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RE: Technical Bulletin: PIR and US Sensor Technology

## Leviton Passive Infrared (PIR) and Ultrasonic (U/S) Occupancy Sensors

### Leviton Key Advantages

- As compared to competition, Leviton integrates features and configurations to simplify the part number selection and reduce your inventory carrying costs. (examples included are: Vandal Resistance, Photocell, Multiple Voltages and Field Configurable/Technology Disable, Multiple lenses, etc.)
- Mechanical Latching relays, standard on all wallbox models, makes ours the most durable and robust occupancy sensors available.
- No-Neutral versions are available as a standard SKU across all wall box sensors (excluding nightlight models) making retrofits a breeze.
- Patented Blinders are built into wall switch sensors eliminating the need for masking tape for a truly professional installation.
- Sensor field of view is the largest in the industry and is de-rated to assure optimal coverage.
- NAFTA compliant and Made in the USA sensors are available to meet government project requirements. (see [www.leviton.com/nafta](http://www.leviton.com/nafta) and [www.leviton.com/usa](http://www.leviton.com/usa) for a complete listing of sensor part numbers)

This section of the document will cover three different aspects of Occupancy Sensors: Coverage area, Field of view, and Coverage pattern.

### Coverage Area

Coverage area is represented in square feet at the floor. Coverage is dependent on mounting location and height, magnitude or quality of detectable motion, direction of motion compared to placement, ambient temperature, and sensitivity adjustment.

General Rules: Optimal placement for a PIR sensor is essential. PIR sensors have a specialized lens used to create "detection zones." As the mounting height and distance from the sensor increase so does the zone coverage, requiring larger movements for detection. This is referred to as Major Motion. Minor Motion on the other hand, means that less movement is required for detection. I

In other words, the PIR sensors divide an area into zones of coverage – "detection zones". The greater the distance from the occupancy sensor, the larger the detection zones increase and then the coverage area has gaps between "detection zones", resulting in detection zones growing in size within the coverage area. Larger detection zones require large motion to activate the sensor. Larger or oddly shaped spaces may require more sensors in order to detect motion throughout the area. In order to regulate and control detection zones, multiple lens types maybe required for different coverage patterns, and variable mounting heights.

**Leviton Advantage: High performance pyrometers and advanced Fresnel Lens technology provide the best and most consistent coverage on the market.**

### Field of View (FOV)

Occupancy Sensors Switch PIR FOV

- Leviton supplies dual pyrometers to generate the best PIR detection possible in a 180° FOV, with a maximum coverage area of approximately 2100 square feet. PIR as a line-of-sight technology has a maximum sensing distance in front of the sensor of 40 feet, with a 60 foot span (30 feet on each side of the sensor). PIR technology is optimal when the following is considered: Heat + Size of Heat Movement + Time Delay = Lights ON. In other words, larger, heated movement within a lengthened time delay will increase the probability of PIR sensing motion.

**Leviton Advantage:** *Leviton EXCLUSIVE dual PIR elements are a key design advantage that provides twice the fine motion detection zones and a larger field of view through a small lens height. Other manufacturers use larger thinner lenses that are inherently prone to damage or tampering, or may offer “vandal resistant” lenses that have poorer range and sensitivity due to the excessive material thickness. Leviton’s unique design of Dual PIR elements, small lens height, reinforced internal cage, and a durable lens material provide a combination of features maximizing a vandal resistance sensor without compromising performance. All Leviton commercial wall switch sensors employ this vandal resistant design.*

#### Occupancy Sensors Switch Ultra-Sonic (U/S) FOV

- Leviton uses a pair of U/S transducers to actively detect Doppler shifts (compressed reflective waves) caused by motion in a space. U/S is more sensitive to small movements since it does not rely on movement between zones or line-of-sight, instead U/S provides complete active coverage of an entire space. Sensitivity is field configurable for best performance in various spaces.

**Leviton Advantage:** *Active U/S technology was chosen by the leading manufacturers in both occupancy and security detector markets for the most reliable and efficient way to eliminate false OFFs. Active technology also allows equipped multi-technology products to be put into single technology mode and operate as U/S only, disabling PIR for areas where the entry point is not in line of sight. Whereas ultrasonic and PIR technologies can be used independently, audio technologies must be used with one of the above technologies due to it’s inherent unreliability for energy savings over time. Audio technologies will keep lights on during vacancy if sound is detected for any reason. Conversation in hallways or adjacent offices, radios or ambient office noise can falsely maintain lights in vacant spaces, negatively impacting energy savings and ROI.*

Example: The OSSMT occupancy wall box sensor with multi-technology (PIR & U/S).

#### Coverage Pattern

Coverage patterns are determined by a variety of factors. For PIR, line of sight, lens and segment masking impact FOV and coverage patterns. For U/S, the direction in which the transmitter and receiver are pointed and the reflectivity of surfaces in the room will impact sensitivity and coverage for the space. When both technologies are active as in a multi-technology sensor, the coverage pattern is generally calculated from the PIR FOV. This is because in multi-technology operation, PIR turns the light ON and the U/S keeps it ON.

**Leviton Advantage:** *Patented FOV blinders are standard in all wall switch sensor models instead of masking tape. Additionally, Leviton provides a Harmonic Ring on the wall and ceiling mount sensors which allows the installers to make micro adjustments to the sensor head for fine-tuning the coverage area.*

## Occupancy Sensor - Operation

This section covers the operational elements of: Multi-technology, Flashing LED status, Sensitivity Adjustment, Functional Variables, Application Considerations, and Walk Testing for PIR Sensors.

#### Multi-Technology Operation

PIR is used to detect motion and turn lights on, while either technology is used to keep lights on while the space is occupied depending on model and adjustments. This scheme permits the U/S to eliminate false OFF

conditions. PIR increases immunity by inanimate motion in an unoccupied space. U/S transducers maximize sensitivity to minor motion. Multi-technology utilizes the best of both to provide optimal energy savings. Adding U/S technology to wall switch sensors assists with some of the challenges of having a sensor in these traditionally troublesome locations. Wall switch locations can be blocked or located in out-of-the-way spots which render PIR useless, multi-technology sensors can provide a better alternative for these blocked spaces or irregular shaped rooms.

### **Flashing LED (False State Detection Circuitry)**

Leviton sensors protect against false triggering the load (lights) ON or OFF (known as False ON or OFF). This is verifiable through the use of indicator LEDs, Red LED signifies PIR technology sensing motion, Green LED signifies U/S technology sensing motion. The LED flashes when the sensor receives a "significant" motion signature and after detection, the relay will close. When the relay closes, there has been a "validation" of the signal, which turns the load ON. This design is intended to prevent the load from turning ON when not needed (False ON). Similarly, sensors attempt to screen areas of coverage to prevent false OFFs.

**Leviton Advantage: Leviton Occupancy Sensors have extremely high payback margins but only because they operate reliably. The LED flashing before "lights ON" is a visual indication that the false-detection algorithms are actively screening out noise.**

### **Vacancy Confirmation**

Leviton multi-technology sensors keep both technologies sensitive after timeout expires. Lights are then temporarily swept off while both technologies look for occupancy for an additional 30 seconds. If vacancy is confirmed during this period, the sensor turns off until the PIR circuitry detects the next entry into the room.

### **Sensitivity Adjustment**

Present on all sensors, it may take several forms depending on the model. A red knob, eye, or range would be the PIR sensitivity and a green knob, or ear would be the U/S sensitivity. This sensitivity adjustment is for fine tuning sensitivity within the general coverage area. The sensitivity adjustment may be used where false triggering is occurring or for when the sensor is not detecting quickly enough.

## **Operational Variables**

### **Temperature**

The environmental temperature of an application will impact operation of passive infrared sensors. Traditional PIR technology detects movement of a heat source between detection zones against a background of ambient heat. In colder environments, PIR sensors will detect a heat signature more readily than in hotter environments.

### **Air Movement**

The air movement within a space can also create challenges for PIR and U/S technologies. With PIR the movement of Hot or Cold air through the detection zones may falsely trigger the sensor and with U/S the air movement can precipitate false triggering by alternating the reflectivity of the U/S field.

### **Application Considerations**

Coverage patterns should be staggered and overlapped to assure optimal coverage. Staggering the sensors mounting location assures that moving objects will cross a detection zone. Overlapping coverage areas is a good way to assure ample coverage.

Narrow aisles need special consideration. For example, a five foot wide aisle requires more sensors for most reliable FOV detection. An object could move within the five feet and still be inside of a single detection zone, and motion would not be sensed.

## Occupancy Sensor Testing (Walk Test)

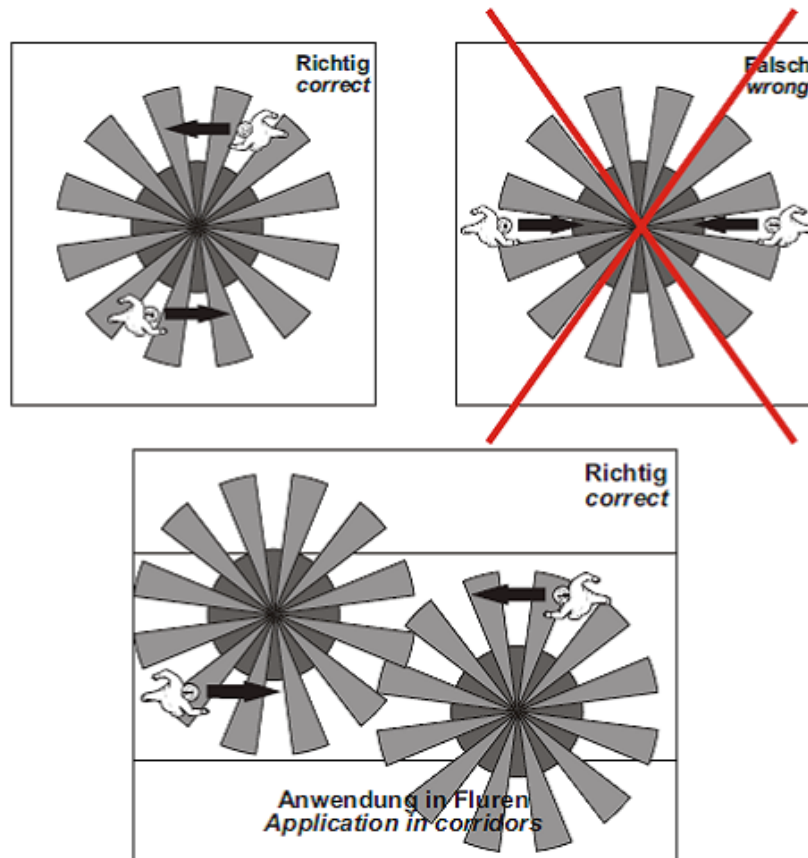
This section of the document will cover the testing parameters for occupancy sensors: Standard Field of View Walk Test, and Two/One Walk Test. (established tests are specified by NEMA but we have found them to not be an accurate assessment of the customer experience and have thus increased our testing.

### Standard Field of View Walk Test

To conduct an industry standard field of view walk test, the walk test must be completed by walking around the perimeter (circumference) of the coverage pattern. This is the most precise way to measure the accuracy of the PIR sensor. Passive Infrared technology divides an area into “detection zones” and functions by detecting the movement of a heat signature from one zone to another. The size of the “detection zones” of the FOV is directly related to the mounting height. The higher the mounting height the larger the motion required to cross the “detection zones” and activate the sensor.

### Two/One Walk Test

Another method for walk testing is to start at the outer edge of the field of view and take two steps towards the sensor and then take one step back from the sensor until you walk directly under the sensor. This is repeated around the entire 360 degree field of view. This demonstrates the difference between the “radial” and “tangential” capability of the sensor. For example, the larger the FOV or coverage area the greater each of these “zones” grows. This could be a dramatic impact for “radial” detection especially for aisle way implementations.



## Lighting Fixture operations (101)

This section will cover three different aspects of lighting fixtures: Occupancy Sensor, Electronic Ballasts, and Fluorescent Ballasts

### Occupancy Sensors

Sensors are a simple relay device, similar to a light switch. When motion is detected a relay closes completing the current path to the ballast which then “strikes” the lamp.

### Electronic Ballasts

Ballast selection and operation varies, always consult a ballast manufacturer for operation and best practices.

- Instant-start electronic ballasts are the most popular type of electronic ballast today because they provide maximum energy savings and they start lamps without delay or flashing. Since they do not provide lamp electrode heating, instant-start ballasts generally consume less energy than comparable rapid-start, program rapid-start or programmed-start ballasts. As a result, they usually provide the most energy efficient solution. Instant-start ballasts use 1.5 to 2 watts less energy per lamp than rapid-start. They also have the least amount of output leads, making for easy installation. Instant-start electronic ballasts provide a high initial voltage (typically 600V for F32T8 lamps) to “strike” the lamp. This high voltage initiates discharge between the unheated electrodes of the lamp. However, the cold electrodes of lamps operated by an instant-start ballast may deteriorate more quickly than the warmed electrodes of lamps operated by a rapid-start, program rapid-start or programmed-start ballasts. Lamps operated by instant-start ballasts will typically withstand 10-15 thousand switch cycles. Instant-start ballasts are typically wired in parallel. This means that if one lamp fails, the other lamps in the circuit will remain lit.
- Rapid-start ballasts have a separate set of windings which provide a low voltage (approx. 3.5 volts) to the electrodes for one second prior to lamp ignition. A starting voltage somewhat lower than that of an instant-start ballast (typically 450-550V for F32T8 lamps) is applied, striking an electrical arc inside the lamp. Most rapid-start electronic ballasts continue to heat the electrode even after the lamp has started, which results in a power loss of 1.5 to 2 watts per lamp. Lamps operated by a rapid-start electronic ballast will typically withstand 15-20 thousand switch cycles. Rapid-start ballasts are typically wired in series. This means that if one lamp fails, all other lamps in the circuit will extinguish.
- Programmed-start electronic ballasts provide maximum lamp life in frequent starting conditions (>50,000 starts). Programmed-start ballasts like the Mark 5TM, Mark 7TM, Mark 10TM, and OptaniumTM programmed-start family of products use a custom integrated circuit which monitors lamp and ballast conditions to ensure optimal system lighting performance. Programmed-start ballasts precisely heat the lamp cathodes to approximately 700°C prior to lamp ignition, thus the lamps are delayed upon startup. This puts the least amount of stress on the lamp electrodes, resulting in maximum lamp life regardless of the number of lamp starts. Programmed-start ballasts are typically wired in series, so if one lamp fails....

### Fluorescent Lamps

These fluorescent tubes are gas-discharge lamps that use electricity to excite mercury vapor. The excited atoms produce short-wave ultraviolet light causing a phosphor to fluoresce, producing visible light. Fluorescent lamps require a ballast to regulate the flow of power through the lamp. A fluorescent lamp converts electrical power into useful light more efficiently than an incandescent lamp. Lower energy cost typically offsets the higher initial cost of the lamp.