

NOW IT'S GETTING HOT: POLYMER RESISTORS AND HEATERS!

Andreas Dreher

WÜRTH ELEKTRONIK MORE THAN YOU EXPECT

YOUR SPEAKER

Andreas Dreher

Technical Project Management

- HDI-Design
- Signal Integrität & High Speed

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Technical Project Management



AGENDA

1. Homepage

- general: <https://www.we-online.com>
- Directly to WE PCB-Technologies: <https://www.we-online.com/pcb>

2. Printed Polymer

- Introduction to the production
- Alignment – printing – drying

3. Survey 1

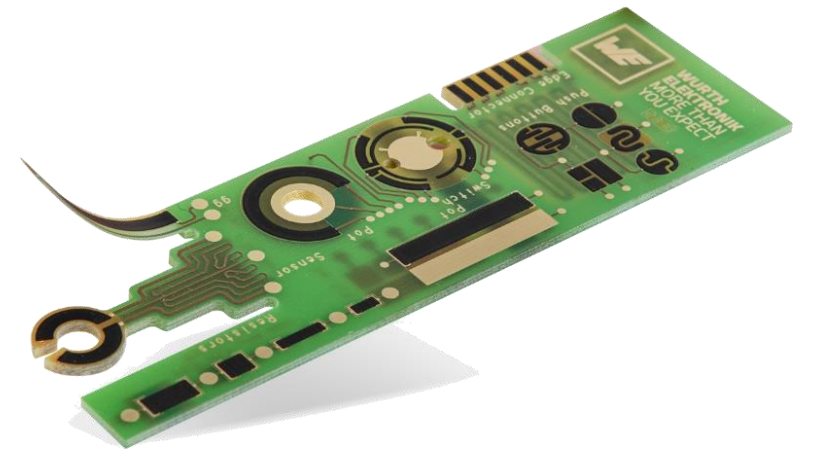
4. Sample WE.polymer

- Different application of Printed Polymer

5. Application examples

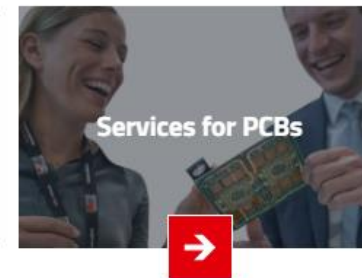
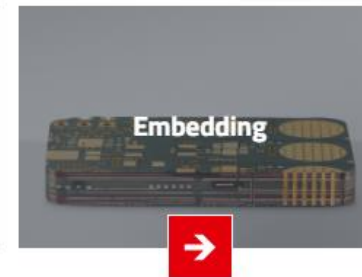
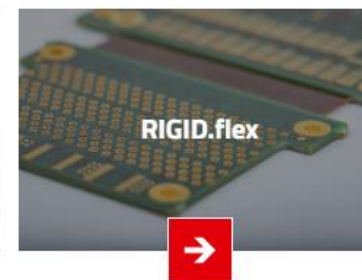
6. Survey 2

7. Q & A Session



Technology Diversity

Are You Looking for a PCB Solution? We'll Find It!



<https://www.we-online.com/pcb>

POLYMER Technology Sample WE.polymer in Detail

> PRINTED RESISTORS

> PUSH BUTTONS

> EDGE CONNECTOR

> LINEAR POTENTIOMETER

> ROTARY POTENTIOMETER

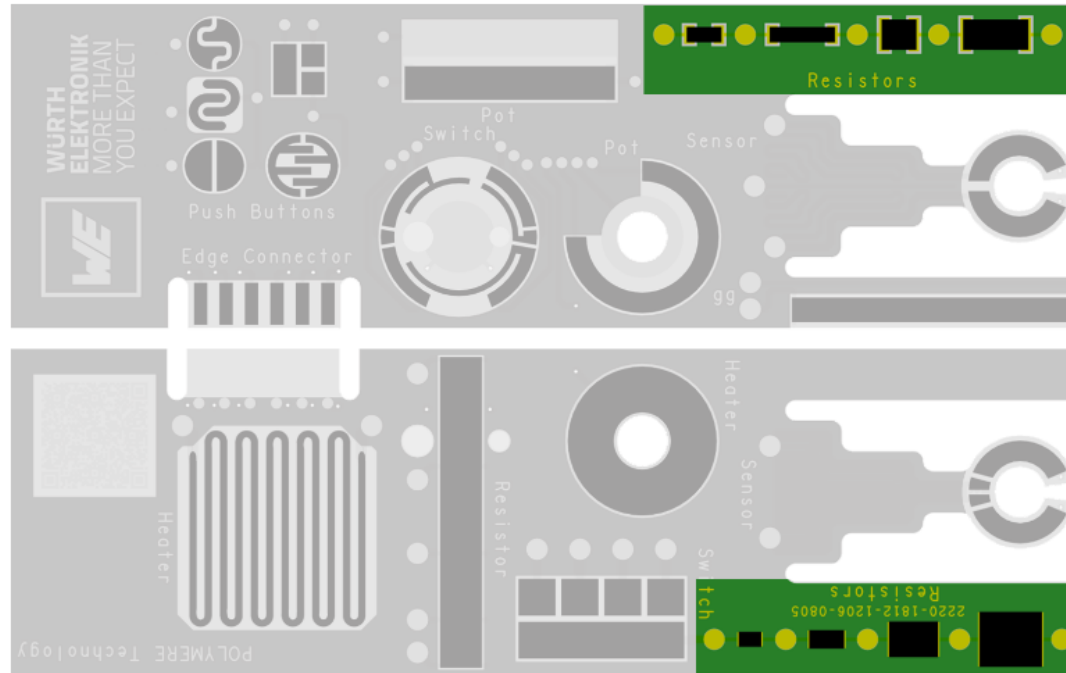
> HEATERS

> POLYMER SENSOR

> SWITCH

> ROTARY SWITCH

> QR CODE



Design: The printed resistors are versatile over a resistance range from 10 ohms to 1 GigaOhm.

Explanations: Printed resistors are ideal for use as pull up/down and/or terminating resistors. Tolerances are $\pm 30\%$ untrimmed, tolerances of $\pm 5\%$ can be achieved using laser trimming. With voltage dividers, a divider ratio of $< 3\%$ can be achieved.

The resistors can be printed on inner and outer layers.

1 SURVEY

Poll: Multiple Choice with one correct answer

Which application are you using?

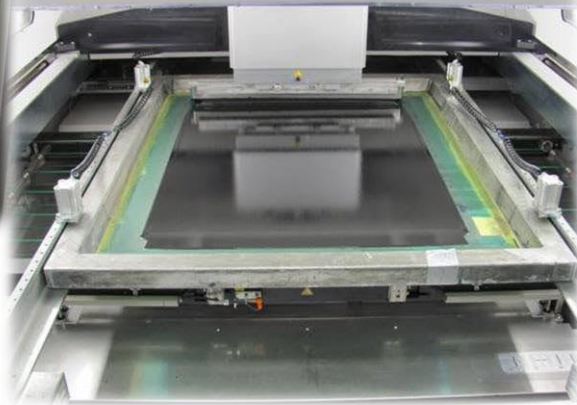
- Printed Resistors or Potentiometer
- Printed contacts or switches
- Printed sensors
- Printed heaters
- No use of Printed Polymer



PRODUCTION OF PRINTED POLYMER



Alignment of the polymer printing to the etched layout (with Fiducials on the edges of the productions panel)



Printing of the individual mixed paste system

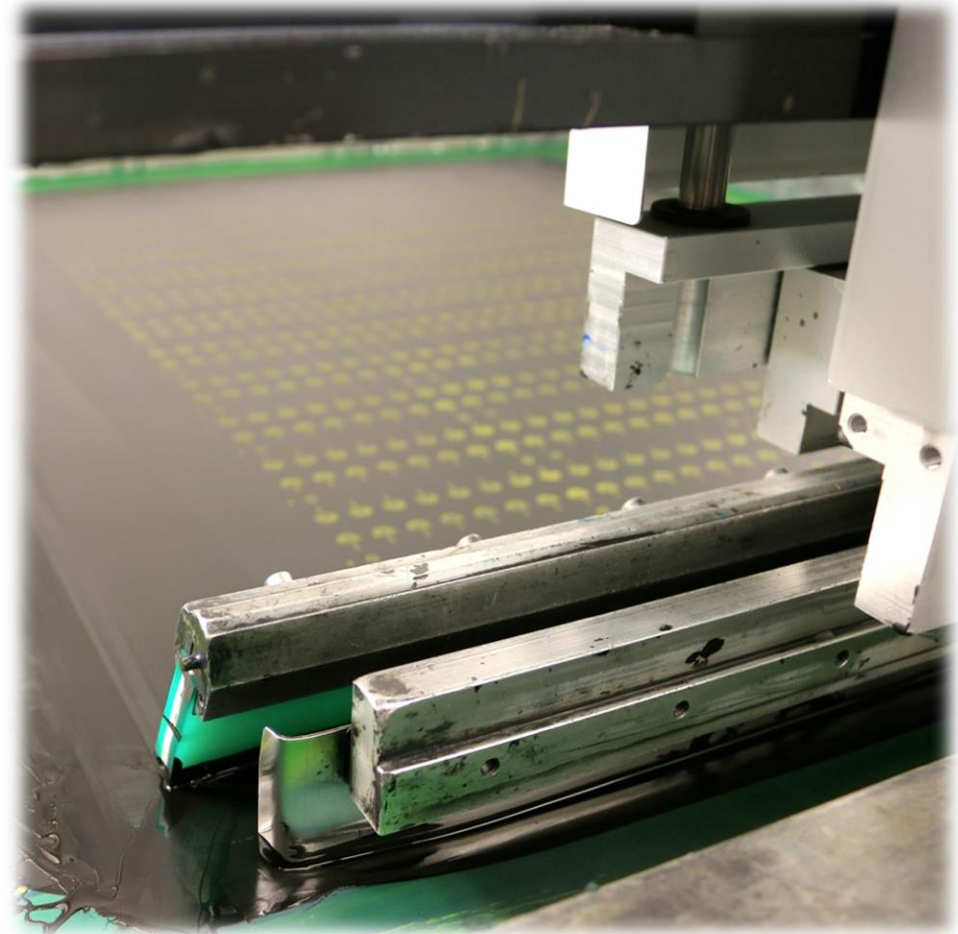
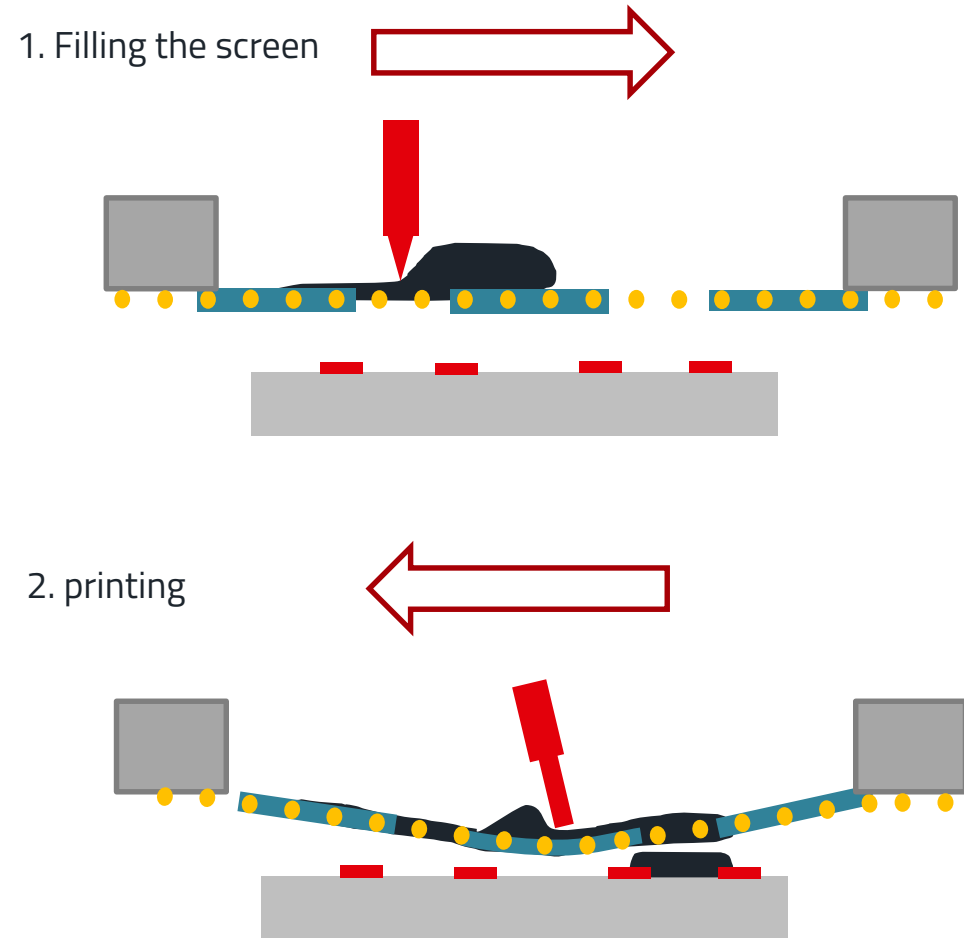


Settling of the print and transport to the oven



Curing of the polymer

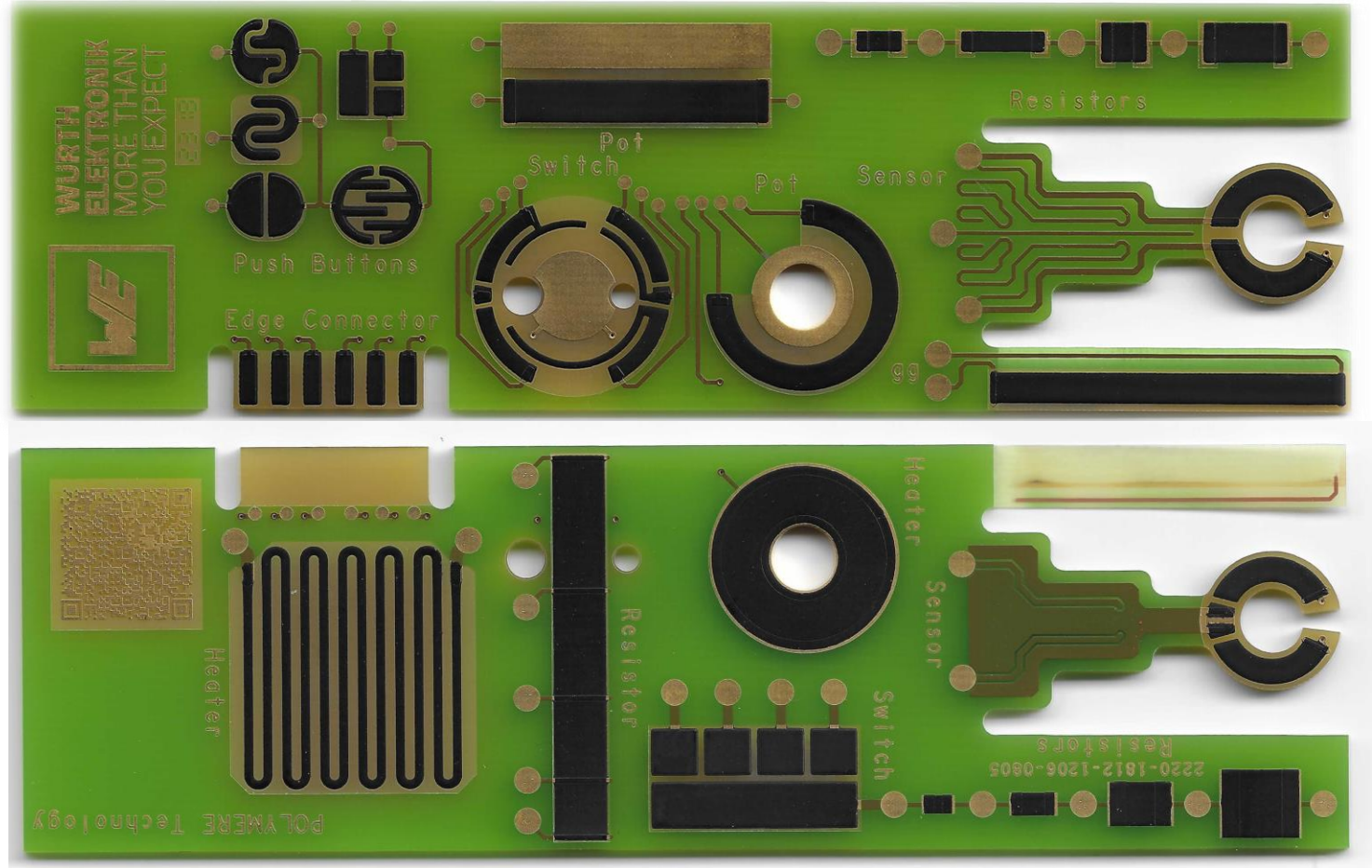
PRODUCTION OF PRINTED POLYMER



SAMPLES FOR PRINTED POLYMER

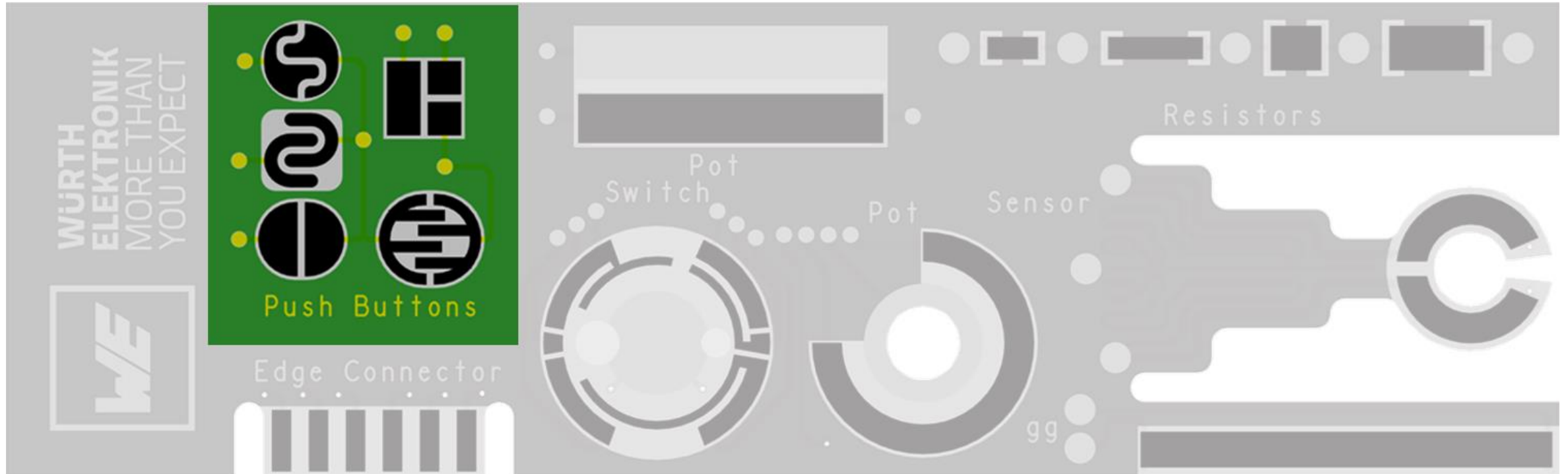
With the shown equipment we manufactured the samples on the right hand side

Let us discover the features on the sample together on the following pages



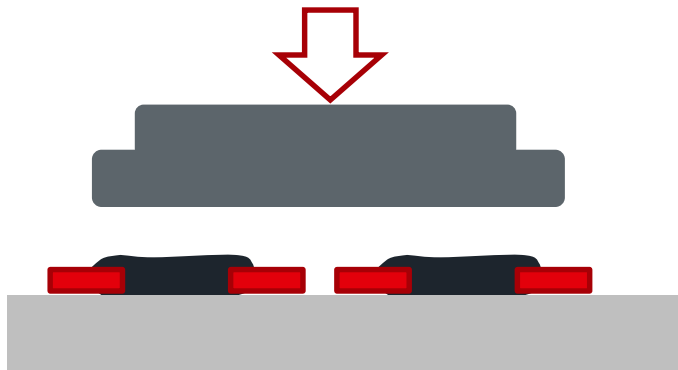
FUNCTIONS OF THE HAND SAMPLE

Contacts & Push Buttons



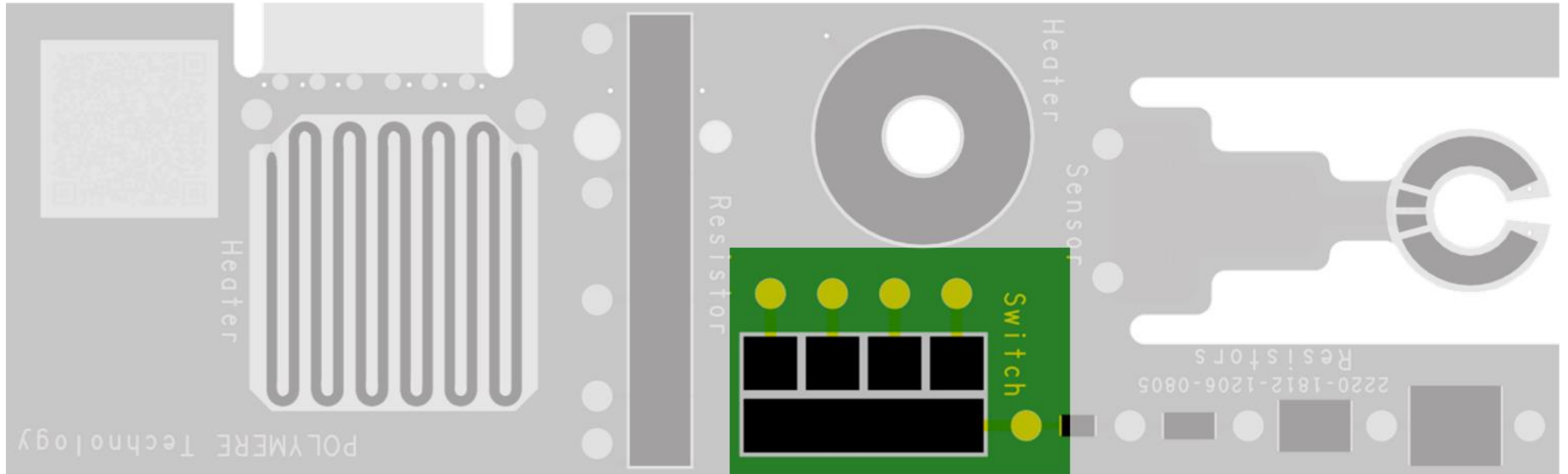
FUNCTIONS OF THE HAND SAMPLE

Contacts & Push Buttons



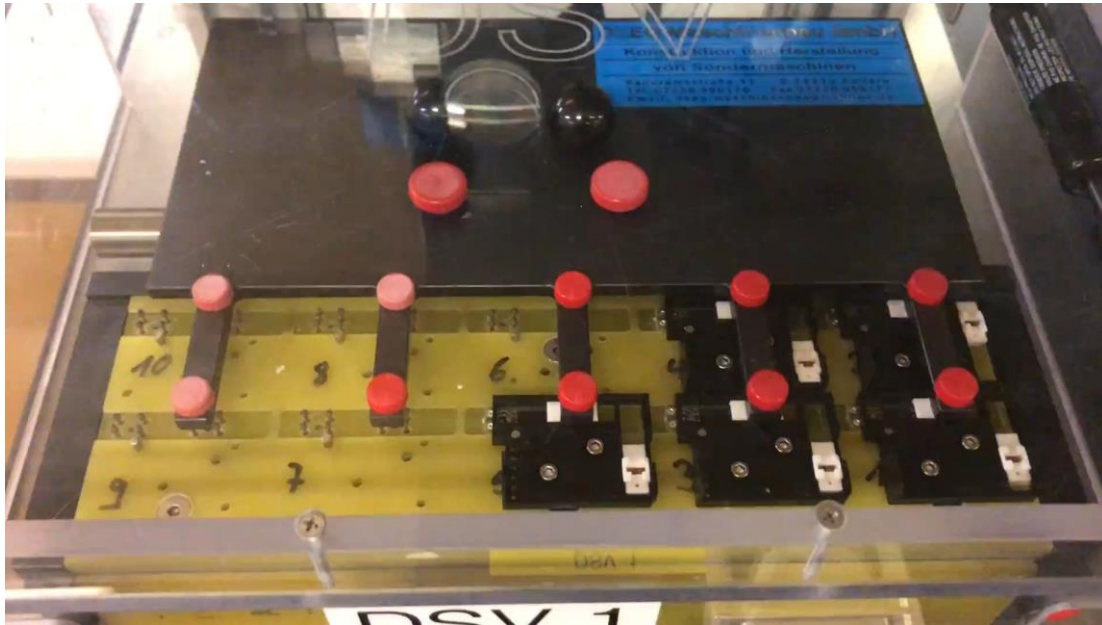
FUNCTIONS OF THE HAND SAMPLE

Switches

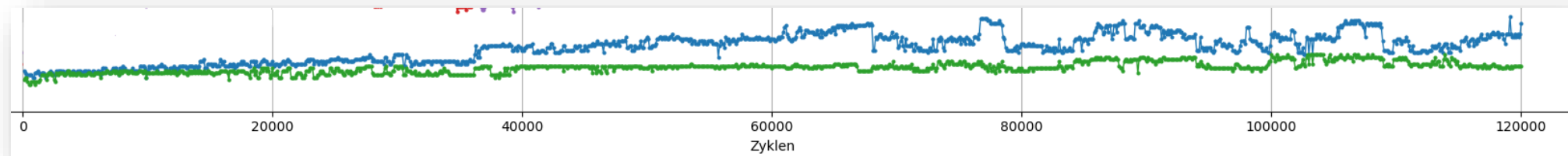
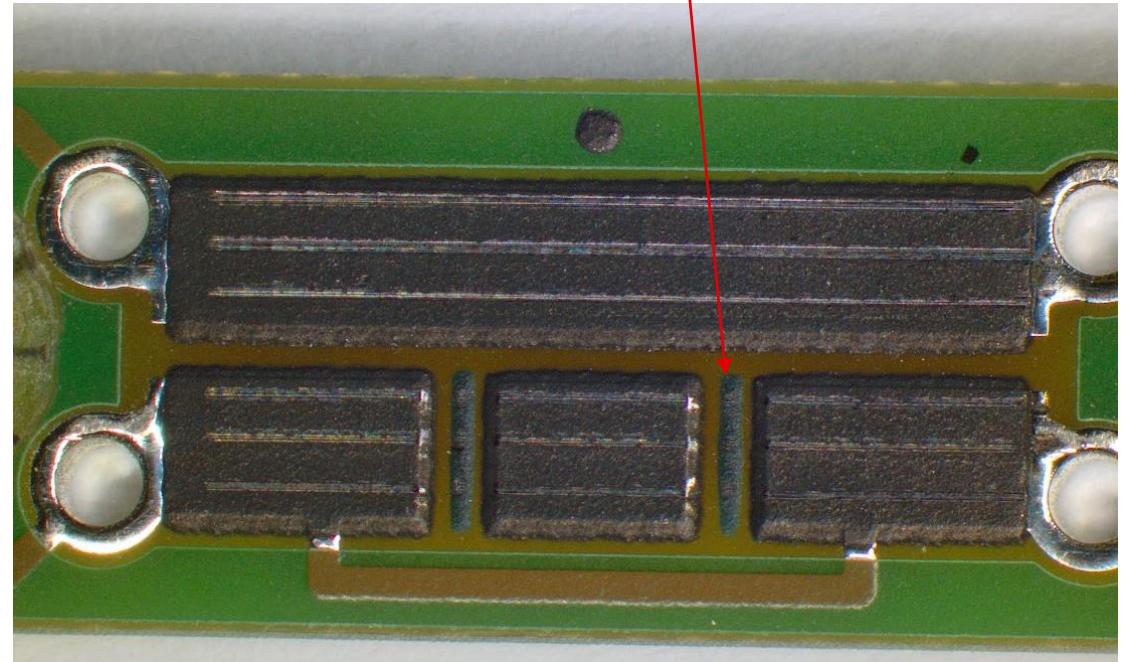


FUNCTIONS OF THE HAND SAMPLE

continuous switching test for switches

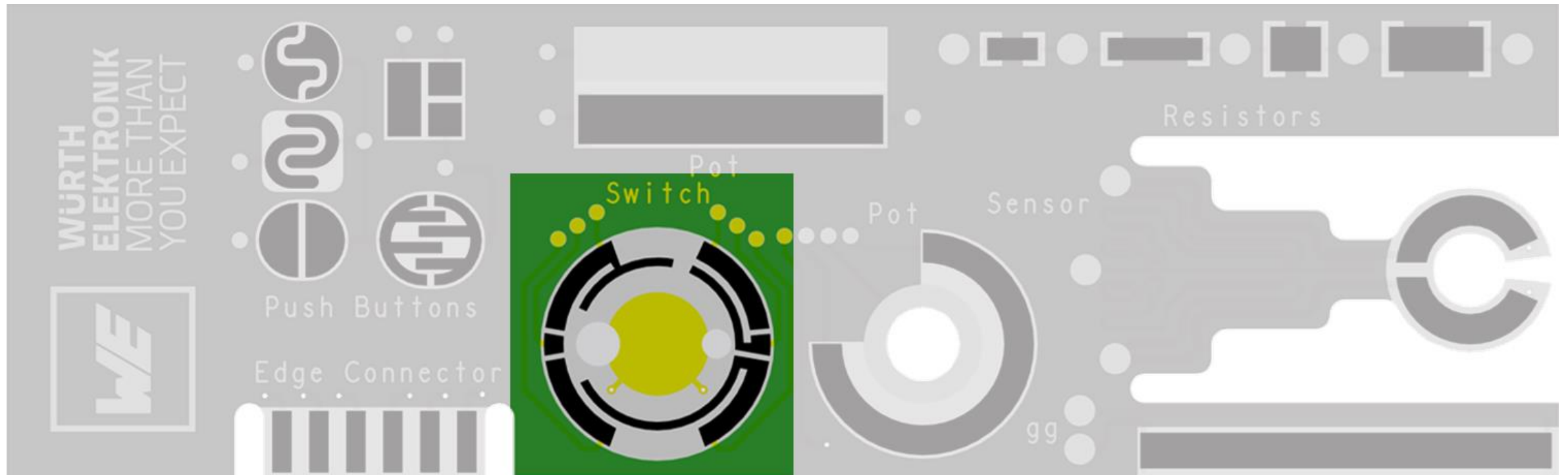


Isolation to prevent shorts



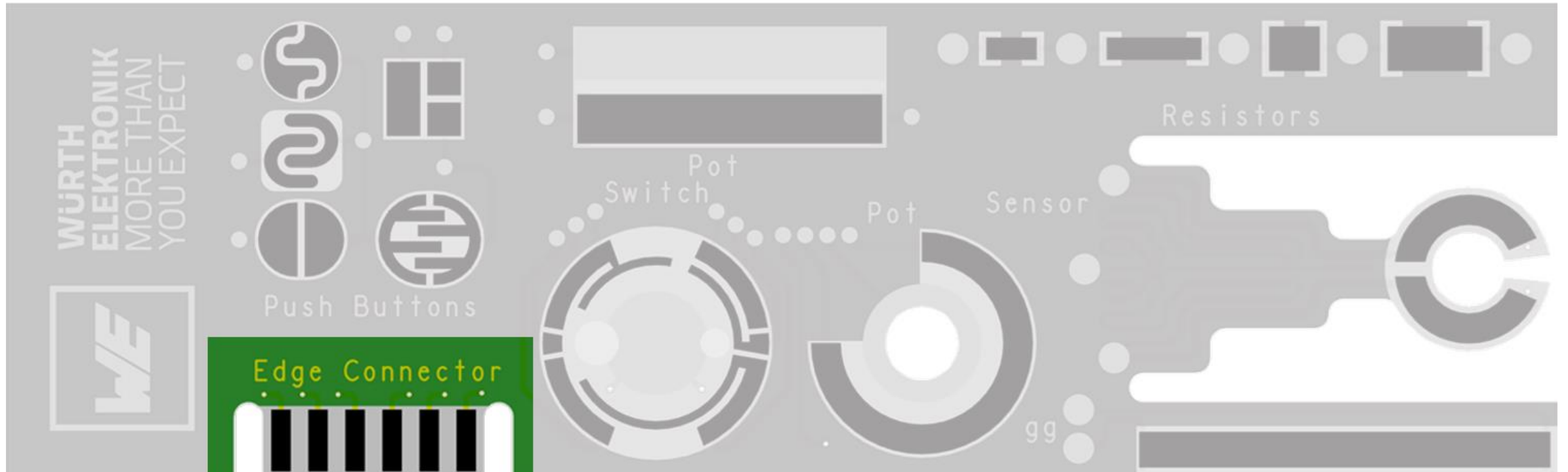
FUNCTIONS OF THE HAND SAMPLE

rotary switch



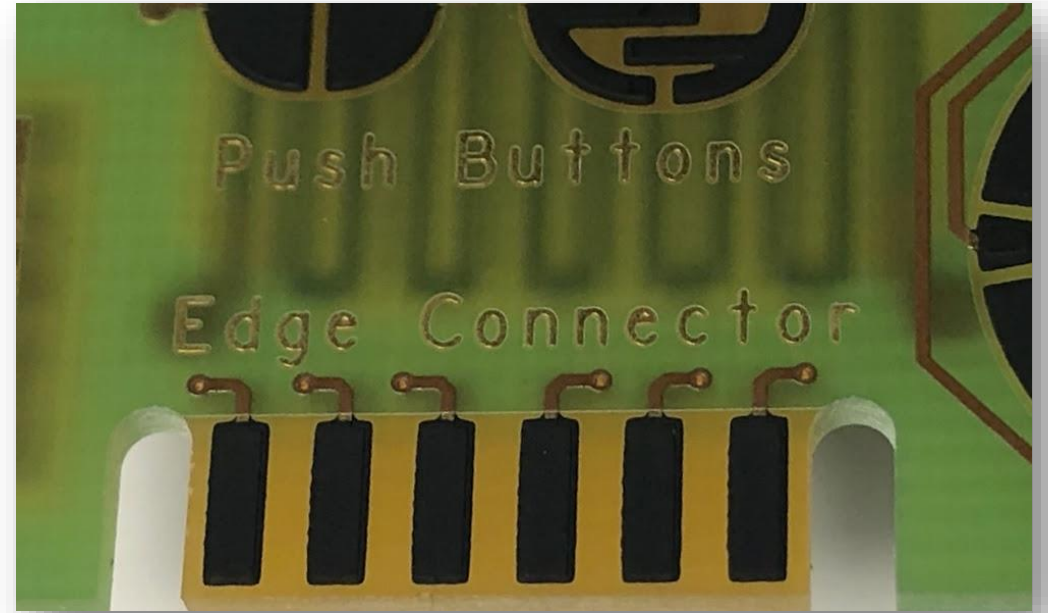
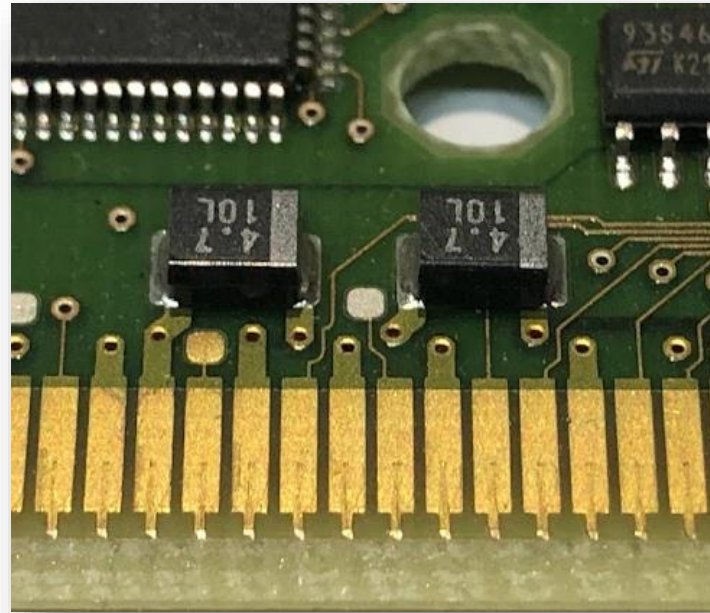
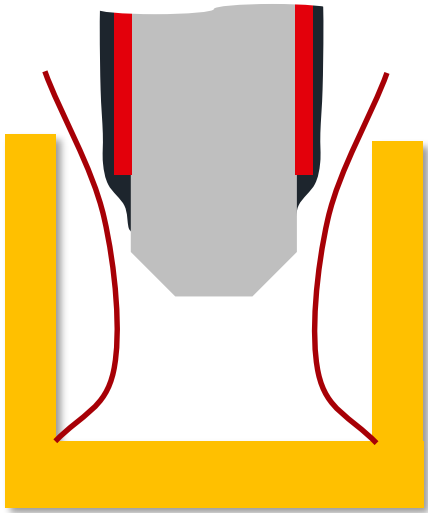
FUNCTIONS OF THE HAND SAMPLE

Edge Connector



FUNCTIONS OF THE HAND SAMPLE

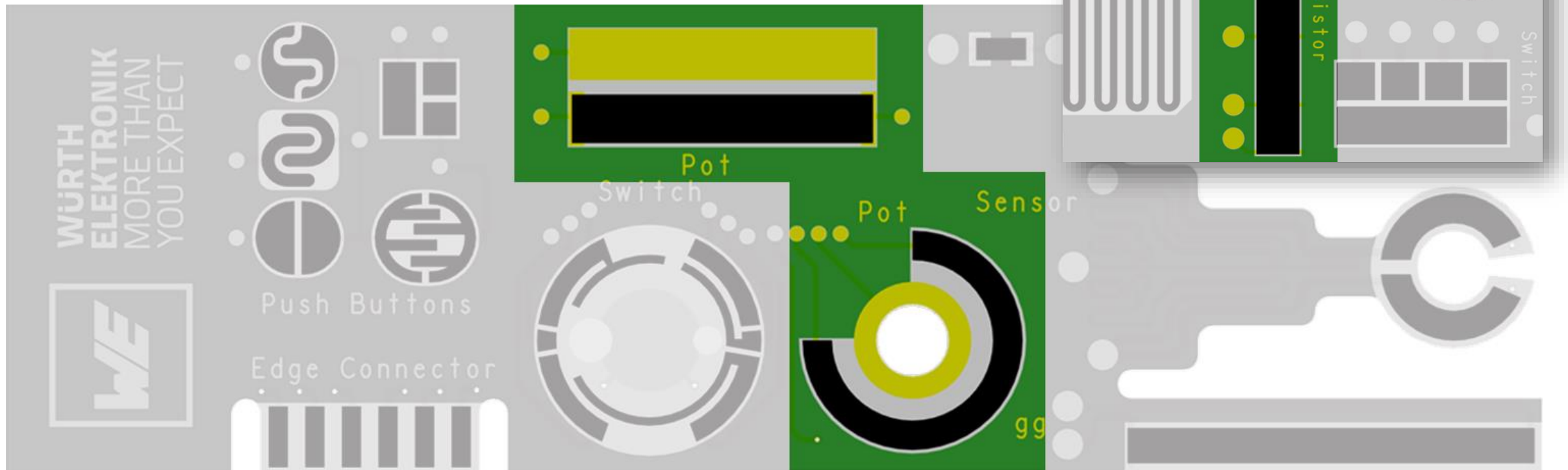
Edge Connector



- No galvanic connection necessary
- No open copper edge

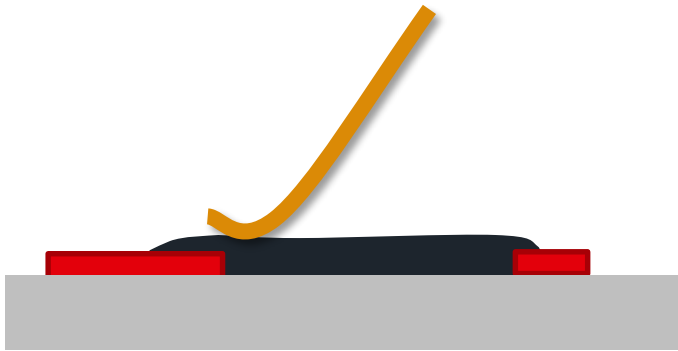
FUNCTIONS OF THE HAND SAMPLE

Potentiometer / Signal Receiver

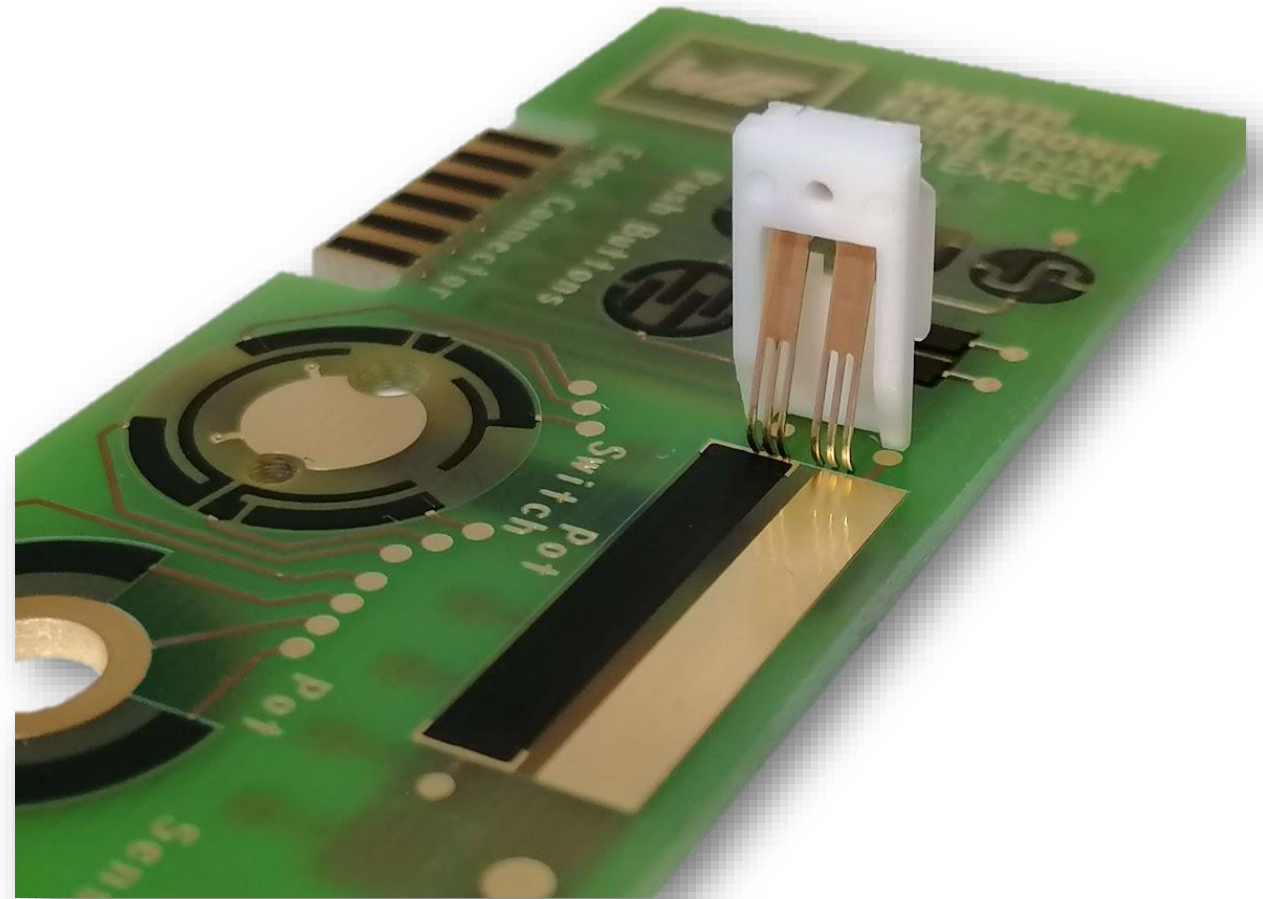


FUNCTIONS OF THE HAND SAMPLE

Potentiometer / Signal Receiver

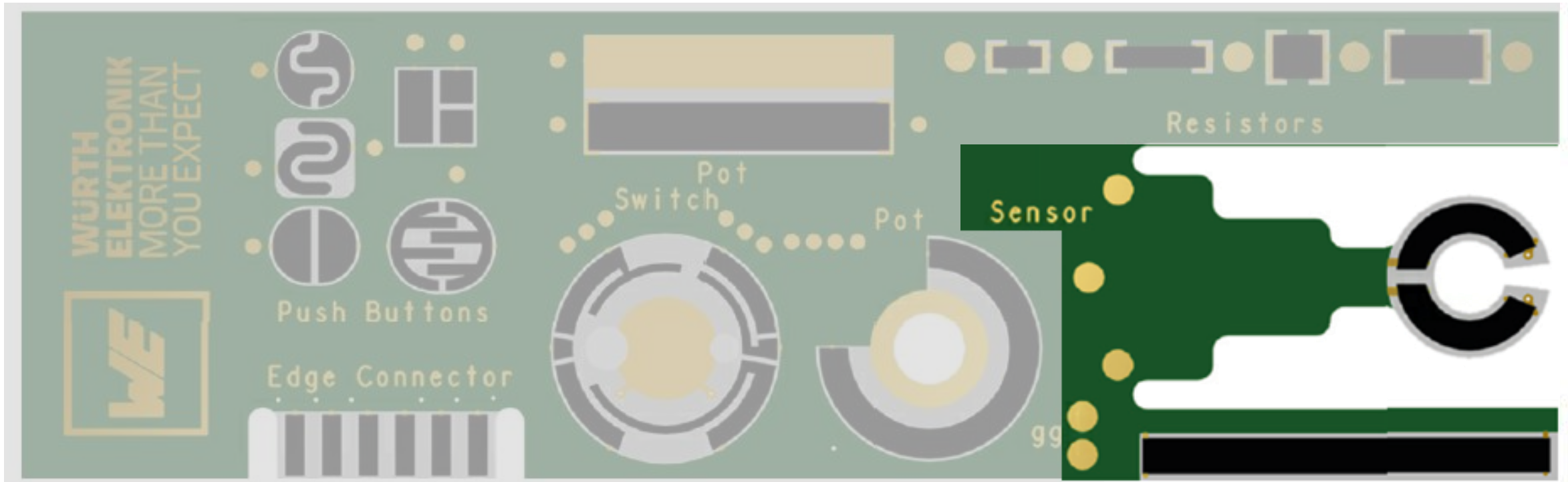


- More than 1 Million. cycles of operation
- linear or logarithmic resistance curves possible



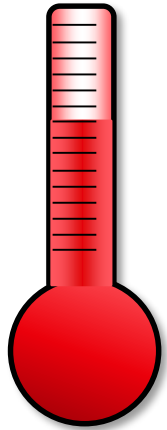
FUNCTIONS OF THE HAND SAMPLE

Sensors

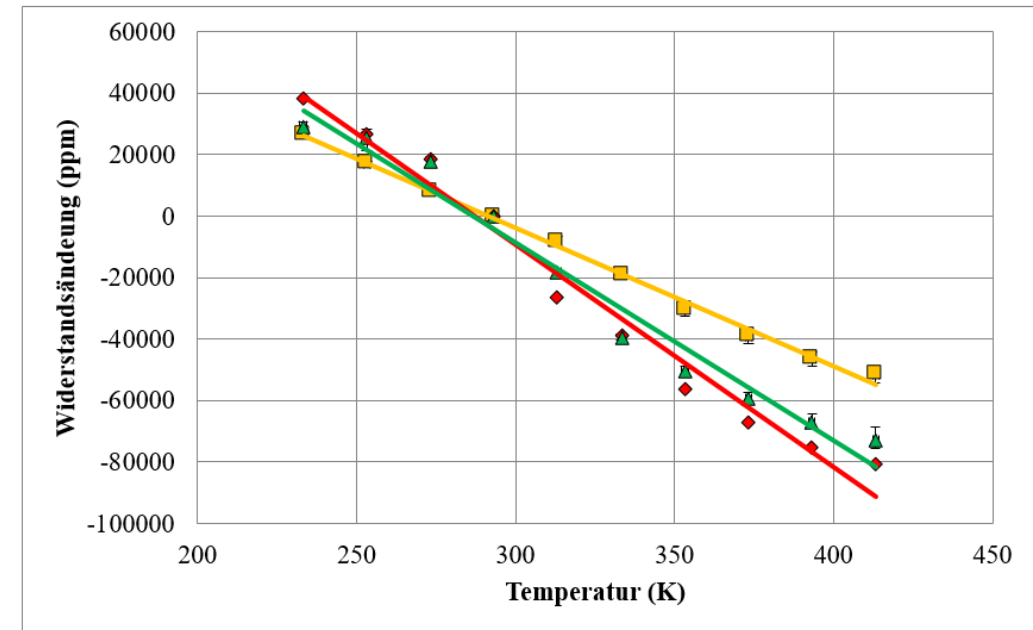


PRINTED POLYMER AS SENSOR

Temperatur Change

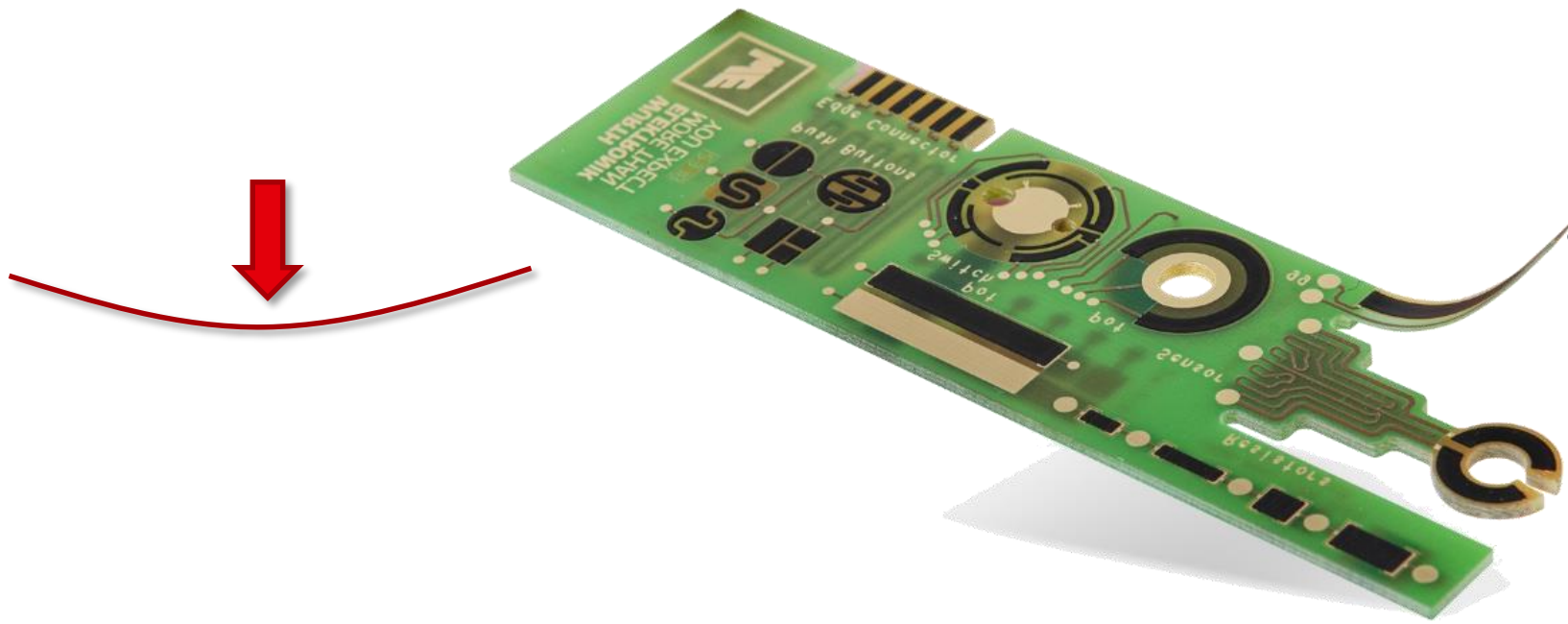


Typical Temperatur Coefficient for different pastes
-450 bis -750 ppm/K



PRINTED POLYMER AS SENSOR

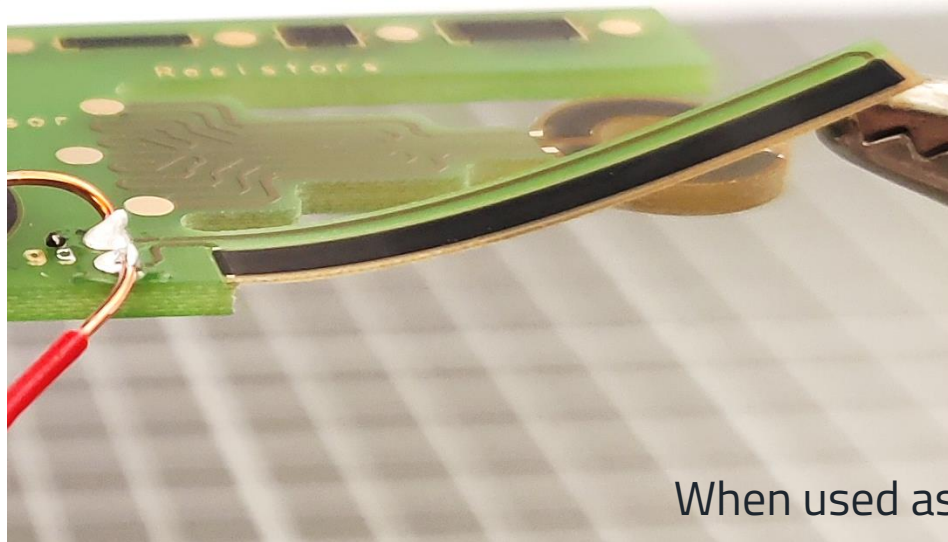
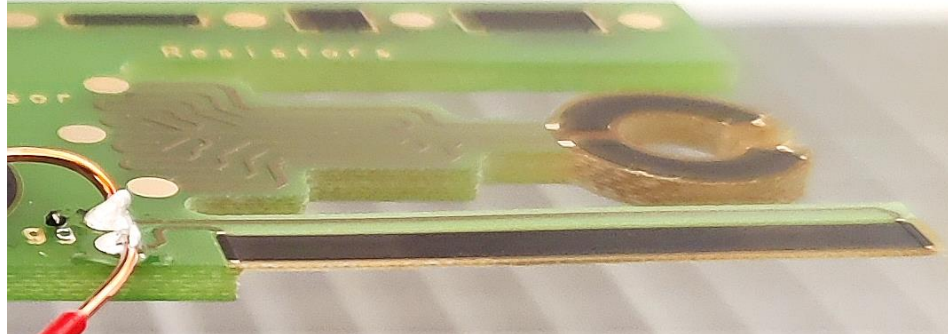
Bend Sensor



- Flexible due to deep-milled FR4

PRINTED POLYMER AS SENSOR

Bend Sensor



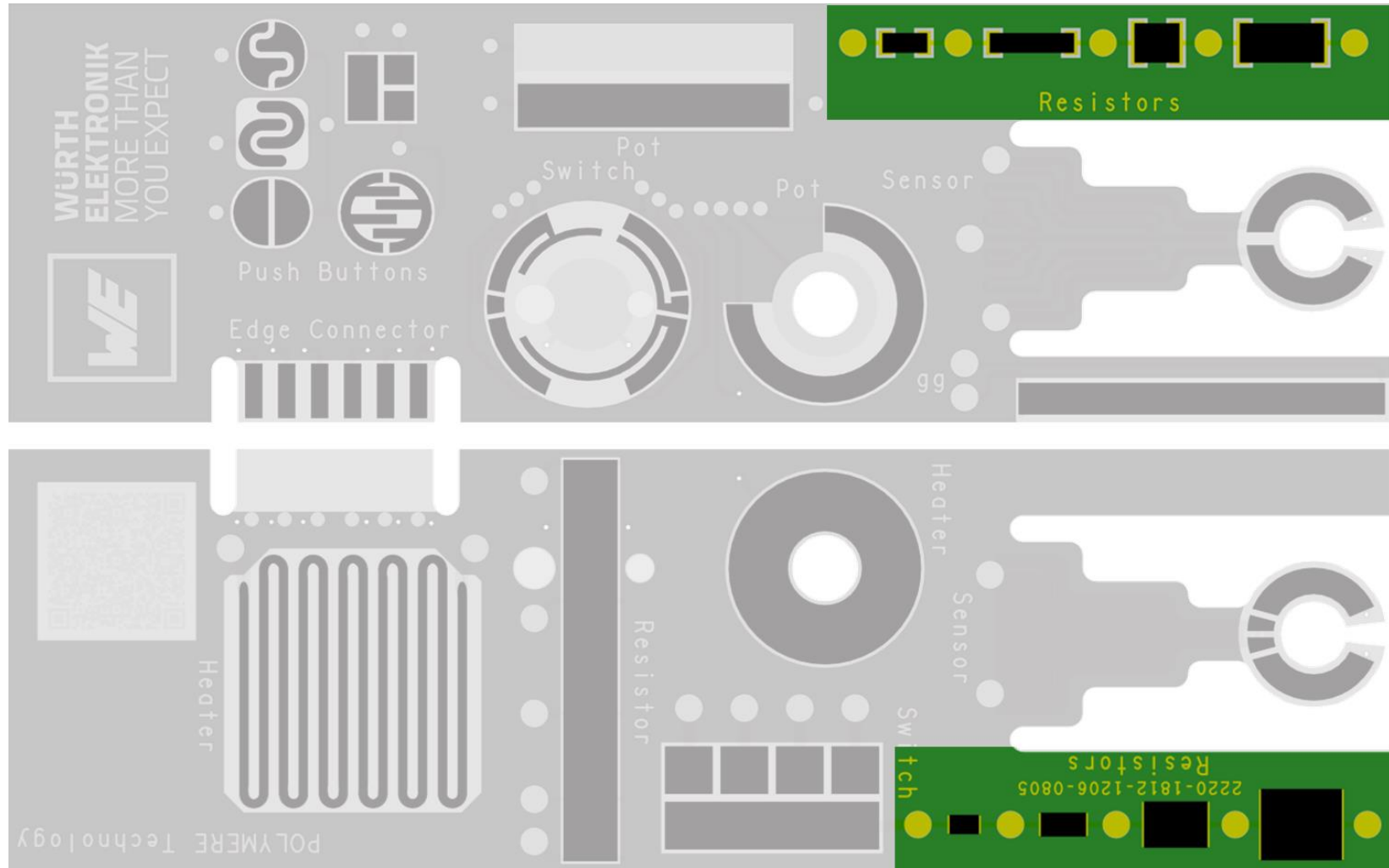
Starting value ~ 1,2 kOhm

change +/- 20 Ohm

When used as a strain gage, meandering is also possible

FUNCTIONS OF THE HAND SAMPLE

Resistors



FUNCTIONS OF THE HAND SAMPLE

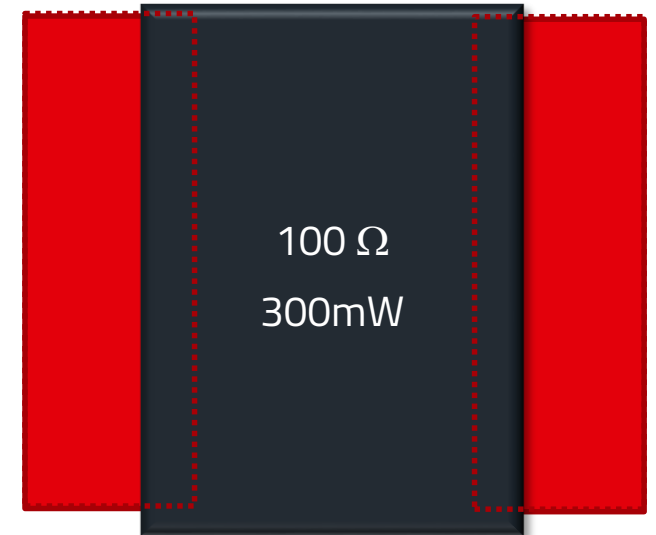
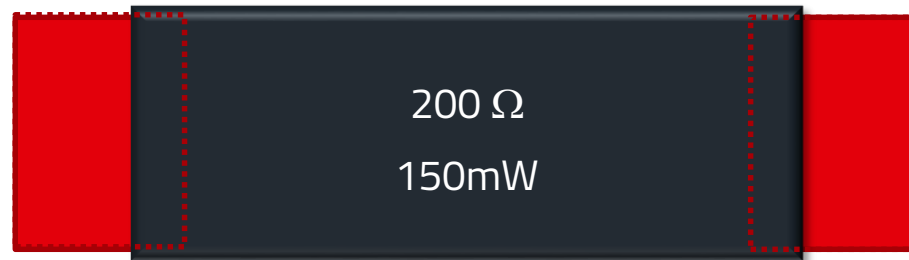
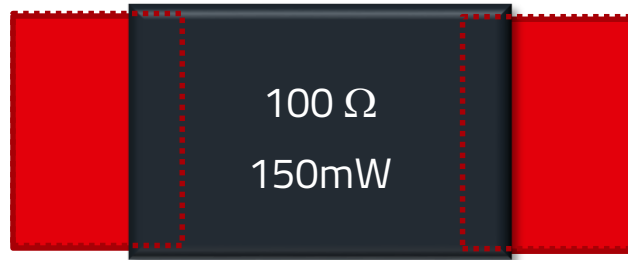
Resistors

Area_{effective}

L x W
1 x 1

L x W
2 x 1

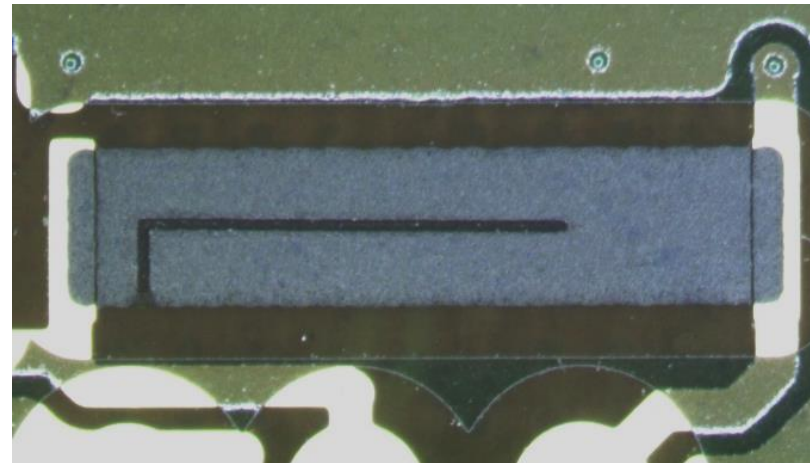
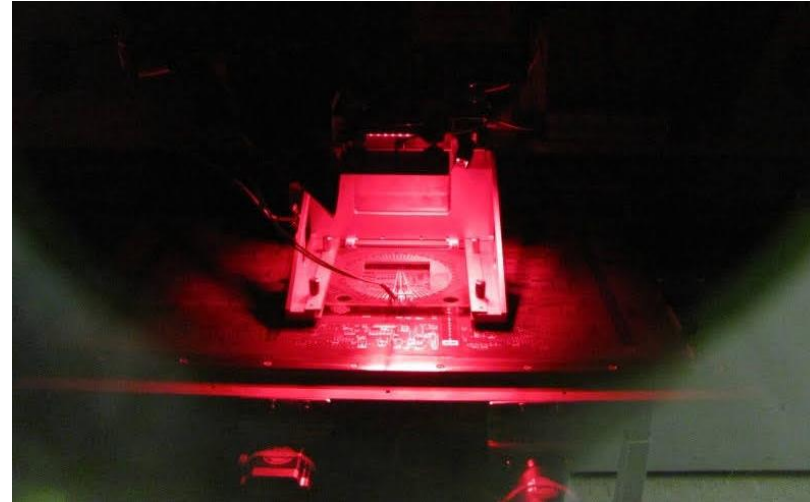
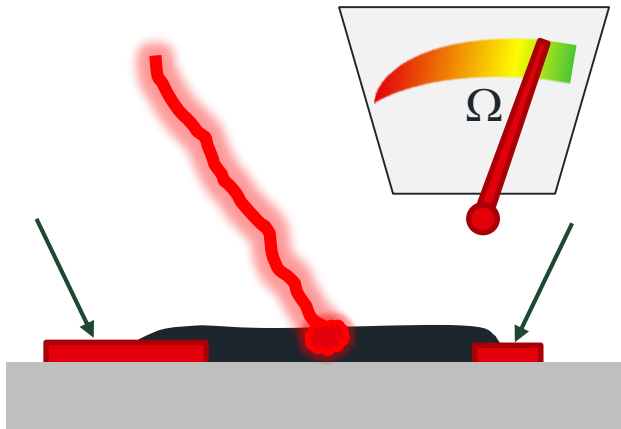
L x W
1 x 2



Typ. Resistance value 100Ω-750kΩ per Square
Typ. power dissipation @ ≤ 40°C ≤ 50 mW/mm²

PRINTED RESISTORS

Laser Trimming



Tolerance of resistance values

- Without laser trimming maximum $\pm 30\%$
- With laser trimming :
 - maximum $\pm 1\%$ after production
 - Over Life time: $\pm 5\%$

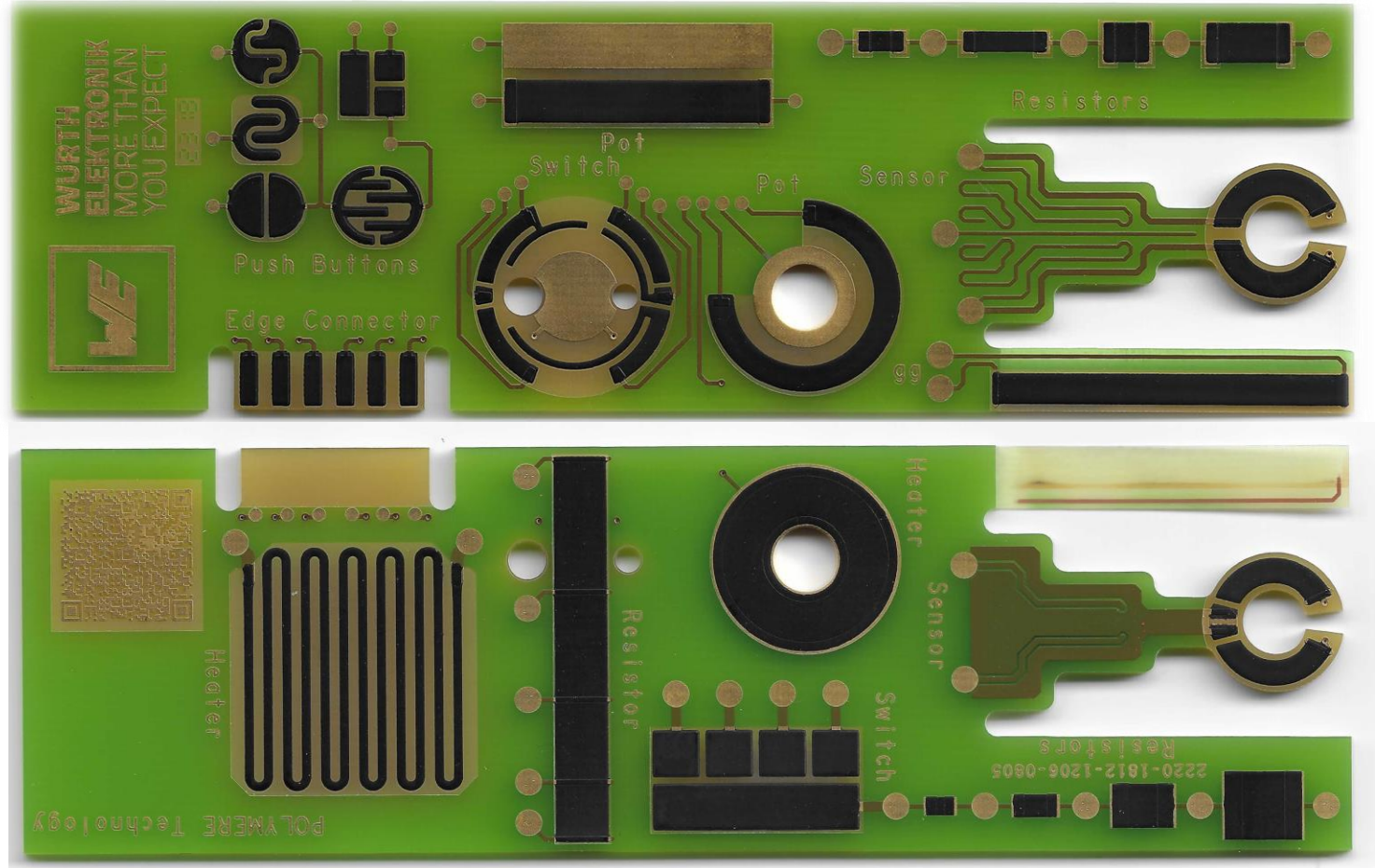
Traceability

- The laser trimming enables perfect traceability through binary coding of additionally designed resistors.

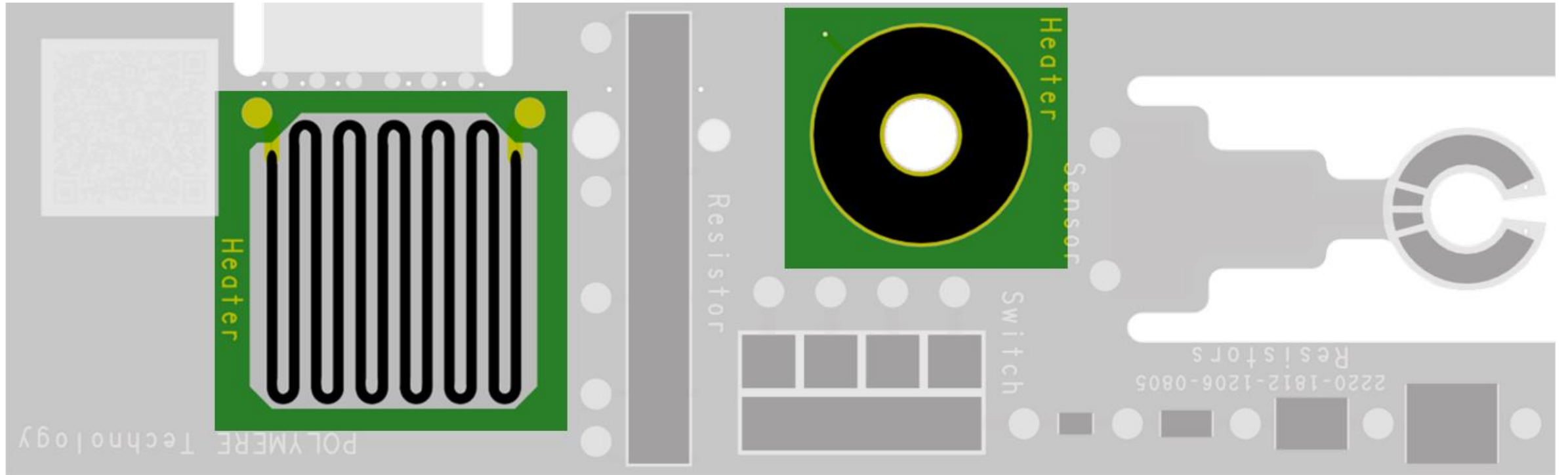
FUNCTIONS OF THE HAND SAMPLE

Resistors

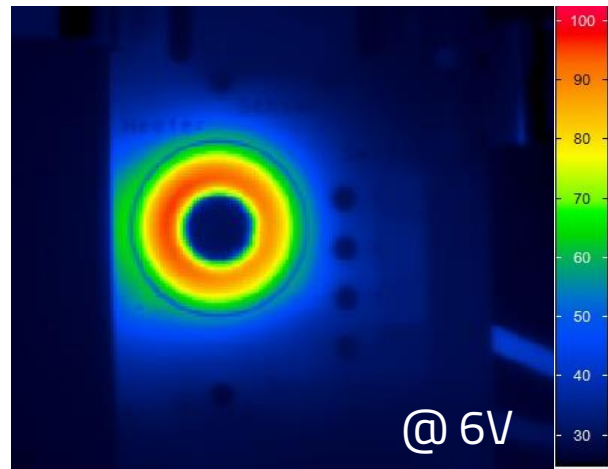
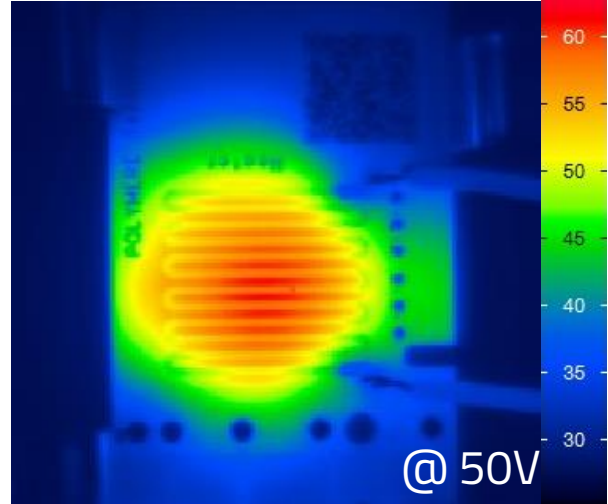
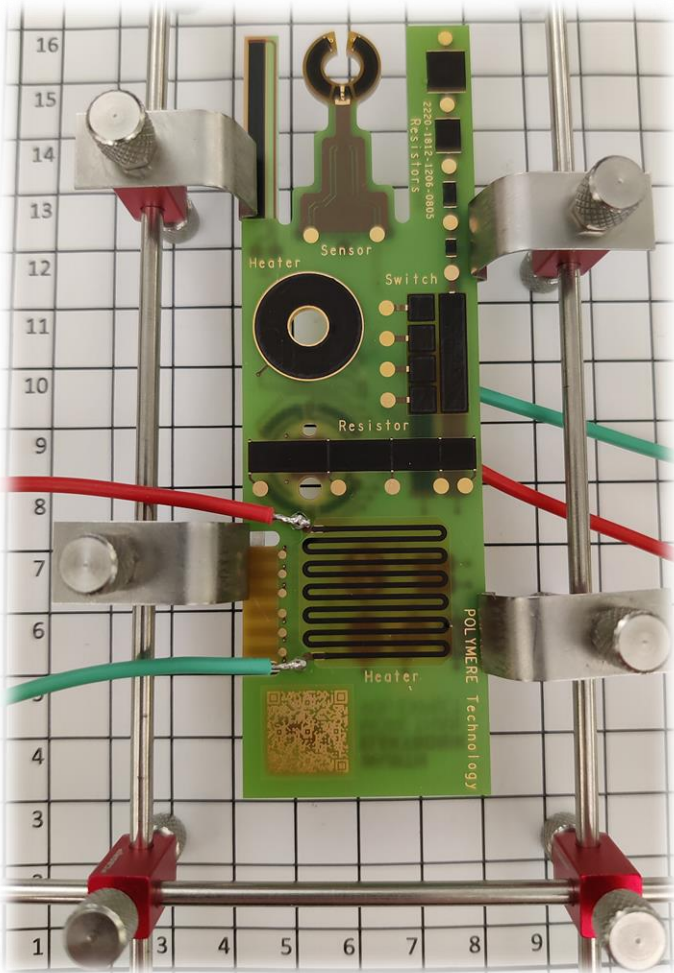
- A wide variety of form factors
- Optimum adaptation to complex PCB contours
- High-voltage applications, e.g. test probes for railway overhead lines
- Polymer-film thickness
~20 - 25um
 - Can be connected directly to heatsinks via heatsink adhesive
 - Simple PCB embedding
- Standard tolerance +/- 30%
- Can be trimmed to +/- 5% by in-house laser trimming



PRINTED HEATER



HEATERS



- Temperature can be adjusted by polymer paste choice or layout

Voltage	Current	Temperature
1V	0,03A	28 °C
2V	0,05A	34 °C
3V	0,08A	44 °C
4V	0,11A	58 °C
5V	0,13A	75 °C
6V	0,16A	99 °C
7V	0,19A	122 °C
8V	0,22A	149 °C
9V	0,24A	178 °C
10V	0,27A	220 °C

APPLICATION IN PRODUCTION

Contacts



Power Derating & Thermal Management



High Voltage



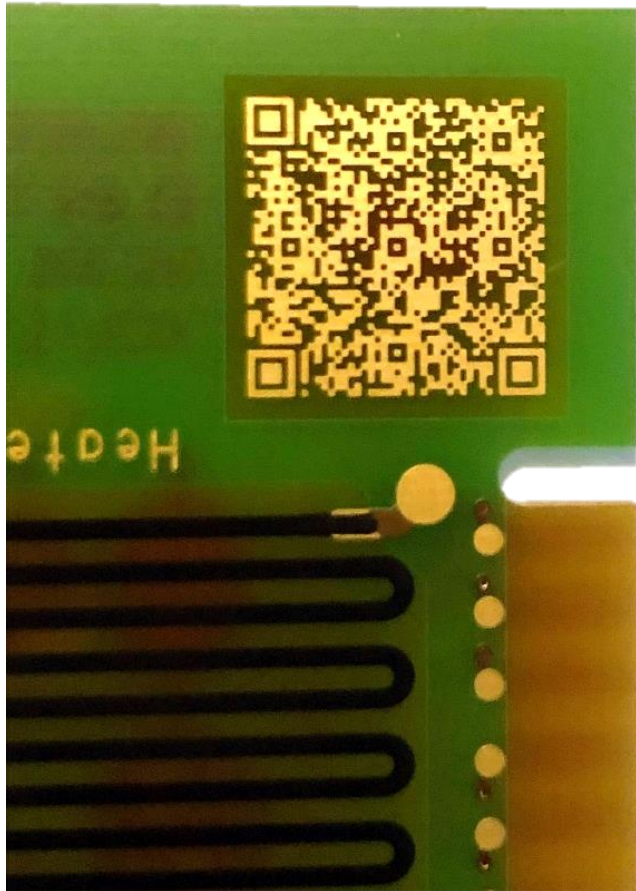
More Information

- **Webinar:** "Printed Polymer - an alternative to SMD assembly,"
- **Tutorial:** "Printed Resistors in a High Performance PCB System - Printed Polymer "



YOUR PERSONAL SAMPLE

Interested in a printed polymer hand sample WE.polymer ?



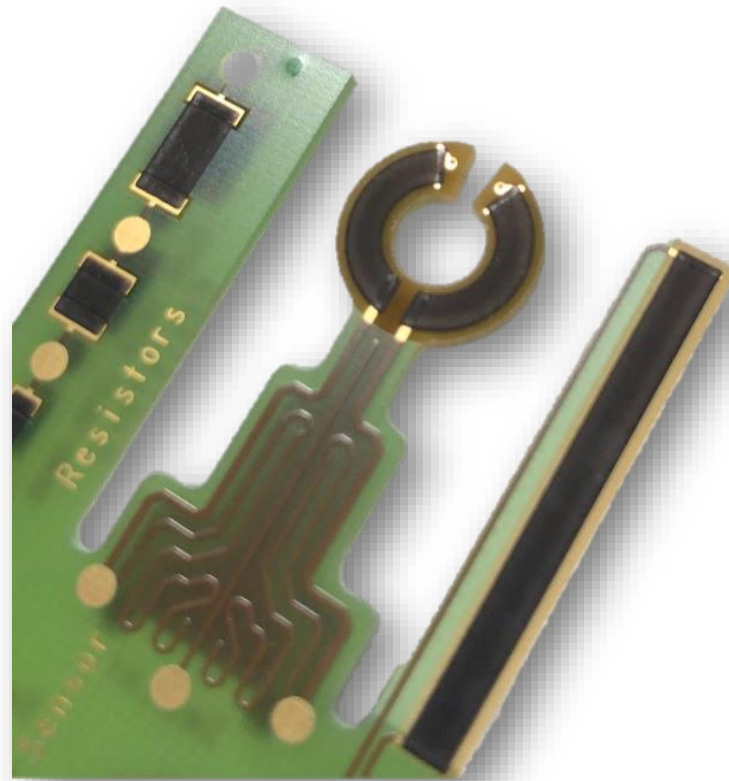
Scan the QR code or
visit the website:

www.we-online.com/polymersample

SURVEY 2

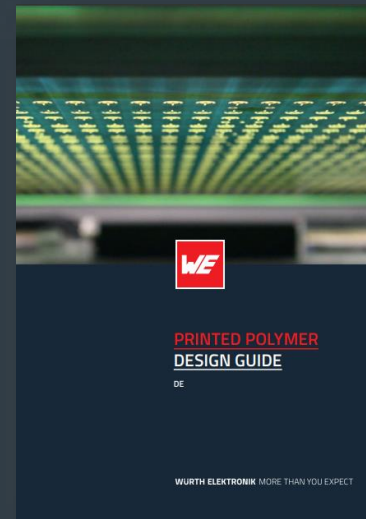
2. Poll:

- What function could the C-shaped circuit shown have?



THANK YOU VERY MUCH FOR YOUR ATTENTION!

Which application do you have?
How can WE support you?



Contact:

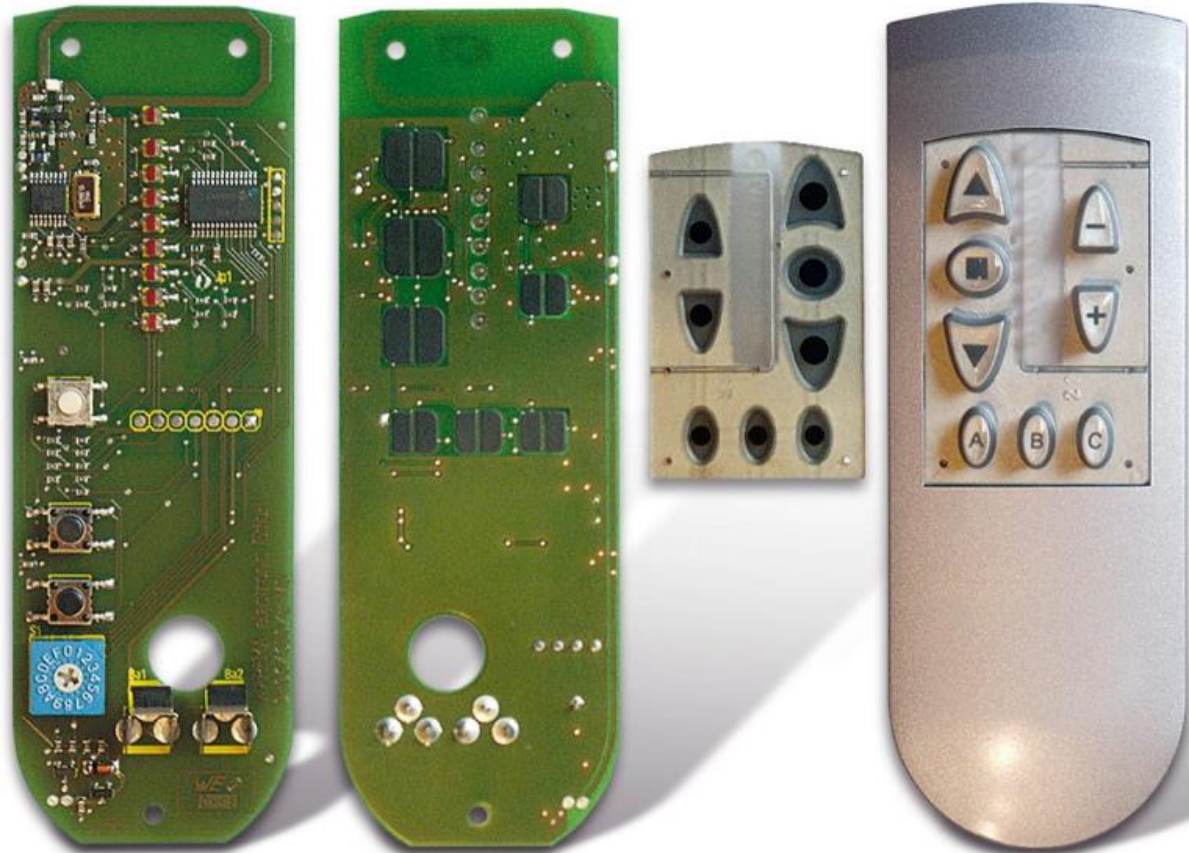
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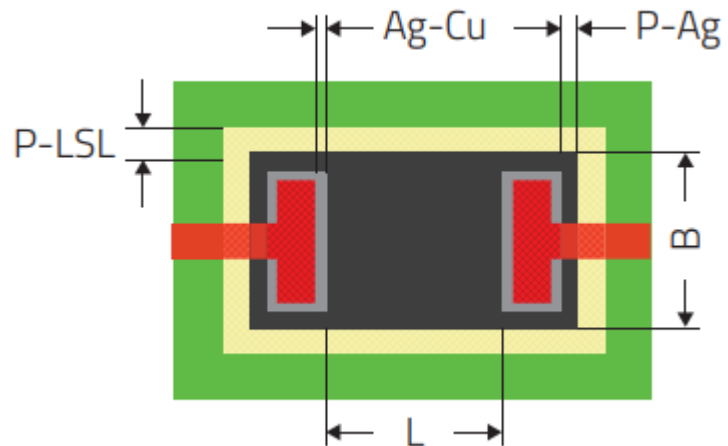
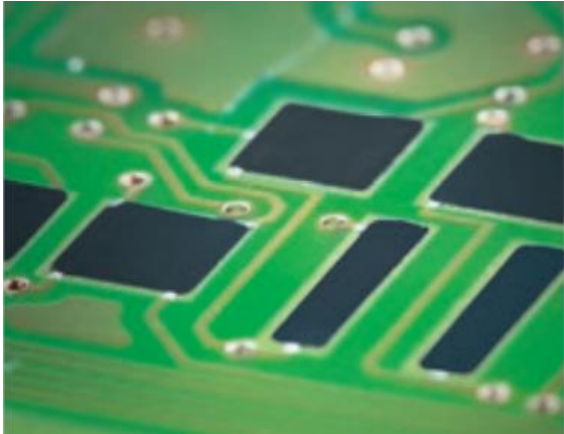




This technology is used in

- Automotive
- Medical sector
- Building sector
- Household sector
- Security technology sectors
- Commercial vehicles

EXTRACT PRINTED POLYMER DESIGN GUIDE



extract [Design Guide](#)

100Ω-750kΩ per Square

Resistor length	L	≥ 2 mm
Resistor width	B	≥ 1.5 mm
Overlap silver to copper	Ag-Cu	≥ 0.25 mm
Overlap resistor to silver	P-Ag	≥ 0.15 mm
Solder mask clearance	P-LSL	≥ 0.25 mm
Overlap polymer to copper	Ü	0.20 mm
Overlap copper to polymer	P-Cu	≥ 0.15 mm
Copper thickness (total)		≤ 50 µm
Distance to other electrical potential		≥ 0.5 mm
Resistor values, typical		100 Ω – 750 kΩ*
Resistor tolerance		+/- 30%**
Dissipation at environmental temperature: ≤ 40°C		≤ 50 mW/mm ²