Infrared revealed – from data transfer to biometrics – Basics of IR lightning

Today's speakers:

Zhelio Andreev
Product manager Optoelectronics
zhelio.andreev@we-online.com
www.we-online.com

Eleni Stark
Marketing
eleni.stark@we-online.com
www.we-online.com

Overview

- **IR LED**
  - Electro-optical properties
  - Pulse capabilities & temperature
  - Switching time
- **Photodetectors**
  - Diode or Transistor
  - Main parameters and differences
- **The perfect pair**
  - How to match the emitter and detetor
- **Application examples**
  - Biometric measurements
  - Data transfer & signals
  - Detection & security

General Introduction

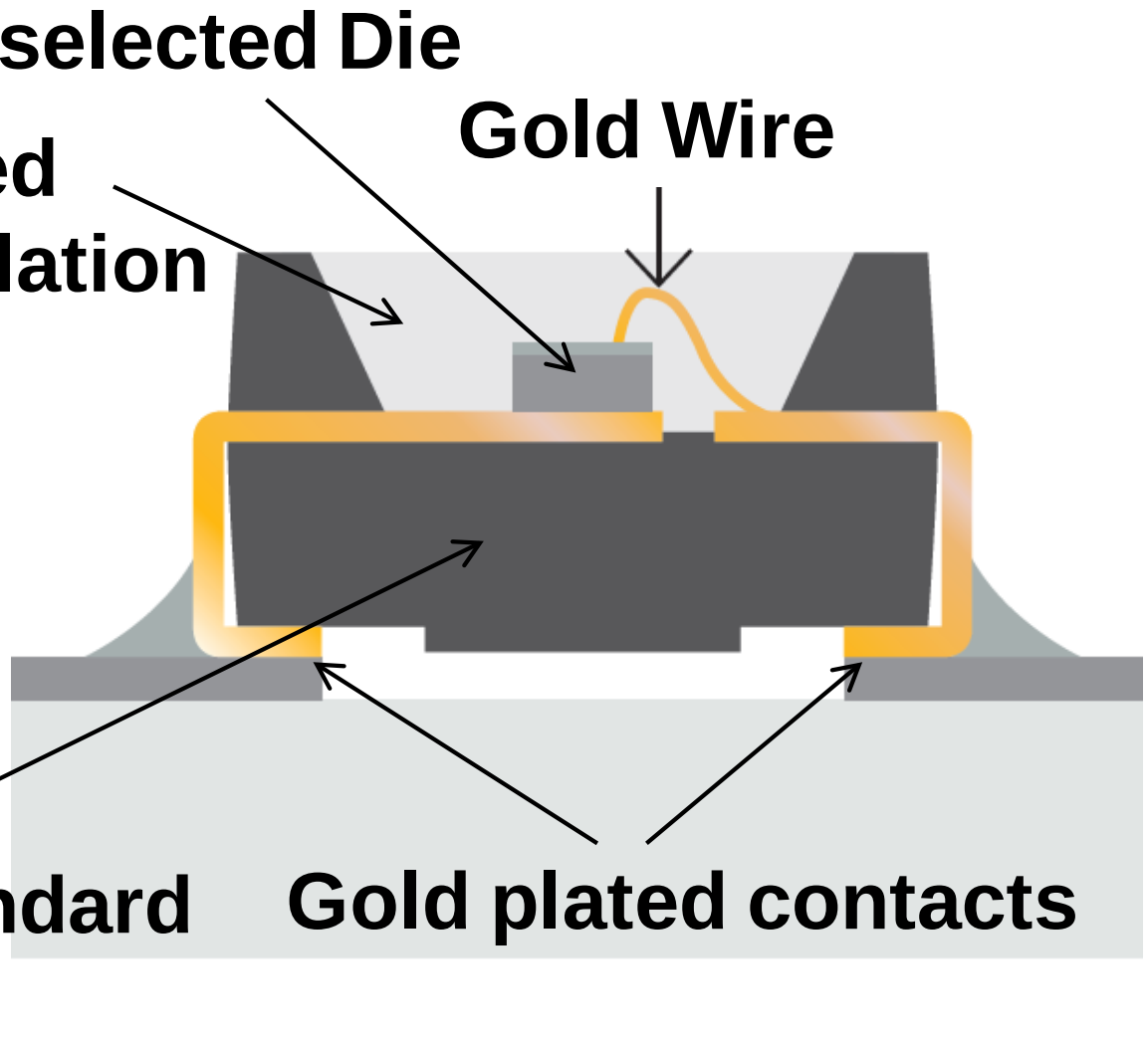
- **How to make the best IR component**

- **Main ingredients of the LED / Detector**
  - IR Emitter chip
  - Si based detector

  - Correct housing – all industry standard packages available

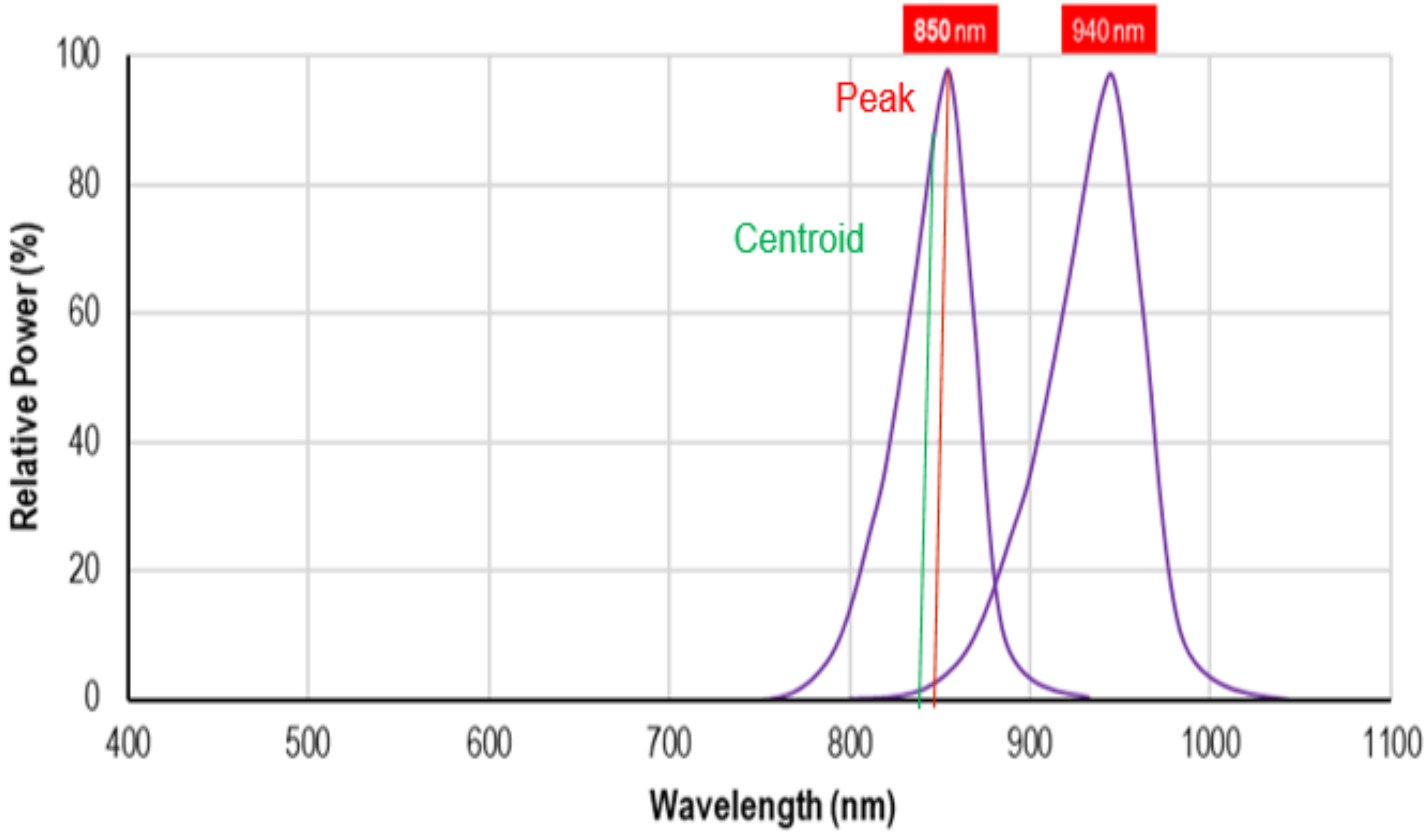
  - Good connection
    - Gold plated contacts

  - The right encapsulation



IR LEDs

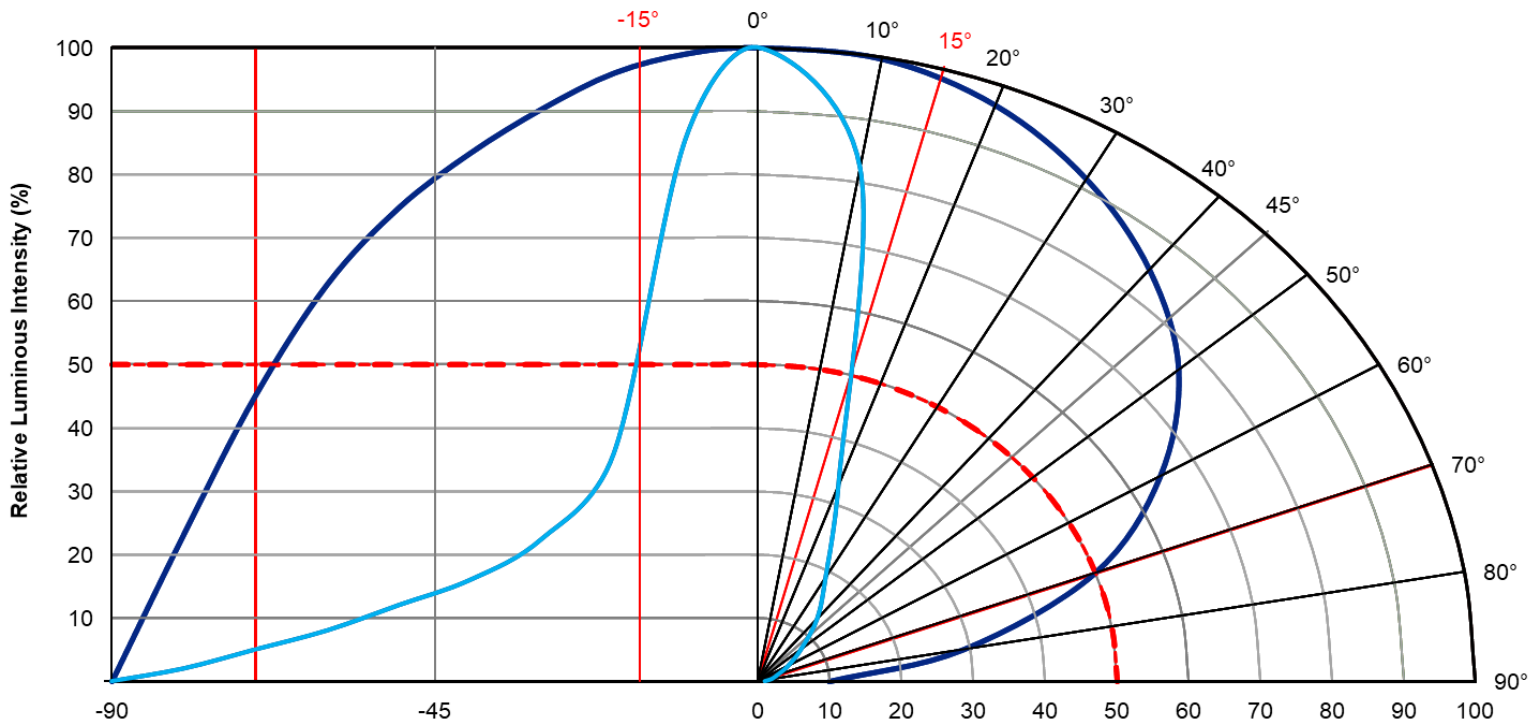
- **Preselected Die**
  - Pretested chips
- **Wavelength**
  - Standard wavelength range – 850nm and 940nm
  - Centroid or Peak wavelength
- **Emission power**
  - Radiant intensity – mW/sr
  - Depend on the viewing angle
  - From 1mW/sr up to 100mW/sr
  - High power LEDs > 300mW/sr



IR LEDs

- **The right encapsulation**
  - Chip protection
  - Non absorbing for the emission wavelength
  - Shape the outgoing light

- **Viewing angle**
  - Available range – 20° to 150° degrees
  - Short range, wide angle application
  - Long range applications



Switching of LEDs

- **Signal**
  - short rise and fall time → high switching frequency
  - e.g. : $t_r = t_f = 10ns$ → $f = \frac{1}{t_r} = 100MHz$

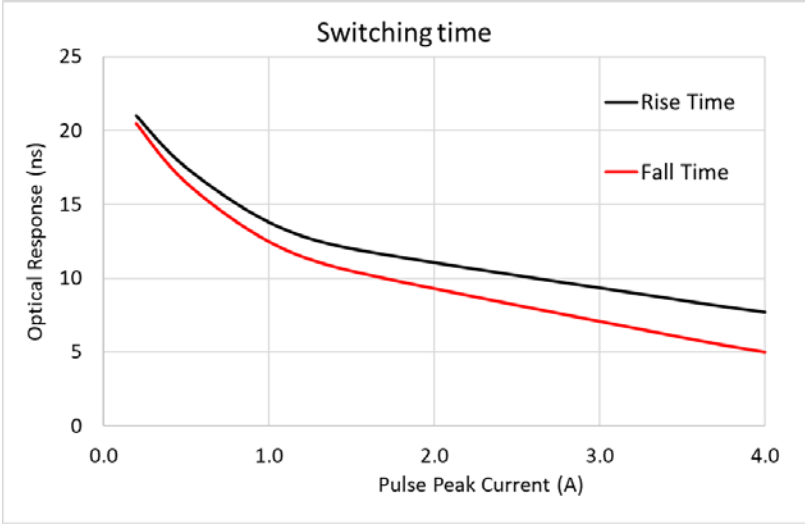
- **What is behind the switching time**
  - Parasitic and junction capacitance
  - Parasitic resistance

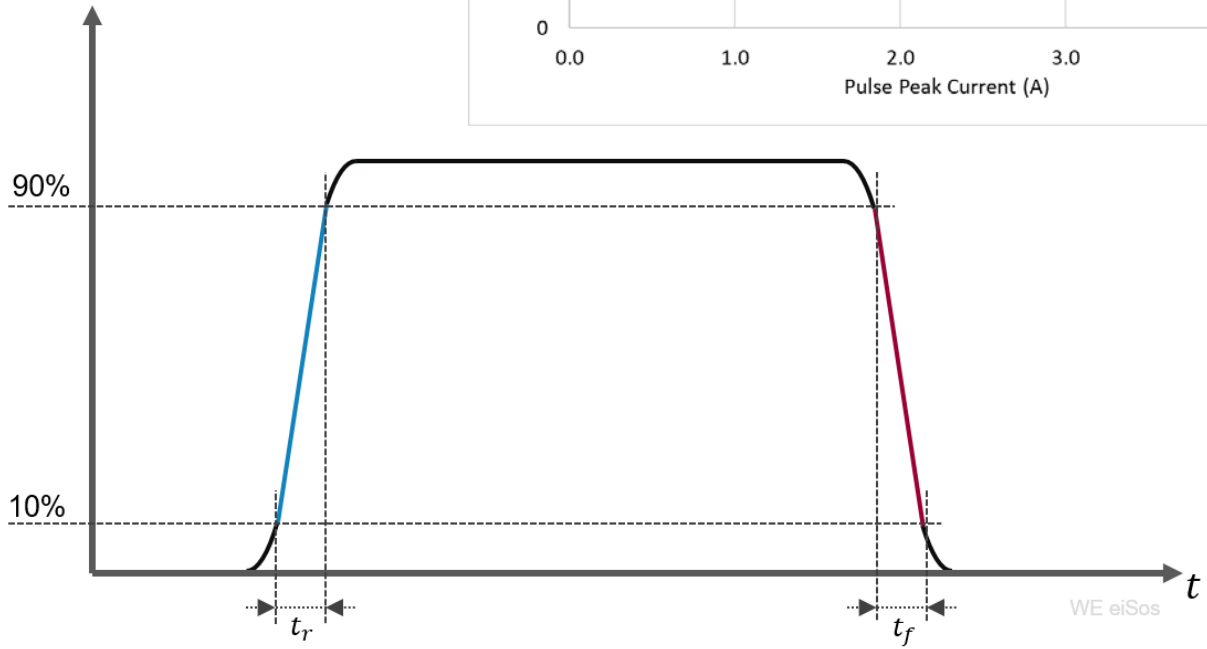
  - The higher the driving current – the faster the switching time

rise time $[t_r]$ / fall time $[t_f]$:

time between 10% and 90% of the optical signal strength at the switch-on moment

Can differ from 20/80% measurement up to x2

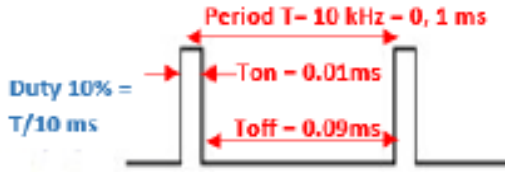


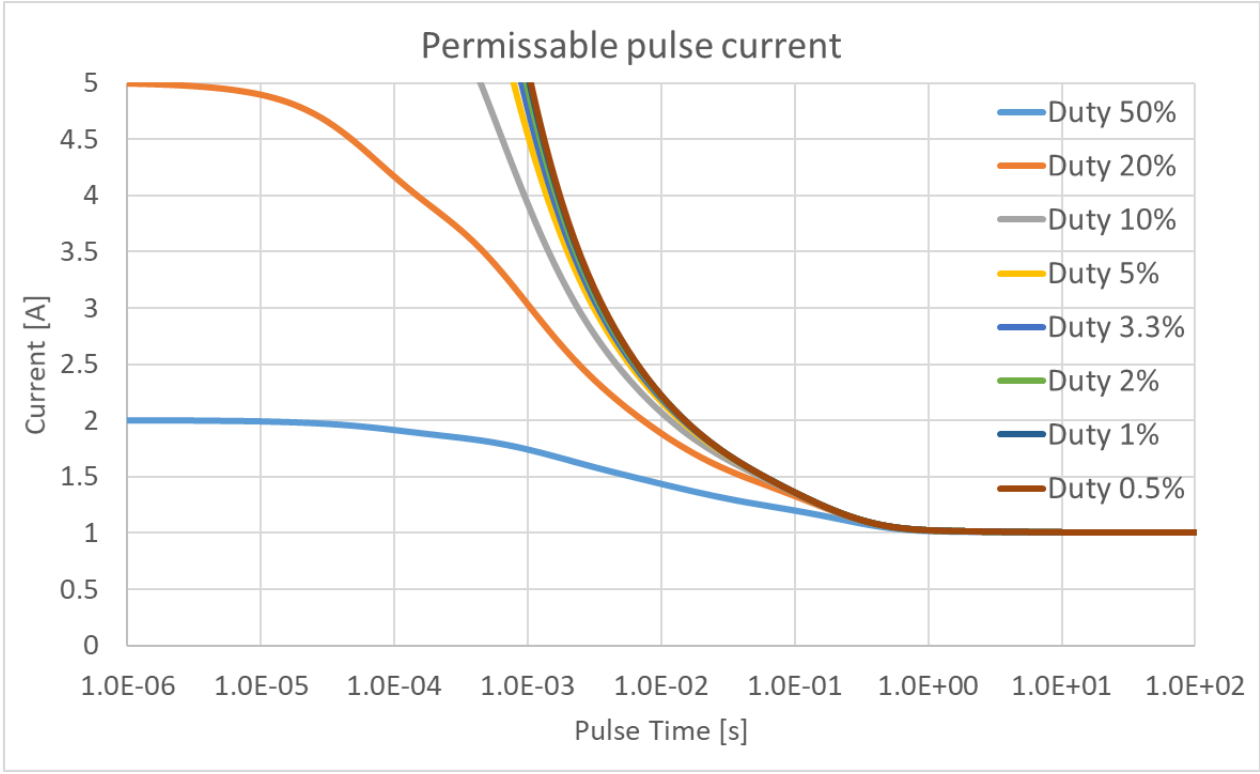


Pulse capabilities

- **Higher power for shorter time**
  - Higher range, better signal

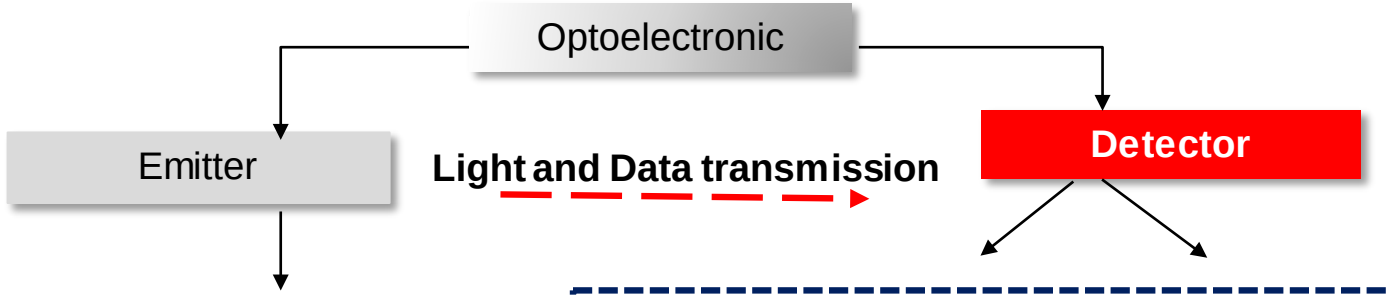
- **What happens at higher currents**
  - Standard chip 8x8mil (0.05mm2) @ 0.7A
  - Heat generation during ON time / relaxation in OFF time
  - Maximum allowed pulse current
    - Depend on the Duty cycle
    - Depend on the Chip size
    - Depend on the Packaging





Photodetektoren

- **What are photodetectors?**
- **Completely new product range - silicon semiconductor photodiodes & phototransistors**



Expansion of the product portfolio in the field of optoelectronics

Infrared LED

Light source / diode that emits light when current is applied to the contacts.

Available with standard peak wavelengths of 850 nm and 940 nm.

Photodiode

Photoelectric detector in which a photocurrent is generated by light.
Current output in µA

☺ Linear output signal
☺ Fast switching times

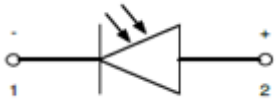
Phototransistor

A transistor that generates and amplifies an electric current through light.
An amplified photodiode
Current output in mA.

☺ Higher output current
☺ Higher Gain

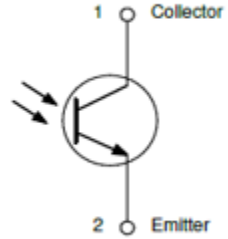
Diode vs. Transistor

Photodiode



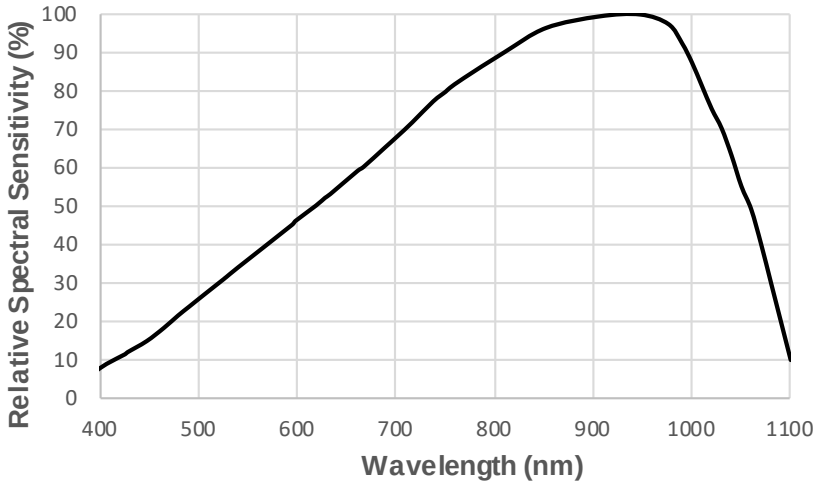
- **Contacts: Anode and cathode**
- **Spectral bandwidth:**
  Wavelength range in which the photodiode receives light
- **Photocurrent in µA**
  Generated when light falls on the photodiode
- **Dark Current**
  Current flowing without light/irradiation
- **Switching times in ns**
- **Available with and without daylight blocking filter**

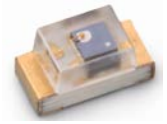
Phototransistor



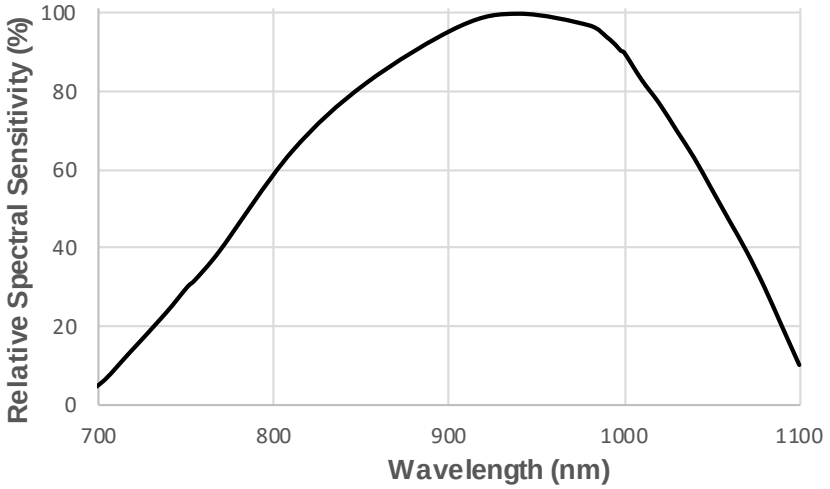
- **Contacts: Collector and emitter**
- **Spectral bandwidth:**
  Wavelength range in which the photodiode receives light
- **Kollektorstrom in mA**
  Generated when light falls on the phototransistor
- **Collector-Emitter Dark Current**
  Current flowing without light/irradiation
- **Switching times in µs**
- **Available with and without daylight blocking filter**

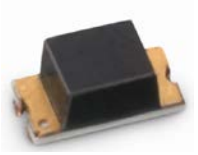
Daylight blocking filter





- **Without daylight blocking filter**
  - Transparent lens
  - Receives visible and infrared light (400-1100nm)

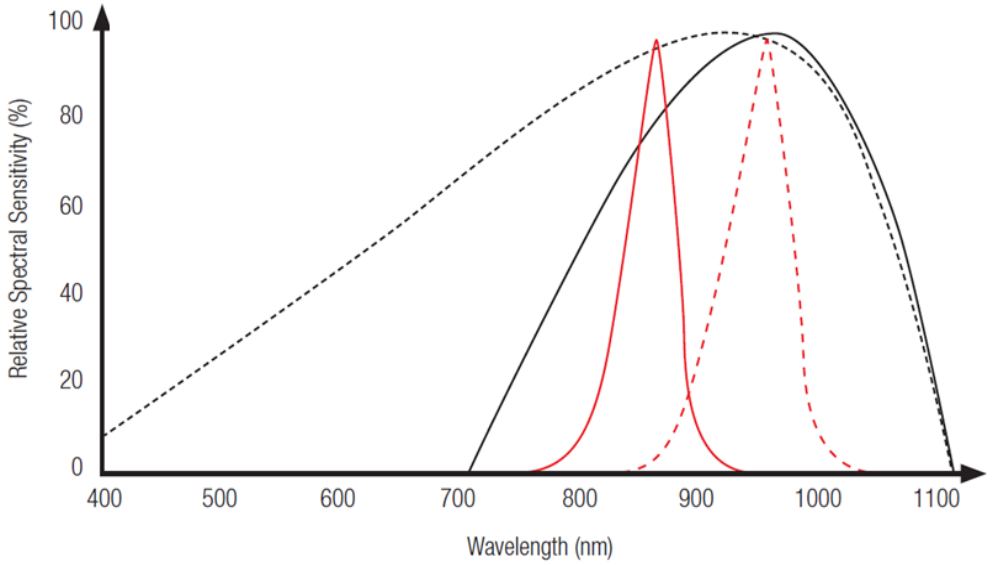




- **With daylight blocking filter**
  - Black lens
  - Blocks the visible light
  - Receives only light in the infrared range (700-1100nm)

Perfect match

- The maximum sensitivity of the photodetectors fits perfectly to the emitter spectrum.
  - 100% @ 940 nm with Filter
  - 95% @ 850 nm with Filter



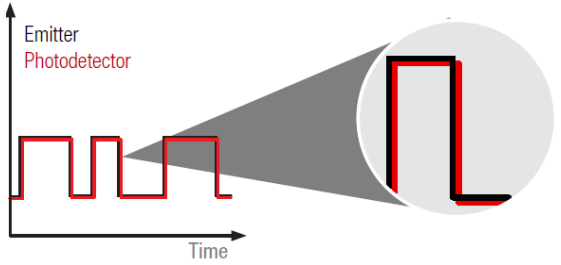
- Perfect data transmission between emitter and detector
- Emitters and detectors are available in all industry standard packages
- One footprint for emitter and detector
- Same package for emitter and detector

0402 (1005)
0603 (1608)
0805 (2012)
1104 (3010)

1206 (3216)
3528 mm
3535 mm
3/5 mm THT

- Switching times up to 100 MHz

The extremely fast switching time of a few nanoseconds ensures high data transmission rates



RoHS COMPLIANT

REACh COMPLIANT

HALOGEN FREE

The products for every application

Infrared LEDs

Series	Size	Wavelength (nm)	Radiant Intensity (mW/sr)	Viewing Angle
WL-SICW	0402,0603,1206	850/940	5-6 @ 20 mA	80°–150°
WL-SISW	0402,1106,1104,1002,1206		0.8-11 @ 20 mA	45°–150°
WL-SIRW	1206		5-20 @ 20 mA	30°
WL-SITW	3528		8-9 @ 50 mA	120°
WL-SIMW	3535		220-350 @ 1 A	90°/130°
WL-TIRW	3 mm, 5 mm		30-85 @ 50 mA	35°

Select the suitable photodetector

Teste die Infrarot Produkte mit unserem Design Kit

Infrared LED Design Kit – Order Code: 154150

Teste die Infrarot Produkte auf REDExpert

Photodiodes and Phototransistors

Series	Size	Wavelength (nm)	Photocurrent @ VR=5V, Ee=1mW/cm² (uA)	Viewing Angle
WL-SDCB	1206	940	1.8	140°
WL-SDSB	1104		2.5	150°
WL-TDRW	THT 5 mm		28	35°
WL-TDRB	THT 5 mm		31	35°

Series	Size	Wavelength (nm)	Photocurrent @ VR= 5V, Ee=1mW/cm² (mA)	Viewing Angle
WL-STCW	0603	940	1.6	150°
WL-STCB	1206		1.8	140°
WL-STSW	1104		2.5	150°
WL-STRB	1206 dome		1.8	30°
WL-STTW	3528		3.1	120°
WL-STTB	3528		2.8	120°

Applications

Security systems
- e.g. smoke detector, camera

Light barriers
- e.g. security areas, counter and encoder, optoelectronic sensors, data transmission

Automatic switches
- e.g. touchless water syphons, toilet systems, hygiene applications, water saving systems

Screens
- e.g. touch & touchless

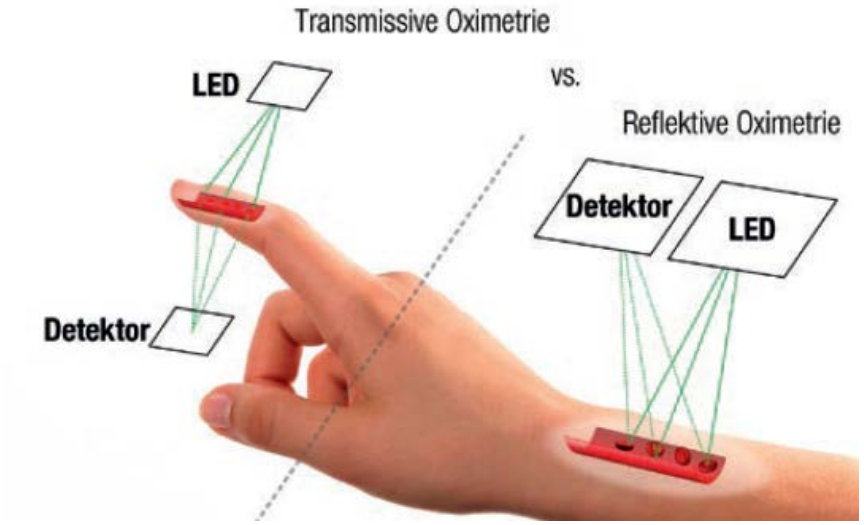
Biometric identification
- e.g. iris recognition, face recognition, vein recognition

Biometrics & health monitoring
- e.g. heart rate monitoring, pulse oximetry, blood pressure

Home appliances
- e.g. remote control, cleaning robot

Application: Biometrics/ Pulse Oximetry

- Non-invasive method for determining oxygen saturation using IR light
- Haemoglobin (red blood pigment) reflects infrared light
- The human pulse can be reproduced by changing the reflection of the heartbeat.



Function

Measurement

Pulse detection by reflection change

→ Voltage change at the transistor

Filtering unit consisting of RC low pass +DC block for measured signal

low-pass filter → all above 4Hz

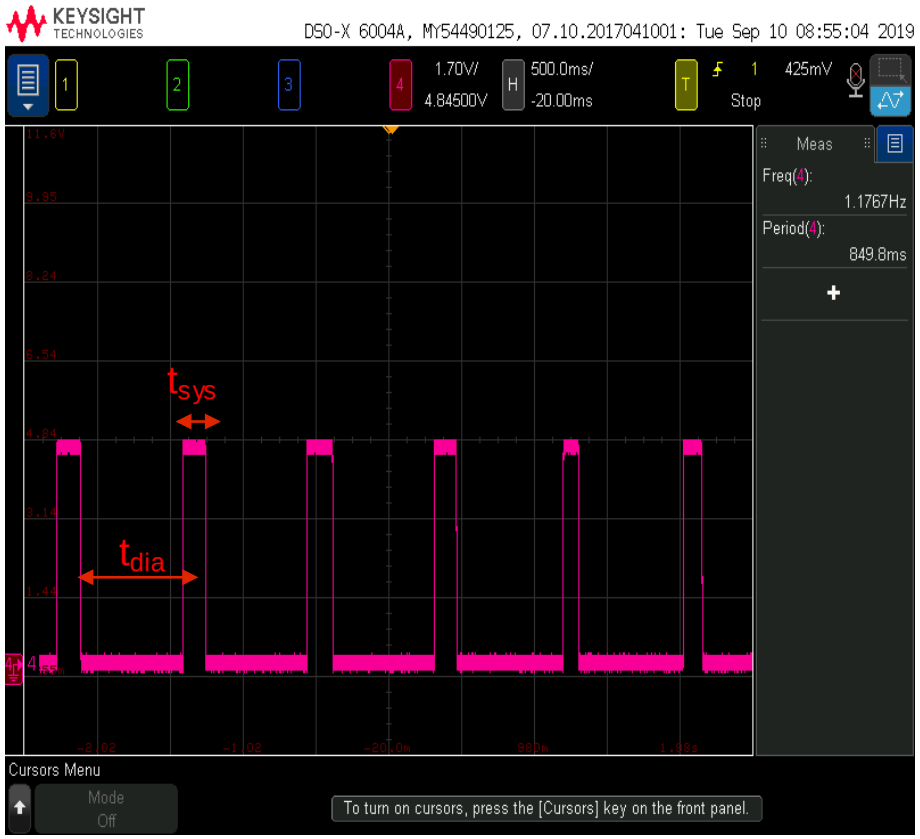
DC Block → Filter DC component of the signal

Amplifier for generating a digital signal

Processing by microprocessor

Counts the time between signals and calculates the pulse

Application: Biometrics/ Pulse Oximetry



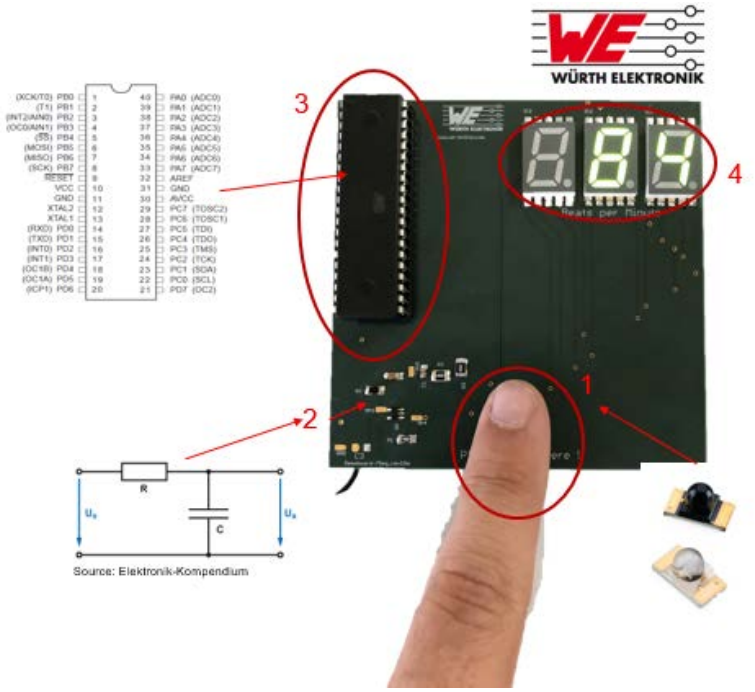
Systole: Blood outflow phase in the heart (t_{sys})

Diastole: Blood inflow phase in the heart (t_{dia})

Perfect interaction between th two components and due to short switching times
→ Real-time measurement

One systole and one diastole each result in one period. The reciprocal of this period results in the frequency.

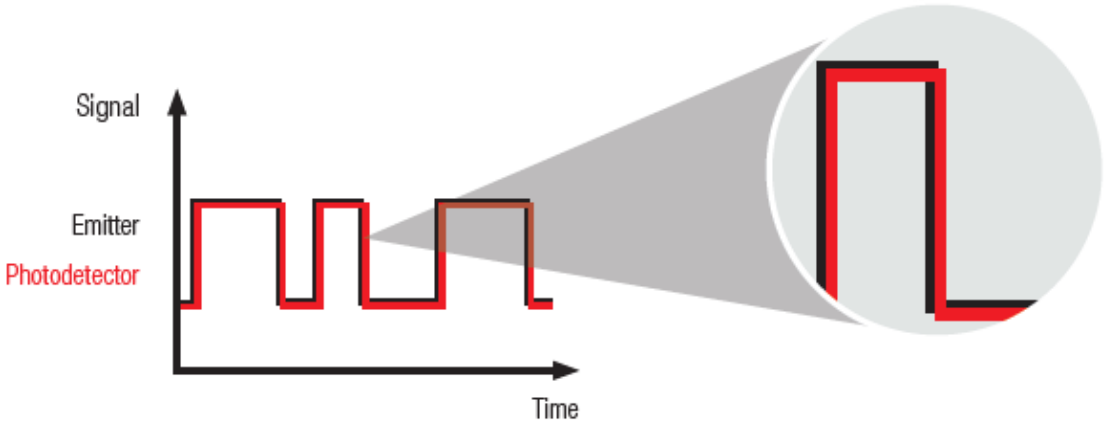
$$\frac{1}{t_{sys}+tdia}$$



1. signal is measured on the finger
2. filtering and amplification of the signal
3. signal processing by microprocessor
4. microprocessor outputs the pulse on the seven segment display

Application: Data transfer

- **Why – data transfer?**
  - Compared to RF – easier to use, no radiation restriction
  - Need direct field of view – a benefit or a drawback?
    - Most secure connection
  - Response time – with the speed of light
  - Remote control
  - Private household measurement
    - Electricity, water, heating



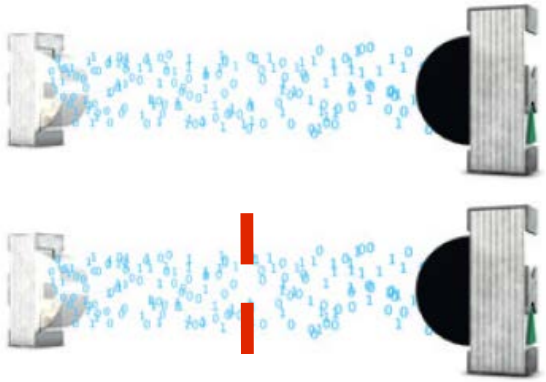
Switching Time up to 100 MHz

The extremely fast switching time of a few nanoseconds ensures high data transfer rates.

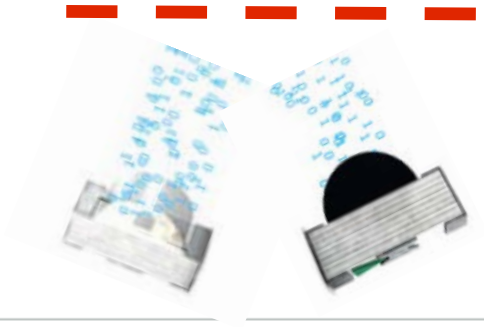
Application: Detectors

- **IR can be used for most detection application**
  - Short range or long range
  - As reflective or transmissive detection
- **House hold appliances**
  - Vacuum robots – ambient recognition
  - Smoke detectors
- **Industry application**
  - Light barriers – security zones
  - Hygiene and water saving in public wash rooms
  - Automated doors and barriers
  - Automated lights
  - License plate recognition in parking lots

Transmissive detection



Reflective detection



Summary

- **WE welcomes you to the world of Invisible Light**

- **IR Emitter and Detector – the perfect match**
  - With all standard footprints
  - Wide range of viewing angles and power outputs
  - As emitter and photodiode or phototransistor

- **A large field of applications**
  - From health monitoring and home robots, to industry robots
  - Detection and security in your house and at work
  - And many more INVISIBLE applications….

- **For any questions – please contact your local sales rep**

Questions & Answers

We are here for you now!
Ask us your questions in the chat and we will answer them live.

eiSos-webinar@we-online.com
eipal.pmhotline@we-online.de