CX-502 Technical Information

Introduction to the CX-502 series

Contents

INTRODUCTION

Why is high reliability required of detectors?

To answer this question, we have been not only continuing to increase detector sensitivity to enhance the ability to detect an intruder, but also committing ourselves to achieving stable, error-free detection. So what can we do to detect an intruder without a false alarm occurrence due to the effect of localised temperature variation? Also, how we can overcome the effects of various types of interference on the detector in order to still reliably detect an intruder?

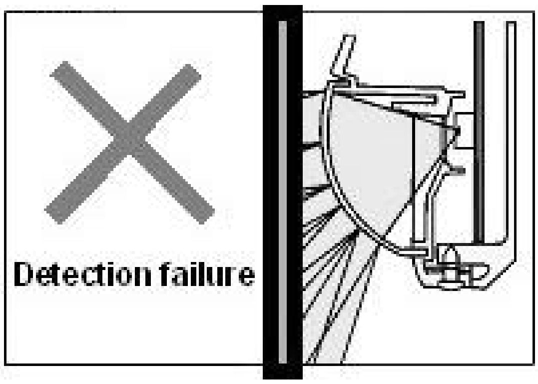
The solution to these conflicting requirements is our CX-502 series.
The CX-502 is available in two models: the standard model (CX-502); and anti-masking model (CX-502AM) that incorporates newly developed functions to cope with ever diversifying needs in the high-security market for improved immunity against interference.
As with the false alarm-immunity features on our other PIR detectors, the CX-502 series involves the proven functions such as Quad Zone Logic as well as the Optex's further advanced proprietary technology such as Advanced Temperature Compensation. Furthermore, the CX-502 series has achieved a higher level of enhanced reliability and stability through low power consumption and silent relay design by the incorporation of a photoelectric MOS relay.

By studying the descriptions of various functions with the CX-502 series, centering on our unique anti-masking techniques, you will find the answers to our earlier goal of how Optex can provide an even higher level of detector reliability.

Anti-masking Model CX-502AM

1. What is anti-masking capability?

The PIR detects the difference in temperature between a human body and the background as a variation in far infrared radiation. Thus, as shown on the right, when an obstacle in front of the lens blocks a detection area, the PIR will not detect a human body. Utilizing this fact, an intruder could intentionally mask the detector and render it ineffective prior to a robbery.



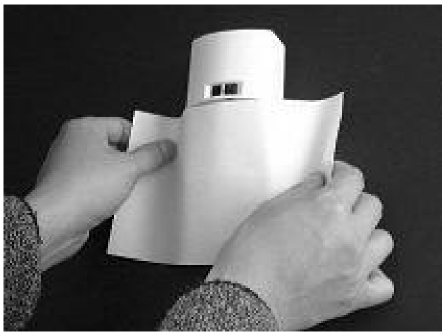
The anti-masking function is a capable of detecting intentional or unintentional interference by a blocking obstruction that would normally jeopardizes detection of human bodies. Conventional anti-masking detectors have a built-in near IR-based AIR (Active Infrared) detector in addition to a PIR to detect a masking object. Also, combination detectors are often used to cope with the problem of masking by use of their microwave.

2. Typical Examples of Masking

(1) Case study of unintentional masking

Accidental masking can occur if boxes are stacked up too high or a hanging poster or sign is placed in front of the detector. Masking may also occur if the lens becomes coated with layers of grease, nicotine dust or paint.
To preclude the possibility of these problems, the detector must be capable of detecting a masking object in front of it or at a long a range as possible.
Incidentally, owing to the operating principle of AIR, conventional anti-masking detectors may be hard to detect a black object of low IR beam reflectivity while they can readily detect a mirror-surfaced or white object of higher reflectivity.

(2) Case study of intentional masking



<u>Blocking material has been pasted to PIR window</u>
A typical attempt for intentional masking is the application of paper or adhesive tape to the lens surface of the detector as illustrated on the right.
The most probable masking material will be a piece of white paper or transparent adhesive tape, which is not conspicuous even when applied to the detector. In general, a transparent adhesive tape of higher IR beam transmittance is said to be harder to detect.

<u>PIR window has been coated with spray</u>
In certain cases, the detector is masked with a paint spray or oil spray. In these cases too, a clear coat, or a colour near to that of the detector, will be used so as to be inconspicuousness.
Generally, a clear spray coat, which allows higher IR beam transmittance, is said to be hard to detect. In reality, not only an anti-masking detector but also a combination detector often fails to detect this type of spray coating the lens.

The variation in sensitivity, with various sprays applied onto the PIR detector, is summarized below.

	Number of spray applications	1st	2nd
	No spray application	100%	100%
1	Clear lacquer (for automobiles)	74.3%	53.7%
2	Clear lacquer (for plastics)	89.4%	76.6%
3	Clear hair spray	93.4%	96.3%
4	Clear silicone oil spray	48.1%	37.7%
5	Clear medical spray	79.4%	56.8%

It can be understood from the data in the table above, that the loss in detection sensitivity is the greatest with No. 4 (silicone oil spray); however, a single layer of coating with this spray causes the PIR sensitivity to drop to approximately half that of the original level. In other words, the PIR is not rendered fully incapable of detection - its sensitivity is only marginally reduced. For example, if silicone oil spray is applied to the PIR whose ordinary detection sensitivity ranges from 1.2 to 1.6℃, the resultant sensitivity range will be approximately 2 to 3℃. To put it differently, if the temperature difference between a human body and the background is 3℃ or greater, the detector can still positively detect the human target. However, in a situation where the temperature difference between a human body and the background is smaller, i.e. during the summertime, the detector may not readily detect the human target. As a result, when masked with a clear spray coating, a conventional PIR detector will fail to overcome this interference.

In contrast, the CX-502AM maintains the high sensitivity of the PIR, while being capable of detecting the spray coating. Furthermore, since it incorporates a comprehensive range of false alarm countermeasures, it will perform well in a hot climate. The immunity to both false alarm and masking with CX-502AM is described later in this booklet.

Incidentally, when masked with only one layer of a coloured spray coat (such as white or black spray), the sensitivity of the PIR drops to 20 to 30% the original sensitivity. An anti-masking detector employing the AIR technique more readily detects a coloured spray coat that causes greater change in light reflectivity and transmittance when compared with a transparent spray coat.

3. Scheme for Detecting a Masking attempt

How then can we detect any of the above-mentioned types of masking? There are two approaches to this issue: The first is the previously mentioned detection technique by incorporating the AIR technology into the PIR detector. The second is the masking detection method using a combination detector that incorporates both the microwave and PIR techniques. The performance of our CX-502AM is described below through comparison of these two approaches.

- **Detection of masking by AIR technique (conventional PIR anti-masking sensors)**

While constantly monitoring the emitted light output from an IR LED, conventional optical anti-masking detectors detect a masking object by sensing the change in the light level. An increase in strength from the light being reflected back from a masking object or a decrease if the lens becomes coated with a spray material. This method can prove ineffective if the object is dark in colour and does not reflect the IR light back (No increase in IR light level), or if the spray is clear which does not obstruct the IR level (No decrease in IR light level)

In contrast, the CX-502AM series boasts reliable detection of a clear spray coating, and can detect a strip of black material situated 30 cm from it, thanks to the built-in twin-window prism.
To sum up, the CX-502AM is high performance anti-masking detector that is far superior to conventional anti-masking detectors.

A table below offers a comparison table for the masking detection performance with the CX-502AM, the older CX-50AM and those of alternative Anti-masking detector products from our competitors. From this table, it will be apparent that the CX-502AM series can most positively detect the masking objects that are defined in the German Vds standard. From this you will be able to appreciate the superior anti-masking capabilities of the CX-502AM over those of other similar products.

Comparison Chart of Anti-masking Performance

<Test method>

Material No.1 to 8: The judging criteria is whether or not the detector can detect a material situated more than 30cm (11.8 inches) away from the front of the detector.
(v : Detection is possible with a material 30cm or more away
– : Detection is impossible at a distance of 30cm or longer)

Material No.9: A piece of adhesive tape is applied to the detector lens surface. Then, ability of the detector to sense the tape is examined.

Material No.10 and 11: The detector is coated with a spray applied from below at the distance of 20cm (7.9 inches).
(v : Detection – : No detection)

<Test condition>
Room temperate

As Vds Standard test (Class C)			Manufacturer	OPTEX	OPTEX	A	B	C	D	E
			Model No.	CX-502AM	CX-502					
			Detection Period	Approx. 10 sec	Approx. 5 sec	Immediately	Approx. 5 sec	Immediately	Immediately	Approx. 20 sec
No.	Material	Size/Notes	Colour							
1	Carton	A3/Carboad	Black	√	–	–	–	–	–	√
2	Cotton towel	300x300mm (12x12 inch)	Ivory	√	–	–	√	–	–	√
3	Wool towel	300x300mm (12x12 inch)	Blue	√	–	–	–	–	–	√
4	Paper	A3/Thin paper	Black	√	–	–	–	–	–	√
5	Steel	B4/Surface coated	Gray	√	–	–	–	–	–	√
6	Rubber foam	A4	Black	–	–	–	–	–	–	√
			White	√	–	–	–	–	–	√
7	Polystyrene	A4	White	√	–	–	–	–	–	√
8	PVC-foil	A4/with letters	Translucent	√	–	–	–	–	–	√
		A4/without letter	Translucent	√	–	–	–	–	–	√
9	Adhesive tape		Clear	√	–	√	√	√	√	√
10	Hair spray		Clear	√	–	√	√	√	√	–
11	Silicone varnish	Lubricant	Clear	√	–	–	–	√	√	–
	Note	A3:297x420mm (11.77x16.5inch) A4: 210x297mm (8.3x11.7inch) B4: 257x364mm (10.1x14.3inch)					*Even if the center of lens is heavily coated with a spray, the detector must be able to detect the	-Differential detection	-Set Vds mode (SW4:off) -Sensitivity of Anti-masking "H" (SW2:off) -Differential detection	

● **Detection based on microwave + PIR techniques (conventional combination detectors)**

The detection principle of conventional combination detectors centering on microwave (MW) and PIR techniques can be categorized into those including the following types:

- A type that, based on the reflected MW, detects a human hand or other object which is approaching the detector for masking purpose (proximity detection system)
- A type that judges whether or not a masking object is present based on the magnitude of variation in the ratio of number of detections with MW to that with PIR (MW/PIR number of detections count system)

Modifying the detection logic with a combination detector can simply create an anti-masking function. There are variants of the above-mentioned systems, each have unique advantages and disadvantages. Therefore, an optimal system must be selected for an intended application.
A system, which detects an approaching object with MW, is hard to detect the masking material applied by spray. In contrast, an MW/PIR number of detections count system is hard to detect a masking method that can interrupt both MW and PIR. In addition, since MW alone may penetrate through a wall or window, this method may detect an object outside the guarded area, possibly leading to false detection of a masking object.

In terms of anti-masking capability only, the CX-502AM performs better than combination detectors (Table 1). It is true that masking detection capability is important. However, what is more important is the balance between the masking detection capability and the detectors reliability. From Table 2 (Evaluation of severity of effects of various false alarm factors with conventional PIR and combination detectors), it would be apparent that in general, those PIR detectors could trigger a false alarm owing to temperature change, while the combination detectors can issue a false alarm owing to vibration. In contrast to conventional PIR, our CX-502AM is more immune to temperature change thanks to its built-in advanced temperature compensation function. As a result, the CX-502AM rarely develops missed or false alarms from either a masking attempt or a genuine intruder. To sum up, the CX-502AM is an outstanding detector that boasts a good balance between detection performance whilst ensuring a high degree of reliability, as contrasted with conventional detectors whose performance is centered on either masking detection or intruder detection.

■ Table 1:Comparison of masking detection system between CX-502AM and combination detectors

Masking detection system	AIR Multi-prism system	Combination MW+PIR MW proximity detection + signal processing	Combintion MW+PIR MW proximity detection system	Combination MW+PIR MW/PIR number of detections count system
Model name	CX-502AM	DX-40PLUS	A	B
Obstacle, such as paper, 30 cm away	√	√	—	√
Paper strip, etc. pasted to PIR lens	√	√	√	√
Attaching of clear adhesive tape to PIR lens	√	—	√	—
Colour spray	√	√	—	√
Clear spray	√	—	—	—

(V: Detection –: No Detection)

■ Table 2: Evaluation of severity of effects of various false alarm factors with conventional PIR and combination detector

Detection Method	PIR	Combination
Insect	—	—
Disturbing light	—	—
Heater	√	—
Vibration	—	√

V: Possibly affected
–: Not affected

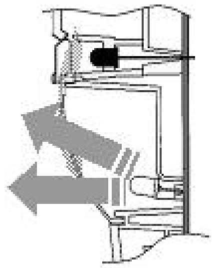
4. Anti-masking Technology on CX-502AM (patent pending)

Beginning with the research into the market demands for anti-masking performance as well as that based on our experience with the previously marketed CX-50AM, we have committed ourselves in expanding the scope of fundamental technologies and continued field tests. As a result, we have successfully developed the CX-502AM as a high performance anti-masking capable PIR detector.
This unique PIR detector has the following three outstanding advantages:

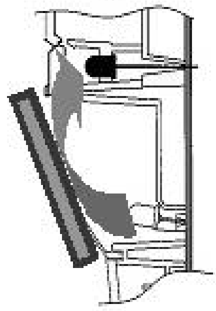
(1) It can detect an adhesive (clear) tape on the lens surface.
(2) It can detect a masking object far away in front of it. (It can detect black paper situated 30 cm away).
(3) It can detect a coat of (clear) spray.

<Detection principle>
The optical system involving prisms and lens has been designed so that the system can receive IR beams from the IR LED's, one located in the PIR lens and the other in the upper prism section. Each IR LED is assigned to an individual detection area. To be able to monitor the detection areas by one photo receiver element, both IR LED's flash alternately, thereby the detector detects the received light level as timed with the ON/OFF status of each IR LED.

(1) Detection of (transparent) adhesive tape on the lens surface

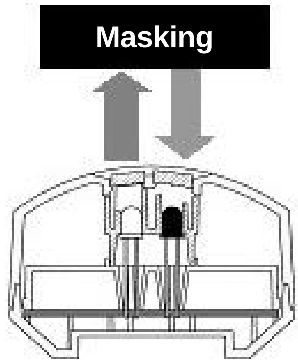


In normal status, the IR LED2 (situated at the bottom of lens section) emits an IR beam to the outside of the PIR lens. A portion of the beam directly reaches the outside of the PIR lens, while another portion of the beam travels inside the lens, and reaches the photo receiver via the receiver prism at the top of the lens.



When a masking object is pasted to the lens surface, and if its reflectivity is high, a portion of the IR beam directed to the top of the lens increases and the amount of light on the photo receiver element will be greater. If the masking object has low reflectivity and absorbs the IR beam, the amount of light on the photo receiver decreases.
The detector senses the variation in the amount of light to detect a masking object.

(2) Detection of an obstacle in front of the detector

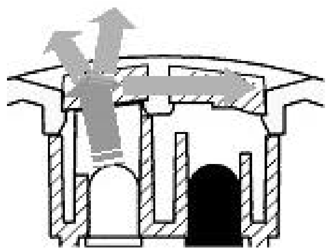


The combination of the IR LED1 in the prism and the photo receiver has enabled detection of a masking object in front of the detector. By forming the prism with a material of high IR beam transmittance, and by arranging the transmitter and receiver areas in parallel in a relatively narrow width, the detection distance in front of the detector has been greatly extended.
In addition, the black-coloured prism allows the detector to be more tolerant to other light interference.

(3) Detection of (clear) spray coating

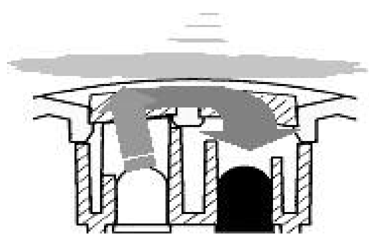
When a ground glass is wet, transmittance and reflectivity of light upon it will vary. Similarly, when the detector is masked with a spray coating, its optical path is altered.

Stand-by status (before application of spray)



The transmitter prism and receiver prism each have reflecting surfaces on both right and left sides so that the light beam from the transmitter prism directly enters the receiver prism. In addition, the reflecting surface of the transmitter prism has a special coating so that when the detector is in stand-by status, a portion of the IR beam (As diffused light) travels to the outside of that prism.

Masked status (after application of spray)



If the transmitter prism is masked with a coat of clear spray, the wet surface of this prism becomes a mirrored surface. Then, the previously diffused IR beam is more strongly reflected. As a result, the amount of the IR beam entering the photo receiver element increases. In contrast, if the transmitter surface is covered with a black spray coating, the reflectivity of this prism gets smaller; thereby the amount of the IR beam entering the photo receiver elements decreases. The detector detects the presence of a masking object by sensing the above-mentioned change in the amount of the IR beam received by the photo receiver element.

5. Functions Specific to the CX-502AM

Self-Checking function
The built-in Self-Checking function diagnoses the operation of the detector every 5 hours to make sure that the detector is functioning correctly.

Initial alarm memory
A flashing LED indicates which detector is activated first amongst several detectors connected in the same alarm loop.

6. Features of the CX-502AM

(1) Anti-masking capability

① The detector reliably detects a clear spray coating.

② The detector can detect clear adhesive tape on the surface of the PIR's lens.

③ The detection distance in front of the detector is improved (detection is capable at 30 cm with black paper).

(2) A highly reliable PIR detector that can detect an intruder, even when it is masked with a spray coating.

Despite the possibility of a false alarm, anti-masking detectors can positively detect an intruder even when masked with a spray coating because they are highly sensitive in their design. Thanks to Optex's patented technologies described below, our CX-502 series always performs well, boasting extremely high degrees of reliability.

(3) Simple installation procedure

The unit's power consumption is very low, and it comes with a number of installer-friendly functions. In essence, the CX-502AM is a detector that has highly balanced performance characteristics, incorporating anti-masking capability, higher reliability of the PIR and simplified installation.

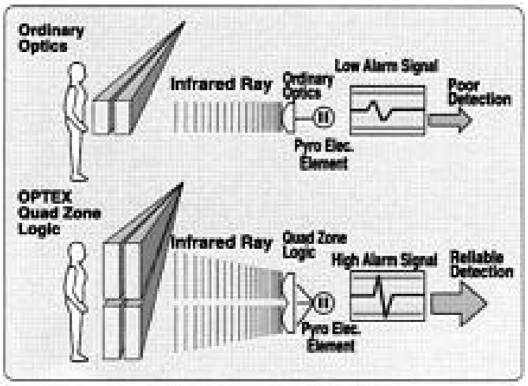
Technical Advantages Common to the CX-502 Series

Quad Zone Logic （Patent Listed）

PIR detectors sense temperature changes, namely changes in the amount of infrared radiation. There are also other factors like light, and spot temperature changes that can affect a detector's reliability.

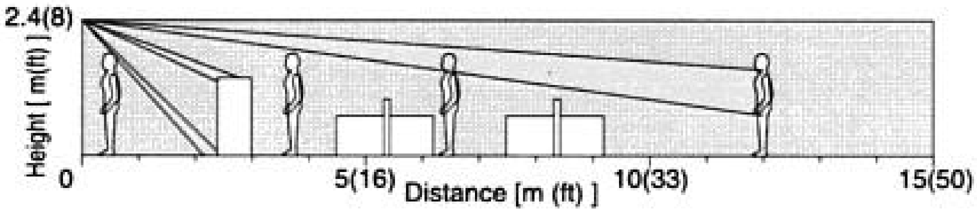
- Light disturbance: Sunlight through windows, Car headlights.
- Overall temperature change
- Fax: Falling page from a thermal facsimile machine.
- Objects: Swinging curtains or blinds that have been heated by the sun.
- Air turbulence: Warm or cold draughts from windows, heaters or air conditioners.

Our patented Quad Zone Logic, with its Offset spherical lens, offers higher density coverage of the detection area, by increasing the number of detection zones.
At shorter distances, the high density, multiple segmented zone pattern, requires 4 to 8 zones to be broken by a human sized object, in order to create an alarm condition.
At longer distances, a human will be detected by 2 or more zones, whilst spot temperature changes such as facsimile machines may not affect, or only partially affect 1 zone. At both ranges, the detector senses signals of differing strengths for humans and spot temperature changes. It is therefore able to eliminate these minor signals as non-hostile, and can therefore prevent false alarms from occurring.

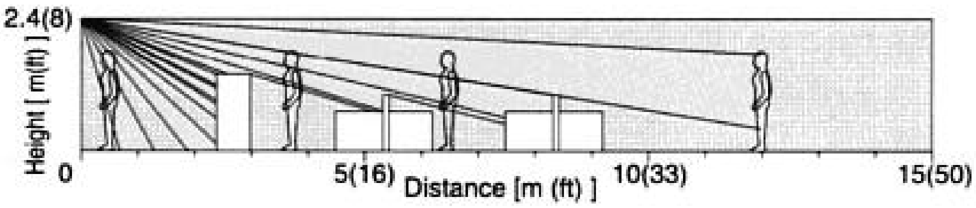


False alarm factors, like light disturbances and temperature changes, are comparatively slow, and can occupy a large part of the detectors field of view. To assist with this, our PIR's use twin elements and a white colour lens.

Conventional Models

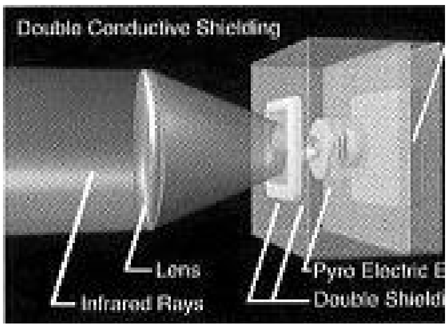


CX-502 Series



Double Conductive shielding of Pyroelectric Element (Patent Listed)

Double filtering and conductive metal shielding of the Pyro blocks out visible light and RFI allowing only infrared energy to reach the pyroelectric elements.



Offset Spherical Lens

A detector must look from a frontal direction downwards. A wide-angle detector must also look out over a horizontally square area. With a Fresnel lens, the optics must be designed to provide each detection zone precisely to these differing directions.

Conventional Flat Lens

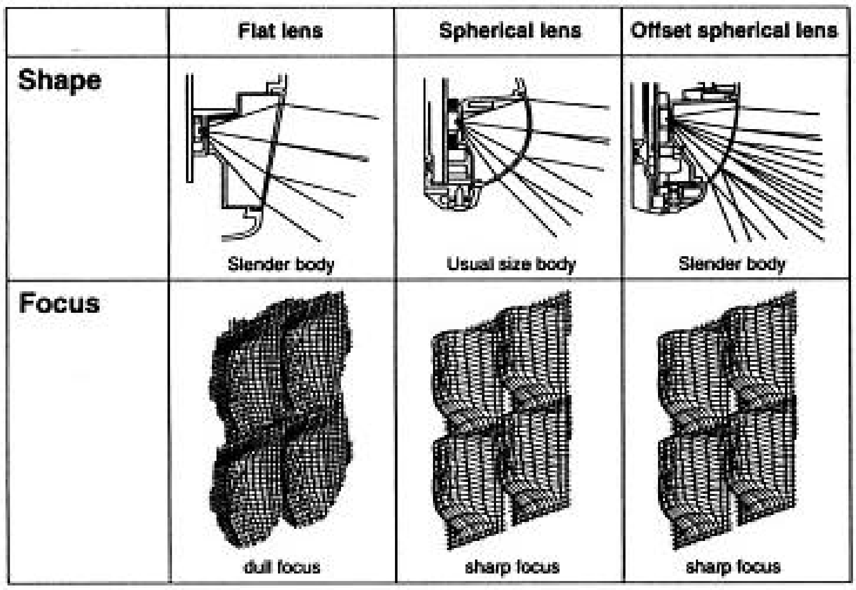
Because of their flat shape, some lens segments are poorly aligned to their detection. This distorts the focused image of the object, and fails to provide sharp detection.

Spherical Lens

It places each lens segment, precisely to its required detection pattern, at a uniform distance from the pyroelectric element. This eliminates sensitivity distortion, and achieves a sharper focus of target objects.

Offset Spherical Lens

The Offset Spherical Lens incorporates the advantages of a spherical lenses capability, with the slender body of a flat lens.



Advanced Temperature Compensation

At a higher ambient temperature, the temperature difference between the background and a human body will be reduced; in this case the PIR could fail to readily detect a human body. With conventional temperature compensation functions, the sensitivity of detector must be set 20% higher at 35℃ than the sensitivity at 25℃ (normal temperature) in order for the detector to offer a stable performance. However, with this setting, the sensitivity of the detector is excessively high at 40℃ or over, which could lead to various problems. To overcome this drawback, Optex's advanced temperature compensation function allows the detector's sensitivity to automatically drop at 40℃ or higher so that the detector can perform more reliably within a wider ambient temperature range.

Sealed Optics

The pyro element is sealed from drafts or ingress of small insects to minimize the possibility of false alarm occurrence usually attributed to these factors.

Photoelectric MOS Relay

The photoelectric MOS relay on the CX-502 series which when compared with conventional reed relays, offers the technical benefits described below:

(1) Low Current Draw

The optimized low power consumption design for the power circuit on the CX-502 series, by incorporation of the photoelectric MOS relay etc., has helped decrease the current consumption to less than 50% as compared with the previous CX-50 models.

	Standard Model		Anti-Masking Model	
	CX-50	CX-502	CX-50AM	CX-502AM
Normal	10mA	5mA	30mA	7mA
Max	15mA	12mA	40mA	19mA

(2) Silent Relay

The photoelectric MOS relay lacks a physical contact that is energized/de-energized with a magnet switch as found on conventional reed relays. Therefore there is no “clicking” sound heard when the relay opens or closes.

(3) Anti-Magnet

Unlike conventional reed relays, the photoelectric MOS relay does not employ magnetic force to open or close its switch; thus, it is never affected even when a powerful magnet field is introduced into close proximity with the detector.

Double PCB Protection Cover

The enclosure of the PCB unit of the CX-502 fully covers all the electronic components on the circuit board. The PCB unit is additionally guarded with the front cover to provide complete protection to the PCB.

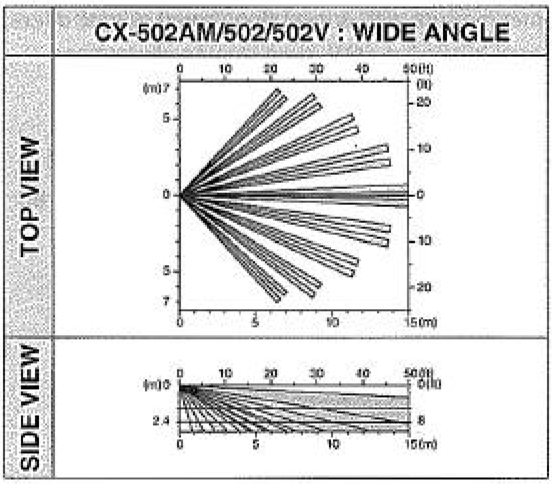
Easy Installation

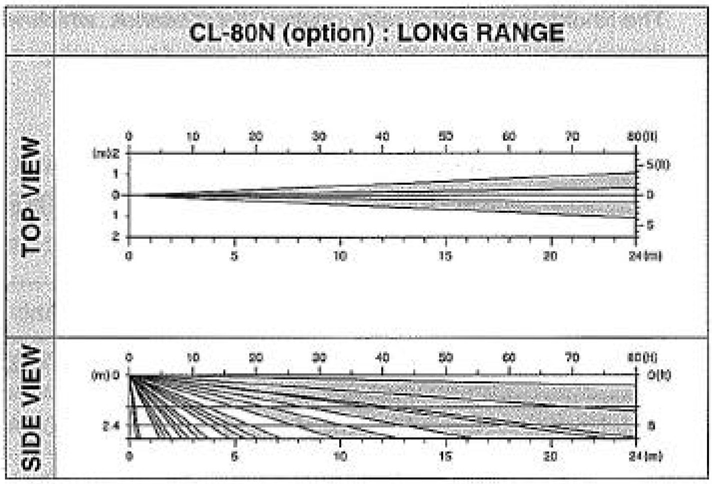
- Using the factory prepared knockouts easily makes the wiring entry holes.
- Thanks to easy-to-view LED’s, engineers and staff have no problem in recognizing their indications making alignment and walk testing much easier.
- The wiring guide on the rear of the product provides a useful wiring space, providing aesthetically acceptable wiring and additional protection for the PCB.
- High-density detection area based on Quad Zone Logic shortens the time needed for positioning and aligning the detector.
- The PCB unit can be easily removed and securely locked back in place. This feature further expedites the installation work.

Compact Size

Despite the diversity of these unique functions, the CX-502 series still boasts a compact design.

DETECTION PATTERNS





SPECIFICATIONS

CX-502

Detection method	Passive infrared
Coverage	Wide angle 85° wide 15m x 15m (50ft. X 50ft.)
Detectin zones	82 zones
Mounting height	1.8 - 3.0m (6 -10ft.)
Sensitivity	1.6°C (3°F) at 0.6m/sec. (2ft./sec.)
Detectable speed	0.3 - 1.5m/sec. (1 -5ft/ sec.)
Power input	9 - 18V DC
Ccurrent draw	5mA (normal) / 12mA (max.)
Alarm period	2.0 ± 0.5 sec.
Alarm output	N.C. 28V DC 0.2A max.
Tamper switch	N.C. Opens when cover removed
Warm-up period	Approx. 1 min. (LED blinks)
LED indicator	LED is blinking during warm-up period. Alarm condition
RF interference	No. alarlm 30V/m
Operating temperature	-20 - +50°C (-4 - +122°F)
Environment humidiky	95% max.
Weight	120g (4.2 oz)

CX-502AM

Current draw	7mA (normal) / 19mA (max.)
Alarm memory	Selectable positive or negative control
Initial alarm memory	Selectable positive or negative control
LED indicator	Red and yellow LED is blinking during warm-upperiod. RED LED : Alarm Memory and Initial Alarm Memory Indicator Yellow LED : Anti-Masking and Self-Checking Indicator
D.L. terminal	Selectable positive or negative control
Weight	135g (4.8 oz)

CX-502V

Current draw	5mA (normal) / 13mA (max.)
Alarm memory	Selectable positive or negative control
D.L. terminal	Selectable positive or negative control
Weight	120g (4.2 oz)

CL-80N (Optional lends for long range curtain pattern)

Coverage	24m x 2.3m (80ft. X 7.7ft.)
Detection Zones	22 zones

DIMENSIONS