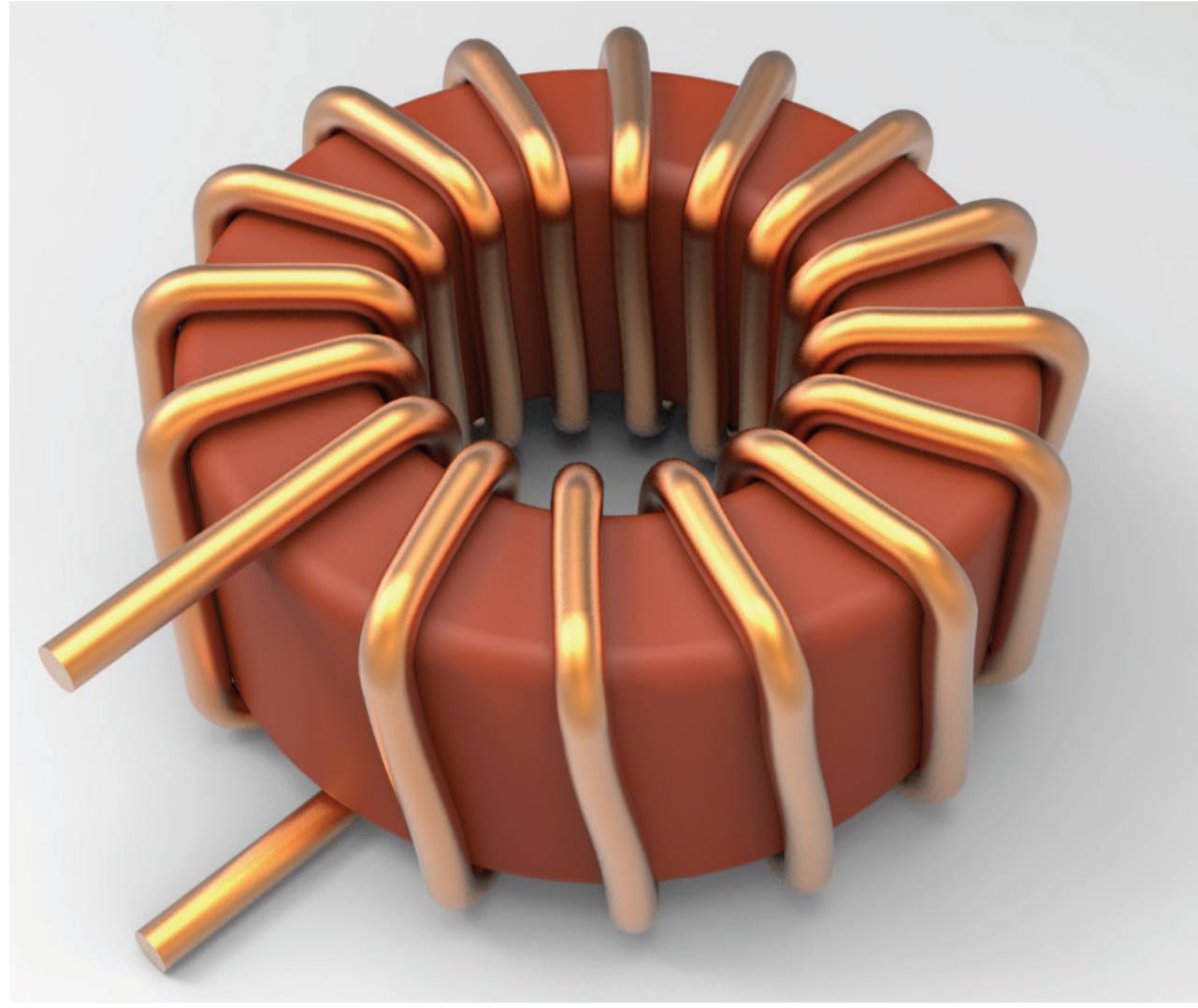


Optimizing Inductor Winding Geometry for Lowest DC-Resistance using LiveLink between COMSOL and MATLAB

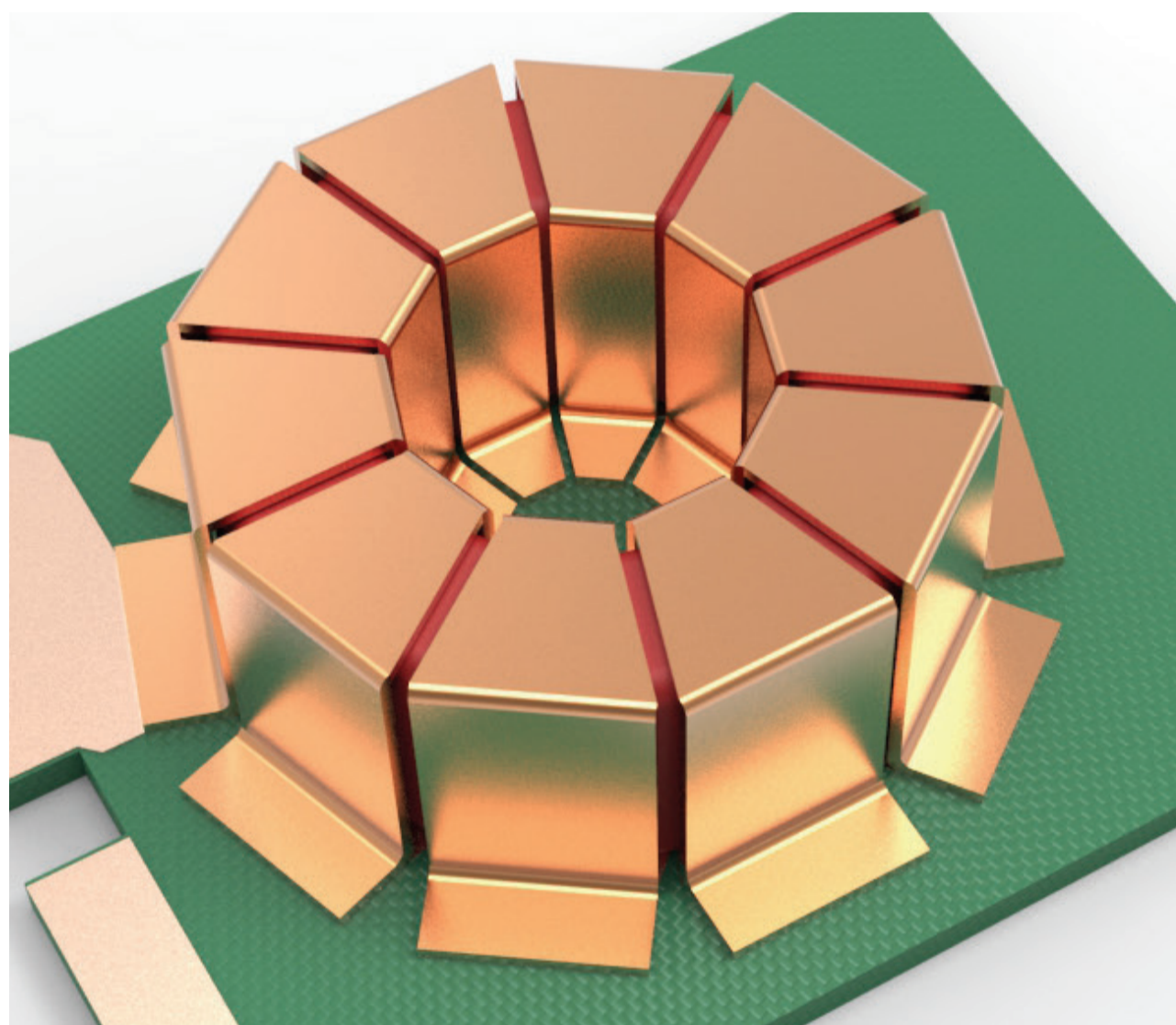
H. Schneider*, T. Andersen, J. D. Mønster, M. P. Madsen, A. Knott and M. A. E. Andersen
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Introduction



Conventional Wire Wound Inductor

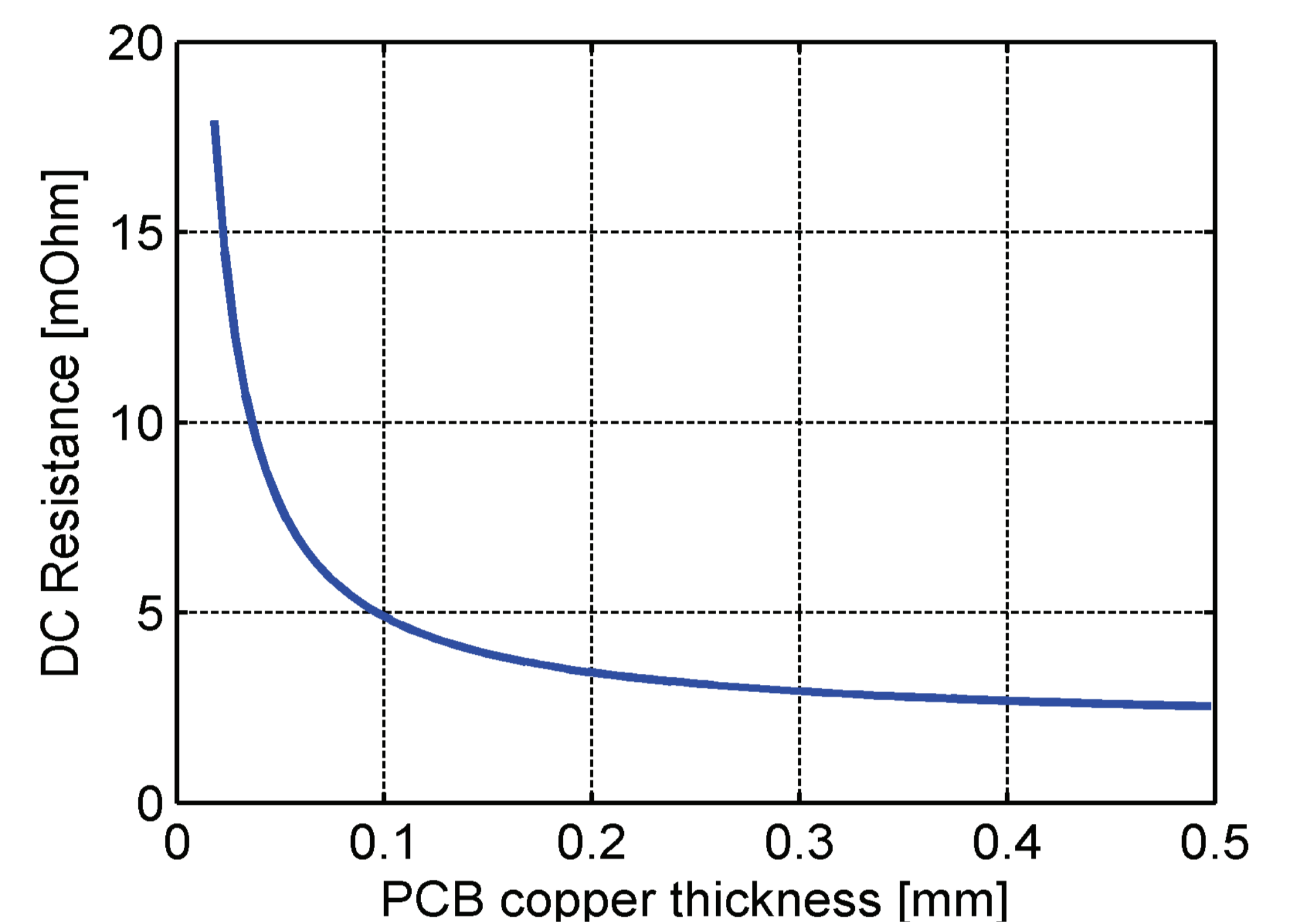
- Limited utilization of the winding space.
- Manual manufacturing process for small core and thick wires.



Hybrid Foil/PCB Wound Inductor

- Fully automated process. From cutout of the foils to pick and placement of the winding assembly.
- Good utilization of the winding space.
- Low price due to mass production of the winding assembly
- Short time to market due to the possibility of a distributed stock of the winding assembly.
- Configurable winding configuration through PCB traces.
- Different core materials can be used with the same winding assembly.

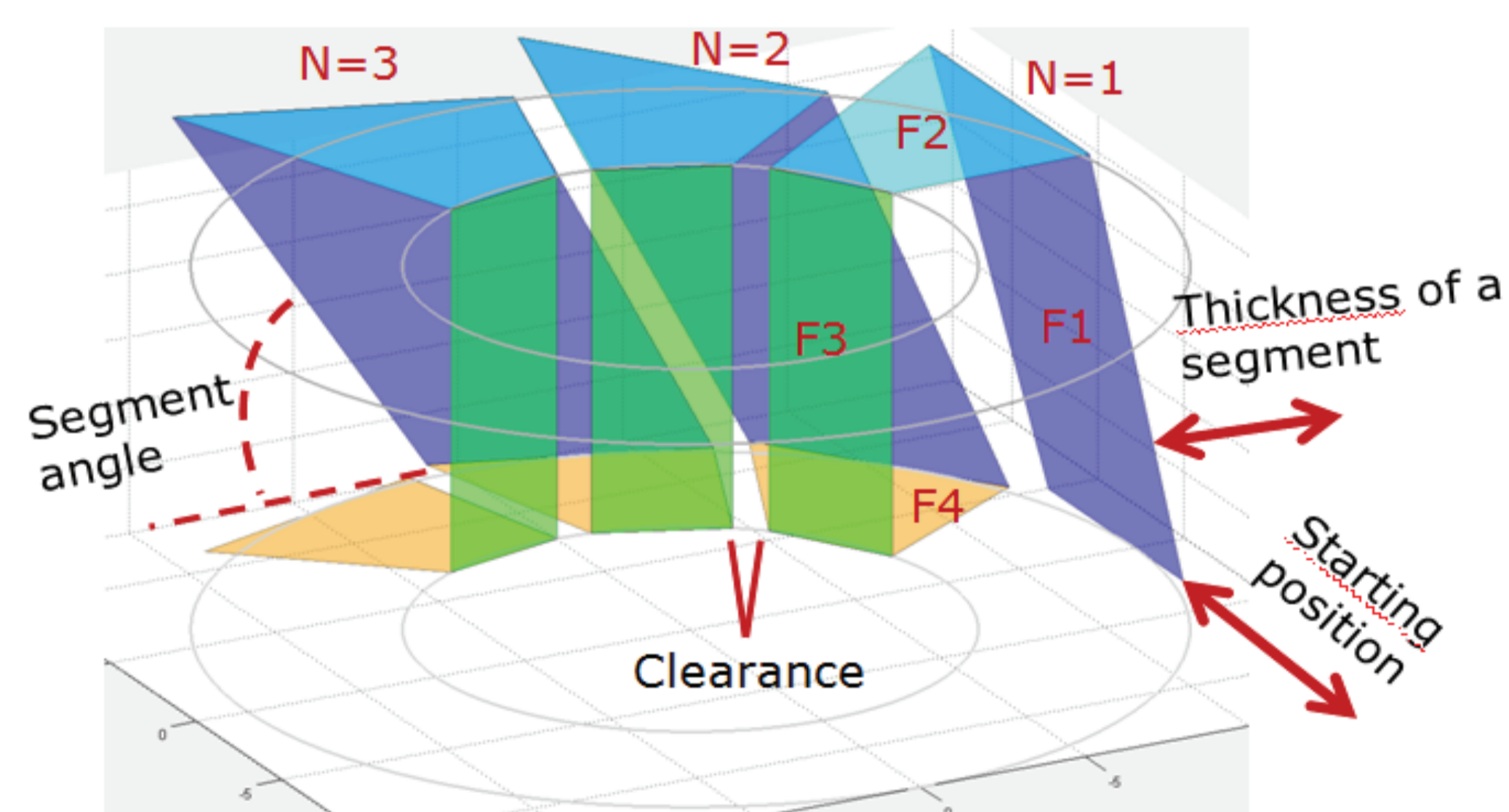
Problem: PCB layer thickness is a bottleneck for high power applications.



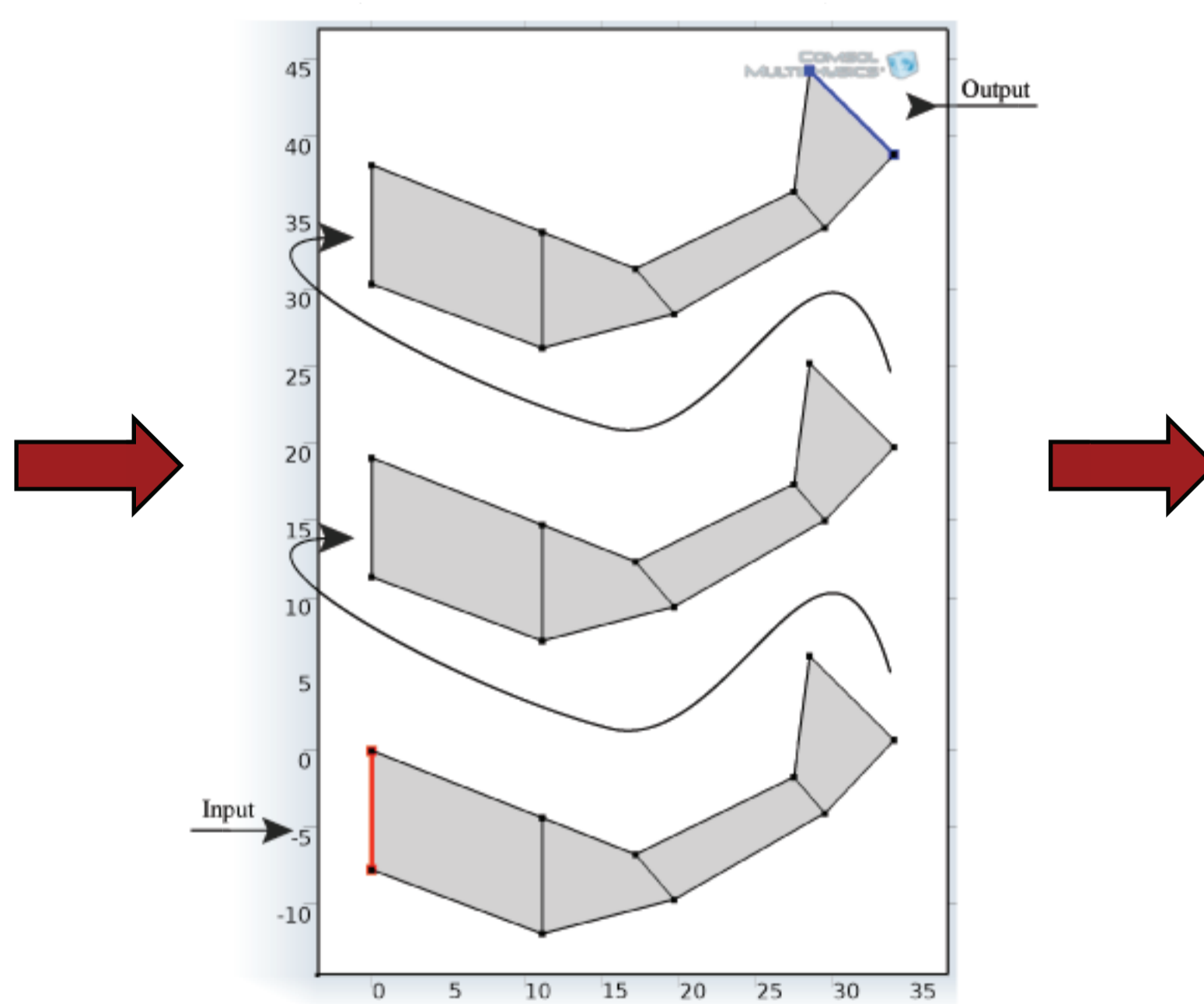
Solution: Optimize the winding configuration by changing the angle of each segment of the winding.

Optimization of the winding configuration

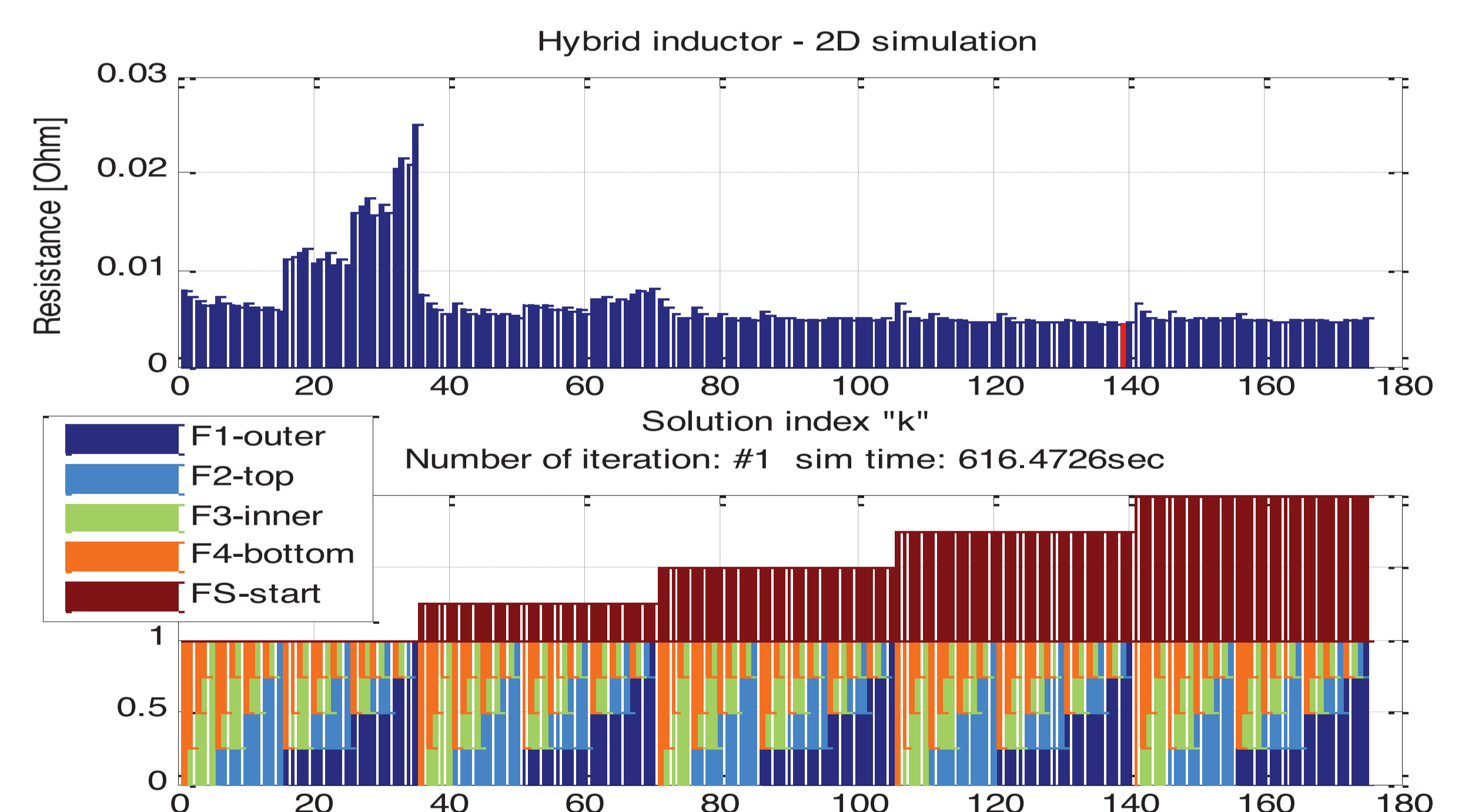
Specification based geometric 3D model in MATLAB



2D continuity and import to COMSOL via LifeLink™



Import result from COMSOL into Matlab and plot results



Results

Case 1: Few turns, PCB layer thickness << Foil thickness			
Number of turns: 10, Segment thickness: F1, F2, F3 = 500 μm, F4 = 70μm, Clearance = 1mm			
Winding angle configuration	Bottom	Opt.	Top
Starting point SP [%]	0	20	0
Outer Foil Segment F1 [%]	0	63	0
Top Foil Segment F2 [%]	0	37	100
Inner Segment F3 [%]	0	0	0
Bottom Segment F4 [%]	100	0	0
DC resistance [mΩ]	6.46	4.75	4.52
Improvement [%]	Ref.	27	30

Case 2: Many turns, PCB layer thickness << Foil thickness			
Number of turns: 100, Segment thickness: F1, F2, F3 = 500 μm, F4 = 70μm, Clearance = 1mm			
Winding angle configuration	Bottom	Opt.	Top
Starting point SP [%]	0	0	0
Outer Foil Segment F1 [%]	0	75	0
Top Foil Segment F2 [%]	0	25	100
Inner Segment F3 [%]	0	0	0
Bottom Segment F4 [%]	100	0	0
DC resistance [mΩ]	435	432	432
Improvement [%]	Ref.	0.8	0.8

Case 3: Few turns, PCB layer thickness = Foil thickness			
Number of turns: 10, Segment thickness: F1, F2, F3 = 500 μm, F4 = 70μm, Clearance = 1mm			
Winding angle configuration	Bottom	Opt.	Top
Starting point SP [%]	0	100	0
Outer Foil Segment F1 [%]	0	38	0
Top Foil Segment F2 [%]	0	21	100
Inner Segment F3 [%]	0	0.5	0
Bottom Segment F4 [%]	100	40.5	0
DC resistance [mΩ]	2.6	2.3	2.6
Improvement [%]	Ref.	11	0