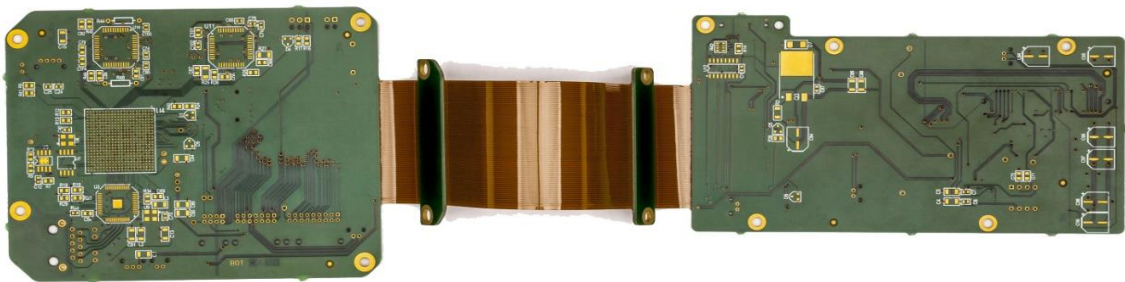


RigidFlex Outer

Design rules and production limits



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Introduction

Basic information

What is RigidFlex Outer PCB?

RigidFlex board with 1-2 flexible copper layers placed on very top or very bottom side of asymmetrical stackup. Flexible layers are covered by coverlay or flexible solder mask.

Notation code

Flex are described using short code which describe number of copper layers. Code also shows position of flexible core inside symmetrical stackup

- **xRi-yF**

X ... Number of copper layers above flex core (on rigid area of PCB)

Y ... Number of copper layers on flex core

- Example of our flexi PCB configurations:

3Ri-2F ... Total of five copper layers with 2 flex on the outer flex core

2Ri-1F ... Total of three copper layers with 1 flex on the outer flex core

Stackup examples

Code	Stackup	Description
1Ri-1F		Two layer RigidFlex with one layer on flex and one on rigid. Flexible core is covered by flexible solder mask
3Ri-2F		Five layer flex with two layer on flex and three layer on rigid. Inner and outer Cu layer on flexible core is covered by coverlay.

Materials

Basic materials

Brand	Type	PI [µm]	Cu [µm]	Cu type	Adhesive [µm]	TG [°C]	Diel. [kV]	Datasheet
Pyrалux AP	AP8525R	50	18/18	RA	Adhesiveless	220	13	Datasheet
	AP9121R	50	35/35	RA	Adhesiveless	220	13	Datasheet

Brand	Type	PI [µm]	Cu [µm]	Cu type	Adhesive [µm]	TG [°C]	Diel. [kV]	Datasheet
ThinFlex W	W-2005RD	50	18/18	RA	Adhesiveless	350	11	Datasheet
	W-2010RD	50	35/35	RA	Adhesiveless	350	11	Datasheet
	A-4005RD	100	18/18	RA	Adhesiveless	250	27,6	Datasheet

*RA Rolled copper; *ED Elektrodeposited copper

Coverlay

Brand	Type	PI [µm]	Adhesive [µm]	TG [°C]	Diel. Stren. [kV]	Datasheet
Pyrалux LF	LF0110	25	25	220	5	Datasheet
	LF0210	25	50	220	5	Datasheet
	LF0220	50	50	220	5	Datasheet

Flexible solder mask

Brand	Type	Datasheet
Peters	SD 2463 HF	Datasheet

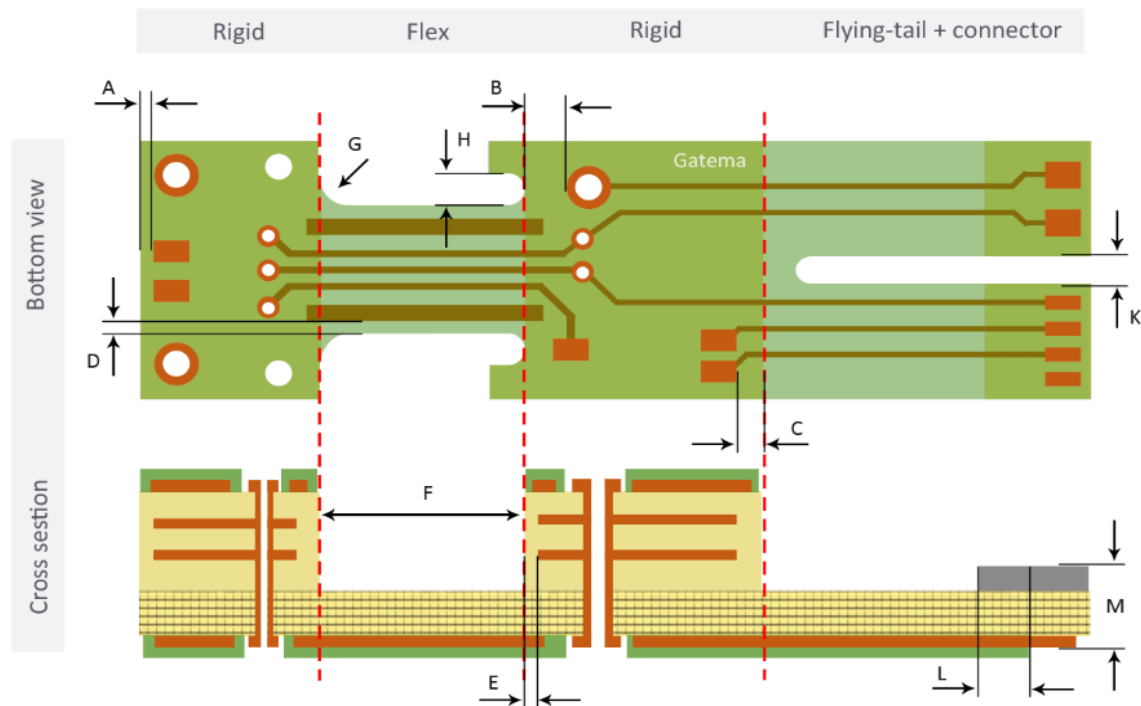
Stiffener basic material

Material	Brand	Thickness [µm]	TG [°C]	Datasheet
Laminate	Isola FR4	-	150	Datasheet
Polyimide	Pyrалux AP	-	220	Datasheet
Polyimide	ThinFlex W	-	350	Datasheet

Design rules: basic rules for xRi-1F

Basic rules

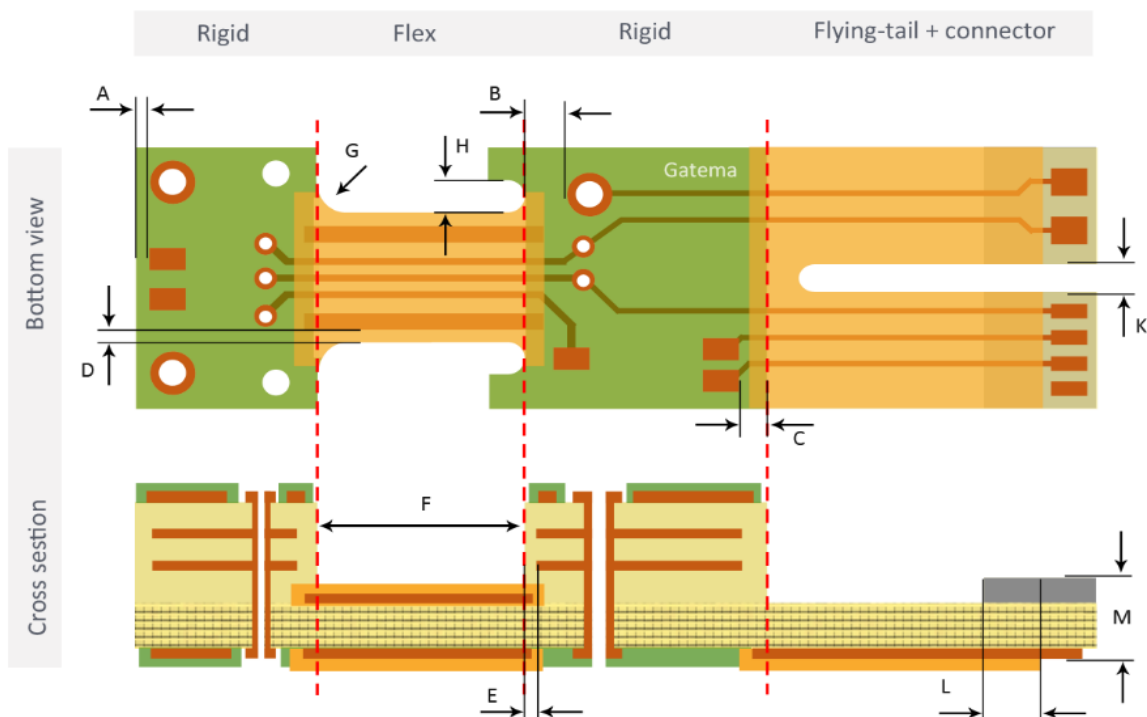
Legend	Description	Standard	Advanced
A	Exposed Cu to board outline	$\geq 0,3$ mm	
B	Spacing via pad to transition zone	$\geq 1,0$ mm	
C	Exposed Cu to transition zone	$\geq 0,8$ mm	
D	Spacing of conductor to flexible contour	$\geq 0,3$ mm	
E	Spacing inner layer to transition zone	$\geq 0,5$ mm	
F	Length of flexible area	$\geq 5,0$ mm	$\geq 3,0$ mm
G	Min diameter (bigger better for prevent material tearing)	$R \geq 1,5$ mm	
H	Outline manufacturing between flex and rigid area	$\geq 1,6$ mm	
K	Outline manufacturing	$\geq 1,6$ mm	$\geq 1,0$ mm
L	Overlap of coverlay (soldermask) with stiffener as prevention from flex material crack	$\geq 0,9$ mm	
M	Z-axis routed stiffener thickness tolerance	± 10 %	
-	Maximal PCB dimension	263 x 385 mm	
- - - -	Transition zone		



Design rules: basic rules for xRi-2F

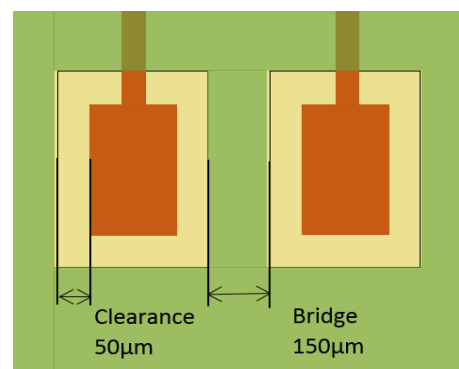
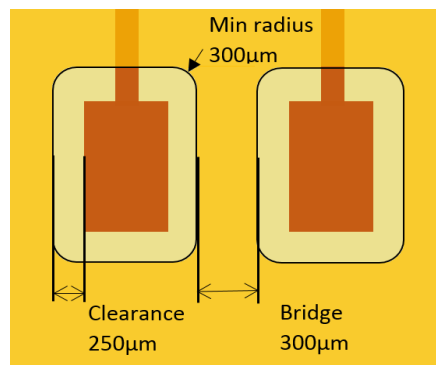
Basic rules

Legend	Description	Standard	Advanced
A	Exposed Cu to board outline	$\geq 0,3 \text{ mm}$	
B	Spacing via pad to transition zone Recommendation in IPC-2223D 5.2.2.3	$\geq 2,0 \text{ mm}$ $3,18 \text{ mm} + \frac{1}{2} \text{ pad diameter}$	
C	Exposed Cu to transition zone	$\geq 0,8 \text{ mm}$	
D	Spacing of conductor to flexible contour	$\geq 0,3 \text{ mm}$	
E	Spacing inner layer to transition zone	$\geq 0,5 \text{ mm}$	
F	Length of flexible area	$\geq 5 \text{ mm}$	
G	Min diameter (bigger better for prevent material tearing)	$R \geq 1,5 \text{ mm}$	
H	Outline manufacturing between flex and rigid area	$\geq 1,6 \text{ mm}$	
K	Outline manufacturing	$\geq 1,6 \text{ mm}$	$\geq 1,0 \text{ mm}$
L	Overlap of coverlay (soldermask) with stiffener as prevention from flex material crack	$\geq 0,9 \text{ mm}$	
M	Z-axis routed stiffener thickness tolerance	$\pm 10 \%$	
	Polyimide (PI) stiffener thickness tolerance	$\pm 5 \%$	
-	Maximal PCB dimension	263 x 385 mm	
- - - -	Transition zone		



Design rules: production limits

Coverlay vs solder mask pad clearance		
Dimension	Polyimid coverlay	Flexible solder mask
Min. bridge	300 µm	150 µm
Min. clearance	250 µm	50 µm
Min radius in pad clearance	300 µm (routed with tool D 0,6 mm)	-
Color	amber	gloss green
Bend radius	unlimited	radius 1,5 mm; 90°
Application	dynamic, semi-dynamic, stable	semi-dynamic, stable



Spacing between PCB in production panel		
Type	Single pieces	Panelised in panel
xRi-1F	$\geq 4,5$ mm	$\geq 2,5$ mm
xRi-2F (coverlay on flexible inner layer)	≥ 12 mm	≥ 12 mm

Other limitations	
Type	Value
Maximal dimension	263 x 385 mm
Min track/isolation	100 µm

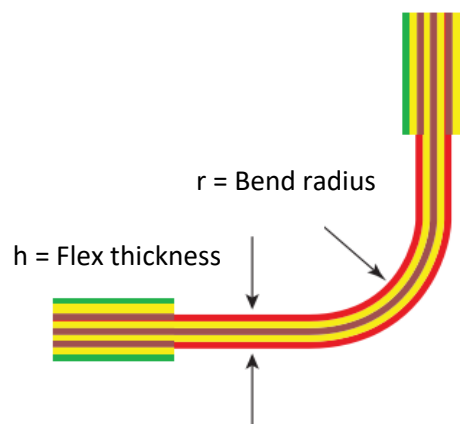
Design rules: General recommendations

Flexi PCB types according to number of bending cycles

1) How to choose proper material?

Choosing proper material depends on final type of application. First type of PCB must be identified than is possible to recommend suitable materials. Type of application depends on number of bending cycles and minimal bending radius

2) Indicate type	Number of bending	Min. bending radius
Dynamic	Frequent	100-150 x flex layer thickness
Semi-Dynamic	Max. 20x	> 20 x flex layer thickness
Stable	Bend to install	> 10 x flex layer thickness



3) Choose flexible core

Application type	Dynamic	Semi-Dynamic	Stable
Copper type	RA copper	RA or ED copper	RA or ED copper
Material	Pyralux AP Thinflex W/A	Pyralux AP Thinflex W/A	Pyralux AP Thinflex W/A

4) Choose soldermask or coverlay

Application type	Dynamic	Semi-Dynamic	Stable
Covering type	Coverlay	Coverlay or flexi SM	Coverlay or flexi SM
Material	Pyralux LF	Pyralux LF Elp. SD 2463 FLEX-HF	Pyralux LF Elp. SD 2463 FLEX-HF

IPC-2223 Sectional Design Standard for Flexible/Rigid-Flexible Printed Boards

We recommend following the design recommendations listed in IPC-2223 Sectional Design Standard for Flexible/Rigid-Flexible Printed Boards when designing a Flex or RigidFlex PCB.

IPC standard is available in online store:

shop.ipc.org

Stackup: Stiffeners + flying tails

Stiffener possibilities

Type and description	Stackup example
Z-axis routed stiffener	

Standard stiffener which thickness is adjusted by z-axis depth routing. Less accurate on final thickness $\pm 10\%$

- + Allow more stiffener thickness from same side of flex PCB
- + Cheap solution

		Z-AXIS ROUT STIFFENER TOP (D)	
Material text	Cu usage	Material	Thick [μm]
IS 400 ML	L5	Stiffener	202
ThinFlex W		Flex laminate	50
Copper (RA)		Copper	18+25 Plt
ENIG		Surface	5
Stackup thickness			Thick [μm]
Estimated			300
Required			300

Polyimide (PI)

Polyimide based stiffener by applied NoFlow prepregs under the high temperature and pressure.

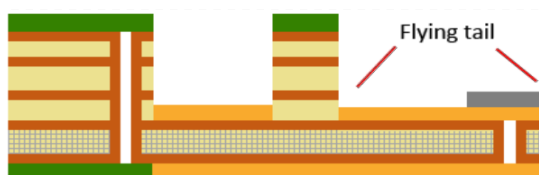
- + More accurate final thickness $\pm 5\%$

		PI STIFFENER BOT (D)	
Material text	Cu usage	Material	Thick [μm]
ENIG	L1	Surface	5
Copper (RA)		Copper	35
PYRALUX AP	L2 (67%)	Flex laminate	50
Copper (RA)		Copper	35
No-flow49N 1x106□		NoFlow prepreg 2	44
No-flow49N 1x106□		NoFlow prepreg 2	56
No-flow49N 1x106□		NoFlow prepreg 2	56
Pyralux AG185018RY		Stiffener PI	50
Stackup thickness			Thick [μm]
Estimated			331
Required			300

Flying tail

What is flying tail?

Flying tail is flexible area on RigidFlex PCB, which is not ended by rigid area and contains exposed pads or vias. Very often is this area with exposed pads (connector fingers in many cases) supported by stiffener. Exposed pads can be placed on both sides of flexible core top and bottom.



		FLYING-TAIL (C)	
Material text	Cu usage	Material	Thick [μm]
Pyralux 0110		Coverlay	25
		Adhesive	25
Copper (RA)	L3 (67%)	Copper	35
PYRALUX AP	L4 (67%)	Flex laminate	50
Copper (RA)		Copper	35
Stackup thickness			Thick [μm]
Estimated			160
Required			-

Stackup: Default stackups

Standard stackup			
Layer count	Thickness	xRi-1F	xRi-2F
2	1,50 mm	<u>1Ri-1F</u>	-
4	1,00 mm	<u>3Ri-1F</u>	
5	1,00 mm		<u>3Ri-2F</u>
6	1,50 mm	-	<u>4Ri-2F</u>

Minimum thickness $\geq 0,8$ mm

Stackup: 1Ri-1F

Standard stackup

Layer count	Thickness	Code
2	1,50 mm	1R1-1F

Stackup preview

Type: Outer RigidFlex 1RI-1F							
5 layer stackup; Tg 150°		RIGID (A)			FLEX (B)		RIGID (A)
Material text	Cu usage	Material	Thick [µm]	Plt drill	Material	Thick [µm]	
Green		Solder mask	20				
Copper (ED)	L1	Copper foil	18+25 Plt	A			
IS400ML 2x1080 [FZ01]		Prepreg	154				
Copper (ED)	L2						
IS 400 ML		Rigid laminate	1006				
Copper (ED)	L3						
IS400ML 1x1080 [FZ01]		Prepreg	77				
No-flow49N 1x106		NoFlow prepreg 2	56				
Copper (RA)	L4						
PYRALUX AP		Flex laminate	50				
Copper (RA)	L5	Copper	18+25 Plt				
GreenSD2463HF		Flexible mask	20				
Stackup thickness			Thick [µm]			Thick [µm]	
Estimated			1559			93	
Required			1540			-	
Plated drill		Start-stop layer					
Through holes		A = L1 - L5					

Stackup: 3Ri-1F

Standard stackup

Layer count	Thickness	Code
4	1,5 mm	3Ri-1F

Stackup preview

Type: Outer RigidFlex 3RI-1F							
5 layer stackup; Tg 150°		RIGID (A)			FLEX (B)		RIGID (A)
Material text	Cu usage	Material	Thick [µm]	Plt drill	Material	Thick [µm]	
Green		Solder mask	20				
Copper (ED)	L1	Copper foil	18+25 Plt	A			
IS400ML 2x1080 [FZ01]		Prepreg	154				
Copper (ED)	L2						
IS 400 ML		Rigid laminate	1006				
Copper (ED)	L3						
IS400ML 1x1080 [FZ01]		Prepreg	77				
No-flow49N 1x106		NoFlow prepreg 2	56				
Copper (RA)	L4						
PYRALUX AP		Flex laminate	50				
Copper (RA)	L5	Copper	18+25 Plt				
GreenSD2463HF		Flexible mask	20				
Stackup thickness			Thick [µm]			Thick [µm]	
Estimated			1559			93	
Required			1540			-	
Plated drill		Start-stop layer					
Through holes		A = L1 - L5					

Stackup: 3Ri-2F

Standard stackup

Layer count	Thickness	Code
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5	1,00 mm	3Ri-2F
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Stackup preview

Type: Outer RigidFlex 3Ri-2F						
5 layer stackup; Tg 150°						
		SECTION RIGID (A)		SECTION FLEX (B)		SECTION RIGID (C)
Material text	Cu usage	Material	Thick [µmm]Plt drill	Material	Thick [µmm]	
Green		Solder mask	20			
Standard	L1	Copper foil	18+25 Plt			
IS400ML 1x1080 [FZ01]		Prepreg	77			
Standard	L2 (0%)	Copper	18			
IS 400 ML		Rigid laminate	507			
Standard	L3 (0%)	Copper	18			
IS400ML 1x1080 [FZ01]		Prepreg	77			
No-flow49N 1x106		NoFlow prepreg 2	56			
Pyralux 0110				Coverlay	25	
No-flow49N 1x106				Adhesive	25	
Standard (ED)	L4 (10%)	Copper	18			
ThinFlex W		Flex laminate	50			
Standard (ED)	L5	Copper	18+25 Plt			
GreenSMDFlex		Solder mask	20			
Stackup thickness			Thick [µm]		Thick [µm]	
Estimated			967		193	
Required			947		-	
Plated drill						
Description		A = through L1-L5				

Stackup: 4Ri-2F

Standard stackup

Layer count	Thickness	Code
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6	1,60 mm	4Ri-2F
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Stackup preview

Type: Outer RigidFlex 4Ri-2F							
6 layer stackup; Tg 150°		RIGID (A)			FLEX (B)		RIGID (A)
Material text	Cu usage	Material	Thick [µm]	Pit drill	Material	Thick [µm]	
Green		Solder mask	20				
Copper (ED)	L1	Copper	18+25 Pit	A			
IS 400 ML		Rigid laminate	507				
Copper (ED)	L2 (37%)	Copper	18				
IS400ML 3x1080 [FZ01]		Prepreg	208				
Copper (ED)	L3 (34%)	Copper	18				
IS 400 ML		Rigid laminate	507				
Copper (ED)	L4 (44%)	Copper	18				
IS400ML 2x1080 [FZ01]		Prepreg	144				
No-flow49N 1x1080		NoFlow prepreg 2	83				
Copper (RA)	L5 (0%)	Copper	18				
ThinFlex W		Flex laminate	50				
Copper (RA)	L6	Copper	18+25 Pit				
Green		Solder mask	20		Adhesive	50	
Pyr lux 0210					Coverlay	25	
Stackup thickness		Thick [µm]			Thick [µm]		
Estimated		1677			148		
Required		1658			-		
Plated drill		Start-stop layer					
Through holes		A = L1 - L6					