

# Semiflex: an award-winning miniaturization success



December 5th, 2018

Speaker:  
Andreas Schilpp

# agenda

1

- **The way to the champion**

2

- **The genes of the champion**

3

- **What may peak performance cost?**

4

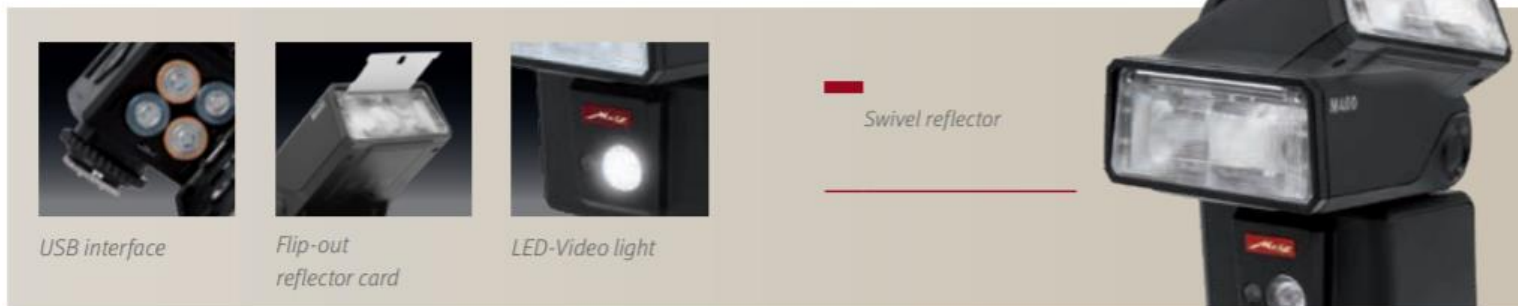
- **What's left in it? Roadmap**

# mecablitz M400 - „Compact and powerful.“

- system flash unit –  
 „Perfectly equipped, attractively packaged.“

CANON FUJIFILM NIKON OLYMPUS PANASONIC PENTAX SONY

## Overview:



[Link](#)

## Project „M400“

### Briefing – specification

- as small as possible
- Energy from 4 AA batteries
- Guide number 40 (ISO100)
- perfect all-rounder for mirrorless system cameras
- as cheap as possible

February:  
First definitions for  
layer stackup

April:  
Meeting at Metz  
with  
interdisciplinary  
development team

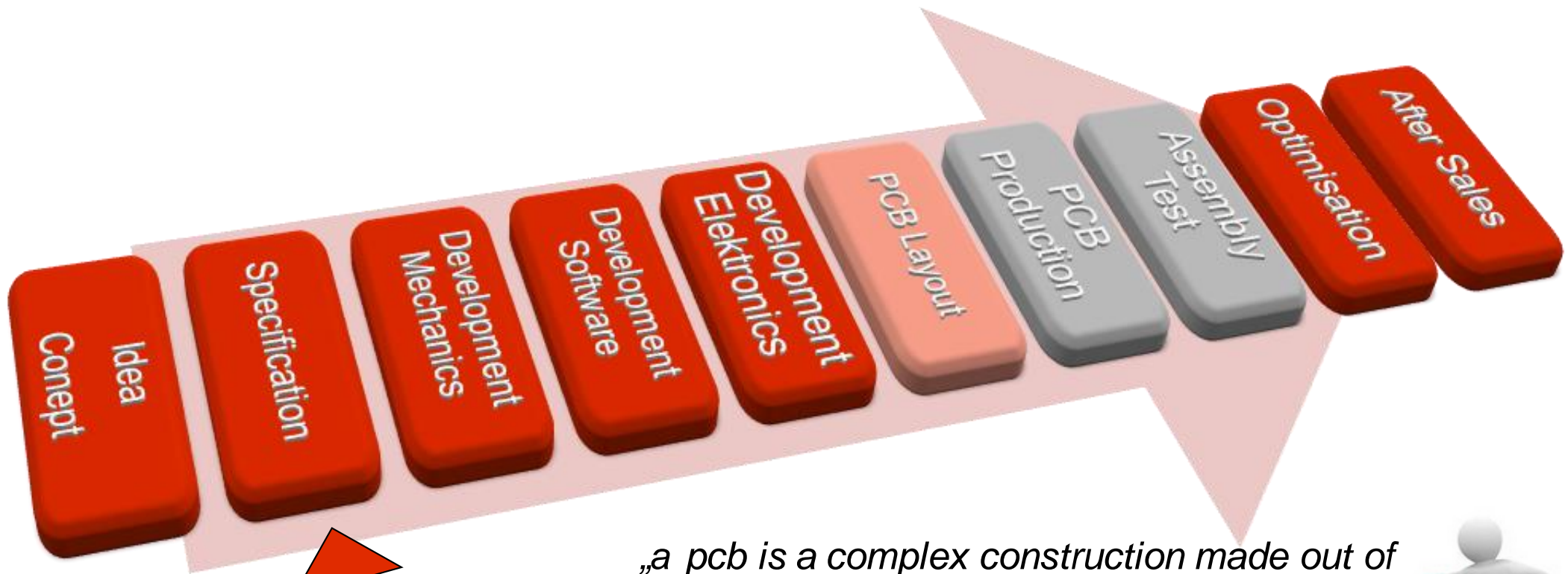
August:  
Start of series  
production

**photokina**  
IMAGING UNLIMITED

**September:  
leading fair**



# Design Chain electronic system development

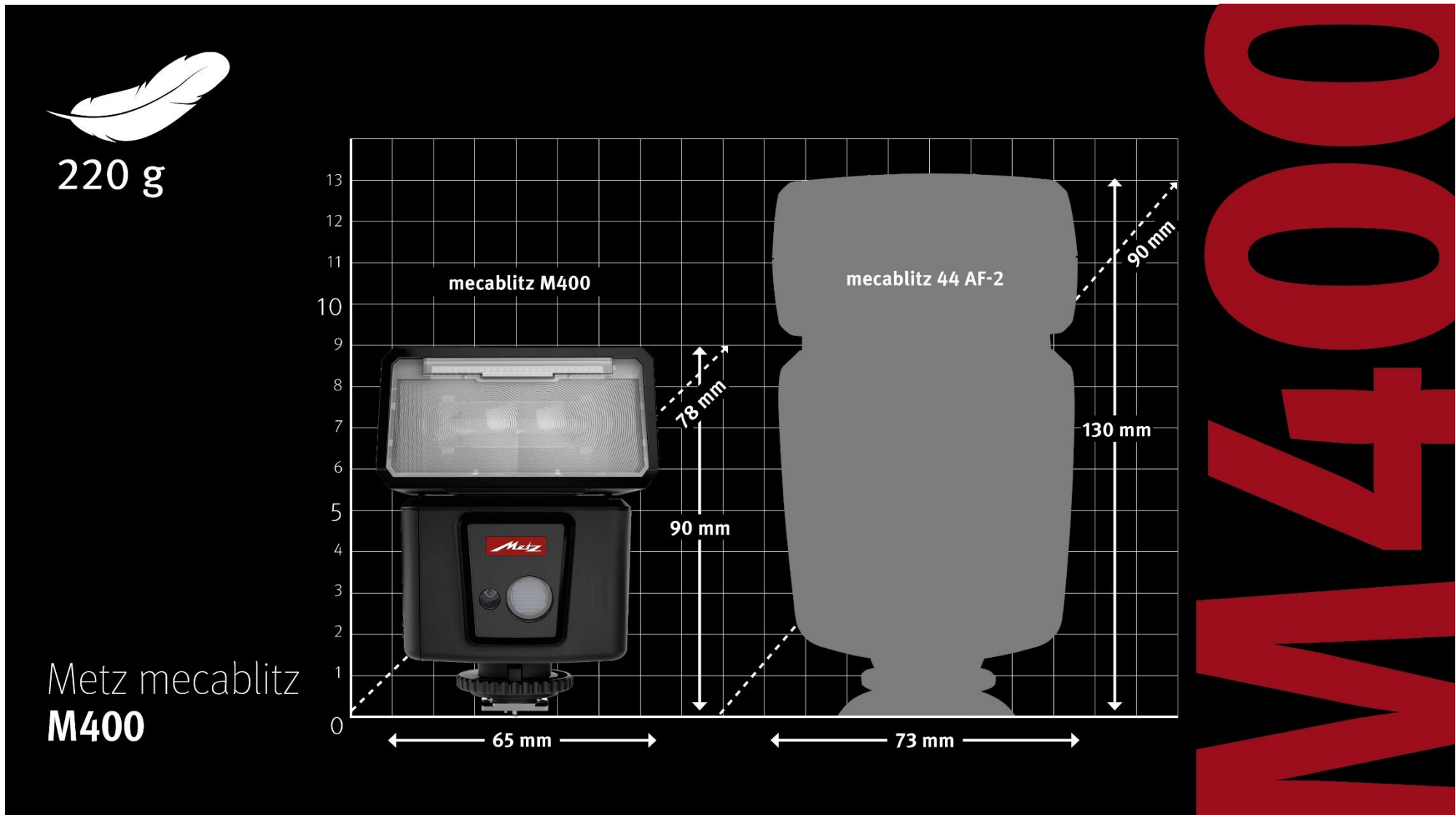


*„a pcb is a complex construction made out of many different materials, produced using a variety of processes for getting tailored functionality!“*



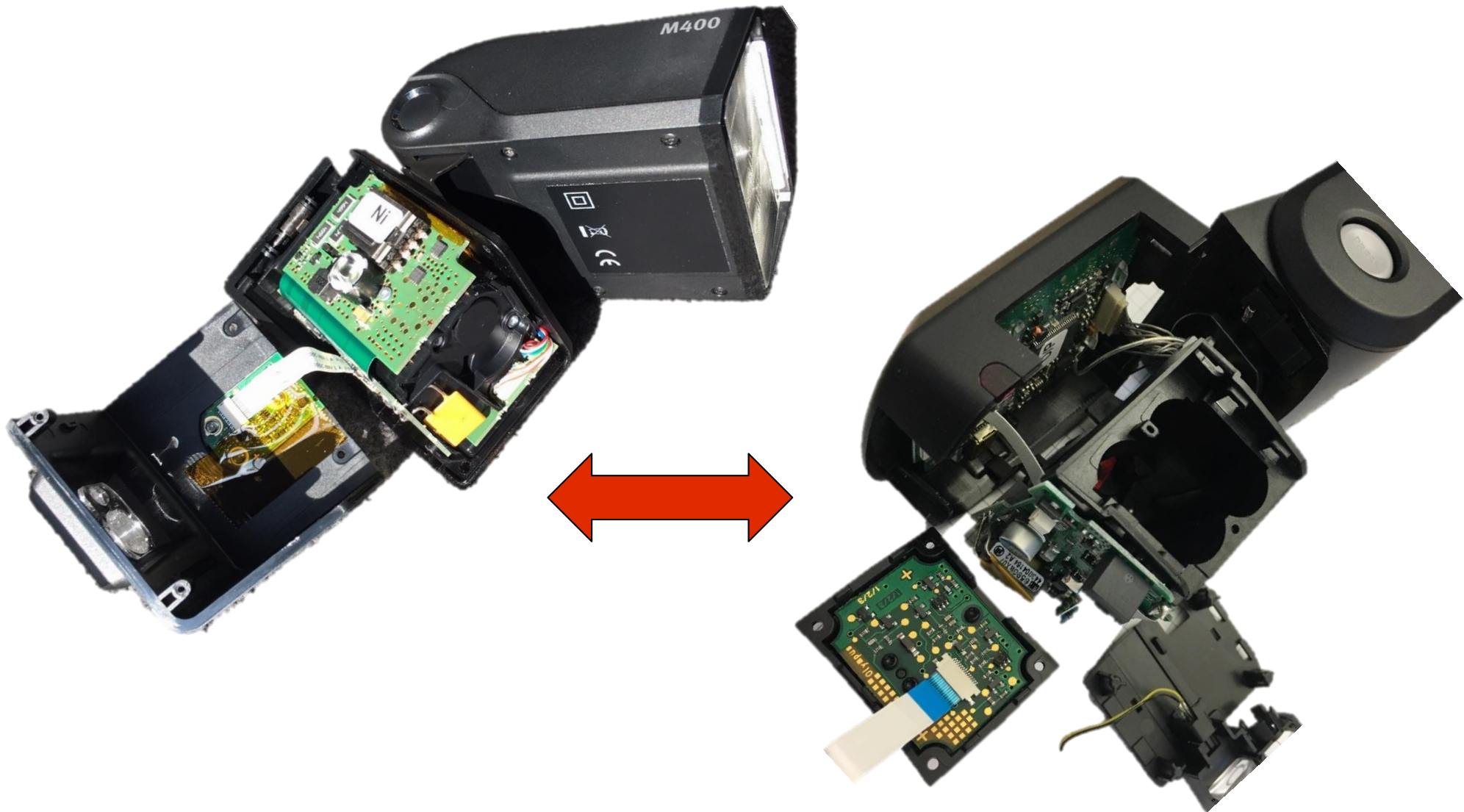
**stated conditions → Specification**

# Größenvergleich / size comparison





# Vergleich Systeme / Comparison of systems



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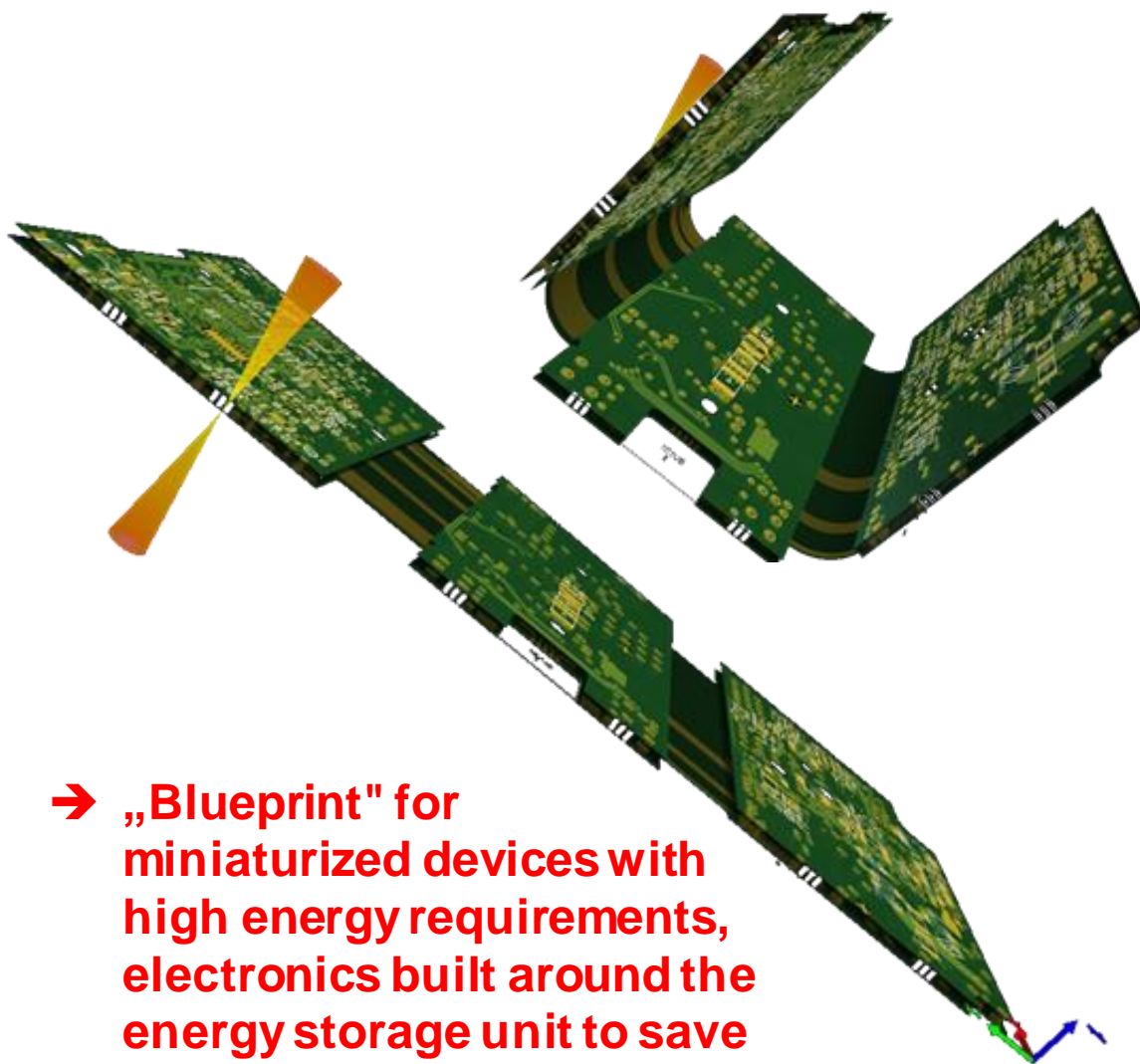
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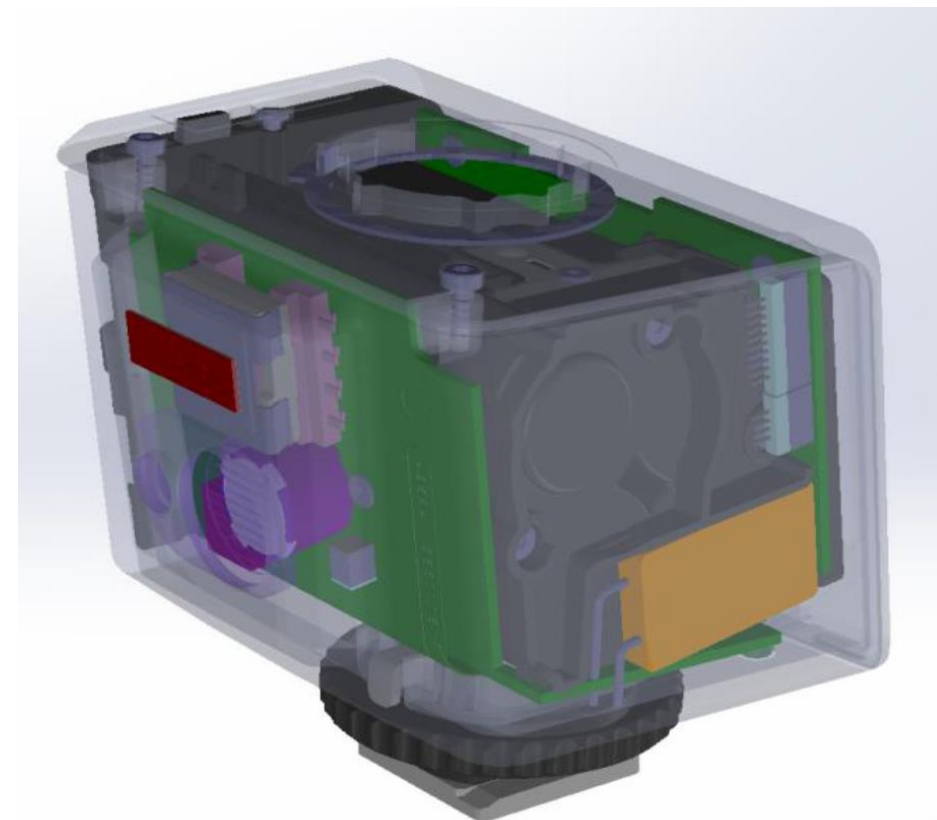
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## The heart of the champion - the Semiflex circuit board



























→ „Blueprint" for miniaturized devices with high energy requirements, electronics built around the energy storage unit to save space!



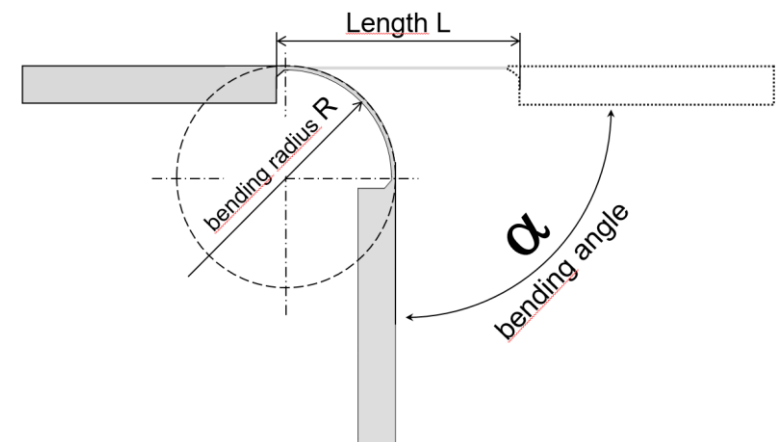
# The heart of the champion - the Semiflex circuit board

## Layer Stackup:

		Rigid	Semiflex
Top Overlay	0,000mm		
Top Solder	0,015mm		
Component Side	0,045mm		
FR4	0,210mm		
Inner Layer 1	0,035mm		
FR4	0,410mm		
Inner Layer 2	0,035mm		
FR4	0,105mm		
FR4	0,105mm		
Solder Side	0,045mm		
Bottom Solder	0,015mm		
Bottom Overlay	0,000mm		

Necessary length L of the bending area is:

$$L = \text{angle } \alpha \times \text{radius } R \times \text{Pi} / 180^\circ + 2 \times 0.4\text{mm (bevel Y)}$$

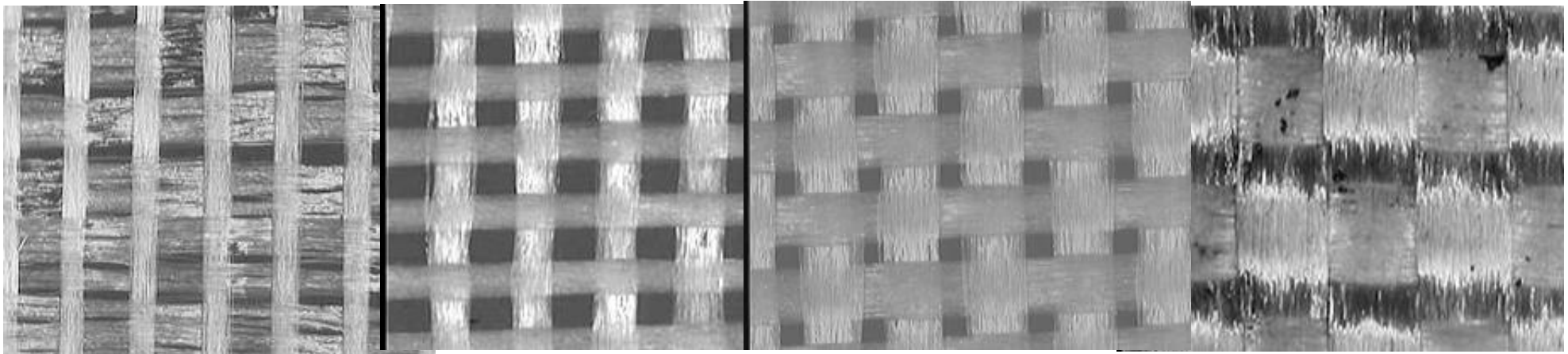


- FR4Semiflex does not have flex areas, but bending areas.
- no flexible material Polyimide!
- no separate drying necessary
- qualified for 10 bends
- Bending radius and direction must be respected!

Winkel [°]	Länge L des Biegebereichs @ Biegeradius [mm]	
	4	5
45	3,9	4,7
90	7,1	8,7
180	13,4	16,5

## Big influence: layer structure and dielectric material

- **Prepreg constructions:** not too coarse and not too fine for Semiflex!



**type 106**  
50 – 55  $\mu\text{m}$

**type 1080**  
60 - 70  $\mu\text{m}$

**type 2116**  
85 – 100  $\mu\text{m}$

**type 7628**  
180 – 210  $\mu\text{m}$

- **Resin and fillers**
  - Tg135 shows the best bending properties
  - higher Tg and fillers worsen the bending properties

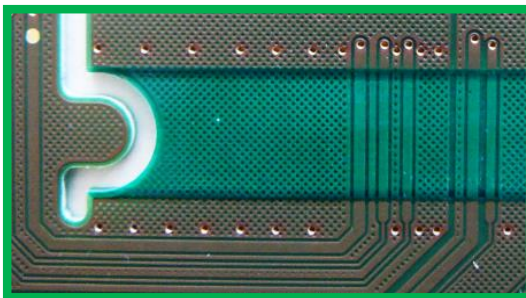
# Designrules FR4 Semiflex


## Maximum copper design

- **Bad:** copper free area in bending zone, small contour radius



- **Good:** balanced copper design in bending area, big contour radius




more than you expect 

### Design Rules


#### FR4 Semiflex

CBT\_Check\_PM\_03  
Application according IPC 2223 Use A: Flex-to-install

These design rules apply to:  
bendable, semiflexible circuit boards with 1 or 2 copper layers in the bending area, externally located.



Example: 1layer in the bending area: 1Ri-3Ri



Example: 2 layers in the bending area: 2Ri-4Ri

Nomenclature: Ri = Rigid, F = Flexible material is not used at all!

Basic information

- Please comply with general standards, such as IPC or IEC
- Please note the useful information and tips in the WE Flex-Rigid Design Guide \*
- Please see the WE Basic Design Guide for rules for line widths, spacing, via and pad sizes, solder mask \*
- Filling of plated through holes (PTH):  
Never use open vias in solder areas! For PTH plugging (IPC Type III) always keep a clearance of 400µm to solder areas on both sides! In case of IPC Type VII (filled and capped) please ask for possible design rules (in special: line space parameters).
- Flex-to-install bending radii for FR4 Tg135: only bending for assembly is allowed!
  - 1 copper layer in a Multilayer stack-up: Bending radius minimum 4mm
  - 2 copper layer and 2-layer circuit boards: Bending radius minimum 5mm
- Bending direction: only allowed in the semiflex area with copper outside the radius (milled area inside bending!)
- Important hint for the assembly: a controlled pre-bending using a bending tool assuring the minimum bending radius prior to the final assembly is important to simplify assembly and to prevent damage!
- Drying before assembly and soldering: FR4 Semiflex circuit boards do not contain flexible material Polyimide. So they could be processed like standard rigid FR4 circuit.
- We will be happy to create the optimal delivery panel for you (best price!)

\* All mentioned documents can be found online at: [www.we-online.com/flex](http://www.we-online.com/flex)

Entstf: Geck, Andrea, 02.01.2018
Geprüft: Schilp, Andreas, 03.01.2018
Freigegeben: Beck, Thomas, 03.01.2018

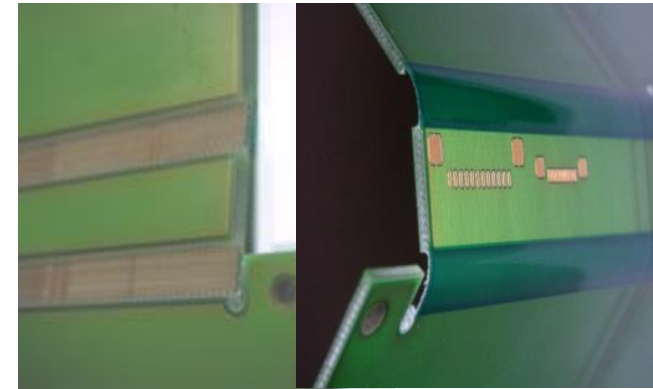
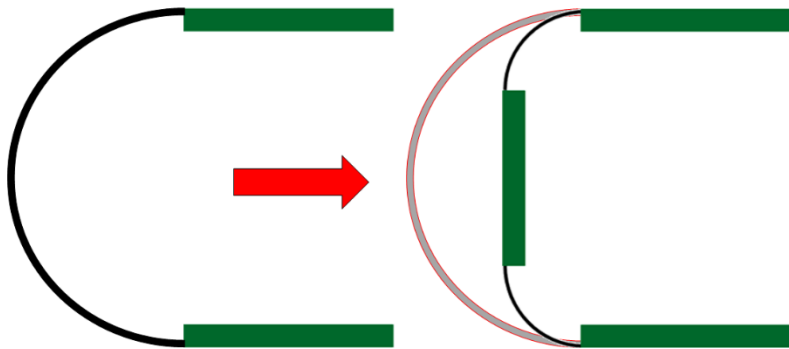
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Neuanlage

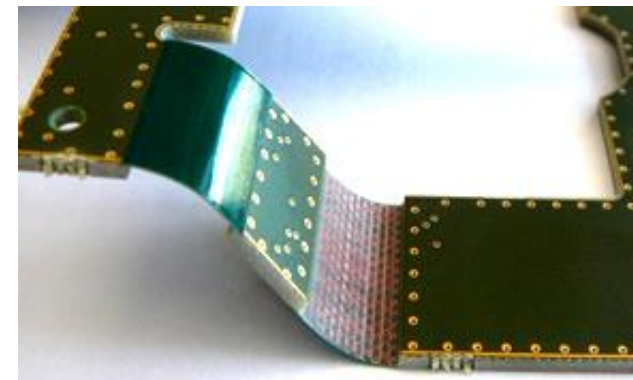
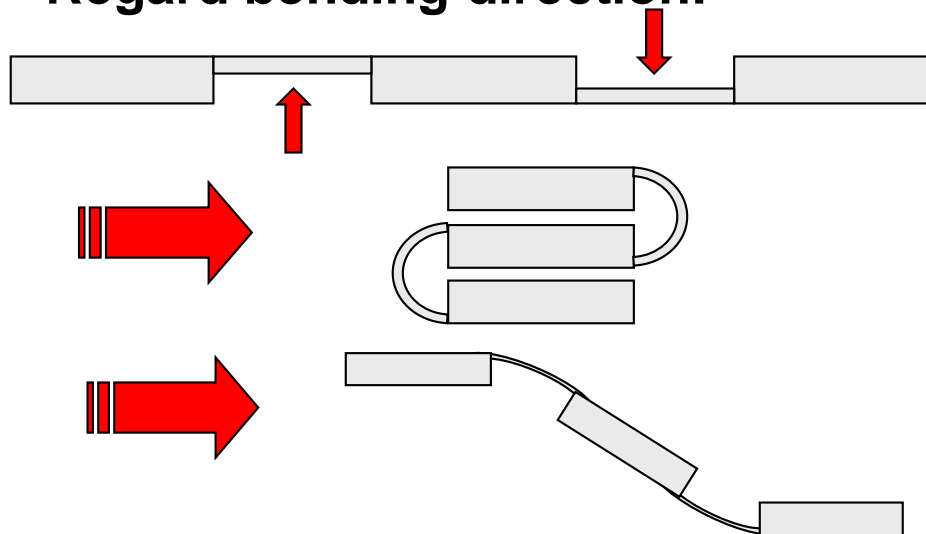


## Designrules FR4 Semiflex

- Replace large 180° areas with 2 x 90° with rigid intermediate part



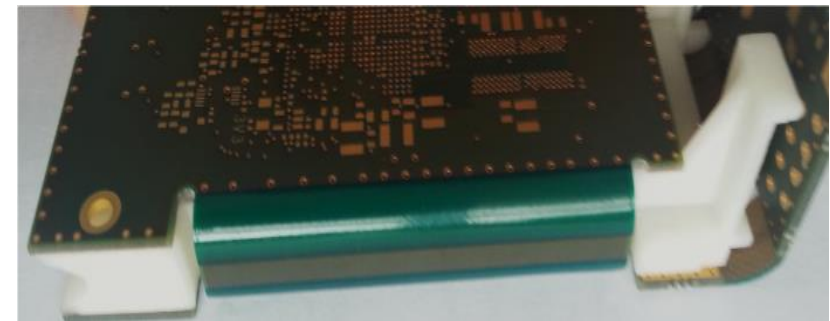
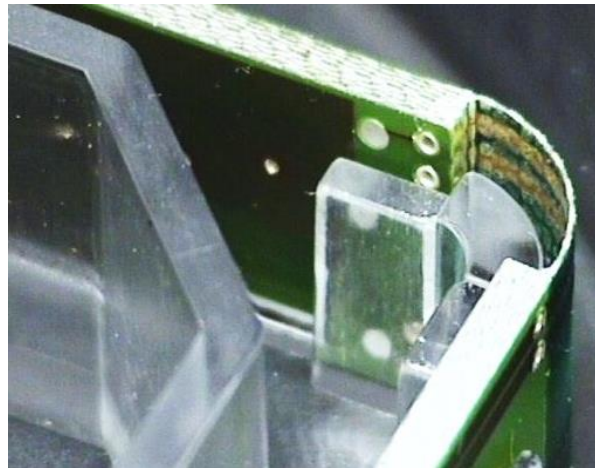
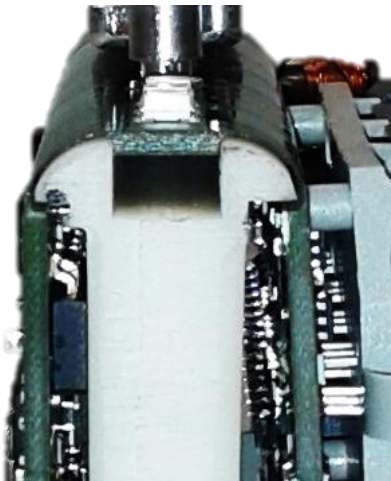
- Regard bending direction:





## Reliability of construction

- **Bending aids: Example (left) or integrated in housing (right)**



- **Array design + panel separation!**
  - Semiflex area must not be damaged during separation!



# How do you get a complex Semiflex in there?

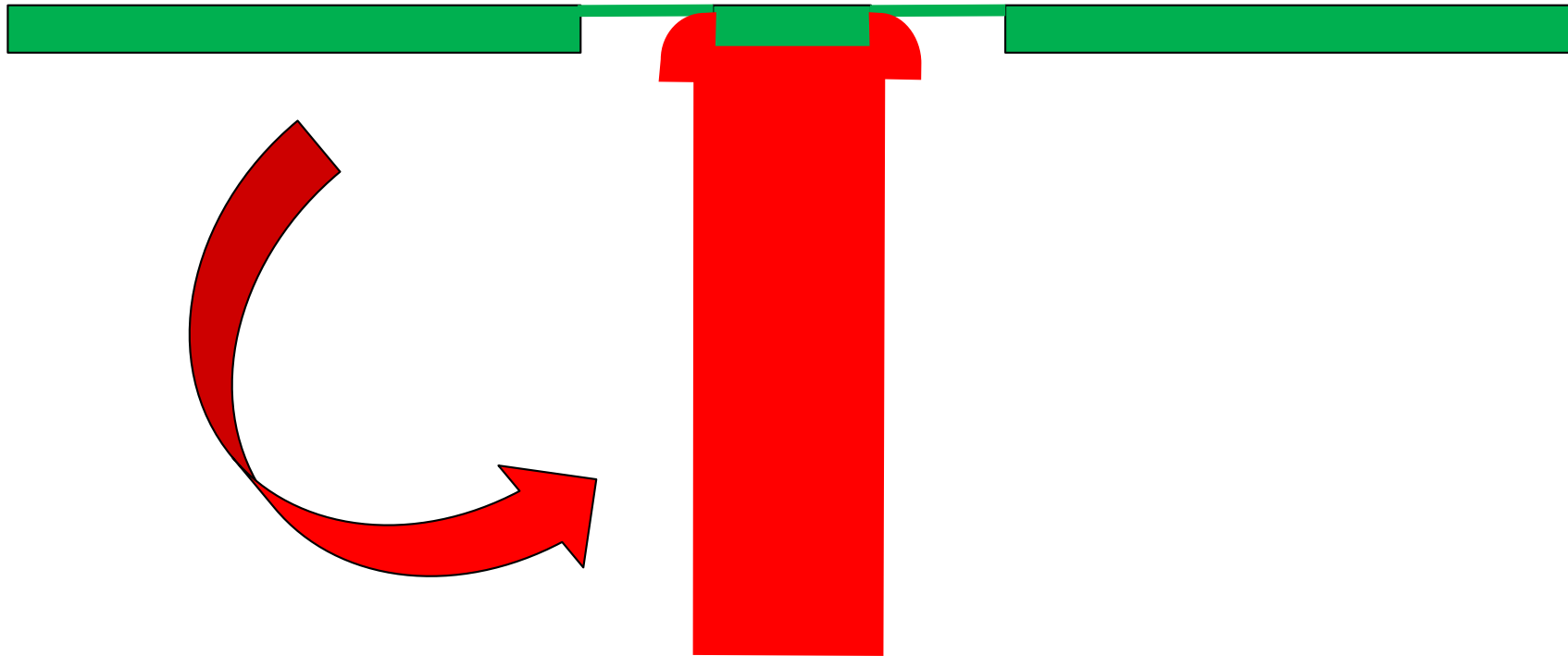


# Bending and assembly tool



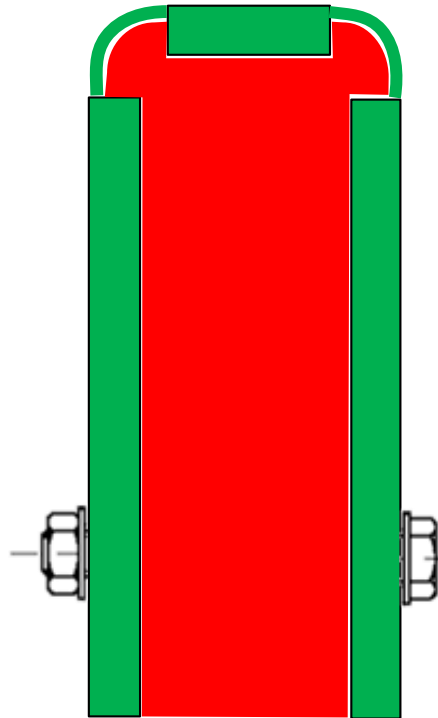
## Reliability of construction

- idea of combined bending + fixing tools:



## Reliability of construction

- idea of combined bending + fixing tools:



- Does that look familiar to you?

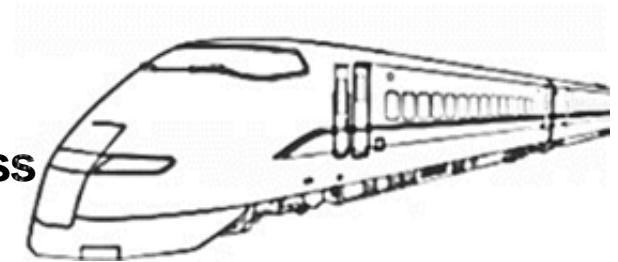
## Gerätemontage M400 / device assembly M400



**perfect job, guys @ metz!**

## Applications Semiflex Technology

- Automotive (headlights, ECU, cameras, distance measuring technology, transmission electronics ...)
- Industrial electronics (sensor technology, LED lights, drive technology, motor control, hydraulic control....)
- Heavy mechanical engineering
- Security technology, building services engineering (access control, climate sensors, control and operating devices, Smart Water Metering)
- Medical technology (charger, handheld devices)
- Railway technology (ECU diesel engine)
- Geotechnics (Switchbox)





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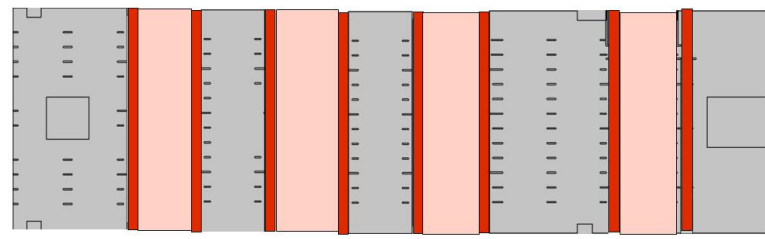
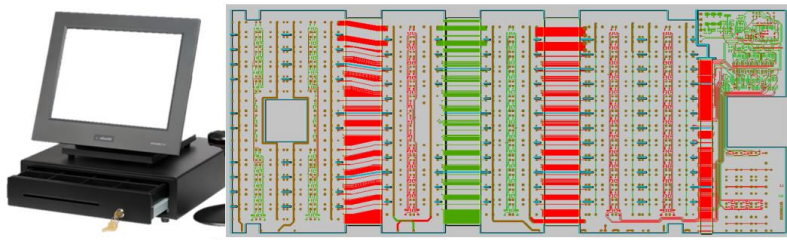
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# cost comparison

**Webinar from March 03, 2015:**



**No more cable spaghetti –  
Wiring 4.0 via Semiflex**

➔ available in our Webinar Archive!





# comparison: total system

	rigid pcbs with cables and connectors	Semiflexible pcb
balance sheet		





# comparison: total system



	rigid pcbs with cables and connectors		Semiflexible pcb		
<b>balance sheet</b>					
	<b>100 pcs</b>	<b>1.000 pcs</b>	<b>100 pcs</b>	<b>1.000 pcs</b>	<b>Remarks</b>
a) pcb price	58,50 €	40,50 €	55,90 €	45,50 €	pcbs from Europe
b) FFC cables, ZIF connectors	30,00 €	13,00 €	-	-	EMS Sweden
c) for this SMD assembly AOI	2,00 €	1,50 €	-	-	EMS Sweden
d) final assembly	2,00 €	1,50 €	-	-	EMS Sweden
e) final test	1,50 €	1,00 €	1,50 €	1,00 €	EMS Sweden
<b>sum of BoM and processing</b>	<b>94,00 €</b>	<b>57,50 €</b>	<b>57,40 €</b>	<b>46,50 €</b>	
			<b>-39%</b>	<b>-19%</b>	<b>cost saving</b>
additional cost factors:					
f) design for	<b>5 pcbs</b>		<b>1 pcb</b>		<b>1</b>
g) inventory control	<b>17 components + 5 stencils</b>		<b>1 component + 2 stencils</b>		
h) assembly expenditure	<b>5 x</b>		<b>1 x</b>		
i) test expenditure	<b>6 x</b>		<b>1 x</b>		
k) stock / logistics	<b>22 positions</b>		<b>3 positions</b>		
l) Pin- and solder connections	<b>312 ZIF-contacts + 312 solder joints</b>		<b>integrated Semiflex connection</b>		
					<b>Reliability</b>

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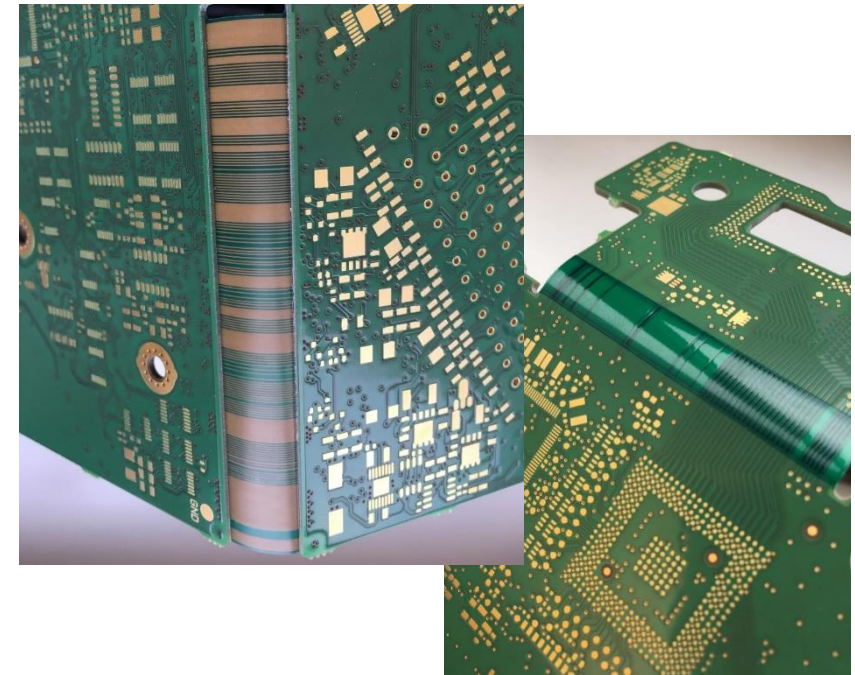
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## Semiflex constructions for special requirements

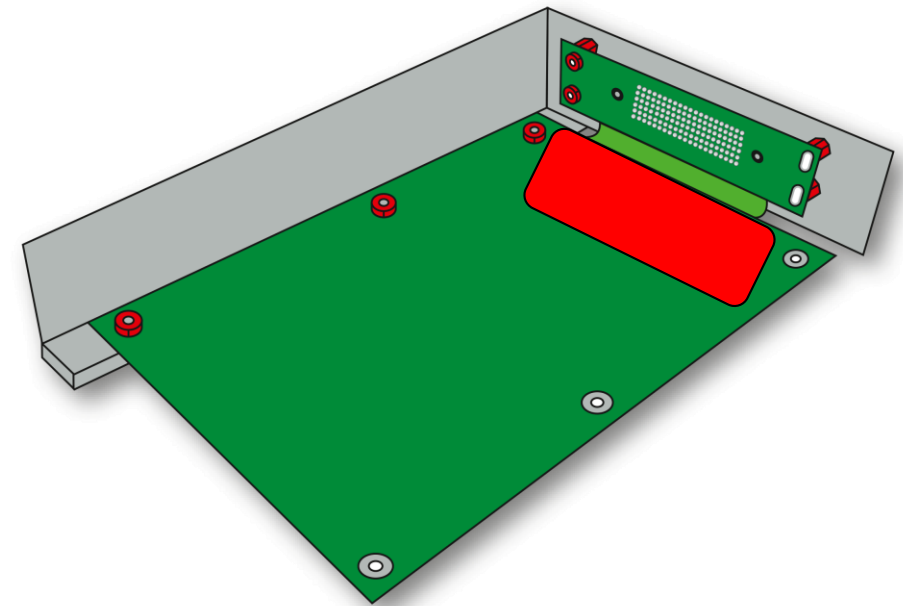
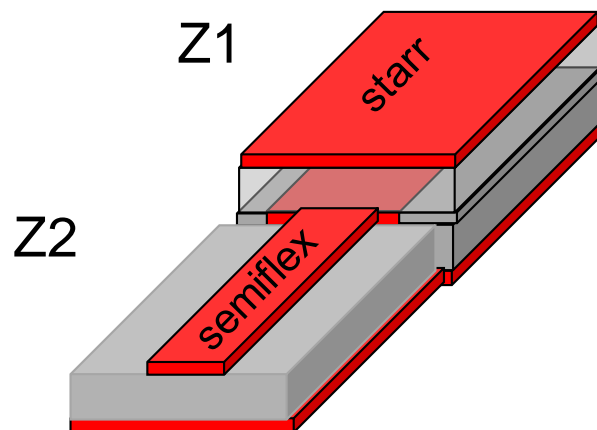
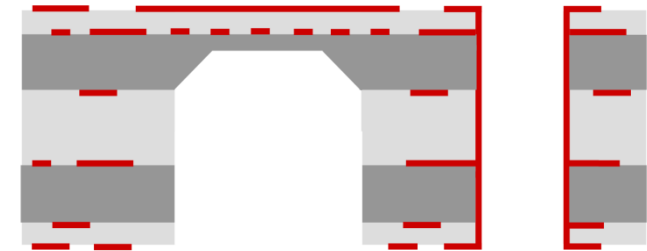
- **application-specific adaptations**
  - The bending area is covered with coverlay
  - use of mid Tg or high Tg base material (Tg150, Tg240)
- **Bending area with 2 copper layers**
- **Adapted laminating technology**
  - improved bending behaviour
  - also for thicker bending areas
  - smaller bending radii
- **Combination with HDI**
  - microvia
  - buried via





## 2Ri – xRi : Semiflexible area with 2 copper layers

- for very high number of connections in the bending area
- for complete reference layer – impedance matching
- ➔ replacement of high pin-count connectors and shielded cables
- ➔ in this case price advantage is even higher!



# 2Ri – xRi : Semiflexible area with 2 copper layers

Rigid area Structure	bend area Thickness	Rigid area Thickness	Material describing	bend area Structure
Flexmask	30			
Soldermask		20		
L1	40	40	Copper-Layer	
Prepreg	65	65	1x 1080	



Nominaldicke (Substrat ohne Cu)		Dickentoleranz		Aufbau	Ist-Dicke (Mittelwert)	Mittlerer Harzgehalt
mm	inch	IPC 4101 Kl. B mm	IPC 4101 Kl. C mm			
0,050	0,002	0,018	0,013	1 x 106	0,059	72,8
0,075	0,003	0,018	0,013	1 x 1080	0,075	61,3
0,100	0,004	0,018	0,013	1 x 1634	0,101	42,5
0,125	0,005	0,025	0,018	1 x 1647	0,132	48,1
0,150	0,006	0,025	0,018	1 x 1651	0,158	48,1
0,200	0,008	0,038	0,025	1 x 7628	0,210	45,7
0,250	0,010	0,038	0,025	2 x 1647	0,264	49,1
0,300	0,012	0,038	0,025	2 x 1651	0,316	49,1
0,360	0,014	0,051	0,038	2 x 7628	0,364	41,3
0,410	0,016	0,051	0,038	2 x 7628	0,397	43,8
0,460	0,018	0,051	0,038	1 x 7628 1 x 2125 1 x 7628	0,457	45,0
0,510	0,020	0,051	0,038	3 x 7628	0,523	39,6
0,560	0,022	0,063	0,051	3 x 7628	0,541	41,3
0,610	0,024	0,063	0,051	3 x 7628	0,590	43,8
0,710	0,028	0,063	0,051	4 x 7628	0,723	41,3

L3	18		
Core	200	FR4	
L5	18		
Prepreg	220	2x2116	
L4	18		
Core	200	FR4	
L5	18		
Prepreg	220	2x2116	
L7	18		
Prepreg	65	1x 1080	
L8	40	Bottom-Layer	
Soldermask	20		

## Summary

- **Congratulation and many thanks to the company metz-mecatech!**
  - for the exemplary cooperation and the information!
- **Semiflex is an affordable 3D technology for reliable miniaturization solutions.**
- **Semiflex solutions are always project-specific!**
  - We will be happy to advise you!
- ***More information in our webinar archive!***
- ***Event note:***  
*AltiumLive, Munich, January 2019 - "Digital Standards for EDA-Tools" presented by Andreas Schilpp [LINK](#)*





Thank you very much for your attention! Questions?

