Photodiode PR5020/21

3 compact Silicon Junctions on a single Die

PR5020 and PR5021 are triple silicon photodiodes with three separate cathodes and one common anode. Therefore, the three segments allow to resolve two transitions. With a wider and thinner photodiode in the center of the die, the PR5020 and the PR5021 are symmetrically designed. Both types offer a low dark current combined with a high sensitivity. The dies are moulded into a small plastic leadless optical DFN package.

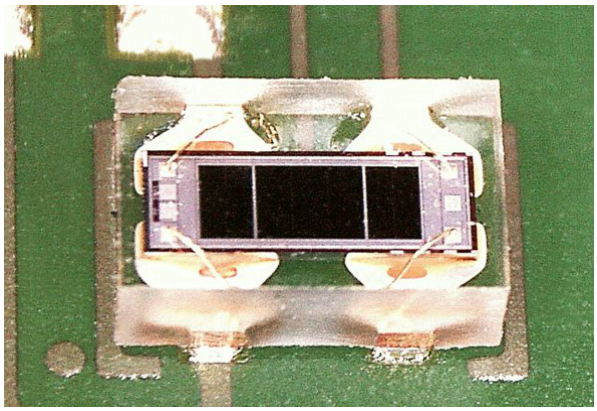
FEATURES

- 3 photodiodes for higher variability
- low dark current
- varied spectral sensitivities
- anti-reflective coating (ARC)

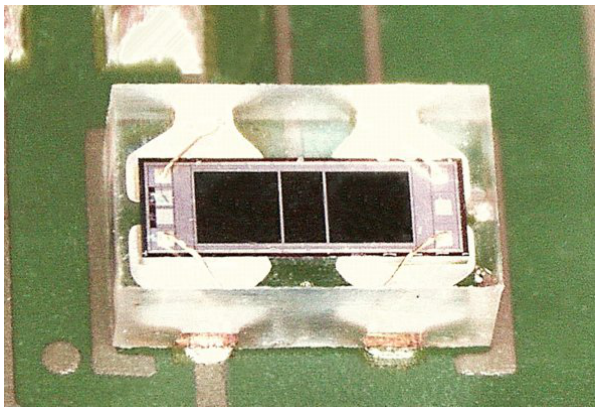
TYPICAL APPLICATIONS

- LASER beam alignment
- position detection
- ambient light detection

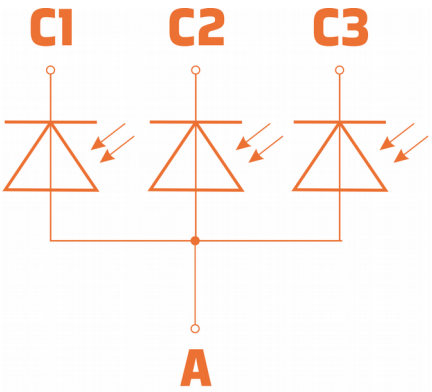
PR5020



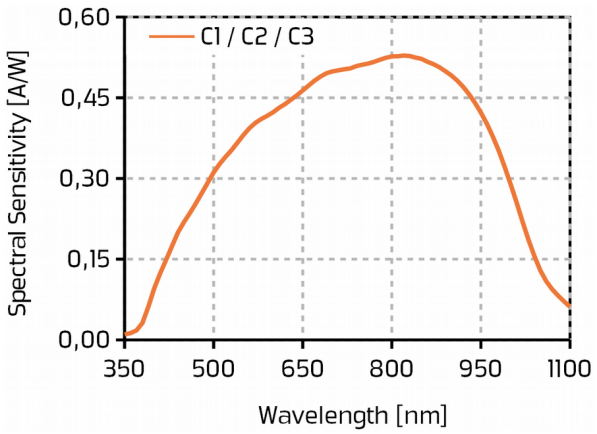
PR5021



CIRCUIT



SPECTRAL SENSITIVITY



Photodiode PR5020/21

Electrical and optical Characteristics

ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Min	Max	Units
V_{C-A}	V(C1, C2, C3) – V(A)	-0.3	35	V
T_A	operating ambient temperature	-40	85	°C
T_S	storage temperature	-40	85	°C
T_{peak}	soldering peak temperature		260	°C
P_{tot}	total power dissipation		100	mW

ELECTRICAL CHARACTERISTICS

Ta = 27°C

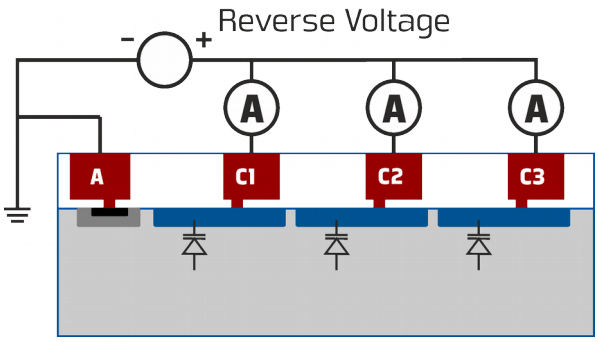
Symbol	Parameter	Conditions		Min	Typ	Max	Units
T_{amb}	operating temperature range			-40		85	°C
$V_{r\ (C-A)}$	reverse voltage V(C1, C2, C3) - V(A)					30	V
A_{PD}	active area (geometrical)	PR5020	C1/C3		0.246		mm²
			C2		0.496		mm²
		PR5021	C1/C3		0.394		mm²
			C2		0.195		mm²
I_d/A	dark current @ $V_{r\ (C-A)}$ = 1 V & T_{amb} = 60°C	PR5020	C1/C3		33		pA
			C2		52		pA
		PR5021	C1/C3		47		pA
			C2		28		pA
I_d/A	dark current @ $V_{r\ (C-A)}$ = 30 V & T_{amb} = 60°C	PR5020	C1/C3		78		pA
			C2		125		pA
		PR5021	C1/C3		110		pA
			C2		71		pA
$\Delta I_d/\Delta T$	temperature coefficient of Id @ T_{amb} > 60°C	$V_{r\ (C-A)}$ = 1 V			13		%/K
		$V_{r\ (C-A)}$ = 30 V			12		%/K
λ_{peak}	peak sensitivity wavelength				830		nm
S_{peak}	peak sensitivity				0.58		A/W
C_{j0}	zero-bias junction capacitance, f = 1 MHz	PR5020	C1/C3		39		pF
			C2		77		pF
		PR5021	C1/C3		62		pF
			C2		32		pF

Photodiode PR5020/21

Dark Current

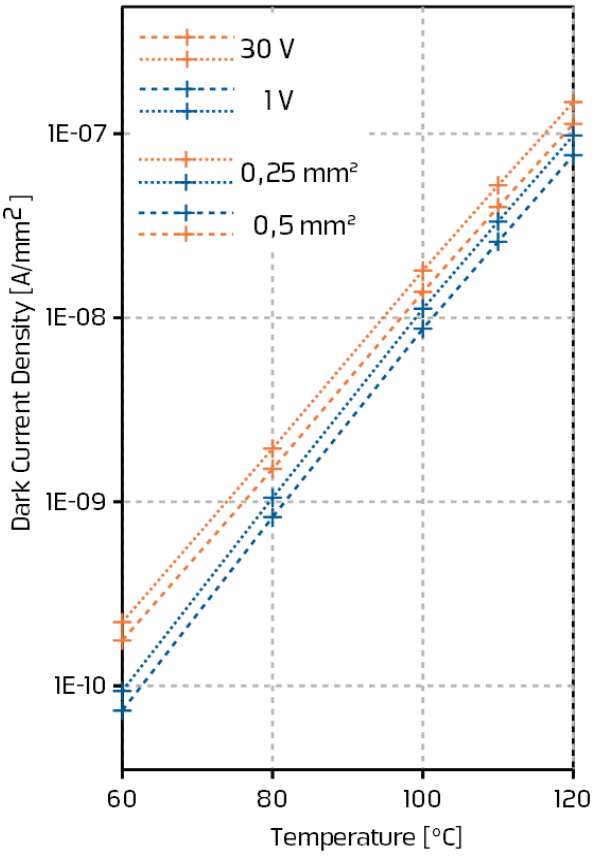
MEASUREMENT SETUP

Dark currents of the C1-, C2- and C3-photodiode are measured as a function of reverse voltage and temperature. The substrate (A) is connected to ground, while a positive voltage is applied to Cx. The dark currents of Cx are measured at each pin separately.



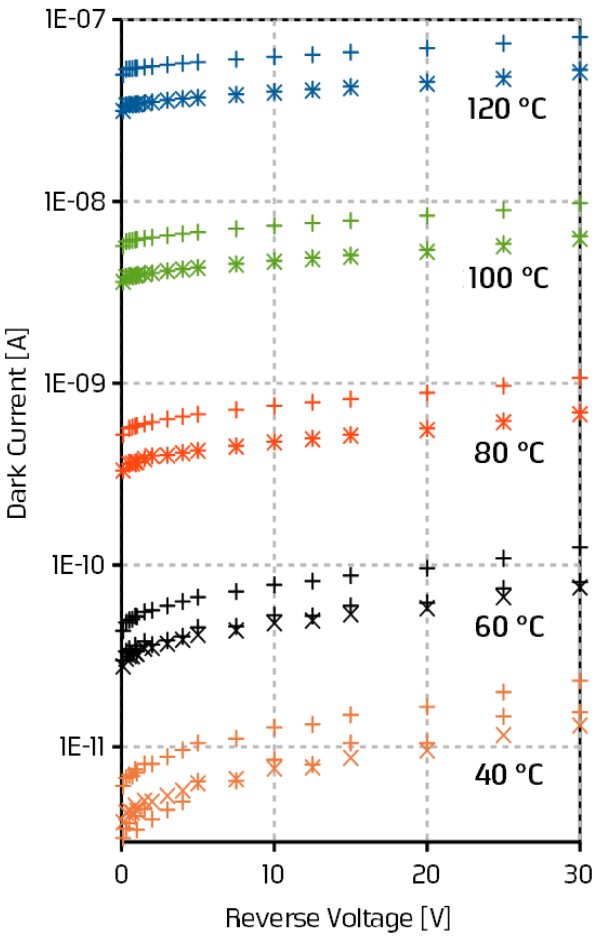
OVER TEMPERATURE

Dark currents for photodiodes of different size in PR5020 are shown at reverse voltages of 1 V (blue) and 30 V (orange). In general, dark currents rise by approximately a factor 10 every 20 °C. Due to edge effects, bigger photodiodes show a smaller leakage current per area.



AS A FUNCTION OF REVERSE VOLTAGE

The following diagram shows the dependency of dark currents of the smaller C1/C3 (lower curves) and the bigger C2 (upper curve) of PR5020 on reverse voltage at different temperatures.

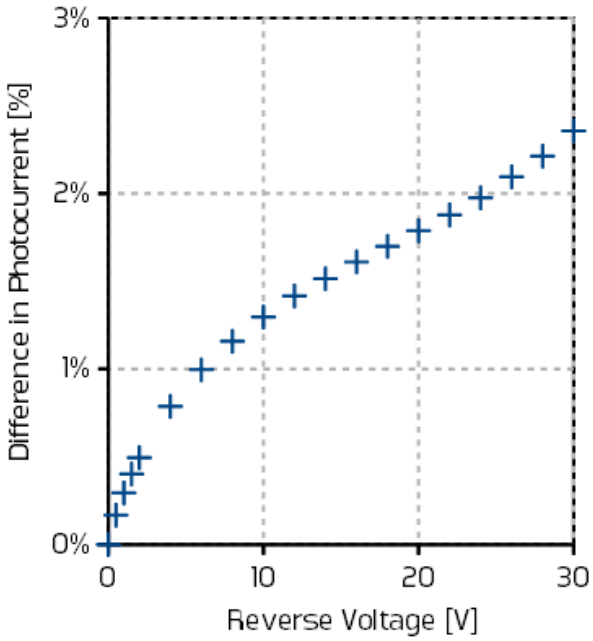


Photodiode PR5020/21

Electrical and optical Characteristics

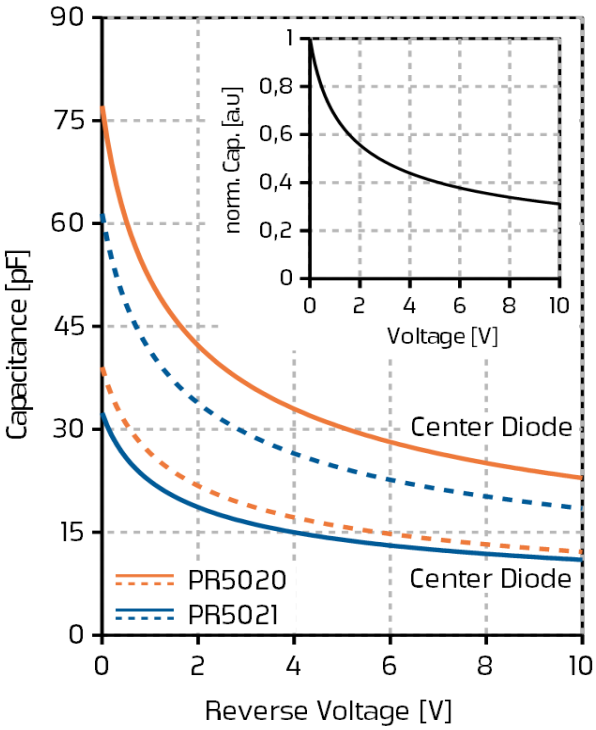
SENSITIVITY AFFECTED BY REVERSE VOLTAGE

The spectral sensitivity increases by a few percent when reverse voltages are applied to the photodiodes.
The diagram shows the relative deviation of the photocurrent to the zero-bias value. The deviation changes insignificantly when illumination is changed. Neither the size nor the position of the photodiodes affect the deviation significantly.
Please notice that the relative deviation increases if the adjacent photodiode is not biased. In that case also the size of the photodiode and the illumination affect the difference in photocurrent measured with increased reverse voltage.



CAPACITANCE

The diagram illustrates the dependency of the capacitances on the applied reverse voltage of the PR5020 (orange) and the PR5021 (blue). Both types have two identical photodiodes C1 and C3 (dashed lines) and a single photodiode C2 located in the center of the dies (solid lines). The capacitances of the photodiodes are proportional to their area and decrease with reverse voltage due to the reduction of the space-charge region.
Taking the area of each photodiode into account leads to a capacitance density of about 157 pF/mm^2 at zero reverse voltage. The decrease of the capacitance with increasing reverse voltage is identical for all photodiodes and shown in the inset.

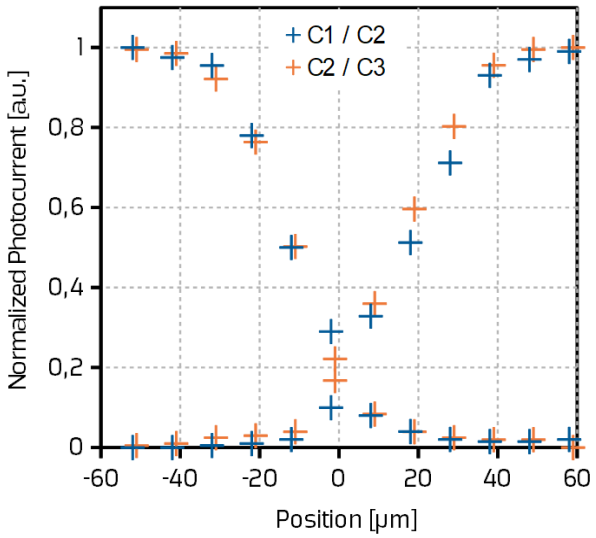


Photodiode PR5020/21

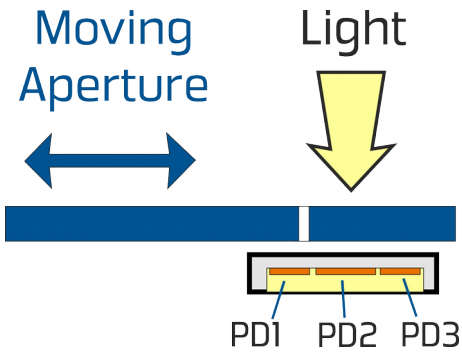
Application Notes

CHANNEL SEPARATION

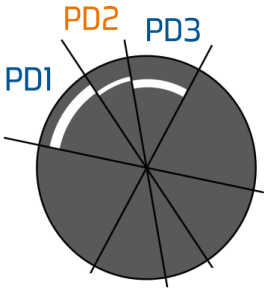
The crossover of a light beam between photodiodes is illustrated. Increments of 10 µm were performed using red light and a diameter of 50 µm. The position of 0 µm corresponds to the center of the die. The photocurrent was measured with zero applied voltage.
Considering a gap between the photodiodes of 27 µm, the observed behaviour is consistent with a sharp channel separation.

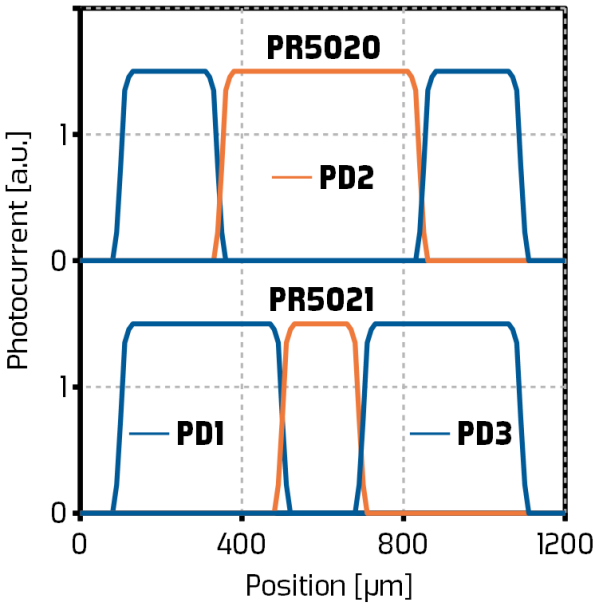


POSITION DETECTION



By shining light on aperture, the passing light can be detected. As given in the schematics above, three different segments can be resolved using PR5020/21. Due to the geometry of the photodiodes, the position of the aperture can be detected as given in the diagram.
Of course, the principle can be transferred to encoder discs to obtain angular resolution:

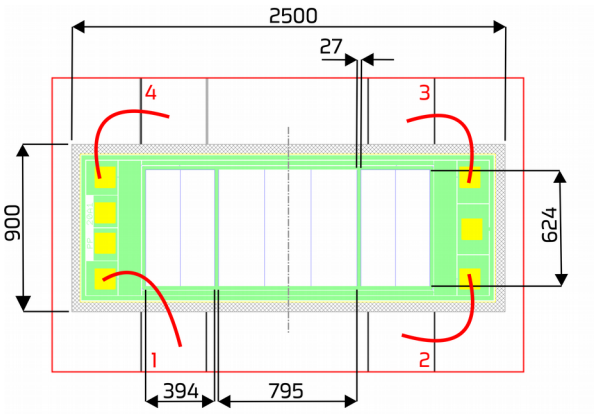




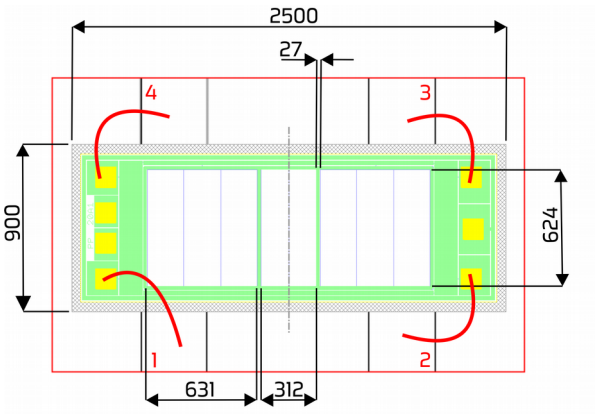
Photodiode PR5020/21

Dimensions

PR5020

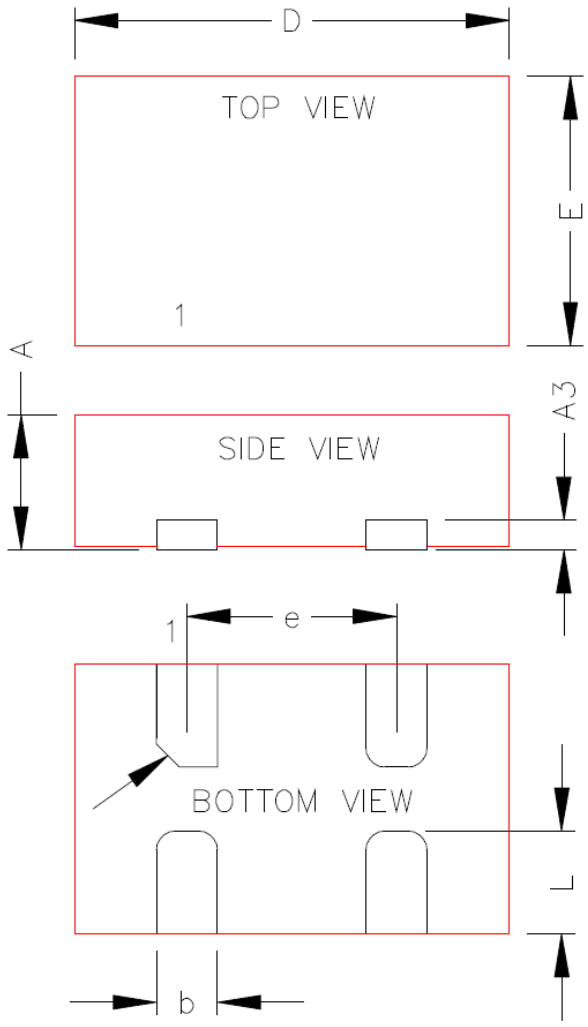


PR5021



LAYOUT AND PIN CONFIGURATION

Pin No.	Pin Name	PIN Function Description
1	A	Common Anode
2	C2	Cathode photodiode 2
3	C3	Cathode photodiode 3
4	C1	Cathode photodiode 1



PACKAGE DIMENSIONS (ODFN)

	MIN	TYP	MAX	Unit
A	0,85	0,9	0,95	mm
A3		0,20 REF.		mm
b	0,35	0,4	0,45	mm
D	2,8	2,9	3	mm
E	1,7	1,8	1,9	mm
e		1,4 BSC*		mm
L	0,6	0,7	0,8	mm

* Basic Spacing Between Centers

Photodiode PR5020/21

Package Information

SOLDERING INFORMATION

A lead-free solder profile with a peak temperature of 260°C or less, according to J-STD-020 should be followed.
Parts should be handled in accordance with the moisture sensitivity level as indicated on the moisture barrier bag, but at least to MSL 3.
Any parts without or with unsealed moisture barrier bag must be dry-baked according to JEDEC guidelines before soldering. Manual soldering must be done with utmost care.
Direct infrared heating should be avoided; pure convection heating is recommended.

TAPE & REEL

Reel diameter: 7" (178 mm)
Tape width: 8 mm
Quantity per reel: 3,000
Packaging: moisture barrier bag
Orientation of ICs in tape: Pins 3 and 4 towards sprocket holes

BARE DIES

PR5010 is available as bare dies on request on tested and sawn wafers or in wafflepack.
Please contact us for minimum order quantities and delivery times.

Disclaimer

Information provided by PREMA is believed to be accurate and correct. However, no responsibility is assumed by PREMA for its use, nor for any infringements of patents or other rights of third parties which may result from its use. PREMA reserves the right at any time without notice to change circuitry and specifications.

Life Support Policy

PREMA Semiconductors products are not authorized for use as critical components in life support devices or systems without the express written approval of PREMA Semiconductor. As used herein:
1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, and whose failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury to the user.
2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

PREMA Semiconductor GmbH
Robert-Bosch-Str. 6
55129 Mainz Germany
Phone: +49-6131-5062-0
Fax: +49-6131-5062-220
Email: prema@prema.com Web site: www.prema.com