3D-Design in Cadence Allegro / OrCAD

Holger Schröter
FED Regionalgruppe Stuttgart
12.04.2017

Overview

- Flex
  - Cross Section
  - Layer Definition
  - Zones
  - Bend Area
  - Interlayer Checks
  - Contour Routing
  - Visualization
  - Cross Hatch Shapes
  - Outlook
- Embedded Components
  - Advantages
  - Cross Section
  - Attachment Method
  - Rules Setup
  - Analysis Modes
  - Additional Layers
  - Part Properties
  - Placement
  - Dual Sided Components
  - Manufacturing
  - Documentation
  - 3D Visualization
- Combination Flex and Embedded Components

Personal Introduction

- Holger Schröter

- Studies: Communications Engineering at TU Braunschweig

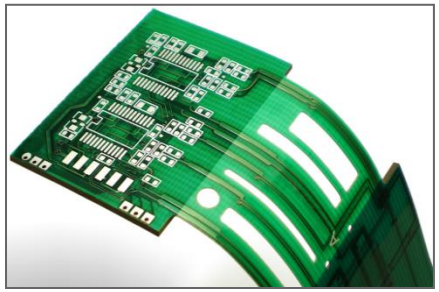
- Distance control radar at TU Braunschweig
- Development and project management for VCO and frequency synthesizer at Tyco Electronics
- Development of memory modules at Qimonda (Infineon)
- PCB Design Flow und Methodology at Intel
- Application Engineer at FlowCAD

Flexible PCB – Design

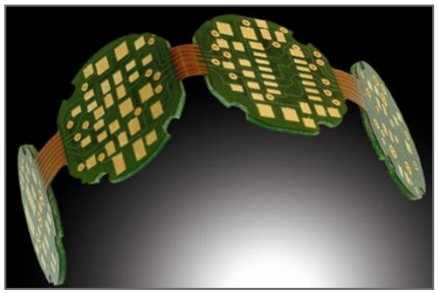
www.FlowCAD.com

Flexible PCB – Overview

- Flex
  - Permanent flexible
  - Based on polyimide
  - In most cases a PCB is build in a package twisted or folded
  - Can be used for static as well as dynamic applications



- Semi-flex
  - Limited number of bending cycles, bending radius
  - Based on FR4
  - Cost efficient „Flex to Install“ solution

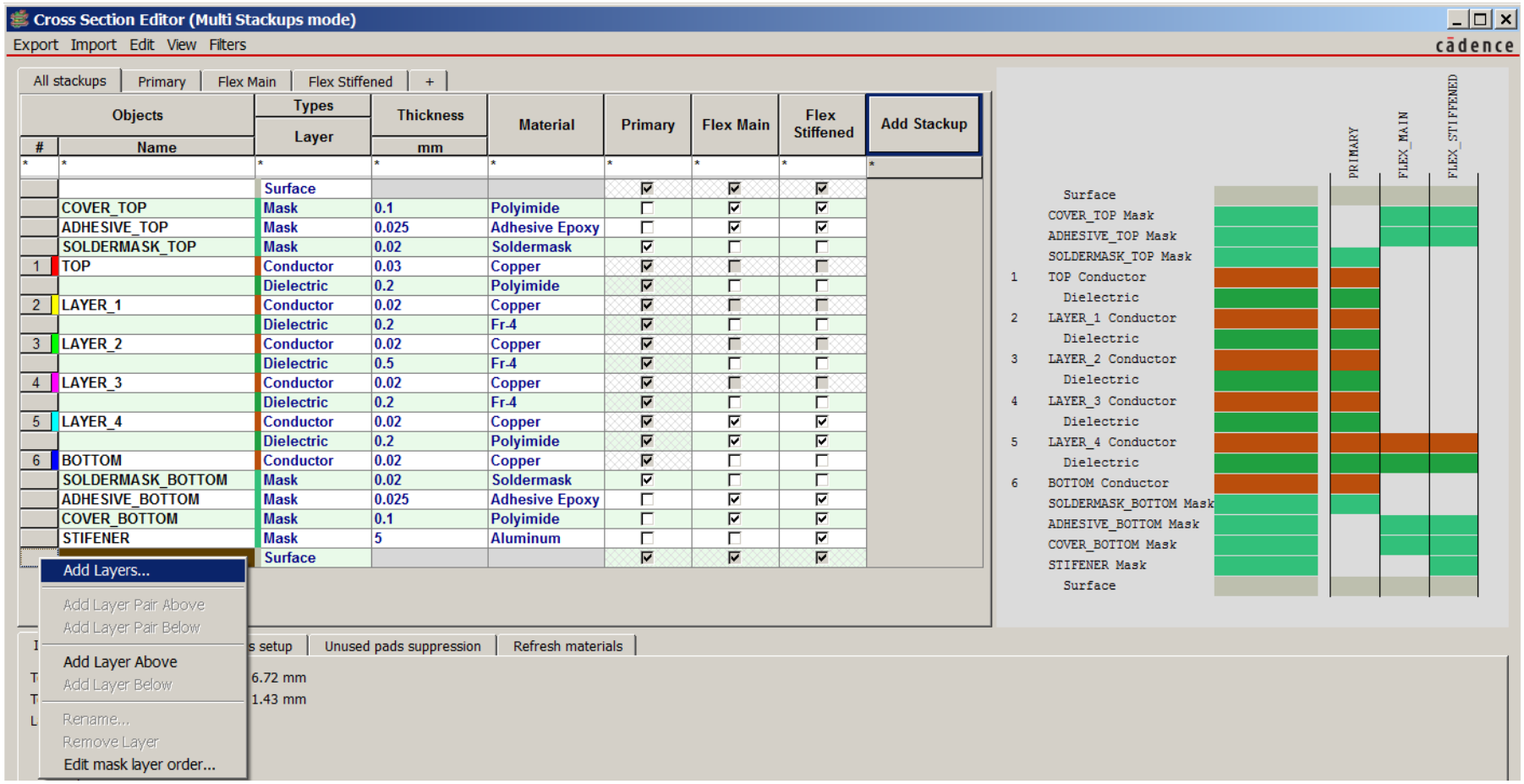


- Rigid-flex
  - PCBs with flexible and rigid areas
  - Combination of polyimide and FR4
  - Connection of rigid PCB without cable and connectors
  - Advantages in costs and signal integrity

www.FlowCAD.com

Cross Section I

- Multi Stackups mode to be enabled under “View”



#	Objects: Name	Types: Layer	Thickness: mm	Material	Primary	Flex Main	Flex Stiffened
		Surface			☑	☑	☑
	COVER_TOP	Mask	0.1	Polyimide	☐	☑	☑
	ADHESIVE_TOP	Mask	0.025	Adhesive Epoxy	☐	☑	☑
	SOLDERMASK_TOP	Mask	0.02	Soldermask	☑	☐	☐
1	TOP	Conductor	0.03	Copper	☑	☐	☐
		Dielectric	0.2	Polyimide	☑	☐	☐
2	LAYER_1	Conductor	0.02	Copper	☑	☐	☐
		Dielectric	0.2	Fr-4	☑	☐	☐
3	LAYER_2	Conductor	0.02	Copper	☑	☐	☐
		Dielectric	0.5	Fr-4	☑	☐	☐
4	LAYER_3	Conductor	0.02	Copper	☑	☐	☐
		Dielectric	0.2	Fr-4	☑	☐	☐
5	LAYER_4	Conductor	0.02	Copper	☑	☑	☑
		Dielectric	0.2	Polyimide	☑	☑	☑
6	BOTTOM	Conductor	0.02	Copper	☑	☐	☐
	SOLDERMASK_BOTTOM	Mask	0.02	Soldermask	☑	☐	☐
	ADHESIVE_BOTTOM	Mask	0.025	Adhesive Epoxy	☐	☑	☑
	COVER_BOTTOM	Mask	0.1	Polyimide	☐	☑	☑
	STIFENER	Mask	5	Aluminum	☐	☐	☑
		Surface			☑	☑	☑

Cross Section II

- Primary Stackup

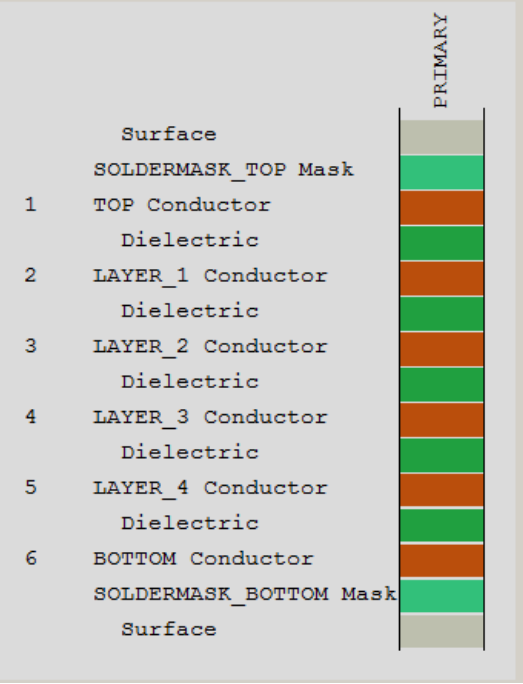
Cross Section Editor (Multi Stackups mode)

Export Import Edit View Filters

cadence

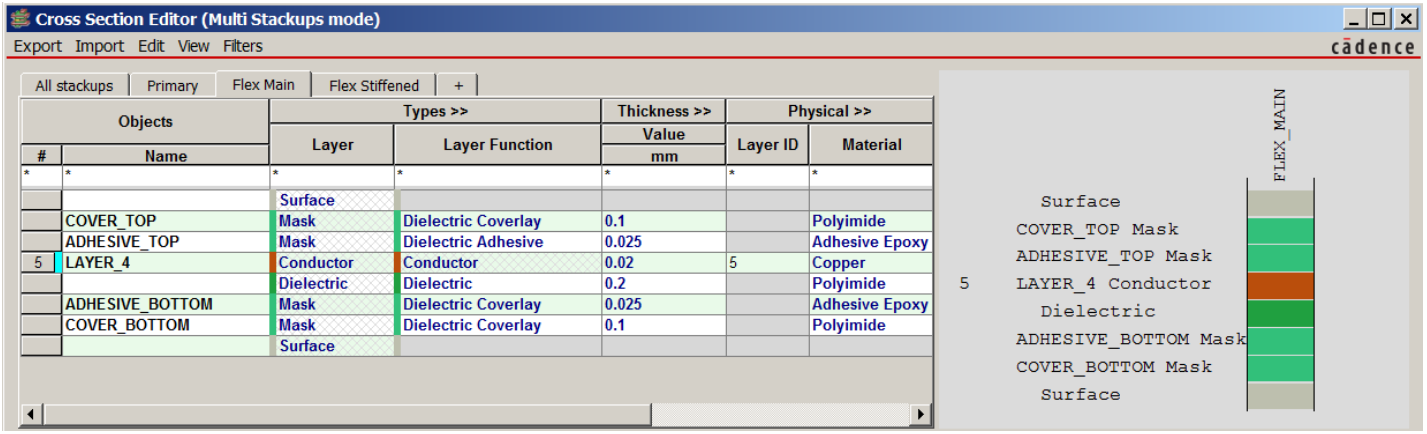
All stackups | Primary | Flex Main | Flex Stiffened | +

#	Objects: Name	Types >>: Layer	Types >>: Layer Function	Thickness >>: Value mm	Physical >>: Layer ID	Physical >>: Material
*	*	*	*	*	*	*
		Surface				
	SOLDERMASK_TOP	Mask	Solder Mask	0.02		Soldermask
1	TOP	Conductor	Conductor	0.03	1	Copper
		Dielectric	Dielectric	0.2		Polyimide
2	LAYER_1	Conductor	Conductor	0.02	2	Copper
		Dielectric	Dielectric	0.2		Fr-4
3	LAYER_2	Conductor	Conductor	0.02	3	Copper
		Dielectric	Dielectric	0.5		Fr-4
4	LAYER_3	Conductor	Conductor	0.02	4	Copper
		Dielectric	Dielectric	0.2		Fr-4
5	LAYER_4	Conductor	Conductor	0.02	5	Copper
		Dielectric	Dielectric	0.2		Polyimide
6	BOTTOM	Conductor	Conductor	0.02	6	Copper
	SOLDERMASK_BOTTOM	Mask	Solder Mask	0.02		Soldermask
		Surface				

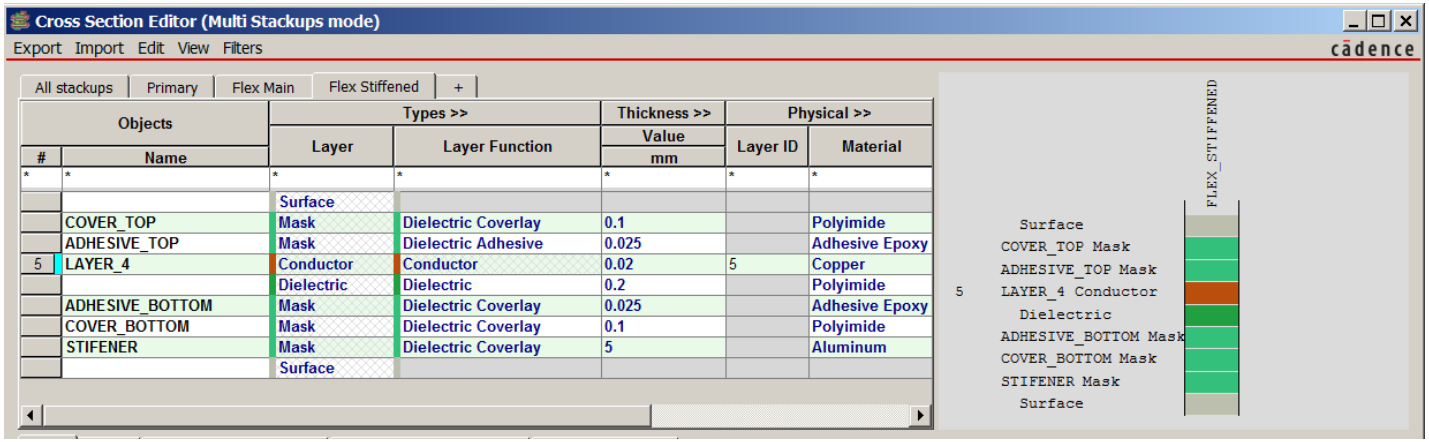


Cross Section III

- Flex Main

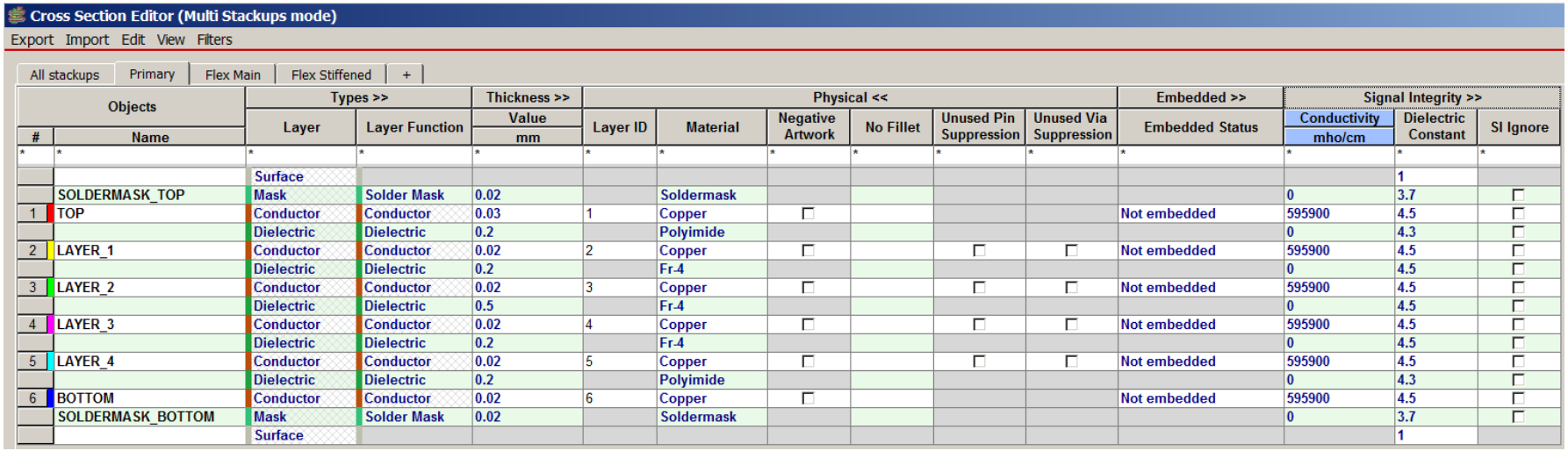


- Flex Stiffened



Cross Section IV

- Layer details can be edited in different stackups
  - Physical details
  - Embedding
  - Signal Integrity



Cross Section Editor (Multi Stackups mode)

Export Import Edit View Filters

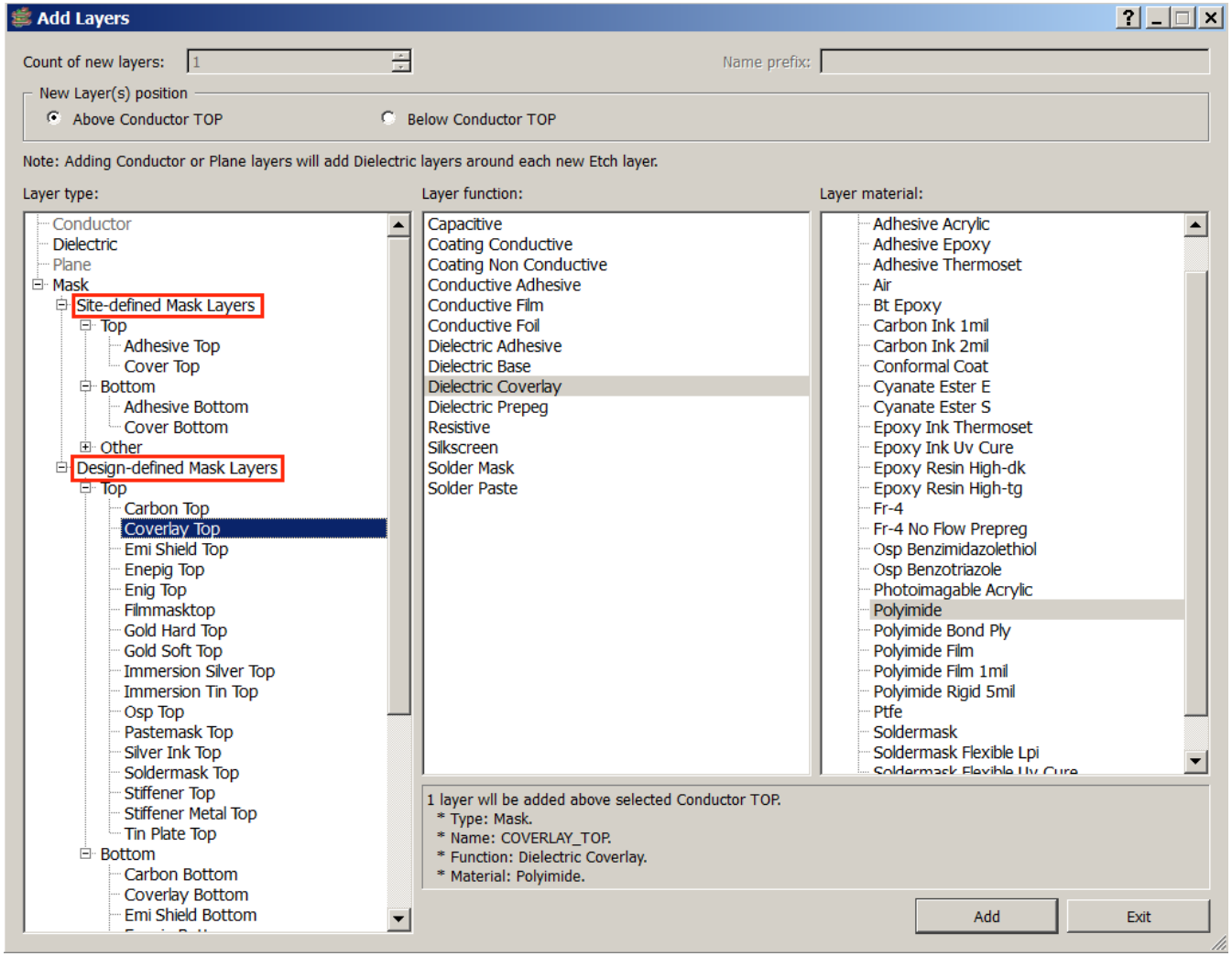
All stackups | Primary | Flex Main | Flex Stiffened | +

Objects		Types >>		Thickness >>	Physical <<						Embedded >>	Signal Integrity >>		
#	Name	Layer	Layer Function	Value mm	Layer ID	Material	Negative Artwork	No Fillet	Unused Pin Suppression	Unused Via Suppression	Embedded Status	Conductivity mho/cm	Dielectric Constant	SI Ignore
*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
		Surface											1	
	SOLDERMASK_TOP	Mask	Solder Mask	0.02		Soldermask						0	3.7	☐
1	TOP	Conductor	Conductor	0.03	1	Copper	☐				Not embedded	595900	4.5	☐
		Dielectric	Dielectric	0.2		Polyimide						0	4.3	☐
2	LAYER_1	Conductor	Conductor	0.02	2	Copper	☐		☐	☐	Not embedded	595900	4.5	☐
		Dielectric	Dielectric	0.2		Fr-4						0	4.5	☐
3	LAYER_2	Conductor	Conductor	0.02	3	Copper	☐		☐	☐	Not embedded	595900	4.5	☐
		Dielectric	Dielectric	0.5		Fr-4						0	4.5	☐
4	LAYER_3	Conductor	Conductor	0.02	4	Copper	☐		☐	☐	Not embedded	595900	4.5	☐
		Dielectric	Dielectric	0.2		Fr-4						0	4.5	☐
5	LAYER_4	Conductor	Conductor	0.02	5	Copper	☐		☐	☐	Not embedded	595900	4.5	☐
		Dielectric	Dielectric	0.2		Polyimide						0	4.3	☐
6	BOTTOM	Conductor	Conductor	0.02	6	Copper	☐				Not embedded	595900	4.5	☐
	SOLDERMASK_BOTTOM	Mask	Solder Mask	0.02		Soldermask						0	3.7	☐
		Surface											1	

www.FlowCAD.com

Layer Definition

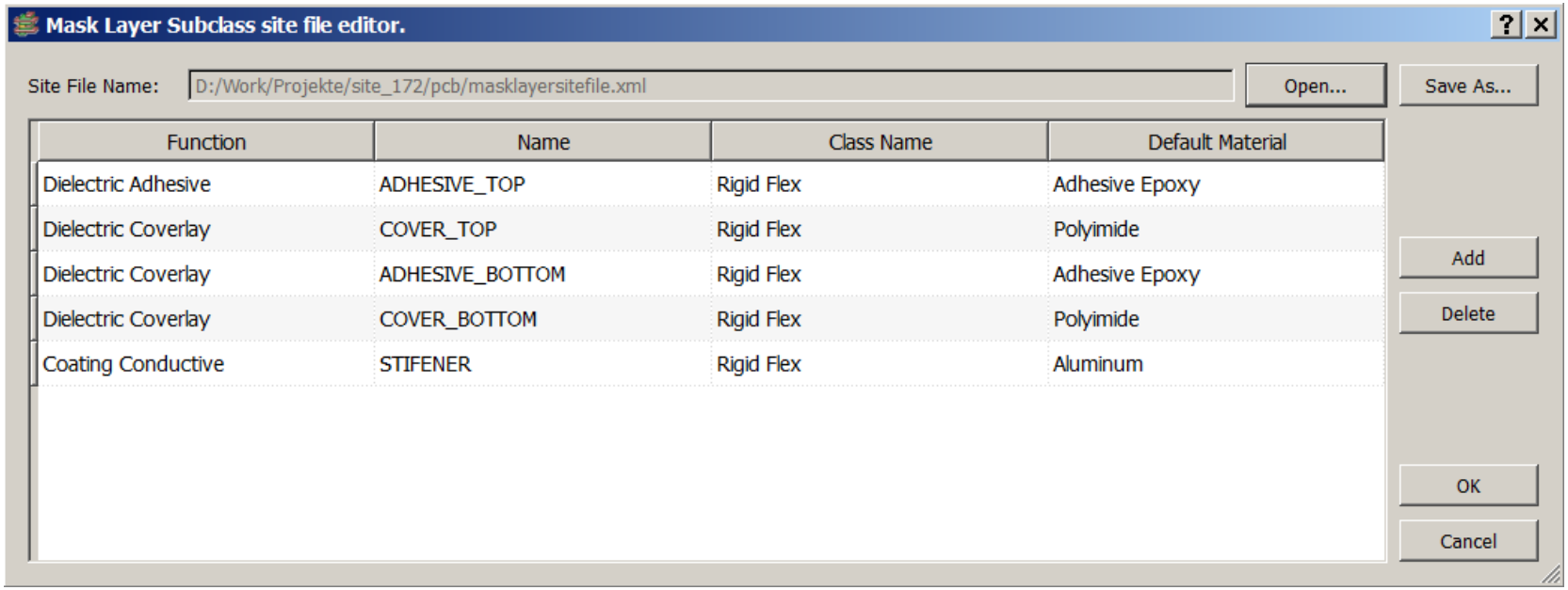
- Add Layers dialog to define Stackup in “All Stackups View”



www.FlowCAD.com

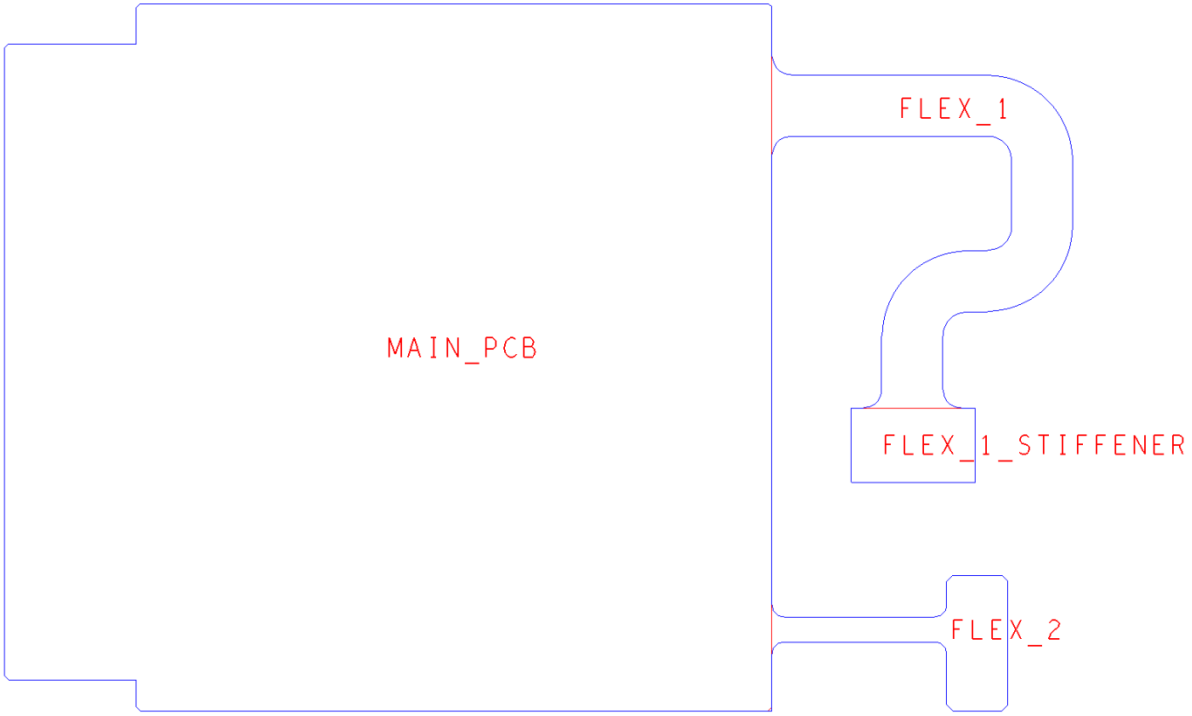
Site Setup

- Mask Layer Site File (“Edit / Site File”)
- Useful due to limitless combinations of materials



- Default location: MATERIALPATH

Zones



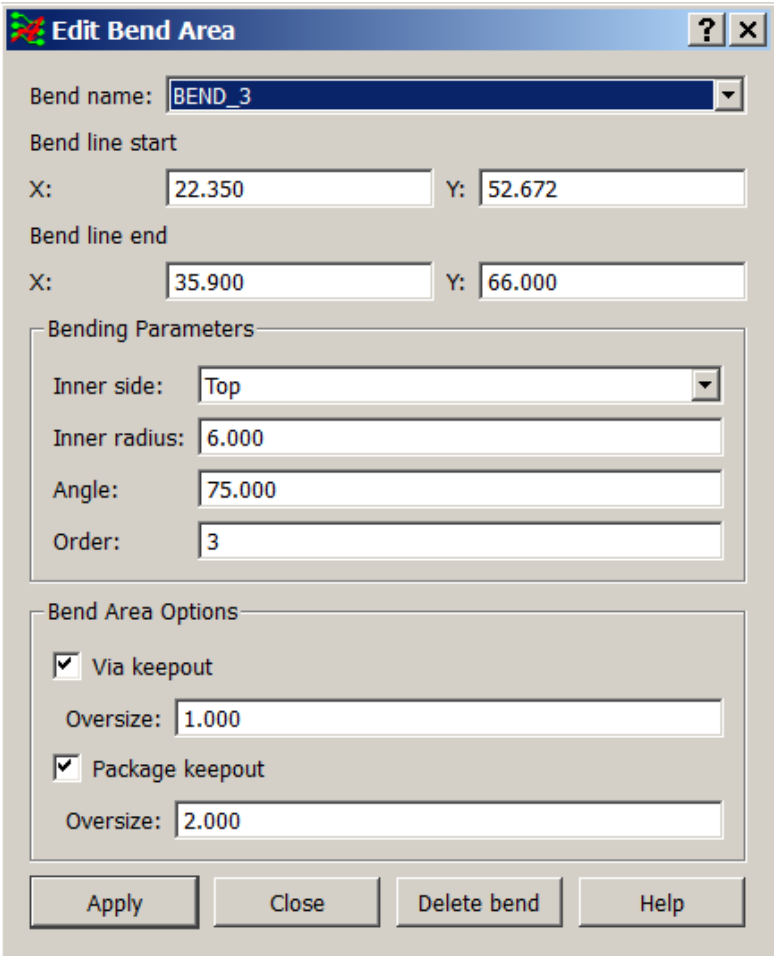
- Defined as shapes in layout
  - "Setup / Zones"

- Constraint regions and rooms can be defined in Zone Manager

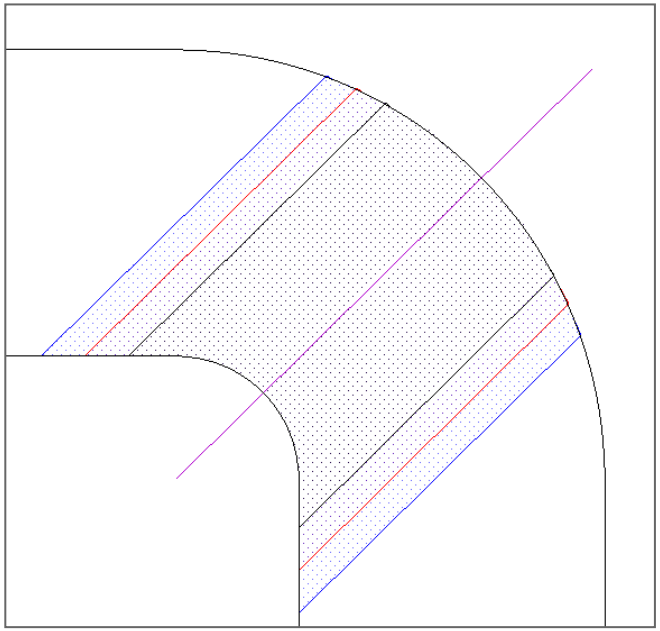
Zone Manager

Select	Name	Stackup	Start Layer	Stop Layer	Constraint Reg	Room
☐	MAIN_PCB	PRIMARY	TOP	BOTTOM		
☐	FLEX_1	FLEX_1	INNER1	INNER2	FLEX	
☐	FLEX_1_STIFFENER	FLEXI_STIFFENED	INNER1	INNER2	FLEX	RF-AMP
☐	FLEX_2	FLEX_2	INNER1	INNER2	FLEX	

Bend Area

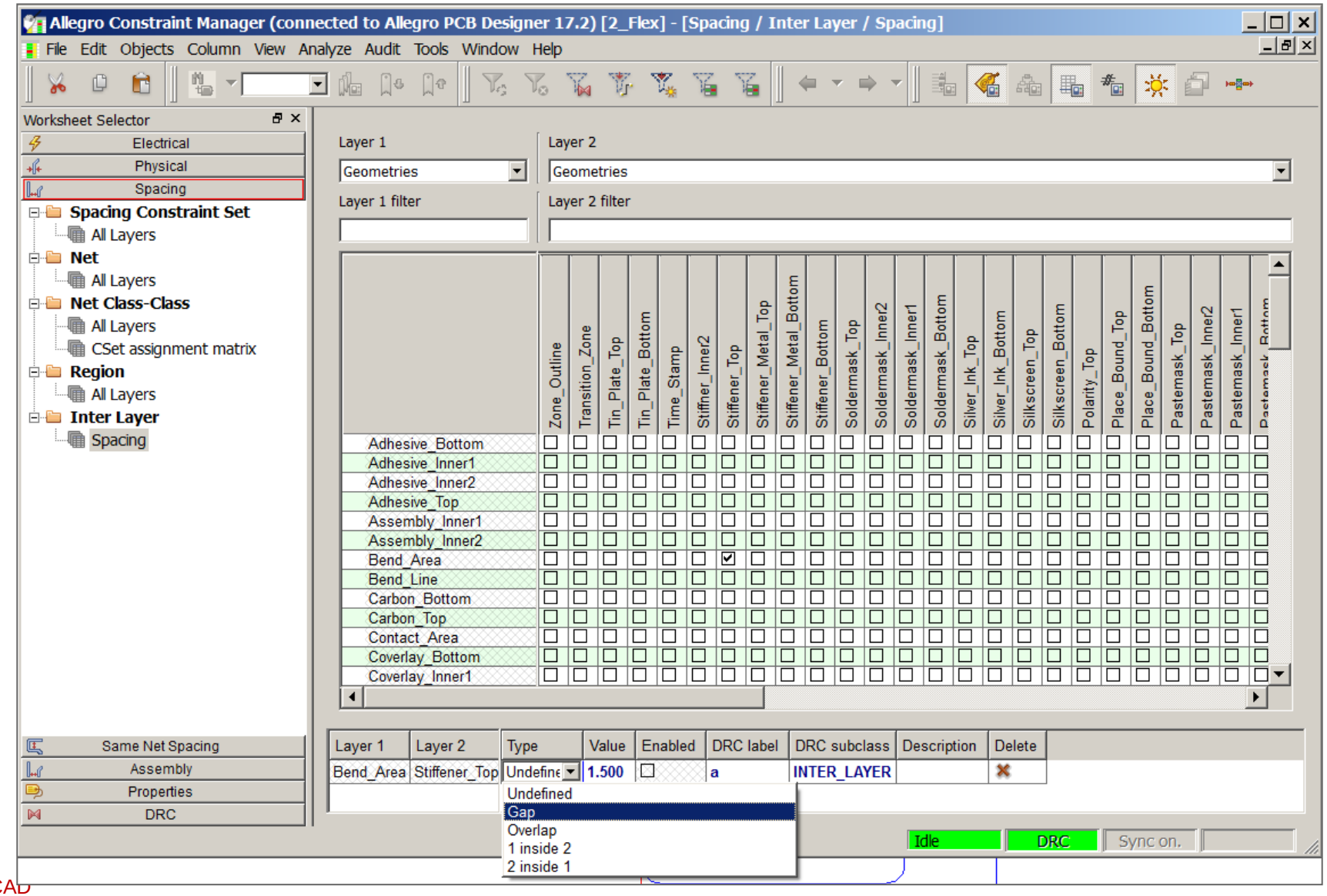


- Bends are defined by following parameters:
  - Position
  - Direction
  - Radius
  - Angle
  - Additional keepouts



www.FlowCAD.com

Interlayer Checks – Constraint Manager



www.FlowCAD.com

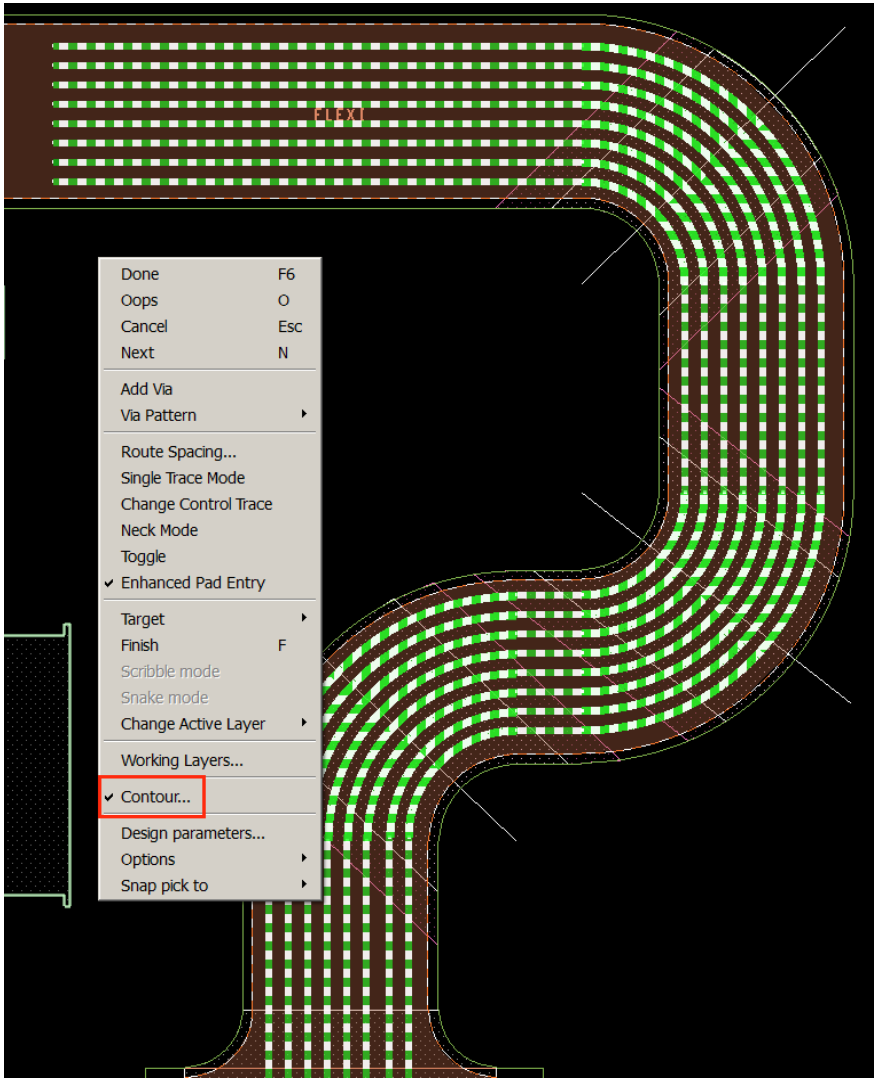
Interlayer Checks – Rule Examples

- DRC engine designed to check
  - Mask layer to mask layer geometry
  - Mask layer to surface metal
- Layer selection GUI
  - Matrix of applicable subclasses
  - Filtering capabilities
  - Comment field
- Gaps:
  - Coverlay to pad
  - Mask to pad
  - Precious metal to coverlay
  - Bend area/line to stiffener, component, pin, and via
- Minimum overlap, e.g.:
  - Transition zone must overlap bend area by 15 mils
- Inside Rule:
  - (Layer 1) inside (layer 2)
  - Geometry on one subclass must be contained within the geometry of another subclass geometry

www.FlowCAD.com

Contour Routing

- Simplified routing of traces along rounded contour of flex boards

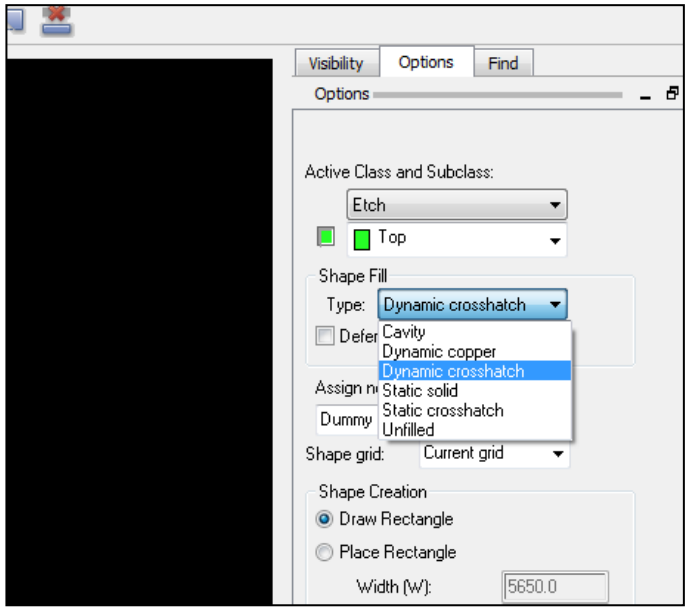


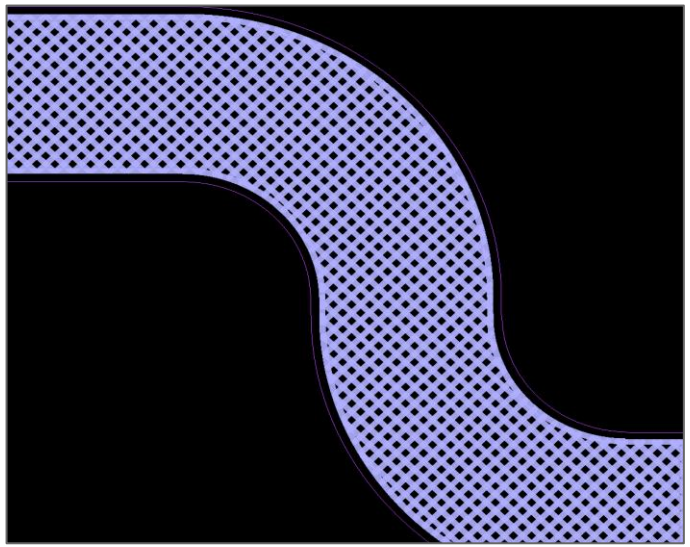
www.FlowCAD.com

Cross Hatch Shapes

- Cross Hatch (Xhatch) shapes are common with Flex PCBs
  - Lighter in weight
  - Adheres better, less prone to cracking at bend areas

- Dynamic cross hatch is supported by shape-add feature

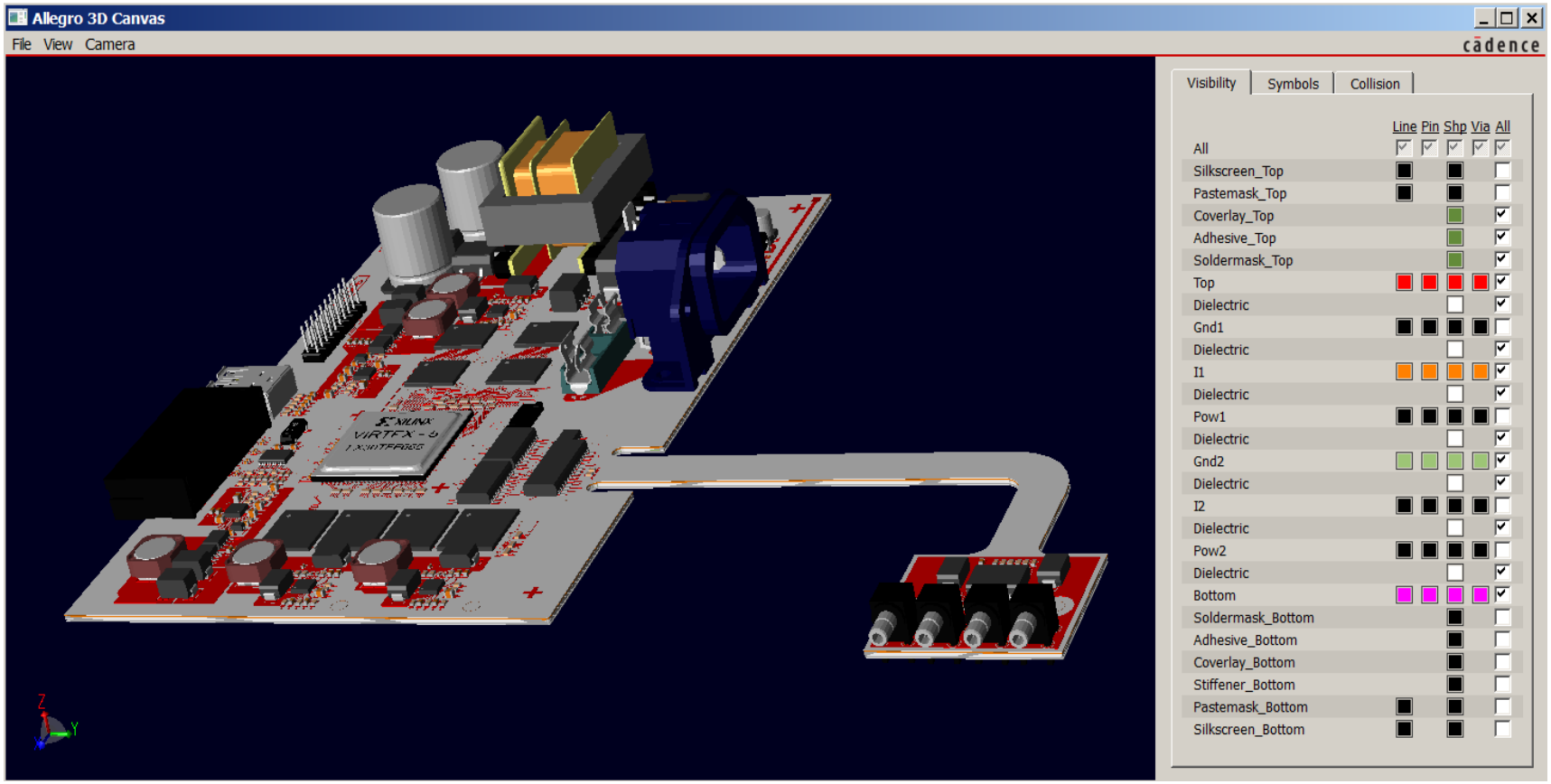




www.FlowCAD.com

Visualization / Interfaces

- Interactive 3D Canvas



- Step export of complete design

Outlook

- Visualization of different stackups in Interactive 3D Canvas
  - Currently only the primary stackup is displayed

- Bending in Interactive 3D Canvas
  - In preparation, planned for this year

Embedded Components

www.FlowCAD.com

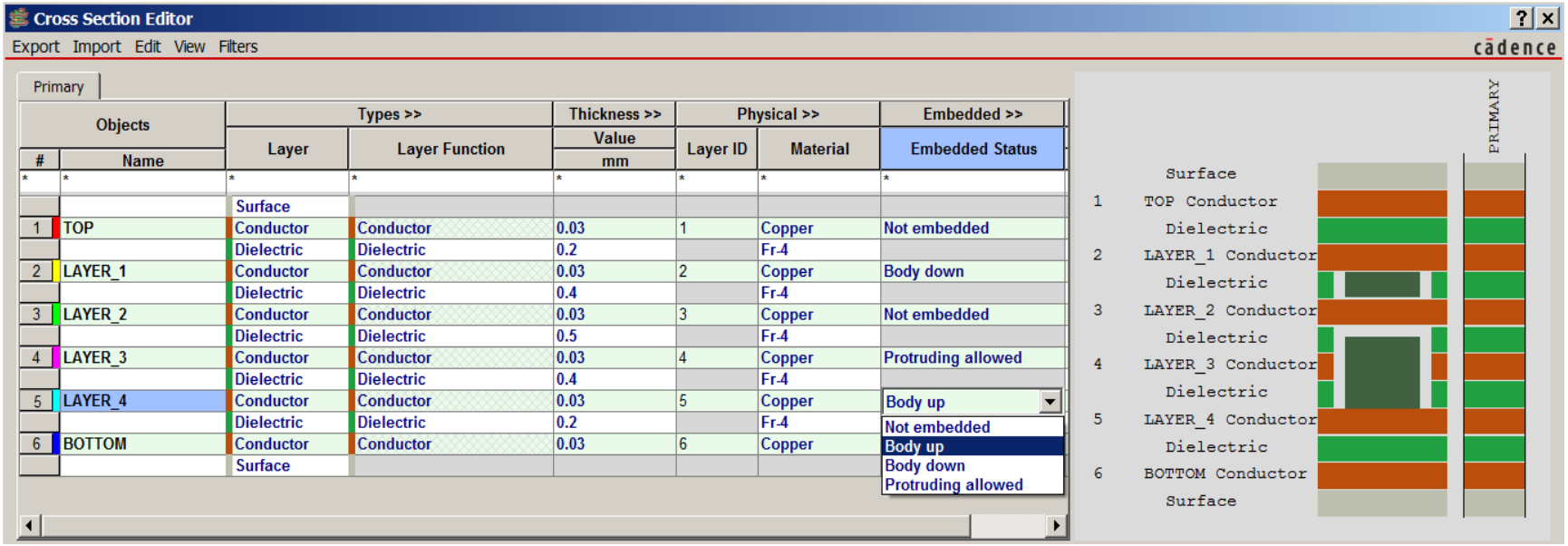
Advantages

- Miniaturization
  - Significant reduction of form factor
- Electrical performance
  - E.g. passives closer to active components
- Protection of components
- Less bending stress
- EMI protection
- IP-protection
  - Internal die has no marking
- Compatible to traditional SMT processes

www.FlowCAD.com

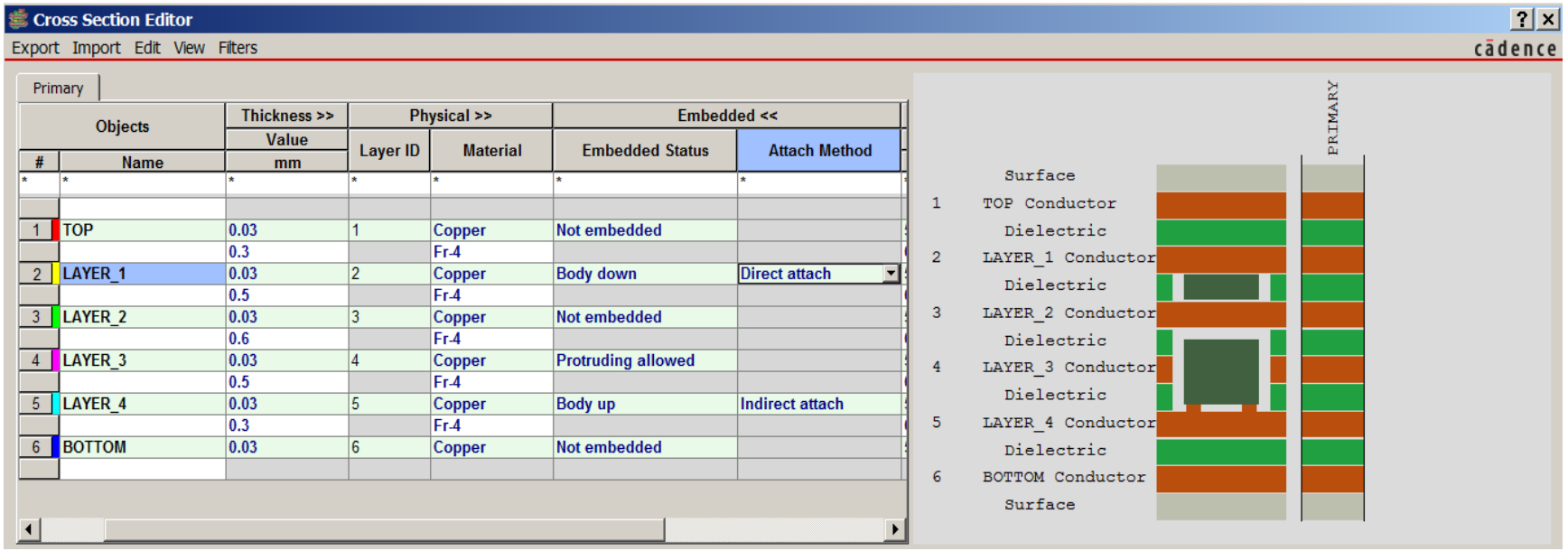
Cross Section

- Not embedded: Default, no embedded placement on this layer
- Body up: Components can be placed on this layer with body up
- Body down: Components can be placed on this layer with body down
- Protruding allowed: Components can break through this etch layer



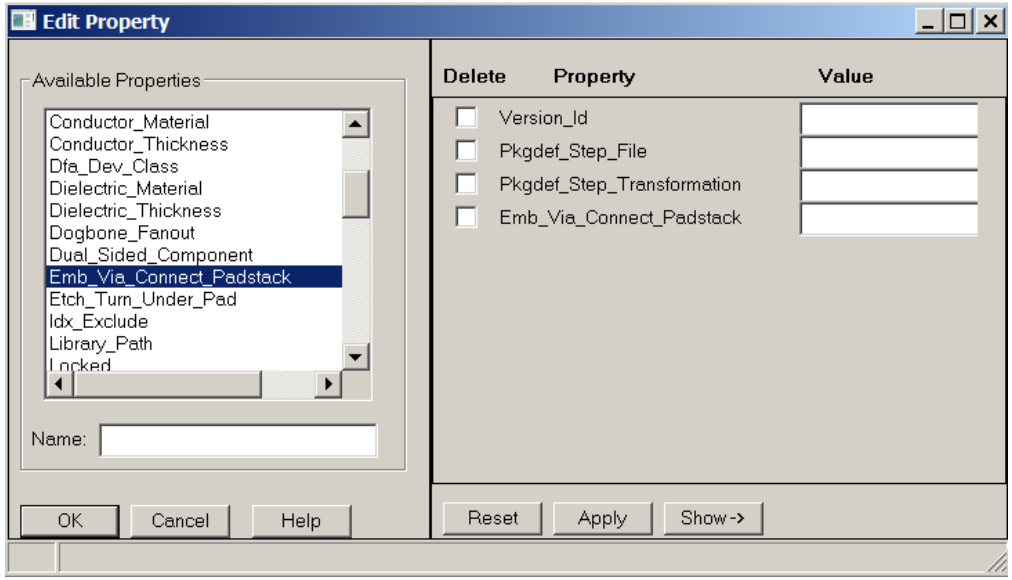
Attachment Method

- Direct attach:
  - Standard process
  - Component is directly soldered to inner layer
- Indirect attach
  - Components are mounted in substrate
  - Contacted by single layer µVias



Indirect Attach Vias

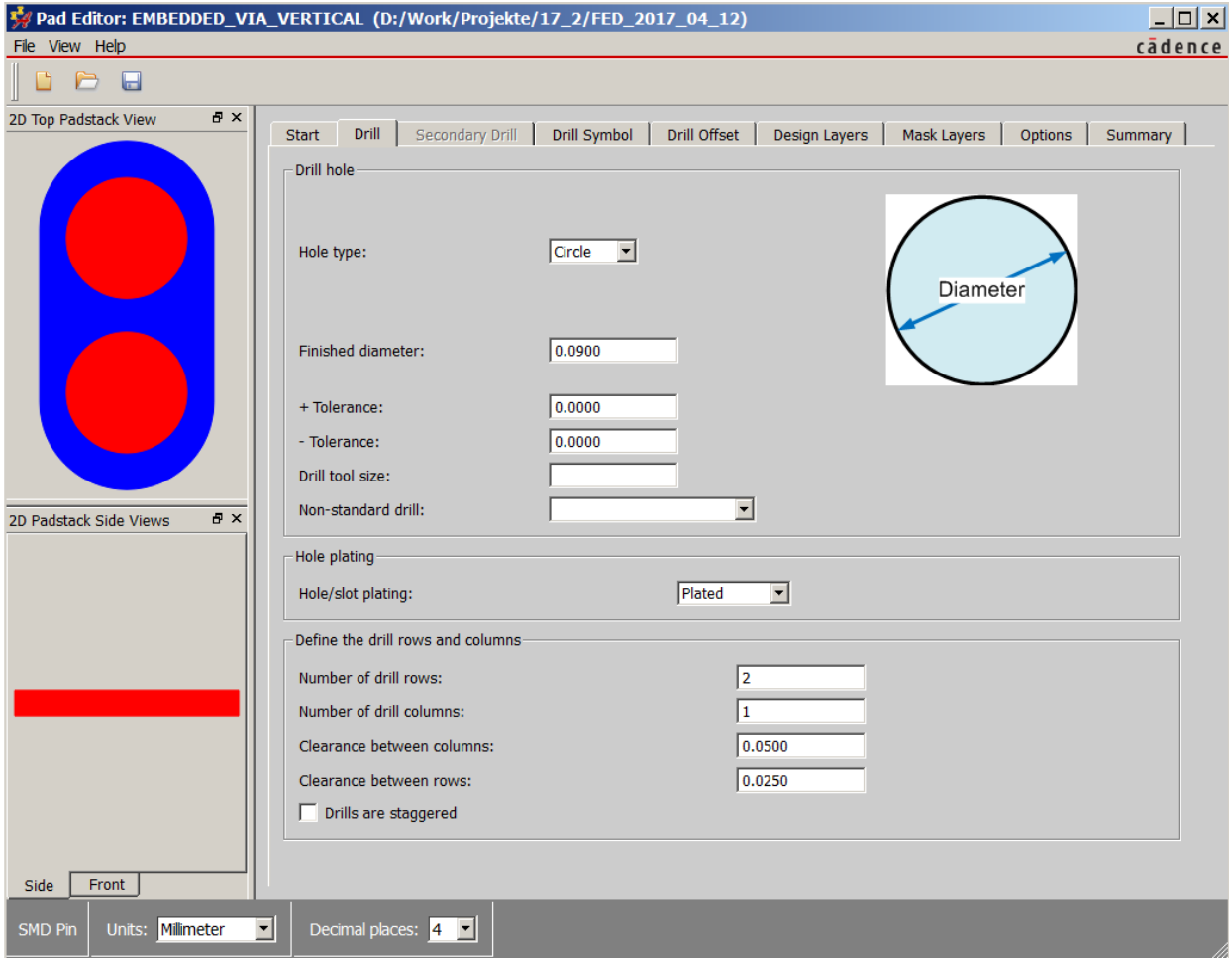
- Property EMB_VIA_CONNECT_PADSTACK
  - Specifies the name of the via padstack to be used for connecting the embedded component to the etch layer (indirect attach)
  - Has to be specified at drawing level of a symbol



www.FlowCAD.com

Redundant Vias

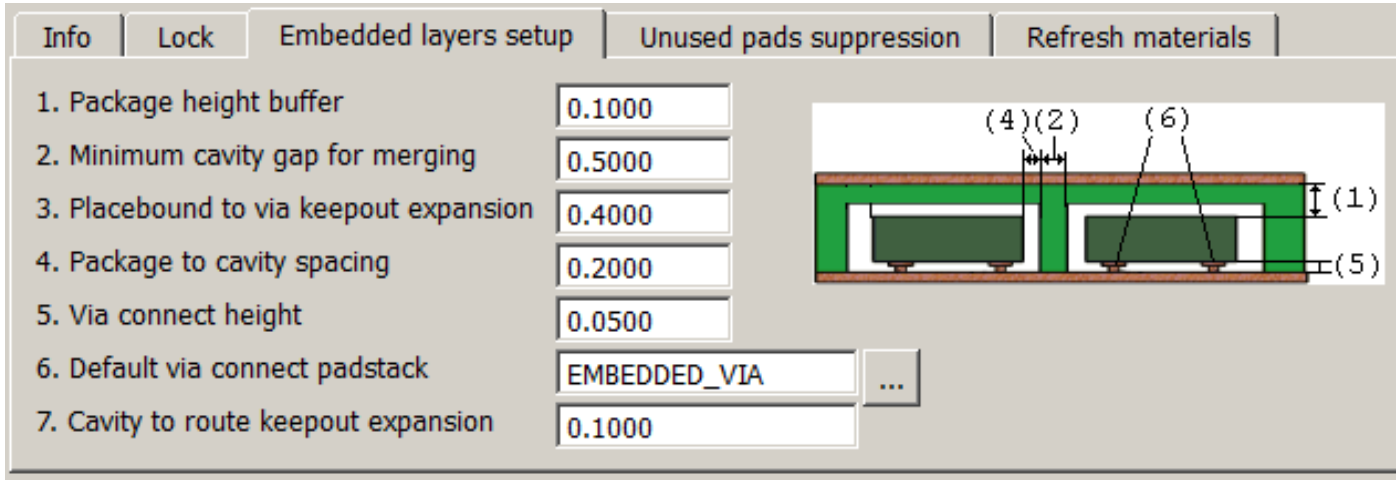
- Possibility to define in Padstack Editor



www.FlowCAD.com

Rules Setup

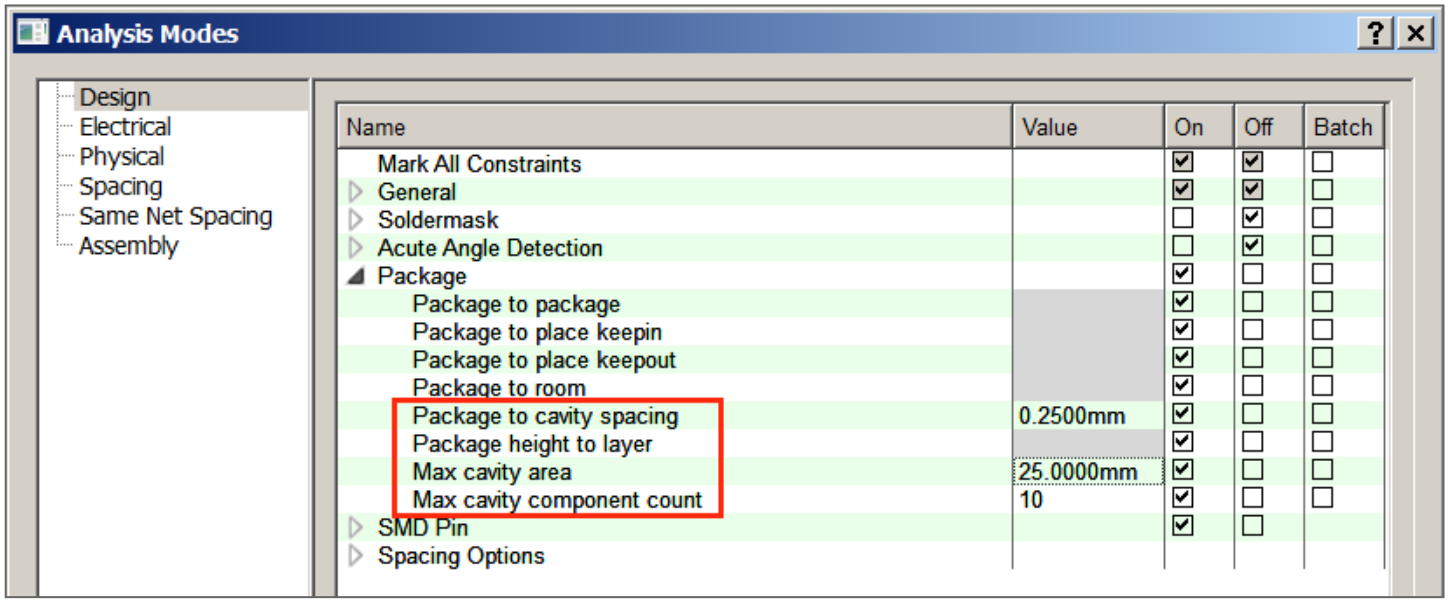
1. Height buffer to next etch layer
2. Minimal gap to next cavity before merging
3. Creates a via keepout based on placebound
4. Package to cavity spacing, same as under Constraints / Modes / Design Options
5. Gap between etch layer and component pad
6. If padstack for embedding is not defined within component, this padstack will be used
7. Route keepout around cavity, when components protrudes



www.FlowCAD.com

Analysis Modes

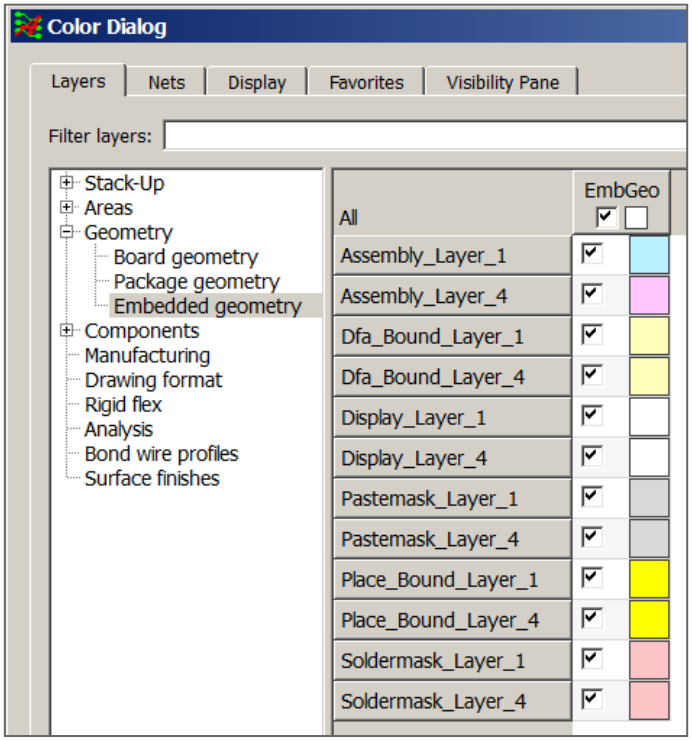
- Package to cavity spacing, same as in Cross Section Editor
- Check package height + buffer to next etch layer
- Maximal area of a cavity
- Maximal number of components in one cavity

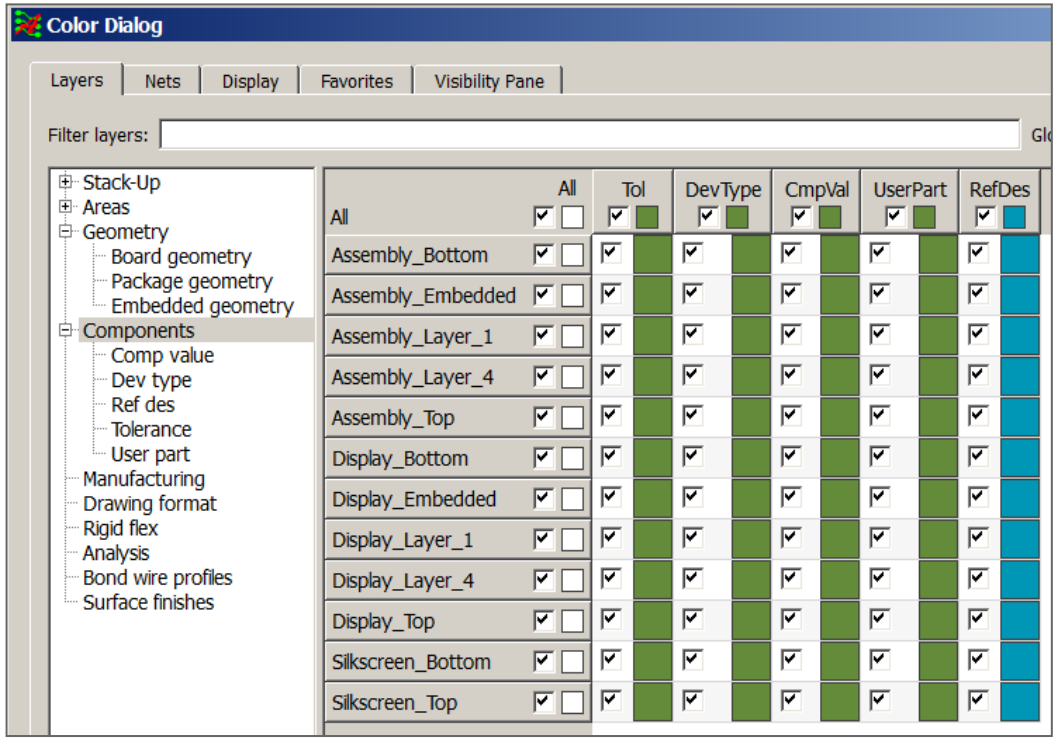


www.FlowCAD.com

Additional Layers

- Required additional layers are auto generated:

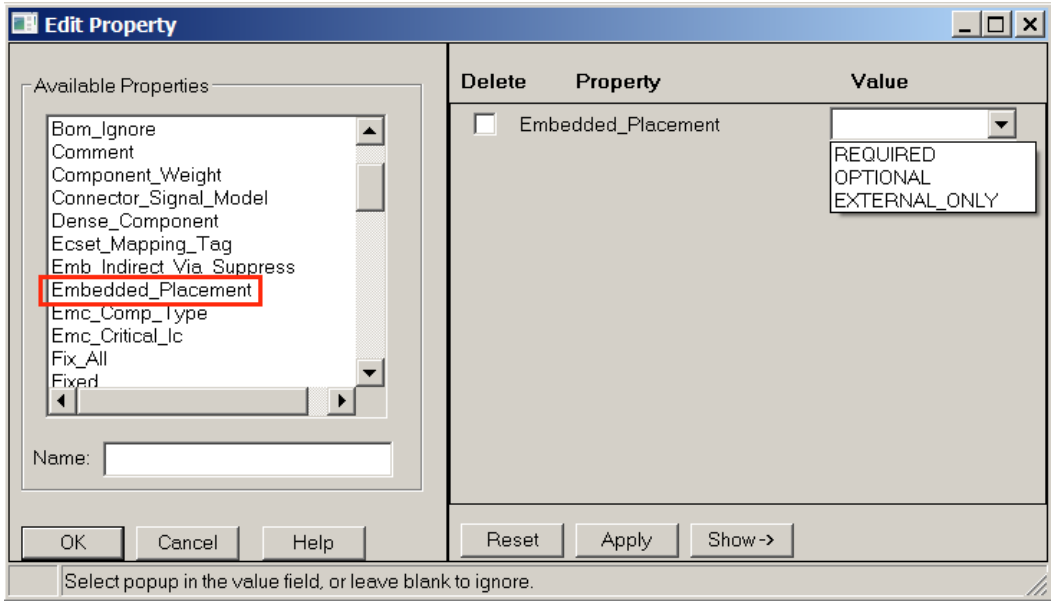


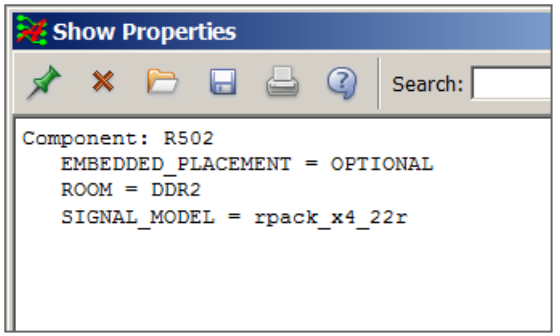


www.FlowCAD.com

Part Properties I

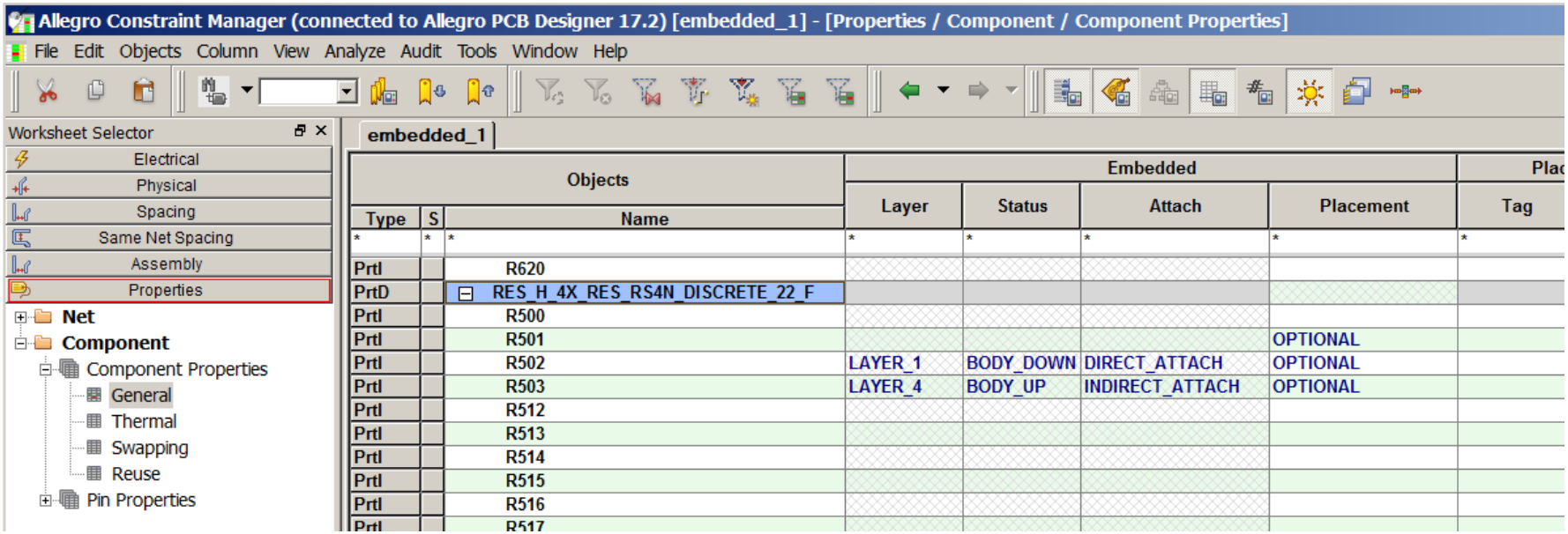
- Embedded Placement is triggered by Property „Embedded_Placement“:
  - Required: Component has to be embedded, no placement on outer layer allowed
  - Optional: Component can be embedded
  - External Only: Placement on outer layer only
- Can already be done at schematic level





Part Properties II

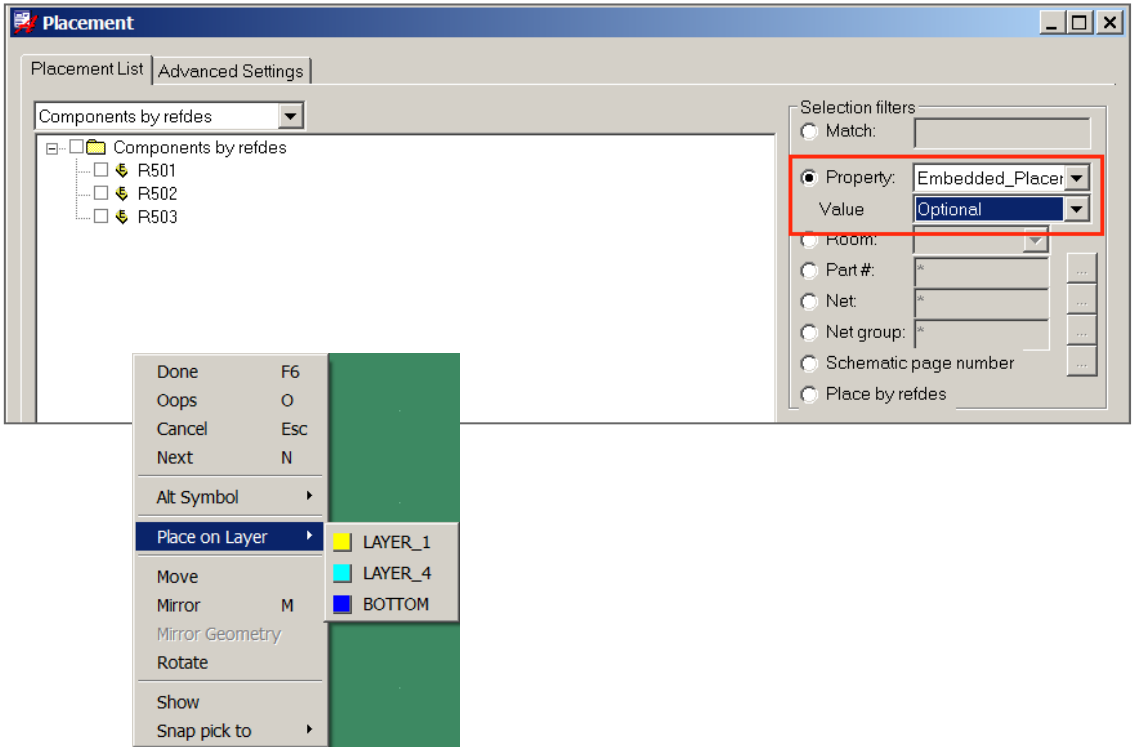
- Handling in Constraint Manager
- Important for Dual Sided Components
  - Embedded Placement Property required to place



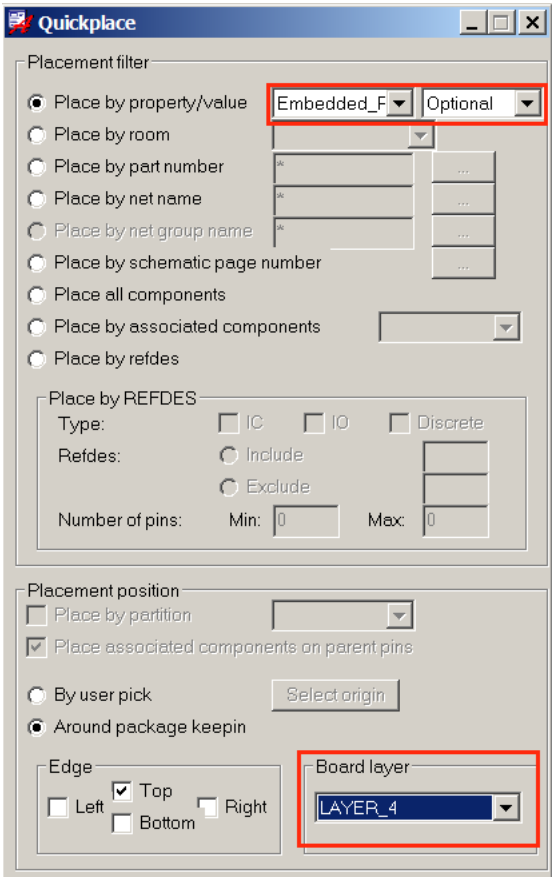
www.FlowCAD.com

Placement

Manual:



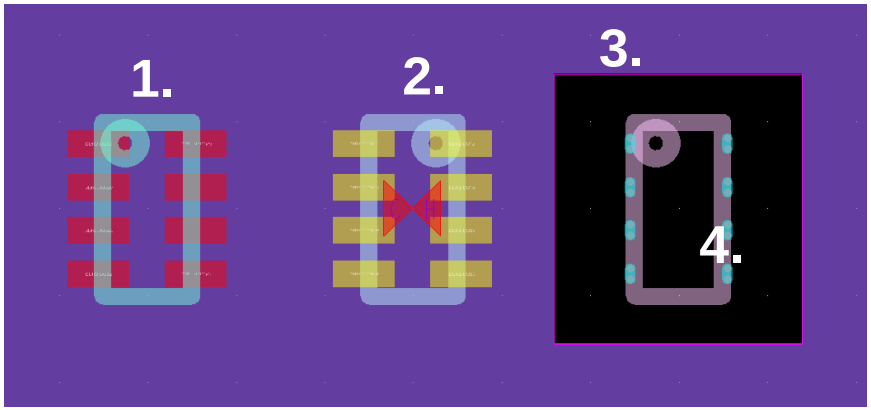
Quickplace:



www.FlowCAD.com

Cases

1. Top
2. Layer_1, Direct attach
   - DRC: Package Height to Layer Spacing
3. Layer_3, Protruding allowed
4. Layer_4, Indirect attach



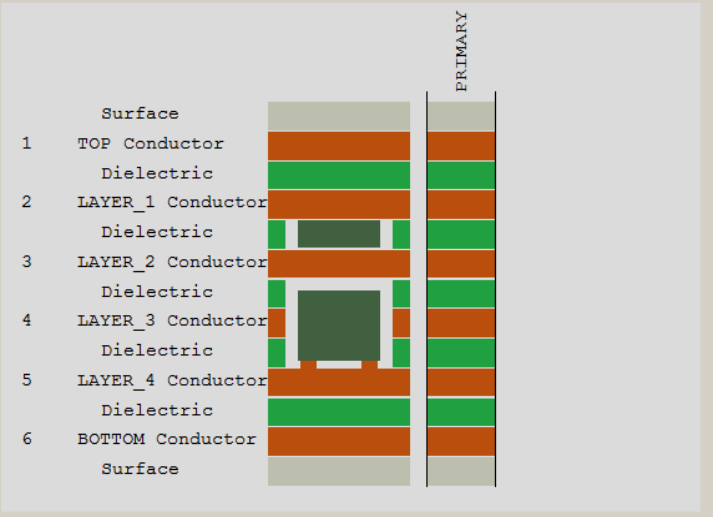
Cross Section Editor

Export Import Edit View Filters

cadence

Primary

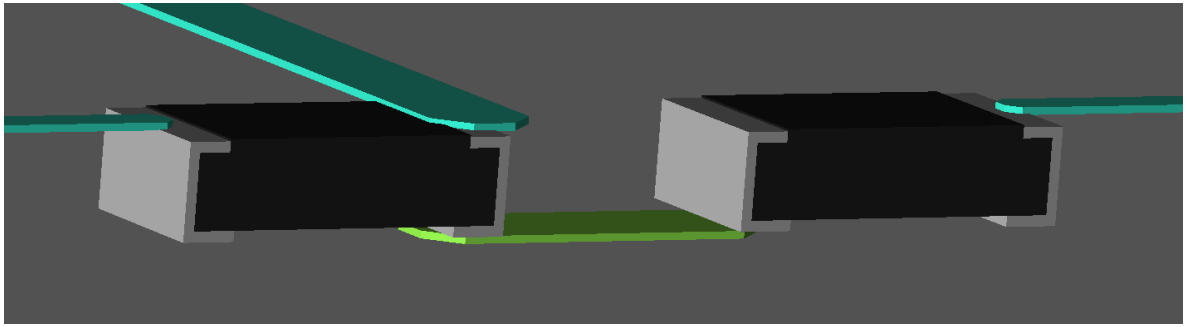
Objects		Thickness >>	Physical >>		Embedded <<	
		Value	Layer ID	Material	Embedded Status	Attach Method
#	Name	mm				
1	TOP	0.03	1	Copper	Not embedded	
		0.3		Fr-4		
2	LAYER_1	0.03	2	Copper	Body down	Direct attach
		0.5		Fr-4		
3	LAYER_2	0.03	3	Copper	Not embedded	
		0.6		Fr-4		
4	LAYER_3	0.03	4	Copper	Protruding allowed	
		0.5		Fr-4		
5	LAYER_4	0.03	5	Copper	Body up	Indirect attach
		0.3		Fr-4		
6	BOTTOM	0.03	6	Copper	Not embedded	

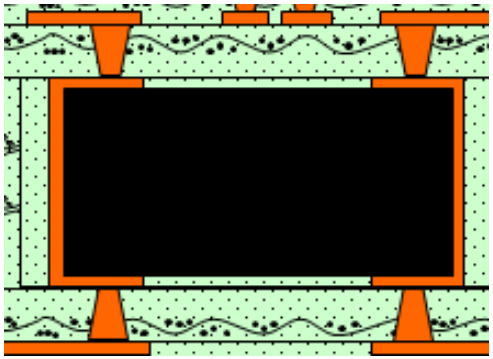


www.FlowCAD.com

Dual Sided Components

- Allegro PCB Editor supports use of dual-sided contact components
- Benefits: Reduction of vias
- Requirement:
  - "DUAL_SIDED_COMPONENT" Property on Symbols (.dra) defined on drawing level
  - Padstacks must have begin and end layer pad
  - "EMBEDDED_PLACEMENT = OPTIONAL or REQUIRED" on Component
    - No placement of dual sided components allowed on outer layers
- All PCB Editor embedded setup methodologies are fully supported:
  - Direct / indirect attach
    - Typically indirect attach is used
  - Body up / body down

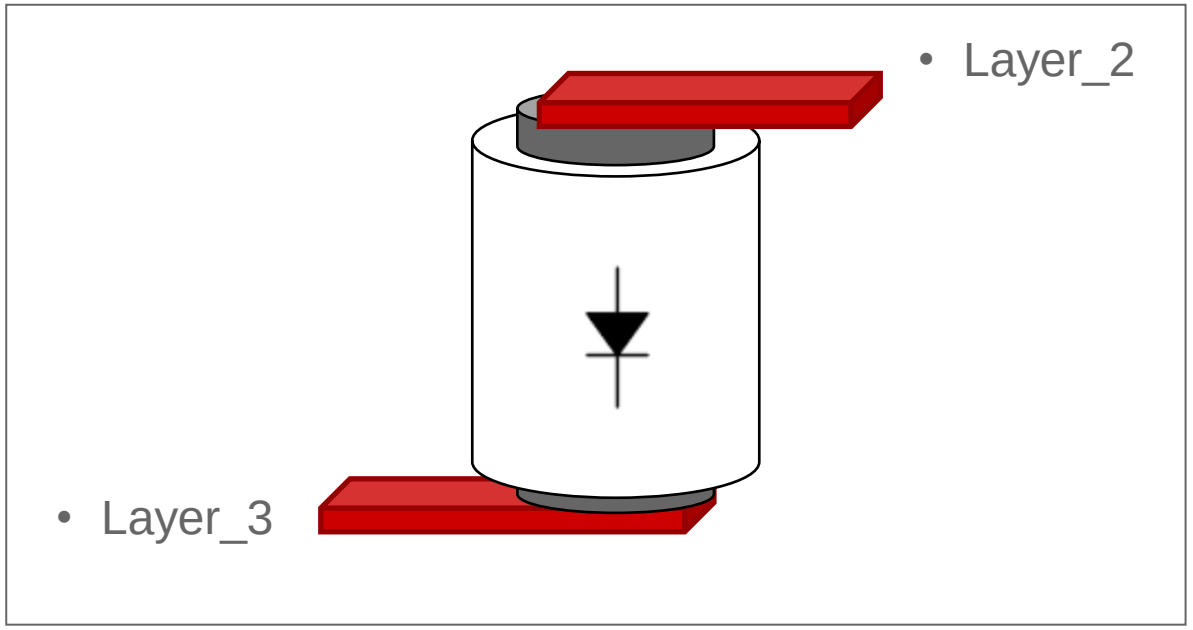




www.FlowCAD.com

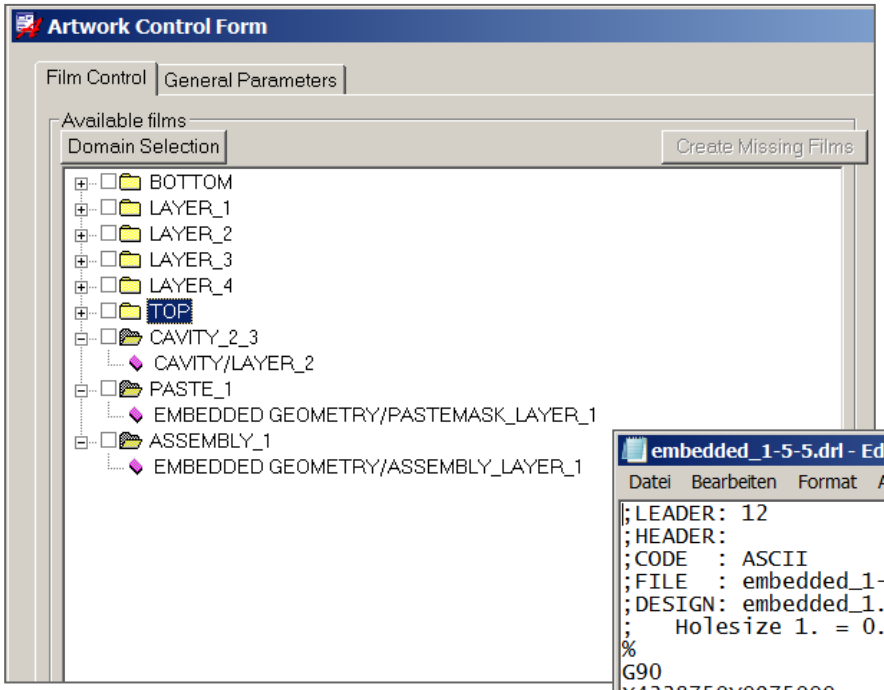
Vertical Components

- “Special case” of Dual Sided Components
- Mapped to different padstacks with Begin or End Layer pad



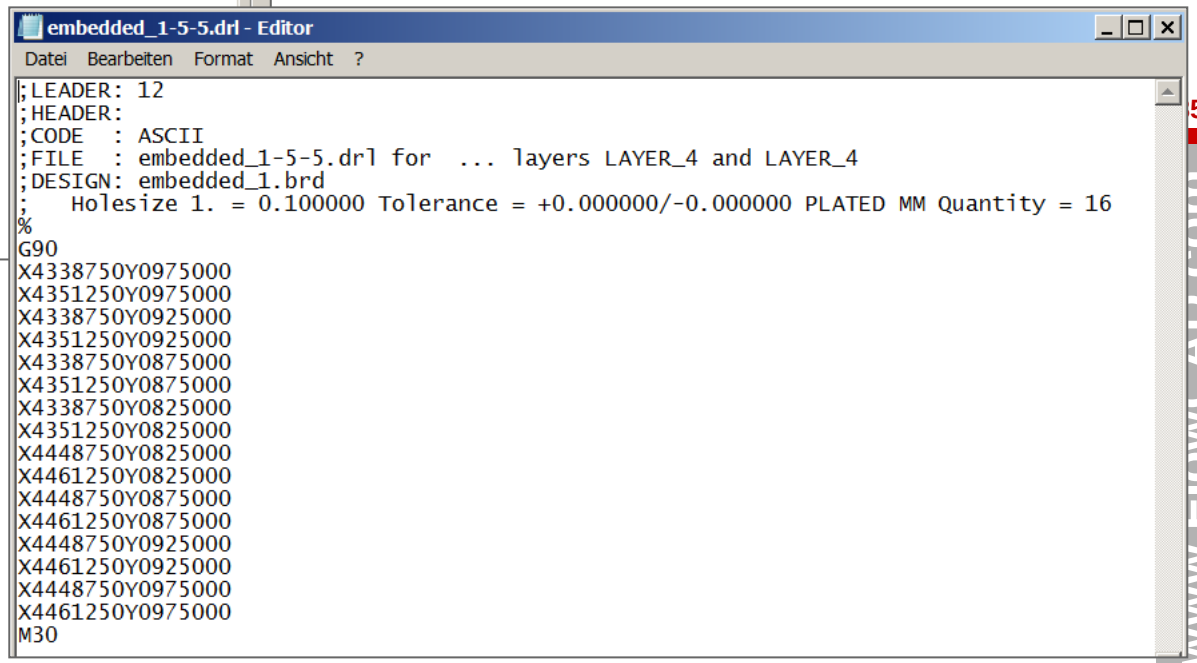
www.FlowCAD.com

PCB Manufacturing



- Embedded layers can be use for Film generation

- NC Drill supports single layer vias for indirect attach



Assembly

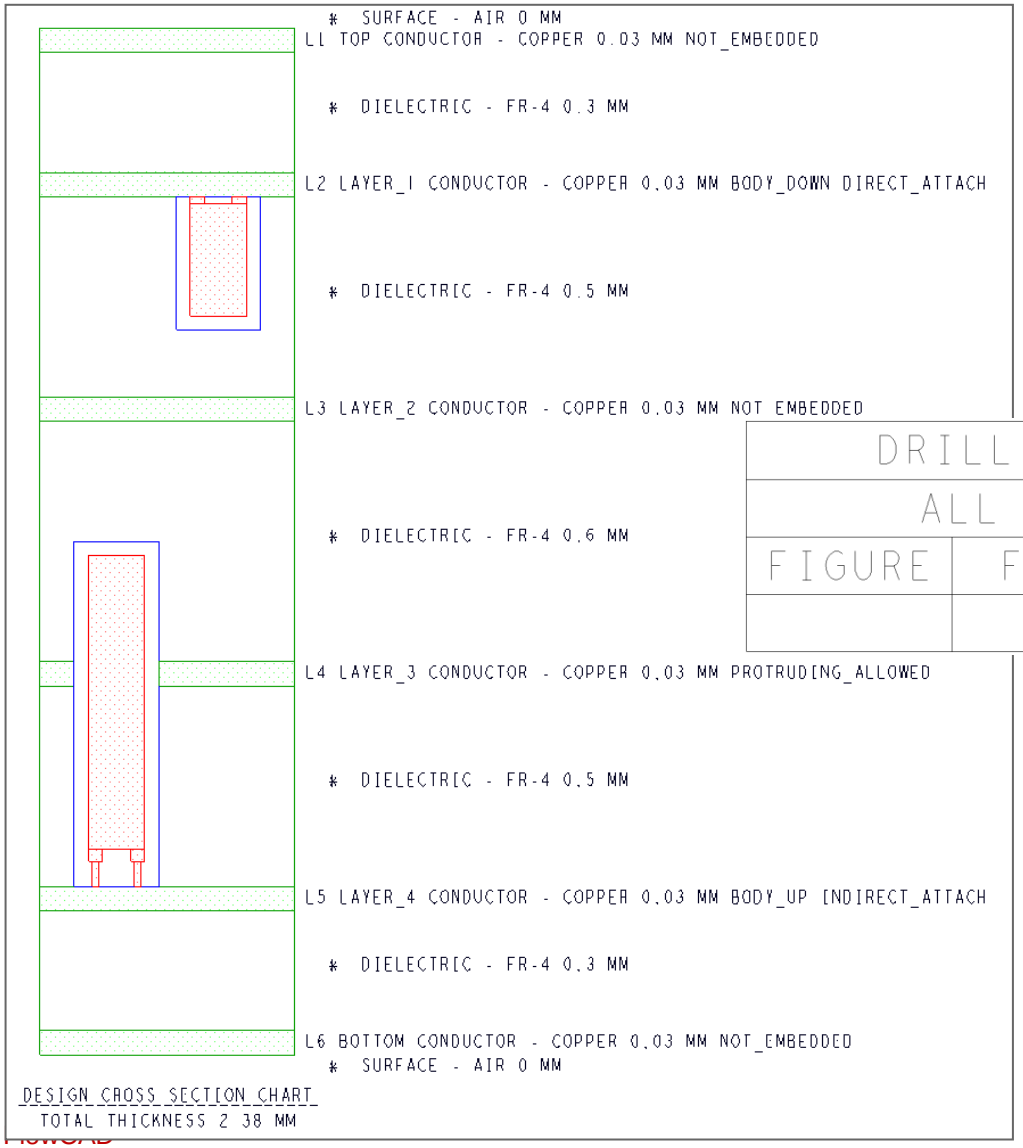
- Reports feature in Allegro PCB Editor support Embedding

	A	B	C	D	E	F	G	H
1	Allegro Report							
2	D:/Work/Projekte/17_2/FED_2017_04_12/embedded_1.brd							
3	Fri Mar 24 12:55:29 2017							
4								
5	REFDES	PART_NAME	EMBEDDED_LAYER	EMBEDDED_STATUS	EMBEDDED_ATTACH	SYM_CENTER_X	SYM_CENTER_Y	SYM_ROTATE
260	R506	RES_V				21.000	10.000	0.000
384	R502	RES_H_4x	LAYER_1	BODY_DOWN	DIRECT_ATTACH	39.000	9.000	0.000
385	R503	RES_H_4x	LAYER_4	BODY_UP	INDIRECT_ATTACH	44.000	9.000	0.000
386								

- IPC2581
- ODB++ Version 9.1

www.FlowCAD.com

Documentation



- Cross Section Chart contains embedding information

Drill Chart supports single layer vias for indirect attach

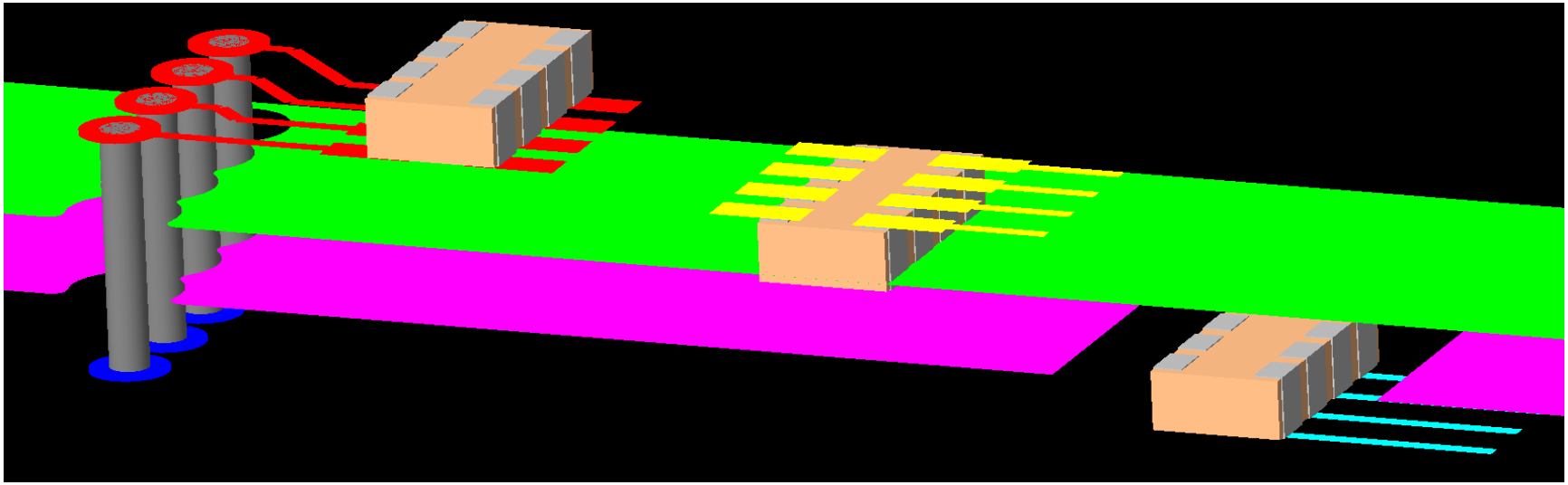
DRILL CHART: LAYER_4 to LAYER_4

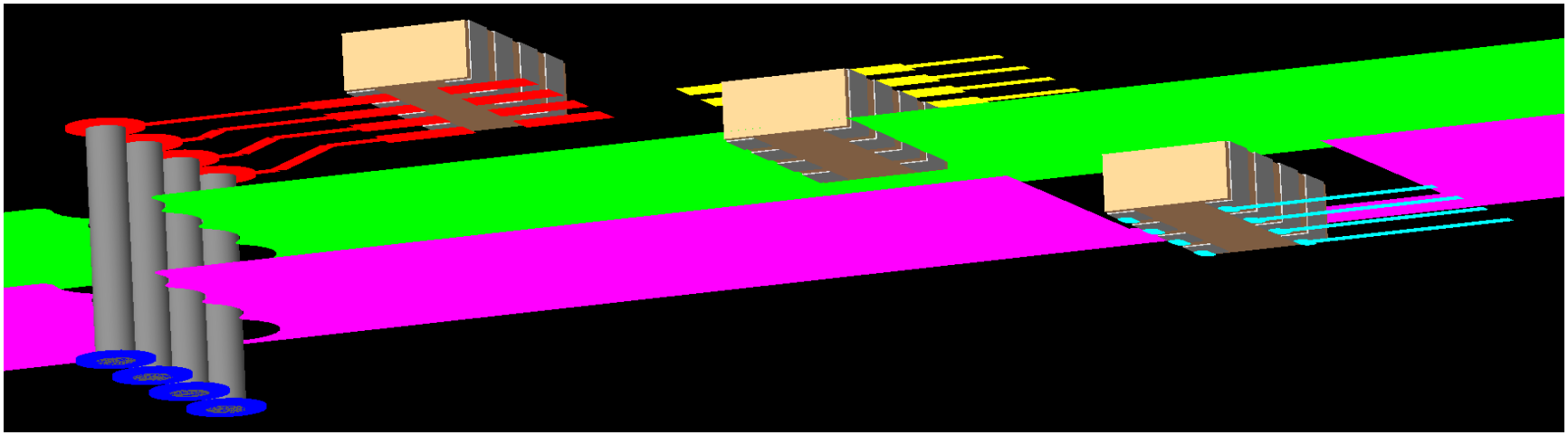
ALL UNITS ARE IN MILLIMETERS

FIGURE	FINISHED_SIZE	PLATED	QTY
	0.1	PLATED	16

www.FlowCAD.com

3D Visualization





www.FlowCAD.com

Combination Flexible PCB and Embedded Components

www.FlowCAD.com

Combination Flex / Embedded Components

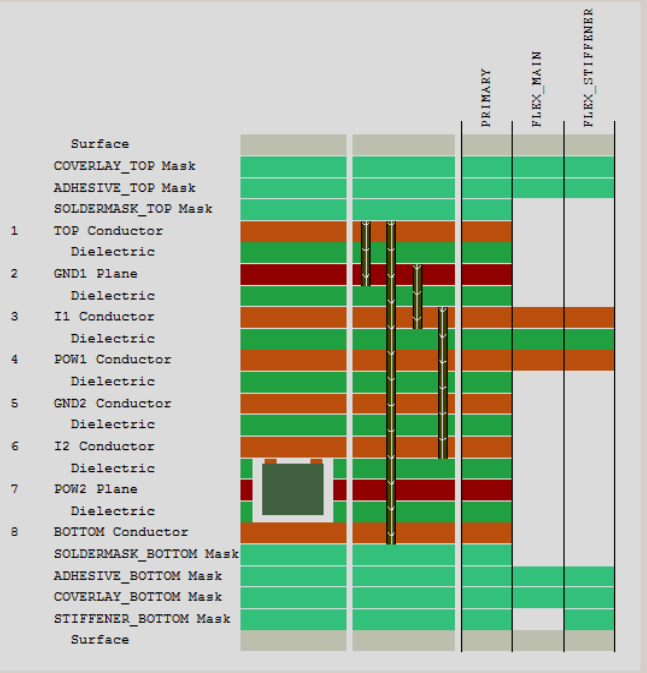
Cross Section Editor (Multi Stackups mode)

Export Import Edit View Filters

cadence

All stackups | Primary | Flex Main | Flex Stiffener | +

#	Name	Types / Layer	Thickness / mm	Material	Primary	Flex Main	Flex Stiffener	Add Stackup
		Surface			☑	☑	☑	
	COVERLAY_TOP	Mask	0.2032	Polyimide	☑	☑	☑	
	ADHESIVE_TOP	Mask	0.025	Adhesive Epoxy	☑	☑	☑	
	SOLDERMASK_TOP	Mask	0.015	Soldermask ...	☑	☐	☐	
1	TOP	Conductor	0.055	Copper	☑	☐	☐	
		Dielectric	0.15	Fr-4	☑	☐	☐	
2	GND1	Plane	0.03	Copper	☑	☐	☐	
		Dielectric	0.25	Fr-4	☑	☐	☐	
3	I1	Conductor	0.033	Copper	☑	☑	☑	
		Dielectric	0.2032	Polyimide	☑	☑	☑	
4	POW1	Conductor	0.033	Copper	☑	☑	☑	
		Dielectric	0.2032	Fr-4	☑	☐	☐	
5	GND2	Conductor	0.033	Copper	☑	☐	☐	
		Dielectric	0.2032	Polyimide	☑	☐	☐	
6	I2	Conductor	0.033	Copper	☑	☐	☐	
		Dielectric	0.25	Fr-4	☑	☐	☐	
7	POW2	Plane	0.03	Copper	☑	☐	☐	
		Dielectric	0.15	Fr-4	☑	☐	☐	
8	BOTTOM	Conductor	0.055	Copper	☑	☐	☐	
	SOLDERMASK_BOTTOM	Mask	0.015	Soldermask ...	☑	☐	☐	
	ADHESIVE_BOTTOM	Mask	0.025	Adhesive Epoxy	☑	☑	☑	
	COVERLAY_BOTTOM	Mask	0.2032	Polyimide	☑	☑	☑	
	STIFFENER_BOTTOM	Mask	5	Ptfe	☑	☐	☑	
		Surface			☑	☑	☑	



Info | Lock | Embedded layers setup | Unused pads suppression | Refresh materials

Total thickness: 7.198 mm
Total thickness without masks: 1.7116 mm
Layers: 15
Conductor: 6
Plane: 2
Mask: 7

Ok | Cancel | Apply | Help

www.FlowCAD.com

Kontakt zu FlowCAD

Für weitere Fragen und Informationen stehen wir gerne zur Verfügung

- Please don‘t hesitate to contact us

FlowCAD (Deutschland)
Mozartstrasse 2
85622 Feldkirchen bei München
Tel: +49 (89) 4563-7770
Fax:+49 (89) 4563-7790
info@FlowCAD.de

FlowCAD (Schweiz)
Hintermättlistrasse 1
5506 Mägenwil
Tel: +41 (0) 56 485 91 91
Fax: +41 (0) 56 485 91 95
info@FlowCAD.ch

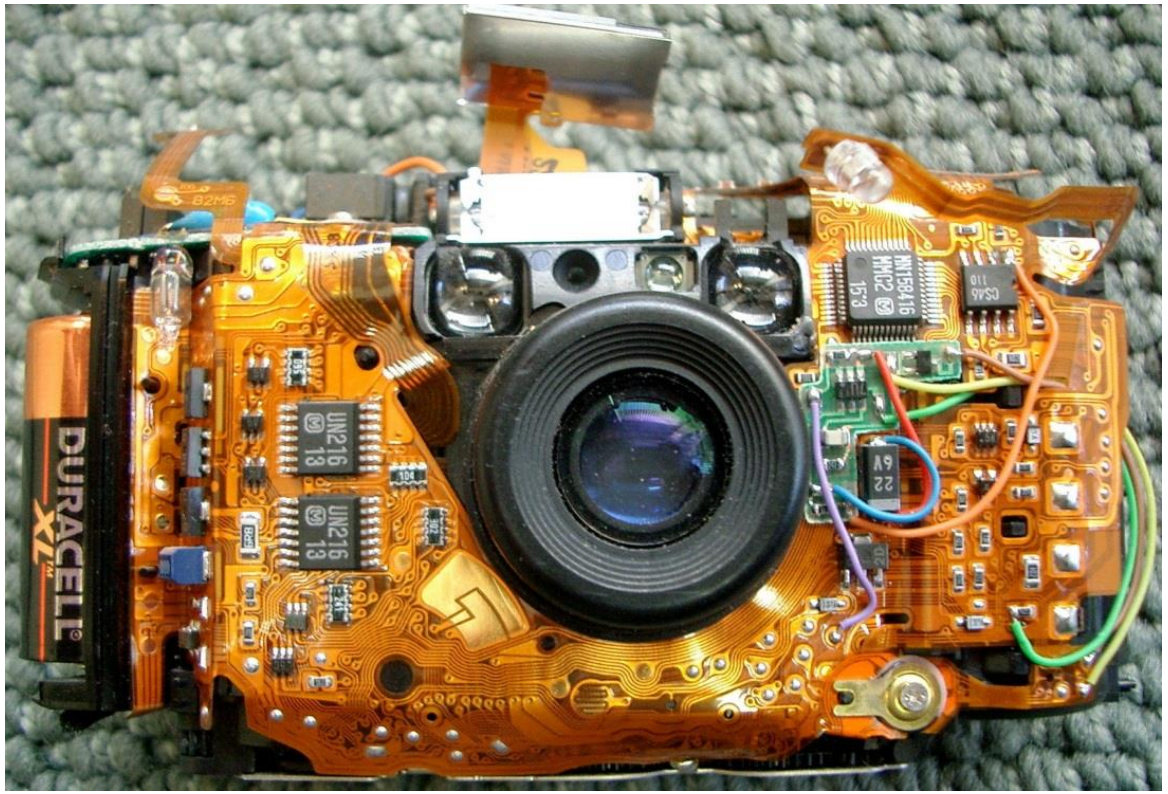
FlowCAD (Polen)
ulica Sasiedzka 2A
80-298 Gdansk
Tel: +48 58 342 75 94
Fax. +48 58 342 70 60
info@FlowCAD.pl

www.FlowCAD.com

Backup

www.FlowCAD.com

Flex Example

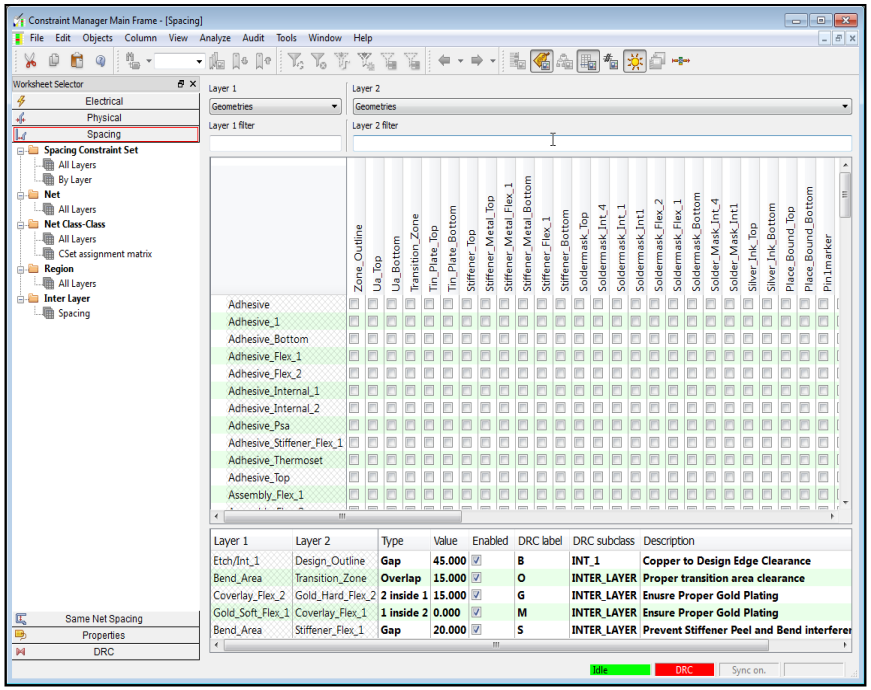


Inter-Layer Design Rule Checks Rigid-Flex

www.FlowCAD.com

Inter Layer Checks

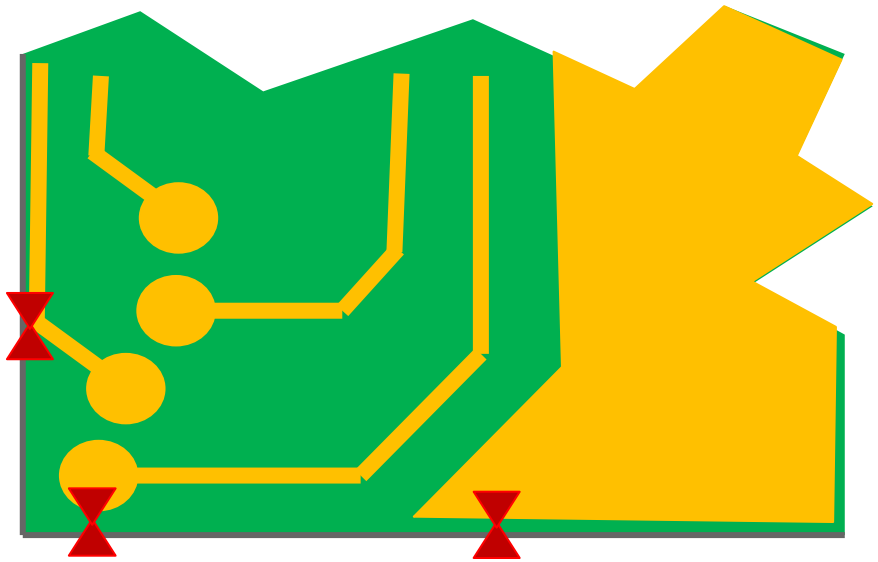
- DRC engine designed to check
  - Mask layer to mask layer geometry
  - Mask layer to surface metal
- Allows checks for
  - Coverlay to pad checks
  - Mask to pad checks
  - Precious metal to coverlay
  - Bend area/line to stiffener, component, pin, and via
- Layer selection GUI
  - Matrix of applicable subclasses
  - Filtering capabilities
  - User defined DRC 2nd letter (“I” fix first character)
  - Comment field



www.FlowCAD.com

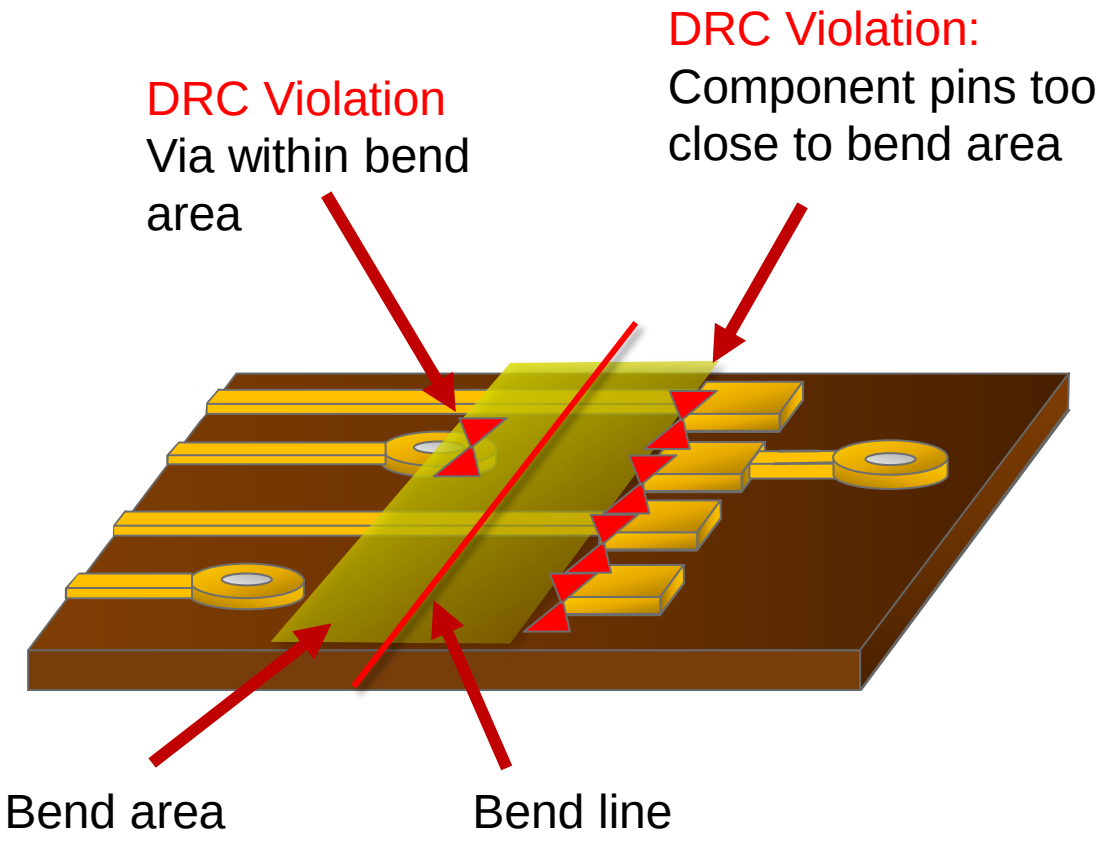
Inter Layer Check Gap Rule

- DRC verifies geometry spacing between subclasses
- Example:
  - Vias, pins and conductors must have 30 mils spacing from Outline



www.FlowCAD.com

Inter Layer Check Gap Rule

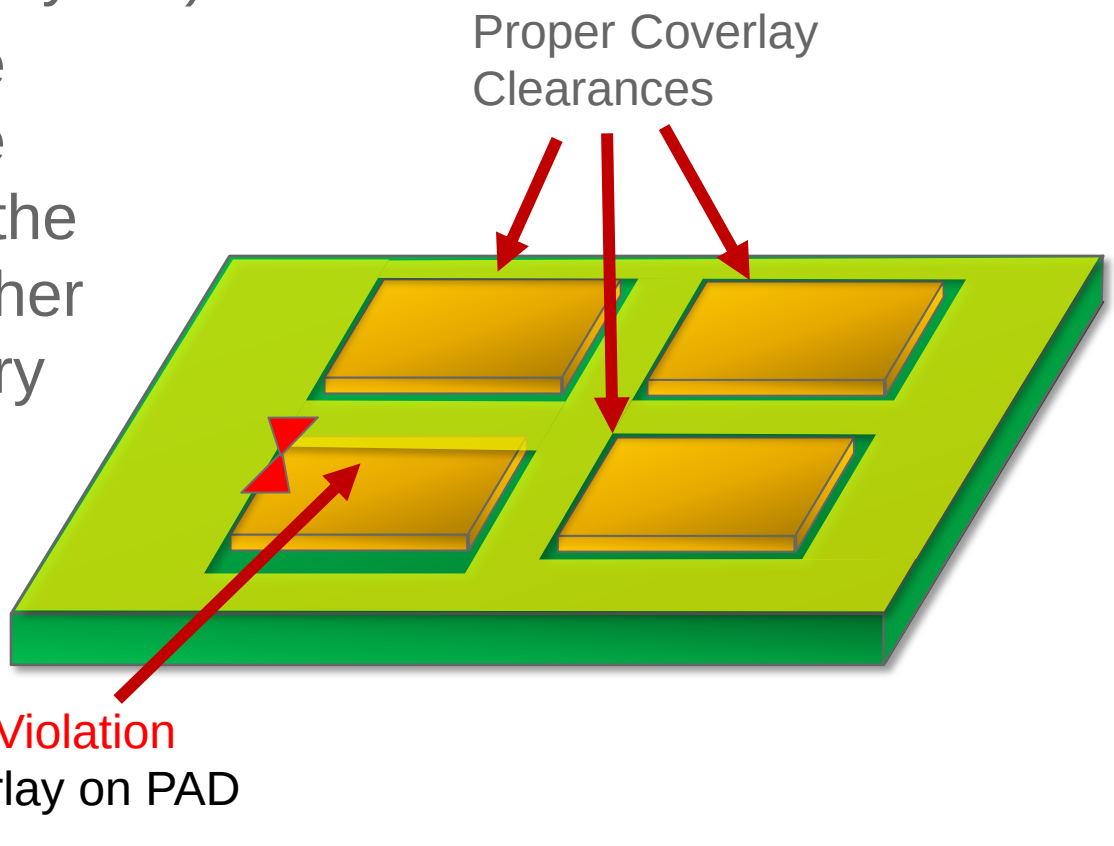


Inter Layer Check Overlap Rule

- Specifies a minimum overlap of two geometries on different subclasses

- Example:
  - Transition zone must overlap bend area by 15 mils
  - Special rules apply in transition zone

www.FlowCAD.com

Inter Layer Check Inside Rule

- (Layer 1) inside (layer 2)
- (Layer 2) inside (layer 1)
- Geometry on one subclass must be contained within the geometry of another subclass geometry