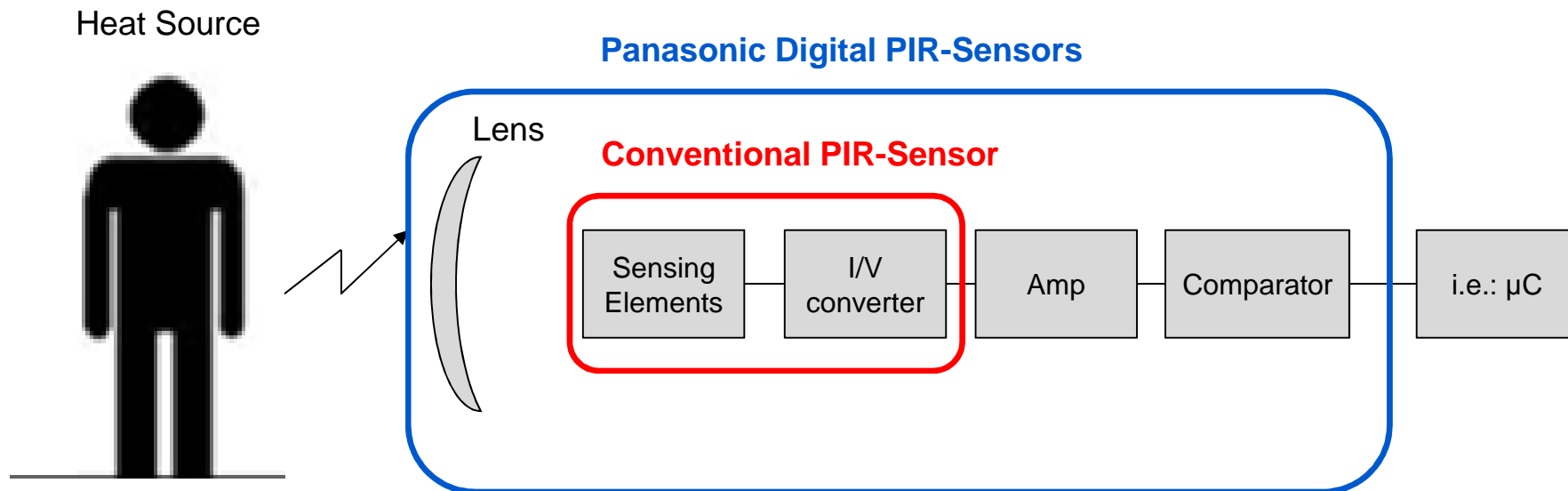


# Panasonic's Pyroelectric Infrared Sensors (PIR-Sensors)

# Basics: Pyroelectric Infrared Sensor – Block Diagram

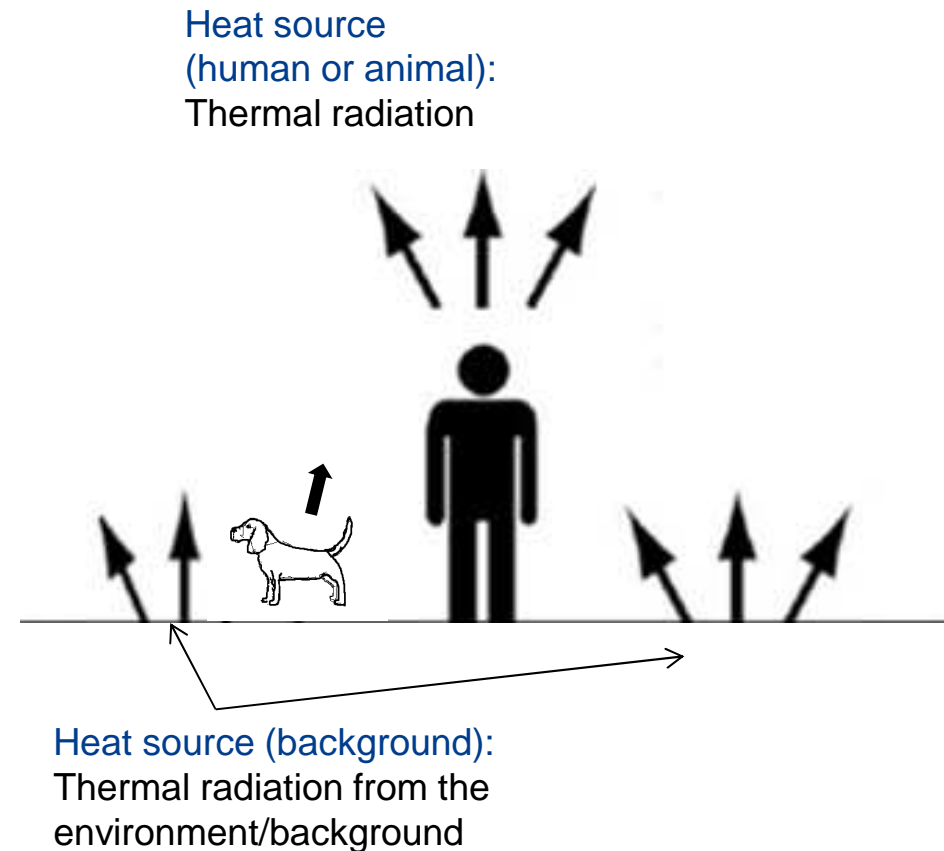
It is a „Plug and Sense Solution“!



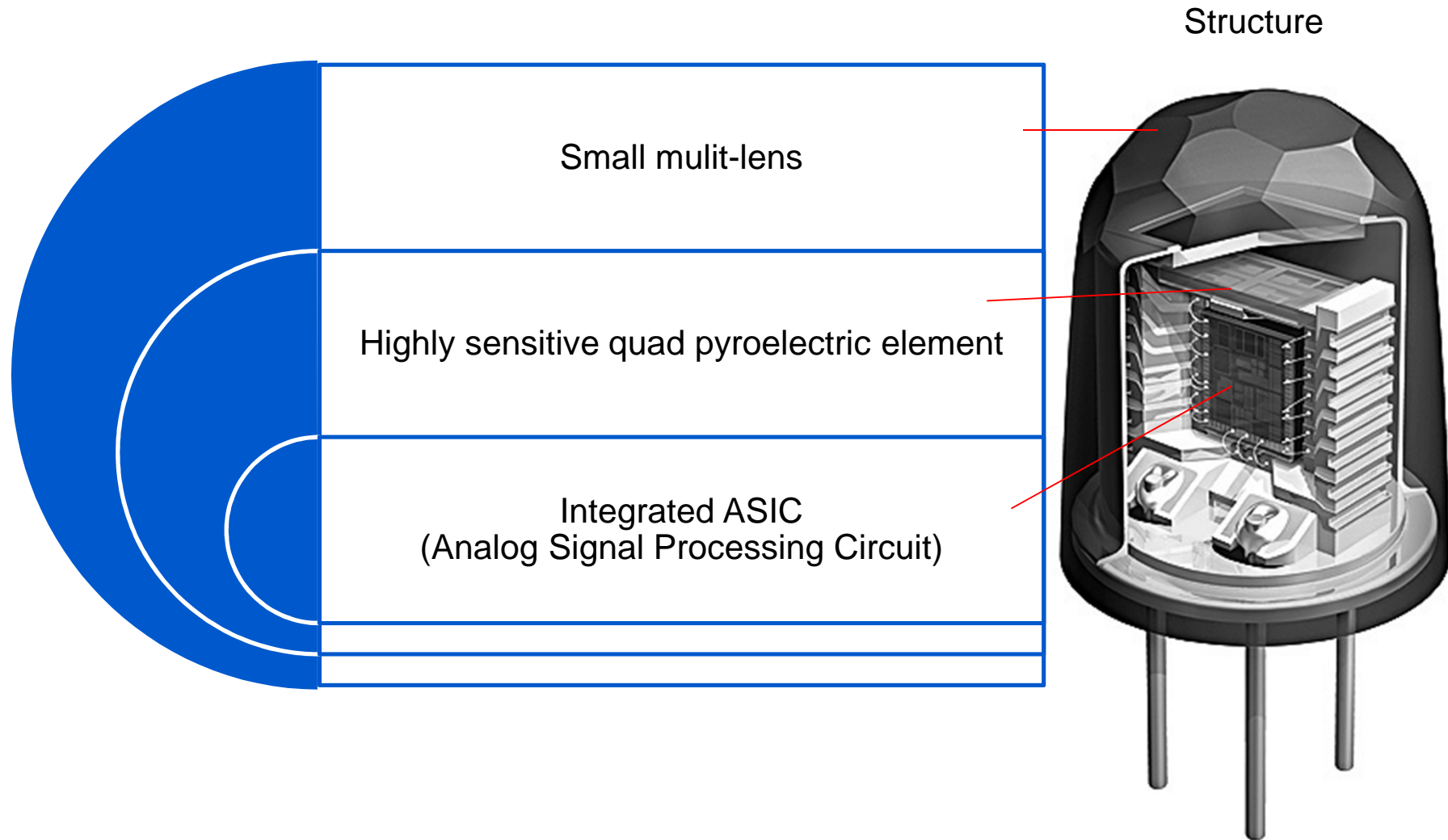
It is not 1:1 comparable with conventional PIR-sensors!  
It contains: Active current/voltage converter-, built-in-amplifier- and comparator-technology.

# Basics: Motion Detector Working Principle

- **Heat source**  
→ An object, which emits thermal radiation, which is different compared to the environment/background.
- **Pyroelectric elements**  
→ Sensing element, detecting thermal radiation and converting it into a electrical signal
- **Optic (lens)**  
→ Focussing the thermal radiation on the pyroelectric elements
- **Amplifier circuit**  
→ Amplification of the small signal, coming from the pyroelectric elements during detection state
- **Decision circuit**  
→ Window comparator circuit, defining the threshold levels, where the sensor shall trigger

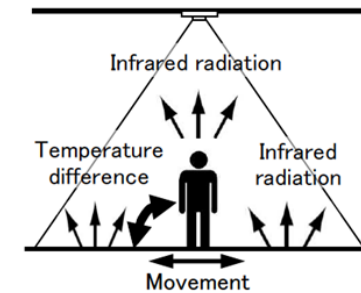


# Basics: Panasonic PIR Features – Structure

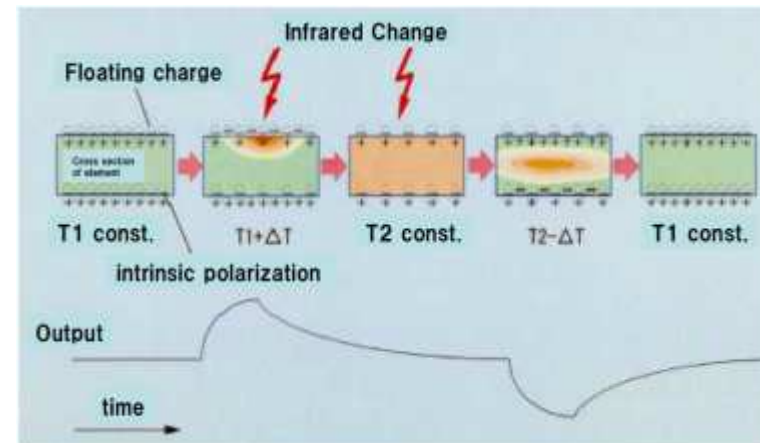


# Basics: Detection Principle

- Material with a temperature > absolute zero (-273°C) emits infrared light
- A human (app. 37°C) emits infrared light in the range of 10µm. The wavelength of the infrared radiation, which an object emits, is directly linked to the temperature of the object ("law of Wien")
- Pyroelectric Infrared Sensors are thermal detectors, detecting change in temperature.
- A PIR-Sensor, which is based on the pyroelectric effect is able to detect movement of people, animals and other objects emitting infrared light. No moving objects can not be detected.



$$i(t) \sim \frac{dT(t)}{dt}$$

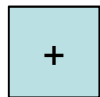


Just change in temperature can be detected → Motion Detector

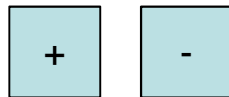
# Basics: Pyroelectric Element

- The core of a PIR-motion sensor is the pyroelectric element, which is polarized (+ or -)
- The pyroelectric element detects a change in thermal radiation and converts it into a small electrical signal
- The pyroelectric element can be used in in different configurations:

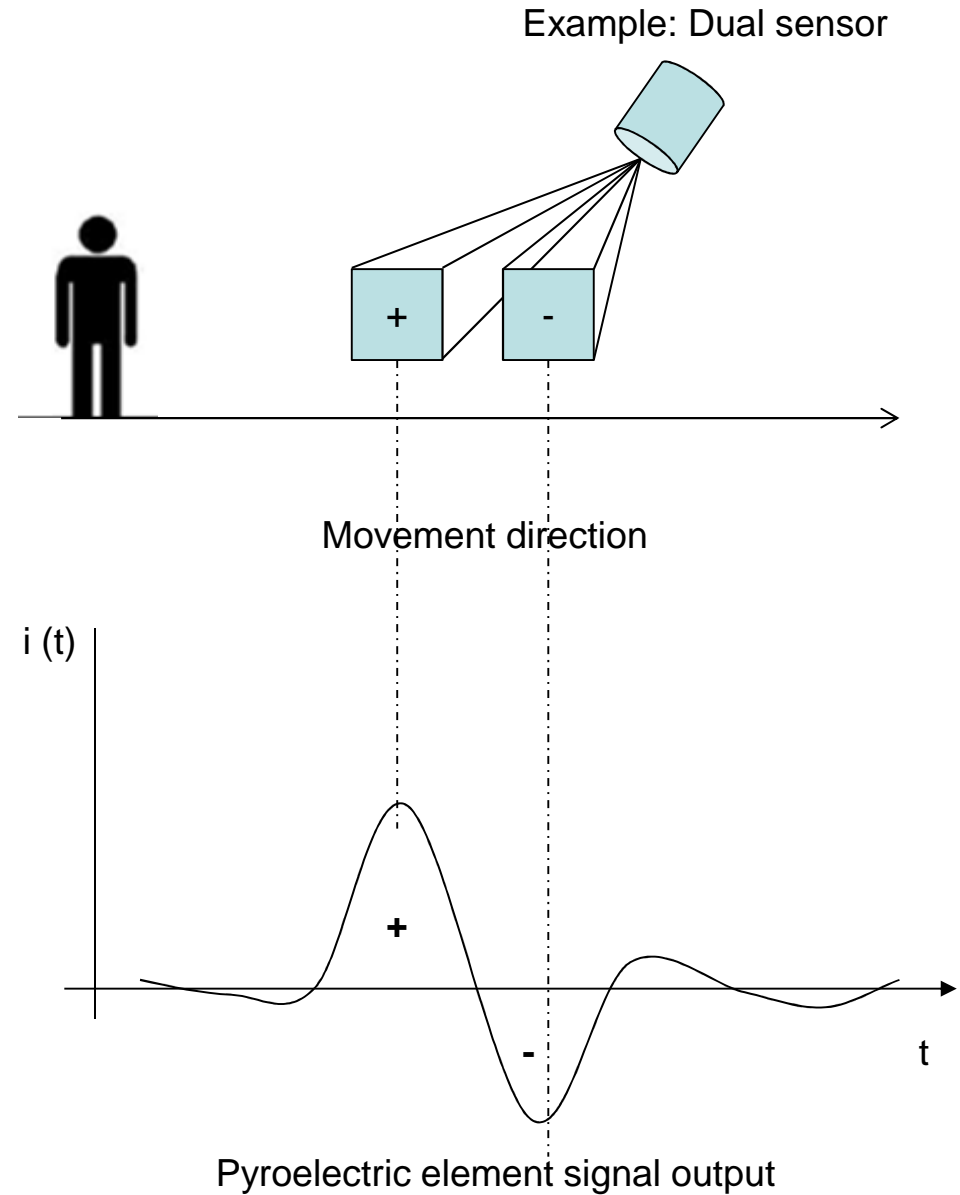
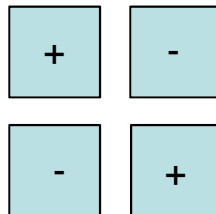
Single



Dual



Quad



# Basics: Pyroelectric Element

## Single:

- PIR-sensor with a single pyroelectric element detects any change of the thermal radiation.
- This configuration is highly sensitive against any temperature change in the environment and shock and vibration for example caused.
- Therefore the risk of false alarms is very high

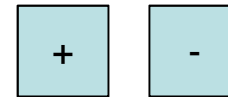
## Dual:

- Negative and positive polarized elements are used.
- This results in a differential sensing/measurement setup
- Temperature change, caused by shock/vibration and warm wind affects both elements at the same time.
- The + element outputs a positive- and the – element a negative-signal.
- The signals are cancelling each other, so the risk of false detection is reduced
- The orientation of the sensor is important.
- Not the preferred solution for ceiling applications

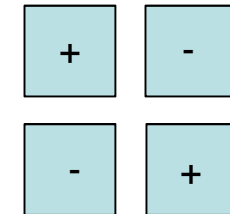
## Single



## Dual



## Quad



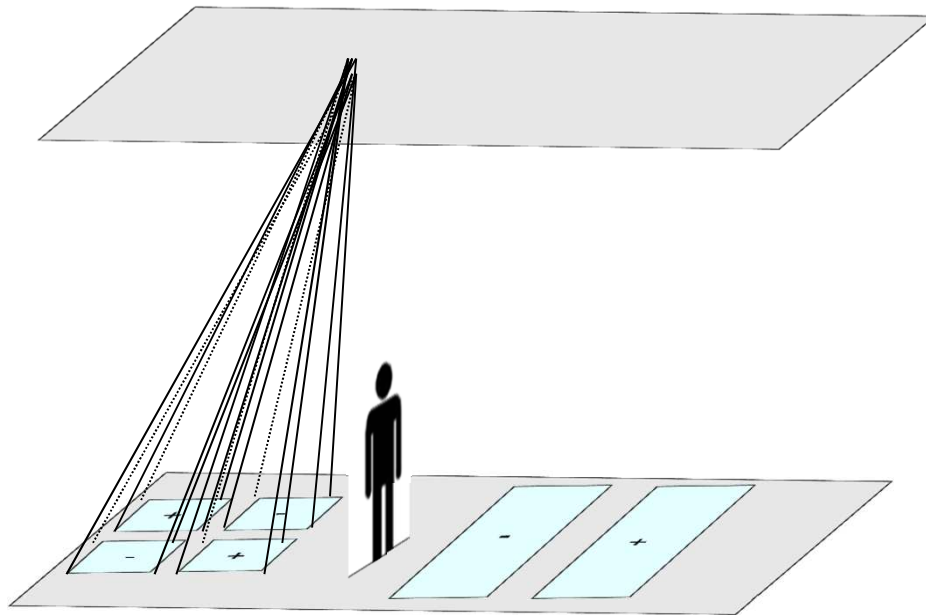
## Quad:

- Four elements for differential measurement
- False detection rate is reduced due to differential sensing/measurement setup.
- **Switching zone density is much higher compared with dual element sensors**
- **Finer resolution, leads in higher accuracy, suitable for small object detection**
- **Perfect for ceiling applications and detection, where high detection accuracy/performance is needed**

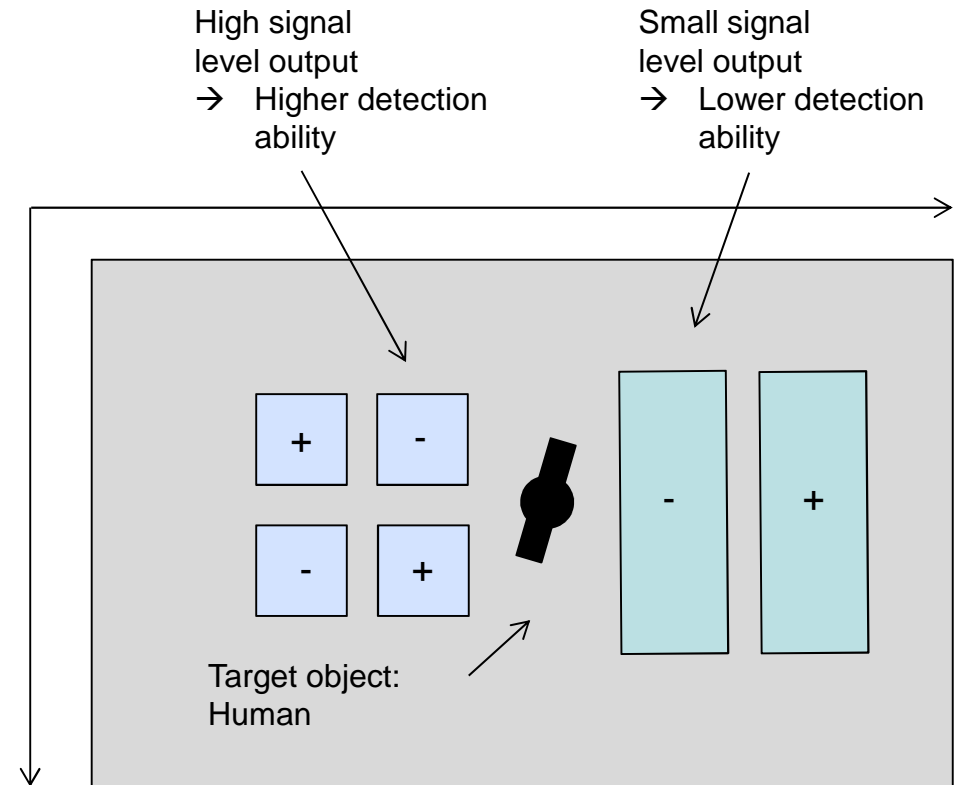
→ All Panasonic PIR-sensors are quad sensors

# Basics: Pyroelectric Element

3D-View



Top View



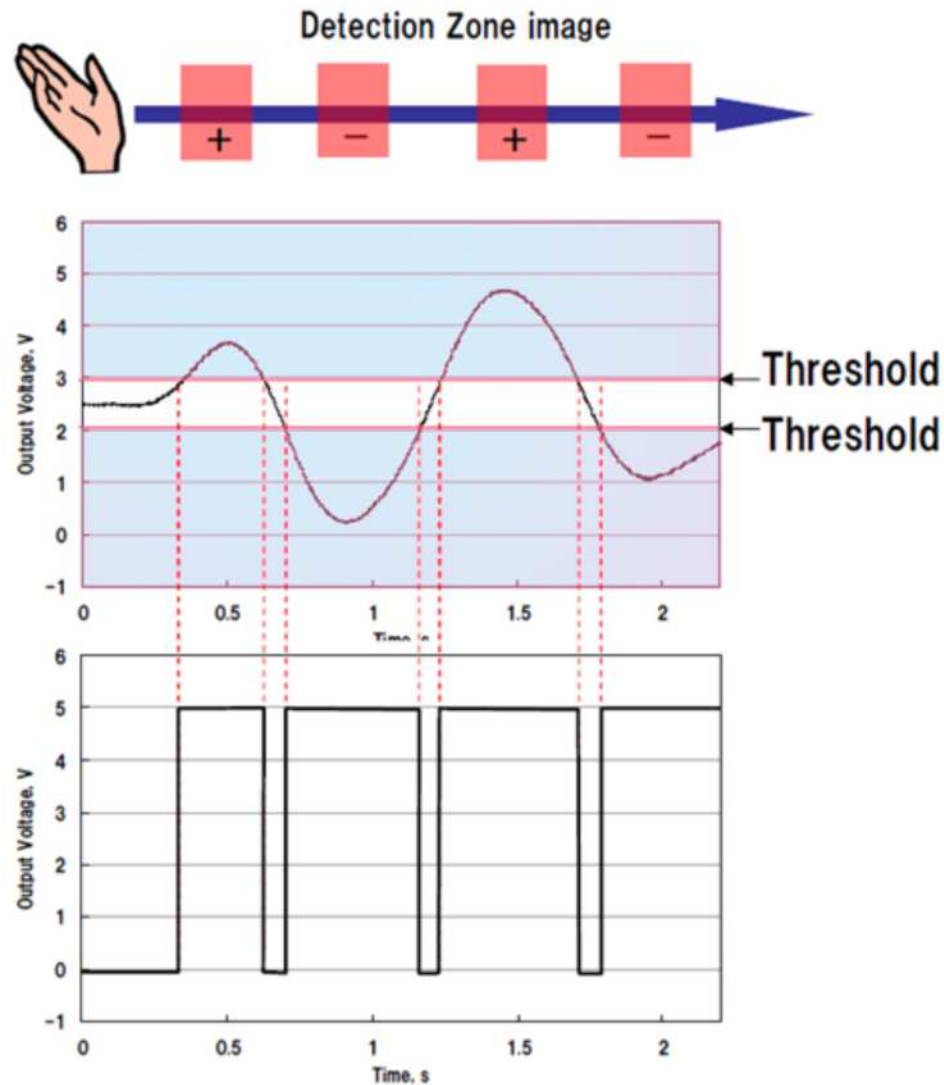
**Each switching zone is smaller for quad sensors.**

- Therefore small movements can be detected more easy compared with dual sensors, for example head movemtent
- Small objects can be detected more easy, for example hand movement, compared with dual sensors
- With quad sensors you can detect in longer distances by keeping the same lens size, compared with dual sensors



# Basics: Output Concept

Ex. Hand Moving image



Panasonic Analog Output Concept

- ✓ 1st and 2nd level amplifier already integrated

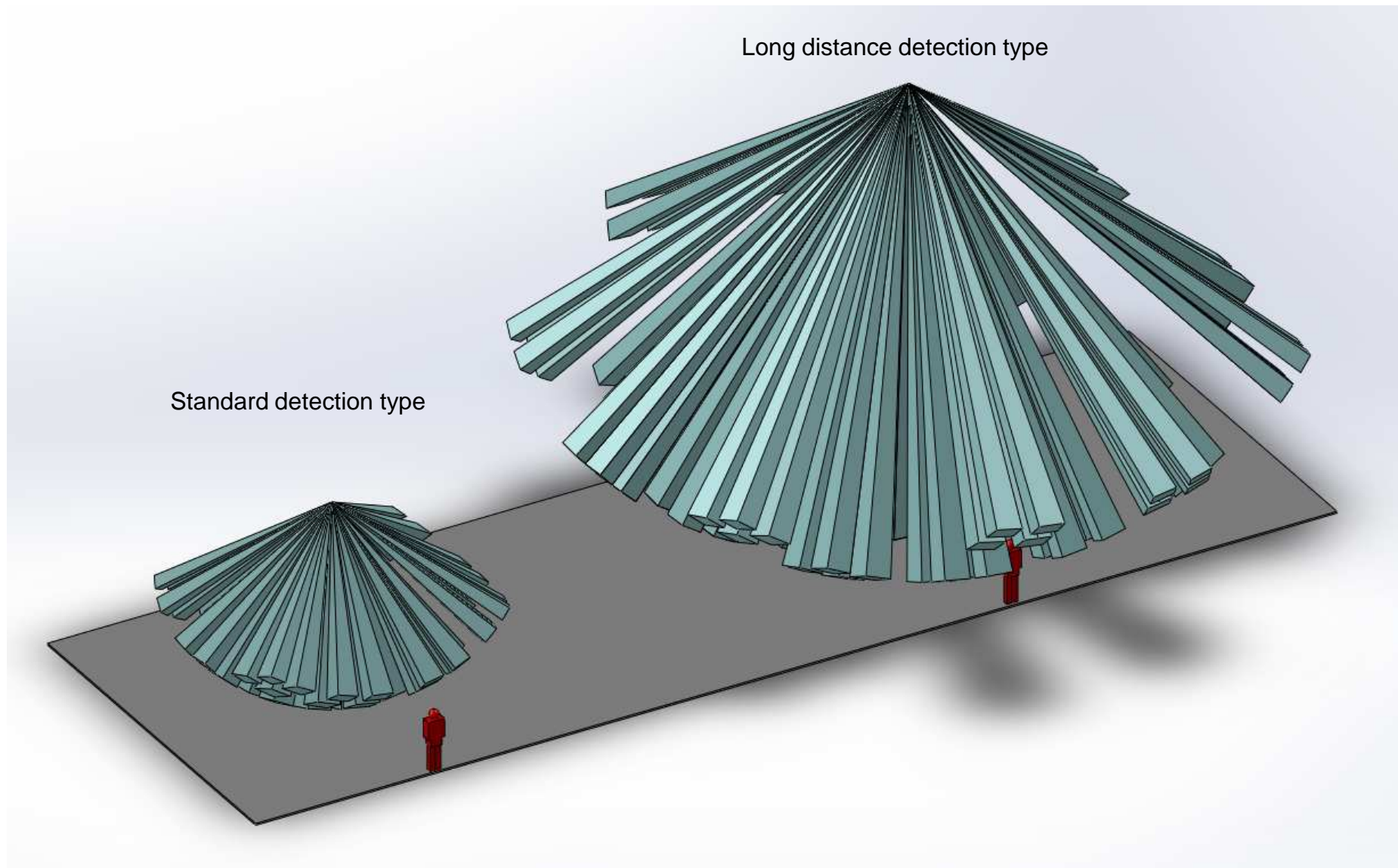
Panasonic Digital Output Concept

- ✓ Amplifier with bandpass + window comparator + output stabilization circuit already integrated

# Product Portfolio

Series		EKMB		EKMC		AMN			
Output		Digital				Analog or digital			
Detection type		Standard	Long distance	Standard	Long distance	Slight motion	Spot	Standard	10m
Appearance									
Current consumption		1µA, 2µA, 6µA		170µA		170µA			
Detection distance		5m	12m	5m	12m	2m	5m	10m	
Detection area	Horizontal	94°	102°	94°	102°	91°	38°	100°	110°
	Vertical	82°	92°	82°	92°	91°	22°	82°	93°
Lens color		white, black, pearl white				white, black			

# Product Portfolio – EKM Series




# Product Portfolio – EKM(B/C) Series

## Low Current Type (Focus: High performance Eco)

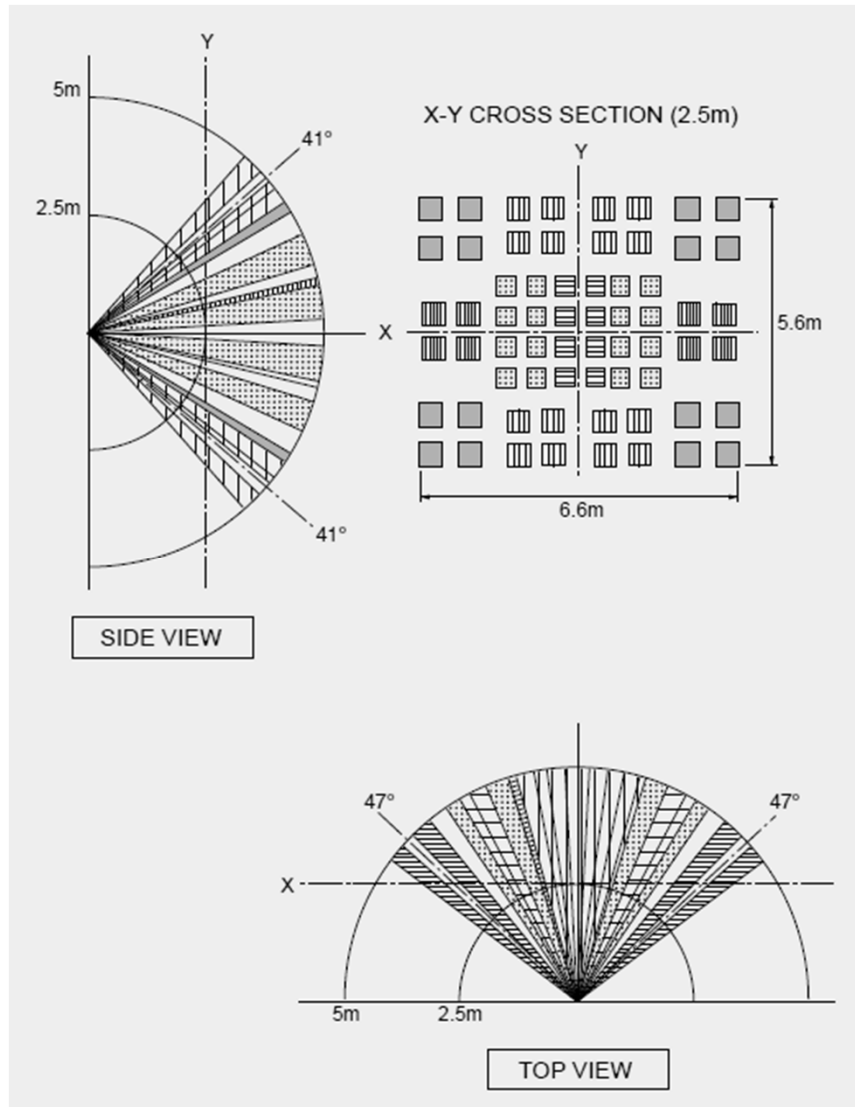


Detection performance	Model no.	Current consumption	Lens color	Output type	Detection distance	Detection area	
						Horizontal	Vertical
Standard detection type 	EKMB1101111	1μA	White	Digital	5m	94°	82°
	EKMB1101112		Black				
	EKMB1101113		Pearl White				
	EKMB1201111	2μA	White				
	EKMB1201112		Black				
	EKMB1201113		Pearl White				
	EKMB1301111K	6μA	White				
	EKMB1301112K		Black				
	EKMB1301113K		Pearl White				
Long distance detection type 	EKMB1103111	1μA	White		12m	102°	92°
	EKMB1103112		Black				
	EKMB1103113		Pearl White				
	EKMB1203111	2μA	White				
	EKMB1203112		Black				
	EKMB1203113		Pearl White				
	EKMB1303111K	6μA	White				
	EKMB1303112K		Black				
	EKMB1303113K		Pearl White				

## Economy Type (Focus cost reduction)

Detection performance	Model no.	Current consumption	Lens color	Output type	Detection distance	Detection area	
						Horizontal	Vertical
Standard detection type 	EKMC1601111	170μA	White	Digital	5m	94°	82°
	EKMC1601112		Black				
	EKMC1601113		Pearl White				
Long distance detection type 	EKMC1603111	170μA	White		12m	102°	92°
	EKMC1603112		Black				
	EKMC1603113		Pearl White				

# Product Portfolio - EKM (Standard Detection Type)



## Characteristics

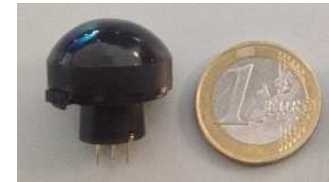
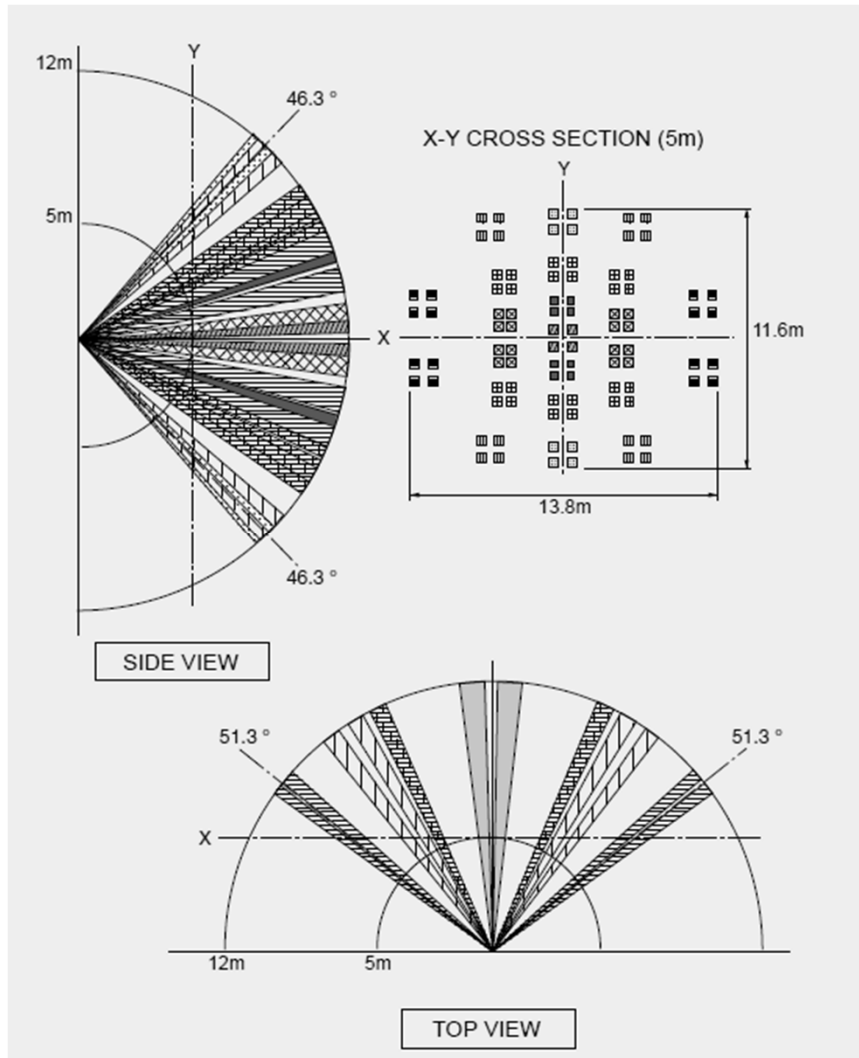
Detection distance	5m *
Detection range (Horizontal x Vertical)	94° x 82°
Detection zones	64
Operating voltage (EKMC)	3V DC min. / 6V DC max.
Operating voltage (EKMB)	2.3V DC min. / 4V DC max.

\*) Temperature difference:  $\geq 4^{\circ} \text{C}$   
 Movement speed: 1,0 m/s (digital)  
 Detection object: Human body size (700mm x 250mm)

### Important!

- Panasonic specifies detection under low temperature difference conditions  $\geq 4^{\circ} \text{C}$
- Professional specification and documentation

# Product Portfolio - EKM (Long Distance Detection Type)

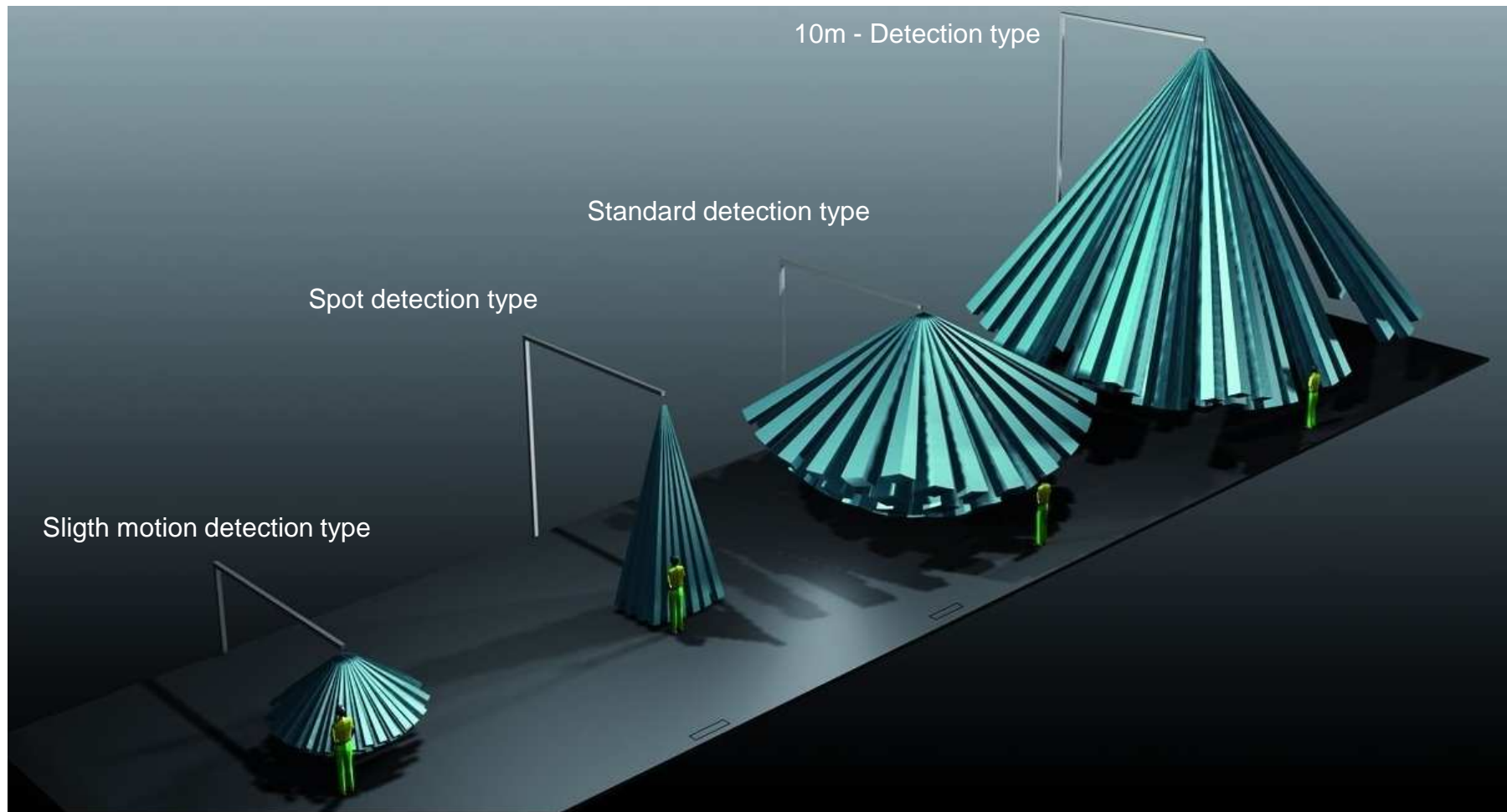


## Characteristics

Detection distance	12m *
Detection range (Horizontal x Vertical)	102° x 92°
Detection zones	92
Operating voltage (EKMC)	3V DC min. / 6V DC max.
Operating voltage (EKMB)	2.3V DC min. / 4V DC max.





\*) Temperature difference:  $\geq 4^{\circ} \text{C}$   
 Movement speed: 1,0 m/s (digital)  
 Detection object: Human body size (700mm x 250mm)

# Product Portfolio – AMN Series



# Product Portfolio – AMN Series

## General Use Types

Detection performance	Model no.	Current consumption	Lens color	Output type	Detection distance	Detection area				
						Horizontal	Vertical			
Standard detection type 	AMN31112	170μA	White	Digital	5m	100°	82°			
	AMN31111		Black							
	AMN21112		White	Analog						
	AMN21111		Black							
Slight motion detection type 	AMN32112		White	Digital				2m	91°	91°
	AMN32111		Black							
	AMN22112		White	Analog						
	AMN22111		Black							
Spot detection type 	AMN33112		White	Digital	5m	38°	22°			
	AMN33111		Black							
	AMN23112		White	Analog						
	AMN23111		Black							
10m detection 	AMN34112		White	Digital				10m	110°	93°
	AMN34111		Black							
	AMN24112		White	Analog						
	AMN24111		Black							



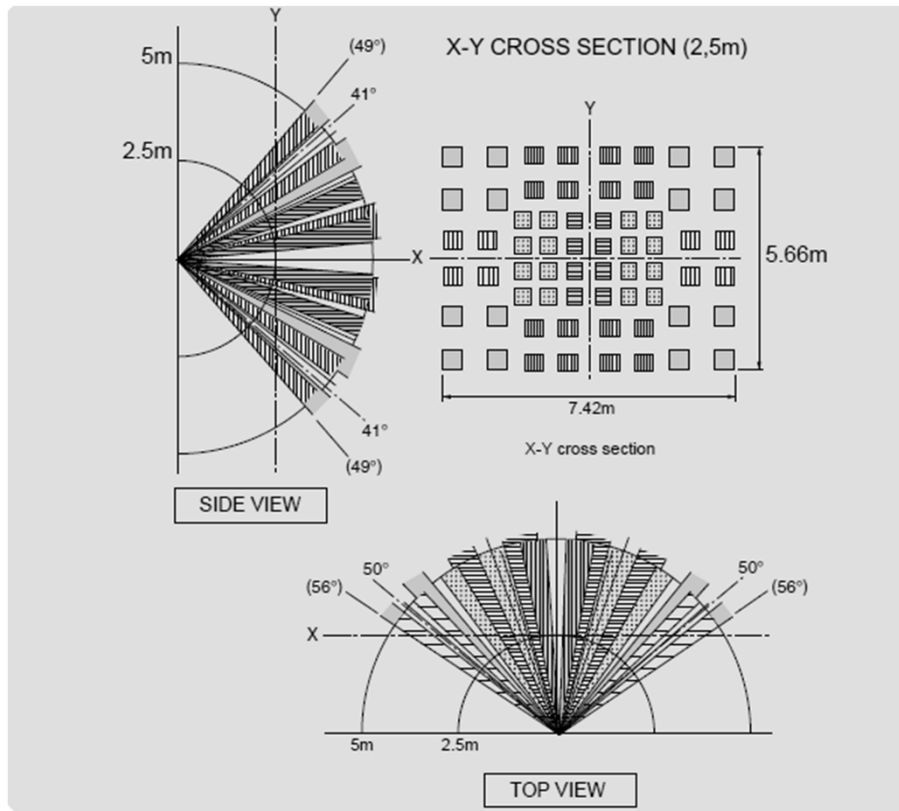
# Product Portfolio - AMN31XXX (Standard Detection Type)



Black



White



## Characteristics

Detection distance	5m *
Detection range (Horizontal x Vertical)	100° x 82°
Detection zones	64
Operating voltage (Digital )	3V DC min. / 6V DC max.
Operating voltage (Analog)	4.5V DC min. / 5.5V DC max.

\*) Temperature difference:  $\geq 4^{\circ} \text{C}$   
 Movement speed: 0,8 – 1,2 m/s (digital); 0,5 – 1,5 m/s (analog)  
 Detection object: Human body size (700mm x 250mm)

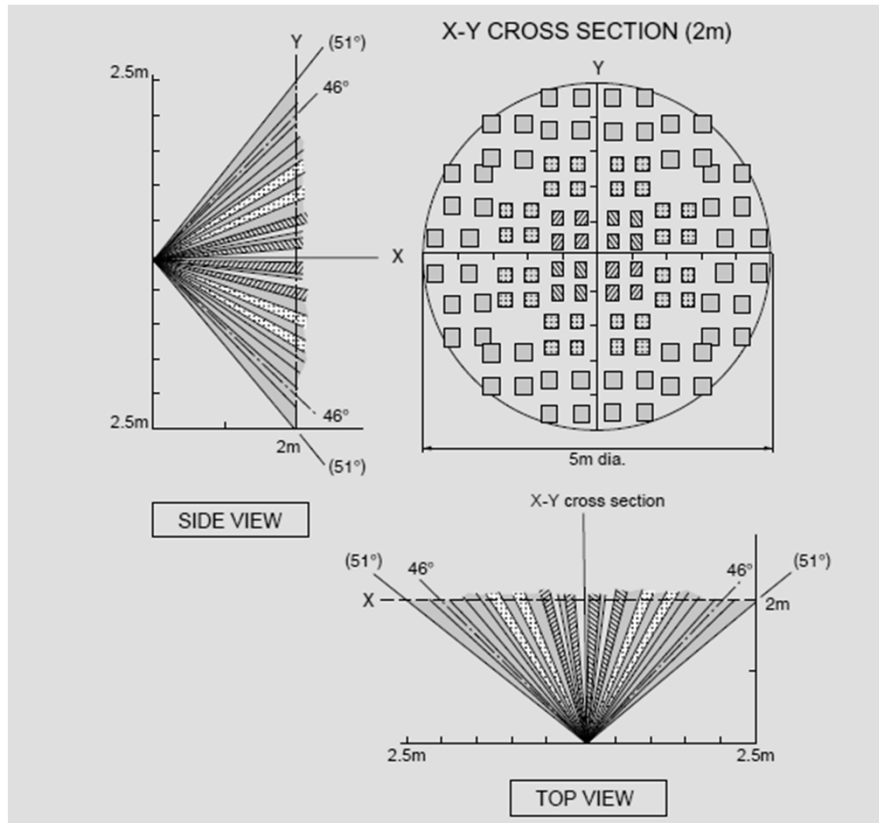
# Product Portfolio - AMN32XXX (Slight Motion Detection Type)



Black



White



## Characteristics

Detection distance	2m *
Detection range (Horizontal x Vertical)	91° x 91°
Detection zones	104
Operating voltage (Digital )	3V DC min. / 6V DC max.
Operating voltage (Analog)	4.5V DC min. / 5.5V DC max.

\*) Temperature difference:  $\geq 4^{\circ} \text{C}$   
 Movement speed: 0,5 m/s (digital); 0,3 – 1,0 m/s (analog)  
 Detection object: Human body size (200mm x 200mm)

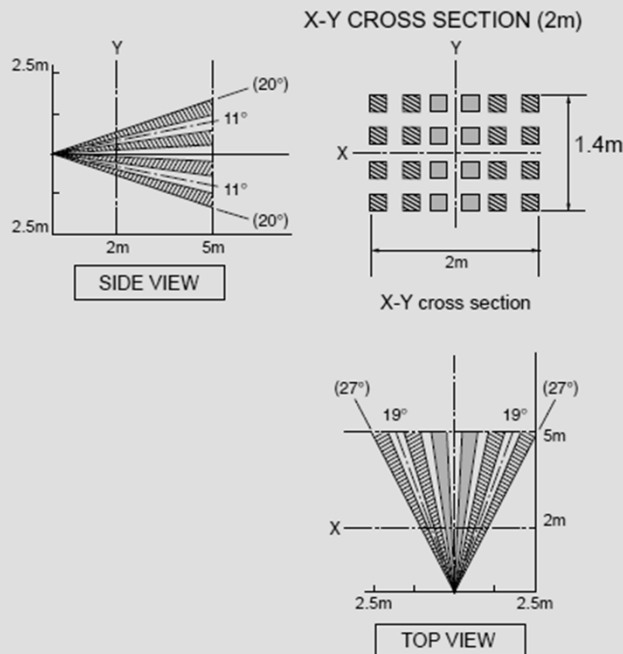
# Product Portfolio - AMN33XXX (Spot Detection Type)



Black



White



## Items

Detection distance	5m *
Detection Range (Horizontal x Vertical)	38° x 22°
Detection zones	24
Operating voltage (Digital )	3V DC min. / 6V DC max.
Operating voltage (Analog)	4.5V DC min. / 5.5V DC max.

\*) Temperature difference:  $\geq 4^{\circ} \text{C}$   
 Movement speed: 0,8 – 1,2 m/s (digital); 0,5 – 1,5 m/s (analog)  
 Detection object: Human body size (700mm x 250mm)

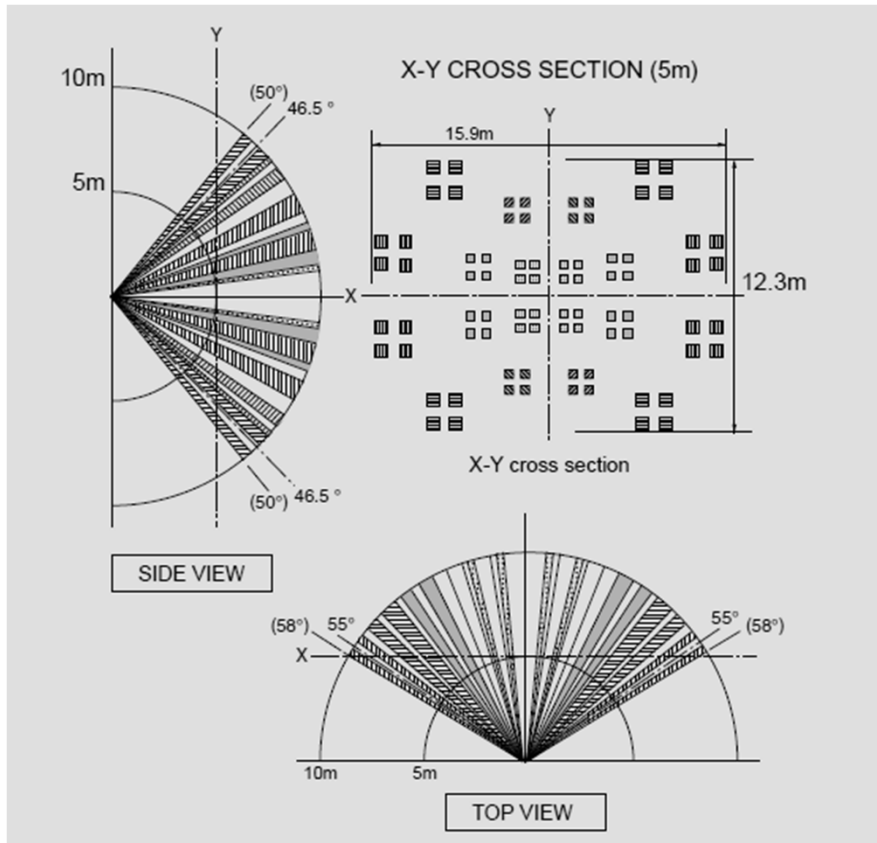
# Product Portfolio - AMN34XXX (10m Detection Type)



Black



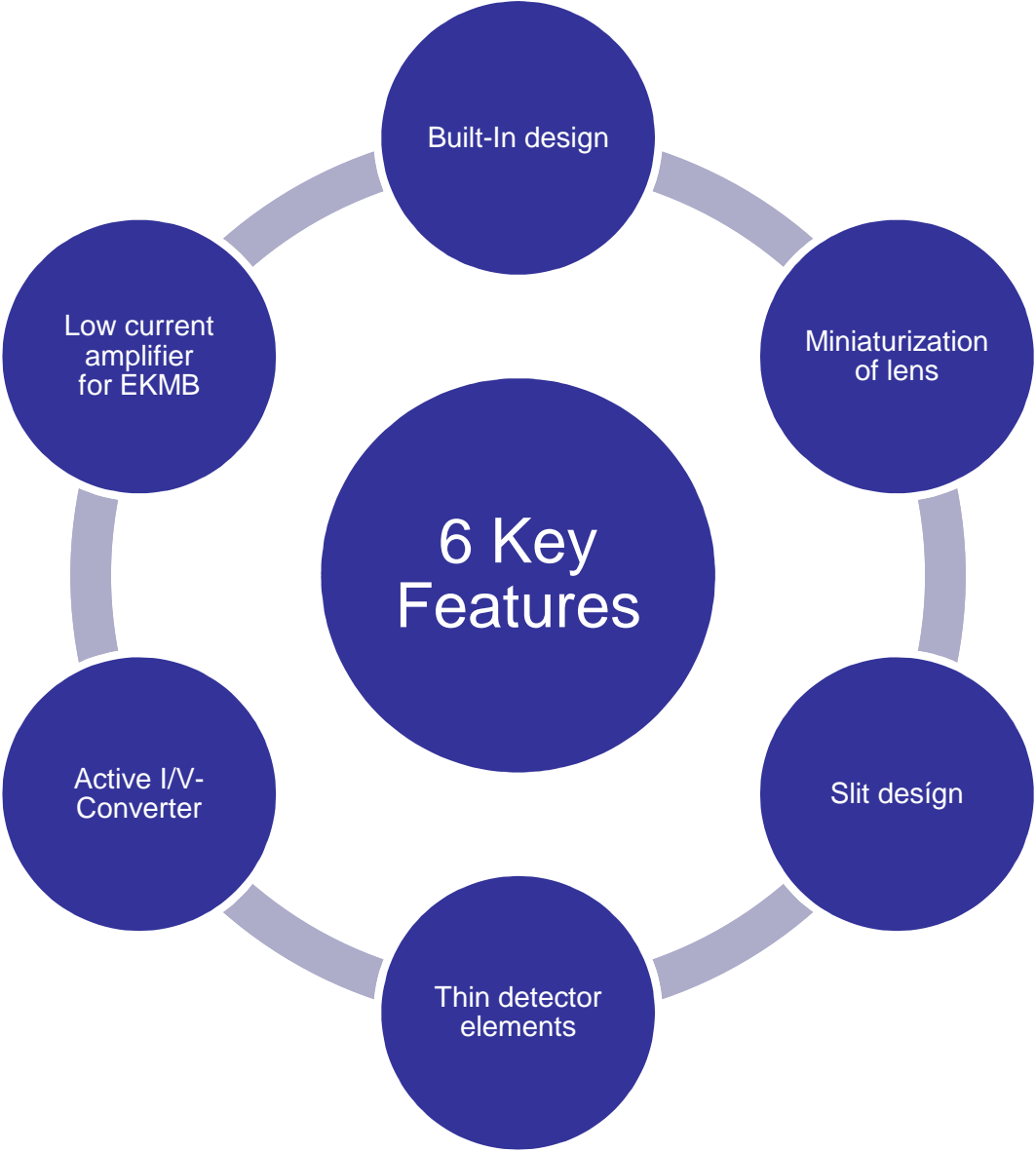
White



Items	
Detection distance	10m *
Detection range (Horizontal x Vertical)	110° x 93°
Detection zones	80
Operating voltage (Digital )	3V DC min. / 6V DC max.
Operating voltage (Analog)	4.5V DC min. / 5.5V DC max.

\*) Temperature difference:  $\geq 4^{\circ} \text{C}$   
 Movement speed: 0,8 – 1,2 m/s (digital); 0,5 – 1,5 m/s (analog)  
 Detection object: Human body size (700mm x 250mm)

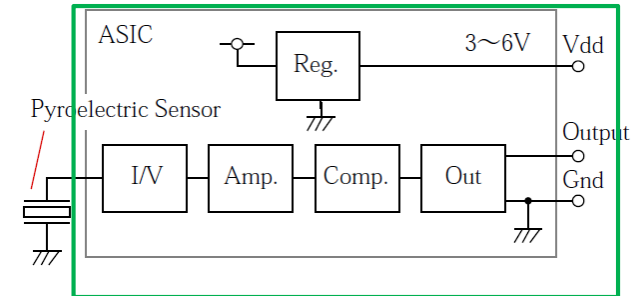
# Key Features



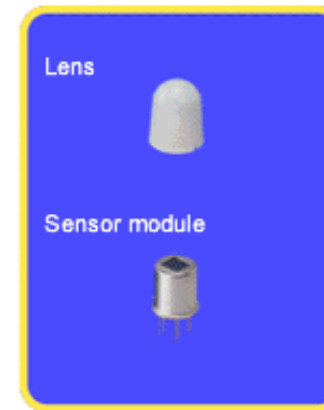
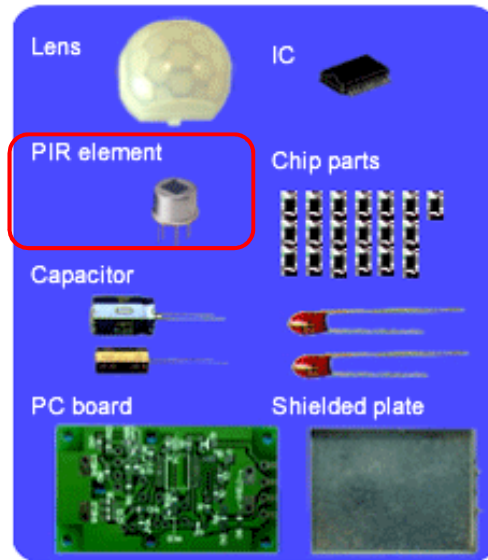
# Key Feature 1 – Built In Design

## Implementation of amplifier and comparator

- PIR Sensors from Panasonic are not comparable with conventional low cost PIR-sensors!
- We offer an „all-in-one-solution“, containing the whole control logic + the lens.



Conventional PIR-Sensor



Panasonic PIR-Sensor

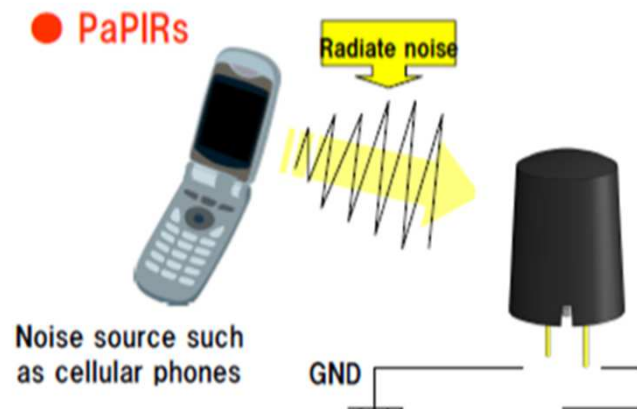
**From a cost point of view Panasonic PIR sensors are not comparable with conventional PIR- sensors because further required components are already integrated!**

## High noise withstand capability due to TO-5 can

### Radiation in the air wireless noise preservation test

Frequency: 500kHz~1GHz

Electrical field strength: 3V/m~10V/m



Electromagnetic signals in the air can trigger the PIR-sensor, which can cause false alarms.

Panasonic PIR-sensors have a high withstand capability against noise/electromagnetic signals, for example coming from mobile phones, because the sensitive amplifier circuit and filtering elements are already integrated.

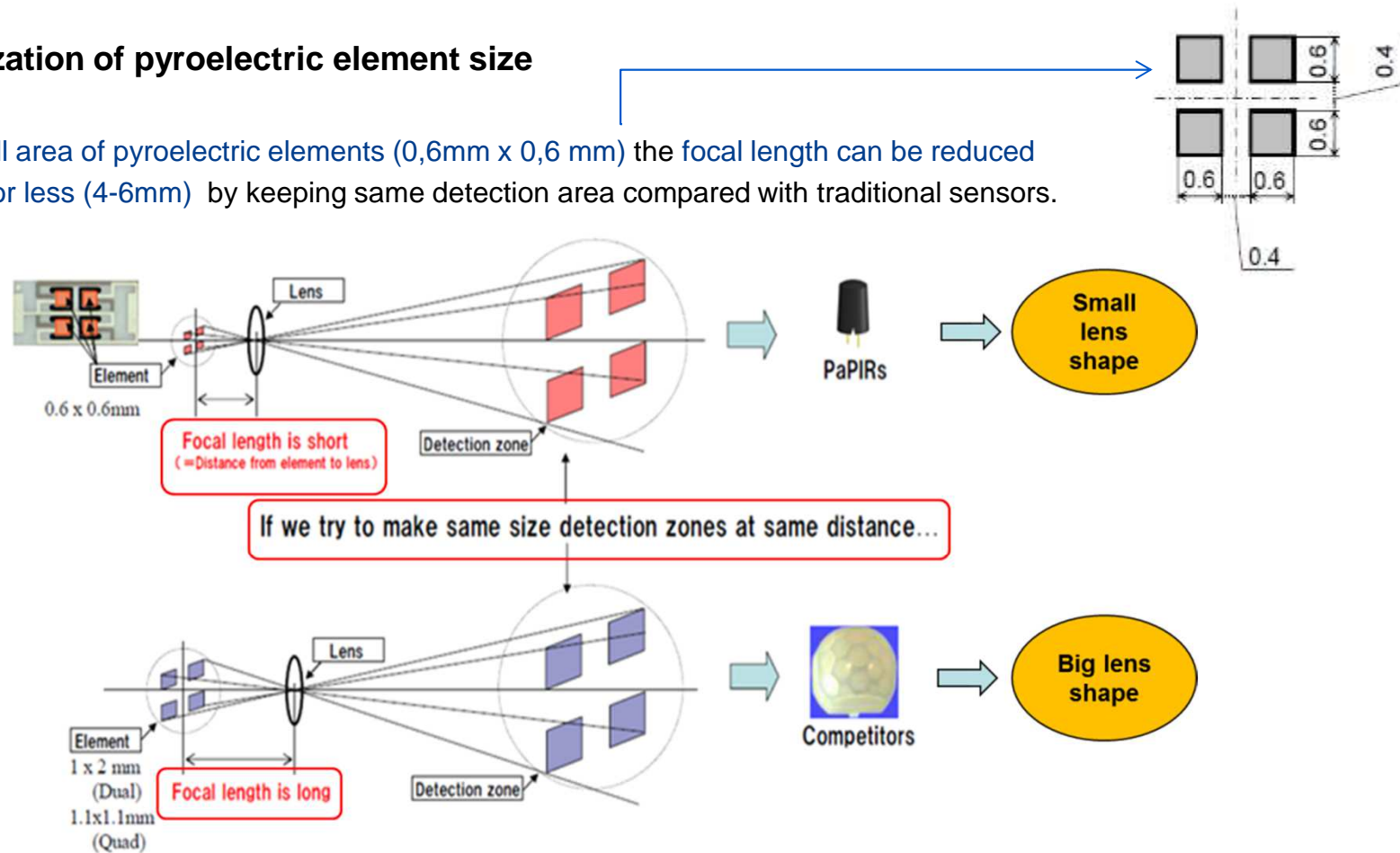
The risk of false alarm is reduced, using Panasonic PIR sensors compared with conventional PIR's, available in the market.

**Probability of false alarm is reduced by using Panasonic PIR's compared with other PIR sensors due to high noise withstand capability, because the amplifier circuit and additional filter elements are already integrated into the TO-5 can!**

# Key Feature 2 - Miniaturization of Lens

## Miniaturization of pyroelectric element size

Due to small area of pyroelectric elements (0,6mm x 0,6 mm) the focal length can be reduced to one half or less (4-6mm) by keeping same detection area compared with traditional sensors.



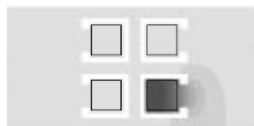
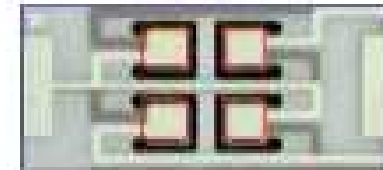
**Miniaturization of lens is achieved!**



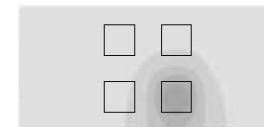
## U-Shape Slit Design

The elements of conventional sensors are the electrodes formed on a flat material by vacuum evaporation, where thermal diffusion occurs to a high extent and the temperature does not increase much.

In the present sensor, a 0.1mm wide, U-shape slit structure has been developed to obtain high sensitivity. The slit shape was designed optimally, based on stress analysis and thermal analysis.



With slit design



Without slit design

**Temperature increase per detection area is about two times greater with slit design than without it!**

**Higher sensitivity is achieved!**

# Key Features - Pyroelectric Element Basics

## Pyroelectric element output signal

$$V_S \sim \frac{A^2}{G}$$

The smaller the size of the pyroelectric element the smaller the signal output

$V_S$  = Output signal voltage

A = Size of pyroelectric element

G = thermal time constant

## Further design rule:

The smaller the size of the pyroelectric element the shorter the focal distance

## Design target:

**Miniaturization of the sensor, including lens**

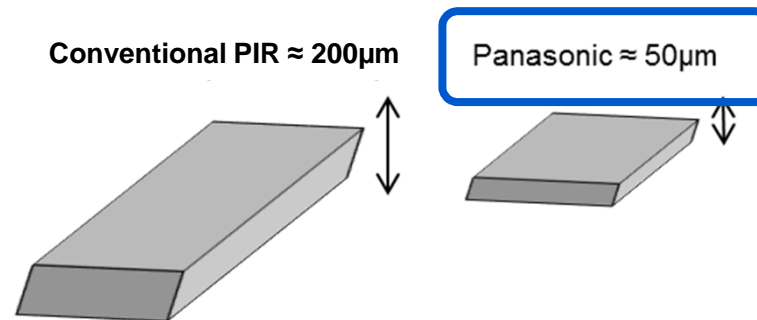
**Improving sensitivity compared to conventional PIR's**

## Challenge:

- Decrease thermal time constant and increase signal to noise ratio
  - Decreasing element thickness
  - U-shape slit design
  - Special I/V-converter

## Decreased element thickness

Due to the **thin pyroelectric element thickness (50 $\mu$ m)** the **thermal time constant is reduced** compared to conventional PIR-sensors, using pyroelectric elements with a thickness of 200 $\mu$ m for example.



**App. 4 times better thermal time constant/detection ability of Panasonic PIR's in comparison to conventional PIR-sensors!**

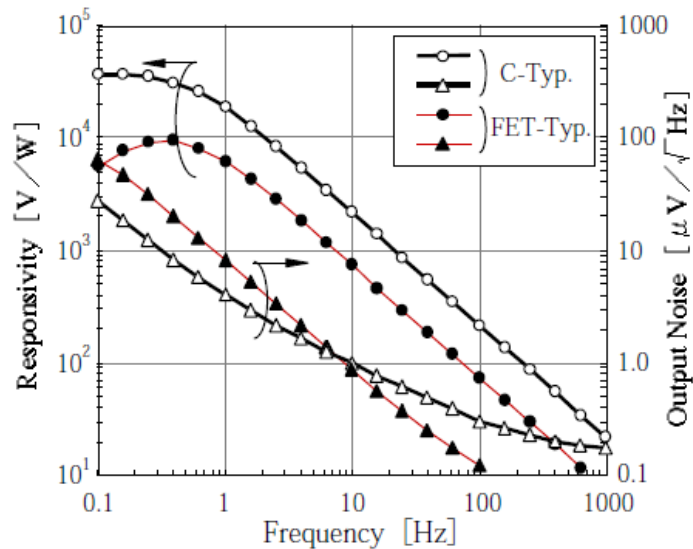
# Key Feature 5 - Active I/V Converter

## Increased signal-to-noise ratio

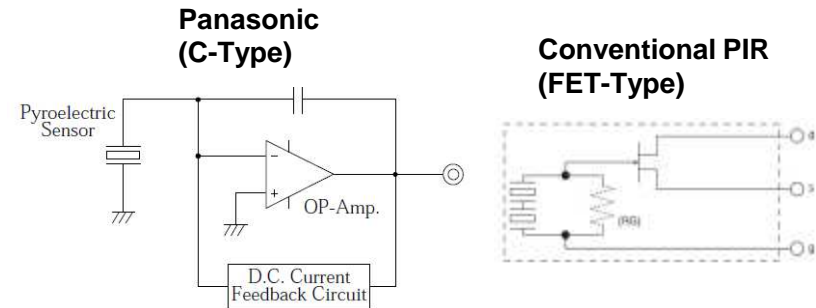
The current/voltage (I/V) converter is characterized by the active conversion of the current into voltage signal level with the help of a condenser element and an operation amplifier.

This improved circuit design allows for a noise reduced and more effective signal conversion.

Therefore the signal-noise-ratio (S/N) is significantly increased compared with PIR-sensors, which are using passive field-effect-transistor (FET) based current to voltage converter technology.



**S/N min 4 times better compared to conventional PIR-sensors!**

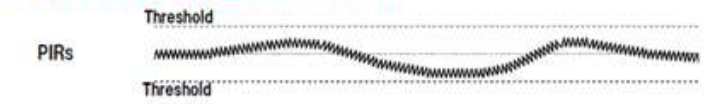


The output of the low frequency by swinging of air is generated.  
 (Movement of lukewarm air generated at summer time etc. It is often generated in outdoor. Though it doesn't turn on in most cases.)

Actually a regular noise overlays it. ※ regular noise : Noise generated in circuit

Because sensitivity is small, the other companies goods adjust sensitivity in the circuit by lowering the threshold. Then, though it becomes external like equal to

● S/N is high (=regular noise is low)



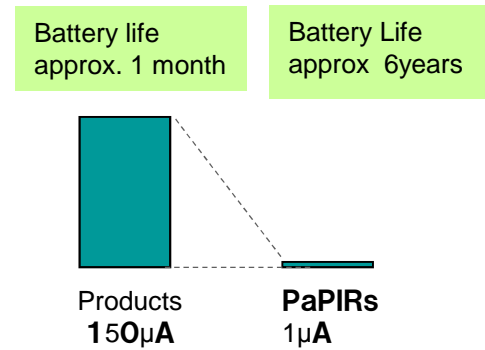
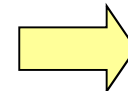
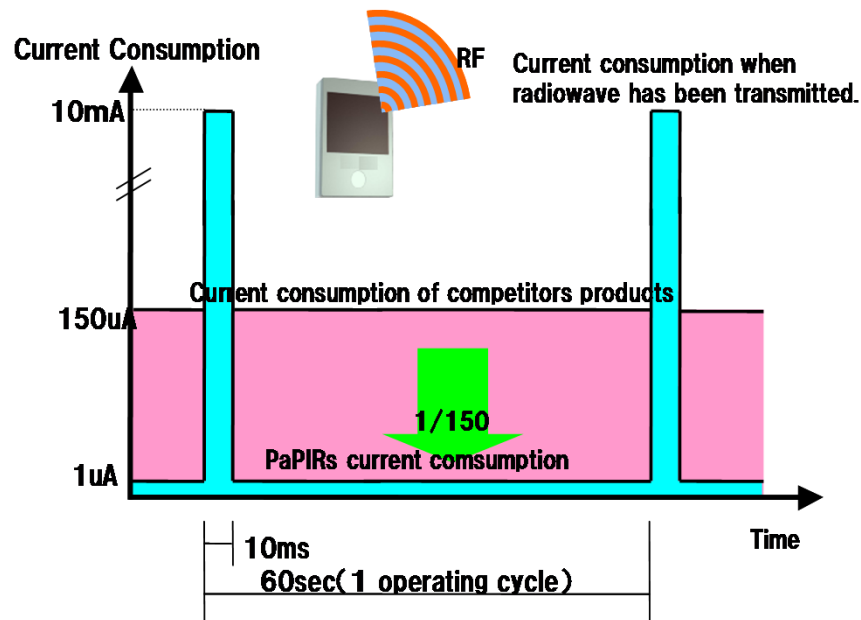
● S/N is low (=regular noise is high)



# Key Feature 6 - Low Current Amplifier

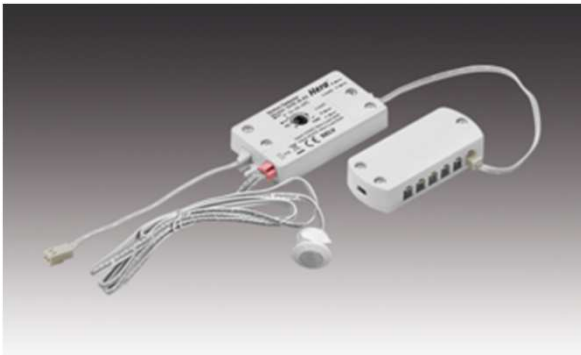
## High end low current amplifier design

World lowest current consumption as PIR sensor > 1, 2 and 6µA with integrated amplifier and electronic circuits by **keeping high noise withstand capability**



**Increased battery lifetime for wireless products!**  
Test report available by request!

## Sensor + Ballast



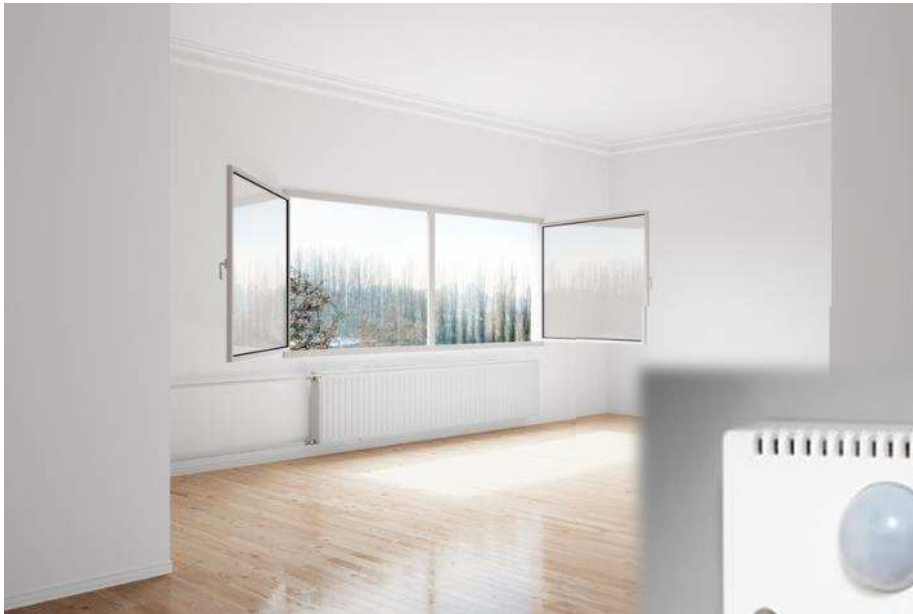
*Image courtesy of Hera*

## Ceiling Sensors



- Perfect for ceiling applications
- Small and unobtrusive
- Highly reliable and accurate

## Thermostat to control the heating system



- Efficient and automatic heating control
- Lower the room temperature, if nobody is detected for a certain time

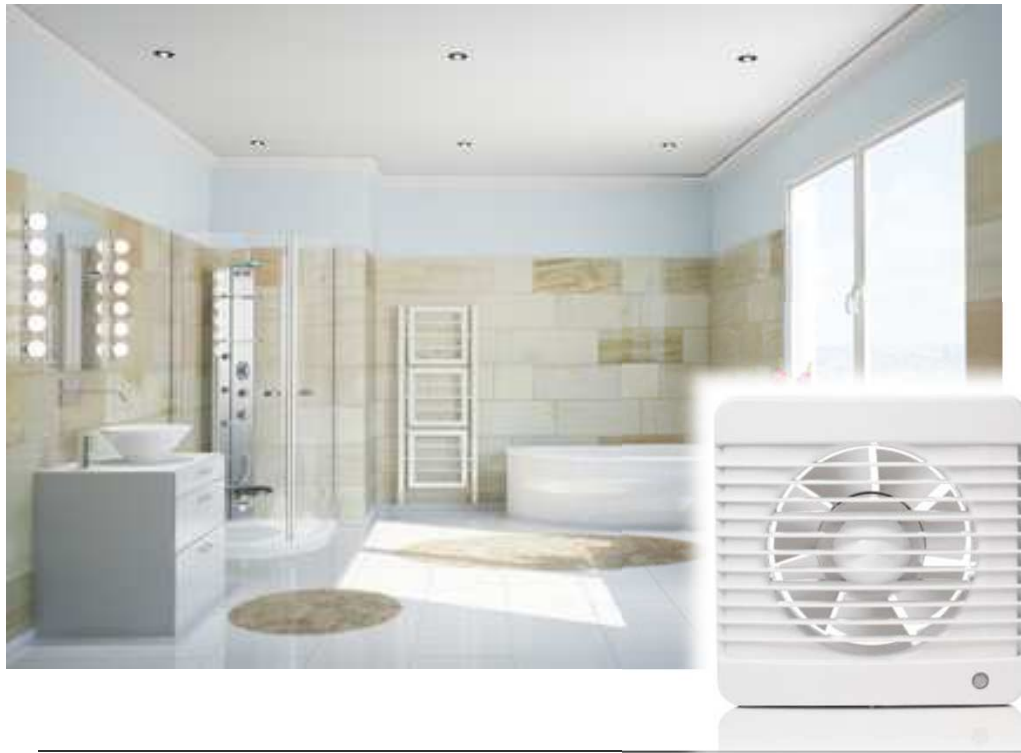


# Ventilation - Application

## Automatic ventilation

In bathrooms and toilets for example

For air quality control systems like air diffusers, used in offices



- Efficient automatic ventilation control
- Air quality level control

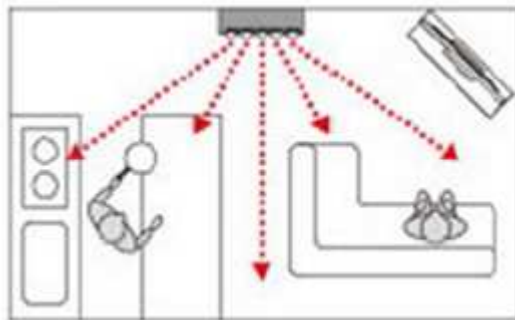
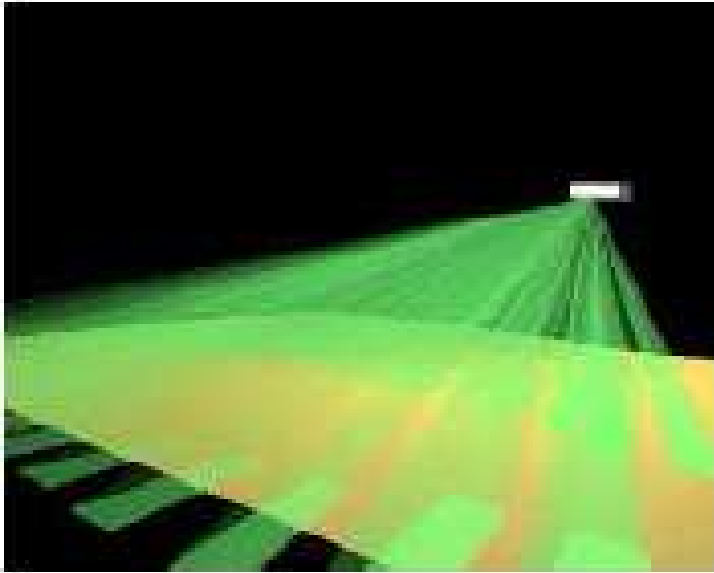


## IP Cameras

- For efficient storage of pictures
- Reducing hardware (cost) for saving pictures
- Sending e-mail to smartphones, when detection happens



## Air-Conditioning Systems



- Reducing energy consumption
- Automatic, appropriate cooling
- Cooling the relevant areas



- Size of lens vs. detection area
- Detection ability
- Immunity against noise
- Current consumption





## Advantages

Technical

● Quality

Cost

Roadmap

- Detection reliability
- Lower false alarm probability
- Outsourced responsibility for detection part
- Improved documentation





**Advantages**

Technical

Quality

● Cost

Roadmap

- Lower R&D costs
- Fast time to market → Fast return of investment
- Lower assembly cost
- Lower cost for documentation





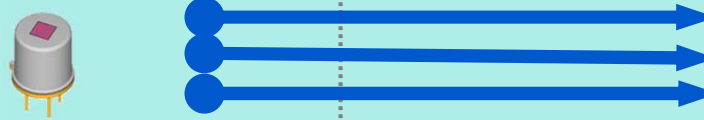
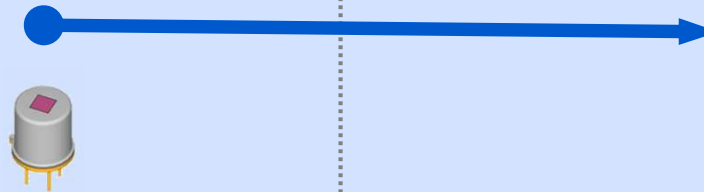
## Advantages

Technical

Quality

Cost

Roadmap

Series	Current Consumption	Comment	2015	2016
PCN Less Type	<b>2<math>\mu</math>A</b> <b>6<math>\mu</math>A</b> <b>30<math>\mu</math>A</b>	<p>Popcorn noise cancellation circuit is reducing false alarms to a minimum.</p> <p>Popcorn noise is a type of electronic noise that occurs in semiconductors. This occurs randomly and can trigger the PIR without detecting anything.</p>		
Digital Serial Type	<b>30<math>\mu</math>A</b>	<p>The target is to replace the analog sensors.</p> <p>The digital serial type is sending a bit pattern via the output. The analog signal can be regained with the bit pattern signal.</p>		

※Please be aware that dates will change due to product development status



# Thank You!