

## DESIGN MATTERS: HIGHLY RELIABLE FLEX-RIGID BOARDS

Klaus Schill-Mulack, Technical Project Management

# AGENDA

Design matters: Highly reliable flex-rigid boards – Made in Europe

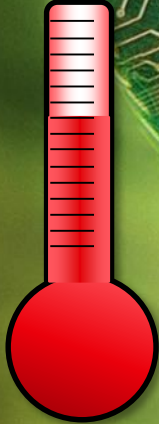
1. The System RIGID.flex
2. Base material and Stackups
3. PCB-Design for RIGID.flex
4. Tests according IPC-6013/ IST



**Klaus Schill-Mulack**  
Technisches Projektmanagement

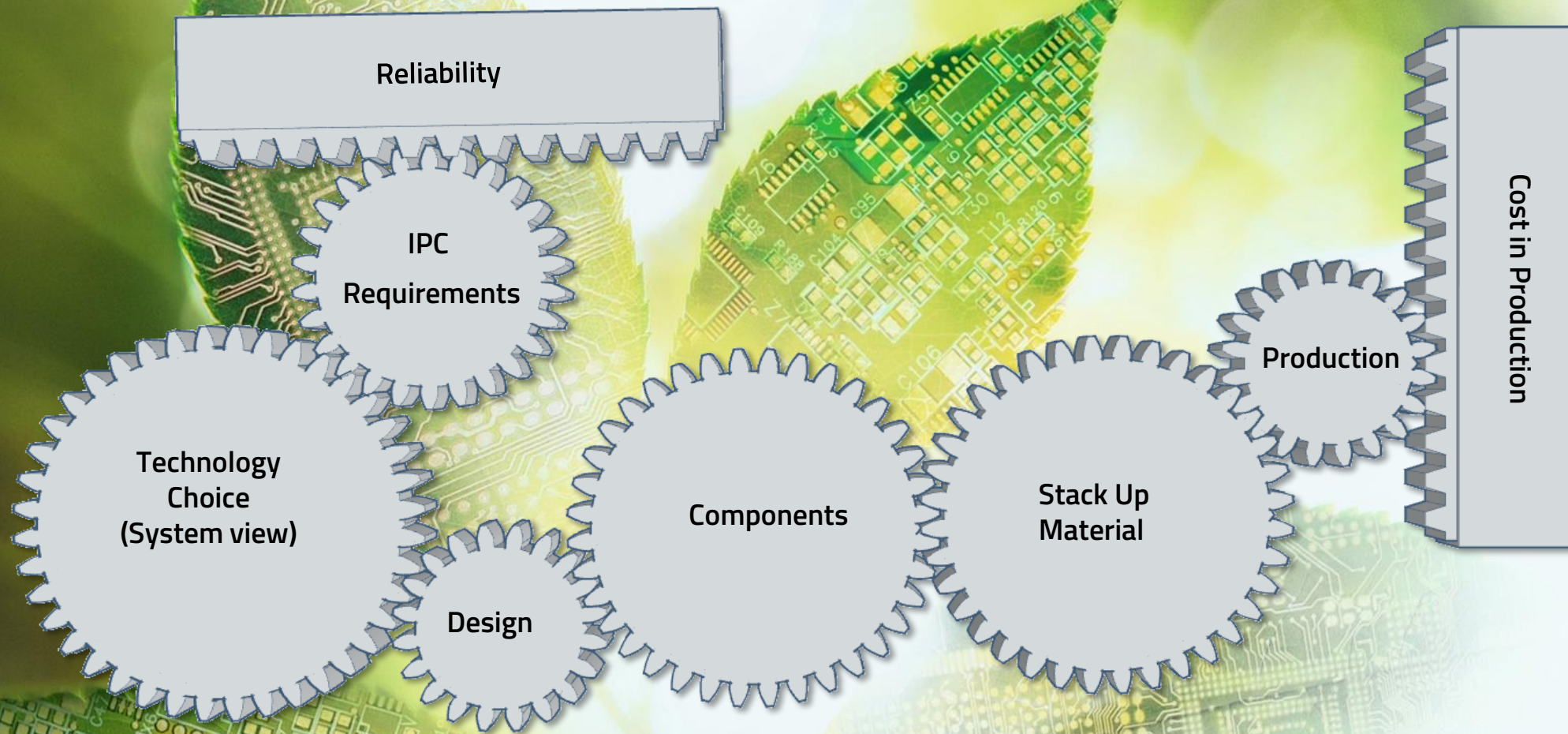


## Reliability – Definition ?



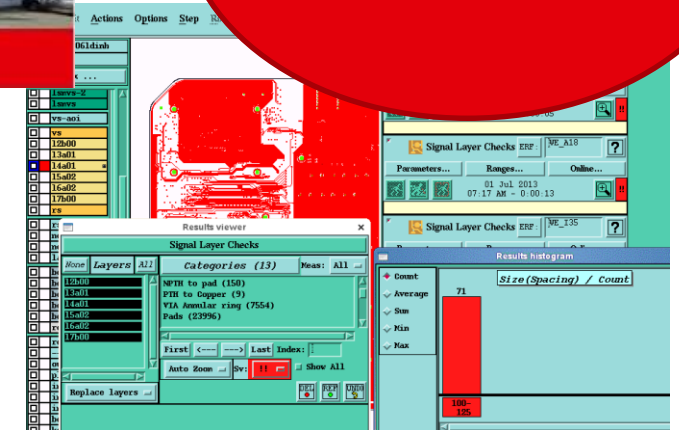
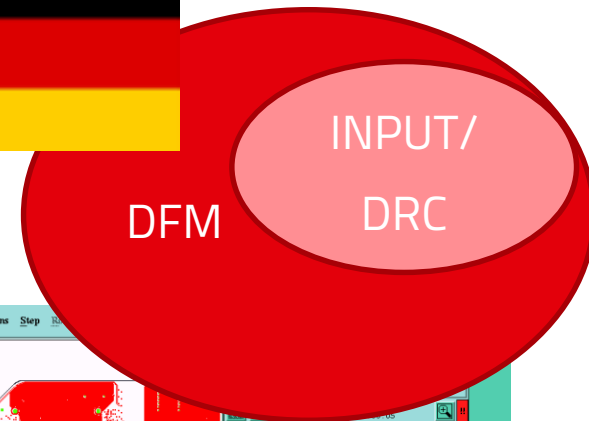
### Reliability

is the probability with which a product will perform its intended function for a given time interval under specified conditions.



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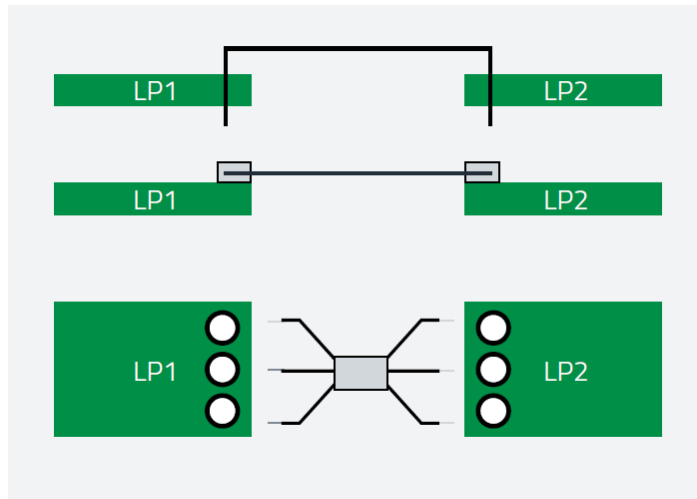
Industries + Production



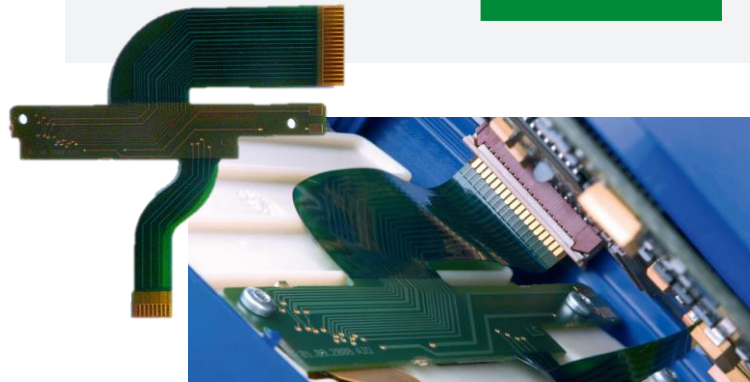
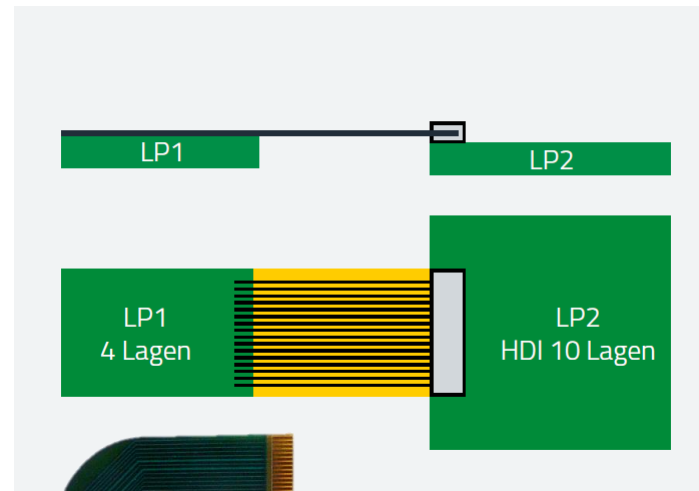
# DESIGN MATTERS: HIGHLY RELIABLE FLEX-RIGID BOARDS

System

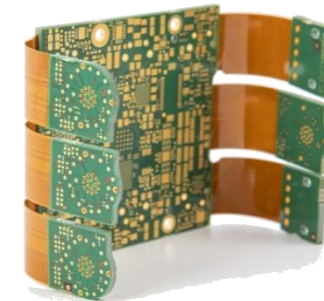
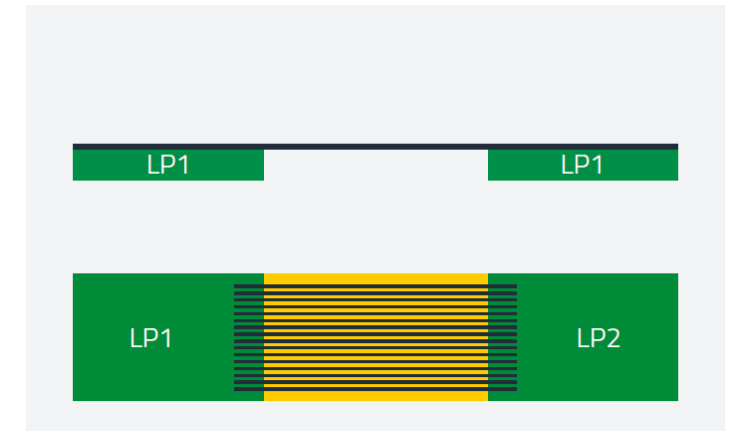
## Non homogenes System



## Partial homogenes System



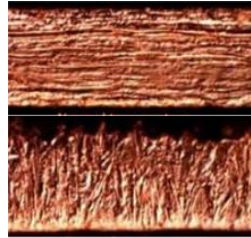
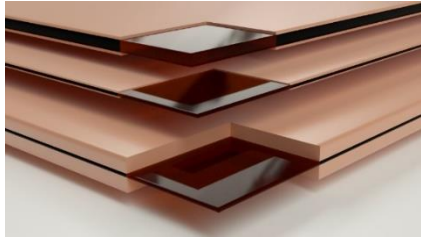
## Homogenes System



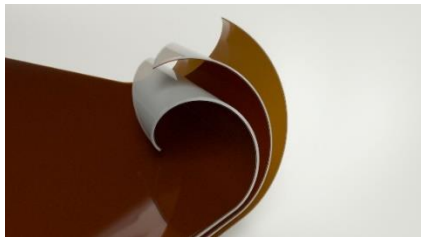
# DESIGN MATTERS: HIGHLY RELIABLE FLEX-RIGID BOARDS

## Base material

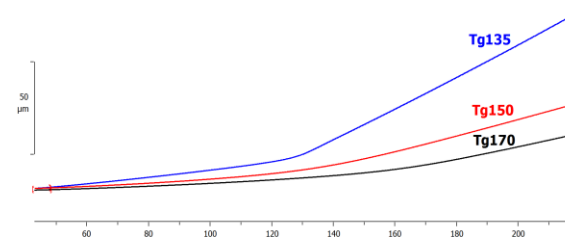
- Base material Polyimid
  - Adhesiveless
  - Copper quality (ED or RA)



- **Coverlay / Bondply**
  - Acrylic Adhesive
  - Epoxy Adhesive



- **Prepreg (Standard)**
  - Adhesive between the layers
  - Glassfibers pre-impregnated with resin
- **Prepreg Low Flow**
  - Standard Prepreg
  - Restricted resin flow
- **Core**
  - Composite of individual prepregs
  - Cladded with copper on both sides



# DESIGN MATTERS: HIGHLY RELIABLE FLEX-RIGID BOARDS

## RIGID.flex Standard Stackups

### Standard 1F-xRi

Material description	Flex area Structure	Viatypes		Standard values	Viatypes					Modifications	
		Standard	Modifications		1F-1Ri	1F-2Ri	1F-3Ri	1F-4Ri	1F-5Ri no plating		
soldermask										flexible soldermask (FRB210)	
copper incl. plating	TopLayer			45µm	L1	L1	L1	L1	L1		
Polymide				50µm							
LowFlow Prepreg				50µm							
copper				19µm	L2	L2	L2			35µm	
core 1										≥ 250µm	
copper				19µm	L3	L3	L3			35µm	
prepreg				2 x 1080						≥ 2 x 1080	
copper				19µm	L4					35µm	
core 2										≥ 100µm	
copper				19µm	L5					35µm	
prepreg				2 x 1080						≥ 2 x 1080	
copper				19µm	L6	L6				35µm	
core 3										≥ 250µm (= thickness core 1)	
copper				19µm	L7	L7				35µm	
prepreg				2 x 106							
copper incl. plating	BottomLayer			45µm	L8	L8	L4	L2			
soldermask											

### Standard xRi-2F-xRi

Material description	Flex area Structure	Viatypes		Standard values	Viatypes			Modification allowed
		Standard	Modification		3Ri-2F-3Ri	2Ri-2F-2Ri	1Ri-2F-1Ri	
Soldermask								
copper incl. plating	TopLayer			45µm	L1	L1	L1	
prepreg				1 x 1080				≥ 1 x 1080
Core 1				18µm	L2	L2		35µm
prepreg				18µm	L3			35µm
Coverlay				3 x 1080				
Polymide				18µm	L4	L3	L2	35µm
Prepreg				50µm				75µm/100µm
Coverlay				18µm	L6	L4	L3	35µm
prepreg				3 x 1080				
Core 2				18µm	L4			35µm
prepreg				18µm	L7	L6		35µm
copper incl. plating	BottomLayer			45µm	L8	L6	L4	
Soldermask								

### Standard 2F-xRi

Material description	Flex area Structure	Viatypes		Standard values	Viatypes				Modifications
		Standard	Modifications		2F-1Ri	2F-2Ri	2F-3Ri	2F-4Ri	
soldermask									flexible soldermask (FRB210)
copper incl. plating	TopLayer			45µm	L1	L1	L1	L1	
Polymide				50µm					
copper	PreLayer			18µm	L2	L2	L2	L2	
LowFlow Prepreg				90µm					≥ 106
core 1									≥ 250µm
copper				18µm	L3	L3	L3		35µm
prepreg				2 x 1080					≥ 2 x 1080
copper				19µm	L4				35µm
core 2									≥ 100µm
copper				18µm	L4				35µm
prepreg				2 x 1080					≥ 2 x 1080
copper				18µm	L4	L4			35µm
core 3									≥ 250µm (= thickness core 1)
copper				18µm	L7	L6			35µm
prepreg				1 x 1080					
copper incl. plating	BottomLayer			45µm	L8	L6	L4	L3	
soldermask									

### Standard xRi-4F-xRi

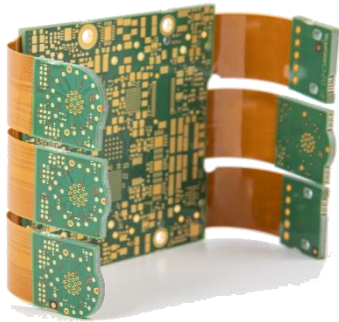
Material description	Flex area Structure	Viatypes		Standard values	Viatypes			Modification allowed
		Standard	Modification		3Ri-4F-3Ri	2Ri-4F-2Ri	1Ri-4F-1Ri	
Soldermask								
copper incl. plating	TopLayer			45µm	L1	L1	L1	
prepreg				1 x 1080				≥ 1 x 1080
Core 1				18µm	L2	L2		35µm
prepreg				18µm	L3			35µm
Coverlay				3 x 1080				
Polymide				18µm	L4	L3	L2	35µm
Bondoly / PP				50µm				75µm/100µm
Prepreg				18µm	L6	L4	L3	35µm
Polymide				111 / 1080				121 / 2116
Prepreg				18µm	L6	L6	L4	35µm
Coverlay				50µm				75µm/100µm
Prepreg				18µm	L7	L6	L6	35µm
prepreg				3 x 1080				
Core 2				18µm	L8			35µm
prepreg				18µm	L9	L7		35µm
copper incl. plating	BottomLayer			45µm	L10	L8	L6	
Soldermask								

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RIGID.FLEX for harsh environment applications

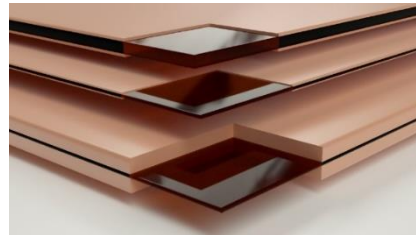
## System

- RIGID.Flex.rigid pcb



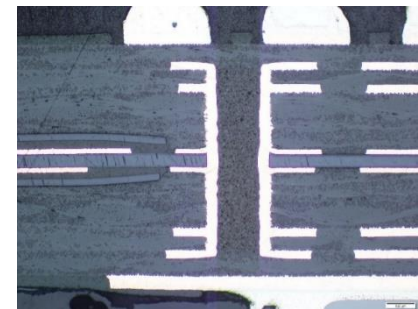
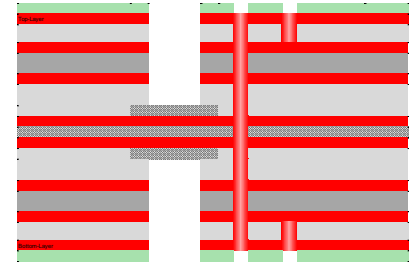
## Material

- Adhesiveless polyimide
- RA-copper
- Standard prepregs (depending on flexsize)



## Stack-up

- Flexlayers symmetrical as innerlayer
- Partial covering coverlay



# DESIGN MATTERS: HIGH RELIABLE FLEX-RIGID BOARDS

## Design Rules – IPC-Specification

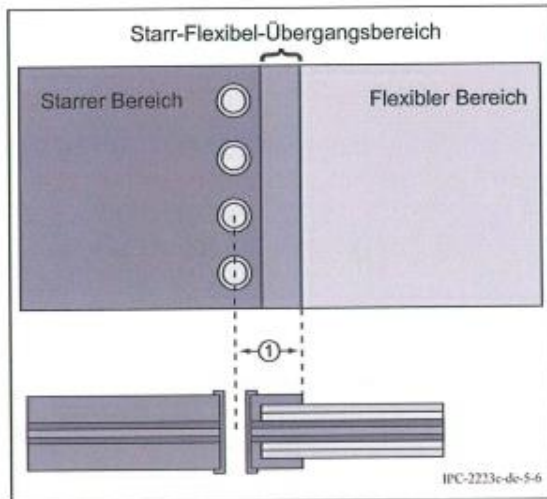


Bild 5-6 Abstand des durchmetallisierten Lochs von der Übergangszone starrer/flexibler Bereiche

Hinweis 1: Minimaler empfohlener Abstand von 3,18 mm [0,125 in] zuzüglich dem halben Restring-Durchmesser, gemessen von der Lochmitte.



IPC-2223E

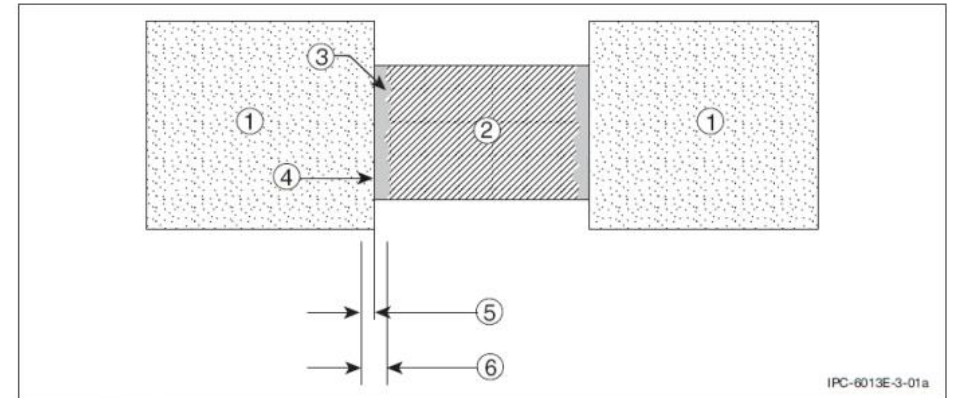
**Sectional Design Standard for Flexible/Rigid-Flexible Printed Boards**



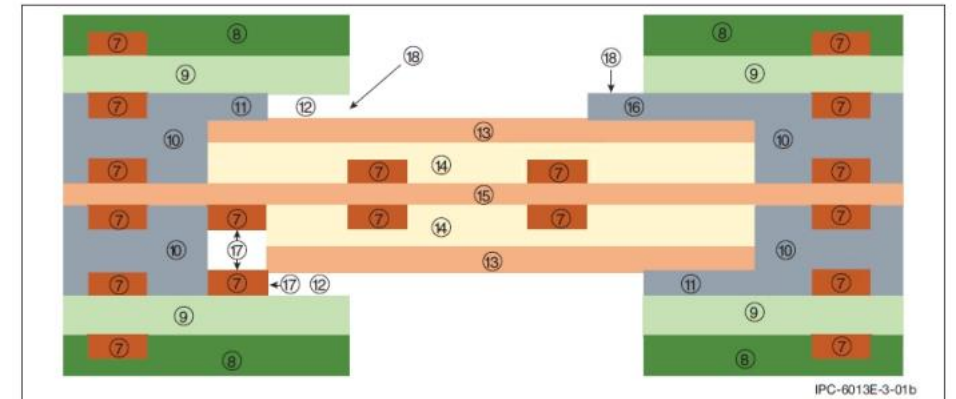
**IPC-6013E**

2021 - September

Qualification and Performance Specification for Flexible/Rigid-Flexible Printed Boards



IPC-6013E-3-01a



IPC-6013E-3-01b

Figure 3-1B Transition Zone

Note 1. Rigid Printed Board

Note 2. Flex Circuit

Note 3. Adhesive or Prepreg Flow

Note 4. Potential Habing of Rigid Printed Board along Edge is permitted in Transition Zone

Note 5. 1.5 mm [0.059 in]

Note 6. Limit of Inspection Range (3.0 mm [0.118 in]), centered on the Transition Zone.

Note 7. Conductor.

Note 8. Solder Mask.

Note 9. Rigid Cap.

Note 10. Prepreg.

Note 11. Overlap.

Note 12. Gap.

Note 13. Polyimide Cover.

Note 14. Cover Adhesive.

Note 15. Polyimide Core.

Note 16. Overlap with Squeeze-Out.

Note 17. Nonconforming Exposed Conductor Due to Lack of Dielectric Insulation.

Note 18. Acceptable Conditions of Gap/Squeeze-out within Inspection Range described in Note 6.

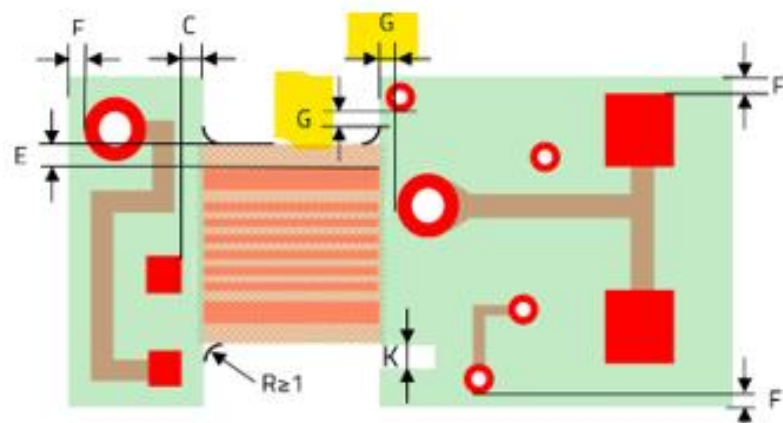
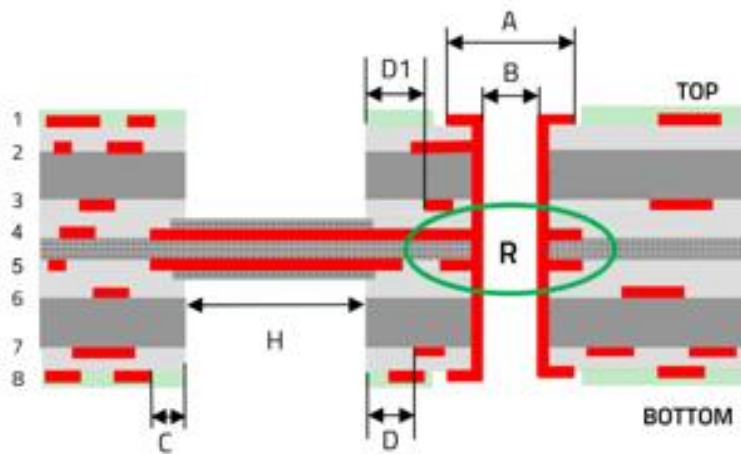
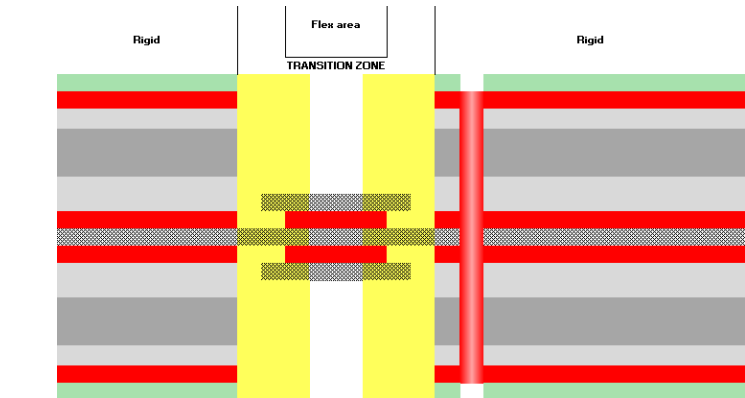
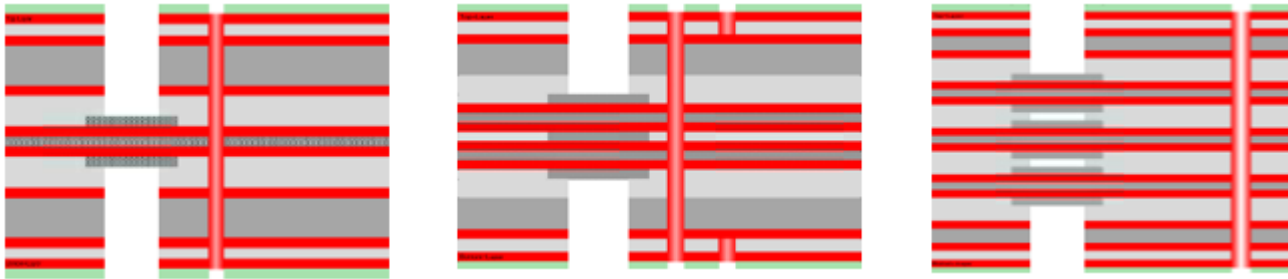
- Transition Zone / IPC-6013
- ±1.5 mm Insufficient bonding
- Adhesive flow
- Deviating thickness values/insulation
- Coverlay overlap in rigid parts min. 0.635 mm

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## Design Rules



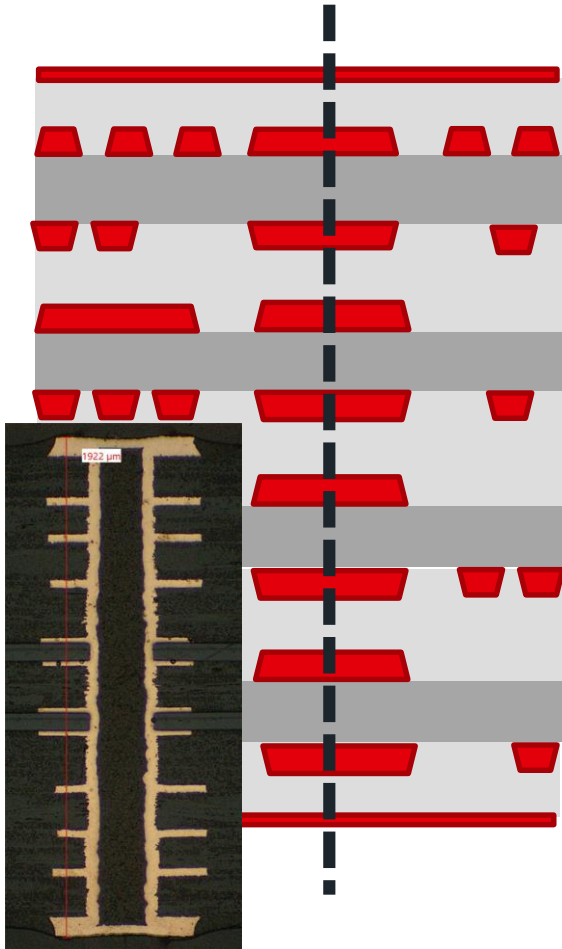
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<https://www.we-online.com/designguideflex>

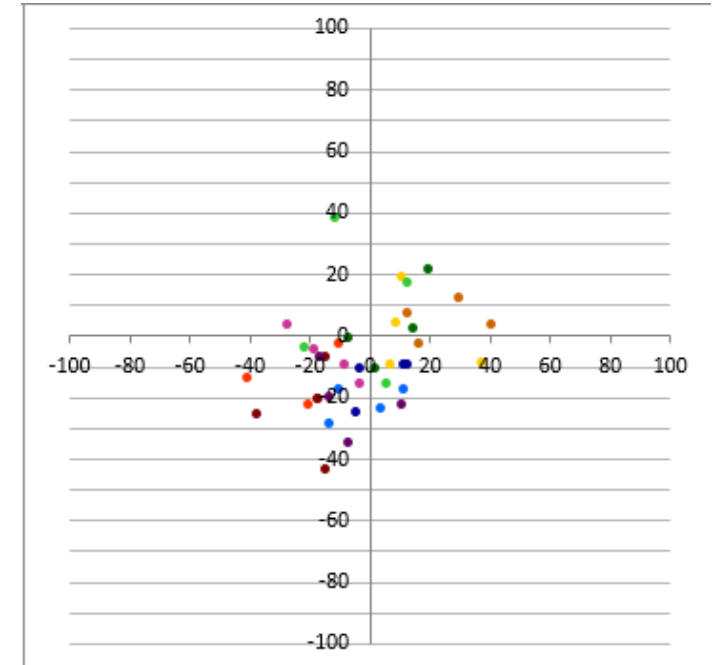
Symbol	Description	Technical Standard	Advanced requirements
G	Flexible area 2F: Distance of via pad to flex-rigid transition	$\geq 1500 \mu\text{m}$	$\geq 1000 \mu\text{m}$
G	Flexible area >2F: Distance of via pad to flex-rigid transition	$\geq 2000 \mu\text{m}$	$\geq 1500 \mu\text{m}$

# DESIGN MATTERS: HIGHLY RELIABLE FLEX-RIGID BOARDS

Design: Annular ring



- Impact on layer offset
  - Material (combination)
  - Layer structure
  - Layout
  - Copper distribution
- Registration system (XRAY, Database)
- Lamination cycle

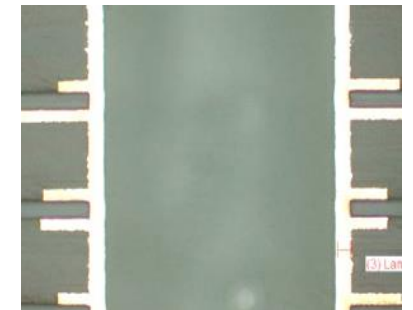
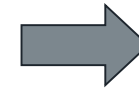
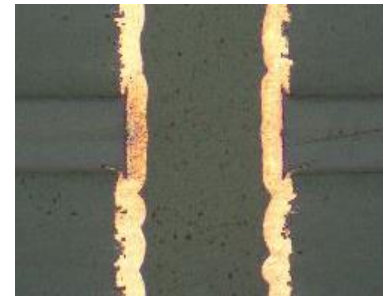
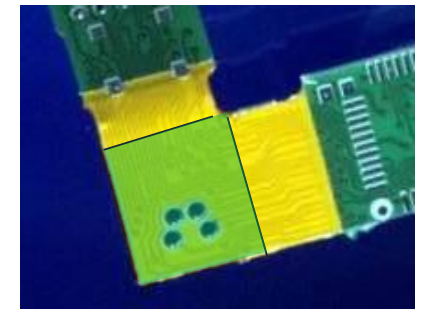
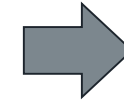
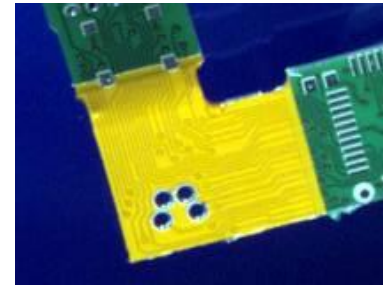


- Flex layers with enlarged drill pad
- 100 % XRAY measurement - all layers

# DESIGN MATTERS: HIGHLY RELIABLE FLEX-RIGID BOARDS

## Vias and Via Pads

- Always place vias in the rigid area
- Use teardrops -> IPC-2221
- Do not remove non-functional pads - removing the pads does not create any additional space for routing
- Keep non-functional pads on the flex layers!



# DESIGN MATTERS: HIGHLY RELIABLE FLEX-RIGID BOARDS

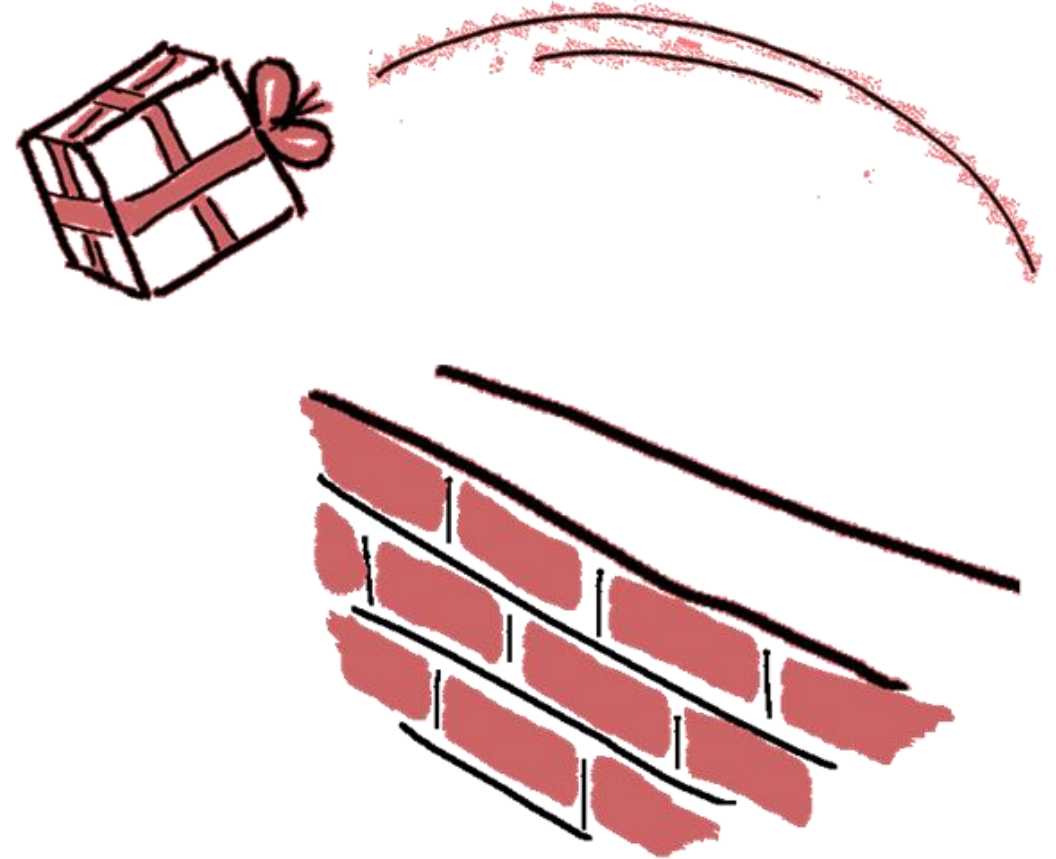
Find a suitable stackup

## **The common way**

- Copy and paste of specifications, materials and stackups from old projects
- Finish of the complete layout process
- Try to find a PCB manufacturer who makes the boards, at least in prototypes

**And what about the series? Yield? Reliability? Cost?**

**The more complex the technology, the less this way works**



# DESIGN MATTERS: HIGHLY RELIABLE FLEX-RIGID BOARDS

Find a suitable stackup: Cooperate With Your PCB Manufacturer

## The better way

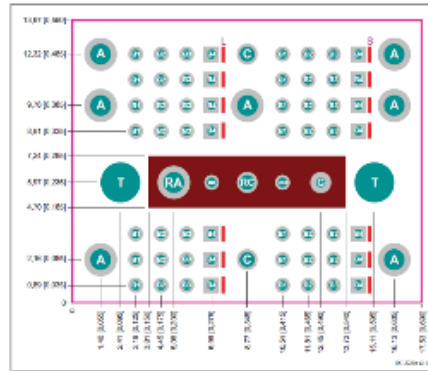
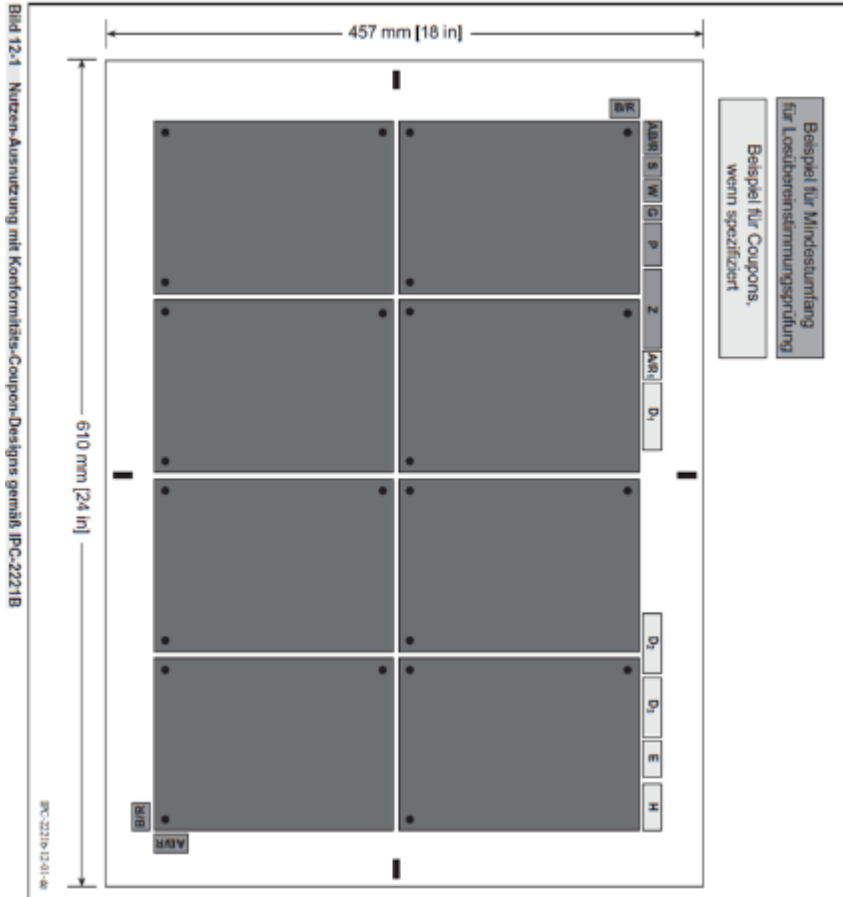
- First, specify your load profile and material requirements
- Then talk to your PCB manufacturer and start a project if needed
  - use standards
  - use digital standards

**This is the better way to efficiently develop quality in every new project. The times when standards had to be transferred from paper or copied from old projects are over.**



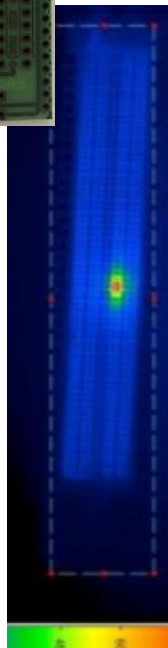
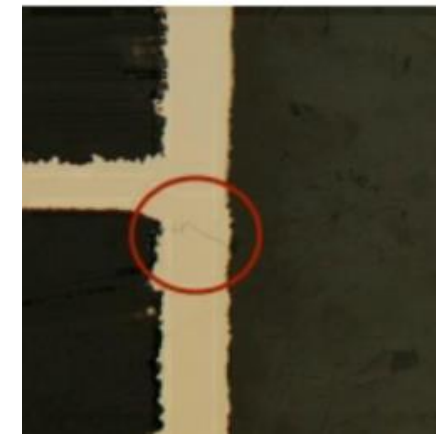
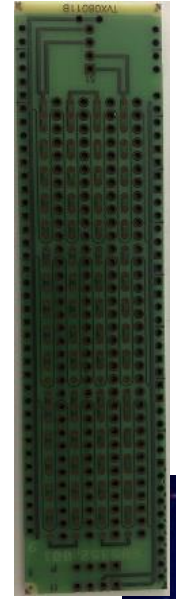
# HIGHLY RELIABLE FLEX-RIGID BOARDS

Test acc. IPC 6012+6013 (IPC2221) & IST



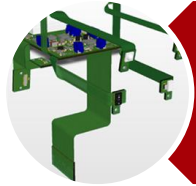
source: IPC2221

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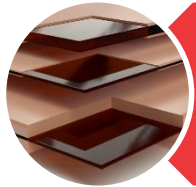


# HIGHLY RELIABLE FLEX-RIGID BOARDS

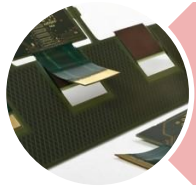
## Summary



Contact your PCB supplier in an early development stage



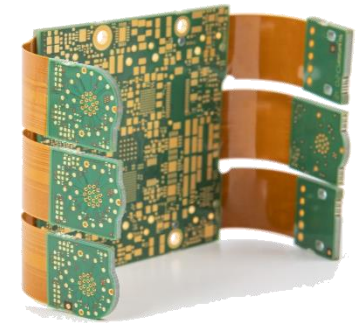
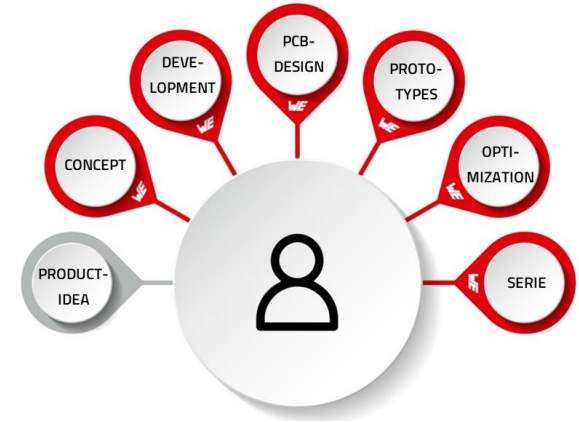
Flex-Rigid offers a wide range of materials and their combinations



Choose the right system



WE are happy to support you 😊



THANK YOU

FOR YOUR ATTENTION