

# Environmental Terms

Environment	Typical Industries & Applications	Recommendations
<b>Normal Temperature</b>	All non-abusive applications from -20° to +55° C	<ul style="list-style-type: none"> <li>All sensor types; choice depends on range, excess gain and electrical and performance requirements.</li> </ul>
<b>High Temperatures</b>	<ul style="list-style-type: none"> <li>Metal processing</li> <li>Painting applications</li> <li>Paper manufacturing</li> <li>Outdoor applications</li> </ul>	<ul style="list-style-type: none"> <li><b>Glass fiber optics:</b> Use when above +100° C; max. to 480° C.</li> <li><b>Plastic fiber optics:</b> Use polycarbonate fibers up to +125° C.</li> <li><b>Remote sensors:</b> Use up to +100° C.</li> </ul>
<b>Low Temperatures</b>	<ul style="list-style-type: none"> <li>Meat processing</li> <li>Food processing</li> <li>Chemical processing</li> <li>Outdoor applications</li> </ul>	<ul style="list-style-type: none"> <li><b>Glass fiber optics:</b> Use below -40° C; min. to -140° C.</li> <li><b>Remote sensors:</b> -40° C to +100° C.</li> </ul>
<b>Moisture</b>	<ul style="list-style-type: none"> <li>Food processing</li> <li>Car washes</li> <li>Pharmaceuticals</li> <li>Bottling plants</li> <li>Outdoor applications</li> </ul>	<ul style="list-style-type: none"> <li>Sensors with NEMA 6 ratings represent the best moisture seals and can resist occasional and prolonged (NEMA 6P) submersion.</li> <li>NEMA 4 and 6 ratings: Can withstand low-pressure washdown.</li> <li>NEMA tests do not take into account the elevated pressures and temperatures of solutions used to wash equipment in food processing applications.</li> <li>See NEMA and IP enclosure ratings chart online.</li> <li>Condensation can be eliminated by using unlensed fiber optics.</li> </ul>
<b>Corrosive Agents</b>	<ul style="list-style-type: none"> <li>Semiconductors</li> <li>Chemical</li> <li>Lumber</li> <li>Pulp/paper</li> <li>Amusement parks (UV light)</li> </ul>	<p><b>Solvents/Alkalis</b></p> <ul style="list-style-type: none"> <li>Stainless steel sensor housings.</li> <li>Glass fiber optic assemblies in stainless steel sheathing.</li> <li>Fiber optic assemblies without epoxy (available by special order).</li> </ul> <p><b>Bases</b></p> <ul style="list-style-type: none"> <li>Fiber optic assemblies with PVC jackets.</li> </ul> <p><b>Acids</b></p> <ul style="list-style-type: none"> <li>Thermoplastic polyester housings; see chart online.</li> <li>Teflon® sheathing; protect the sensing tip from direct contact with concentrated acids.</li> <li>Polyethylene jacket of standard plastic fiber optic cables resists acids, but can degrade with prolonged contact.</li> </ul>
<b>Dirt, Dust, Fog</b>	<ul style="list-style-type: none"> <li>Lumber</li> <li>Ceramics ovens</li> <li>Paper</li> <li>Steel</li> <li>Mining</li> </ul>	<p><b>High Excess Gain</b></p> <ul style="list-style-type: none"> <li>Excess gain data should be carefully evaluated.</li> <li>Opposed-mode sensors with excess gain above 1000x.</li> </ul> <p><b>Lens Size</b></p> <ul style="list-style-type: none"> <li>Smaller lens concentrates the beam for greater penetrating ability.</li> <li>Larger lenses will yield greater range, but will disperse available sensing energy.</li> </ul> <p><b>Inductive Proximity Sensors</b></p> <ul style="list-style-type: none"> <li>For metal targets and short sensing ranges.</li> </ul>
<b>Vibration &amp; Shock</b>	<ul style="list-style-type: none"> <li>Metal (stamping)</li> <li>Printing (presses)</li> <li>Packaging</li> </ul>	<ul style="list-style-type: none"> <li>Lightweight sensing components; smaller sensors.</li> <li>Anti-vibration mounts placed between the sensor and mounting bracket.</li> <li>Glass or plastic fiber optic assemblies can withstand more than 100 Gs of acceleration.</li> <li>Glass fibers cannot tolerate repeated flexing. Use plastic, hi-flex or coiled fibers.</li> <li>Remote sensors can withstand up to 15 Gs of acceleration.</li> <li>One-piece self-contained sensors with epoxy-encapsulated circuitry withstand up to 10 Gs of acceleration.</li> </ul>
<b>Hazardous Areas</b>	<ul style="list-style-type: none"> <li>Chemicals/Gas/Oil/Refinery</li> <li>Grain elevators</li> <li>Airbag manufacturers</li> </ul>	<ul style="list-style-type: none"> <li>Special sensing equipment must be installed, using measures to avoid sources of ignition.</li> <li>See chart defining Hazardous Location Classifications online.</li> <li>NAMUR photoelectric sensors.</li> <li>Glass and plastic fiber optics. (Plastic fiber optics are preferred, as it is easier to seal around the fiber bundle at the barrier between the hazardous and safe environment).</li> </ul>

# English-Metric Conversion

Accessories

Reference

Hookups

Wiring Diagrams

Reference Charts

Glossary

International Reqs

Inch Fraction	Inch Decimal	Millimeter
—	.0039	0.1
—	.0079	0.2
—	.0118	0.3
1/64	.0156	0.397
—	.0157	0.4
—	.0197	0.5
—	.0236	0.6
—	.0276	0.7
1/32	.0312	0.794
—	.0315	0.8
—	.0354	0.9
—	.0394	1
3/64	.0469	1.191
1/16	.0625	1.588
5/64	.0781	1.984
—	.0787	2
3/32	.0938	2.381
7/64	.1094	2.778
—	.1181	3
1/8	.1250	3.175
9/64	.1406	3.572
5/32	.1562	3.969
—	.1575	4
11/64	.1719	4.366
3/16	.1875	4.762
—	.1968	5
13/64	.2031	5.159
7/32	.2188	5.556
15/64	.2344	5.953
—	.2362	6
1/4	.2500	6.350
17/64	.2656	6.747
—	.2756	7

Inch Fraction	Inch Decimal	Millimeter
9/32	.2812	7.144
19/64	.2969	7.541
5/16	.3125	7.938
—	.3150	8
21/64	.3281	8.334
11/32	.3438	8.731
—	.3543	9
23/64	.3594	9.128
3/8	.375	9.525
25/64	.3906	9.922
—	.3937	10
13/32	.4062	10.319
27/64	.4219	10.716
—	.4331	11
7/16	.4375	11.112
29/64	.4531	11.509
15/32	.4688	11.906
—	.4724	12
31/64	.4844	12.303
1/2	.500	12.700
—	.5118	13
33/64	.5156	13.097
17/32	.5312	13.494
35/64	.5469	13.891
—	.5512	14
9/16	.5625	14.288
37/64	.5781	14.684
—	.5905	15
19/32	.5938	15.081
39/64	.6094	15.478
5/8	.625	15.875
—	.6299	16
41/64	.6406	16.272

Inch Fraction	Inch Decimal	Millimeter
21/32	.6562	16.669
—	.6693	17
43/64	.6719	17.066
11/16	.6875	17.462
45/64	.7031	17.859
—	.7087	18
23/32	.7188	18.256
47/64	.7344	18.653
—	.7480	19
3/4	.750	19.050
49/64	.7656	19.447
25/32	.7812	19.844
—	.7874	20
51/64	.7969	20.241
13/16	.8125	20.638
—	.8268	21
53/64	.8281	21.034
27/32	.8438	21.431
55/64	.8594	21.828
—	.8661	22
7/8	.875	22.225
57/64	.8906	22.622
—	.9055	23
29/32	.9062	23.019
59/64	.9219	23.416
15/16	.9375	23.812
—	.9449	24
61/64	.9531	24.209
31/32	.9688	24.606
—	.9842	25
63/64	.9844	25.003
1	1.000	25.400
—	—	—

To convert millimeters to inches, multiply by 0.0394.

To convert inches to millimeters, multiply by 25.4.

# Temperature Conversion

Celsius°	Fahrenheit°
-62	-80
-57	-70
-51	-60
-46	-50
-40	-40
-34	-30
-29	-20
-23	-10
-17.8	0
-17.2	1
-16.7	2
-16.1	3
-15.6	4
-15.0	5
-14.4	6
-13.9	7
-13.3	8
-12.8	9
-12.2	10
-11.7	11
-11.1	12
-10.6	13
-10.0	14
-9.4	15
-8.9	16
-8.3	17
-7.8	18
-7.2	19
-6.7	20
-6.1	21
-5.6	22
-5.0	23
-4.4	24
-3.9	25
-3.3	26
-2.8	27
-2.2	28
-1.7	29
-1.1	30
-0.6	31

Celsius°	Fahrenheit°
0.0	32
0.6	33
1.1	34
1.7	35
2.2	36
2.8	37
3.3	38
3.9	39
4.4	40
5.0	41
5.6	42
6.1	43
6.7	44
7.2	45
7.8	46
8.3	47
8.9	48
9.4	49
10.0	50
10.6	51
11.1	52
11.7	53
12.2	54
12.8	55
13.3	56
13.9	57
14.4	58
15.0	59
15.6	60
16.1	61
16.7	62
17.2	63
17.8	64
18.3	65
18.9	66
19.4	67
20.0	68
20.6	69
21.1	70
21.7	71

Celsius°	Fahrenheit°
22.2	72
22.8	73
23.3	74
23.9	75
24.4	76
25.0	77
25.6	78
26.1	79
26.7	80
27.2	81
27.8	82
28.3	83
28.9	84
29.4	85
30.0	86
30.6	87
31.1	88
31.7	89
32.2	90
32.8	91
33.3	92
33.9	93
34.4	94
35.0	95
35.6	96
36.1	97
36.7	98
37.2	99
37.8	100
43	110
49	120
54	130
60	140
66	150
71	160
77	170
82	180
88	190
93	200
100	212

Temperature Scale	Water Boiling Point	Water Freezing Point	Conversion Formula
° F (Fahrenheit)	212° F	32° F	° F = (° C x 9/5) + 32
° C (Celsius or Centigrade)	100° C	0° C	° C = (° F - 32) x 5/9

**NOTE:** For temperatures not given in the table, use the conversion formula above.



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Sensing

Safety

Vision

Wireless

Indication

**2.4 GHz**

One of the ISM bands in the radio spectrum that is recognized worldwide. Experiences more path loss than 900 MHz band.

**2-wire sensor**

A sensor designed to wire in series with its load, exactly like a limit switch. A 2-wire sensor remains powered when the load is "off" by a residual "leakage current" that flows through the load.

**902-928 MHz Band**

One of the ISM bands in the radio spectrum recognized in North America, Australia, and Israel; characterized by lower throughput but better range and wall penetration.

**A****A/D converter**

(Analog to Digital Converter) An electronic device that converts data from analog form to digital, or binary code for a computer.

**AC**

(Alternating Current) A sinusoidal current rated at a given frequency.

**Acceleration**

The rate of change of velocity, with respect to time.

**Access guard**

A type of perimeter guarding, typically used to guard doorways, cell entries or exits, walkways, and machine access points.

**Accuracy (1)**

1. The degree to which a measured value is similar to an actual value. 2. The extent to which vision sensors can correctly measure and obtain a true value of a feature.

**Accuracy (2)**

The difference between indicated value and actual value, at room temperature. In most cases, the accuracy of a measurement and inspection sensor is comprised of two main sources of error: the resolution and the linearity.

**Acquisition**

The manner in which outside information is brought into an analysis system; an image acquisition generally involves A/D conversion.

**Adjustable guard**

A guard that can be adjusted to accommodate various jobs or set-ups.

**Adjustable-field mode**

Adjustable-field sensors use two receivers and a comparator circuit to cancel sensing response whenever the intensity of the reflected light reaching the long-range receiver exceeds the intensity of the reflected light reaching the close-range receiver. As a result, any object lying beyond the sensor's "cutoff point" can be reliably ignored.

**Alignment**

Positioning of a sensor so that the maximum amount of the emitted energy reaches the receiver sensing element.

**AM**

Abbreviation for Amplitude Modulation. Type of modulations in which the data signal is "attached" to a carrier wave by varying the amplitude of the carrier wave.

**Ampere**

(Amp) A unit of measurement of electric current.

**Amplifier**

A device that accepts a small signal and outputs a larger signal generally matching the characteristics of the input signal. Amplifiers are available to boost electrical and optical signals.

**Analog**

Pertaining to a class of devices or circuits in which the output varies as a continuous function of the input.

**Analog output**

A sensor output that varies over a range of voltage (or current) and is proportional to some sensing parameter (as opposed to a digital output).

**AND logic**

A logic function in which all of two or more defined input conditions must exist simultaneously before a load is energized (A and B and C = output).

**Angle of acceptance**

The included angle of the area of sensor response.

**Angle of divergence/acceptance**

See Effective Aperture Angle (EAA)

**Angle of incidence**

The angle at which light strikes a surface.

**Angle of view**

1) The angle formed between two lines drawn from the most widely separated points in the object plane to the center of the lens. 2) The angle between the axis of observation and perpendicular to the specimen surface.

**Antenna**

An electronic component used to transmit and receive radio waves, in a narrow frequency range.

**Antirepeat**

The function of the control system designed to limit the machine to a single stroke or cycle even if the tripping or actuating means is held operated.

**Anti-tie down**

A feature of a two-hand control where both hand controls must be released before the machine can restart.

**Aperture**

1. The size of a lens opening. 2. A mechanical part attached to a lens used to restrict the size of a lens opening.

**Architecture**

Overall design or structure of a system or network, including all hardware and software.

**Area guard**

A safeguarding technique that provides a means of continually sensing or detecting an individual within an area adjacent to or associated with a hazard.

**Area light**

An area light provides even illumination in a concentrated area.

**Area-scanning device**

A safeguarding device that creates a sensing plane to detect the presence of an individual or object.

**ASCII**

Acronym of American Standard Code for Information Interchange. Pronounced askee. An 8 bit coded character set used to represent alphanumeric, punctuation marks and certain special control characters.

**ASIC**

Acronym for Application Specific Integrated Circuit. A chip designed for a specific application rather than a general-purpose chip such as a microprocessor.

**Aspect Ratio**

The width to height of an object. The ratio states the relationship of one side to the other. A computer monitor is 4:3, meaning 4 units wide by 3 units high.

**Asynchronous**

Describes serial communication that does not use a receive and transmit synchronizing clock signal to transmit data.

**Attenuation**

Lessening or loss of signal intensity during transmission.

**Auto power-up**

A safety light screen system feature that enables the system to be powered up into the RUN mode (or recover from a power interruption) without requiring a manual reset.

**Awareness device**

A barrier, signal, light or signage that warns individuals of an approaching, present, or the proximity of a hazard.

**B****Background**

The parts of a scene in and around the Feature of Interest (FOI) that are not "of interest" to the software.

**Background suppression**

A photoelectric proximity sensing mode with response that is similar to a diffuse sensor, but with a defined range limit. Two background s fixed-field and adjustable-field.

**Backlight**

Lighting option that provides even, low-intensity light. It is placed behind the target and aimed directly back towards the camera. The resulting silhouette can be inspected for proper size and shape.

**Band**

A section of the RF spectrum.

**Bandwidth**

Width of radio frequency band. For analog signals, this is measured in Hertz. With digital signals, bandwidth describes the amount of data that can be transferred through a signal connection in a given time, measured in bits or bytes per second.

**Bar code**

A coding system designed to be read and decoded by optical scanners. One dimensional or linear bar codes are made up of black bars and white spaces, representing a string of numbers or letters. Two-dimensional bar codes are read on two axes and typically contain more data in a smaller space.

**Baud Rate**

Data rate in bits per second.

**Beam angle**

The cone of sonic energy emitted by an ultrasonic sensor that diverges with distance.

**Beam Diameter**

The portion of a beam that must be blocked to cause an individual photo receiver to change state. One of the factors in determining resolution of a safety light screen. Also known as effective beam diameter.

**Beam pattern**

A two-dimensional graph of a sensor's response. Beam patterns are helpful in predicting the performance of the sensor.

**Beam Spacing**

The distance from the center of one beam to the center of an adjacent beam, and one factor in determining resolution of a safety light screen. Also known as beam pitch.

**Bend radius**

The radius below which an optical fiber should not be bent. Usually bend radius is a function of tensile strength.

**Bifurcated fiber**

A fiber optic assembly that is branched to combine emitted light with received light in the same assembly.

**BiModal output**

An exclusive Banner output circuit design that offers either sinking (NPN) or sourcing (PNP) output, depending upon the polarity with which the two DC supply leads are connected.

**Binding**

Locking a Node to a specific Gateway by teaching the Node the Gateway's unique serial number. After a Node is bound, the Node only accepts data from the Gateway to which it is bound.

**Bipolar output**

The dual output configuration of a DC sensing device, where one output switch is a sinking device (NPN) and the other output switch is a sourcing device (PNP). The solid-state equivalent of a DPST relay (for most loads).

**Blanking**

An optional function that allows a light screen system to ignore objects located within the sensing field so as not to create an OFF-state of the safety outputs and cause a Trip or Latch condition.

**Blind spot**

The area close to a sensor lens, where light energy is returned to the emitter rather than the receiver, rendering the sensor effectively blind. This effect is most pronounced with some retroreflective sensors.

**BLOB**

A connected region in an image in which all pixels have the same gray-level value.

**Blocked condition**

A condition that occurs when an opaque object of sufficient size interrupts one or more light screen beams. When a blocked condition occurs, OSSD1 and OSSD2 outputs simultaneously turn off within the system response time.

**Bright-field**

Lighting of objects or surfaces at an angle close to perpendicular so that the light is reflected back into the optics directly.

**Broadband**

A high-speed data transmission rate, where two or more signals may share the cable.

**Burn-through**

Describes the ability of high-powered modulated opposed mode sensors to "see" through paper, thin cardboard, opaque plastics, and materials of similar optical density.

**Bus**

A common pathway or circuit between multiple devices. One of the primary network configurations or topologies.

**Bus Network**

A network architecture in which multiple devices are connected by a shared communication line.

**C****Cable assembly**

An optical fiber cable that has connectors installed on one or both ends.

**Carrier Wave**

A high-frequency waveform that can be modulated in amplitude, phase or frequency to carry a signal from a transmitter to a radio receiver.

**Cascade**

Series connection (or "daisy-chaining") of multiple sensors.

**Category 0 Stop (Functional)**

An uncontrolled stop produced by immediately removing power to the machine actuators.

**Category 1 Stop (Functional)**

A controlled stop achieved with power remaining to the machine actuators. Power is removed after the stop is achieved.

**Category 2 Stop (Functional)**

A controlled stop with power left available to the machine actuators.

**CCD**

Abbreviation for Charge Coupled Device. An analog device that captures light for conversion to electricity.

**Channel**

A path for communications. A range of radio frequencies used by a transceiver during communication.

**Character**

A single letter, digit or punctuation mark requiring one byte storage.

**Circuit**

1. An electronic path between two or more components capable of providing a number of channels. 2. Interconnection of conductors to carry an electrical current.

**Cladding**

The material surrounding the core of an optical fiber. The cladding has a lower refractive index (faster speed) to keep the light in the core.

**CMOS**

Acronym for Complementary Metal Oxide Semiconductor. A CMOS-based chip that records the intensities of light as variable charges similar to a CCD chip.

**C-mount**

Threaded lens mount developed from 16 mm movie work; used extensively for closed-circuit television.

**CNC**

Abbreviation for Complementary Normally Closed

**Coating**

A protective layer applied over the fiber cladding to protect it from the environment.

**Collimated source**

A light source that emits light in parallel beams.

**Collimation**

The process by which a lens converts a divergent beam into a parallel beam of light.

**Color marks**

Also known as registration marks or index marks, color marks are used extensively in packaging applications for registering the cutoff of wrapping or bagging materials so that product names and other information always appear in the same location.

**Color sensitivity**

The change in output when the color of a target changes.

**Common mode failure**

The failure of multiple components or equipment resulting from the same root cause.

**Complementary Normally Closed**

(CNC) An auxiliary (non-safety) output that is always in an opposite state to its associated normally open safety output, even in the event of a single failure.

**Complementary output**

The dual output configuration of a sensing device, where one output is normally open and the other is normally closed.

**Complementary Protective Equipment**

Devices used to assure or supplement the operation of a primary safeguard.

**Contact**

One of the current-carrying parts of a relay, switch, or connector that open and close to complete associated electrical circuits.

**Contact configuration**

Refers to the construction of a relay or a switch, in many configurations, for example, SPDT (Form C), with one normally open, one normally closed, and one common between the two.

**Contamination**

Dirt, dust, smoke, or fog in the sensing path; plus dirt, dust, fog, oil, grease, or soot build-up on the face of a sensor can all contribute to attenuation of the light energy available for sensing.

**Continuous trigger**

Functionality that allows a sensor to take pictures continuously without being triggered by an external device.

**Contrast**

The ratio of the amount of light falling on the receiver in the "light" condition as compared to the "dark" condition. Optimizing contrast in any sensing situation will increase the reliability of the sensing system.

**Control Relay (CR)**

A relay that is used to perform logic functions in a machine control circuit.

**Control reliability**

A method of ensuring the performance integrity of a control system or device. Control circuits are designed and constructed so that a single failure or fault within the system does not prevent the normal stopping action from being applied to the machine when required, or does not create unintended machine action, but does prevent initiation of successive machine action until the failure is corrected.

**Controlled stop**

The stopping of machine motion while retaining power to machine actuators during the stopping process.

**Convergent mode**

A special variation of diffuse mode photoelectric proximity sensing which uses additional optics to create a small, intense, and well-defined image at a fixed distance from the front surface of the sensor lens.

**Core**

The central region of an optical fiber through which light is transmitted. It has a higher refractive index (slower speed) than the surrounding cladding.

**Corner-cube prisms**

A prism having three mutually perpendicular surfaces and a hypotenuse face. Used in retroreflectors.

**Coupler**

A device that combines two or more fiber optic signals into one, or divides one fiber optic signal into two or more.

**Coupling**

1. Transfer of energy from one circuit to another.
2. Transfer of light energy using a fiber optic cable. This term does not imply that a coupler is used.

**Critical angle**

The maximum angle from the central axis of a fiber optic cable at which light can be confined within the core.

**Crosstalk (Optical)**

Optical crosstalk occurs when a photoelectric receiver responds to light from an adjacent emitter.

**Current**

The flow of electrons through a circuit. Measured in "amperes."

**Current sinking output**

The output of a DC device that switches ground (DC common) to a load. The load is connected between the output of the device and the positive side of the power supply. The switching components is usually an open collector NPN transistor, with its emitter tied to the negative side of the supply voltage.

**Current sourcing output**

The output of a DC device that switches positive DC to a load. The load is connected between the output of the device and the ground (DC common) side of the power supply. The switching component is usually an open collector PNP transistor, with its emitter tied to the positive side of the supply voltage.

**Cutoff distance/point**

Definable point at which the a sensor will actuate or will cease to operate. All objects beyond the cutoff point are ignored by the sensor. Cutoff point can be influenced by the range of the sensor and by its other physical specifications.

**Cyclic Reporting**

The Gateway polls the Node at user-defined intervals.

**D****Dark condition**

One of two sensing conditions in a sensing application which is characterized by a lower level of received sensing energy, or in some case, no energy. See also Light Condition.

**Dark operate**

(D/O) The initiation of a photoelectric sensor's output (or of timing logic) when the receiver goes sufficiently dark. See also light operate.

**Dark-field**

Lighting of object or surfaces at very shallow or low angles so that the light does not enter the optics directly.

**DC (Direct Current)**

A current that flows only in one direction through a circuit.

**Deadband**

The region where the sensor cannot make measurements.

**Defined area**

The "screen of light" generated by a safety light screen system, defined by the height and the separation of the emitter and receiver. When the defined area is interrupted by an opaque object of a specified cross section, a Trip or Latch condition results.

**Demod (Demodulation) Falling**

A discrete input point must detect a specific number of inputs low before the input is considered to have changed state.

**Demod (Demodulation) Rising**

A discrete input point must detect a specific number of inputs high before the input is considered to have changed state.

**Depth of field**

The distance, length or the size of the sensing surface or field from the outer edge toward the hazard. Also known as "depth of detection."

**Depth penetration factor**

Compensation factor for distance an object can penetrate the sensing field of a Presence Sensing Safeguarding Device (PSSD) before the device reliably detects the intrusion and signals a stop. Often abbreviated as Dpf.

**Depth-of-field (1)**

The range of distance within which a sensor has a response. Used to define the response pattern of proximity-mode sensors, especially ultrasonic and photoelectric convergent, fixed-field and adjustable-field sensors.

**Depth-of-field (2)**

The in-focus range of an imaging system. Measured from the distance behind an object to the distance in front of the object with all objects appearing in focus.

**Depth-of-focus**

The range of lens to image plane distance having the image formed by the lens appearing in focus.

**Device Address**

Unique identifier for each wireless device on a network.

**DeviceNet**

The bus-type wiring scheme, specifically for automation sensors, that allows sensors and controllers to exchange data over a single cable.

**Diffraction**

The bending of light rays as they pass around corners or through holes smaller than their own wavelengths.

**Diffuse light**

Soft lighting that is scattered from a variety of angles in order to eliminate shadows and view highly specular surfaces.

**Diffuse mode**

A photoelectric proximity sensing mode in which light from the emitter strikes a surface of an object at some arbitrary angle and is diffused from the surface at all angles.

**Diffuse Source**

A light source that illuminates a target from many directions, eliminating shadows or glare.

**Digital output**

A sensor that exists in only one of two states: "on" or "off." The outputs of most sensors and sensing systems is digital.

**Digitization**

Sampling and conversion of image or signal into a digital code by scanning or using an analog to digital converter.

**DIN standard**

(Deutsches Institut für Normung) A collection of German industry standards.

**Diode**

A two-layer semiconductor that allows current to flow in only one direction.

**Divergent mode**

A variation of the diffuse photoelectric sensing mode in which the emitted beam and the receiver's field of view are both very wide.

**Diverse-redundancy**

The practice of using components, circuitry or operation of different designs, architectures or functions to achieve redundancy and to reduce the possibility of common mode failures.

**DPDT**

(Double-Pole Double-Throw) A relay with two sets of single-pole double-throw (Form C) contacts that are operated simultaneously by a single action.

**Dpf**

See Depth Penetration Factor.

**DPST**

(Double-Pole Single-Throw) A switch configuration that has four terminals. One pair is used to connect or disconnect to the other pair.

**Dropping resistor**

A precision resistor used to convert a 4 to 20 mA signal to a voltage signal.

**DSSS**

Abbreviation for Direct Sequence Spread Spectrum. A method for generating spread spectrum transmissions where the transmitted signal is sent at a much higher frequency than the original signal, spreading the energy over a much wider band medium interference environments. The receiver is able to de-spread the transmission and filter the original message. DSSS is useful for sending large amounts of data in low to

**Dual channel**

Duplication or redundant system that minimizes the possibility of a failure to danger in the event of a single fault. This is because the second independent channel maintains the ability to arrest dangerous motion.

**E****Edge**

A change in pixel values exceeding some threshold between two adjacent regions of relatively uniform values. Edges correspond to changes in brightness corresponding to a discontinuity in surface orientation, reflectance, or illumination.

**Effective Aperture Angle (EAA)**

The maximum angle of deviation from the optical alignment of the emitter and the receiver within which the safety light screen continues in normal operation. Also known as Angle of Divergence/Acceptance, or Field-of-View.

**Effective beam**

The "working" part of a photoelectric beam. Not to be confused with the actual radiation pattern of the emitter, or with the field of view of the receiver.

**Electromechanical**

Any device using electrical energy to produce mechanical movements.

**Electromechanical relay**

Conventional switching relays consisting of "hard" contacts (metal-to-metal), switched to opened or closed position by applying voltage to an electromagnetic coil.

**Electro-Sensitive Protective Equipment (ESPE)**

An assembly of devices and/or components working together for protective tripping or presence sensing purposes and comprising as a minimum: a sensing device, controlling/monitoring devices, and output signal switching devices. See IEC61496-1

## Emergency Stop

A control function that is initiated by a single human action to arrest dangerous machine motion, or otherwise avert arising or reduce existing hazards to persons, damage to machinery or to work in progress. See ANSI/NPFA79, IEC60204-1, or ISO13850.

## EMI

Abbreviation for Electromagnetic Interference. Electrical "noise" which may interfere with proper operation of sensors, programmable logic controllers, counters, data recorders, and other sensitive electronic equipment.

## Emissivity

A measurement of the thermal signature and characteristics of different materials and surfaces.

## Emitter

1. The sensor containing the source of sensing energy in opposed-mode sensing. 2. The emitting device within any sensor (e.g. LED, laser diode, ultrasonic transducer, etc.). 3. The light-emitting component of a safety light screen system, consisting of a row of synchronized modulated LEDs. The emitter, together with the receiver (placed opposite), creates a "screen of light" called the defined area.

## Ethernet

Access method for computer network (Local Area Networks) communications, defined by the IEEE as the 802.3 standard.

## Exact blanking

A configuration allowing a light screen system to ignore stationary objects (such as brackets or fixtures) that interrupt a specific number of light beams.

## Excess gain

The measurement of the amount of light falling on the receiver of a sensing system over and above the minimum amount of light required to just operate the sensor's amplifier.

## External device monitoring

A means by which a safeguarding device monitors the state of external devices that may be controlled by the safety device.

# F

## Fail to Safe

A design or event in which a failure or fault within a system causes the hazardous machine motion or process to achieve a safe state (Commonly confused with "fail-safe").

## Fail-safe

A description of a circuit or system that is guaranteed not to fail in the event of a malfunction so that the catastrophic loss of function is not possible.

## Failure

An event in which an item (e.g. component, circuit, or device) ceases to perform its required function.

## Failure to danger

A failure which delays or prevents a safety system from arresting dangerous machine motion, thereby increasing risk to personnel.

## False triggering

Refers to a change in a sensor's output, when there should be no change.

## Fast response

Any response time that is faster than 1 millisecond.

## Fault

The state of an item (e.g. component, circuit, device or machine) characterized by its inability to perform a required function. A fault is often the result of a failure of the item itself, but may exist without prior failure. See Failure.

## Fault exclusion

The ability to minimize or eliminate known possible failures or faults through design, selection of components, or implementation of additional measures.

## Fault tolerance

The ability of a system to function as it was designed even in the presence of faults or failures.

## Feature

Used in vision applications to describe any characteristic descriptive of an image or a region in an image.

## Ferrule

A ceramic, plastic or stainless steel part of a fiber optic termination that holds the end of the fiber and aligns it to the sensor for fiber mounting.

## FHSS

Abbreviation for Frequency Hopping Spread Spectrum. A method for generating spread spectrum transmissions where the signal is switched between different frequency channels in a pseudorandom sequence known by both the transmitter and the receiver pair. FHSS is useful for sending small, redundant packets of data in a high interference environment.

## Fiber

A thin filament of glass or plastic consisting of a core (inner region) and a cladding (outer region) and a protective coating.

## Fiber optics

Transparent fibers of glass or plastic used for conducting and guiding light energy. Used in photoelectrics as "light pipes" to conduct sensing light into and out of a sensing area.

## Field of view (1)

The area of response of an optical sensor.

## Field of view (2)

The area of object space imaged at the focal plane of a camera.

## Filters

A device placed over a light source or a sensor to select or reject specific frequencies of light.

## Final Switching Device (FSD)

Component of a safety-related control system that interrupts the circuit to the machine primary control element (MPCE) when the output signal switching device (OSSD) goes to the OFF-state.

## Fixed blanking

A way to configure a light screen system to ignore stationary objects (such as brackets or fixtures) that are always present at a specific location within the defined area.

## Fixed-field mode

Fixed-field sensors use two receivers and a comparator circuit to cancel sensing response whenever the intensity of the reflected light reaching the long-range receiver exceeds the intensity of the reflected light reaching the close-range receiver.

## FlexPower™

The ability of a device to take multiple types of power including battery, line, or solar.

## FM

Abbreviation for Frequency modulation. A type of modulation in which the data signal is "attached" to the carrier wave by varying the frequency of the carrier wave.

## FMEA

Abbreviation for Failure Mode and Effects Analysis, a testing procedure by which potential failure modes

in a system are analyzed to determine their results or effects on the system.

## Focal length

The distance from a lens' principal point to the corresponding focal point. Also referred to as the equivalent focal length and the effective focal length.

## FOI

Abbreviation for Feature of Interest. The crucial visual information within the imaged scene that the customer is trying to detect for an inspection.

## Forced-guided contacts

Relay contacts that are mechanically-linked, so that when the relay coil is energized or de-energized, all of the linked contacts move together. If one set of contacts in the relay becomes immobilized, no other contact of the same relay will be able to move. The function of forced-guided contacts is to enable the safety circuit to check the status of the relay. Forced-guided contacts are also known as "mechanically-linked contacts," "positive-guided contacts," "captive contacts," "locked contacts," or "safety relays."

## FOV

Abbreviation for Field of View. The area of object space imaged at the focal plane of a camera.

## Frequency

The number of recurrences of a periodic phenomenon in a unit of time. Electrical frequency is measured in Hertz (Hz).

## Frequency response

The maximum frequencies an analog sensor can track. All analog sensors have an inherent response time that limits their ability to measure periodic motions at high frequencies.

## Front lighting

An arrangement in which the object is illuminated and viewed from the same side.

# G

## Gain

An increase in signal power, voltage, or current by an amplifier.

## Gain potentiometer

An electronic device used to set the gain or the switching threshold of a sensor. Also known as a sensitivity adjustment.

## Gate

A combinational logic circuit having one or more input channels.

## Gateway

A wireless network master communication device used to control and initiate commands to other devices in the system. Serves as a "portal" from one network to another and communicates between the wireless network and the central control process.

## General Duty Clause

Section 5(a)(1) of the Occupational Safety and Health Act of 1970 (Public Law 91-596, 91st Congress, S.2193, 29Dec1970) places primary accountability on the employer for work place safety. "5(a)(1) Each employer shall furnish to each of his employees employment and a place of employment which are free from recognized hazards that are causing or are likely to cause death or serious physical harm to his employees." OSHA inspectors often use section 5(a)(1) of the "General Duty Clause" as the bases of citations resulting from on-site inspections.

Accessories

Reference

Glossary

International Reps



**General Requirements for All Machines**

(29CFR1910.212) requires that one or more methods of machine guarding shall be provided to protect the operator and other employees from hazards, and the guarding device shall be in conformity with any appropriate standards.

**GHz**

Gigahertz. 1 GHz=1000 MHz.

**Glass fibers**

Glass fiber assemblies are constructed of a bundle of individual glass fibers, contained and protected by a sheath (typically a flexible armored cable).

**Good Engineering Practice**

Minimum guidelines that specify commonly-used and recognized design principles, well-tried and robust components, and safety practices to make the workplace free of industry recognized hazards and compliant to relevant standards.

**Gray scale**

Variations of values from white, through shades of gray, to black in a digitized image with black assigned the value of zero and white the value of one.

**Ground**

A conducting path between an electric circuit or equipment and the earth, or some conducting body serving in place of the earth.

**Guard**

A protective physical barrier that prevents an individual from accessing a hazardous area.

**Guarded machine**

The machine whose point of operation or other hazardous area is guarded by the safety system.

**GUI**

Acronym for Graphical User Interface, a graphics-based interface through which a user may communicate with a computer.

**H**

**Half Wave**

Antenna type whose overall span is one half the length of the wave that can be transmitted.

**Hand control**

A hand-operated mechanism or device used as an actuating control. Two normally open "input switches" are used as hand controls in a two-hand control system

**Hard guard**

Screens, bars, or other mechanical barriers affixed to the frame of the machine intended to prevent entry by personnel into the hazardous area(s) of a machine.

**Hazard**

A potential source of harm.

**Hazard point**

The closest reachable point of the hazardous area.

**Hazardous area**

An area that poses an immediate or impending physical hazard.

**Hazardous situation**

A circumstance in which a person is exposed to a hazard, or any specific activity done on or around the machine during its lifecycle that results in a potential source of harm. See B11.TR3 for further information.

**Hermetic seal**

An air-tight seal.

**Hop**

1. The act of changing from one frequency to another.
2. The device to device transmission link, such as from the Master device to the Slave device.

**Housing**

Describes several aspects of a sensor: body style, housing material, and sealing capacity.

**Hysteresis**

Intentional time lag added to a circuit to prevent false actuation or intermittent operation (chatter).

**Hz**

(Hertz) The international unit of frequency, equal to one cycle per second. Named after the German physicist, Heinrich Rudolph Hertz.

**I/O**

(Input-Output) Provides communication channels to system and to manufacturing process.

**Image**

Projection of an object or a scene onto an imager chip.

**Image acquisition**

The capture and generation of an image of an object or scene on the imager chip. Involves the use of illumination, optics, filters and the vision sensor.

**Image quality**

The degree to which an image shows contrast.

**Imager chip**

The physical device that replaces film in a digital camera system. Two common types are CCD and CMOS. Also known as imager or image sensor.

**Individual fiber**

A fiber optic assembly having one control end and one sensing end. Usually used in pairs in the opposed sensing mode.

**Inductive proximity sensor**

Sensors with an oscillator and coil which radiate an electromagnetic field that induces eddy currents on the surface of metallic objects approaching the sensor face.

**Input**

1. The signal (voltage or current) applied to a circuit to cause the output of that circuit to change state.
2. The terminals, jacks or receptacle provided for reception of the input signal.

**Input voltage**

The power source required by an electric or electronic device (e.g. a self-contained sensor) in order for the device to operate properly.

**Inspection**

1. The process of examining a part to match the part to a known "good" reference.
2. A specific file or program run in the vision software to look at a specific part. Also known as a recipe.

**Integrity**

The degree to which a circuit, system or device can be expected to perform unimpaired an anticipated function in the event of a fault. Integrity depends on several characteristics including fault tolerance, fault exclusion, risk reduction, reliable and well-tried components, well-tried safety principles, and other design considerations.

**Intensity**

Degree of strength of electricity, light, heat or sound per unit area or volume.

**Interlocked guard**

A guard or barrier interfaced with a machine control system so as to restrict access to or prevent inadvertent access to the hazard.

**Internal lockout**

A Lockout condition due to an internal safety system problem.

**Intrinsic safety**

A design technique applied to electrical equipment, such as sensors, switches, and wiring for hazardous locations. The technique involves limiting energy to a level below that required to ignite a specific hazardous atmosphere. Intrinsic safety design often eliminates the requirement for explosion-proof enclosures. (Also see "NAMUR".)

**Intrinsic safety barrier**

A protective component designed to limit the voltage and current in an explosive area. The barrier functions outside of the explosive location to divert abnormal energy to ground.

**Inverting output**

Analog photoelectric sensors provide a variable voltage or current output signal that is inversely related to and decreases with the strength of the light signal. Also known as negative slope.

**IP rating**

A rating system established by the IEC which defines the suitability of sensor and sensor system enclosures for various environments. Similar to NEMA ratings for enclosures.

**ISM Band**

Abbreviation for Industrial, Scientific, and Medical band. Part of the radio spectrum that does not require a license for use.

**K**

**Key reset**

A key-operated switch used to reset a safety system to the RUN mode following a Lockout condition or to reset a safety system from a Latch condition.

**kHz**

Abbreviation for kilohertz, 1000 hertz.

**L**

**L Configuration**

In a safety light screen application, the installation of two emitter/receiver pairs to create a vertical and a horizontal sensing field. Gains advantages of both area guarding and point-of-operation guarding techniques to reduce the possibility of pass-through hazards.

**LAN**

(Local Area Network) A computer network dedicated to sharing data among several single-user computers.

**Laser**

(Light Amplification by the Stimulated Emission of Radiation) A device that creates a narrow, intense and coherent light. Many lasers deliver light in an almost-perfectly parallel collimated beam that is very pure, approaching a single wavelength.

**Latch condition**

The response of a safety or safeguarding device in which an OFF-state is maintained after the device has been actuated until the safeguard is cleared, re-closed, or re-armed and a manual reset is performed.

**Latched**

Setting in which an output will stay on until the inspection result from subsequent inspection changes.

**Latency**

Maximum acceptable delay between transmission and reception.

**Leakage current**

An undesirable small value stray current which flows over or through an insulator.

**LED**

Abbreviation for Light Emitting Diode. A semiconductor that emits light when current flows through it.

**Legend**

Any type of marking, sign, or inscription which identifies the device type, function or purpose.

**Lens**

The optical component of a sensor that collimates or focuses light rays onto a receiver optoelement (photoelectric sensing) or an imager chip (vision sensing).

**Light condition**

One of two sensing conditions in a sensing application which is characterized by a higher level of received sensing energy. This term is generally used in photoelectric sensing. See Dark Condition.

**Light operate**

(L/O) The program mode for a photoelectric sensor in which the output energizes (or the timing logic begins) when the receiver becomes sufficiently light.

**Light screen**

See Active Opto-electronic Protective Device.

**Light source**

Any device serving as a source of illumination.

**Lighting geometry**

The physical relationship between the light source, the target object and the vision sensor.

**Lighting technique**

The way a light source is physically positioned relative to the object it is illuminating.

**Line of sight**

An unobstructed radio path between a radio's transmitter and receiver status.

**Line voltage**

The normal in-plant power line supply voltage which is usually 120 or 220/240 or 440V ac.

**Linearity**

The maximum deviation above or below the ideal output of the sensor.

**Load**

A general term for a device (or a circuit) that draws power when switched by another device or circuit.

**Lockout Condition**

A safety system condition that is automatically attained in response to certain failure modes (an internal lockout). When a Lockout condition occurs, the safety system's safety outputs turn OFF, the failure must be corrected, and a manual reset is required to return the system to RUN mode.

**Logic**

Methods used to condition a sensor output signal by way of timing or counting, or to coordinate control of a process by comparing multiple sensor outputs.

**Logic module**

A sensing system accessory that interprets one or more input signals and modifies and/or combines those input signals for control of a process.

**Log-log scale**

A graph with logarithmic x and y scales. A logarithmic scale reveals percentage changes. A change from 100 to 200, for example, is presented in the same way as a change from 1,000 to 2,000.

**Low-Angle Light**

Low-angle lighting enhances the contrast of surface features.

**M****Machine Primary Control Element (MPCE)**

An electrically-powered element, external to the safety system, which directly controls the machine's normal operating motion in such a way that the element is last (in time) to operate when machine motion is either initiated or arrested. (Examples include motor/motor contactors, magnetic clutch brake, or electrically operated valve.)

**Machine response time**

The time between the activation of a stopping device and the instant when the dangerous parts of the machine reach a safe state.

**Machine secondary control element (MSCE)**

An electrically-powered element, independent of the machine primary control element(s), capable of removing power from the machine's actuator (prime mover) of the relevant hazardous parts and is typically controlled by the secondary switching device (SSD).

**Machine vision**

Computerized image measurement, analysis, and interpretation used to improve production processes and quality.

**Master Control Relay (MCR)**

A relay that is used to provide electrical power to the machine control circuitry. Typically interfaced with the Master Start/Stop (ON/OFF) and Emergency Stop functions.

**Master Stop Control (MSC)**

An electrically-powered device, external to the E-stop Safety Module, that provides a safety stop by immediately removing electrical power to the hazard and, if necessary, by applying braking to dangerous motion. This stopping action is accomplished by removing power to the actuator coil of either Master Stop Control Element.

**Master/Slave**

Model for communication protocol between devices or processes, in which one device initiates commands (master) and other devices respond (slave). The Gateway is the Master device to the Nodes which are the Slave devices.

**Mechanically-linked contact**

See Forced-Guided Contact.

**Microsecond**

One millionth of a second. 1 microsecond = 0.000001 second or 0.001 millisecond.

**Millisecond**

One thousandth of a second. 1 millisecond = 0.001 second or 1000 microseconds.

**Milliwatt (mW)**

A unit of power equal to one thousandth ( $10^{-3}$ ) of a watt.

**Minimum Object Sensitivity (MOS)**

The minimum-diameter object that a safety light screen system can reliably detect. Objects of this diameter or greater will be detected anywhere in the defined area. A smaller object can pass undetected through the light if it passes exactly midway between two adjacent light beams.

**Modbus**

An openly-published, communication protocol that is a means of connecting almost any industrial electronic device. Runs at layer 7 of the OSI model. Defines message structure for a client/server environment. Often used with TCP/IP over Ethernet and runs on RS-232 or RS-485.

**Modulation**

In photoelectrics, modulation of an emitter means to turn it on and off at a high frequency (typically several kilohertz). A modulated sensor's receiver and amplifier are tuned to the frequency of modulation. Only the modulated light is amplified, and all other light which reaches the receiver is ignored.

**Monitoring**

The verification of system components to detect failures or faults of any part of the monitored system that could affect the performance of safety-related functions.

**Muting**

The automatic suspension of the safeguarding function of a safety device during a non-hazardous portion of the machine cycle.

**N****NAMUR**

Devices and sensors designed for use with certified switching amplifiers with intrinsically-safe circuits. NAMUR sensors are most commonly used in explosive environments.

**Nanometer**

Unit of length used to specify the wavelength of light energy. 1 nm = 0.000000001 meter.

**NC**

Abbreviation for Normally Closed.

**Negative slope**

Analog photoelectric sensors provide a variable voltage or current output signal that is inversely related to and decreases with the strength of the light signal. Also known as inverting output.

**NEMA**

The National Electrical Manufacturers Association (NEMA) has established guidelines for specifying the degree of sealing offered by any particular electrical enclosure design.

**Network ID (NID)**

A system-level parameter allowing multiple radio devices to operate as a complete wireless network. Enables multiple wireless networks to be co-located within range of each other.

**NO**

Abbreviation for Normally Open.

**Node**

A wireless network slave device used to provide sensing capability in a remote area or on the factory floor. This device aggregates and communicates data back to a gateway device for transmission back to a central control unit.

**Noise**

(Electrical) Describes undesirable energy that may cause false response of sensing system logic or may be falsely recognized as a received signal by a sensor amplifier. Includes EMI and RFI.

**Non-inverting output**

Analog photoelectric sensors provide a variable voltage or current output signal that is directly related to and increases with the strength of the light signal. Also known as positive slope.

**Normally Closed (NC)**

Designation that states the contacts of a switch or relay are closed or connected when at rest. When activated, the contacts open or separate.

**Normally Open (NO)**

Designation that states the contacts of a switch or relay are normally open or not connected. When activated, the contacts close or become connected.

**NPN output (Current sinking)**

A transistor available as an output switch in DC sensors and logic modules. Usually configured with its collector open and its emitter connected to ground (DC common). In this configuration, a load is connected between the output (collector) and the positive of the DC supply. This output configuration is also called a "sinking" output.

**Null**

Used in analog sensing and control to describe the minimum voltage (or current) in an analog output range. Analog sensors have an adjustment for setting the null value.

**O**

**OCR**

Abbreviation for Optical Character Recognition. Recognition of each character in a string by a vision system.

**OFF State**

The state in which the output circuit is interrupted and does not permit the flow of current.

**OFF-delay**

Timing logic in which the output energizes immediately when an input signal is received, and remains energized as long as the input signal is present.

**Ohm**

Unit of measurement for resistance and impedance.

**Omn**

Omn-directional antenna. Antenna that radiates power equally in all directions and is equally receptive to signals from all directions.

**ON State**

The state in which the output circuit is complete and permits the flow of current.

**On-axis light**

On-axis lighting provides even, diffused illumination for flat, reflective surfaces.

**ON-delay**

Timing logic in which timing begins at the leading edge of an input signal, but the output is energized only after the preset ON-delay has elapsed.

**Opaque**

A term used to describe a material that blocks the passage of light energy.

**Operating voltage**

Refers to the range of voltage in which the sensor or device can operate.

**Opposed mode**

A photoelectric sensing mode in which the emitter and receiver are positioned opposite each other so that the light from the emitter shines directly at the receiver. An object is detected when it breaks the light beam that is established between the two.

**Optical crosstalk**

An unwanted situation which occurs when a photoelectric receiver responds to light from an adjacent emitter.

**Optical short circuit**

Deflection of one or more beams around an object in the defined area which may result in reduced detection capability of a light screen or in the worst case, of an object being allowed to pass through undetected. The result of locating a sensing field next to a highly reflective surface e.g. stainless steel, glossy paint.

**Oscillate**

To swing back and forth between a minimum and maximum value. One complete oscillation is regarded as one cycle.

**OSI Method**

Open Systems Interconnection. A methodology used for communication and computer network protocol design, where the functions of the protocol are divided into seven layers.

**Output**

1. The section of a sensor or control circuit that energizes and/or de-energizes the attached load (or input). 2. The useful energy delivered by a circuit or device.

**Output delay**

The time from when the inspection is triggered until the sensor output turns on.

**Output duration**

The time from when an output turns on until it turns off. Also known as Pulsed Output.

**Output Signal Switching Device (OSSD)**

Abbreviation for Output Signal Switching Device. The safety outputs of a safeguarding device that are used to initiate a stop signal by achieving an OFF-state. (Note: Includes, but is not limited to, solid-state outputs, relay contacts, or other electrical contacts.)

**P**

**Parallel**

Connection of two or more parts of a circuit to the same pair of terminals, so that current divides between the parts.

**Pass-through hazard**

A situation that may exist when personnel pass through a safeguard (at which point the hazard stops or is removed), and then continue into the guarded area. At this point the safeguard may not be able to prevent an unexpected start or restart of the machine with personnel within the guarded area.

**Path Loss**

Describes attenuation as a function of wavelength of the operating frequency and the distance between the transmitter and receiver.

**Peer/Peer**

Model for communication protocol in which any device in the network can send and receive data, and initiate communication.

**Perimeter guard**

A safeguarding technique that provides a barrier or means of detection at the boundary of a hazard or hazardous area.

**Photocell**

A resistive photosensitive device in which the resistance varies in inverse proportion to the amount of incident light.

**Photodiode**

A semiconductor diode in which the reverse current varies with illumination. Characterized by linearity of its output over several magnitudes of light intensity, very fast response time, and wide range of color response.

**Photoelectric sensor**

An electrical device that responds to a change in the intensity of light falling upon it.

**Phototransistor**

A phototransistor is a photojunction device in which current flow is directly proportional to the amount of incident light.

**Pixel**

Acronym for picture element. The smallest unit on a display screen.

**PLC**

Abbreviation for Programmable Logic Controller. A control device that employs the hardware architecture of a computer and relay ladder diagram language.

**PNP output (Current sourcing)**

A transistor available as an output switch in DC sensors. Usually configured with its collector open and its emitter connected to the positive of the sensor supply voltage. In this configuration, a load is connected between the output (collector) and ground (DC common). This output configuration is also called a "sourcing" output.

**Point of operation**

The location of a machine where material or a workpiece is positioned and a machine function is performed upon it.

**Point-of-operation guarding**

Safeguards, such as hard guards or safety light screens, which are designed to protect personnel from hazardous machine motion associated with the machine's point of operation.

**Point-to-Point**

Indicates a direct connection between two devices in a network.

**Polarization**

The alignment of the perpendicular electrical and magnetic fields that make up a light wave.

**Polarized light**

Light which has all component waves in the same direction of displacement. Natural light is made up of waves having a variety of displacements.

**Polarizing filter**

A filter that polarizes light passing through it.

**Polycarbonate**

Thermoplastics characterized by high-impact strength, light weight, and flexibility. Used as a shatter-resistant substitute for glass.

**Positive Opening (Safety Switch)**

Safety switch that employs a rigid mechanical link from the actuator to open Normally Closed contacts. The normal operation of the switch will force apart contacts, even those that are welded shut.

**Positive slope**

Analog photoelectric sensors provide a variable voltage or current output signal that is directly related to and increases with the strength of the light signal. Also known as non-inverting output.

**Positive-guided contact**

See Forced-guided contact.

**Potentiometer**

A variable resistor, primarily used as a voltage divider. Potentiometers are used to set sensor sensitivity (as a threshold adjustment).

**Power monitoring**

Monitoring function accomplished through a series-parallel connection of contacts that provide feedback about the machine's status. Power is supplied to the

module as long as both contactors work as they should.

### Power-Up/Power-Interrupt Lockout

A Lockout condition of a safety light screen system that, if Auto Power-Up is OFF, occurs when the system is powered up (including power-ups after a loss of power).

### Presence-sensing device

A device that creates a sensing area to detect the presence of an individual or object.

### Presence-Sensing Device Initiation (PSDI)

An application in which a presence-sensing device is used to start the cycle of a machine.

### Presence-Sensing Safeguarding Device (PSSD)

Abbreviation for Presence-Sensing Safeguarding Device. A presence-sensing device used as a safeguard.

### Programmable I/O

A type of input/output that is not factory set and therefore can have its purpose changed. This I/O can be reprogrammed for general output, pass, fail, ready, error and general input.

### Protocol Layering

Division of protocol design into smaller of parts, each of which accomplish smaller tasks. Layering keeps each design simple.

### Proximity

(Sensing) Direct sensing of an object by its presence in front of a sensor.

### Proxing

In retroreflective sensing, "proxing" is used to describe undesirable reflection of the sensing beam directly back from an object that is supposed to break the beam.

### Pulsed output

The time from when an output turns on until it turns off. Also known as Output Duration.

## Q

### Qualified Person

An individual who, by possession of a recognized degree or certificate of professional training, or by extensive knowledge, training, and experience, has successfully demonstrated the ability to solve problems relating to the subject matter and work.

### Quarter Wave

Antenna type whose overall span is one quarter the length of the wave that can be transmitted.

## R

### Radio

1. Transmission or reception of electromagnetic radiation in the radio frequency band, used to send information through a medium without the use of wires. 2. Equipment used to transmit and receive radio signals.

### Range

The specified maximum operating distance of a sensor or sensing system.

### Ratio

Relation in degree or number between two similar things.

### Receiver

1. The transducer element that responds to the sensing energy. 2. The name for the half of an opposed pair of photoelectric or ultrasonic sensors that receives the sensing energy from the emitter.

3. The light-receiving component of a safety light screen system, consisting of a row of synchronized phototransistors. The receiver, together with the emitter (placed opposite), creates a "screen of light" called the defined area.

### Reduced resolution

A configuration that allows a light screen system to intentionally ignore the interruption of consecutive light beams within the defined area. The effect is to ignore multiple objects with cross-sections less than a certain size, while increasing the size of an object that will be reliably detected anywhere within the defined area. Sometimes called "Floating Blanking."

### Redundancy

The duplication of components or circuitry providing the same function should a component or circuit fail.

### Reflection

The return of light waves from surfaces on which they are incident.

### Reflectivity

A measure of the efficiency of any material surface as a reflector of light, as compared to a Kodak white test card, which is arbitrarily rated at 90% reflectivity.

### Refraction

The bending of light rays as they pass through a transmission medium of one refractive index into a medium with a different refractive index.

### Region of Interest

The area inside defined boundaries that the user wants to analyze.

### Relay

An electromechanical device that opens or closes contacts in response to a small current or voltage change of an electric circuit. This device effects the operation of other devices in the same or another electric circuit.

### Reliability

The ability of a machine's circuits and components to consistently perform its stated function within its specifications without failing.

### Remote sensor

Remote sensor describes the part of a photoelectric component system that contains only the optical elements. The circuitry for system power, amplification, logic, and output switching are all located at a central location, typically a control cabinet.

### Repeatability

A measure of the repeat accuracy of a sensor and/or timer and/or control mechanism. Usually expressed as a distance or time.

### Repeater

A communication device that extends the transmission range of a data signal by amplifying or regenerating the signal. Used in long-distance transmission.

### Reset

The use of a manually-operated switch to restore the safety outputs to the ON state from a Latch condition, or return to the RUN mode from a Lockout condition.

### Resolution (1)

The degree of sharpness of a displayed or printed character or image. On screen, resolution is expressed as a matrix of dots.

### Resolution (2)

1. The smallest detectable change in position or size of an object. 2. The closest distance between two objects (points) in an image identifiable as two separate objects rather than one object. 3. The minimum size (diameter or cross section) of

an object that a safety light screen will reliably detect. Calculated by adding the beam spacing dimension to effective beam diameter. Objects of this size or larger will be detected anywhere in the sensing field.

### Response time

The time required for the output of a sensor or sensing system to respond to a change of the input signal (e.g. a sensing event). Also known as response speed.

### Retroreflective mode

A retroreflective photoelectric sensor contains both the emitter and receiver. A light beam is established between the sensor and a special retroreflective target. As in opposed sensing, an object is detected when it interrupts this beam.

### Retroreflector

A reflector made out of highly reflective material is used in retroreflective sensing to return the emitted light directly back to the sensor.

### RF

Radio Frequency. Electromagnetic signals in the radio band.

### RFI

Abbreviation for Radio Frequency Interference. Interference caused by electromagnetic radiation at radio frequencies to sensors or other sensitive electronic circuitry. RFI may generate false signals or random triggering of equipment or processes.

### Ring Light

A ring light provides diffused illumination over a small area.

### Risk

The probability of the occurrence of harm and its severity.

### Risk assessment

A procedure used in machine safety to identify, document and eliminate or reduce hazards in a particular machine or process.

### ROI

Abbreviation for Region of Interest. The area inside defined boundaries that the user wants to analyze.

### RS-232

Industrial standard for serial transmission between computers and peripheral devices.

### RSSI

Received Signal Strength Indication. The measurement of the strength of received signal strength in a wireless environment. See Site Survey.

## S

### Safeguard

A guard (barrier) or safeguarding device used to protect personnel from hazards by preventing or restricting access, or by detecting the presence of an individual.

### Safeguarding

Measures (including guards, safeguarding devices, awareness devices, safeguarding methods, or safe work procedures) used to protect personnel from hazards which cannot reasonably be eliminated, or from the risks which cannot be sufficiently reduced by inherently safe design measures.

### Safeguarding device

A device that detects or prevents inadvertent access to a hazard (i.e. not a guard or a barrier). Also known as a Protective Device.

Accessories

Reference

Glossary

International Reps

**Safety device**

A technique or means to reduce the risk of harm to personnel from a machine hazard which includes but is not limited to Safety Light Screens, Emergency Stop Buttons, Guards (barriers), Interlocking, Enabling Pendants, Two-hand Control, Restraints, or Lockout/Tagout equipment.

**Safety distance**

The calculated distance between a hazard and its associated safeguard.

**Safety edge**

A safeguarding device consisting of a sensing edge and a control, used to detect individuals who comes into contact with the sensing edge.

**Safety interlock switch**

A switch on a guard barrier used to detect if the guard is opened. Designed to prevent intentional defeat. Electromechanical safety interlock switches use positive opening contacts. Other forms of safety interlock switch include magnetic, RF tag, optical, or inductive.

**Safety light curtain**

See safety light screen.

**Safety light screen**

A safeguarding device comprising an LED array emitter and receiver element which creates a sensing field or plane. When an individual or object interrupts this sensing field, the light screen detects the interruption and initiates a stop command. Also known as Active Opto-electronic Protective Device -AOPD, Presence Sensing Safeguarding Device, safety light curtain, light devices and optical guards.

**Safety mat**

A safeguarding device consisting of a sensing surface and a control. The sensing surface is capable of detecting the presence of individual(s) on its surface.

**Safety module**

A device that performs a specific safety function(s) and consists of monitored, multiple, mechanically-linked relays, or monitored solid-state safety outputs. Commonly confused with a single, discrete mechanically-linked "safety" relay. Also known as Safety Interface Module or Safety Relay Modules.

**Safety relay**

An electromechanical relay with force-guided contacts which allow the monitoring of a safety device's circuit to check relay status. See also force-guided contacts.

**Safety stop**

Removal of power to the Machine Primary Control Elements that allow for an orderly cessation of motion for safeguarding purposes. Also known as a Protective Stop.

**Safety Stop Interface (SSI)**

An interface which provides the means to integrate external devices to effect a stop command. It consists of two input channels (A&B), which are compatible with devices that have two Normally Open hard contacts or relay outputs.

**SCADA**

Supervisory Control And Data Acquisition. Process control system that collects data from sensors or machines in remote areas and sends them to a central computer for control and management.

**Secondary Switching Device (SSD)**

An output which, in a lock-out condition, performs a back-up safety function by going to the OFF-state and initiating an appropriate machine control action.

**Self-checking circuitry**

A circuit with the capability to verify that all of its own critical safety circuit components, along with their redundant backups, are operating properly.

**Self-contained**

Describes a sensor that contains the sensing element, amplifier, power supply, and output switch in a single package.

**Sensing mode**

The method or way in which a sensor detects an object.

**Sensitivity control**

An adjustment made to a sensor's amplifier that determines the sensor's ability to discriminate between different levels of received sensing energy (e.g. between two light levels reaching a photoelectric receiver).

**Sensor**

A device that senses a change in a physical quantity, such as light intensity, and converts that change into a useful control signal.

**Separation distance**

The calculated distance between a hazard and its associated safeguard. See Safety distance.

**Serial port**

A socket that receives a standard connector and protocol connecting external devices to a computer's serial interface.

**Series**

The connection of components end to end in a circuit, that provide a single path for the current.

**SET**

An actuation or adjustment feature of some Banner sensors, which simplifies the process of setting the sensor's operating sensitivity. With a single user input, the sensor automatically sets the operating sensitivity below the threshold.

**Set point**

Condition initiated by the user to control a sensor's output(s) during sensing events. This condition may use one or two parameters (depending on the sensing technology being used) within which is an acceptable range for sensing events to occur.

**Shape**

An object's physical and optical characteristic, often refers to its spatial contours.

**Sheathing**

An outer covering that protects optical fibers. Can be made of stainless steel flexible conduit, PVC, or some other type of flexible tubing.

**Signal-to-Noise Ratio**

The ratio of the maximum value of an output signal to the standard deviation amplitude of the noise on the signal.

**Simultaneity**

Concurrent events, actions, or actuations occurring within a specific time frame. This time frame is 0.5 second in a Two-Hand Control or Two-Hand Trip applications per ANSI B11.19, ANSI/RIA R15.06 and ISO 13851 (Note: ISO 13851 defines this as synchronous actuation).

**Sinking output**

The output of a DC device that switches ground (DC common) to a load. The load is connected between the output of the device and the positive side of the power supply.

**Skew angle**

An alignment technique used in diffuse, retroreflective, and convergent-mode photoelectric sensing to increase the optical contrast ratio.

**Solenoid**

A coil equipped with a movable iron core that will produce linear motion as a result of current passing through the coil (the iron core is pulled into the center of the coil). When current is removed, a spring returns the iron core to the original position.

**Solid-state**

Any element that can control current without moving parts, heated filaments, or vacuum gaps.

**Solid-state switch**

A solid-state device where switching is accomplished by a solid-state element such as a transistor or SCR.

**Sourcing output**

The output of a DC device that switches positive DC to a load. The load is connected between the output of the device and the ground (DC common) side of the power supply.

**SPDT**

Abbreviation for Single Pole Double Throw. Refers to a three terminal switch or a relay (electromechanical or solid-state) having one normally open (Form A) contact and one normally closed (Form B) contact that have an electrically common point (complementary switching). Also known as Form C.

**Specular**

Describing a mirror-like finish that returns light energy at an equal and opposite angle from the angle of incident light.

**Spread Spectrum**

A technique in which the transmitter sends (or spreads) a signal over a wide range of frequencies. The receiver then concentrates the frequencies to recover the information.

**SPST**

Abbreviation for Single Pole Single Throw. Refers to a switch or a relay contact (electromechanical or solid-state) with a single contact that is either normally open or normally closed.

**Standards**

A specification, criterion or benchmark that is widely used, accepted or is sanctioned and codified by a standards agency. Safety standards are minimum requirements for product and machine design, manufacture, use and evaluation.

**Star Network**

A network topology where all nodes are connected to a central node. This central node is responsible for gathering and distributing data among the other nodes.

**Supplemental guarding/safeguarding**

Additional means used to prevent or hinder personnel from accessing the guarded hazard by augmenting the primary means of safeguarding.

**Surface reflectivity**

A measure of the efficiency of any material surface as a reflector of light, as compared to a Kodak white test card which is arbitrarily rated at 90% reflectivity.

**Switch transistor type**

The transistor, a solid-state device designed to switch DC current, can be either NPN or PNP. Some sensors offer Bipolar output, both NPN and PNP or BiModal output, either NPN or PNP.

**Switchpoint**

The signal level at which the sensor's output turns on or off. Often used interchangeably with threshold.

## T

**Target**

1. Any object being sensed 2. A retroreflective material that returns light back to a sensor

**TCP/IP**

Abbreviation for Transmission Control Protocol/Internet Protocol. A protocol for communication between computers, used as a standard for transmitting data over networks and as the basis for standard Internet protocols.

**TDMA**

Time Division Multiple Access. A wireless network communication architecture that provides a given slot of time for each device on the network. Provides guaranteed opportunity for each device to transmit to the gateway.

**TEACH**

A feature on some Banner sensors which allows the sensor to "learn" the light and dark sensing conditions, based on user inputs. The sensor can then automatically adjust the sensitivity to place the operating threshold midway between threshold for the light and the dark condition.

**Thermopile**

A "thermometer" for measuring heat radiation consisting of several thermocouple junctions.

**Threshold**

In photoelectric sensing, threshold is the point at which adequate received signal level overcomes sensor circuit hysteresis and causes the sensor output to change state. It is also the point at which the light and dark condition are differentiated.

**Through-beam sensing**

See "opposed sensing mode."

**Topology**

The pattern of interconnection between devices in a communication network. Some examples include: Bus, Ring, or Star configurations.

**Transducer**

A device that converts energy of one form into another form. The sensing element of a non-contact presence sensor that converts a change in incident sensing energy (e.g. light, sound, etc) into a proportional electrical quantity such as voltage or current.

**Transistor**

An active semiconductor device having three or more electrodes. The three main electrodes used are the emitter, base and collector.

**Translation**

Movement in the X and/or Y direction from a known point.

**Translucent**

Term used to describe materials that have the property of reflecting a part and transmitting a part of incident radiation.

**Transparent**

Permitting passage of electromagnetic radiation of specified frequencies, such as visible light or radio waves.

**Trigger**

A mechanism, usually a photoelectric sensor, that initiates the vision sensor to take action when a prespecified event occurs.

**Trip condition**

The response of a safety or safeguarding device in which an ON-state is achieved when the safeguard is cleared, re-closed, or re-armed, without operator intervention.

**Trip initiate**

The resetting, reclosing, or clearing of a safeguard causing the initiation of machine motion or operation. Trip Initiate is not allowed as a means to initiate a machine cycle per NFPA 79 and ISO 60204-1, and is commonly confused with PSDI.

**TTL**

Abbreviation for Transistor Transistor Logic. A digital circuit composed of bipolar transistors wired in a certain manner. Indicates a digital rather than an analog circuit.

**Two-hand control device**

An actuating control that requires concurrent actuation of both of the operator's hands to initiate and control machine motion during the hazardous portion of the machine cycle.

**Two-hand trip**

An actuating control that requires concurrent actuation of both of the operator's hands to initiate the machine cycle. Typically used on full revolution clutch or single-stroke machines.

**Type 2 light screen**

A set of design, construction and testing requirements for light screens described by IEC 61496. The "types" perform differently in the presence of faults and under influences from environmental conditions. Type 2 requirements are less stringent than those for Type 3 or Type 4

**Type 4 safety light screen**

A set of design, construction and testing requirements for light screens described by IEC 61496. The "types" perform differently in the presence of faults and under influences from environmental conditions. Type 4 requirements are the most stringent.

## U

**UL**

Abbreviation for "Underwriters Laboratory, Inc.", a testing agency for products sold in the United States. A device that has "UL approval" has been type-tested and approved by Underwriter's Laboratory as meeting certain electrical and/or safety codes.

**Ultrasonic**

Sound energy at frequencies just above the range of human hearing, starting at about 20 kHz. Banner ultrasonic sensors function at between 75 to 400 kHz, depending on model.

**Uncontrolled stop**

The stopping of machine motion by removing power to the machine actuators, all brakes and/or other mechanical stopping devices being activated.

**Universal Safety Stop Interface (USS)**

Abbreviation for Universal Safety Stop Interface. An interface that provides a means to integrate external devices to effect a stop command. It consists of two input channels (A&B), which are compatible with Banner solid-state OSSD outputs with "handshake" verification (two-wire hookup), or with devices that have two normally open hard contacts or relay outputs (four-wire hookup).

**UV**

Abbreviation for ultraviolet. Invisible short wavelength light energy that lies immediately beyond the violet end of the color spectrum between approximately 100 and 380 nm.

## V

**Vibration**

An oscillating change in displacement, with respect to a fixed reference.

**Visible light**

The wavelength range of 400-750 nm to which the human eye is sensitive.

**Vision**

Electronic imaging applied in manufacturing settings for the purpose of control, whether it is process control, machine tool control, robot control or quality control. Vision sensing is used to improve production processes and quality.

**Vision tools**

A tool set included in vision software used to analyze an image and extract information for judgment criteria.

**Voltage**

The force, or pressure, of electricity that exists between two points and is capable of producing a flow of current when a closed circuit is connected between the two points.

## W

**Wave**

A physical activity that rises and falls, or advances and retreats periodically as it travels through a medium.

**Wave amplitude**

The maximum change from zero of the characteristic of the wave.

**Wave angle**

The angle at which a wave is propagated from one point to another.

**Wavelength**

In a periodic wave, the distance between points of corresponding phase of two consecutive wave cycles.

**Wireless**

Refers to radio wave transmission used to transfer data or signals between locations that have no physical connections.

**Wireless Sensor Network**

Network of low-power electronic devices combining sensing and processing ability. The devices communicate wirelessly to a gateway device, connecting remote areas to the central control process.

**Working distance**

The distance from the camera to the object under inspection.

## X

**X-ray**

Electromagnetic radiation with high frequency, short wavelengths between .01-10 nm, able to penetrate solid objects.

## Y

**Yagi**

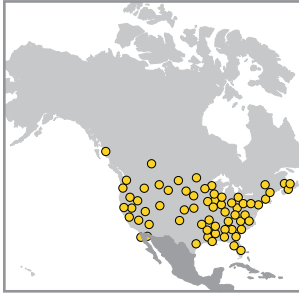
Antenna type that is directionally sensitive to signals received from the front and less sensitive to those received from the sides or rear.

## Z

**Zoom**

To electronically or optically enlarge or reduce the size of an image.

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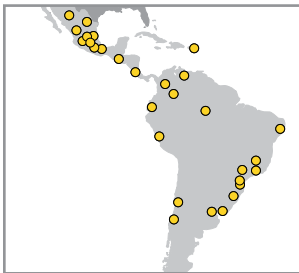
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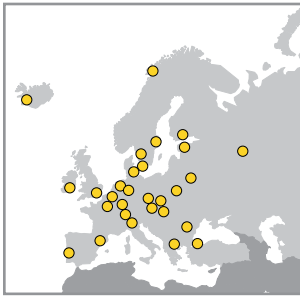
Reference

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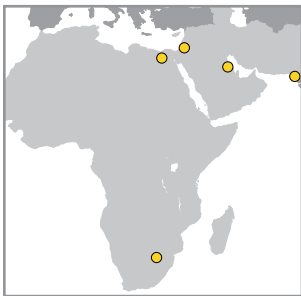
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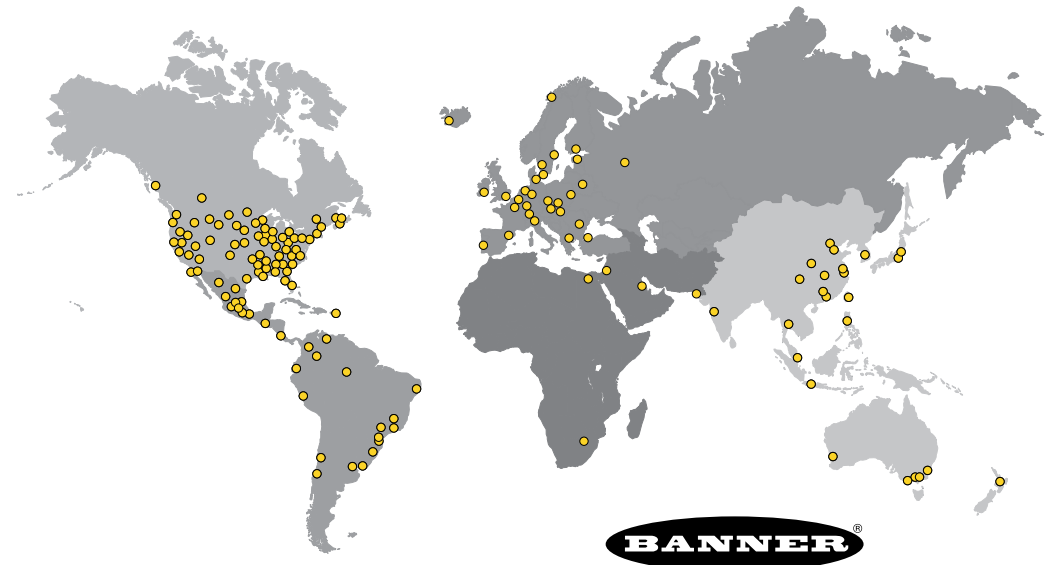
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BRT-40X18A	44991	717
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