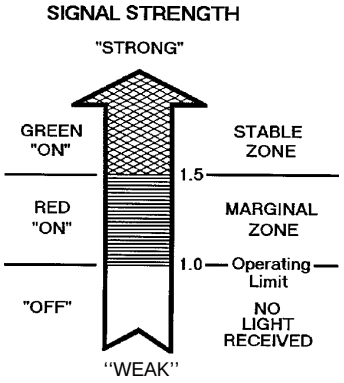
Subminiature DC Sensors

FEATURES
- 5 feet retro or 6.5 feet polarized scan range with FE-RR1 reflector
- 8 or 28-in. diffuse scan range
- 8 in. wide angle diffuse scan range
- 6.5 or 33 feet thru scan range
- 10 to 28 VDC operation
- Sealing: NEMA 12 and IP64
- Modulated infrared LED for ambient light rejection
- Combination alignment/self diagnostic indicator
- Sensitivity adjustment (except emitters)
- Short circuit protection
- False pulse and reverse polarity protection
- Vertical or horizontal mounting choice
- Current sourcing output (optional)

GENERAL INFORMATION
The small package size of FE7B sensors allow usage in limited access and/or restricted space areas. A mounting bracket (included) makes mounting and alignment easy. Each sensor is self-contained, incorporating a pulsed LED, phototransistor receiver and amplifier circuitry with solid state output in one package. The FE7B operates on a broad range DC voltage from 10 to 28 VDC and provides current sinking or current sourcing output up to 100 mA.

Self-diagnostic function alignment indicator. When a sufficient light level is being received, the indicator light is green. But when the light level decreases to 150% of the minimum operating level the indicator turns red. This simplifies installation, alignment, and troubleshooting.

SELF DIAGNOSIS INDICATION



FOR A COMPLETE SENSOR – RETROREFLECTIVE SENSOR

Required
- Retroreflective sensor – **FE7B-RA6G-M**
- Reflector – **FE-RR1**
- Appropriately rated DC power supply

FOR A COMPLETE SENSOR – DIFFUSE SCAN SENSOR

Required
- Diffuse scan sensor – **FE7B-DA6-M**
- Appropriately rated DC power supply

ORDER GUIDE RETROREFLECTIVE SCAN – 5 FT. RANGE (1,5 M)

Description	Catalog Listing
Dark operated (D.O.) sinking (NPN) output; horizontal mount	**FE7B-RA6G-M**
Light operated (L.O.) sinking (NPN) output; horizontal mount	FE7B-RB6G-M
Dark operated (D.O.) sourcing (PNP) output; horizontal mount	FE7B-RD6G-M
Dark operated (D.O.) sinking (NPN) output; vertical mount	**FE7B-RA6VG-M**
Light operated (L.O.) sinking (NPN) output; vertical mount	FE7B-RB6VG-M
Dark operated (D.O.) sourcing (PNP) output; vertical mount	FE7B-RD6VG-M

POLARIZED RETROREFLECTIVE SCAN – 6.5 FT. RANGE (2 M)

Description	Catalog Listing
Dark operated (D.O.) sinking (NPN) output; horizontal mount	**FE7B-RPA6-M**
Light operated (L.O.) sourcing (PNP) output; horizontal mount	FE7B-RPE6-M
Dark operated (D.O.) sinking (NPN) output; vertical mount	**FE7B-RPA6V-M**
Light operated (L.O.) sinking (NPN) output; vertical mount	FE7B-RPB6V-M
Dark operated (D.O.) sourcing (PNP) output; vertical mount	FE7B-RPD6V-M
Light operated (L.O.) sourcing (PNP) output; vertical mount	FE7B-RPE6V-M

ORDER GUIDE DIFFUSE SCAN – 8 IN. RANGE (20 CM)

Description	Catalog Listing
Light operated (L.O.) sinking (NPN) output; horizontal mount	**FE7B-DA6-M**
Dark operated (D.O.) sinking (NPN) output; horizontal mount	FE7B-DB6-M
Light operated (L.O.) sourcing (PNP) output; horizontal mount	FE7B-DD6-M
Light operated (L.O.) sinking (NPN) output; vertical mount	**FE7B-DA6V-M**
Dark operated (D.O.) sinking (NPN) output; vertical mount	FE7B-DB6V-M
Light operated (L.O.) sourcing (PNP) output; vertical mount	FE7B-DD6V-M

ORDER GUIDE DIFFUSE SCAN – 28 IN. RANGE (71 CM)

Description	Catalog Listing
Light operated (L.O.) sinking (NPN) output; horizontal mount	**FE7B-DLA6-M**
Dark operated (D.O.) sinking (NPN) output; horizontal mount	FE7B-DLB6-M
Light operated (L.O.) sinking (NPN) output; vertical mount	FE7B-DLA6V-M
Light operated (L.O.) sourcing (PNP) output; vertical mount	FE7B-DLD6V-M

Mounting bracket is included with all units.

ORDER GUIDE WIDE ANGLE DIFFUSE SCAN - 8 IN. SCAN RANGE (20 CM)

Description	Catalog Listing
Light operated (L.O.) sinking (NPN) output; horizontal mount	FE7B-DA6-M-916
Light operated (L.O.) sinking (NPN) output; vertical mount	FE7B-DA6V-M-916
Same as above except 1 m cable, no hardware, bulk packed	FE7B-DA6V-M933
Light operated (L.O.) sourcing (PNP) output; horizontal mount	FE7B-DD6-M-916
Same as above except black housing, 1 m cable, no hardware, bulk packed	FE7B-DD6-M936A

Thru scan listings next page.

Subminiature DC Sensors

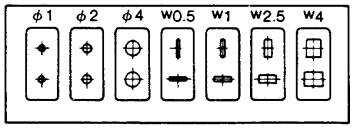
FOR A COMPLETE SENSOR

Required

- **Thru scan emitter – FE7B-TA6E-M**
- Thru scan receiver – **FE7B-TA6GR-M**
- Appropriately rated DC power supply

- Capable of detecting small objects (0,1mm dia.) by use of proper aperture mask

FE-PA7B3-M



For application information, see page C192.

ACCESSORIES

Description	Catalog Listing
Mounting bracket	FE-PA7B1
Aperture mask, set	FE-PA7B3-M

ORDER GUIDE THRU SCAN – 6.5 FT. RANGE (2 M)

Description	Catalog Listing
Emitter; horizontal mount	**FE7B-TA6E-M**
Receiver; dark operated (D.O.) sinking (NPN) output; horizontal mount	**FE7B-TA6GR-M**
Receiver; light operated (L.O.) sinking (NPN) output; horizontal mount	FE7B-TB6GR-M
Receiver; dark operated (D.O.) sinking (NPN) output; vertical mount	FE7B-TA6VGR-M
Receiver; light operated (L.O.) sinking (NPN) output; vertical mount	FE7B-TB6VGR-M
Receiver; light operated (L.O.) sourcing (PNP) output; vertical mount	FE7B-TE6VGR-M

ORDER GUIDE THRU SCAN – 33 FT. RANGE (10 M)

Description	Catalog Listing
Emitter, horizontal mount	FE7B-TLA6GE-M
Receiver, dark operated (D.O.) sinking output; horizontal mount	FE7B-TLA6GR-M
Emitter; vertical mount	FE7B-TLA6VGE-M

Note: Both the long range emitter and the long range receiver must be used together to achieve the 10M scan.

SPECIFICATIONS

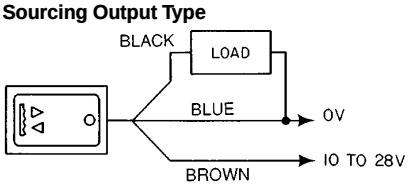
		Thru	Retro	Polar	Diffuse
Maximum Scanning Distance (in clean air)		6.5 ft (2 m), 33 ft. (10 M)	5 ft. (1,5 m)	6.5 ft. (2 m)	8 in. (20 cm), 28 in. (71 cm) Wide angle: 8 in. (20 cm)
Supply Voltage		10 to 28 VDC; 10% max. power supply ripple			
Power Dissipation		Emitter – 0.48 watts max.; Receiver – 0.36 watts max. (excluding load)		0.56 watts max. (excluding load)	
Current Consumption		Emitter – 17 mA max., Receiver – 13 mA max. (excluding load)		20 mA max. (excluding load)	
Output	Load Current	100 mA max. (open collector, light or dark operated) current sinking			
	Voltage Drop	1.0 VDC max. sinking 100 mA			
	Leakage Current	Off state: < 10µA			
Maximum Rate of Operation		15,000 operations/minute			
Typical Response Time	On	1 msec. (2 msec. max.)			
	Off	1 msec. (2 msec. max.)			
Circuit Protection		False pulsing, Short circuit, Reverse polarity			
Temperature Range		–4°F to 140°F (–20°C to 60°C)			
Sealing		NEMA 12 and IP64			
Housing		Case ABS resin, Lens PMMA acrylic resin, Cable vinyl			
Mounting		Horizontal side mounting bracket included			
Weight		3.5 ozs. (99,2 g)			
Logic		Built-in ON-OFF (immediate response) control; light or dark operated by individual catalog listing			

Note: Polarized light source is visible red.

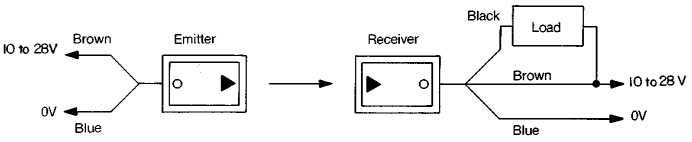
INSTALLATION/WIRING

Instruction Sheet PK 9074 is included with each sensor, and is also available upon request. Use receiver wiring for retro and diffuse units.

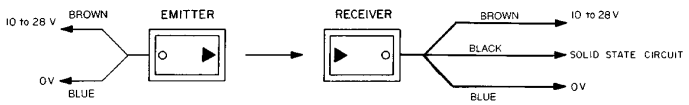
Sourcing Output Type



Standard Relay Or Solenoid Sinking Output Type

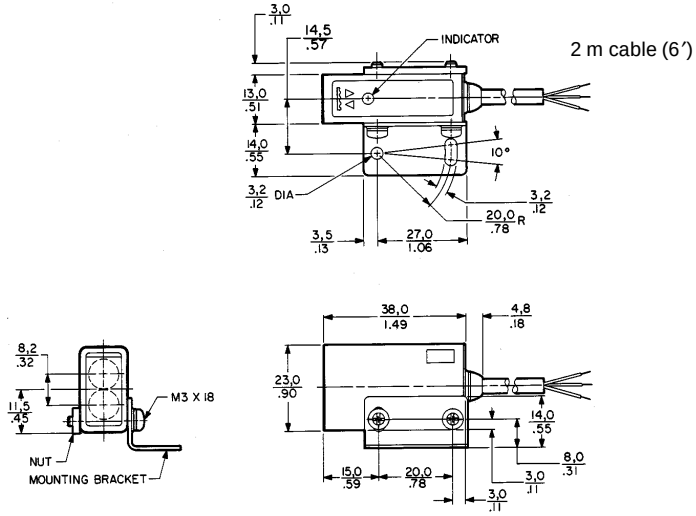


Solid State Circuit Interface

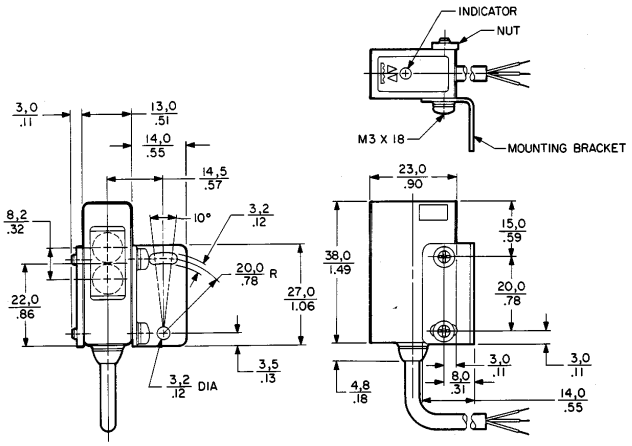


MOUNTING DIMENSIONS (For reference only)

Horizontal Mount

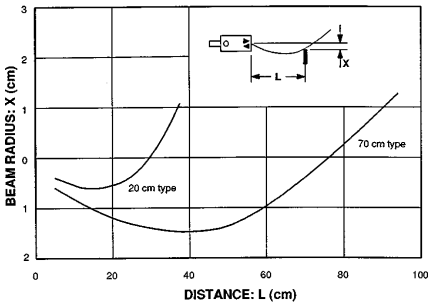


Vertical Mount

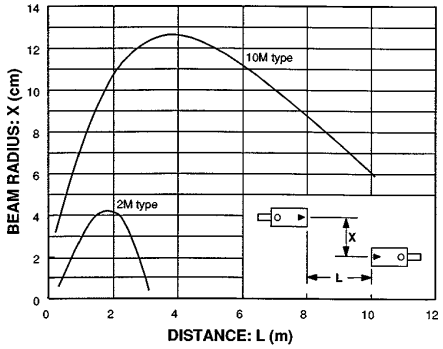


BEAM RADIUS CURVES

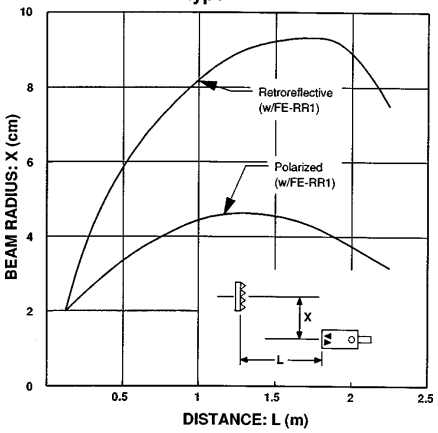
Diffuse-scan type



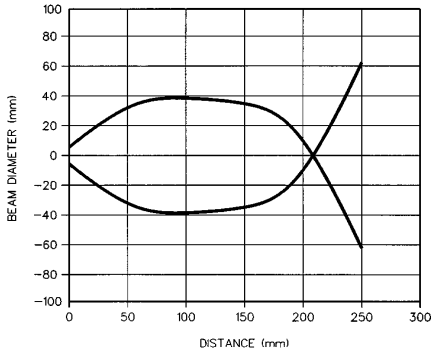
Through-scan type



Polarized retroreflective scan type
Retroreflective type

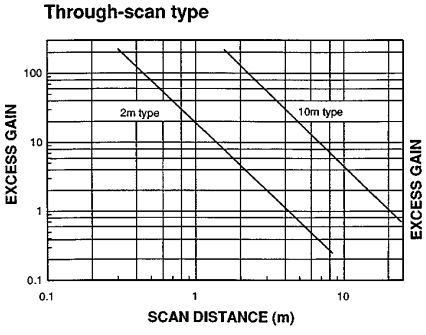


Wide-angle diffuse scan type

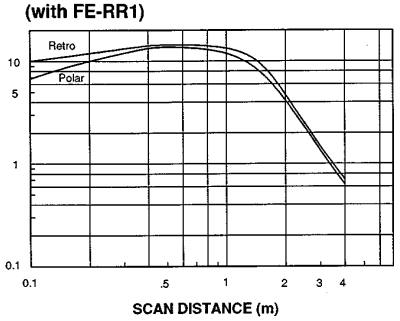


EXCESS GAIN

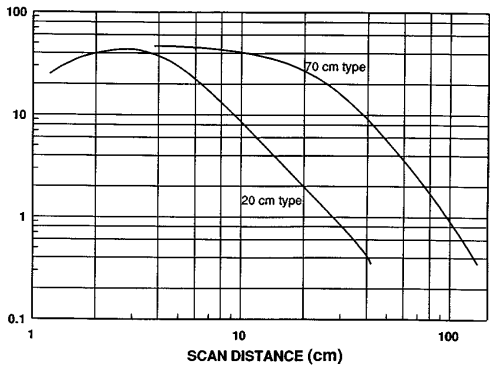
Through-scan type



Polarized Retroreflective-scan type
Retroreflective-scan type
(with FE-RR1)



Diffuse-scan type



Photoelectric

Reference and Index Pages

Glossary of Terms

A

Actuator—mechanism of the switch or switch enclosure which operates the contacts.

Alignment—placing the emitter (light source) and receiver (photoreceiver or reflector) so as to direct the maximum amount of light on the photosensor. At long distances, when the light beam has widened, the receiver should be centered in the beam to lessen the chance of the emitter and receiver drifting out of alignment due to vibration or shock.

Alternating Current (AC)—one that reverses at regularly recurring intervals of time and has alternately positive and negative values.

Ambient—in the area. 1) light—Light in the area of the photosensor, but not originating with the control light source. Ambient light can adversely affect non-modulated control operation, and should be screened, if possible, from the sensor; 2) Temperature—average temperature of surrounding medium such as water, air, or earth, into which the heat of the equipment is dissipated.

Analog Output—having the property of being continuously variable, as opposed to having discrete states.

AND Logic—an output is produced only when all inputs are present.

Aperture—most often an external cap (with a small opening) placed over the receiver lens to help detect small objects. It lets even a small object block enough light to be detected. Also, an internal aperture in most receivers reduces the effect of off-axis ambient light.

Attenuation—loss or reduction of beam intensity as a result of environmental factors, dust, humidity, steam etc.

Auxiliary Actuator—a mechanism, sold separately, to provide basic switches with easier means of operation and adjustment and adapt switches to different operating motions by supplying supplemental overtravel.

B

Basic Switch—a self-contained switching unit. It can be used alone, gang-mounted, built into assemblies or enclosed in metal housings.

Break—to open an electrical circuit.

C

Cascade—to combine logic circuitry to get more complex logic or timing control. (Inputs and outputs are wired in series.)

Characteristics—This term is used by MICRO SWITCH in a restricted sense and refers only to switch operating characteristics such as pretravel, operating force, etc.

Clean Air—ideal conditions. Climate controlled or sterile area.

Complementary Output—both N.O. and N.C. outputs are available for use. A circuit that provides sink or source capability with a single input. Output that can be both light operated and dark operated. (Also known as 4-wire DC controls.)

Control—the complete system; sensor, amplifier, output.

Control Base—unit remote from sensor in which amplification and conditioning of the input signal takes place. Usually contains a power supply and an output device.

Convergent Beam—A variation of the diffuse scanning mode. A photoelectric control whose optical system is the key to its operation. It simultaneously focuses and converges a very small, intense beam to a fixed-focal point in front of the control. The control is essentially blind a short distance before and beyond this focal point. Convergent beam scanning is used to detect the presence or absence of small objects while ignoring nearby background surfaces.

Convertible Output—output that can be wired either as Normally Open or Normally Closed, but not at the same time.

Corrective Factor—the mathematical factor that, when multiplied by the sensing distance of a given sensor, will adjust sensing distance for the different metals being used as targets.

Current—time value of movement of free electrons. One ampere equals one coulomb per second. Conventional reference is opposite to direction of actual electron movement.

Current Consumption—the amount of current required to power a sensor or control (excluding load). See *supply current.*

Current Sinking—an output type such that when it is On, current flow is from the load into the device's output, then to ground. Output is Normally High. The sensor ''sinks'' current from the load through the sensor to ground. The load is connected between the positive lead of the supply and the output lead of the sensor.

Current Sourcing—an output type such that when it is On, current flow is from the device into the load. Output is Normally Low. The sensor ''sources'' current to the load. The load is connected between the output lead and the negative ground lead of the supply.

D

Dark Operated (D.O.)—control operating mode in which the output (load) is energized when the light is blocked (retro/thru scan) or object not present (diffuse), the photosensor is dark.

Diffuse Scan—a reflective scanning technique in which reflection from a near-by non-shiny surface illuminates the photosensor in the receiver. Sometimes called proximity scan because of the required nearness of the light source and photosensor to reflecting surface. Also used to detect color contrast as in registration control.

Digital Circuit—a circuit that has only two stable states, operating in the manner of a switch; that is, it is either On or Off.

Digital Output—output that is of only two stable states, appearing in the manner of a switch; that is, it is either On or Off or High or Low (i.e., high voltage or low voltage).

Direct Current (DC)—a unidirectional current in which changes in value are so small that they may be neglected. As ordinarily used, the term designates a practically non-pulsating current.

Direct Scan—see *thru scan.*

Disable—to prevent the output despite an input signal. A wiring terminal for this purpose is provided on most MICRO SWITCH control bases. The disabling circuit may receive its signal from the current sinking output of a photoelectric logic card, or modulated LED control, or from an electromechanical limit switch, etc. Disabling is used to prevent false or unwanted signals from triggering the control.

Double Break Contacts—(Twin break). This breaks the circuit in two places. Referred to as form Z circuitry also.

Double-Pole Double Throw (DPDT)—switches which make and break two separate circuits. This circuit provides a normally open and normally closed contact for each pole.

Glossary of Terms

E

Effective Sensing Distance—the difference between nominal sensing distance and the ± % manufacturing tolerance.

Enable—the opposite of disable. To allow output in response to an input signal. We often speak of one light source-photoreceiver pair (the ''gating'' pair) enabling a second pair (the ''inspect'' pair).

Enclosed Switch—a basic switch unit (contact block) enclosed in a durable metal housing. The enclosure protects the switching unit, provides mounting means, and fitting for conduit connection.

Environment-Proof Switch—a switch which is completely sealed to ensure constant operating characteristics. Sealing normally includes an ''O'' ring on actuator shaft and fused glass-to-metal terminal seals or complete potting and an elastomer plunger-case seal.

Excess Gain—the ratio of optical power available at a given emitter-to-receiver range to the minimum optical power required to trigger the receiver.

Explosion-Proof—having the ability to contain an explosion within the sensor or housing if it were to occur.

Explosion-Proof Switch—a UL listed switch capable of withstanding an internal explosion of a specified gas without ignition of surrounding gases.

External Inhibit—see *disable.*

Extreme Contamination—coal bins, residue on lens.

F

Fall Time—a measure of the time required for the output voltage of a circuit to change from a high voltage level to a low voltage level, once a level change has started (90% to 10%).

False Pulse—an improper change of state of the output, usually associated with Turn-Off or Turn-On.

False Pulsing—circuitry designed to clamp output Off until the power supply has time to reach proper voltage level. Typically 200-500 msec.

False Pulse Protection—circuitry designed to clamp output Off until the power supply has time to reach proper voltage level. Typically 200-500 msec.

Fiber Optics—transparent fibers of glass or plastic used for conducting and guiding light energy. Fiber optics are used in photoelectrics as light pipes consisting of a bundle of small optical fibers (glass) or single strand (plastic) housed inside a flexible sheathing.

G

Ground—a conducting path, intentional or accidental, between an electric circuit or equipment and the earth, or some large conducting body serving in place of the earth (a voltage reference).

H

Hall Effect Technology—the description given to the following phenomena: when a semiconductor, through which a current is flowing, is placed in a magnetic field, a difference in potential (voltage) is generated between the two opposed edges of the
conductor in the direction mutually perpendicular to both the field and the conductor. Typically used in sensing magnetic fields.

Hardwired—physically interconnected and intended for a specific purpose. Hardwired logic is essentially unalterable.

Hazardous Location—defined as an area in which flammable or combustible mixtures are present.

Head-On—a condition whereby the target approaches the sensing face of the proximity sensor with its center along the sensing face.

High Contamination—heavy particle laden air, extreme washdown environments, grain elevators.

Hermetically Sealed Switch—a switch completely sealed to provide constant operating characteristics. All junctures made with metal-to-metal or glass-to-metal fusion.

Hysteresis, Switching—the principle associated with sensors, such that the operate point is not at the same level as the release point. In solid state sensors, it is accomplished electrically. In mechanical switches, it results from the storing of potential energy before the transition occurs. Also known as differential, and is usally expressed as a percentage of the operate point (e.g. 3-15%).

I

Immediate Response—control transfers On/Off state immediately when target enters the detection range, and reverses state immediately when target leaves detection range.

Inductive Technology—technology based on inductance, the property of an electric circuit by which an electromotive force is induced in it by a variation of current, either 1) in the circuit itself, or 2) in a neighboring circuit.

Infrared (IR)—the invisible radiation (as opposed to visible light) that certain LEDs emit. Standard MICRO SWITCH modulated LED controls have infrared emitting LEDs.

Inhibit—see *disable.*

Input—1) The device or collective set of devices used for bringing data into another device; 2) The signal or stimulus put into a circuit to make the output do something.

Input Signal Duration—a length of time the light beam is blocked (in dark operated mode), or uninterrupted (in light operated mode). Or, the length of time a target is within the operating range.

Insulator—a non-conducting support for an electric conductor. A material that does not conduct electricity.

Integrated Circuit (IC)—an interconnected array of active and passive elements integrated within a single semiconductor substrate or other compatible material, and capable of performing one complete electronic function.

Interface—a common boundary between electronic systems, or parts of a single system.

Interface Circuit—a circuit that links one type of device with another. Its function is to produce the required current and voltage levels for the next stage of circuitry from the previous stage.

Interrogate (Gate)—a function usually performed by a gating light source-photoreceiver pair; asking (interrogating) whether a certain condition has been met (for example, proper fill level in boxes moving along a conveyor), and thereby enabling or disabling an inspect light source-photoreceiver pair (which will count only full boxes).

Intrinsically Safe—limits electrical/thermal energy to levels incapable of causing ignition. External barriers are required.

IP—European environmental ratings similar to USA NEMA ratings.

L

Latching Logic—signal modification that causes the output to be energized and remain energized (maintained output). Latched output may be immediate or delayed. Usually, the latch is released by closing a circuit between the reset (RS/D) terminal and ground.

Leakage Current—small current flowing through or leaking from the output device in the Off state due to semiconductor characteristics.

LED (Light Emitting Diode)—a solid state light source that emits variable light, or (in MICRO SWITCH modulated LED controls) invisible, infrared radiation.

Light Operated (L.O.)—control operating mode in which the output is energized when the light beam is not blocked (retro/thru scan), or object is present (diffuse) the photosensor is illuminated.

Linear (Output)—output that is a continuous amplified version of its input. That is, the output is a predetermined variation of its input.

Load Current—units = Amps/milliamps (DC) or Amps RMS/milliamps RMS (AC). The maximum amount of current that a proximity sensor will switch through its load. Load current for a particular device can be calculated by dividing the load voltage by the load resistance. Attempting to switch a higher load current than the sensor is rated for will result in sensor failure.

Logic—the modification of an input signal that produces delayed, pulsed, latched, or other output response. Logic circuitry is sometimes an integral part of the control, but more often, a separate plug-in card or module.

Low Contamination—warehouse locations, light industry applications, material handling operations.

M

Magnetic Blow-Out Switch—contains a small permanent magnet which provides a means of switching high DC loads. The magnet deflects arc to quench it.

Maintained Contact Switch—designed for applications requiring sustained contact after plunger has been released, but with provision for resetting.

Manufacturer's Tolerance—the maximum variation from standard allowed by the manufacturer between products with the same catalog listing.

Make—to close or establish an electrical circuit.

Maximum Load Current—the maximum amount of current that can flow through a sensor and not cause sensor failure.

Moderate Contamination—milling operations, areas of high humidity, steam.

Modulated Light Source (MLS) Control—a photoelectric control that operates on modulated (pulsed) infrared radiation, and responds only to that frequency rather than steady light intensity. Modulated LED controls offer a high rejection of troublesome ambient light.

Momentary Short Circuit Protection—output circuit protection designed to protect the output device from damage due to a temporary (1-3 sec.) short circuit or until an external fuse can interrupt current.

Momentary Switch—a switch with contacts that return from operated condition to normal condition when actuating force is removed. Unless otherwise stated, all switches in this catalog are momentary.

N

NEMA Ratings—National Electrical Manufacturers Association ratings of an enclosure's ability to provide a degree of protection against contact with equipment and against specified environmental conditions.

Noise, Electrical—noise results from the presence of undesirable electrical voltages or current. It causes devices to operate erratically (if the noise is on the supply line to a device), or produces false information on erratic operation if present on wires carrying signals from the output of a device to the load. Noise can be present in the supply or picked up on lines in many ways. Pick-up from noisy adjacent wires or metal parts is possible. Good wiring practice and/or additional parts can be used to diminish the effects of noise.

Nominal Sensing Distance—an approximate dimension value measured from the face of the sensor to the nearest point of the target. It does not take into consideration manufacturer's tolerance or operational variables. Also known as the operating point.

Nonincendive—inability under normal operation to ignite a hazardous mixture.

Non-modulated Controls—controls designed for indoor applications subject to neither bright ambient light nor extreme vibration. Usually incandescent lamp controls, scanners and light source-photoreceiver pairs.

Normally High—the state of a control in which the output is high (logic 1) in voltage in the rest (Off) condition.

Normally Low—the state of a control in which the output is low (logic 0) in voltage in the rest (Off) condition.

O

Off Delay Logic—adjustable delay (after input signal stops) before output is de-energized.

Off State Current—the supply or bias current flowing into a solid state device when it is in the unactuated state (see Leakage Current).

Ohm—the unit of electrical resistance. Resistance through which a current of one ampere will flow when a voltage of one volt is applied.

On Delay Logic—adjustable delay (after onset of input signal) before output is energized.

One-shot Logic—see *pulsed logic.*

Opacity—the characteristic of an object that prevents light from passing through. The opposite of translucent. Opaque objects are easy to detect since they block light almost entirely.

Operating Mode—refers to the condition of the photosensor (dark or light illuminated) that energizes output. A mode selector switch determines the operating mode.

Operating Temperature—actual range over which sensors can be operated. Usage outside the temperature limits will result in loss of stability, change in operate point and possible permanent damage to the sensor. Nominal sensing distance is determined at 25 – C.

Optical Power—power or intensity of the projected light available from a particular emitter; beam intensity.

OR Logic—an output is produced when any one or more inputs are present.

Output—the useful energy delivered by a circuit or device. Can mean energy produced at the output terminals of an amplifier—a source of energy.

P

Parallel Circuit—a circuit in which current has two or more paths to follow. Two electrical elements are in parallel if both terminals of both elements are electrically connected.

Photocell—a resistive, bulk effect type of photosensor, the type used when it is desirable to wire several photoreceivers in series or in parallel. The resistance decreases with increasing light intensity.

Photoreceiver—a unit consisting of photosensor, focusing lens, and protective enclosure.

Photosensor—a light sensitive portion of a photoelectric control that converts a light signal into an electrical signal. MICRO SWITCH uses photocells and phototransistors.

Phototransistor—a type of photosensor. Typically used where speed of response is important or ambient temperature variations are great.

Polarized Photoelectric Controls—controls that emit a visible LED beam and use a special lens which filters the beam of light so that it is projected in one plane only. The control responds only to the de-polarized reflected light from corner-cube type reflectors (FE-RR1) or special polarized reflective tape.

Power Dissipation—units = Watts/milliwatts (DC) or Volt-Amps (AC). The amount of power that is consumed and converted to heat in normal operation.

Supply Voltage (max) x Supply Current (max) = Power Dissipation

Volts x Amps = Watts (DC) or Volt/Amps (AC)

Precision Snap-Acting Switch—an electromechanical switch having predetermined and accurately controlled characteristics and having a spring loaded quick make and break contact action.

Proximity Scan—See *diffuse scan.*

Proximity Sensor—a sensor with the ability to detect the presence of a metal target, within a specified range, and without making physical contact.

Pull-Down Resistor—a resistor connected across the output of a device or circuit to hold the output equal to or less than the zero input level. Also used to lower output impedance of digital or analog devices. Usually connected to a negative voltage or ground.

Pull-Up Resistor—a resistor connected across the output of a device or circuit to hold the output voltage equal to or greater than the input transition level of a digital device. Usually connected to the positive voltage or plus supply.

Pulse—a momentary sharp change in current, voltage, or other quantity that is normally constant. A pulse is characterized by a rise and fall and has a finite duration.

Pulsed Logic—a signal modification that produces output independently of input signal duration. Pulse duration (dwell) is usually adjustable. Also referred to as one-shot logic. Pulsed logic may be immediate or delayed.

R

Rectifier—a device that converts alternating current into direct current.

Reed Technology—technology where the reed contacts are designed to be actuated by a magnet. When a magnetic field is brought close to the reed contacts, the contacts are drawn together to make the circuit.

Reflective Scan—a scanning technique in which the light source is aimed at a reflective surface to illuminate the photosensor. Retroreflective, specular, diffuse scan and convergent beam are all reflective scan techniques.

Regulation %—the ratio of voltage extremes due to loading or line fluctuations. The process of holding constant a quantity such as voltage by means of a system that automatically corrects errors. For example, as more current is drawn from a battery or power supply, the output voltage tends to decrease (load regulation). With a power supply derived from AC, the DC output voltage can vary with the variation in AC voltage (line regulation).

Repeatability—the ability of a sensor to reproduce output readings when the same value is applied to it consecutively in the same direction, for a specified number of cycles, or specified time duration.

Response Time—the time it takes for a device to respond to an input signal. The sum of the sensor, amplifier, and output response is the total response time.

Retroreflective Scan—the reflective scan technique that uses a special reflector (retroreflector) to return light along the same path it was sent.

Reverse Polarity Protection—circuitry, usually a diode which prevents current from flowing into the control in case of accidental mis-wiring of the plus (+) or minus (–) terminals, preventing damage to the unit.

Ripple—the alternating component of voltage from a rectifier or generator. A slight fluctuation in the intensity of a steady current.

Rise Time—a measure (10% to 90%) of the time required for an output voltage to rise from a state of low voltage to a high voltage level, once a level change has started.

S

Saturation Voltage—the voltage drop appearing across a control device that is fully turned On.

Scan Technique—a method of scanning objects. The two general categories are through and reflective scan.

Self-Contained Control—a photoelectric control in which all three phases of control – sensing, signal conditioning, and output – occur in a single device.

Self-Contained Sensor—a proximity sensor in which all three phases of control, sensing, signal conditioning, and output, occur in a single device.

Sensing Distance—the maximum recommended distance between the sensor and a standard target at which the sensor will effectively and reliably detect the target.

Sensitivity—maximum recommended distance between the sensor and standard target at which sensor will effectively and reliably detect the target.

Sensor—a sensing element. The basic element that usually changes some physical parameter to an electrical signal.

Series Circuit—a circuit in which current has only one path to follow.

Shielded Sensor—a sensor which ''senses'' only to the front of its face and ignores metals to its side. The presence of such side metal, however, may cause a slight shift in operating characteristics.

Signal Conditioning—to process the form or mode of a signal so as to make it intelligible to or compatible with, a given device, including such manipulation as pulse shaping, pulse clipping, digitizing, and linearizing.

Signal Ratio—1) broadly, the comparison of light seen by a photosensor when the beam is blocked to the light seen when the beam is not blocked; 2) More specifically, the comparison of photocell resistance when sensor is dark to when it is illuminated. Proper control application involves establishing a large dark-to-light ratio.

Single-Pole Double-Throw (SPDT)—switch which may either make or break a circuit, depending on how it is wired.

Single-Pole Single-Throw (SPST)—switch with only one moving and one stationary contact. Available either normally open (N.O.) or normally closed (N.C.).

Slide-By—the condition whereby the target approaches the sensing face of the proximity sensor in such a direction that its center will cross the axis of the sensing face at right angles.

Slight Contamination—indoor locations, non-industrial areas, office buildings.

Specular Scan—a reflective scan technique in which reflection from a shiny surface illuminates the photosensor, which must be precisely positioned to receive the reflected light. The angle of incidence equals the angle of reflection.

Standard Target—an object used for making comparative measurements of operating distance. A square of mild steel, 1 mm thick. The length of the side of the square is equal to either:

A: the diameter of the circle inscribed on the active surface of the sensitive face of the sensor, or

B: three times the rated operating distance, whichever is the greater.

Supply Current—units = Amps or milliamps. The amount of current necessary to maintain operation of a photoelectric control, proximity sensor or control base. Sometimes referred to as Current Consumption.

Supply Voltage—units = Volts. The range of power required to maintain proper operation of a photoelectric control, proximity sensor or control base. The difference in potential (or range of difference in potential) necessary to operate the unit.

Switching Frequency—the actual number of targets to which the sensor can respond in a given time period, usually expressed as Hertz (cycles per second).

T

Target—the part or piece being detected.

Thermal Drift Chart—a chart illustrating sensor operating variance due to changes in temperature.

Threshold Response—a control type that responds to the change in input signal level. Plug-in amplifiers are either threshold or transition responsive.

Thru Scan—a scanning technique in which the emitter (light source) is aimed directly at the receiver. Also called direct scan and transmitted scan, since light is transmitted directly, not reflected to the sensor. Presently, it is the only scanning technique commonly used to scan distances greater than 40 feet.

Time Delay Before Availability—also known as False Pulse Protection. Outputs are turned Off when power is first applied during this time period.

Transient Protection—circuitry to guard against spikes induced on the supply lines by inductive sources such as heavy motors or solenoids turning On and Off.

Transients—in electronic usage, usually refers to an unwanted, temporary, large increase or decrease in a current or supply voltage that only occurs occasionally. Almost always due to reactive components during rapid changes in voltage or current.

Transition Responsive—a control type that responds to the rate of change in light intensity rather than the level change. Used to detect fast moving objects that cause little change in light intensity level.

Translucent—allows light to pass through. Detecting translucent objects is often best done with retroreflective scan, during which the light must pass through the object twice, thereby causing more of a signal change (larger signal ratio).

TTL Compatibility—TTL (transistor-transistor-logic) requires NPN (current sinking) input signals. Reliable operation demands maximum input sensor voltage drop of 0.8 V. Most TTL compatible interface devices have voltage drops of less than 0.7 V.

U

UL—Underwriter's Laboratories, Inc., a non-profit organization that establishes, maintains and operates laboratories for the examination and testing of devices, systems and materials primarily for safety.

Unshielded Sensor—a sensor with limited side and front sensing capabilities.

Usable Sensing Distance—sensing distance after temperature range tolerance and manufacturers tolerance are taken into account.

V

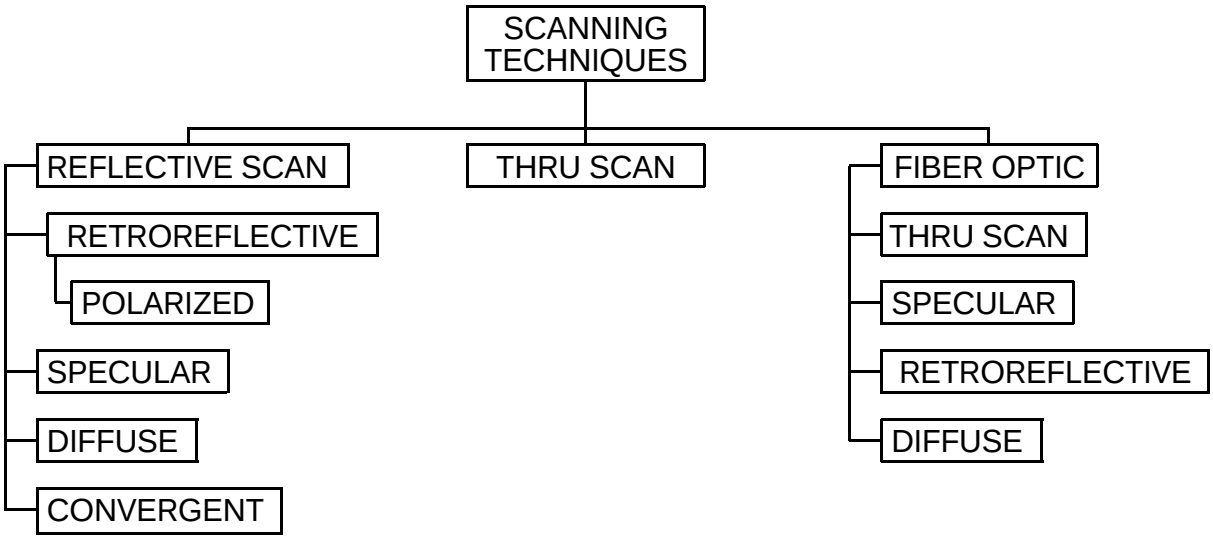
Voltage—units = Volts (DC) or Volts RMS (AC). The term used to designate the electrical energy differential that exists between two points and is capable of producing the flow of current when a closed path is connected between the two points.

Voltage Drop—units = Volts (DC) or Volts RMS (AC). Sometimes referred to as Saturation Voltage. In any solid state control that switches a load, there will be some voltage dropped across the output. This voltage drop or saturation voltage will often vary with the amount of current going through the output section and the load. It should be specified with current conditions.

Photoelectric Sensors/Controls

Scanning Techniques

OVERVIEW



Retroreflective
- Light beam is directed at a reflective target (reflector, tape or other reflective object) – one which returns light along the same path it was sent.
- The object to be detected passes between photoelectric control and reflective target.

Polarized
- Will work only with cornercube reflector or special polarized reflective tape.
- Will not false trigger when sensing shiny object.

Specular
- Light beam is directed at a shiny surface which will always occupy the same position in relationship to the photoelectric control.
- Light will be reflected at the same angle at which it was received.
- When object is not present light will be reflected at a different angle.

Diffuse
- Light beam is directed at the object to be detected.
- Light will be reflected off the object in many directions.
- Some of the light reflected from the object will be sensed by the receiver.

Convergent
- Light beam is directed at object to be detected (ignore's background surfaces).
- Object must be at a given distance in relationship to photoelectric control before light will be reflected to receiver.

Thru
- Light source (emitter) and receiver are placed opposite each other.
- The object to be detected passes between the two.

Fiber Optic
- Not a scanning technique but rather another way of transmitting light beam.
- Must use bifurcated cables when using retroreflective and diffuse scans.

Photoelectric Sensors/Controls

Scanning Techniques

ADVANTAGES/APPLICATION CONSIDERATIONS

Scan Types	Advantages	Application Considerations
Retroreflective/Polarized	1. One sided scanning 2. Ease of alignment 3. Immune to vibration	1. Avoid detecting small parts or precise positioning 2. Avoid clear material detecting 3. Avoid sensing shiny objects (use polarized controls)
Polarized	1. One sided sensing 2. Does not false trigger off highly reflective objects 3. Senses clear materials 4. Ease of alignment 5. Immune to vibration	1. Reduced scan range compared to retrotreflective 2. Avoid detecting small parts or precise positioning
Specular	1. Best for shiny versus dull surfaces 2. Detecting height differential from background, i.e., cloth on a shiny table	1. Alignment angle between emitter and receiver critical 2. Distance from control to target must be constant
Diffuse	1. No reflector required 2. Convenient for installation 3. One sided scanning 4. Senses clear materials when distance is not fixed 5. Color sensing (incandescent controls) 6. Ease of alignment	1. Sensing range is always specified to white test paper 2. Shiny material requires close control of scanning angle 3. Background object's reflectivity cannot be more than target reflectivity 4. Large effective beam, avoid small parts detection 5. Contaminated area a problem 6. Avoid counting applications
Convergent	1. First choice for detecting clear materials 2. Ignores unwanted background surface reflection 3. Detects objects with low reflectivity 4. Detects height differential	1. Distance must be constant 2. Surface reflectivity a factor
Thru	1. Most reliable when target is opaque 2. Long range scanning, most excess gain 3. Use in high contamination areas, dirt, mist, condensation, oil film, etc. 4. Precise positioning or edge-guiding of opaque material 5. Parts counting	1. Avoid clear material detecting 2. For small parts must use aperture 3. Alignment critical 4. Additional wiring (2 units) 5. Vibration a factor
Fiber Optics	1. High temperature applications 2. Where space is limited 3. Size and flexibility of fiber leads 4. Corrosive areas 5. Noise immunity	1. Cost 2. Breakage 3. Short range scanning

Photoelectric Sensors/Controls

Scanning Techniques

There are several scanning techniques — ways to set up an emitter (light source) and receiver (photosensor) to detect objects. The best technique to use is the one that yields the highest signal ratio for the particular object to be detected, subject to scanning distance and mounting restrictions.

Characteristics of the objects to be detected that have a bearing on which scan technique to use include:

- degree of opacity
- degree of reflectiveness
- position of objects as they pass the control
- color as a special consideration

REFLECTIVE SCAN

With a reflective scan control, the light source and photosensor (usually in the same housing) are placed on the same side of the object to be detected. The light beam is reflected either from a permanent reflective target or directly from the object to be detected back to the photosensor. There are five types of reflective scan:

- Retroreflective
- Polarized Retroreflective
- Diffuse
- Convergent
- Specular

Retroreflective Scan

With retroreflective scan, emitter (light source) and receiver (photosensor) are in the same housing. The light beam is directed at a retroreflective target — one which returns the light along the same path it was sent. Retroreflective targets are available as acrylic disks, tape or chalk. Perhaps the most commonly used retro target is the familiar bicycle-type reflector. A larger reflector returns more light to the receiver, and thus allows greater distance scanning. With retro targets, alignment is not critical. The control (emitter and receiver) can be as much as 15° to either side of the perpendicular to the target. Also, since alignment need not be exact, retroreflective scan is an excellent way to counteract vibration.

Retroreflection from a stationary target normally provides a high signal ratio as long as the object passing between the control and target is not highly reflective. Retroreflective scan is a preferred technique to detect translucent objects, and assures a higher signal ratio than is obtainable with thru scan. With thru scan, the ''dark'' signal may not register very dark at the photosensor in the receiver, because some light will pass through the object. With retroreflective scan, however, any light that passes through the translucent object on the reflector is diminished again as it returns from the reflector.

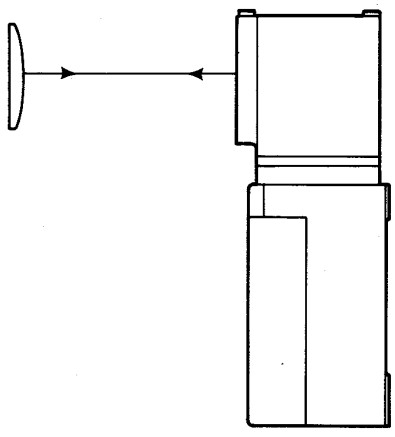
Another way to use retroreflective scan is to apply retroreflective tape or chalk coding to cartons or other items that must be sorted.

Retroreflective scanning is useful in conveyor applications and general beam break applications. It is not as reliable as thru scanning if the environment is dirty, if scanning distance is great, or if product breaking the beam is reflective (e.g. glass, polished stainless, etc.).

Some retroreflective controls can be used at distances up to 40 feet in clean air conditions. As the distance to target increases a larger retro target should be used to intercept and return as much light as possible.

Single-unit wiring and maintenance are additional advantages of retroreflective scanning.

Retroreflector scan advantages include single-unit wiring and non-critical alignment with reflector.



Polarized Scan

Polarized scan is a modified retroreflective scan. As with other retroreflective controls, polarized controls usually contain both an emitter and receiver in one unit. Polarized controls use a special lens which filters the emitter's beam of light so that it is projected in one plane only. The receiver responds only to the de-polarized reflected light from corner-cube type reflectors or polarized sensitive reflective tape. It is designed to ignore the light reflected from highly reflective targets such as shrink wrap materials, shiny luggage or aluminum cans.

The visible beam can be seen on the reflector for easier and more accurate alignment.

Must be corner cubed reflector or polarized sensitive reflective tape.

Photoelectric Sensors/Controls

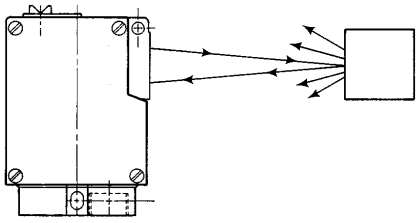
Scanning Techniques

Diffuse Scan

Usually diffuse scan controls contain both the emitter and the receiver. In the diffuse scanning mode the emitted light strikes the product surface at some arbitrary angle and the light is then diffused from the surface at all angles. The product or target is the reflector. The target actually makes the beam instead of breaking the beam.

Non-shiny (matte) surfaces such as kraft paper, rubber, and cork absorb most incident light and reflect only a small amount. Light is reflected or scattered nearly equally in all directions. In diffuse scan, the control is positioned perpendicular to a dull surface. Emitted light is reflected back from the target to operate the receiver. Because the light is scattered, only a small percentage returns. Therefore, scanning distance is somewhat limited. A portion of the diffused light is returned to the receiver. Alignment is not critical in picking up diffuse reflection. Diffuse scan is the mode to use for web break and ejected part detection, conveyor jam detection, etc.

Target makes the beam instead of breaking the beam



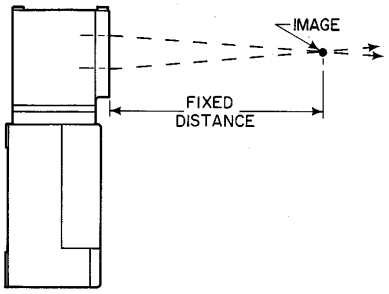
Convergent Beam

Convergent beam scanning is a special variation of the diffuse mode. The control's optical system is the key to its operation. It simultaneously focuses and converges the light beams to a fixed-focal point in front of the control. The control is essentially blind a short distance before and beyond this focal point. Operation is even possible when highly reflective backgrounds are present. Like diffuse scanning, convergent beam scanning senses light reflected back directly from an object.

Convergent beam scanning is used to detect products which are only inches away from another reflective surface. It is the first choice for edge-guiding or positioning clear or translucent materials. Because the beam is well defined, it is also a good second choice for position sensing of opaque materials.

Parts can be sensed on a conveyor from above while ignoring the conveyor belt. Or they can be sensed from the side without detecting guides or rails directly in back of the object. Convergent beam scanning can detect the presence of fine wire, resistor leads, needles, bottle caps, pencils, the stack height of material, fill level of clear liquids and discriminate the product against its background. It is also capable of sensing black code marks against a contrasting background.

Fixed focus light beams



Specular Scan

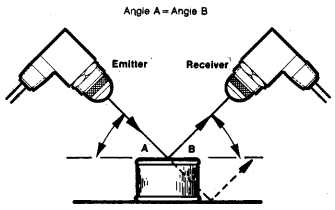
In the specular scanning mode, the emitter and receiver are in separate housings. An emitter and receiver are mounted at equal angles from the perpendicular to a reflective surface (see below). The distance from the surface of an object to the control(s) must remain constant.

The specular mode is useful in some applications where differentiating between a shiny and a dull surface is necessary. An example of this would be checking for the presence or absence of foil or poly wrap on cartons.

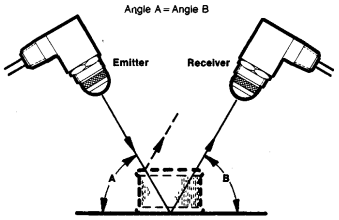
The angle at which light strikes the reflecting surface equals the angle at which it reflects from the surface. Positioning of the emitter (light source) and receiver must be precise (mounting brackets which fix the emitter-receiver relationship are available), and the distance of the reflecting surface from the emitter and receiver must be consistently controlled. The size of the angle determines the depth of scanning field. With a narrower angle, there is more depth of field. With a wider angle, there is less depth of field. In a fill level detection application, for example, this means that a wider angle between emitter and receiver allows detection of fill level more precisely.

Specular scan provides a good signal ratio when required to distinguish between shiny and non-shiny (matte) surfaces. When monitoring a non-flat shiny surface with high and/or low points that fall outside the depth of field these points will appear as dark signals to the receiver.

Target reflects beam to photoreceiver



Target interferes with beam



Photoelectric Sensors/Controls

Scanning Techniques

THRU SCAN

In thru (sometimes referred to as direct) scan, the emitter (light source) and receiver (photosensor) are positioned opposite each other, so light from the emitter shines directly on the receiver. The object to be detected passes between the two. If the object is opaque, thru scan will usually yield the highest signal ratio and is a logical first choice.

As long as the target blocks enough light as it interrupts the light beam, it may be skewed or tipped in any manner. As a rule of thumb, object size should be at least the diameter of the receiver lens. When detecting small objects, place an aperture over the receiver lens in order to reduce its diameter. Detecting small objects typically requires thru scan.

Because thru scan does not rely on the reflectiveness of the object to be detected or a permanent reflector for light to reach the receiver, no light is lost at the reflecting surface.

While thru scan provides the longest scanning distance, it has certain limitations. Alignment is critical, and difficult to maintain where vibration is a factor. Also, with separate emitter and receiver, there is additional wiring which may be inconvenient if the application is difficult to reach. This factor also adds to installation time and cost.

FIBER OPTICS

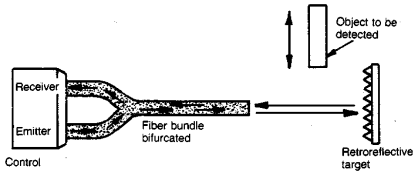
Fiber optics is not a scanning technique, but a method of controlling or transmitting the signal (light beam) from or to the control. Fiber optics use transparent fibers of glass or plastic to conduct and guide light energy. They are used in photoelectric controls as light-pipes.

The control's beam is transmitted through a cable. It returns through a separate cable either combined in the same cable assembly (bifurcated) or within a separate cable assembly (thru scan) to the receiver.

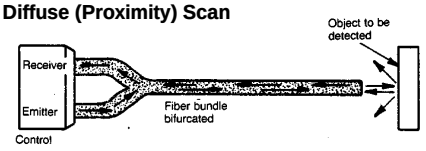
Scanning options depend on the type of cable selected. Retroreflective and diffuse scan use a bifurcated cable and thru scan uses two separate cables (emitter and receiver). Scan distances vary depending on type of scan from 0.4 to 54 inches. An optical lens accessory that attaches to some cable ends significantly increases scan distances.

Combining the optic cables with photoelectric controls has many advantages. Small parts detection and usage in limited mounting space is obvious. High temperature, high vibration or high electrical noise levels at any control can cause false triggering. With fiber optics, the light emitting and receiving components are located remotely at the control's housing and only passive light-transmission fibers need be exposed to the severe environment.

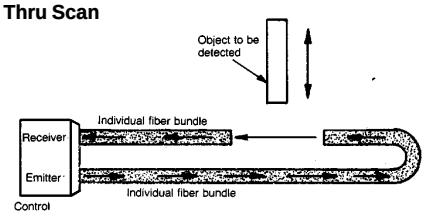
Retroreflective Scan



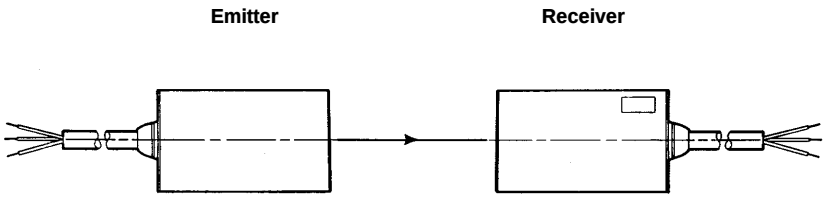
Diffuse (Proximity) Scan



Thru Scan

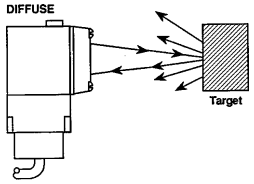


In thru scan the emitter is aimed directly at the receiver.



Photoelectric Sensors/Controls

Product Selection/Feature Guide



Diffuse

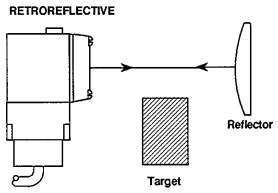
- Light beam is directed at the object to be detected.
- Light will be reflected off the object in many directions.
- Some of the light reflected from the object will be sensed by the receiver.

Advantages

1. No reflector required
2. Convenient for installation
3. One sided scanning
4. Senses clear materials when distance is not fixed
5. Ease of alignment

DIFFUSE

Product Type	Scan Range	Page Number	Input		Output					Logic Capab.	Diagnostic Output	Sealing	
			DC	AC	NPN	PNP	Relay	SS/ac	FET			NEMA	IP
MHP	6 or 18″	C19	●	●	●	●		●			●	4X, 6P	
HDMP/MP	18″, 3′ or 10′	C26	●	●	●	●	●	●	●	●		4X, 6P/4, 13	
FE7A	2.75″	C94	●		●							12	64
FE7B	8″ or 28″	C97	●		●	●						12	64
FE7C	15″ or 39″	C102	●	●	●	●		●			●	12	64
FE7D	2.3′	C110	●	●			●						66
FE8B	12″	C113	●		●	●						4	67
CP18	4, 8 or 16″	C77	●	●	●	●			●			4	67
GP5	3.2′	C17	●	●			●					4	66



Retroreflective

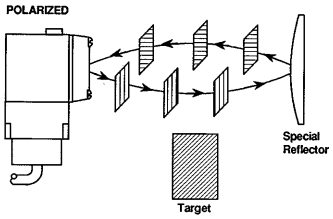
- Light beam is directed at a reflective target (reflector, tape or other reflective object) — one which returns light along the same path it was sent.
- Target object passes between the sensor and a reflective surface.

Advantages

1. One sided scanning
2. Ease of alignment

RETROREFLECTIVE

Product Type	Scan Range	Page Number	Input		Output					Logic Capab.	Diagnostic Output	Sealing	
			DC	AC	NPN	PNP	Relay	SS/ac	FET			NEMA	IP
MHP	18 or 30′	C19	●	●	●	●		●			●	4X, 6P	
HDMP/MP	30′	C26	●	●	●	●	●	●	●	●		4X, 6P/4, 13	
FE7B	7′	C97	●		●	●						12	64
FE7C	10′	C102	●	●	●	●		●			●	12	64
FE8B	10′	C113	●		●	●						4	67
CP18	13′	C77	●	●	●	●			●			4	67
MLS7A	10′	C156	●		●							4, 9	
MLS8C	40′	C157	●	●			●	●	●	●		4	
GP5	23′	C17	●	●			●					4	66



Polarized

- Will work only with cornercube reflector or special polarized reflective tape.
- Will not false trigger when sensing shiny object.

Advantages

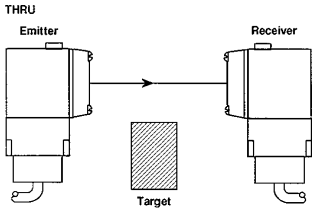
1. One sided sensing
2. Does not false trigger off highly reflective objects
3. Senses clear materials
4. Ease of alignment

POLARIZED

Product Type	Scan Range	Page Number	Input		Output					Logic Capab.	Diagnostic Output	Sealing	
			DC	AC	NPN	PNP	Relay	SS/ac	FET			NEMA	IP
MHP	8′	C19	●	●	●	●		●			●	4X, 6P	
HDMP/MP	15′ - 20′	C26	●	●	●	●	●	●	●	●		4X, 6P/4, 13	
FE7B	6.7′	C97	●		●	●						12	64
FE7C	9.8′	C102	●	●	●	●					●	12	64
FE7D	9.8′	C110	●	●			●						66
CP18	4.9′	C82	●		●	●						4	67
GP5	13.1′	C17	●	●			●					4	66
MLS8C-P	15′	C157		●			●			●		4	

Photoelectric Sensors/Controls

Product Selection/Feature Guide



Thru

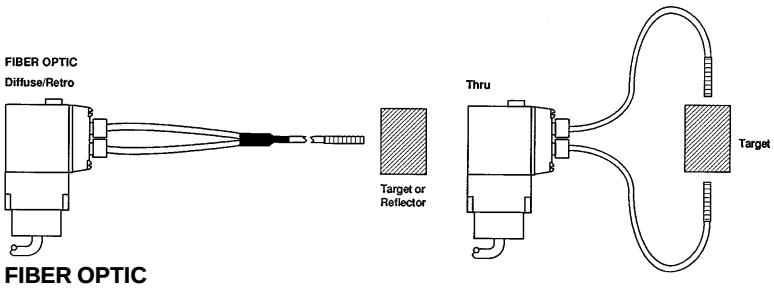
- Light source (emitter) and receiver are placed opposite each other.
- The object to be detected passes between the two.

Advantages

1. Most reliable when target is opaque
2. Long range scanning, most excess gain
3. Use in high contamination areas, dirt, mist, condensation, oil film, etc.
4. Precise positioning or edge-guiding of opaque material and parts counting.

THRU

Product Type	Scan Range	Page Number	Input		Output					Logic Capab.	Diagnostic Output	Sealing	
			DC	AC	NPN	PNP	Relay	SS/ac	FET			NEMA	IP
MHP	100′	C19	●	●	●	●		●			●	4X, 6P	
HDMP/MP	325′/200′	C26	●	●	●	●	●	●	●	●		4X, 6P/4, 13	
FE7A	5′	C94	●		●							12	64
FE7B	6.7′ or 32.8′	C97	●		●	●						12	64
FE7C	16′ or 49′	C102	●	●	●			●			●	12	64
FE7D	33′	C110	●	●			●						66
PJ7	39″	C118	●		●	●							65
FE8B	16′	C113	●		●	●							67
CP18	98′	C82	●	●	●	●			●			4	67
MLS2B	2500′	C156		●			●			●		4	
GP5	49.2′	C17	●	●			●					4	66



Fiber Optic

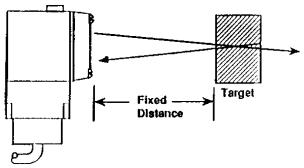
- Not a scanning technique but rather another way of transmitting light beam.
- Must use bifurcated cables when using retroreflective and diffuse scans.

Advantages

1. High temperature applications
2. Where space is limited
3. Size and flexibility of fiber leads
4. Corrosive resistance, noise immunity.
5. Color sensing

FIBER OPTIC

Product Type	Scan Range	Page Number	Input		Output					Logic Capab.	Diagnostic Output	Sealing	
			DC	AC	NPN	PNP	Relay	SS/ac	FET			NEMA	IP
MHP	D to 2.86″ T to 43.3″	C19	●	●	●	●		●			●	4X, 6P	
HDMP/MP	R to 60″ D to 4″ T to 30″	C26	●	●	●	●	●	●	●	●		4X, 6P/4, 13	
FE7B-F	D 0.4″	C100	●		●	●						12	64
FE7C-F	D to 9″ T to 32″	C108	●	●	●	●		●				12	64
FE5F	D to 3.15″ T to 15.75″	C122	●		●	●				●	●		40
HPX	D to 9″ T to 32″	C7	●		●	●					●		40



Convergent

- Light beam is directed at object to be detected (ignores background).
- Object must be at a given distance in relationship to photoelectric control before light will be reflected to receiver.

Advantages

1. First choice for detecting clear objects
2. Ignores unwanted background surface reflection
3. Detects objects with low reflectivity
4. Detects height differential

CONVERGENT BEAM

Product Type	Scan Range	Page Number	Input		Output					Logic Capab.	Diagnostic Output	Sealing	
			DC	AC	NPN	PNP	Relay	SS/ac	FET			NEMA	IP
MHP	1 or 2.5″	C19	●	●	●	●		●			●	4X, 6P	
HDMP/MP	1.5″ or 4″	C26	●	●	●	●	●	●	●	●		4X, 6P/4, 13	
PJ7	.79-1.6″	C118	●		●	●							65

Application Note: Enclosures are based, in general, on the broad definitions outlined in NEMA standards. Therefore, it will be necessary to ascertain that a particular enclosure is adequate when exposed to the specific conditions that might exist in intended applications. Except as might otherwise be noted, all references to products relative to NEMA enclosure types are based on MICRO SWITCH evaluation only. For application/scan/product use see next page.