B.E.G. LUXOMAT® Application notes for high-bay (GH) detectors

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1. INFRARED RADIATION

On the electromagnetic spectrum, infrared lies between visible light and micro-waves. Infrared is primarily the radiation of heat. Heat radiation is produced by movements of the atoms and molecules in an object. This means that every object with a temperature above absolute zero, even an ice cube, radiates in the infrared spectrum. The higher the temperature, the more the atoms and molecules move, and the higher the infrared radiation they produce.

Infrared radiation produced by living beings is not uniform; this can be clearly seen by using an infrared camera. Among living beings, humans, on account of their body temperature of 37°C, radiate most strongly in the infrared spectrum, with a wavelength of about 10 μm. The mouth is in fact significantly warmer than the fingers, meaning that the infrared radiation emitted from the mouth is greater than that emitted by the fingers.

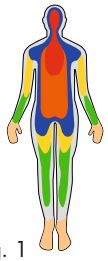

Fig. 1

Passive infrared sensors (PIR sensors) work in the 10 μm band and make it possible to use infrared radiation for motion detection, as they are perfectly suited to the heat radiated by people or animals. Passive infrared means that the sensors do not emit radiation, only detect it.

Therefore the radiation must reach the sensor for it to detect movement. The following factors can influence this:

- Temperature: A higher temperature, hence greater heat radiation, is more easily detected by the sensor. For example, the brakes on a truck may have a greater temperature than a person, and can therefore be detected more easily at the same distance.
- Distance: Since radiation becomes weaker with distance, the sensor can detect a movement better at a distance of 2m than it can at 20m away.
- Absorption: Clothing can absorb heat radiated by the body, i.e. less heat radiates through warm winter clothing than thin summer clothing.
- Temperature difference: Heat radiated by a human body is greater in a cool environment than in a warm one. Therefore movement along a wall heated by the sun will be less well detected by the detector than movement along a cool wall (as a rule of thumb, the temperature difference should be about 2°C).

2. DETECTION

So that it can also detect distant motion, a PIR motion or occupancy detector includes a lens which concentrates the radiation falling on the sensor. The sensor reacts to differences. Therefore it consists of two sensor surfaces. To reliably detect motion, the radiation must hit both surfaces sequentially.

Through the structure and focal length of the lens, the surface of the floor is divided into sectors. For the detector to reliably detect a movement, several sectors have to be crossed. With movement across the detector, more sectors are crossed than with movement towards the detector. The greater the distance to the detector, the larger the sectors projected by the lens. In this way, for movement at a greater distance to the detector, fewer sectors are crossed. The detector does not pick up movement if it only takes place within one sector.

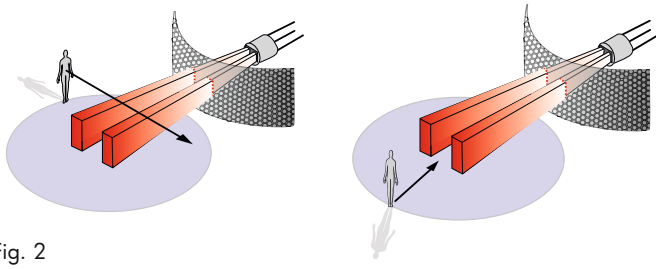

Fig. 2

Modern detectors have a high-resolution lens, a capable analysis unit and not one, but several sensors. The detection area can change according to the arrangement of these sensors. For instance, if three sensors are in a line, the detection area is not round, but oval, which is ideal for the detection of movement in warehouse aisles for example.

3. SAMPLE APPLICATION IN WAREHOUSES/WAREHOUSE AISLES

In large warehouses, many lights are required in order to ensure complete lighting coverage of the area. However, people only stay in small areas of the warehouse, with the result that sufficient light only needs to be provided for those areas.

Warehouses usually have main aisles from which side aisles branch off. Light is only required in a side aisle when a person enters it.

However, for planning the detector type and arrangement for motion detection and lighting control in this kind of warehouse, additional information such as ceiling height and ambient temperature is required.

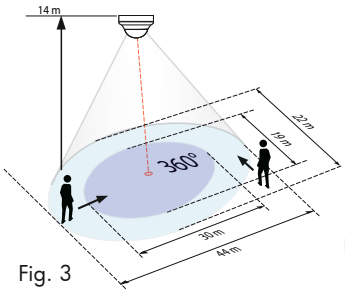

Fig. 3

PD4-M-1C-GH-SM
Part number: 92245

4. MOUNTING HEIGHT AND AMBIENT TEMPERATURE

In warehouses or sports halls, the ambient temperature is between 16-30 °C. Light clothing or sportswear would normally be worn in these temperatures. In these conditions, mounting heights of up to 10m are recommended. Mounting height should be reduced by about 2m if the warehouse staff have to wear protective headgear.

If the detector is installed at the maximum mounting height of 14m, the peripheral sectors at about 22m from the detector are very large. This means that movement in those areas must be large and rapid for it to be picked up by the detector.

In cold stores, the temperature is between about -10 °C and +15 °C. Thick, warm clothing is worn. Only the hands and face emit body heat. Hence it is difficult for the detector to pick up a movement. Here, mounting heights of up to 8m are recommended. If protective headgear is used, the recommended mounting height is about 6m.

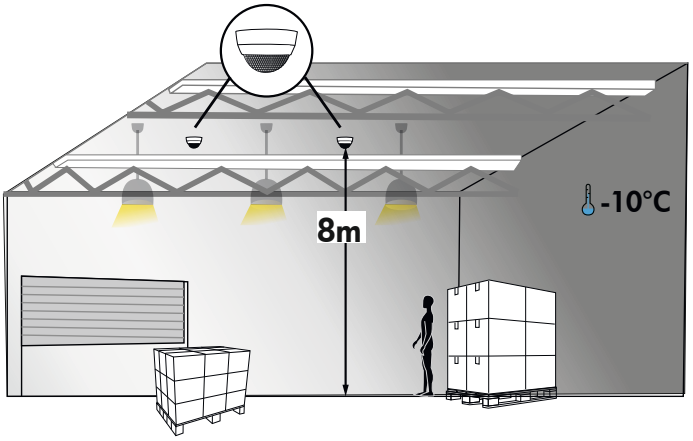

Fig. 4

If protective headgear is used, the recommended mounting height is reduced.

Machines as well as people move around in warehouses. Fork lift trucks are commonly used. If lighting also has to be activated by movement of fork lift trucks, the type of truck used plays a decisive role, as an electrically-driven model will radiate less heat than a gas or petrol-driven one.

5. MOUNTING LOCATIONS IN SIDE AISLES

High-bay detectors are often designed to produce not a round detection area, but an oval one. At a mounting height of 14m, depending on the heat radiated by the object, the detector can pick up movements across the sensor even at a distance of 22 m.

If the detector is mounted centrally in a side aisle, its detection area could potentially extend into the main aisle. Movements that take place in this area of the main aisle are seen as movements across the sensor by the detector mounted in the side aisle, and will be picked up by this detector. In this case, it can occur that the detector switches on the lighting in the side aisle, although nobody is there.

However, it is difficult to restrict the detection area with blinds in such a way that it does not extend into the main aisle, as the boundary between side and main aisles is hard to define.

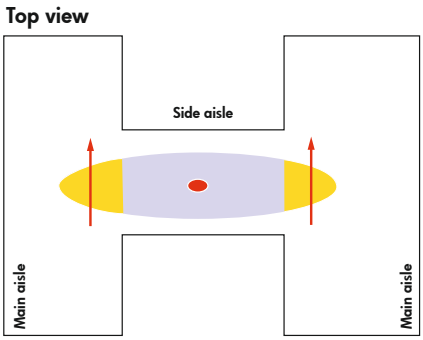

Fig. 5

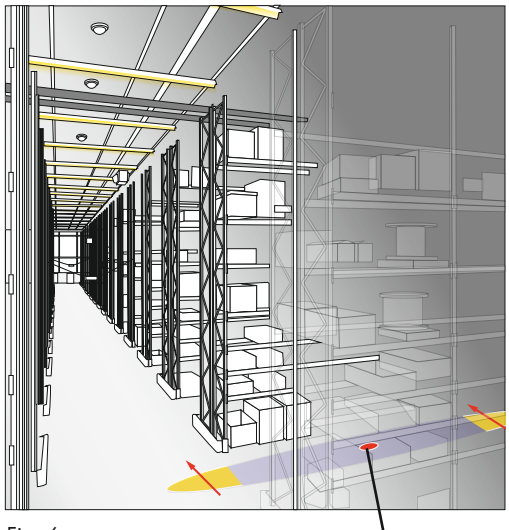

Fig. 6

Placement detectors

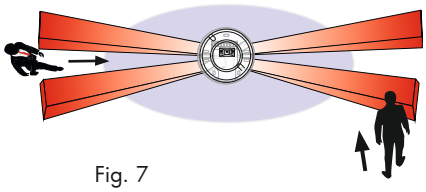

Fig. 7

In this case, entering the side aisle represents movement towards the sensor. Because of the distance between the entrance to the side aisle and the detector's mounting location, the sectors at the entrances are large. It takes a while for the second sector to be reached, meaning that the light is switched on somewhat late.

It is therefore advised to install two detectors in warehouse side aisles. These are mounted at the entrance/exit areas of the aisle, and work together in master-slave mode. Both detectors react to movement, but only the master device switches the light on. If it detects movement, the slave device sends signals to the master device.

The detection areas of the two devices must overlap in the centre of the side aisle. For longer aisles, another slave device may be needed. (Fig. 8).

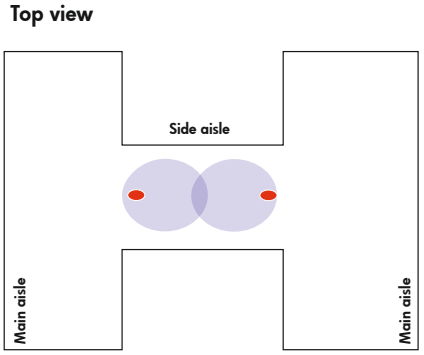

Fig. 8

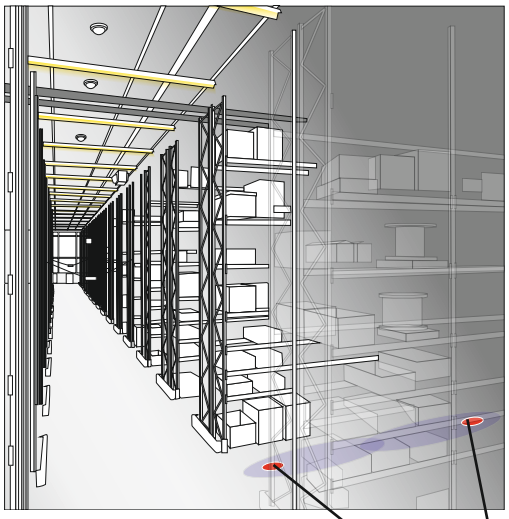

Fig. 9

Placement detectors

So that movement in the main aisles is not detected, half the lens (the side towards the main aisle) should be covered with blinds. There are frequently several parallel side aisles, divided from each other by open racking. Since the detector may also pick up movement from neighbouring aisles through the open racking, it is also recommended that blinds are used to filter out this area. (Fig. 9).

Recommendation:
In warehouse side aisles, a master device should be installed at the start of the aisle and a slave device at the end of the side aisle. The detection area should be adjusted to local conditions using blinds. (Fig. 10)

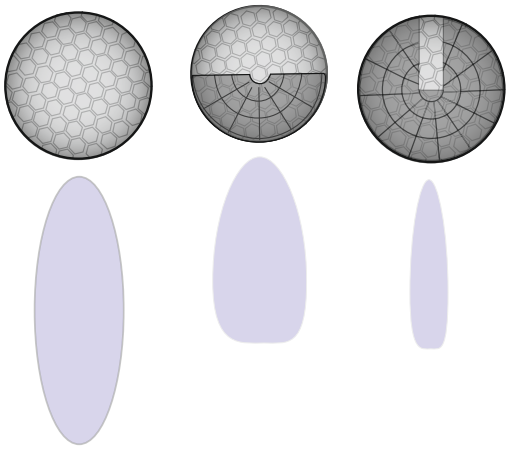

Fig. 10

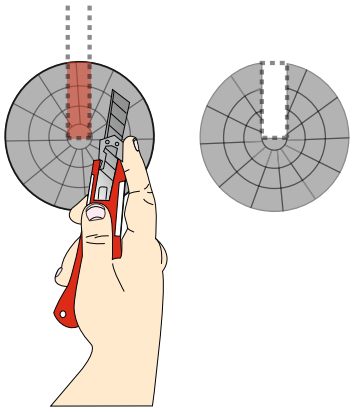

Fig. 11

6. WIRING AND APPLICATION EXAMPLE

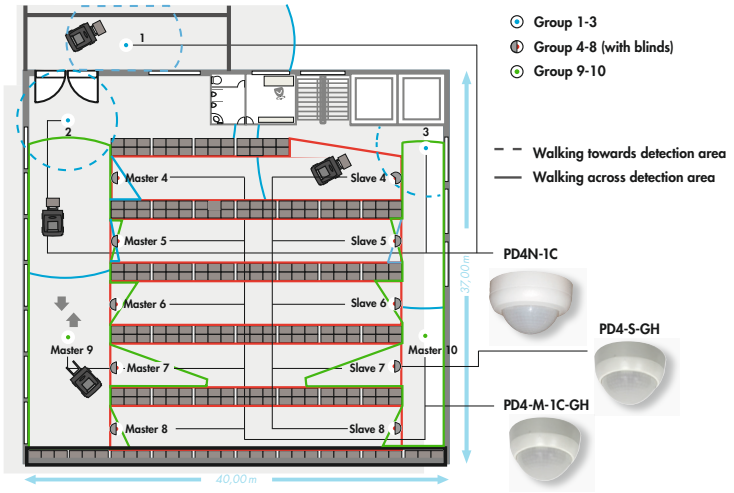

Fig. 12

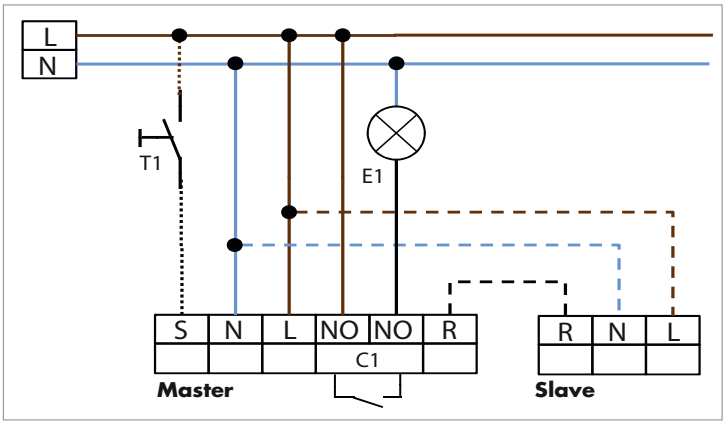

Fig. 13

7. HIGH-BAY DETECTORS AND LIGHTING CONTROL

Occupancy detectors can regulate the light, or in other words maintain the desired lux value. Essentially, this lighting regulation is based on light reflected from the floor. Detectors and lights are typically installed on or in the ceiling. Therefore the light fittings emit light downwards towards the floor, from which a proportion of the light is reflected towards the ceiling. The detector measures light reflected from the floor. If the measured light level is below the light level set, the detector switches the light on and regulates it to the value set, so that there is always a constant brightness level in the room.

The higher the detector is located, the harder it is to measure the reflections, as the amount of light reaching the detector falls off as mounting height increases. Occupancy detectors with lighting regulation, i.e. with a DIM or DALI interface, should not be located higher than 5m. If only the on-off function is required (motion detector), mounting heights can be chosen according to specification.