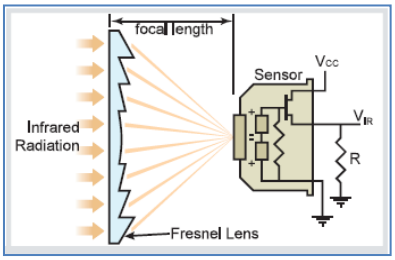
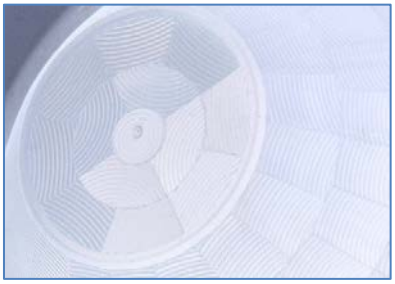
Understanding PIR-based Sensors

What is a PIR sensor?

PIR is a short form of Passive Infrared. A PIR sensor is an electronic device capable of sensing the presence and movement of a warm object (human body or vehicle) by measuring the change of infrared (IR) energy radiated from that moving object within its field of view. PIR is considered the most commonly used sensing technology in intrusion detectors for security, and occupancy/ vacancy sensors for lighting control.

A PIR sensor is made up of a multi-segment Fresnel lens and, a pyroelectric infrared sensor operating together with signal processing, power converting and output control electronics. A Fresnel lens is employed to focus the infrared energy emitted from a warm object onto the pyroelectric infrared sensor for signal processing. Each effective Fresnel lens segment is designed to collect the change of infrared radiation from a corresponding detection zone; therefore, a Fresnel lens combined with multiple segments will provide a specific detection pattern featuring multiple detection zones distributed within the range. By using different lenses designed with different Fresnel segment combinations, a PIR sensor can thus provide different coverage.





IR-TEC offers a very wide range of PIR-based motion/occupancy sensors and lenses for selection. To know more about IR-TEC sensors, please visit www.irtec.com for more details.

Operating principles

All objects with a surface temperature above absolute zero (-273°C) emit heat energy in a form of electromagnetic radiation. Usually this radiation is not visible to the human eye because it radiates at infrared wavelengths, but it can be detected by electronic devices designed for such a purpose. A PIR sensor is purposely designed to detect the change of thermal infrared energy with wavelength ranging from 8-15 um which corresponds to the range of human body temperature.

Types of PIR sensors

A. By the Way of Mounting

PIR sensors can be categorized as "ceiling sensors" and "wall sensors" by the way of mounting. Ceiling sensors are designed for mounting on ceiling or integrating with light fixtures to provide "conical look-down" detection patterns; wall sensors are designed for mounting on wall or corners to provide "horizontal fan-out" detection patterns. In general, ceiling sensors are more suitable for open spaces, with or without partitions; wall sensors are more suitable for enclosed spaces without objects that may block the sensor "seeing" the occupant.

IR-TEC offers a wide range of PIR-based ceiling and wall sensors. IR-TEC's ceiling sensors can be flexibly mounted on ceiling or integrated with OEM lighting fixtures via different mounting brackets. IR-TEC's wall sensors which can be mounted into the wall box (the WALLSENZR series in-wall sensors), or on the wall/corner with a swivel mounting bracket which provides horizontal/vertical angle adjustment.

B. By the Voltage of Power

PIR sensors also can be categorized as "low voltage sensors" and "line voltage sensors" by the operation voltage. Low voltage sensors are designed to operate with power voltage lower than 50V (typically 24V, 12V, or lower), and they are normally used for intruder detection in security systems or occupancy/vacancy sensing for automatic lighting/HVAC control systems. Line voltage sensors are designed to operate with line voltage power at 110/120V, 234/240V/277V, or 380/477V, and they are normally used to switch on/off the load with or without output level control, such as 0-10V dimming for lighting.

IR-TEC offers a wide range of low and line voltage PIR-based sensors designed for broad applications. Numerous models of power pack and controller are available for integrating with a variety of low voltage sensors to provide zone-based lighting/HVAC control for commercial/industrial applications. For more details of IR-TEC's PIR-based sensors, please visit www.irtec.com.

Application Notes

There is no perfect motion/occupancy sensing technology which is good for all applications, so we should realize that even though PIR is the most commonly used sensing technology in the industry, it still has limitations and physical characteristics while using a PIR-based sensor to do the job. The following are some application notes for people who like to understand more about using PIR-based sensors.

- Movement is essential for PIR sensor to detect. Stillness is not detectable for PIR sensor.
- PIR sensor requires unobstructed line-of-sight to detect the movement within its range.
- PIR is more sensitive to the movement across its detection zones than toward the sensor.
- Temperature differences between the object and background is imperative for PIR sensing.
- The closer the object and ambient temperatures, the harder it is for a PIR sensor to “see”.
- Warm air and strong wind within the range could cause “false detection” of PIR sensors.
- Blind areas are inevitable for PIR sensors. The farther from the sensor, the larger the area.
- Size of the object matters. The larger the object, the easier for sensor to sense the motion.
- The closer the object is to the sensor, the faster for PIR sensor to catch the movement.
- PIR sensor can also “see” moving pets, animals and vehicles within its detection range.
- Blocking or masking part of the lens can avoid picking up movement from adjacent areas.
- High bay ceiling sensors require the highest sensitivity, so are more sensitive to environment.
- Stable and quality power supply is essential for PIR sensors to achieve reliable operation.
- A cold, just-started electric vehicle or fast moving car may not be detected by a PIR sensor.

Best Practices When Using PIR-based Occupancy Sensors

Application	Recommendations	Caution
Break room	• For larger break rooms, ceiling sensors are highly recommended. • For non-enclosed break room, wall sensor mounting at the wall/corner that allows sensor to "see" only the occupants within the area is the best option.	• Sensors placed in non-enclosed break room must be carefully positioned to avoid seeing pass by movements from adjacent areas. • Smaller spaces may be better served by wall sensors; however the sensors should be properly placed so that they are not blocked by open doors from entry ways, , or refrigerators.
Classroom	• Sensors should cover instructor's desk, the room entrance, and other areas where people may sit for a long periods of time. • Mount the sensor on the wall with door to avoid seeing pass by movement from corridor.	• Ensure the sensors not being blocked by things that are hung from the ceiling. • Ensure that the wall sensor is not blocked when the door is left open.
Conference Room	• Larger conference rooms may require multiple sensors for complete coverage. • Wall sensors can be used for medium and small conference rooms. • Rooms with manual-on switch can use ceiling sensor over the table and presentation area.	• Properly position the sensor so it is directed away from doors and windows. • Ensure that the wall sensor is not blocked when the door is left open. • Manual switch should be included for override control of the lighting.
Corridor	• Make sure all access points into the corridor are covered by the sensors. • Select the sensor with lens for corridor detection can provide better coverage with less number of sensors required. • Longer delay can be set to avoid distracting occupants in the rooms lining the corridor.	• Occupancy sensors are preferable to vacancy sensors for corridors, especially those with multiple access points, because vacancy sensors would require numerous switches by doorways. • Multiple sensors may be required to cover a long corridor or an odd-shaped hallway.
Office, Private	• Recommend to use PIR+HFD dual-tech sensor to get better minor motion sensing capability. • In-wall sensor with manual override switch is always the best option for small and medium offices.	• Ensure that the wall sensor is not blocked when the door is left open. • The areas with minor motions such as typing, or page turning, MUST be covered by the sensor with better minor motion detection.
Office, Open	• Complete coverage must be provided in the walkways with overlapping coverage to avoid blind spots. • If cubicle partitions are tall, placing a ceiling sensor right above the partition will provide the best sensing performance.	• The areas with minor motions like typing, writing, or page turning, MUST be covered by the sensor with minor motion detection. • Do NOT set delay time shorter than 5 minutes as frequent switching can be a nuisance for neighboring cubicles.
Restroom	• In-wall sensors are highly recommended for individual restrooms. • One ceiling sensor can be placed over the stall to cover two adjacent units.	• For odd-shaped restrooms, multiple sensors may be required to provide total coverage. • Vacancy sensing control is not recommended for public restroom.
Storage	• Ceiling sensors are recommended for storage rooms with shelves and racks.	• Stacks between the occupant and sensor will block the sensor from seeing the occupant.
Parking Garage	• Fixtures with sensor integrated are highly recommended due to cost effectiveness.	• Sensors for driveways and parking areas should be set with different modes and parameters.
Warehouse	• For high-bay lighting, select the sensors with lenses that are designed for high-bay. • Blind spots are inevitable for mid and high bay applications.	• Not all ceiling sensors are suitable for high-bay. • The sensors must be placed carefully to protect them from being knocked off by forklifts and other equipment.