# SENSORS AND LIGHT MANAGEMENT SYSTEMS FOR INDOOR LUMINAIRES

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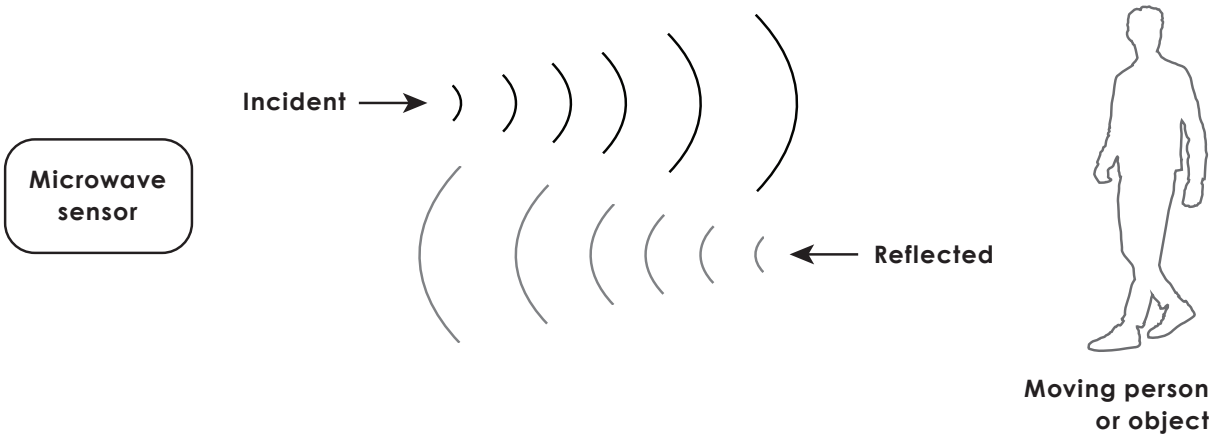
# 1. Microwave sensors

A microwave motion detector uses microwave technology to analyze its environment. This is achieved by sending out microwave signals, and the length of time it takes for the signal to return to the motion detector is measured. These MW sensors detect motion through the principle of Doppler radar and are similar to a radar speed gun. Simply put, when an object "meets" the transmitted microwave, this object "bends" it (a wave phase shift occurs). Depending on which direction this object is moving, the wave is curved to one side or the other. **If the sensor detects that the wave has been curved, it knows that there is movement in the room**.

Compared to the PIR sensor, for MW sensors it does not matter whether the object emits heat, but only whether the object moves in the room.




Microwave sensors are ideal for large spaces and areas that have an awkward shape or where fine motion is detected, such as a garden or driveway due to it providing greater coverage and security. A microwave sensor will offer additional levels of detection that a PIR cannot, such as a pet in the garden or a car pulling into a driveway. **These detectors sense motion in terms of speed and size, as opposed to a PIR sensor which senses in terms of heat and light**. Microwave sensors can false trigger due to things such as trees blowing in the wind. Although at a reduced sensitivity level, they can also see-through plastic, glass, and thin walls.

**Important**

- Microwaves are often reflected against various walls, doors, etc. - there is a possibility that the sensor will react to movements that actually take place outside its operating range (undesirable).
- MW sensors can also respond to various structural vibrations that are not actually real motion.

## 1.1. Sensor parameters

Best for applications where movement is needed to be detected, like:

- Corridors
- Large spaces and areas
- Parking lots and driveways
- Etc.

Not recommended to use where people are present, but stationary, like:

- Office rooms
- Classrooms
- Etc.

**This sensor can be used for such VIZULO luminaires:**

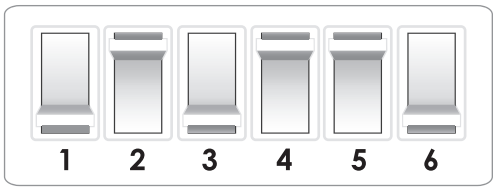
- Oak Gen2, Acorn Gen2, Fern
- Leaf, Dove, Shell

Microwave sensors (provided by VIZULO) have such parameters:

| | |
|---|---|
| **Power Source** | 220 – 240 VAC (50/60 Hz) |
| **Rated load** | 400 W |
| **Stand-by power** | <0.5 W |
| **Sensitivity** | 10% / 50% / 75% / 100% |
| **Hold-time** | 5 s / 90 s / 5 min / 15 min * |
| **Daylight sensor** | 2 lux / 10 lux / 50 lux, disable * |
| **Microwave frequency** | 5.8 GHz ± 75 MHz |
| **Detection range (diameter)** | 10 m * |
| **Installing Height (Max)** | 6 m * |
| **Detection angle** | 30° ~ 150° * |
| **Working temperature** | -20 ~ +60 °C |
| **IP rating** | IP20 |
| **Certificates** | Semko, CB, CE, RCM, RoHS, RED |

* - Other values available on demand, contact us for more information!

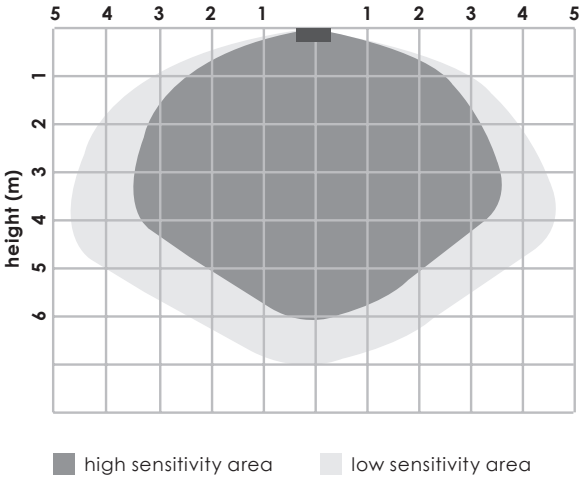
**DIP switches**



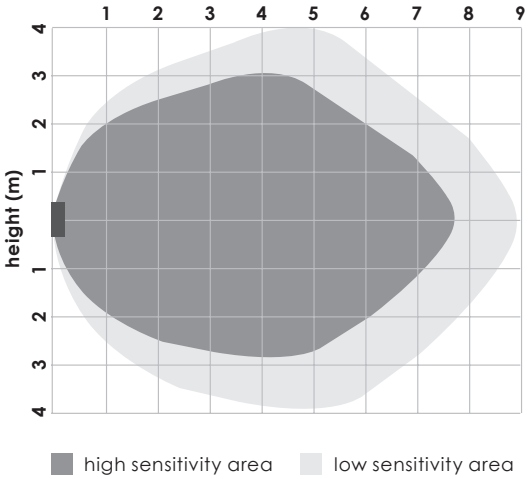
**Settings:**

- Sensitivity can be adjusted by selecting the combination on the DIP switches for different applications;
- Hold-time refers to the time period that the light remains 100% on if no more movement is detected;
- Different daylight threshold can be pre-set on DIP switches. Light will always turn on upon movement if daylight sensor is disabled.

**Ceiling mounting (m)**

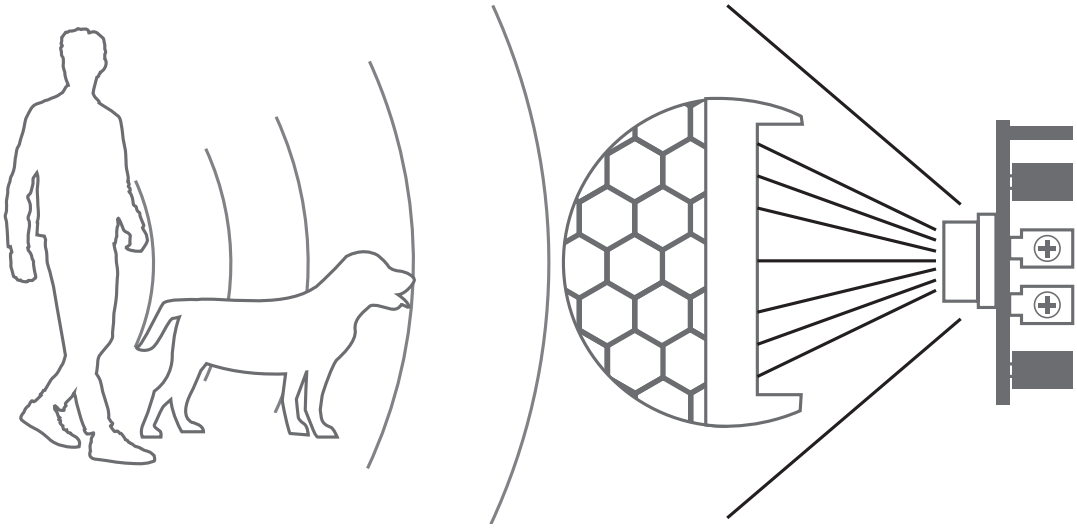



**Wall mounting (m)**



# 2. PIR sensors

A passive infrared, or PIR, sensor measures infrared light that is coming off an object in its visible area. In simple words, infrared light is nothing more than heat, that humans are not able to see with the naked eye. It means that every person, animal, or thing that is warmer than ambient temperature will emit this IR radiation. The larger and warmer the infrared source, the more radiation it will emit.



So PIR sensors detect general movement, but do not give information on who or what moved. However, it is usually possible to adjust the sensitivity of these sensors.

More accurately, these sensors can detect changes in their fields of vision, such as when the ambient infrared light is interrupted or otherwise altered. When an object, such as a person, passes in front of the background, such as a wall, the temperature at that point in the sensor's field of view will rise from room temperature to body temperature, and then back again. The sensor converts the resulting change in the incoming infrared radiation into a change in the output voltage, and this triggers the detection. Objects of similar temperature but different surface characteristics may also have a different infrared emission pattern, and thus moving them with respect to the background may trigger the detector as well.

So PIR sensors detect general movement, but do not give information on who or what moved. However, it is usually possible to adjust the sensitivity of these sensors.

**Important**

Infrared waves are blocked by many different materials, such as glass, plastic, and so on. This means that the receiver part of the PIR sensor must not be located, for example, behind the diffuser, because in that case the sensor will not work at all - the receiver must be located outside the luminaire.

## 2.1. Sensor parameters

Best for applications where presence is needed to be detected, like:

- Office rooms
- Classrooms
- Etc.

Not recommended to use in such scenarios:

- Sensor is blocked by any object
- Intensive movement is needed to be detected
- And other.

So, in general it is better to use:

- PIR sensor - for presence detection
- Microwave sensor - for general movement detection

**This sensor can be used for such VIZULO luminaires:**

- Acorn Gen2
- Pine, Milzo Number 2
- Leaf, Dove

PIR sensors (provided by VIZULO) have such parameters:

| | |
|---|---|
| **Power Source** | 110 - 130 VAC or 220 - 240 VAC |
| **Rated load** | 200 W |
| **Time setting** | 5 s, 30 s, 1 min, 3 min, 5 min, 8 min (adjustable) |
| **Detection range (Max)** | 8 m |
| **Detection angle (Max)** | 100° |
| **Light control** | < 10 - 2000 lux (adjustable) |
| **Relative humidity** | < 93% RH |
| **Detection moving speed** | 0.6 ~ 1.5 m/s |
| **Working temperature** | -10 ~ +40 °C |
| **Certificates** | CE, RoHS, EMC |

**Settings:**

- You can select output to work only in the light below 10 lux or in any other light (daylight threshold)
- Adjustable sensitivity
- Choose working time-delay of the load: 5 s, 30 s, 1 min, 3 min, 5 min, 8 min.

The time that the load works can delay automatically: it re-computes time after the last sensing.

# 3. Microwave/PIR sensor - daylight threshold

Almost all Microwave and PIR sensors support Daylight function (with Daylight sensor). It is also called Daylight threshold. Generally, several different Daylight threshold values can be set for a sensor (see sensor specifications above). In this case, the Daylight functionality is quite simple - **the light will not turn on if ambient lux level exceeds the daylight threshold preset**. Normally, this lux value can also be set to "0" or "disabled" - in this case the light will turn on, regardless of the amount of ambient light.

The main idea of this function is to allow the light not to turn on during the day (when it is not needed) even if a PIR or Microwave sensors sends a signal to turn on.

# 4. Multi/DALI sensors

These kinds of sensors offer Daylight-dependent regulation and presence-dependent control of light (PIR based). In this combination sensors can work more efficiently by combining daylight and artificial light to suit user's needs. Moreover, using this combination of methods helps to avoid false triggers and unwanted switching on of the luminaires.

Other important difference (as the title suggests) is DALI presence. No matter what infrastructure is available to the customer (with or without existing DALI network), we offer flexible solutions which will be suitable for different situations. In simple words, we offer 2 different options in combination **with DALI luminaires** *:

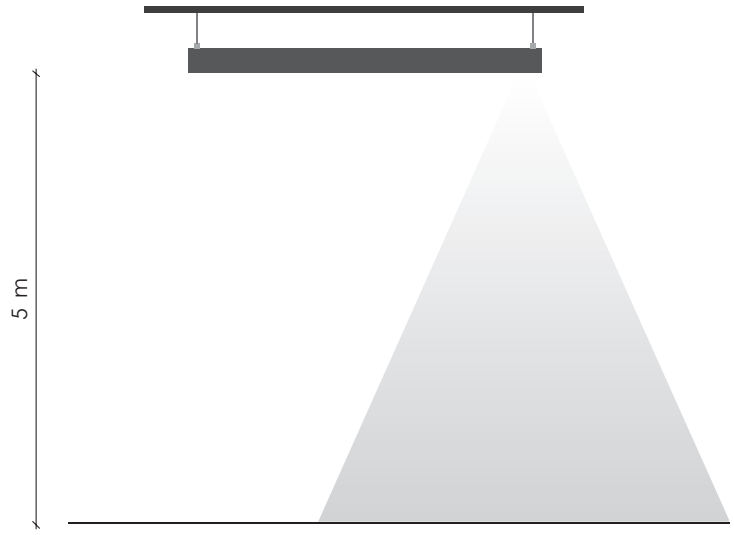
1. For infrastructure **with** existing DALI network - in this case sensors (or luminaires with sensors) can be connected to already existing DALI network as usual, and no other components are needed.
2. For infrastructures **without** DALI network - in this case we can offer an autonomous system which makes local DALI network itself. Additional DALI power supply will be needed. Everything else stays the same - sensors (or luminaires with sensors) can be connected to the autonomous DALI system.

* - More information about availability of functions and solutions for different luminaires available on demand!

**Best suited for applications with high energy-efficiency demands.**

In the next sections options for different height will be present.

## 4.1. Standard height




Best for low height applications such as:

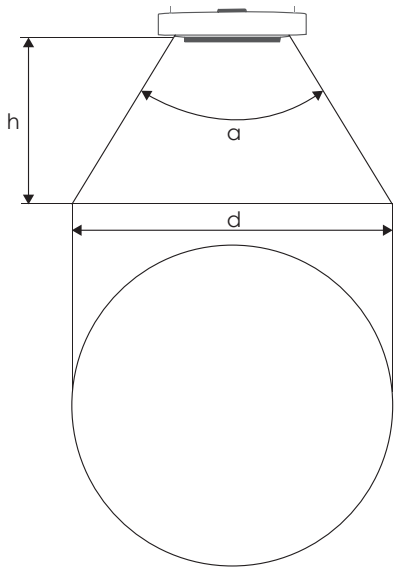
- Corridors, passages and garages
- Office buildings, schools

**This sensor can be used for such VIZULO luminaires:**

- Acorn Gen2
- Pine, Milzo Number 2

With this sensor we offer various features, such as:

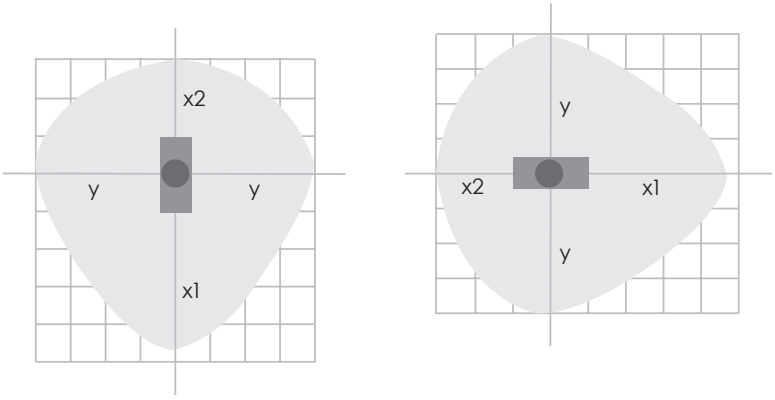
- Monitoring of ambient light and motion detection;
- Remote control interface allowing infrared remote-control interaction;
- Individual adjustment of the parameters with configuration software;
- And many more!



This sensor (provided by VIZULO) has such parameters:

| | |
|---|---|
| **Power Source** | DALI |
| **Mounting height (Max)** | 5 m |
| **Detection angle for PIR detection** | 84° |
| **Detection angle for light measurement** | 30° - 60° |
| **Light measurement range** | 0.5 - 2000 lux |
| **Type of protection** | IP20 |
| **Working temperature** | -20 ~ +50 °C |
| **Min temperature difference between ambient temperature and detected object** | ±4 °C |

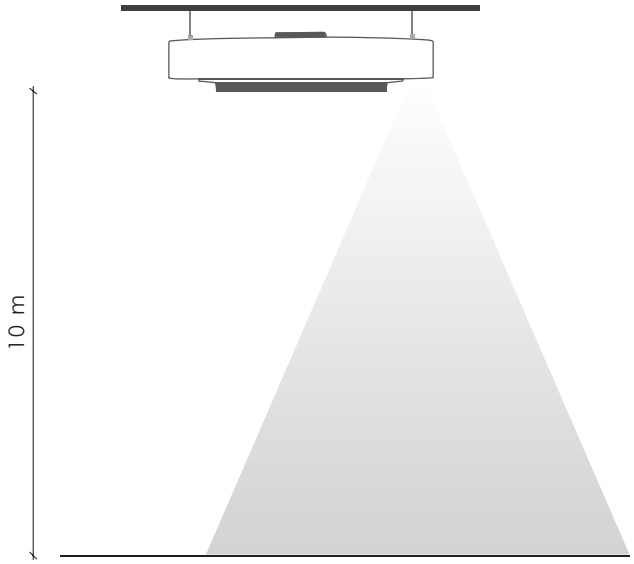

Light level recognition area will not be perfectly round, and it depends on how the sensor is positioned. See the picture bellow!




For motion detection PIR technology is used. PIR Lens is made to detect moving people in working areas with the following performance criteria:

- Up to 2 m mounting height: detection of slight motion;
- Above 2 m mounting height: no slight motion (no sitting person) detection;
- Movement ≥ 1.0 m/s for mounting heights up to 5 m.

## 4.2. High Bay (up to 10 m)




Best for medium height applications such as:

- Factory buildings
- Storage buildings and warehouses

**This sensor can be used for such VIZULO luminaires:**

- Acorn Gen2 High-bay

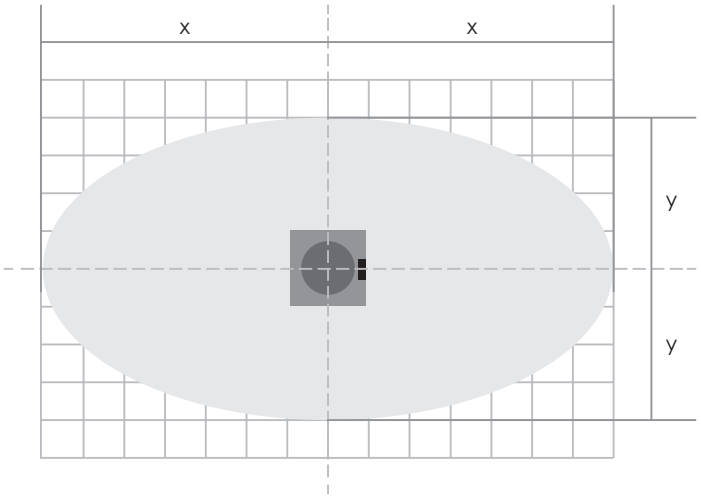
With this sensor we offer various features, such as:

- Monitoring of ambient light and motion detection;
- Remote control interface allowing infrared remote-control interaction;
- Individual adjustment of the parameters with configuration software;
- And many more!

This sensor (provided by VIZULO) has such parameters:

| | |
|---|---|
| **Power Source** | DALI |
| **Mounting height (Max)** | 5 - 10 m |
| **Detection angle for PIR detection** | 72° |
| **Detection angle for light measurement** | 30° - 40° |
| **Light measurement range** | 0.5 - 2000 lux |
| **Type of protection** | IP66 |
| **Working temperature** | -20 ~ +50 °C |
| **Min temperature difference between ambient temperature and detected object** | ±4 °C |

The light measurement has a cone-shaped detection area. See the picture bellow!



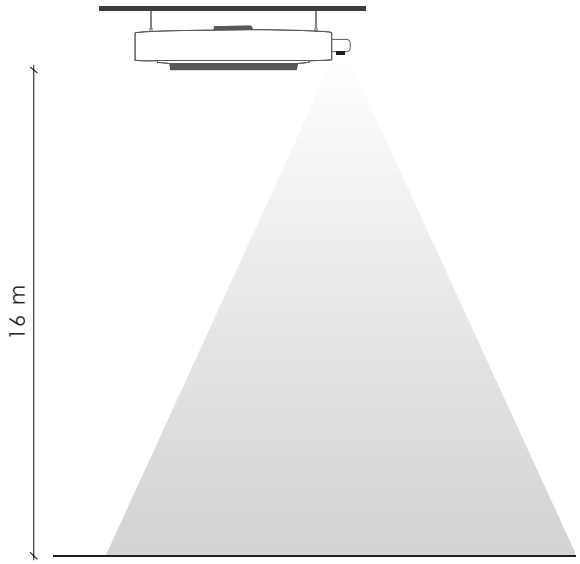

For motion detection PIR technology is used. PIR Lens is made to detect moving people in working areas with the following performance criteria:

- Movement ≥ 1.0 m/s for mounting heights up to 7.5 m;
- Movement ≥ 1.5 m/s for mounting heights up to 10.0 m.

**Important**

Reaction time of the sensor (time between motion detected and event information send to DALI Bus) is no more than 25 ms. The reaction time of the system can be extended by factors such as the amount of data on the bus, the number of connected devices or the control device used (Application Controller).

## 4.3. High Bay (up to 16 m)




Best for medium height applications such as:

- Factory buildings
- Storage buildings and warehouses with high ceiling

**This sensor can be used for such VIZULO luminaires:**

- Acorn Gen2 High-bay

With this sensor we offer various features, such as:

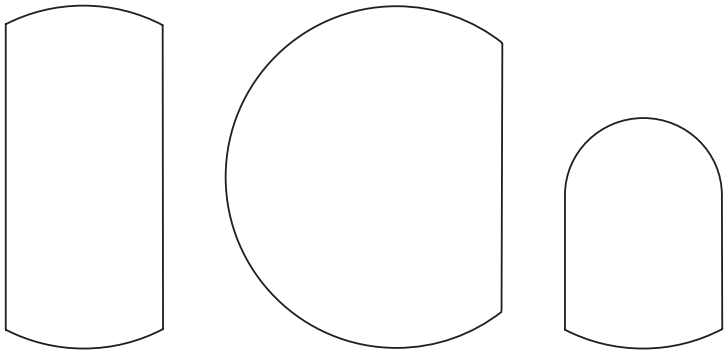
- Monitoring of ambient light and motion detection;
- Remote control interface allowing infrared remote-control interaction;
- Individual adjustment of the parameters with configuration software;
- Double terminals for through wiring;
- And many more!

This sensor (provided by VIZULO) has such parameters:

| | |
|---|---|
| **Power Source** | DALI |
| **Mounting height (Max)** | 8 - 16 m |
| **Detection angle for PIR detection** | 72° (up to 12 m) / 60° (13 - 16 m) |
| **Detection angle for light measurement** | 13° |
| **Light measurement range** | 0.5 - 2000 lux |
| **Type of protection** | IP65 |
| **Working temperature** | -20 ~ +50 °C |
| **Min temperature difference between ambient temperature and detected object** | ±4 °C |

The light measurement has a cone-shaped detection area just like for High Bay sensor up to 10 m.

For motion detection PIR technology is used. For this sensor optional shaders are available to regulate shape of motion detection area. See the picture bellow!

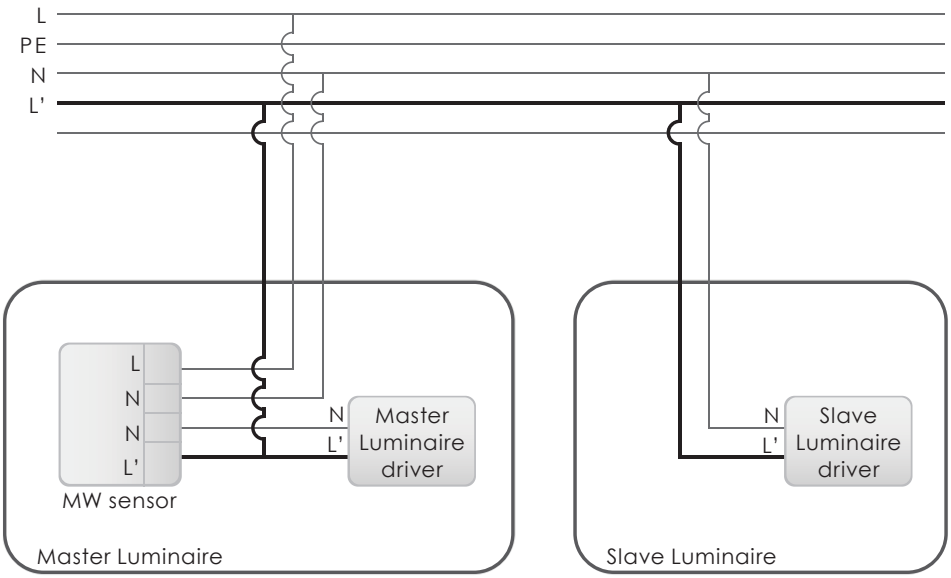


# 5. Master/Slave wiring

Master/slave is a model of asymmetric communication or control where one device or process (the “master”) controls one or more other devices or processes (the “slaves”) and serves as their communication hub.

Suppose one luminaire is a Master and the other a Slave. In this case, the Master luminaire will be equipped with some kind of sensor (for example, PIR or MW), but the Slave luminaire will not have a sensor. A sensor connected to the Master luminaire will control both the Master itself and all Slave luminaires connected to it at the same time.

Below is an example of Master/Slave wiring diagram.




In this case, more Slave luminaires can also be connected.

## 5.1. Calculating maximum quantity of Slave luminaires (per Master)

The maximum number of Slave luminaires that can be "enslaved" by one Master depends on 2 factors:

- Luminaire power
- Maximum rated load of the sensor

So, knowing only a specific sensor, it is not possible to say what will be the maximum number of luminaires that can be enslaved. However, if the wattage of the luminaires is known, this number can be determined.

Let us assume that the maximum rated load of some sensor is 400 W. This means that the total power of all luminaires connected to this sensor must not exceed the specified 400 W.

Now let's look at a simple example when it is known that the power of the Master luminaire is 70 W, but the power of one Slave luminaire is 50 W. The question is how many Slave luminaires can be connected in this case?

First, we immediately subtract the Master luminaire from the total available power to understand how much power is left for the Slave luminaires:

$$Power_{available\text{-}slave} = Load_{rated} - Power_{master} = 400 - 70 = 330\ W$$

As we can see, 330 W remains available for Slave luminaires. It was mentioned earlier that the power of one Slave luminaire is 50 W. So, to get the maximum amount of Slave units it is necessary to divide the total available power of the Slave by the power of one Slave luminaire:

$$N_{slave} = \frac{Power_{available\text{-}slave}}{Power_{slave}} = \frac{330}{50} = 6.6$$

We see that the result of the calculation is not an integer - in this case, round the result down to the nearest integer, which in this case is 6.

**So, in this example a maximum of 6 Slave luminaires can be connected to one Master luminaire.** Of course, it is not forbidden to connect less than 6 Slave luminaires.

# 6. Corridor function

Luminaires with built in corridor function are a very simple and highly efficient way of reducing energy consumption. Wherever light must be provided 24 hours a day for statutory reasons, the corridor function helps provide the right light, combined with energy-efficient and cost-effective operation. This economical form of 24-hour lighting is ideal for:

- Pedestrian underpasses
- Underground train stations
- ATM booths
- Telephone kiosks
- Hotels
- Public buildings and hospitals
- And many more!

The corridor function allows to **control the lighting depending on the detected movement**. The system is connected to a motion sensor. As soon as the sensor detects movement, the luminaire or group of luminaires lights up to 100% or another set value. When a person leaves the room, the motion sensor switches off after a certain time and the light intensity automatically decreases gradually either to the selected level or completely.

It is **characterized by the following features**:

- When a person enters a room, luminous intensity is increased;
- When the person leaves the room, a presence detector will switch off after some time, and luminous intensity will be reduced automatically;
- The corridor function is built into the control gear and is enabled automatically;
- Users may choose between using pre-programmed lighting profiles or programming light levels and sequences individually.

Let's look at typical configuration parameters:

For optimum adjustment to a variety of situations, there is a choice of different profiles that are defined by a few parameters:

1. **Fade-in time:** period of time starting as soon as the presence of persons is detected. During fade-in time, luminous intensity fades to the presence value.
2. **Run-on time:** period of time starting as soon as no presence of persons is detected any more. When the presence detector again reports the presence of persons during run-on time, run-on time starts all over again. If this is not the case, fade time starts after run-on time has elapsed. This time is set directly at the presence detector.
3. **Fade time:** period of time during which luminous intensity fades from the presence value to the absence value.
4. **Fade time:** period of time during which luminous intensity fades from the presence value to the absence value.
5. **Absence value:** luminous intensity set for the absence of persons.
6. **Presence value:** luminous intensity set for the presence of persons.

Some of our MW sensors are compatible with Corridor Function - more specific information on demand!

**Important**

The Corridor Function can only be used in combination with drivers that support this function and DALI.

# 7. RF wireless sensor

We offer a Microwave technology-based sensor with RF interface which is a solution for situations, where client already has wire infrastructure which lacks DALI lines. By using this RF wireless sensor, it is possible to avoid changes in existing wire infrastructure. This sensor is also convenient to use in situations where running additional wires can be challenging or expensive.

**This sensor can be used for such VIZULO luminaires:**

- Stone, Fern
- Shell

With this sensor we offer various features, such as:

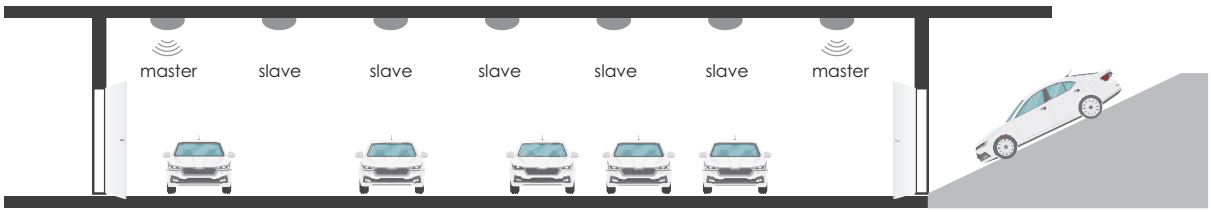
- Special photocell to measure and differentiate natural light from LED light from behind the fixture cover;
- DALI dimming control method;
- One-key commissioning via programmable remote control;
- Fast and simple commissioning / grouping of wireless sensor by the rotary switch;
- Corridor function;
- Master-slave wiring.

This sensor (provided by VIZULO) has such parameters:

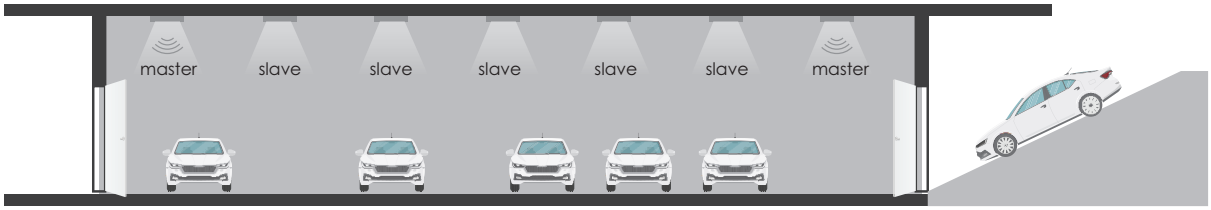
| | |
|---|---|
| **Sensor type** | Microwave |
| **Operation frequency** | 5.8 GHz ± 75 MHz |
| **Mounting height (Max)** | 6 m |
| **Detection range (diameter)** | 12 m |
| **Detection angle** | 30° ~ 150° |
| **RF frequency** | 868 MHz (FSK mode, default) |
| **RF transmission distance** | 30 m indoor / 50 m outdoor |

## 7.1. Application example - Carpark

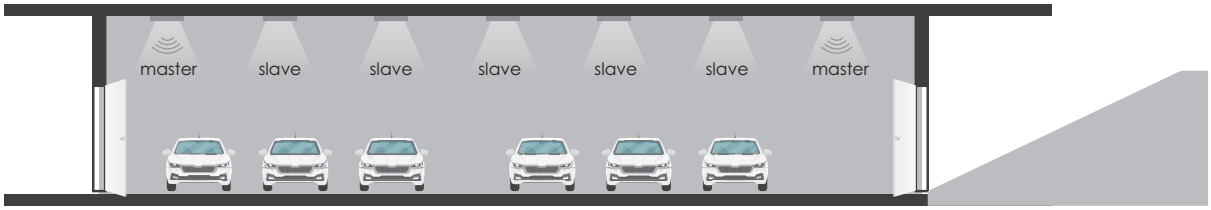
1. With sufficient natural light, the sensor is not triggered by motion.



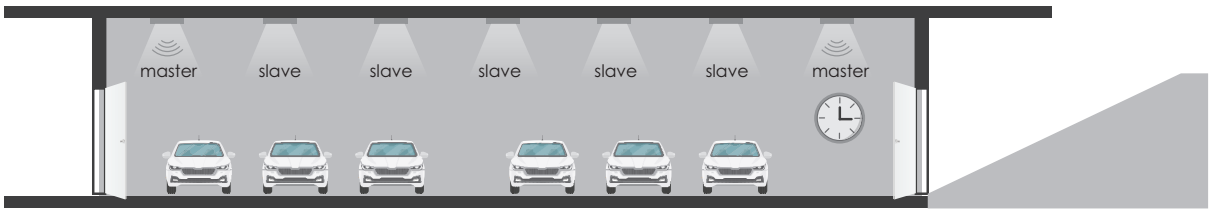

2. With insufficient natural light, the sensor is triggered by motion, the master switches on the light and sends RF ON signal to all slaves.



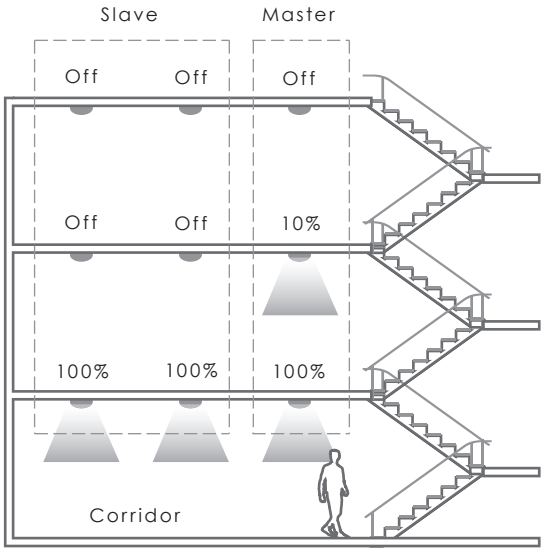

3. After the hold-time, the whole group of lamps dim to predefined dimming level when no movement is detected.



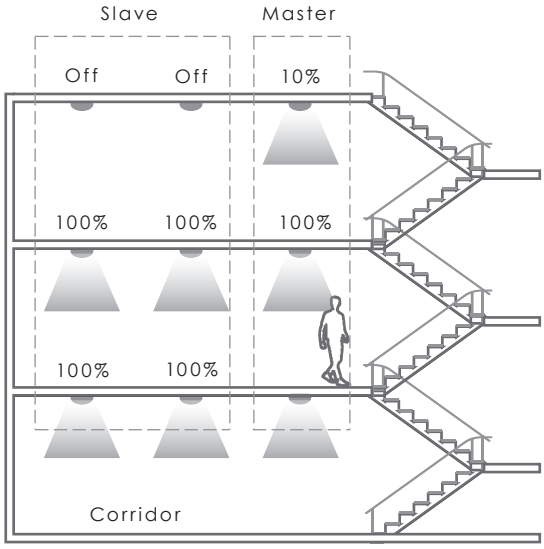

4. The whole group of lamps switch off automatically after the stand-by period.



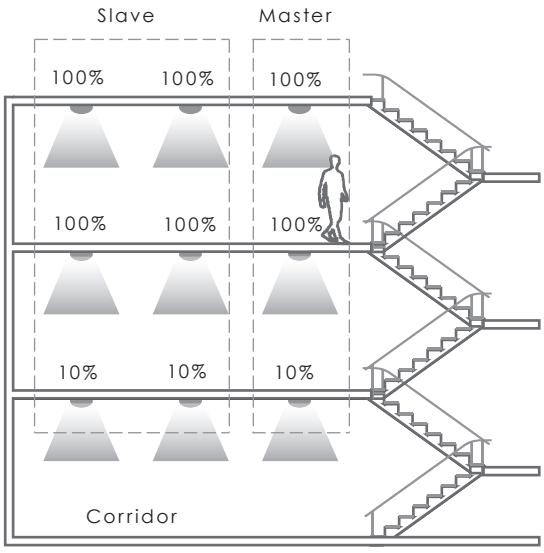
## 7.2. Application example - Staircase and corridor



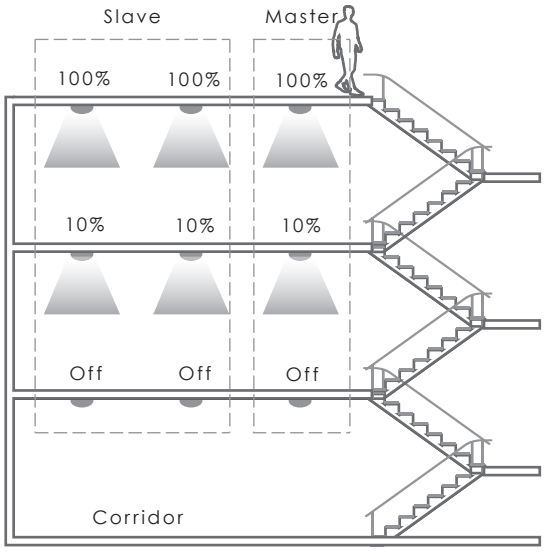

1. While the 1st sensor detects motion on the 1st floor, it switches the light on at 100% and sends signal to all slave units. All slaves on the 1st floor turn on and the master on the 2nd floor switches on at stand-by level.




2. The person walks to the 2nd floor; the 2nd master switches the light on at 100%. All slaves on the 2nd floor turn the light on and the master on the 3rd floor switches on at stand-by level.




3. The person walks to the 3rd floor; the 3rd master switches the light on 100%. All slaves on the 3rd floor turn the light on and the master on the 4th floor switches on at standby level. Meanwhile, the lights on the 1st floor are dimmed to stand-by level after hold-time.

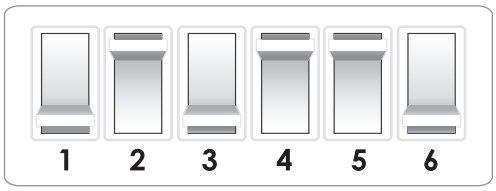


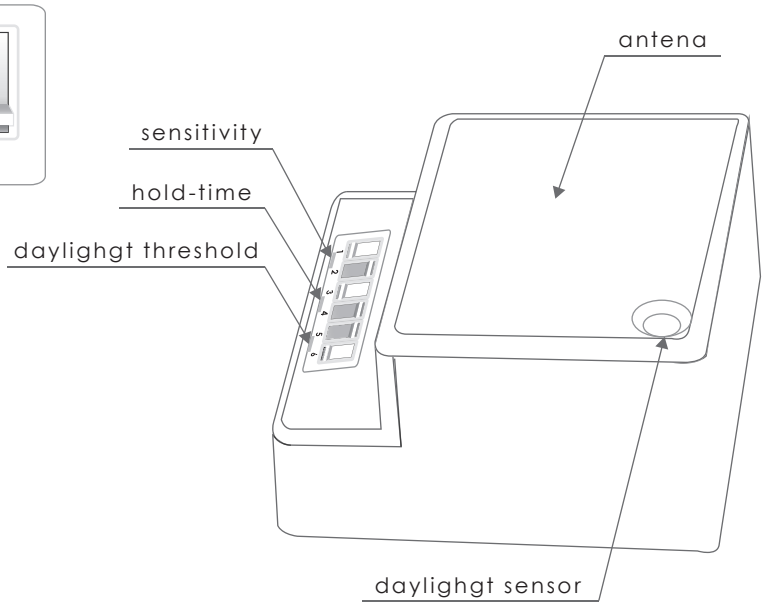

4. The person walks to the 4th floor; the 4th master switches the light on at 100%. All slaves on the 4th floor turn the light on. Meanwhile, all sensors on the 1st floor turn the light off after stand-by period, and all lights on the 2nd floor dim to stand-by level after hold-time.

# 8. Setting with DIP Switch and Rotary Switch

Indoor sensors (except for Multi/DALI sensors), can be manually configured by using either DIP Switches or Rotary Switches. Here will be examples on how to use these 2 kinds of switches.

## 8.1. DIP switches (Microwave sensor)




This senor has a total of 6 DIP Switches which are just simple 2-position switches (other sensors can have different number of switches, but principle of using them stays the same).

**1. Sensitivity**

Sensitivity can be adjusted by selecting the combination on the DIP switches (1 and 2) for different applications.

I - 100%
II - 75%
III - 50%
IV - 10%

| | 1 | 2 | |
|---|---|---|---|
| I | ● | ● | 100% |
| II | ● | ○ | 75% |
| III | ○ | ● | 50% |
| IV | ○ | ○ | 10% |

**2. Hold-time**

Hold-time refers to the time period that the light remains 100% on if no more movement is detected. DIP switches 3 and 4.

I - 5 s
II - 90 s
III - 5 min
IV - 15 min

| | 3 | 4 | |
|---|---|---|---|
| I | ● | ● | 5 s |
| II | ● | ○ | 90 s |
| III | ○ | ● | 5 min |
| IV | ○ | ○ | 15 min |

**3. Daylight sensor**

Different daylight threshold can be pre-set on DIP switches (5 and 6). Light will always turn on upon movement if daylight sensor is disabled.

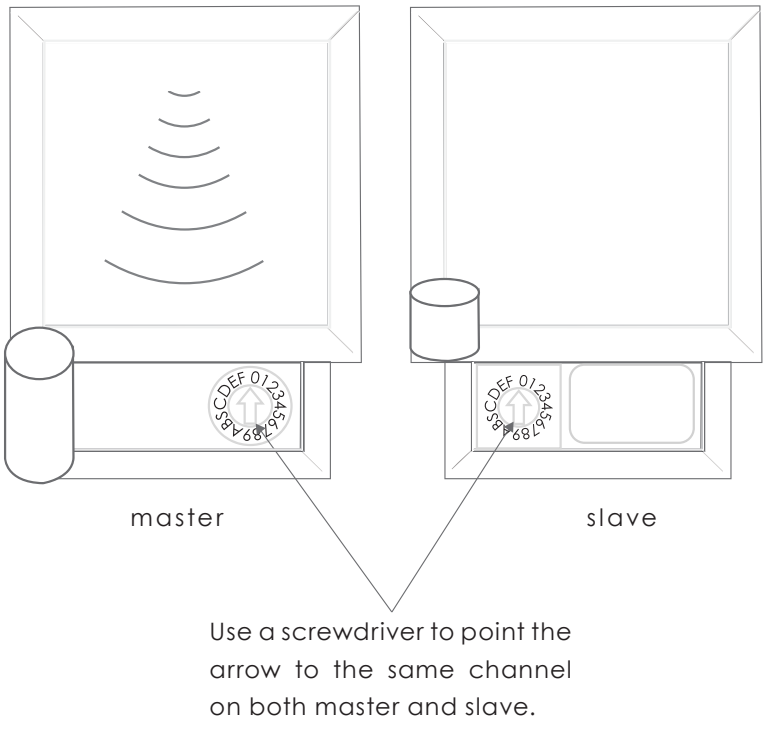
I - disable
II - 50 lux
III - 10 lux
IV - 2 lux

| | 5 | 6 | |
|---|---|---|---|
| I | ● | ● | disable |
| II | ● | ○ | 50 lux |
| III | ○ | ● | 10 lux |
| IV | ○ | ○ | 2 lux |

## 8.2. Rotary switches (RF sensor)

In this case Rotary switch is used only for sensor grouping (setting up groups of specific sensors).

15 channels are available for fast grouping via rotary switch on the RF sensor antenna, simply selecting the same channel on each unit, the grouping is automatically completed.




Channel “0” is not for fast grouping, and sensors can only be grouped by remote control with this channel.

# 9. Order information

Indoor sensors are available already mounted in our luminaires (not as accessories) and the type of sensor (and its working mode) can be determined by the model name of a product.

## 9.1. Sensor abbreviations in Model Name

Examples of different sensor designations are given:

| Sensor type | Abbreviation | Model name example ** |
|---|---|---|
| No sensor | NS | FR 022 830 P12 TT ND1 NS0 |
| microwave (mw) | MW | FR 022 830 P12 TT ND1 MW0 |
| mw, master | MM | FR 022 830 P12 TT ND1 MM0 |
| mw, corridor function | MC | FR 022 830 P12 TT ND1 MC0 |
| mw, corridor function, master | MK | FR 022 830 P12 TT ND1 MK0 |
| RF receiver | RR | FR 022 830 P12 TT ND1 RR0 |
| microwave, RF transceiver | TR | FR 022 830 P12 TT ND1 TR0 |
| PIR sensor * | PI | ACE 270 840 D08 AW124 CAH DE1 PINN |
| PIR sensor (high bay) * | PH | ACE 270 840 D08 AW124 CAH DE1 PHNN |
| Multi/DALI sensor | DL | PN PS 14 840 0580 SP N1DL0 N |
| Multi/DALI sensor, master | DM | PN PS 14 840 0580 SP N1DM0 N |

* - PI (for Acorn Gen2) for 5 - 10 m height and PH for 8 - 18 m (only for Acorn Gen2).

** - For full model name explanation, see "Technical specification" for different luminaires on our website (vizulo.com).

## 9.2. Additional luminaire cost with specific sensor

Additional cost (for total luminaire price) for different types of sensors can be seen in the table below. These additional costs are approximate and can vary for different luminaires (more information on demand)!

| Sensor used | Additional cost |
|---|---|
| No sensor (NS) | *** |
| Microwave sensor (MW, MM, MC *, MK *) | *** |
| PIR sensor (PI) | *** |
| RF receiver (RR) | *** |
| RF transceiver (TR) | *** |
| Multi/DALI sensor (up to 5 m) ** | *** |
| Multi/DALI high bay sensor (up to 10 m) ** | *** |
| Multi/DALI high bay sensor (up to 16 m) ** | *** |

* - Only for DALI luminaires.

** - As fully autonomous DALI system (see chapter 4). Price without autonomous DALI system will be lower.

*** - Contact us for newest price (as it may change)!

# 10. Compatibility table

| Luminaire | Microwave (Slave) | Microwave (Master) | RF wireless | PIR Basic | PIR DALI Basic | | | PIR DALI Pro | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | < 5 m | 5-10 m | 11-16 m | < 5 m | 5-10 m | 11-16 m |
| Acorn Gen 2 | V | V | | | | V | V | | V | V |
| Oak Gen2 | V | V | | V | V | V | | V | V | |
| Fern | V | V | V | V | V | V | | V | V | |
| Stone | V | V | V | | | | | | | |
| Pine | | | | V | V | V | | V | V | |
| Icicle | V | | | | | | | | | |
| Straw | | | | | | | | | | |
| Leaf Slim | V | V | | V | | | | | | |
| Dove | V | V | | V | V | | | V | | |
| Shell Basic | V | V | V | | | | | | | |
| Nest | | | | | | | | | | |
| Sunflower | | | | | | | | | | |
| Bamboo | | | | V | V | | | V | | |
| Mint | | | | | | | | | | |
| No rules | | | | | | | | | | |
| Milzo Number 1 | | | | V | | | | V | | |
| Milzo Number 2 | | | | V | V | | | V | | |
| Milzo Number 3 | | | | | | | | | | |

Available PIR sensor types:

- **Basic** - requires no external controller (no connection to external DALI network allowed);
- **Pro** - external controller required.

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