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Issue: #TB141
Date: 10/26/99
Topic: PIR Lens Technology

PIR Lens Technology

The heart of passive infrared (PIR) sensor technology is the lens. As the "eyes" of the sensor, it collects the infrared energy data generated by matter in space. Moving energy sources, such as humans, will emit radiant heat that is then collected by the lens. These data are passed to the sensor circuitry for interpretation; based on this, a signal is transmitted to switch lighting in the area. Because appropriate signals depend on the collection of comprehensive and accurate data, the quality and design of the lens is critical.

Fresnel Lens Technology

The lens technology most commonly used in passive infrared occupancy sensors today is based on the Fresnel principle, which is that the contour of the refracting surface of a lens defines its focusing properties. A non-spherical surface contour (also referred to as "aspheric") will minimize optical aberrations and refract a higher percentage of the light energy being collected in the desired direction. This aspheric surface consists of grooves that can be varied in depth and thickness.

Advanced Lens Technology

While Fresnel lens technology is the foundation for the lenses used in The Watt Stopper's PIR sensors, there are important differences between common Fresnel lens and the advanced types found in our products. Most importantly, The Watt Stopper utilizes lenses that have been specifically developed for use in our sensors. This involves an exclusive specification and lens design process, during which a prototype lens is crafted by hand and tested for effectiveness. Once the lens has passed this rigorous testing stage, the manufacturing process can begin, utilizing advanced plastics materials to customize lenses with excellent infrared optical properties. This process is applied for each sensor product to ensure that the specific capabilities intended for each sensor type are obtained. For instance, the lens design for The Watt Stopper model CI-200 sensor affords 360° coverage for a range up to 1200 square feet. By comparison, the lens for the WPIR sensor was designed for a coverage range of 300 square feet.

Another significant difference between The Watt Stopper patented lenses and common Fresnel

lenses is the use of multiple lens segments and tiers. This unique design is accomplished by identifying and selecting specific segments or "cells" of a common Fresnel lens design that have exceptional optical properties for a specific range. These cells are then pieced together with other segments. The effect, rather like a patchwork quilt, is illustrated in Figure 1, which represents a lens surface. Lastly, these segments are arranged in levels, or tiers, to achieve multi-dimensional coverage.

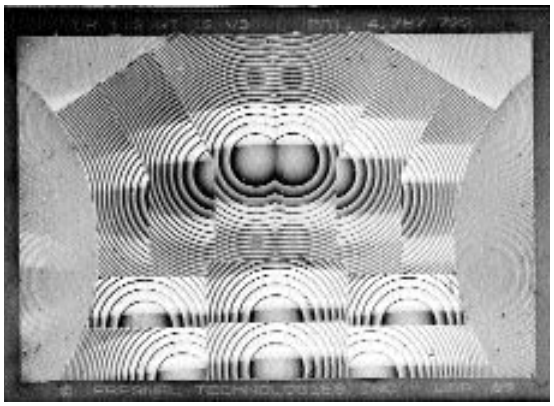

Figure 1. Representation of a lens surface, consisting of multiple Fresnel cells.

Experts in the field of optics have developed different designs or patterns, each of which is protected by its own patent, to provide different coverage capabilities. For instance, The Watt Stopper WPIR sensor includes 4-5 distinct tiers of segments in order to provide overlapping coverage of areas within the defined field of view. These tiers are represented in Figure 2 by the differently shaded

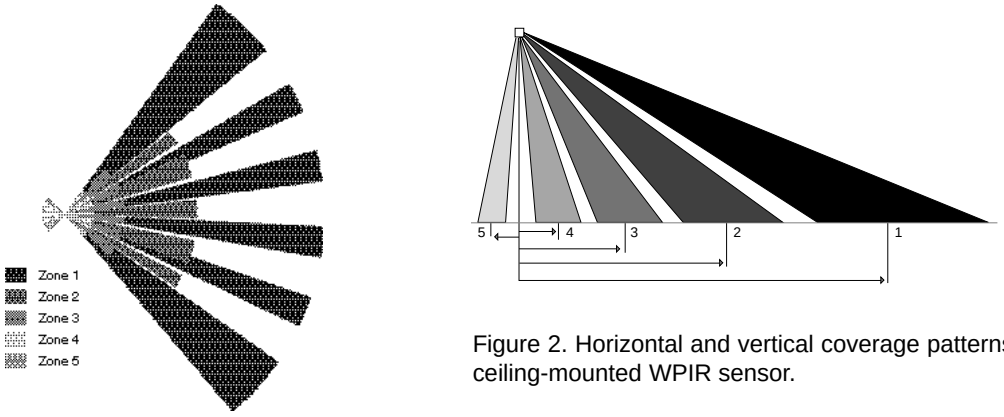

Figure 2. Horizontal and vertical coverage patterns for ceiling-mounted WPIR sensor.

zones. Such multi-dimensional coverage is particularly important in certain areas, such as offices, where activities are conducted at varying levels (i.e., sitting at a desk, standing at files, etc.) and consist of fine motion activities that involve only hand movements. By covering these different levels, the lens detects more types of energy.

In contrast, a sensor being used to detect gross motion at long range will require a completely different lens and coverage pattern. For instance, detecting occupancy in a corridor requires that the sensor identify walking motion at substantial distances. This application would require a coverage pattern like that represented in Figure 3. Ultimately, customizing the lens design and pattern for

specific applications results in a more accurate "snapshot" of the covered area to the sensor.

Finally, The Watt Stopper employs lenses that utilize different types of lens materials than many other sensor manufacturers. By using lens materials that reduce the negative effects of visible light (i.e., solar short-wavelength infrared waves), the sensors eliminate possible false triggers.

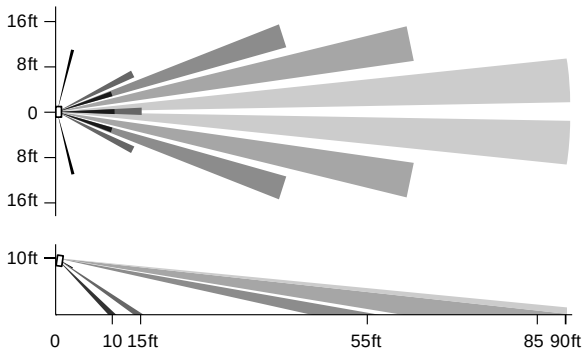

Figure 3. Long-range coverage pattern of a CX-100-1 lens.

References

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2. Fresnel Technologies, Inc. "Poly IR® Fresnel Lenses for Infrared Wavelengths," 1995.
3. Fresnel Technologies, Inc. Data Sheets, 1991.