880nm

SBCX1, SBCX1-4, SBCX1-6: these models offer the greatest optical gain available in any reflective mode sensor. They can reliably detect most non-reflective black materials in applications where opposed mode sensing is not possible (e.g. inked web break monitoring). The high power of these models gives them a wide depth-of-field and a large sensing spot. As a result, they cannot easily ignore objects in the background or foreground, and cannot be used for precise position control (use model SBCV1).

MULTI-BEAM Scanner Block Modifications

The following are popular modifications to MULTI-BEAM 3- & 4-wire scanner blocks. *They are not stocked, but are available on a quote basis.*

HIGH SPEED MODIFICATION "MHS": scanner blocks with 1 millisecond response may be modified for 300 microsecond (0.3 millisecond) response. This modification is designated by adding suffix "MHS" to the scanner block model number (e.g.- SBCV1MHS, etc.).

The MHS modification reduces the available excess gain by about 50%, and also decreases the sensor's immunity to some electrical "noise".

ZERO HYSTERESIS MODIFICATION "MZ": amplifier hysteresis may be removed from 3- and 4-wire scanner blocks when attempting to sense very small signal changes (contrasts less than 3). This modification is designated by adding suffix "MZ" (Modified Zero hysteresis). Be sure that all variables affecting the sensor's optical response remain constant before ordering the zero hysteresis modification.

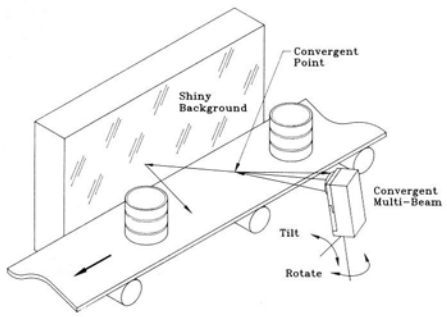
INSTALLATION AND ALIGNMENT

The greatest amount of light energy is returned to the receiver of a convergent sensor when the reflecting surface is located at the sensor's focus point. A convergent sensor will sense an object for some distance in front of and behind the focus point. This zone of response is the convergent sensor's *depth of field*.

The depth of the sensing field is determined both by the sensor's optical gain and by the reflectivity characteristics of the object to be sensed. As a reference, the depth of field for a matte white object is read along the horizontal axis of the sensor's excess gain curve or beam pattern (see page 2). A *smaller* depth of field will result with an object of low reflectivity. Conversely, a shiny surface, if viewed straight-on, will be detected within a large depth of field.

Problems with convergent sensing are often the result of false light return from a highly reflective background surface. This type of problem is easily corrected by tilting the MULTI-BEAM more than 10 degrees in any direction from the perpendicular to the shiny background surface (figure 1). With the sensor tilted, the shiny background surface directs the reflected sensing light away from the convergent sensor (specular reflection). There usually is enough light energy for sensing purposes right at the convergent point to overcome any angular misalignment of the sensor to the object that is to be sensed.

Figure 1. "Skew" angle included in mounting scheme to ignore shiny background surface.



In some situations where the background surface is highly reflective and where the object to be detected has very low reflectivity, the convergent beam sensor may be directed squarely at the background surface. The object is sensed when it passes *inside* the convergent point, and blocks the light from reaching the background.

Banner offers a variety of 2- and 3-axis mounting brackets for use with MULTI-BEAM sensors. See the Banner product catalog for bracket information.

Alignment: Presence/absence applications

NOTE: The Alignment Indicating Device LED on the top of the sensor is used during alignment.

1) First, loosely mount the MULTI-BEAM so that the distance from the *front surface* of the lens to the object to be detected is equal to the sensor's focus distance (see the individual model description for focus point specification).

2) With power applied to the MULTI-BEAM power block (terminals #1 and #2; observe polarity on DC models) and with the object to be detected in place, adjust the position of the MULTI-BEAM relative to the object for the fastest pulse rate of the alignment indicator. If the LED appears to be "on" steadily, it is actually pulsing at a rate too fast to be seen. Slow the pulsing to a "countable" rate by reducing the sensitivity (counterclockwise rotation of the adjustment). Being able to count the change in pulse rate when the sensor's position is changed will allow more accurate alignment.

3) Turn the sensitivity control fully clockwise. (This is a 15-turn potentiometer, clutched at both ends.)

4) Remove the object. If the the alignment indicator LED goes "off", secure the MULTI-BEAM in that position. Check operation by alternately placing the object in position and then removing it. The LED should follow the action by coming "on" when the object is present and going "off" when the object is removed.

NOTE: The alignment indicator LED may pulse when the object is present. Sensing reliability increases with increasing pulse rates. A steady "on" condition is the best situation, but this may not always be possible to achieve if the object to be detected has low reflectivity.

5) If the alignment indicator stays "on" when the object is *removed*, the MULTI-BEAM is receiving false light returned from a background surface. Reduce the sensitivity (counterclockwise rotation of the adjustment) until the alignment indicator LED goes "off", plus two more full turns. Place the object in position and check that the alignment indicator LED comes "on". Follow step #4 (above).

NOTE: If, in step #5, the LED does not come "on" when the object is placed in position, the sensor is receiving *as much or more* light energy from the background as from the object. In this situation, consider including a skew angle (figure 1) in the sensor mounting, or converging on the background as discussed previously.

6) With the MULTI-BEAM mounting hardware secured, complete the wiring by connecting the load to the output circuit of the power block (terminal #3 and/or #4). Refer to the hookup information for the power block in use. Check operation of the load by alternately inserting and removing an object at the focus point. Adjust the logic module timing (if any), as required.

NOTE: Logic modules (except models LM1, LM2, and LM10) include a light/dark operate programming jumper. Removing the jumper will invert the output state of the power block (from normally open to normally closed or vice versa).

Alignment: Color registration sensing applications (Visible LED model SBCVG1 or SBCV1)

MULTI-BEAM scanner block model SBCVG1 (visible green emitter) is used for most applications which require color differentiation. Model SBCV1 (visible red emitter) performs well with most bold color differences, except those involving red-on-white and similar contrasts (e.g. orange-on-yellow, etc.)

Most applications like registration control, which involve differentiating between two colors, operate with low optical contrast (i.e. - only a small difference in light level at the sensor's receiver between the light and dark conditions). As a result, secure mounting and proper alignment of the MULTI-BEAM are particularly important.

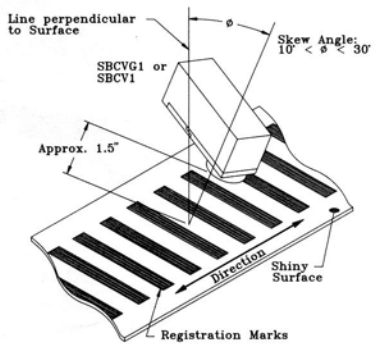
It is also necessary to maintain the mechanical stability of the surface being sensed (e.g.-stabilize web flutter). The convergent optics of the MULTI-BEAM require that, in order for the sensor to consistently sense color difference, the distance from the sensor lens to the surface to be sensed be held constant.

1) First, loosely mount the MULTI-BEAM so that the distance from the *front surface* of the lens to the surface to be scanned is equal to the sensor's focus point (1.5 inches for models SBCVG1 and SBCV1).

2) With power applied to the power block (terminals #1 and #2 - observe polarity on DC models), position the material so that the visible image (spot) of the emitted light is reflecting from the lighter of the two colors. Adjust the sensor position to obtain the fastest pulse rate of the Alignment Indicating Device LED, then lock the sensor into that position by tightening the mounting hardware.

NOTE: If the material to be sensed is shiny, the sensor may receive *too much* light reflected from the darker color if the sensor is mounted directly perpendicular to the material's surface. Include a 10 to 30 degree "skew" angle, when mounting the MULTI-BEAM, to compensate for the mirror-like properties of a shiny surface (figure 2).

Figure 2. Color sensing with SBCVG1 or SBCV1: include "skew" angle to mounting when material is shiny.



3) Present the *darker* of the two colors to the visible image:

a) If the alignment indicator turns "off" when the visible image is on the dark color, increase the sensitivity (turn the adjustment clockwise) until the alignment indicator *just turns "on"*. Reduce the sensitivity control from that point until the alignment indicator *just turns "off"*, plus two more full turns.

b) If the alignment indicator stays "on" when the visible image is on the dark color, decrease the sensitivity (turn the adjustment counterclockwise) until the alignment indicator *just turns "off"*, plus two more full turns.

c) If the alignment indicator does not turn "on" even at maximum gain (15-turn control fully clockwise) when the visible image (spot) is on the dark color, set the control to two full turns down from maximum. NOTE: If the sensitivity control setting ends up near minimum, the dark color is returning too much light energy to the sensor. In this case, readjust the sensor mounting to increase the skew angle. This will allow the sensitivity to be set closer to the middle of its range, where adjustment is more forgiving.

4) With the MULTI-BEAM mounting hardware secured, complete the wiring by connecting the load to the output circuit of the power block (terminal #3 and/or #4). *Refer to the hookup information for the power block in use.* Check operation of the load by alternately presenting the light and dark colors to the sensor. Adjust the logic module timing (if any), as required.

NOTE: Logic modules (except models LM1, LM2, and LM10) include a light/dark operate programming jumper. Removal of the jumper will invert the output state of the power block (from normally open to normally closed or vice versa). *Caution: do not attempt to remove the programming jumper while power is applied to the MULTI-BEAM!*

TROUBLESHOOTING TABLE

SYMPTOM	PROBABLE CAUSE	CORRECTION
Alignment indicator never comes "on", and output never switches the load.	Sensitivity is too low.	Turn sensitivity control clockwise to increase gain.
	Object to be sensed is outside the MULTI-BEAM's field of view.	Follow alignment procedure.
	Loose connection.	Check power supply at power block terminals #1 and #2.
	Failure of a sensor component.	Test MULTI-BEAM using Banner model LMT. Replace failed module.
Alignment indicator never comes "on", but load is switched correctly.	Broken alignment indicator LED (sensor will continue to operate).	Replace scanner block (if alignment indicator is required).
Alignment indicator is always "on", and output never switches.	False light returned by background object.	Turn sensitivity control counterclockwise to decrease gain. Angle the sensor if background is shiny. Use model with less gain and/or a shorter focus point.
	Optical crosstalk from broken lens.	Turn sensitivity control counterclockwise to decrease gain. Replace upper cover assembly (see Banner catalog for model number).
	Failure of sensor component.	Test MULTI-BEAM using Banner model LMT. Replace failed module.
Alignment indicator follows the sensing action, normally, but the output is energized all of the time.	Output of power block failed (shorted).	Replace power block module. Check load demand against power block switch rating.
Alignment indicator follows the sensing action, normally, but the output never energizes.	Failure of logic module or power block.	Test MULTI-BEAM using Banner model LMT. Replace failed module.
	Loose connection.	Check wires to load.
Sensitivity cannot be set to sense the difference between the light and dark conditions. The sensitivity is either too high or too low.	Low optical contrast (less than 2:1).	Re-position the MULTI-BEAM and follow alignment procedure. Increase difference in reflectivity between the light and dark conditions (e.g.-drill hole through background). Evaluate alternative sensing methods.

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