DIGITAL WE DAYS 2023

SENSING WITH LIGHT - FROM LEDS TO OPTICAL SENSORS

WÜRTH ELEKTRONIK MORE THAN YOU EXPECT

TODAY'S SPEAKERS

PRESENTATION
Dominik Köck
Product Manager

MODERATION
Markus Eberle
Marketing Department

INFORMATION ABOUT THE WEBINAR

You are muted during the webinar.
However, you can ask us questions using the chat function.

Duration of the presentation	30 Min
Q&A:	10 – 15 Min

Any questions?
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On our channel	Würth Elektronik Group
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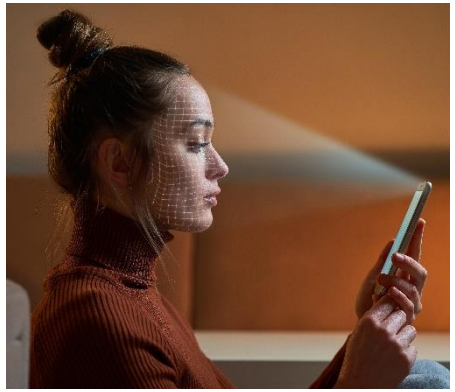
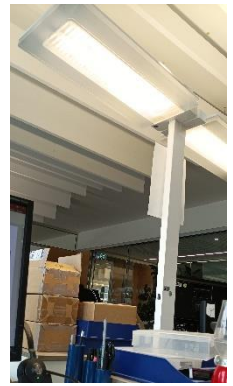
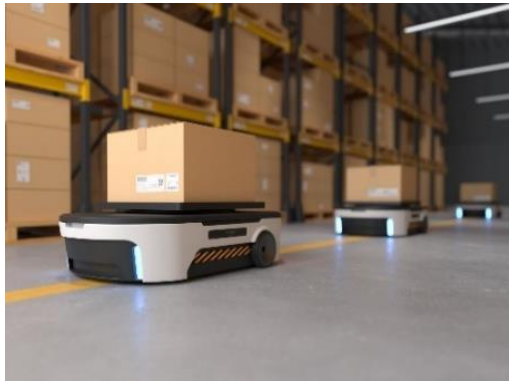
OPTICAL SENSORS AND WHERE TO FIND THEM

Optical Sensors in Daily Life

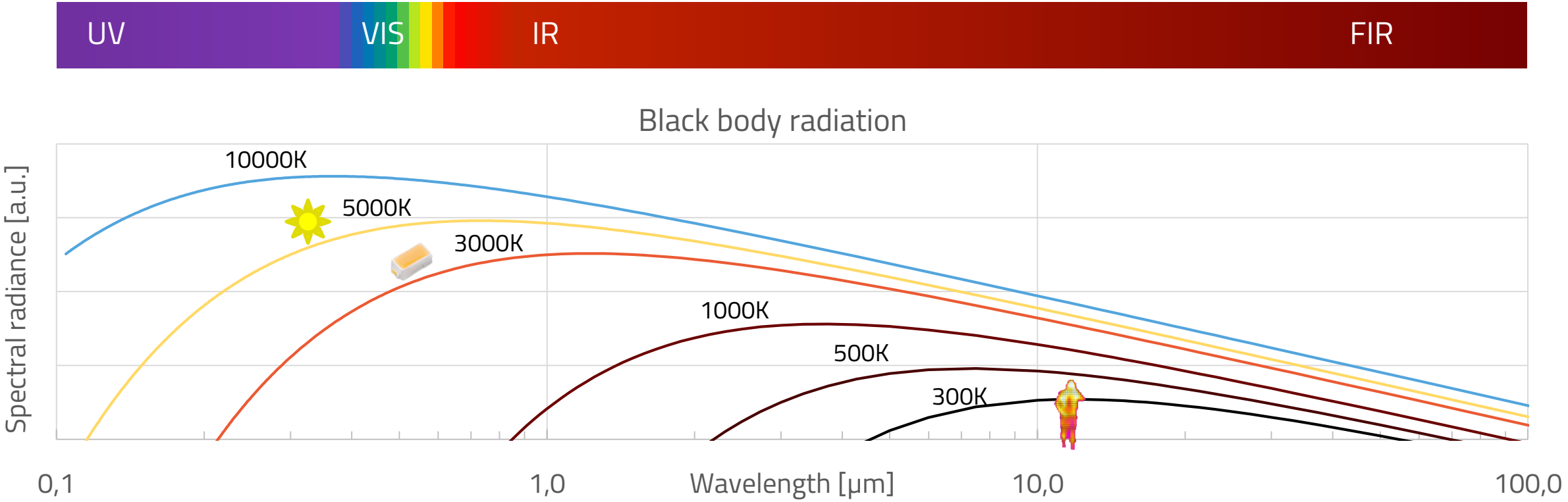







WHAT IS LIGHT?



WHAT IS LIGHT?

Application Areas

UV
100-400nm
- High energy
- Curing, disinfection
- Can damage skin and eyes

Visible light
400-780nm
- Signaling, Illumination
- Visible with eyes

Infrared
780nm – 1mm
- Low energy
- Transmit data or sense objects
- Invisible to human eye

→ **Very useful for sensing applications!**

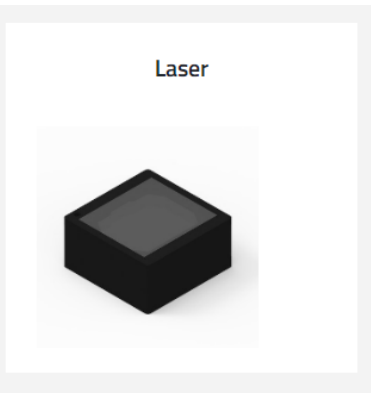
OPTOELECTRONIC PORTFOLIO

Würth Elektronik Portfolio

UV
275-405nm

Visible light
400-730nm

Infrared/LASER
850nm – 940nm

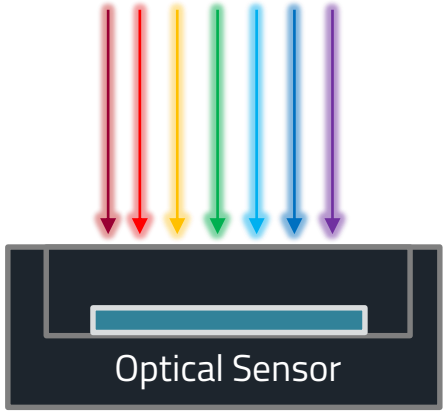


IN DEVELOPMENT: **Optical Sensors**

PRINCIPLES OF OPTICAL SENSORS

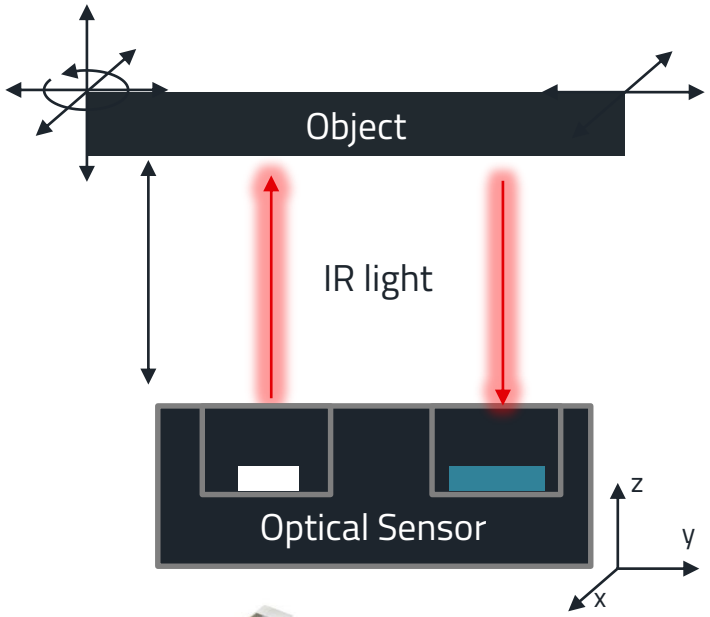
Light or Object Detection

Light detection

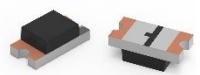


Würth Elektronik
Photodiodes and
Phototransistors

Object detection with light



Würth Elektronik
Infrared LEDs



Würth Elektronik
Photodiodes and
Phototransistors

In Development:
2 in 1 packages

UNDERSTANDING DATASHEET PARAMETERS FOR OPTICAL SENSING

Emission and Detection

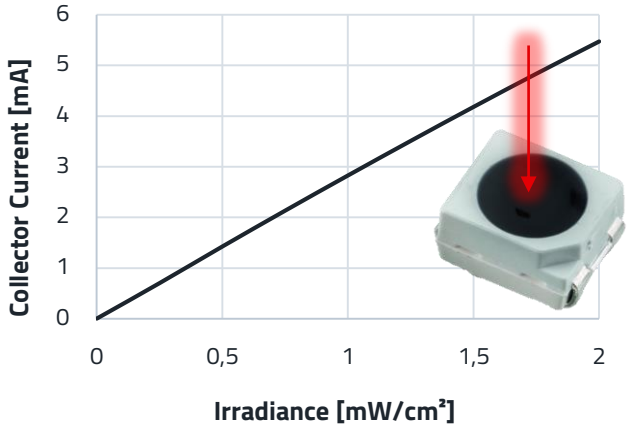
Detection:

WL-STTB Phototransistor:

1541411NEA210

Electrical & Optical Properties:

Properties		Test conditions	Value			Unit
			min.	typ.	max.	
Wavelength of Peak Sensitivity	λ_{Peak}			940		nm
Range of Spectral Bandwidth	λ		700		1100	nm
Collector Current	$I_{CE.P}$	V_{CE} = 5 V Ee = 1 mW/cm² λ = 940 nm	0.6	2.8		mA
Collector-Emitter Dark Current	$I_{CEO.Dark}$	V_{CE} = 20 V Ee = 0 mW/cm²			100	nA
Viewing Angle Phi 0°	$2\theta_{50\%}$			120		°



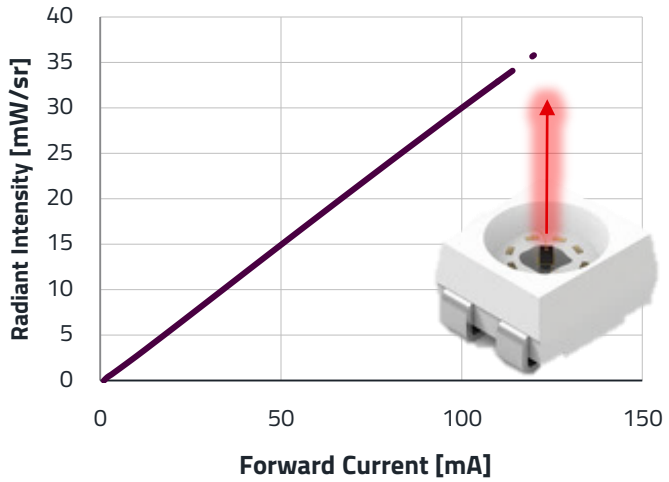
Detection:

WL-SITW Infrared LED:

15414194AA211

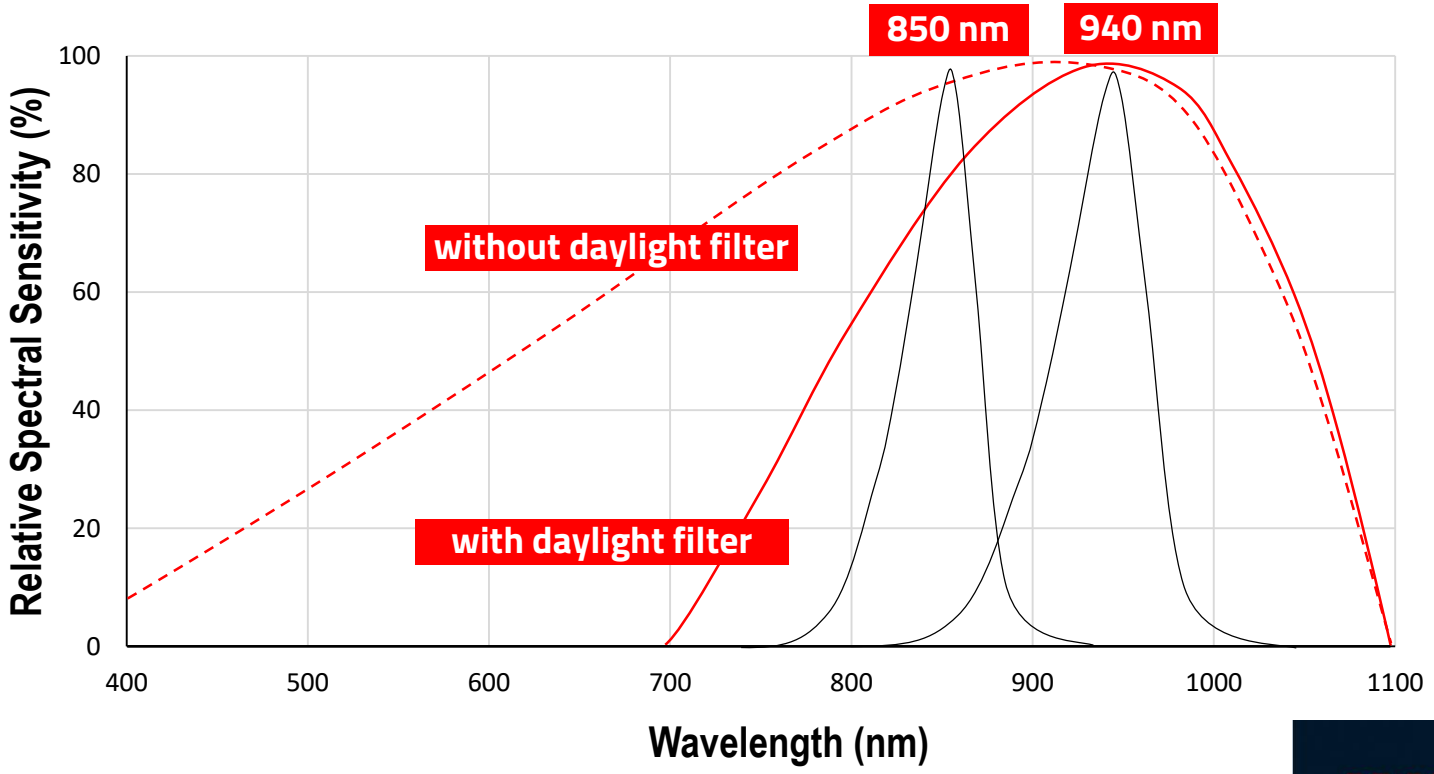
Electrical & Optical Properties:

Properties		Test conditions	Value			Unit
			min.	typ.	max.	
Peak Wavelength	λ_{Peak}	100 mA		940		nm
Centroid Wavelength	$\lambda_{Centroid}$	100 mA		940		nm
Radiant Intensity	I_e	100 mA	10	30		mW/sr
Forward Voltage	V_F	100 mA		1.4	2	V
Spectral Bandwidth	$\Delta\lambda$	100 mA		50		nm
Viewing Angle Phi 0°	$2\theta_{50\%}$	100 mA		120		°

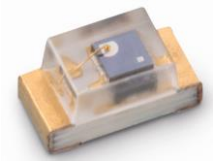


UNDERSTANDING DATASHEET PARAMETERS FOR OPTICAL SENSING

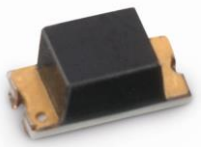
Spectrum



- **Without daylight filter**
  Waterclear lens
  400-1100 nm
  Also detection of visible LED



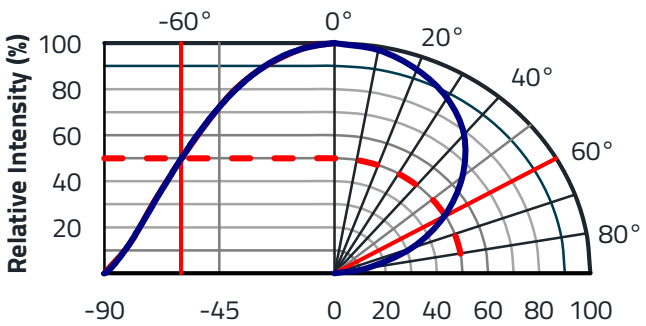
- **With daylight filter**
  Black lens
  700-1100 nm
  Perfect for IR LED

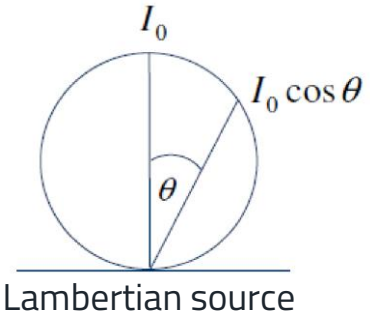


UNDERSTANDING DATASHEET PARAMETERS FOR OPTICAL SENSING

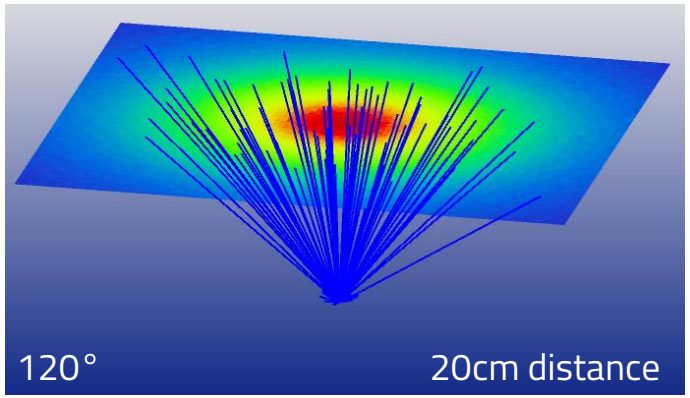
Viewing angle

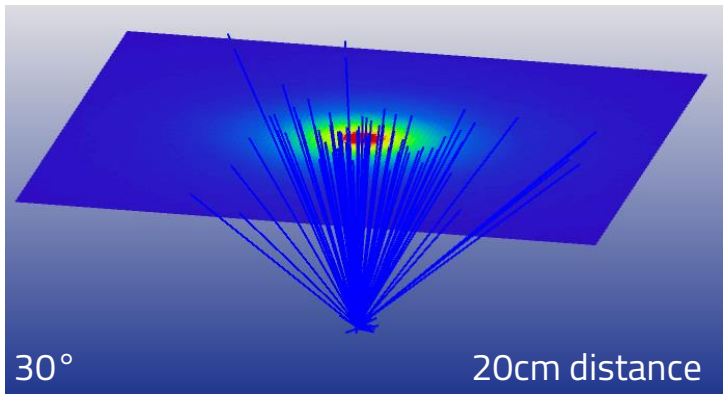
- Definition of viewing angle:
  - Full width angle of half maximum intensity
- Viewing angle determines emission characteristic:
  - Small viewing angle – focused emission
  - Large viewing angle – large area irradiation

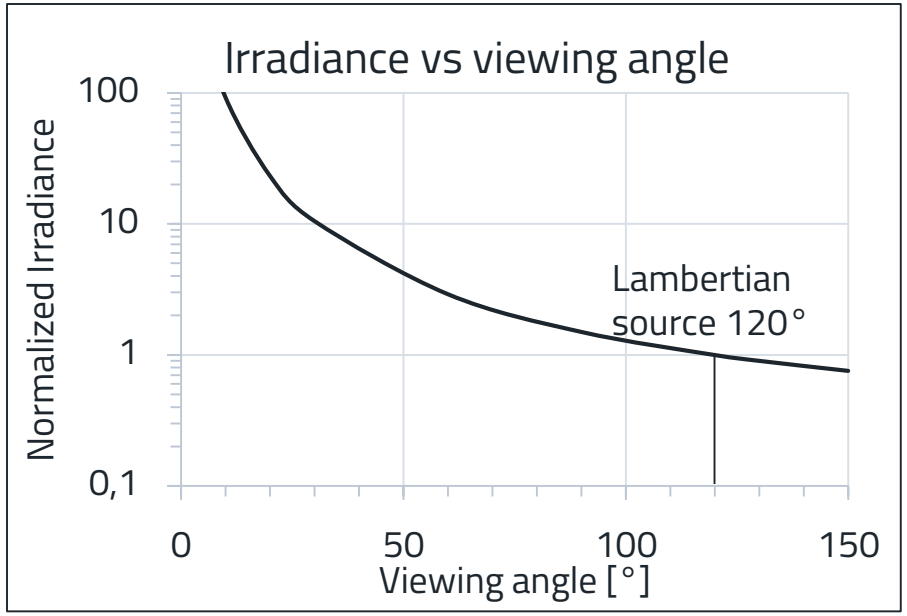




- Lambertian source for ideal emitting surfaces – 120° viewing angle
- Smaller viewing angle can be achieved with optics

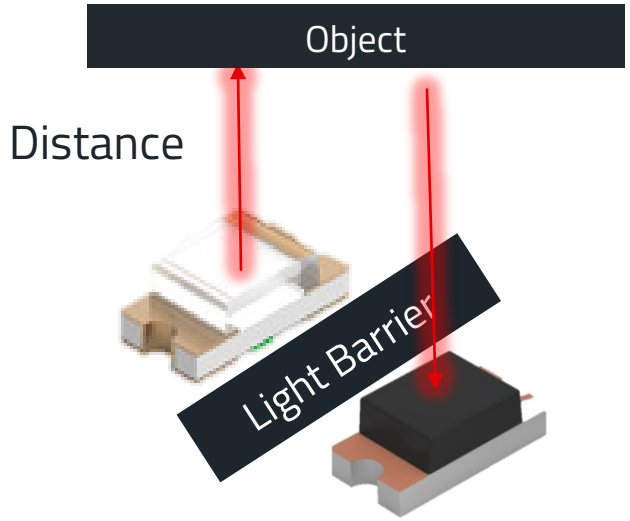






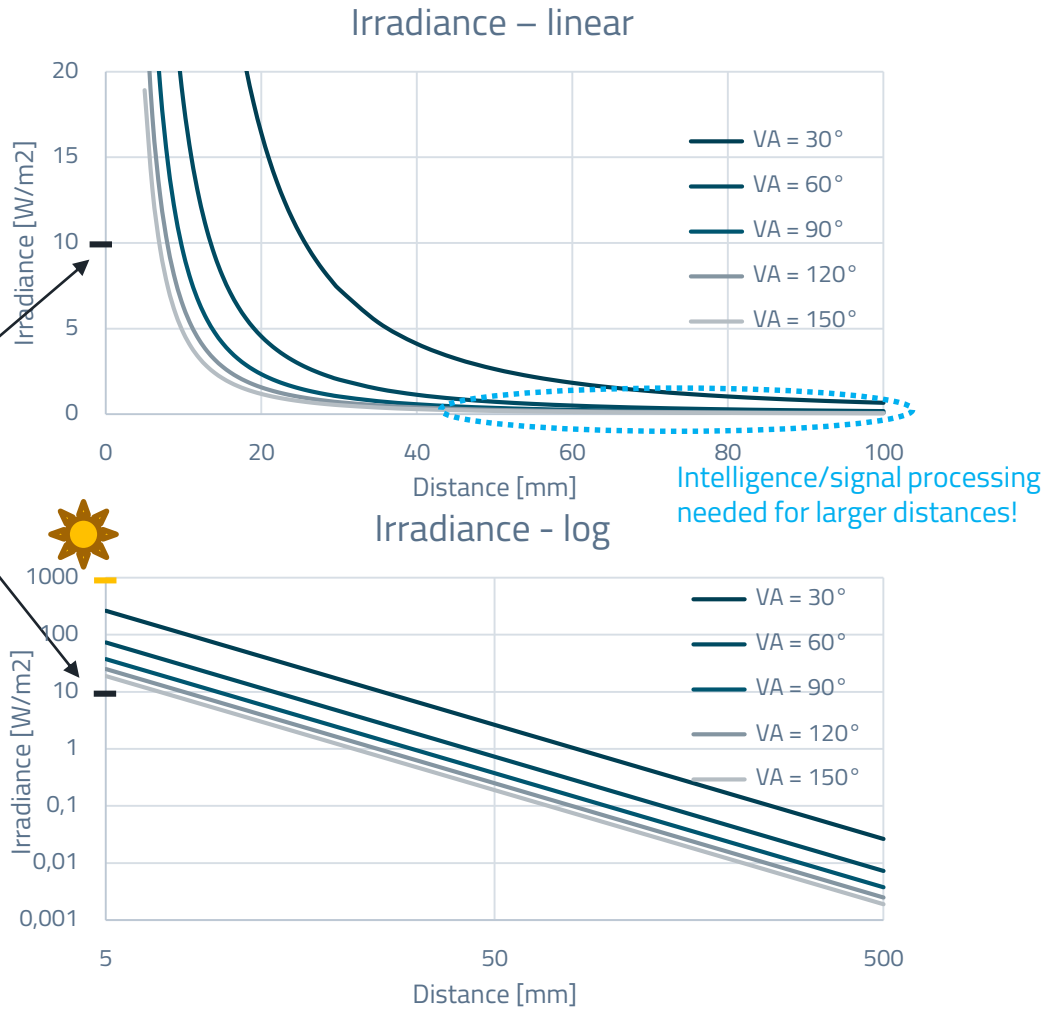
PRINCIPLE OF A REFLECTIVE SENSOR

Understanding the Distance Behaviour



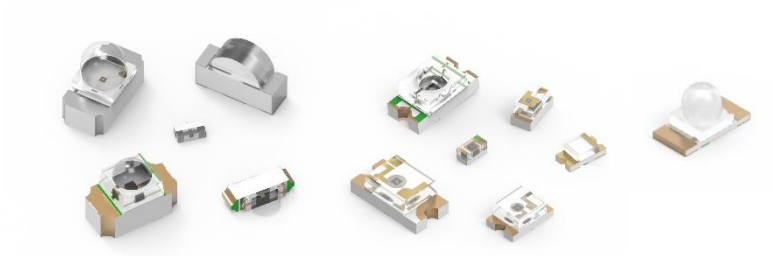
Typical measurement condition for detectors:

$V_R = 5\ V$
$Ee = 1\ mW/cm^2$
$\lambda = 940\ nm$



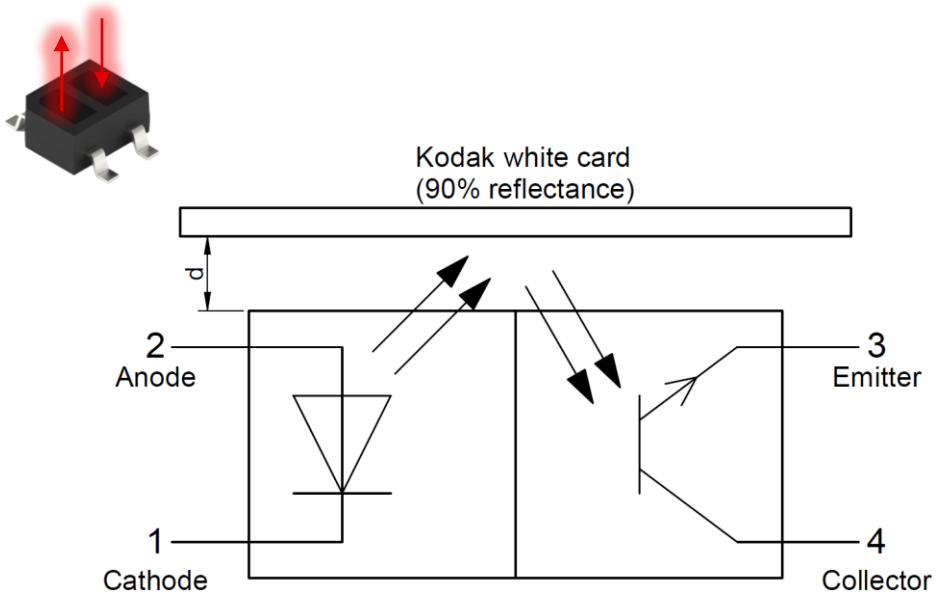
- Simulated for 4mW radiant flux

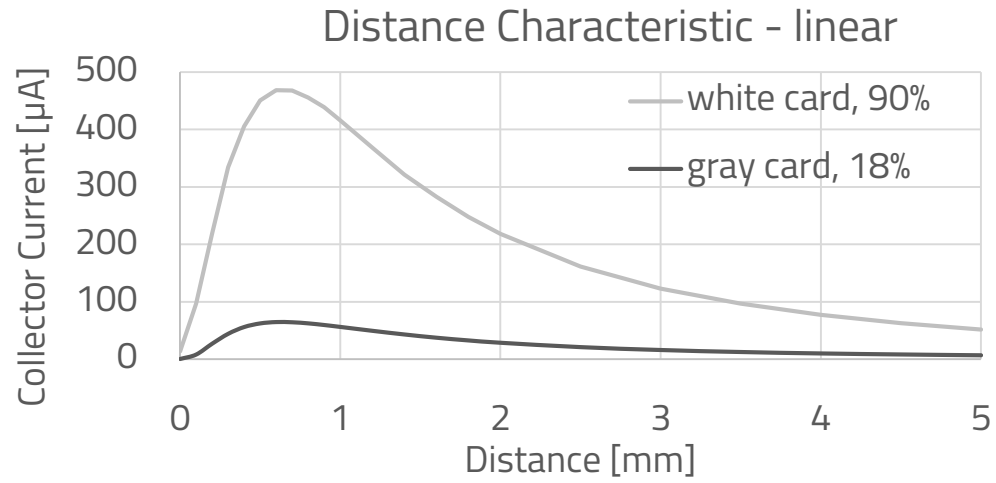
(Most of 940nm Chip LEDs from WL-SICW, WL-SISW, WL-SIRW)

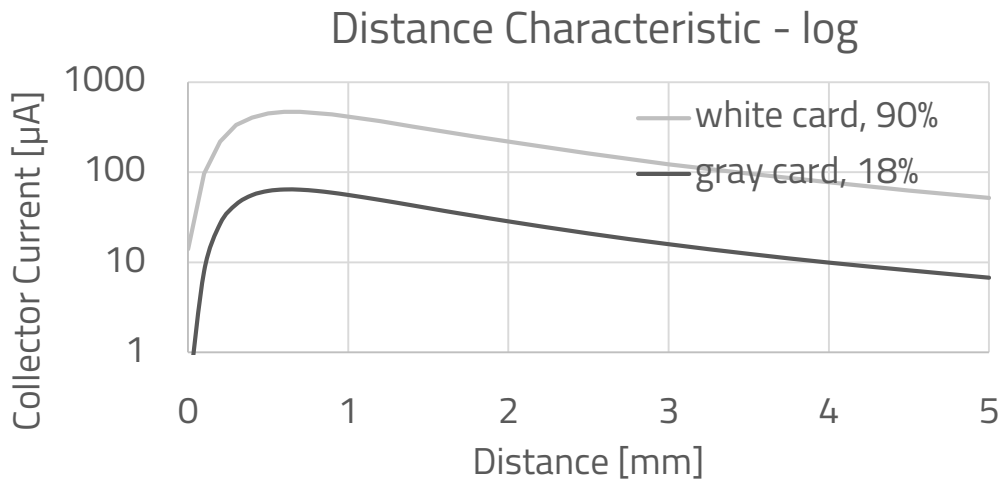


PRINCIPLE OF A REFLECTIVE SENSOR

Optical Sensor – Reflective, 2 in 1 package

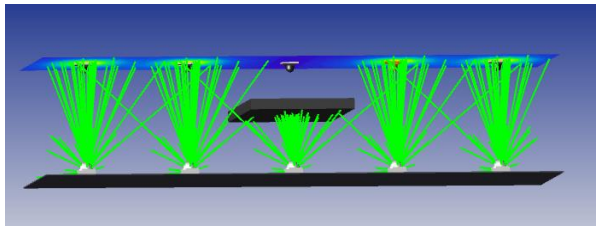


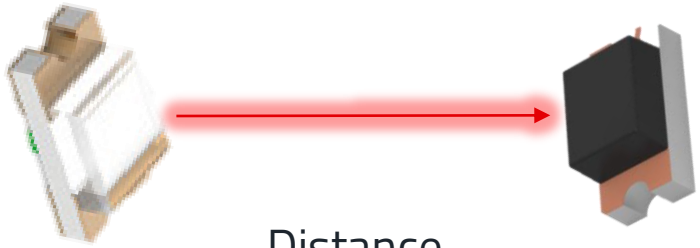




PRINCIPLE OF A TRANSMISSIVE SENSOR

Understanding the Distance Behaviour



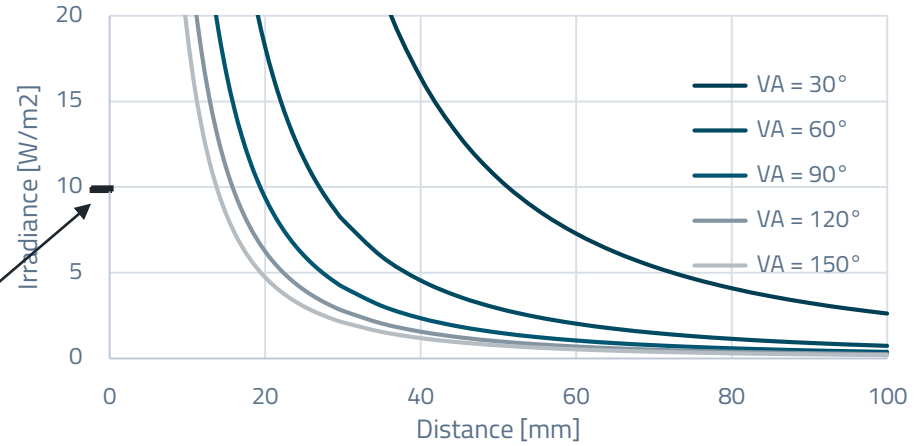


Distance

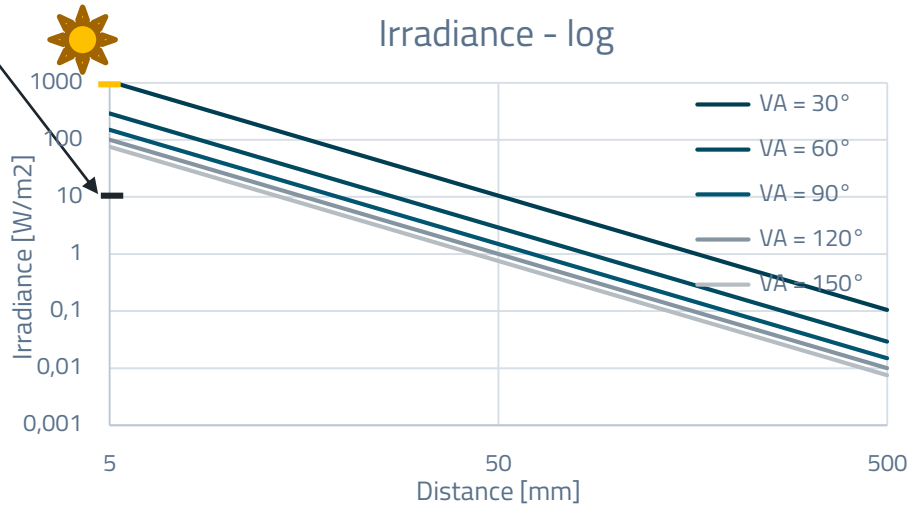
Typical measurement condition in datasheet:

$V_R = 5\ V$
$Ee = 1\ mW/cm^2$
$\lambda = 940\ nm$

Irradiance - linear



Irradiance - log



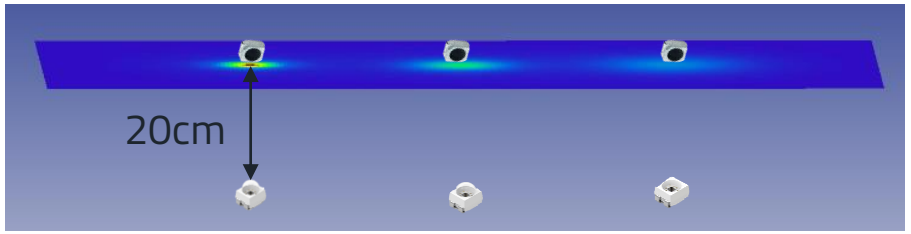
- Simulated for 4mW radiant flux

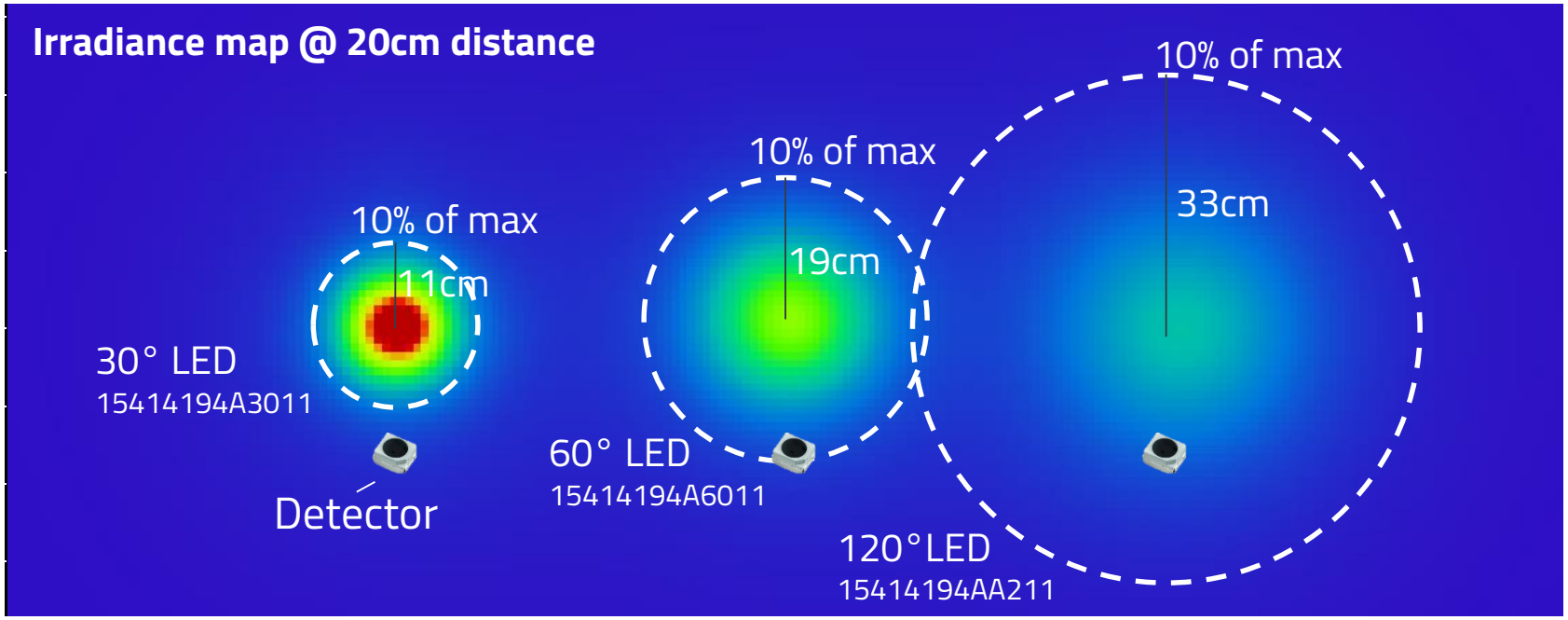
(Most of 940nm Chip LEDs from WL-SICW, WL-SISW, WL-SIRW)

PRINCIPLE OF A TRANSMISSIVE SENSOR

Tolerance to Missplacement

What happens when the detector is not placed centered?



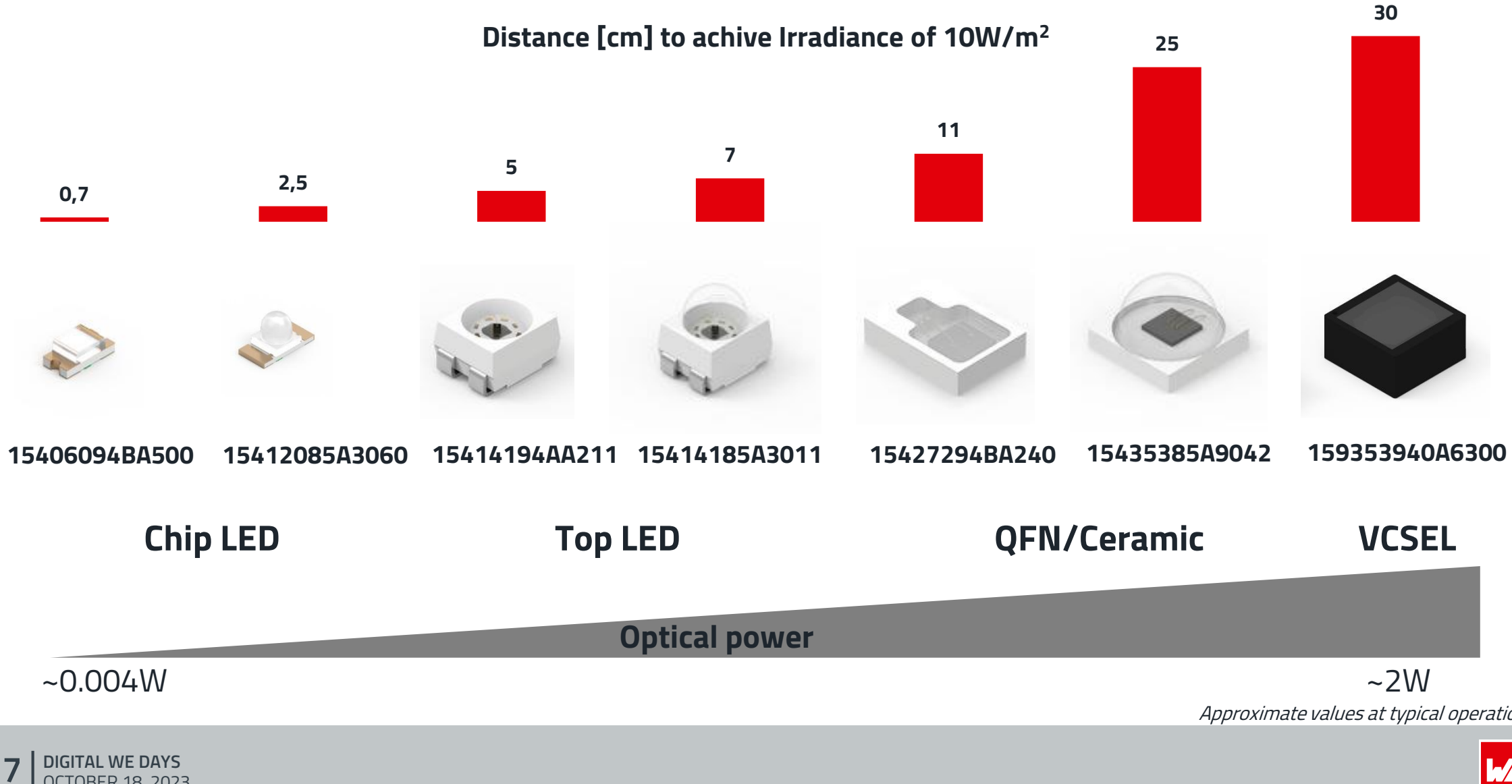


COMPARISON OF INFRARED TYPES

Different LEDs – Different Applications

	Chip LED/PLCC 	**QFN EMC/ Ceramic** 	**VCSEL** 	**Optical sensor** 
Max. radiant intensity/ flux	<150mW/sr	Up to 800mW/sr or 1.4W	2.1W	<200mW/sr
Viewing angle	30-120°	90-150°	45-110°	10-120°
Application	Signal and Detection	Illumination	Illumination, ToF	Object detection
Advantage	Cheap, flexible, small form factor	High intensity	Homogenous illumination, fast switching	Low form factor, low power, 2 in one package
Typical size	0402, 0603, 0805, 1206, 0606, 1210, 3528	2720, 2835, 3030, 3737, 5630	3535	2016, 2734, 4424

COMPARISON OF INFRARED EMITTERS

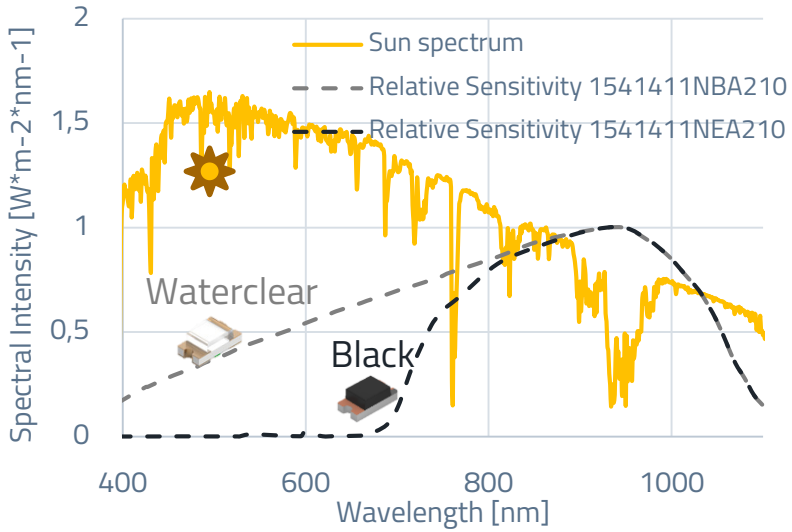


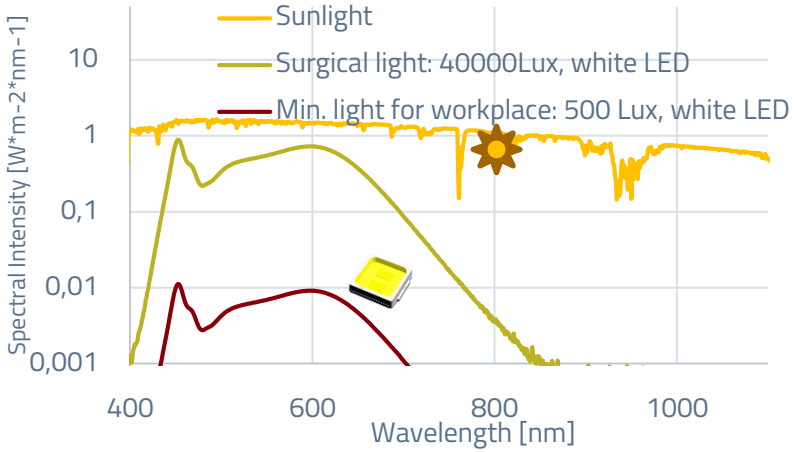
Approximate values at typical operation conditions

EFFECT OF AMBIENT LIGHT TO DETECTION

Light Detection Optical Sensors

- Typical test conditions of WE phototransistors/ photodiodes:
  - **10W/m²**
- What a detector sees under direct sunlight:
  - Waterclear lens: **~470W/m²**
  - Black lens: **~247W/m²**
- **Direct sunlight can change the behaviour of an optical sensor!**
- **Sunlight IR emission can be orders of magnitudes larger than artificial lighting!**





SUMMARY

Sensing with light - From LEDs to Optical Sensors

- **Würth Elektronik Optoelectronic Portfolio already includes products that can be used for optical sensing:**
  - Phototransistors
  - Photodiodes
  - Infrared LEDs

- **Understand optical datasheet parameters and their relation to detection**

- **Different detection principles where shown:**
  - Reflective
  - Transmissive

- **Distance characteristic simulations are shown:**
  - Useful for choosing which component to be used in application
  - What is useful distance of detection?

Questions

& Answers

We are here for you now!
Ask us directly via our chat or via E-Mail.

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