Flex in Focus

Designing the Perfect Stackup for Flex

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EMA Design Automation

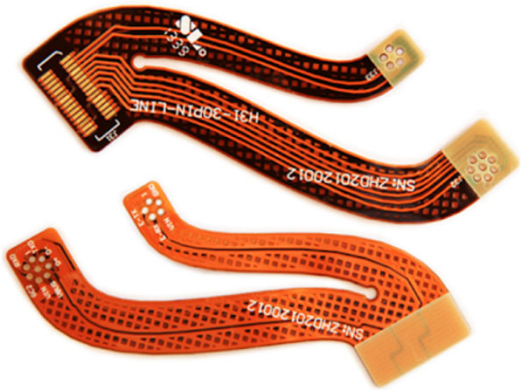
Agenda

- Types of Flex Boards
- Stack-up Overview
  - Flex
  - Flex with Stiffener
  - Rigid-Flex
  - Combination
  - Material Selection
- Considerations throughout the design process:
  - Deliverables
  - Fabrication Drawing
- Early Flex Fabricator Involvement

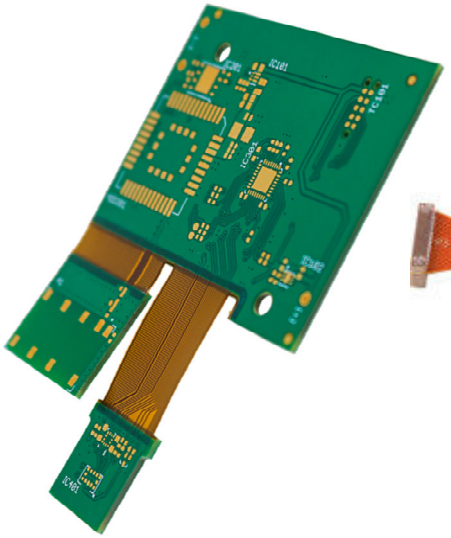
Types of Flex Boards

Flex

Flex with Stiffener



Rigid-Flex



Combination

IMAGES:
https://www.multi-circuit-boards.eu/en/products/printed-circuit-boards/flexible-pcb.html
https://www.gtpcb.com/sale-40891901-automotive-flexible-pcb-board-with-blue-solder-mask-and-white-silkscreen.html

IMAGES:
https://www.epectec.com/flex/industries-market-focus/flex-and-rigid-flex-pcbs-for-itar-applications.html
https://www.glenair.com/flex-circuit-assemblies/index.htm

Stack-up - Flex

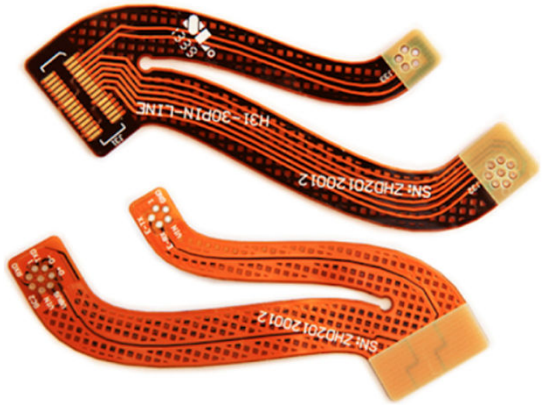
Sample Two Layer Flex Stack-up

Coverlay
Coverlay Adhesive
Copper
Adhesive
Polyimide
Adhesive
Copper
Coverlay Adhesive
Coverlay

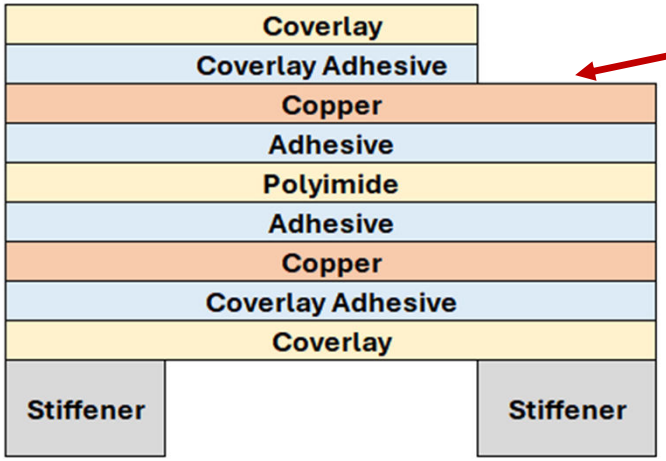
Basic Differences from Rigid Stack-up:

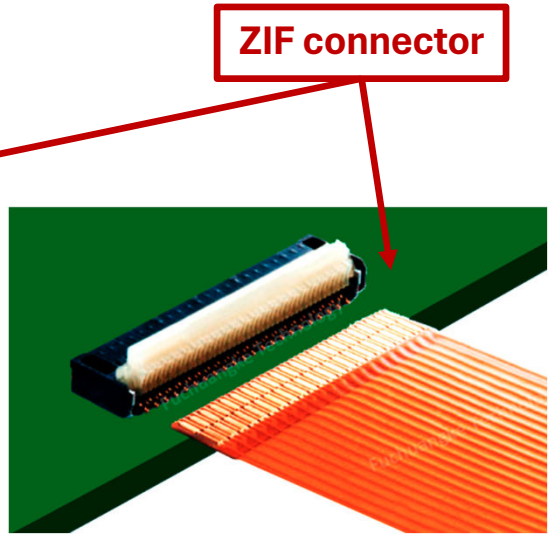
- Coverlay and adhesive are used in place of soldermask
- Polyimide (or similar) is used in place of FR4 / pre-preg
- Can have odd number of layers
- 1/3 oz or 1/2 oz copper weight is most widely used for flexibility

Stack-up – Flex with Stiffener



Sample Two Layer Flex with Stiffener Stack-up



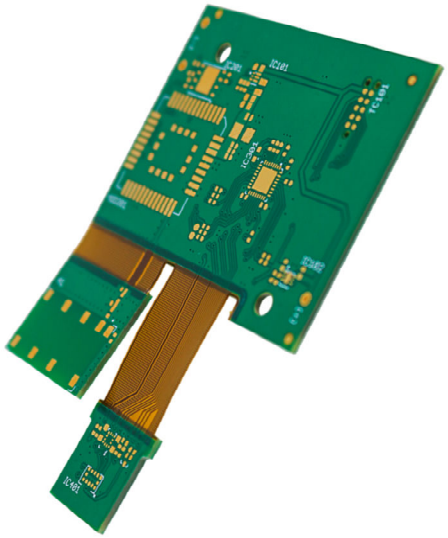


Most common uses for Stiffener:

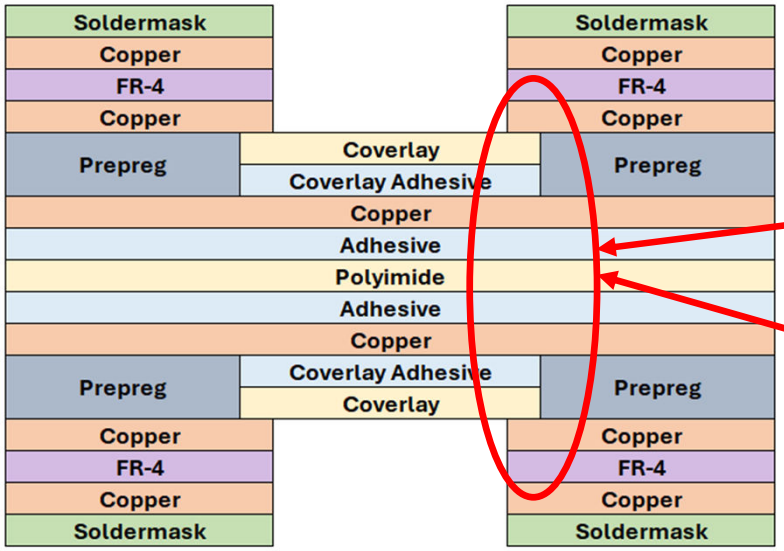
- To mount a small number of components on a flex board
- For a ZIF connector (zero insertion force): The coverlay is pulled back exposing the copper over the stiffener. That end is plugged into a connector.

https://www.mouser.com/new/molex/molexeasyon/

Stack-up – Rigid-Flex



Sample Rigid-Flex Stack-up



*Rigid section has **6 layers***

*Flex section has **2 layers***

Traces should cross the boundary perpendicular to transition line

No holes or vias within 50mils of rigid-flex transition

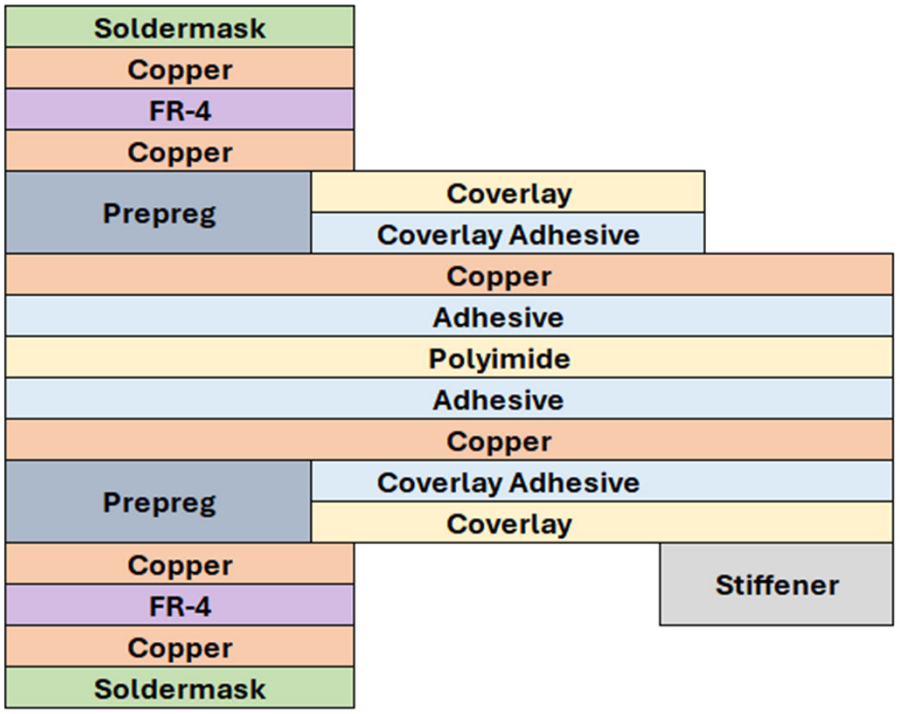
- This is two separate stack-ups put together, both need careful consideration.
  - There is a transition that happens between the flex and rigid materials.

Stack-up - Combination

- This is could contain three or more unique stack-ups. All need careful consideration.

Sample Combination Stack-up

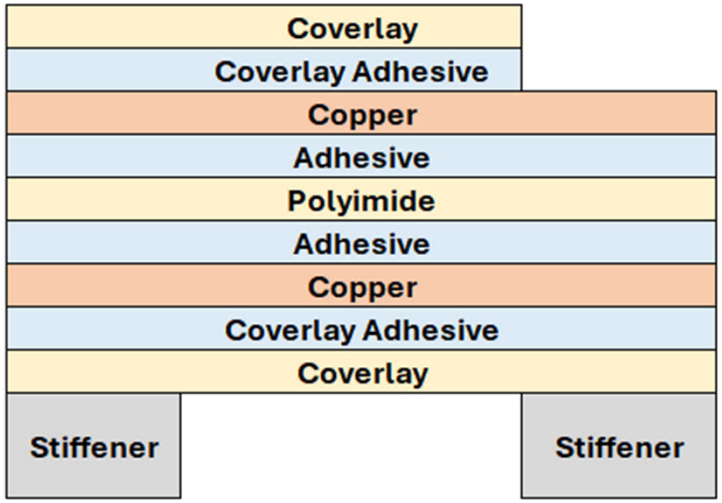
(Rigid-Flex / Flex with Stiffener)



Material Selection

- Each part of a flex stack-up has multiple options based on the needs of the deign.
- Most choices will depend on cost, temperature rating, flexibility among other design constraints.

Layer	Options
Dielectrics	Polyimide (Kapton), Polyester
Coverlay/Soldermask	Coverlay + Adhesive, Flexible Soldermask
Stiffener	FR-4, Polyimide (PI), Metal

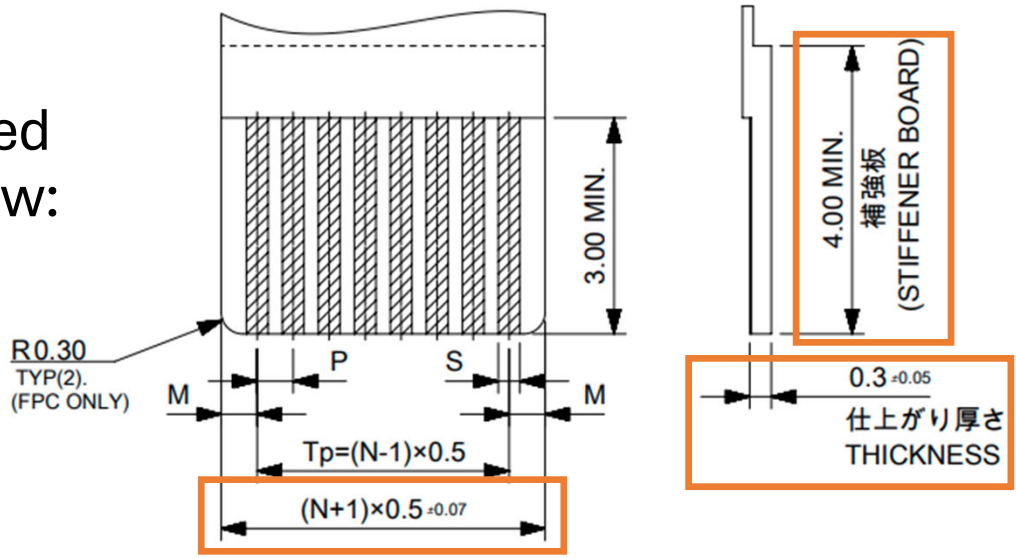


Considerations Throughout the Design Process

- Deliverables
- Fabrication Drawing

Deliverables

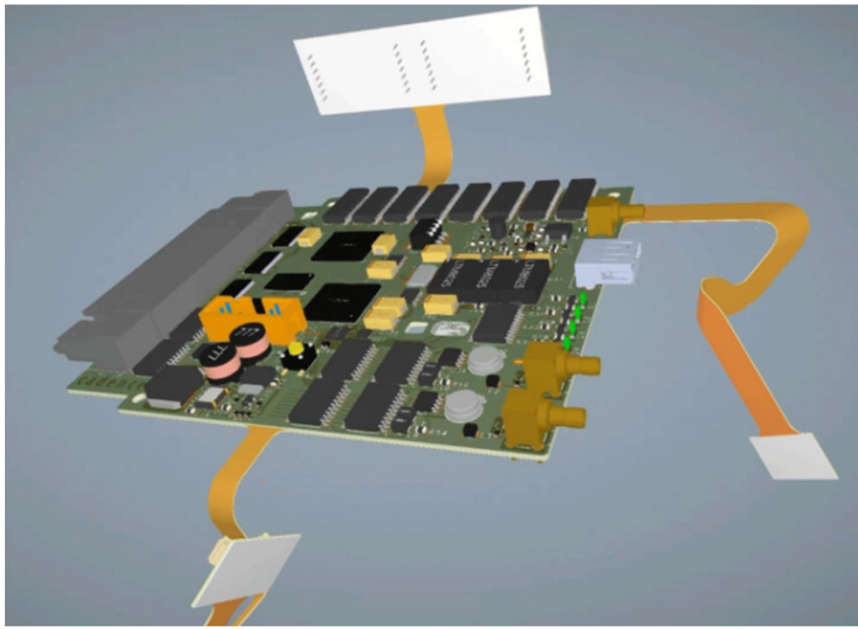
- Extra gerber files required:
  - Outlines of each unique stack-up / zone
  - Stiffener outlines and hole sizes
  - Top & bottom coverlay
- Extra pages or documentation might need to be included in the drill drawing to show:
  - Stiffener thicknesses and dimensions, especially for ZIF connectors (critical for installation)
  - Stiffener installation side
  - Bend lines and final assembly



IMAGES:
https://www.molex.com/content/dam/molex/molex-dot-com/products/automated/en-us/salesdrawingpdf/781/78127/781272210_sd.pdf?inline

Deliverables

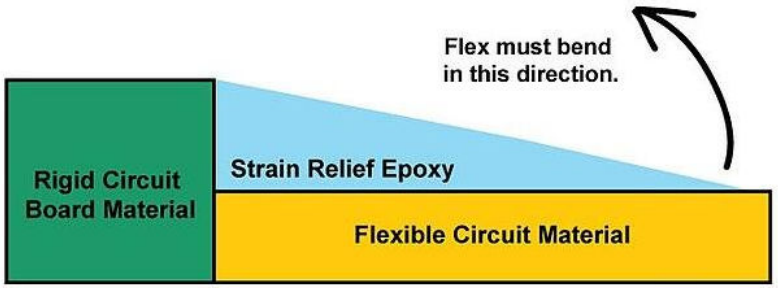
- Many PCB Design programs have advanced 3D model generation, including:
  - Correct thicknesses for each region
  - Bend lines set to correct bend angle
- These 3D models can help verify mechanical feasibility before a board is fabricated
- These models can also allow clearance checking between separate regions of the board when the model is folded.



IMAGES:
https://www.ema-eda.com/how-to-page/how-to-use-the-3dx-canvas-to-analyze-a-pcb-in-3d/

Fabrication Drawing – Notes

- Reference IPC-6013 (flex) instead of or in addition to IPC-6012 (rigid)
- Epoxy might be used at rigid-flex transitions for strain relief
  - This strengthens transition but lowers the bend radius
- Soldermask/coverlay material call outs will likely refer to different IPC Specifications:



IPC Spec	Materials for Flex Applications
IPC-4202	Flexible Base Dielectrics for Use in Flexible Printed Boards
IPC-4203	Cover and Bonding Material for Flexible Printed Circuitry
IPC-4204	Flexible Metal-Clad Dielectrics for Use in Fabrication of Flexible Printed Circuitry

IMAGES:
https://blog.epectec.com/the-use-of-strain-relief-with-rigid-flex-printed-circuit-boards
https://www.saturnflex.com/technology_hub/ipc_standards.php

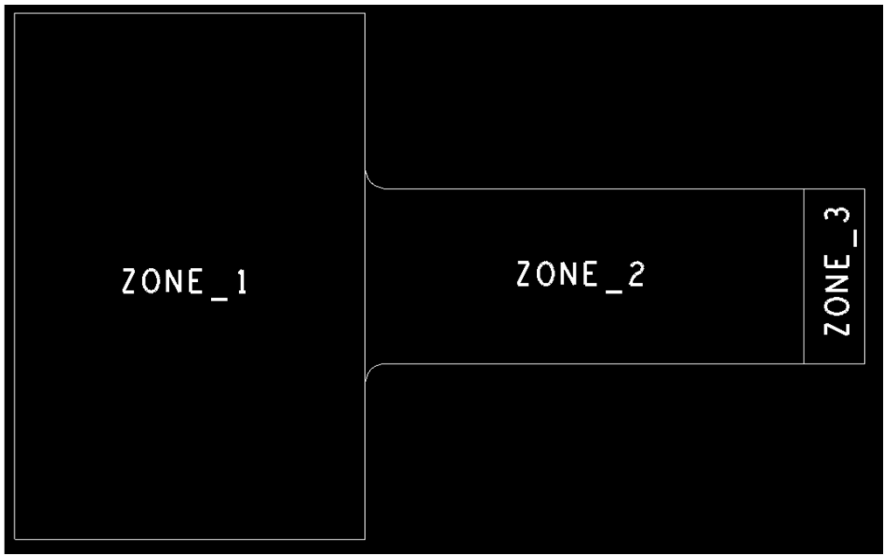
Fab Drawing – Stack-ups & Callouts

Make sure to callout all separate stack-ups **and** which regions of the board reference each stack-up.

STACKUP TABLE

Unit = Millimeter

#	NAME	TYPE	FPC	FLEX	PRIMARY
		SURFACE	0	0	0
	STIFFENER_TOP	MASK	0.2032		
		DIELECTRIC	0.025		
	TOP_SOLDERMASK	MASK			0.02
1	TOP	CONDUCTOR			0.02
		DIELECTRIC	0.0127	0.0127	
		DIELECTRIC	0.025	0.025	0.025
2	LAYER_1	CONDUCTOR	0.018	0.018	0.018
		DIELECTRIC	0.08	0.08	0.08
3	LAYER_2	CONDUCTOR	0.018	0.018	0.018
		DIELECTRIC	0.025	0.025	0.025
		DIELECTRIC	0.0127	0.0127	
4	BOTTOM	CONDUCTOR			0.02
	SOLDERMASK_BOTTOM	MASK			0.02
		SURFACE	0	0	0
	TOTAL	THICKNESS	0.4196	0.1914	0.246
		ZONE NAME	ZONE_3	ZONE_2	ZONE_1



Early Flex Fabricator Involvement

Engage flex fabricator early in process to help drive design decisions across multiple stakeholders.

Make sure all necessary departments are involved to ensure the most collaboration.

This allows you to find creative solutions that save time and money.

Electrical

- Material options/requirements
- Copper thickness
- Minimum trace/space
- Controlled impedance calculations

Mechanical

- Board thickness
- Bend radius

Management

- Lead time
- Fabrication cost
- Design cost

Main Takeaways

- Determine appropriate “type” for needs of the design
- Understand different material requirements based on “type”
- Make sure documentation clearly calls out stack-ups, regions, and design specifications
- Check in often with all involved departments/collaborators

Thank you!

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