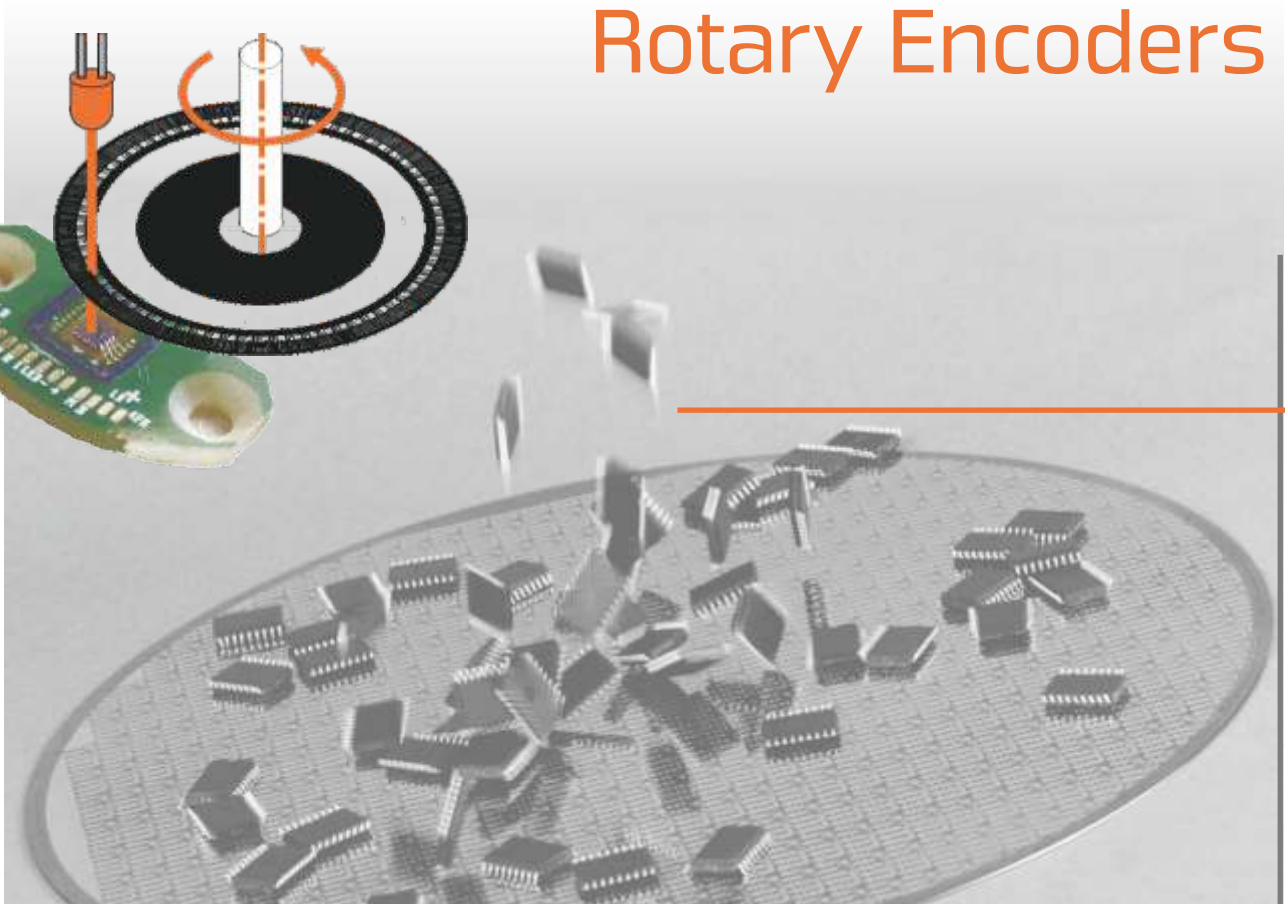
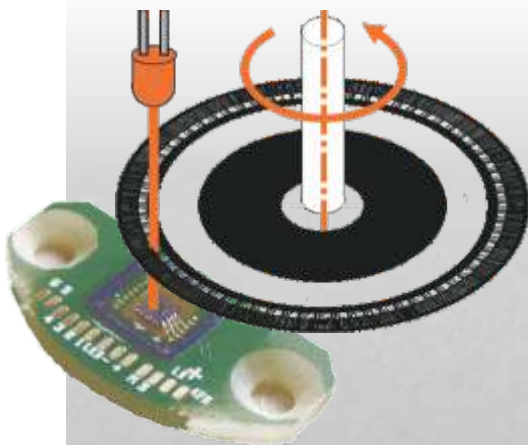


# PREMA SEMICONDUCTOR GmbH

---

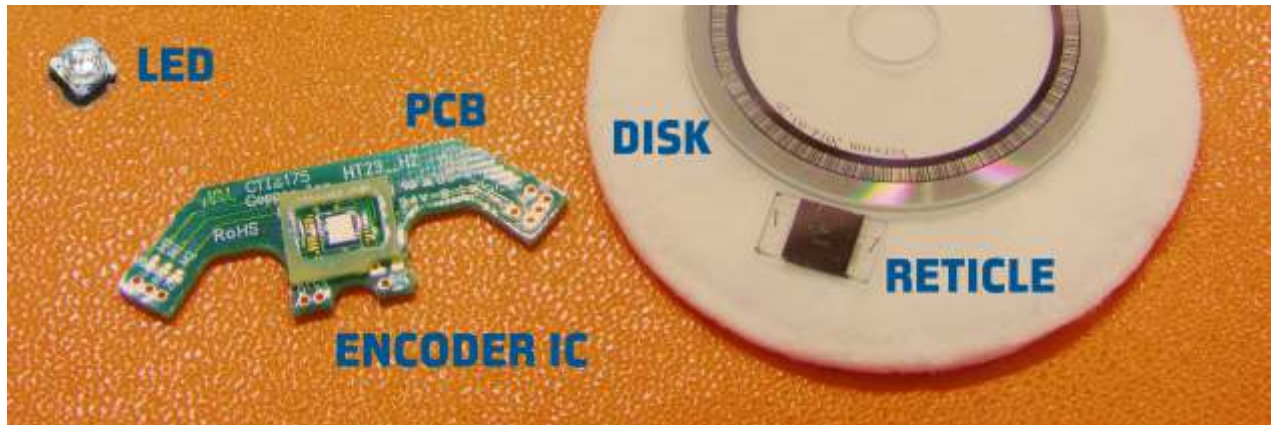


## Sensor Solutions for Rotary Encoders



Quality made in Germany

# Table of Contents



To meet **individual requirements**, several model types of **encoder ICs** with different properties are offered by PREMA Semiconductor GmbH. In addition to encoder ICs, **offered** as bare dices, packaged ICs or chip-on-board, **supplementary parts** like LED with lens, reticle and encoder disk can also be provided.

<b>1.</b>	<b>INTRODUCTION.....</b>	<b>3</b>
	Optical Quadrature Encoders	
<b>2.</b>	<b>ENCODER IC - PR510I.....</b>	<b>4</b>
	High Performance - Easiest Assembly	
<b>3.</b>	<b>ENCODER IC - PR520I.....</b>	<b>6</b>
	Flexible Concept with Reticle	
<b>4.</b>	<b>ENCODER IC - PR530I.....</b>	<b>8</b>
	Small Package for Linear and Rotary Encoders	
<b>5.</b>	<b>SOLUTIONS AND SERVICES.....</b>	<b>10</b>
	Approved Combinations of single Components	

## Optical Quadrature Encoders photosensors with complex signal processing

Optical encoders measure rotations, such as in robots, pumps, machine tools or printers. Critical parameters are resolution given by number of increments, maximum speed and track radius. There can be extra features, such as index track, rotation direction detection or commutation tracks (U/V/W).

PREMA offers ICs that can be used in a wide range of encoders. They excel with a quick assembly, high resolutions without interpolation, an innovative method to produce a sharp Z (index) pulse, and high performance of photocurrent amplifiers allowing a low LED current.

**In general, the high sensitivity of photodiodes and the low offset/noise of the amplifiers allow to operate LEDs at low intensities. By reducing the LED current down to 5 mA or less, longer LED lifetimes are obtained.**

In the following three different types (PR5101 / PR5201 / PR5301) are described in detail. An overview of their features is given here.

**PR5101** with **on-chip pattern** of A/B and Z photodiodes for maximum tolerance against ambient light and **easiest assembly**

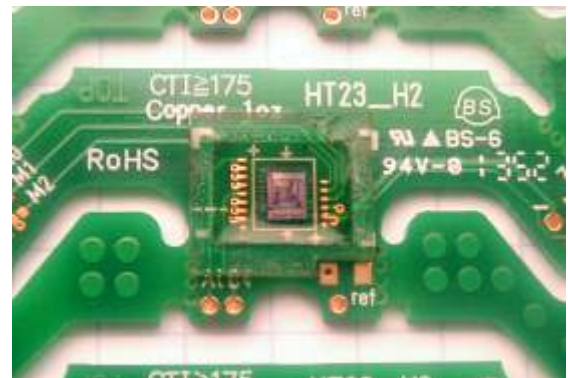
- high immunity against mechanical tolerances
- angular resolution of quadrature photodiode arrays A and B with up to 2500 increments at 12.8 mm average A/B track radius
- highly accurate Z index channel for absolute angle reference detection by an innovative method
- differential measurement between interwoven photodiodes A, A', B and B', provides an outstanding common mode light rejection
- additional U, V and W channels for commutation signals (brushless motors)

**PR5201** with large-scale photodiodes and **attached reticle** to reach **highest flexibility** regarding resolution and track radius

- angular resolution for A/B channel from 100 to over 10,000 increments, defined by the pattern on the reticle
- highly accurate Z index channel for absolute angle
- detects the rotation direction
- Z channel gating with different options
- LED current control

**PR5301** for small linear and rotary encoders with resolutions of 50, 150 or 300 lines per inch

- no reticle required
- tiny 1.8 mm x 2.9 mm DFN package
- A and B channel digital output
- photodiodes with antireflective coating

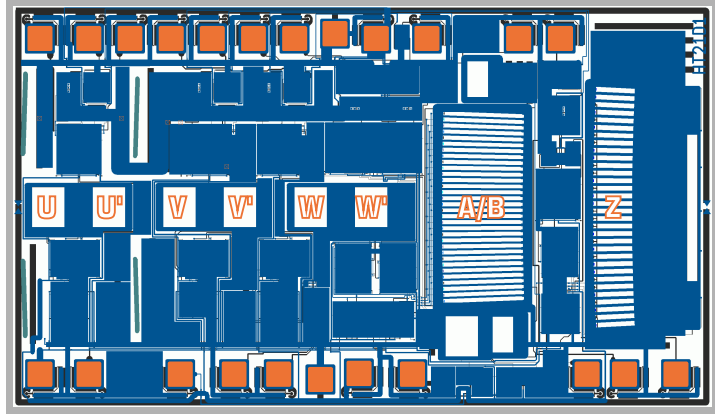


# High Performance - Easiest Assembly

## ENCODER IC

# PR5101

**no reticle is needed**



The PR5101 encoder consists of 6 channels:

- **A** and **B** channel for incremental signals
- **Z** channel for zero angle detection
- **U**, **V** and **W** channel for **brushless motor control**

PR5101 utilizes an innovative method to generate the Z signal that is a sharp and precise pulse at a defined zero point.

A/B channel can have an optical resolution of up to 2500 increments per revolution with a disk diameter of 31 mm, or 12.9 mm A/B track radius. PR5101 does not rely on any interpolation method.

The combination of all photodiodes in a fixed and interwoven grid with integrated amplifiers allows an easy assembly of the encoder IC on the PCB.

The differential measurement between A-A', B-B' etc. channels provides an excellent common-mode light rejection and allows the usage of low LED currents.

By modifying from PR5101, PREMA can customize size and position of the photodiodes already for mid-sized volumes.

In standard configuration, digital outputs can source and sink a current of 1mA per channel. Further encoder IC with varied interface specifications can be developed on demand. In addition to digital outputs, the analog signal of selected channels is buffered and available for adjustment and calibration purposes.

**Supply voltage:**

3 - 12 V

**Supply current:**

~2 mA

**Operating temperature range:**

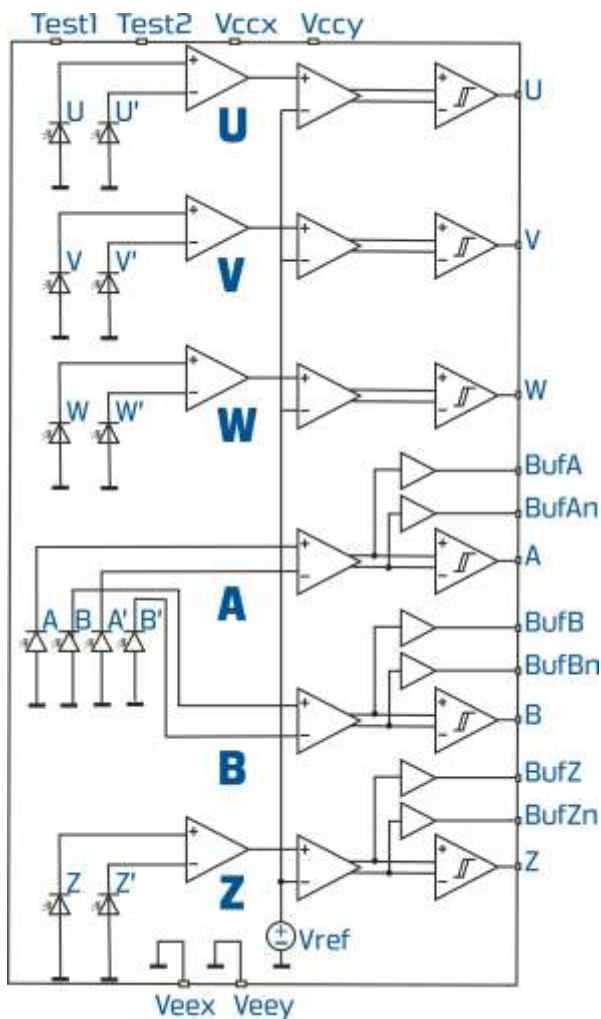
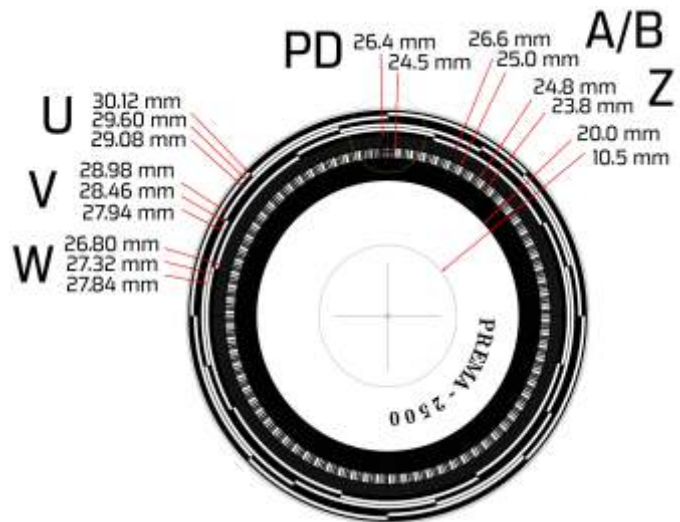
-40 - 125°C



## Adapted Encoders Disk

### LED - encoder disk - reticle - PR5101

- example encoder disk with A/B, Z, U, V and W channel, a diameter of 31.0 mm and 2500 increments per revolution
- Since the encoder pattern (A/B, Z) is predefined by photodiodes, no reticle is needed on top of the encoder IC PR5101. This makes the assembly specifically easy.



- By the position of the photodiodes and the defined structure of the encoder disk, the signal of each channel is generated by two inversely phased photocurrents.
- Therefore, precise, stable and quickly responding signals are obtained. In addition, PR5101 can be utilized in a wide temperature range.

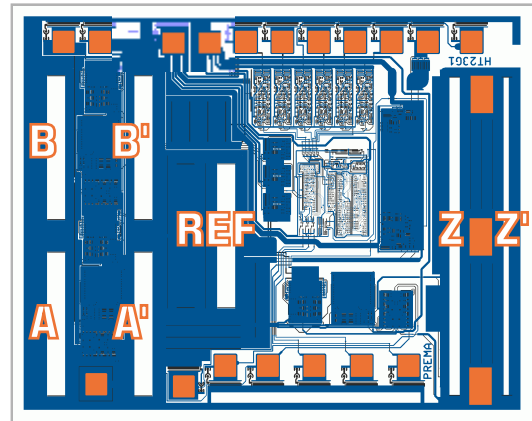


# Flexible Concept with Reticle

## ENCODER IC

# PR5201

for custom-specific resolutions



For **higher flexibility at lower** production **volumes**, PR5201 uses a reticle to adapt the photodiodes of the IC to **customized resolutions** and **radii** for A/B and Z channel. PR5201 includes a **LED current control**.

### Features:

- sharp Z channel pulse, generated by an innovative method for zero angle detection
- A/B channel with resolutions from 100 to >10,000 increments per revolution
- adaptable to different track radii
- ungated and gated Z channel (synchronization with A/B channel)
- measures direction of rotation
- output with 4-fold pulse density, triggered at each A or B phase change
- LED current control using a reference channel (REF) and triggers an alarm pin in case of insufficient light intensity due to ageing LED
- easy alignment of encoder IC, reticle and encoder disk due extra markers

**Supply voltage:**  
3 - 12 V

**Supply current:**  
~2.5 - 3.5 mA

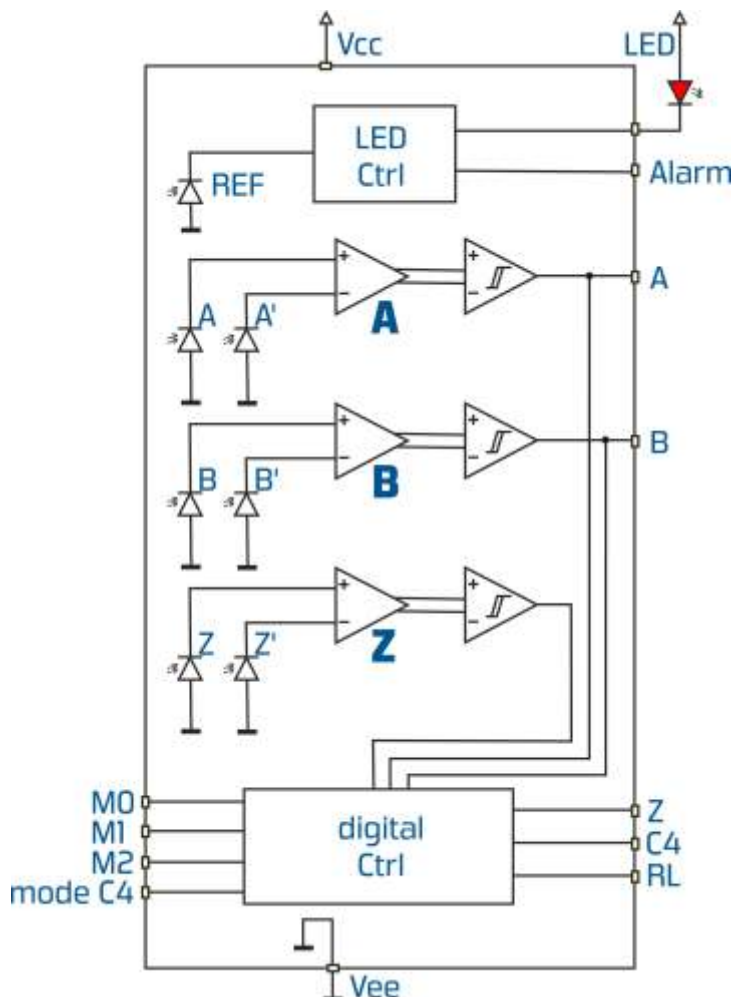
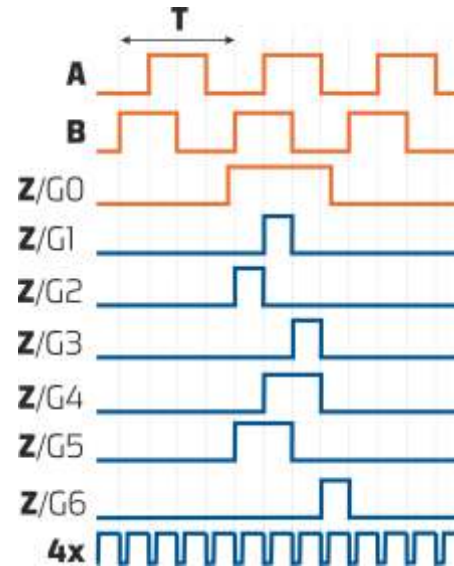
**Operating temperature range:**  
-40 - 125°C

**LED current:**  
6 - 20 mA

## Versatile Allrounder

### multiple pinning options rule the output signals

- Output signal of **Z** channel (zero angle detection) can be triggered by **M1**, **M2** and **M3** (see block diagram).
- Shape and position of **Z** signal can be defined with respect to the **A/B** signals by seven different gating modes G0-G6



- Using **mode C4** pin, different options for reading out the direction of rotation and a receiving a signal with a four times higher frequency (**4x**) than the **A/B** signals can be realized.
- The LED current is controlled by an additional photodiode (REF); insufficient light irradiation is displayed at the **Alarm** pin.



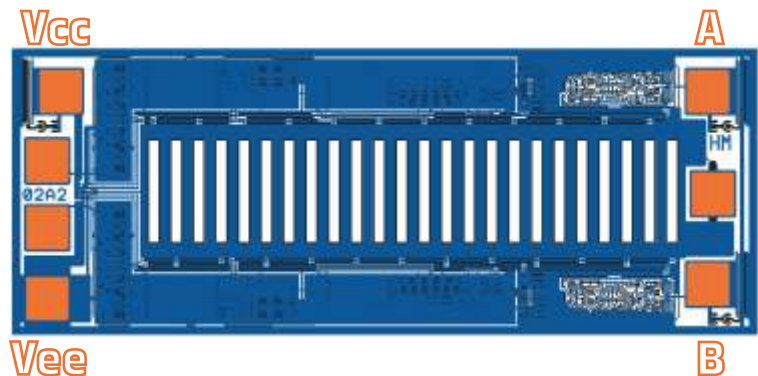
also in QFN package

# Tiny Chip in a DFN package

## ENCODER IC

# PR5301

with 50, 150 and 300 lpi



PR5301 is a **sensor IC** with A and B channel **digital output**. It comes in a **small DFN package** for easy use in linear or rotary encoders. **Custom-specific resolutions** can be realized by changing only the final metalization layer. As standard ICs, the following versions are **available**:

PR5301-050	for <b>50 lpi</b> resolution
PR5301-150	for <b>150 lpi</b> resolution
PR5301-300	for <b>300 lpi</b> resolution

### Features

- fixed resolutions of 50, 150 or 300 lpi, no reticle required
- small DFN package (1.8  $\mu\text{m}$  x 2.9  $\mu\text{m}$ )
- A and B channel digital output
- photodiodes with anti-reflective coating
- high sensitivity for low LED current
- best for red or near-infrared light

### Supply voltage:

2.7 - 12 V

### Supply current:

~0.4 - 1.5 mA

### Operating temperature range:

-40 - 85°C

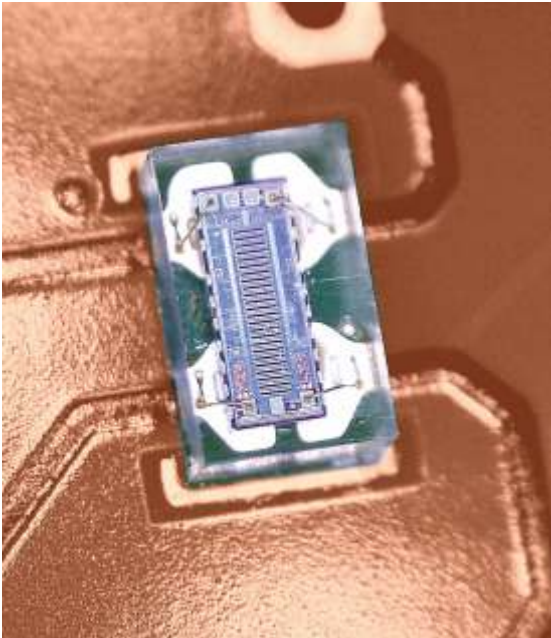
### LED current:

2 - 20 mA

Encoder ICs can also be delivered as bare dies (2,225  $\mu\text{m}$  x 910  $\mu\text{m}$ ) on tested and inked wafers, or singulated dies on adhesive film.



## Save Money, make it smaller cost-efficient encoder IC for special applications

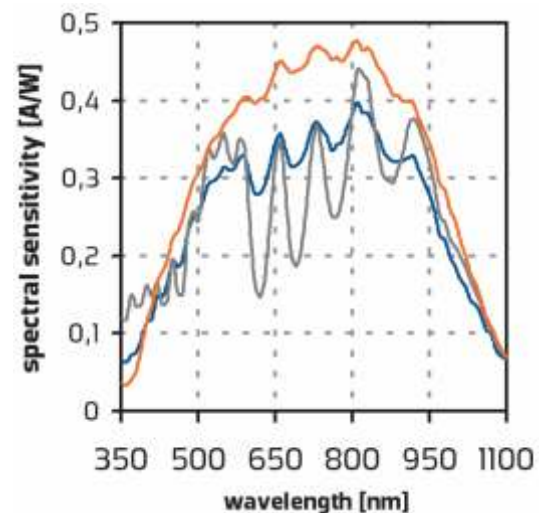


### High efficiencies

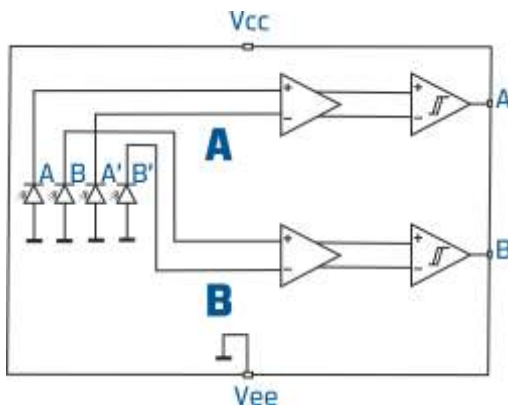
The photodiodes of the Encoder IC PR5301 are covered with an anti-reflective coating to reach highest efficiencies. So, despite the small photosensitive area the system can work already at very low LED current levels.

### Anti-reflective coating

Photodiodes are usually covered by a standard passivation layer that causes interference and reflects part of the incident light (grey curve). In the fabrication process of the PR5301, the passivation layer is replaced by an anti-reflective coating (ARC). Adjusted index of refraction and thickness of the ARC reduce interference and increase the sensitivity (orange curve). To reduce their capacitance, photodiodes are often segmented. Although this prevents a contiguous ARC, the sensitivity is still improved against the standard process (blue curve).



### Block diagram



Kalabi Yau / Shutterstock.com

# Solutions and Services



**Besides** design and production of the encoder sensor **ICs**, PREMA **offers** a range of **services** needed to manufacture encoders. In cooperation **with reliable partner** companies, PREMA produces customized **PCBs**, encoder **disks** or **assembly solutions**.

## Encoder ICs produced by PREMA

Encoder ICs can be delivered as tested wafers, in waffle packs or assembled on PCBs. Standard chip configurations are available from stock.

Special chip configurations (e.g. sensor tracks, signal processing, output drivers) can be designed and produced on demand.

## Encoder ICs assembled on PCB

Encoder ICs can be assembled as chip on board. There are universal PCBs available without initial engineering costs.

Besides, PREMA can design special PCBs according to customer's demand and for specific requirements (e.g. extended temperature range).

## Additional components assembled on PCB

Encoder ICs can be combined with other circuits, such as line drivers, bus interfaces, surge suppressors or connectors. PREMA can design and layout a circuit that meets your specifications. The PCB assembly can yield in potential savings for our customers.



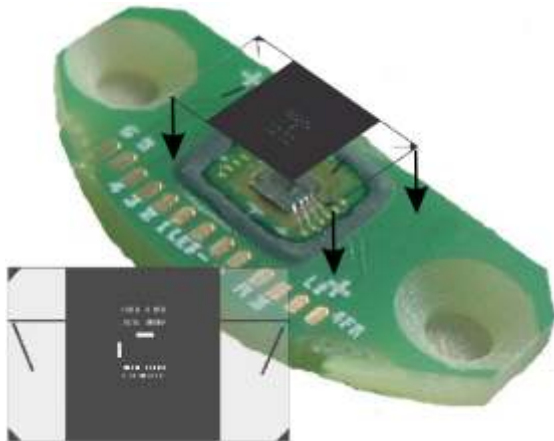
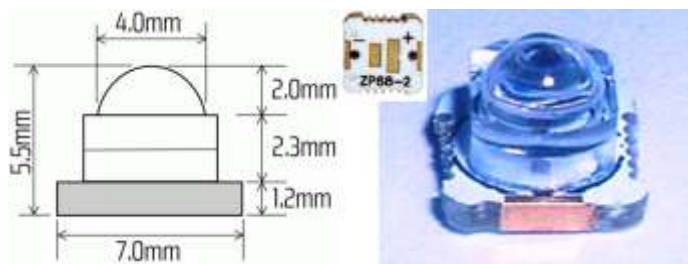
## System Solution

### approved combination of single components

PREMA provides solutions for the electronic and optical components of encoders. The mechanical construction and the assembly of the encoders is the business of our customers. Our know-how in semiconductors and optical systems, combined with your know-how in electromechanical systems, leads to cost-effective products with high performances

#### Reticles

The track geometry of PR 5201 is defined by a reticle to be mounted on top of the chip sealing. For specific requirements on resolution and track radius, PREMA calculates the geometry and provides the pattern in DXF format. Reticles are mounted by our customers, based on the DXF data provided by PREMA.

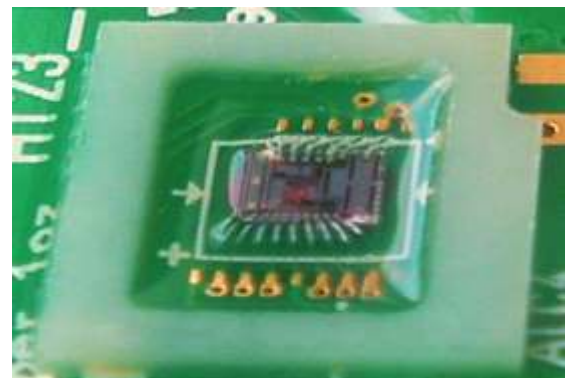


#### LEDs for encoders

The quality of an optical encoder relies on a homogeneous and well collimated light beam. PREMA offers a flat LED-lens combo tested with PREMA encoder chips. Alternatively, the encoder has also been tested with several LED types available on the market.

#### Encoder disks for PREMA encoder chips

For each diameter, resolution and combination of tracks an individual pattern for the disk must be produced. PREMA will calculate the geometry and provide the pattern in DXF format. Disks are mounted by the customer. For some geometries, PREMA has disks on stock.



# Unique Fabrication Process



**PREMA Semiconductor GmbH** has more than 30 years of experience in designing and manufacturing analog and mixed-signal circuits. With our in-house wafer processing facilities, we offer turnkey services from design,

prototypes, test, to series production in high volumes. It gives us the flexibility to react quickly on special demands, re-designing the circuit according to your requirements and producing wafers with modified circuits.

PREMA is a mid-sized, independent company. Our location in the Frankfurt area is perfectly suited for close cooperation's with international customers.

In cooperation with reliable partners for chip-on-board, PCB and mechanical assembly we can offer complete solutions on PCB or module level.

© 2015 PREMA Semiconductor GmbH

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 services, data, or specifications.

Edition w05/2015

## **PREMA Semiconductor GmbH**

Robert-Bosch-Str. 6

55129 Mainz

Germany

Phone: +49-6131-5062-0

Fax: +49-6131-5062-220

Email: [prema@prema.com](mailto:prema@prema.com)

**[www.prema.com](http://www.prema.com)**

