Breakout Design: Package and Traces

Scott McMorrow
Samtec, Inc.

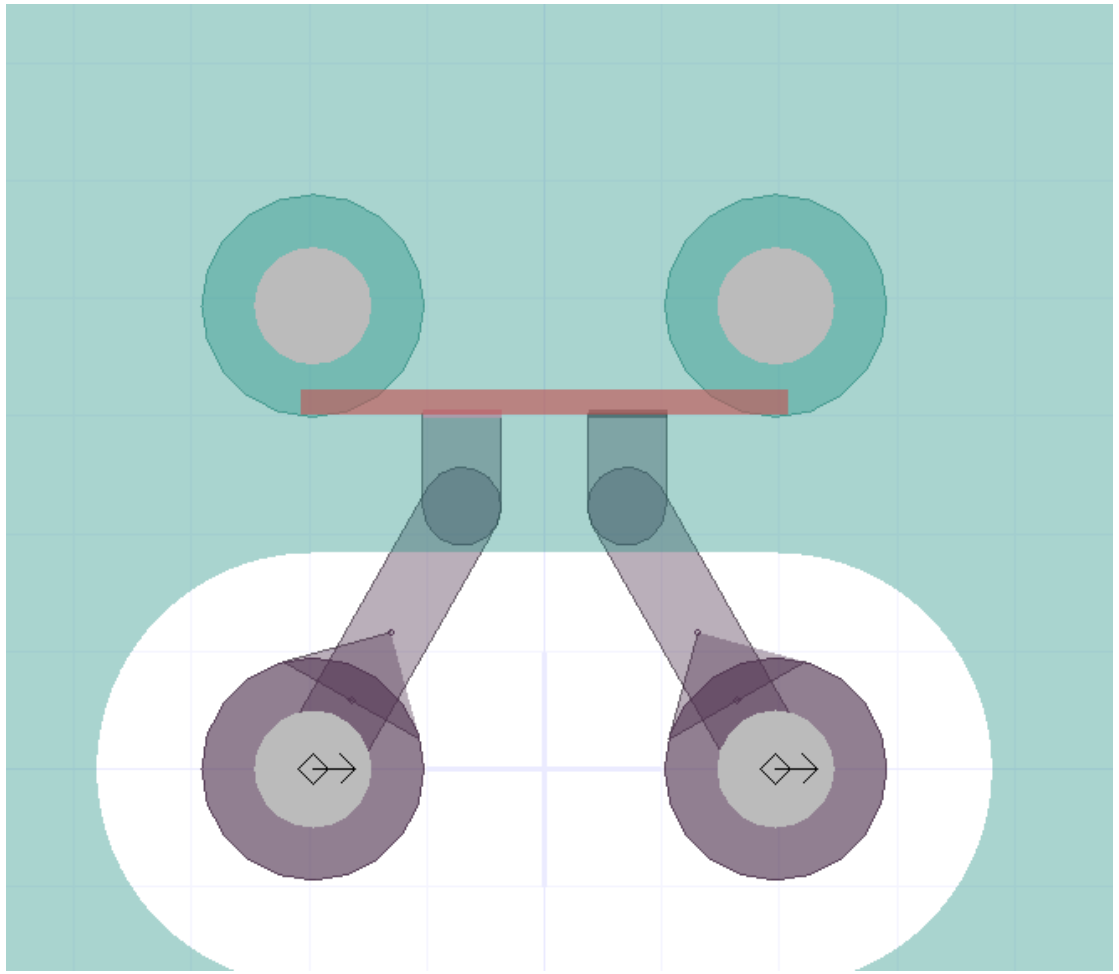
Table of Contents

- Trace Design
- Zones of control
- Show a step-by-step process to create near-optimal transitions
  1. Create a through design with launch on top and bottom
  2. Use this to adjust
     a. Signal via drill size
     b. Thin and thick trace antipads
     c. Ground via drill size
- Remove bottom launch and add trace escape
  - Optimize plane antipads above and below the trace escape layer
  - Optimize the fillet tuning feature
  - Fine tune ground via radius

BOR Trace Design

gEEk spEEk

- Important Parameters
  - $viaDiameter_SigVia - 0.2, 0.225, 0.25 mm (8, 9,10 mil)
  - $padAnnularRing - 0.115, 0.127 mm (4.5, 5 mil)
  - $minAnnularClearance – 0.1 mm (4 mil)
  - Pad Diameter = $viaDiameter_SigVia + 2 * $padAnnularRing

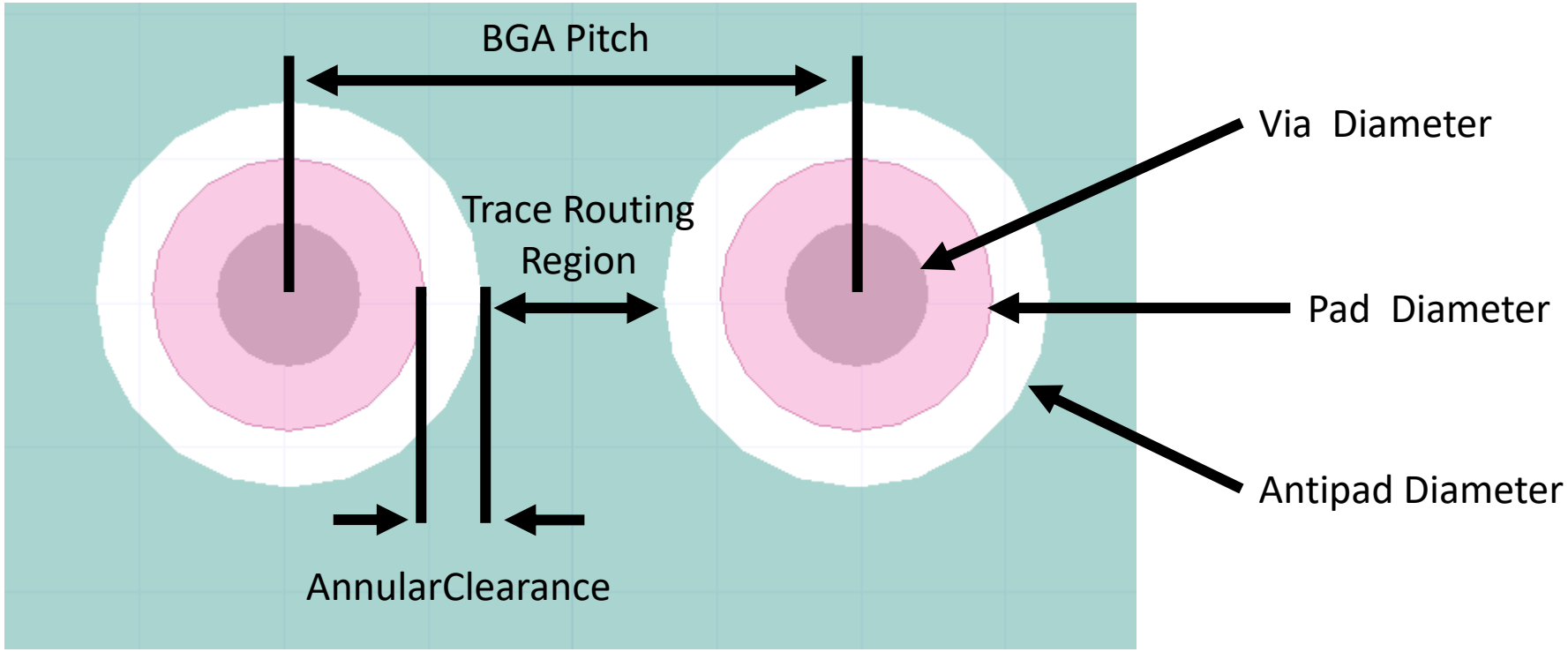


Routing Region

Remember!

A via pad defines the via capture region that is the circular probability of error of the drill strike location.

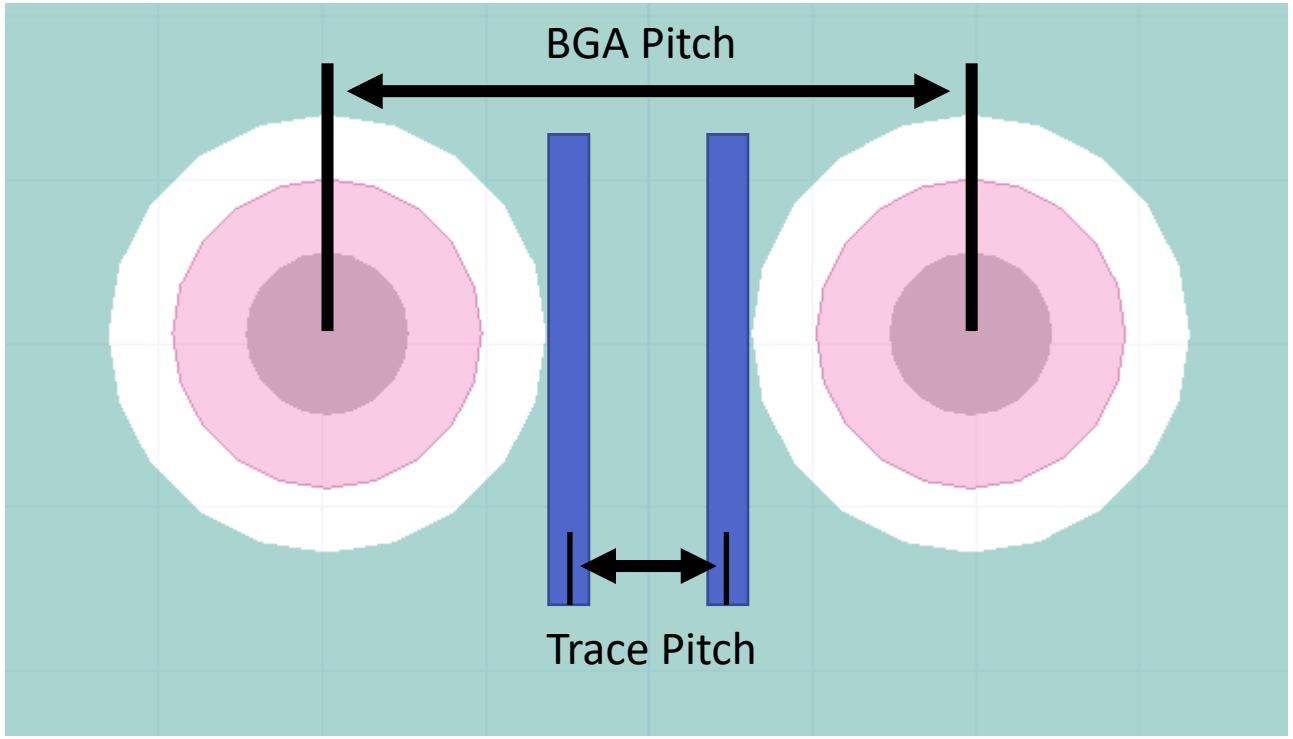
An annular clearance is created to account for manufacturing tolerances in placement of the via and the trace etch.



Available Trace Routing Space = BGA_Pitch – Antipad_Diameter

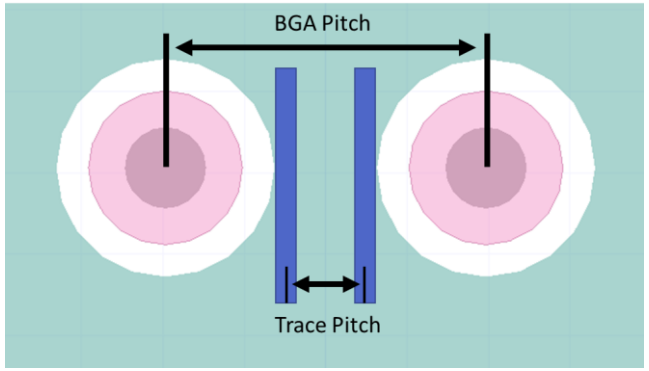
Antipad_Diameter = ViaDiameter + 2 x PadAnnularRIng+ 2 x MinimumAnnularClearance

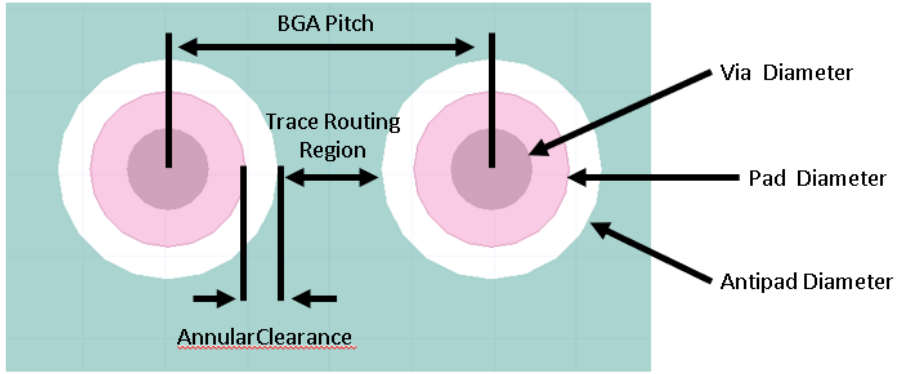
Trace Geometry



Trace Routing Space = TracePitch + TraceWidth

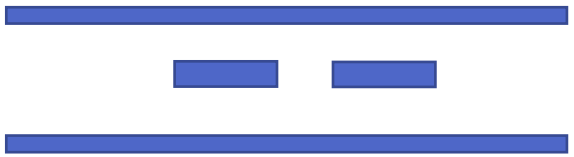
Routing Space for 1 mm BGA

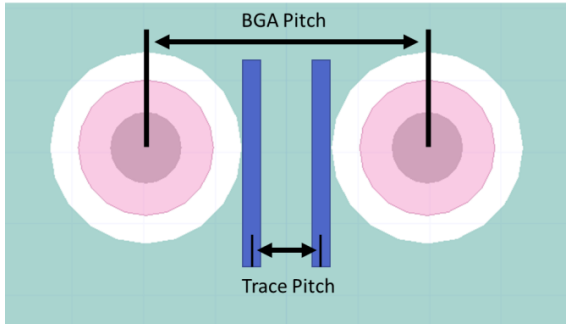




BGA Pitch (mm)	Via Diameter (mm)	Pad Annular Ring (mm)	Min Annular Clearance (mm)	Available Routing Space (mm)	Available Routing Space (mi)
1	0.2	0.115	0.1	0.37	14.57
1	0.2	0.127	0.1	0.346	13.62
1	0.225	0.115	0.1	0.345	13.58
1	0.225	0.127	0.1	0.321	12.64
1	0.25	0.115	0.1	0.32	12.60
1	0.25	0.127	0.1	0.296	11.65

Trace Design for 92.5 Ohm Impedance
Trace Dk = 3, 0.25 mm Drill, 0.115 mm Clearance





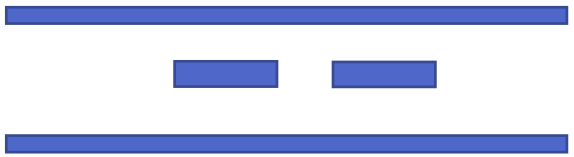
Allowable Trace Routing Range
@92.5 ohm

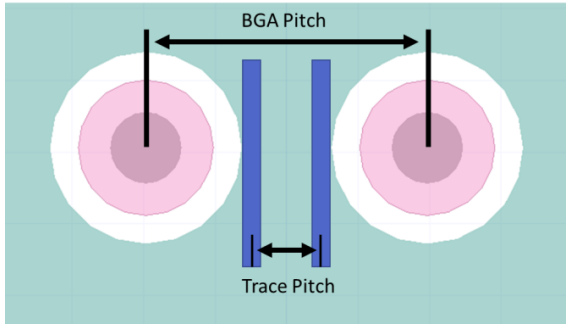
Trace Width (mil)	Pitch (mil)	Route Space (mil)
3.75	6.1	9.85
4	6.6	10.6
4.25	7.1	11.35
4.5	7.6	12.1
4.75	8.1	12.85
4.8	8.2	13
4.9	8.5	13.4
5	8.7	13.7

27_metal	signal	copper	programmableAnisotropicMaterial	0.6mil
27_die	dielectric	programmableAnisotropicMaterial		5mil
28_metal	signal	copper	programmableAnisotropicMaterial	0.6mil
28_die	dielectric	programmableAnisotropicMaterial		5.39mil
29_metal	signal	copper	programmableAnisotropicMaterial	0.6mil

BGA Pitch (mm)	Via Diameter (mm)	Pad Annular Ring (mm)	Min Annular Clearance (mm)	Available Routing Space (mm)	Available Routing Space (mi)
1	0.2	0.115	0.1	0.37	14.57
1	0.2	0.127	0.1	0.346	13.62
1	0.225	0.115	0.1	0.345	13.58
1	0.225	0.127	0.1	0.321	12.64
1	0.25	0.115	0.1	0.32	12.60
1	0.25	0.127	0.1	0.296	11.65

Trace Design for 92.5 Ohm Impedance
Trace Dk = 3.5 , 0.225 mm Drill, 0.115 mm Clearance





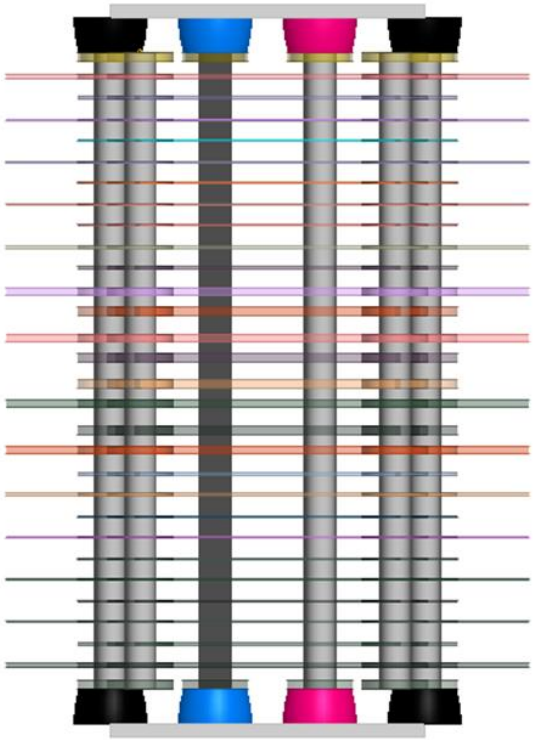
Allowable Trace Geometry Range @92.5 ohm

Trace Width (mil)	Pitch (mil)	Route Space (mil)
3.75	6.94	10.69
4	7.5	11.5
4.25	8.2	12.45
4.5	8.9	13.4
4.75	9.7	14.45
4.8	9.9	14.7
4.9	10.3	15.2
5	10.7	15.7

27_metal	signal	copper	programmableAnisotropicMaterial	0.6mil
27_die	dielectric	programmableAnisotropicMaterial		5mil
28_metal	signal	copper	programmableAnisotropicMaterial	0.6mil
28_die	dielectric	programmableAnisotropicMaterial		5.39mil
29_metal	signal	copper	programmableAnisotropicMaterial	0.6mil

BGA Pitch (mm)	Via Diameter (mm)	Pad Annular Ring (mm)	Min Annular Clearance (mm)	Available Routing Space (mm)	Available Routing Space (mi)
1	0.2	0.115	0.1	0.37	14.57
1	0.2	0.127	0.1	0.346	13.62
1	0.225	0.115	0.1	0.345	13.58
1	0.225	0.127	0.1	0.321	12.64
1	0.25	0.115	0.1	0.32	12.60
1	0.25	0.127	0.1	0.296	11.65

Zones of Control



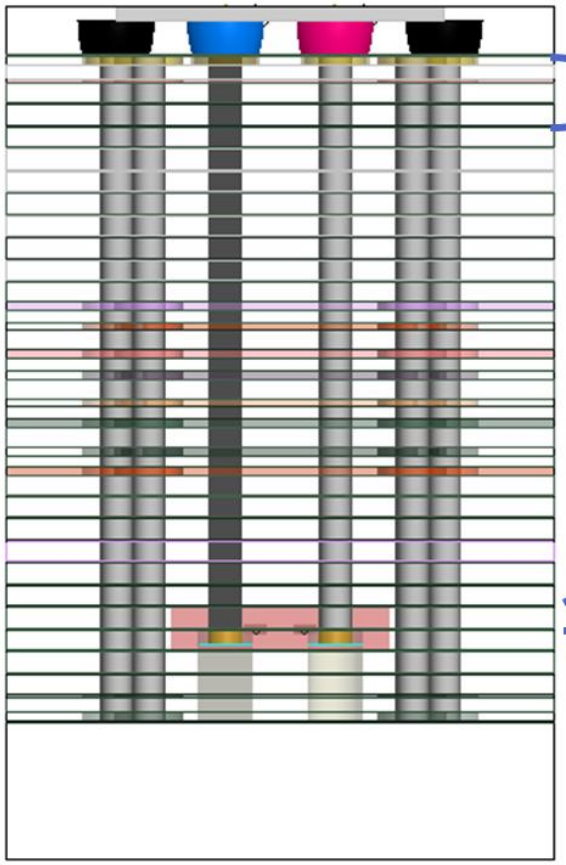
PlanesBelowTop

ThinTraceLayers

ThickPowerPlaneLayers

ThinTraceLayers

BackdrillLayers



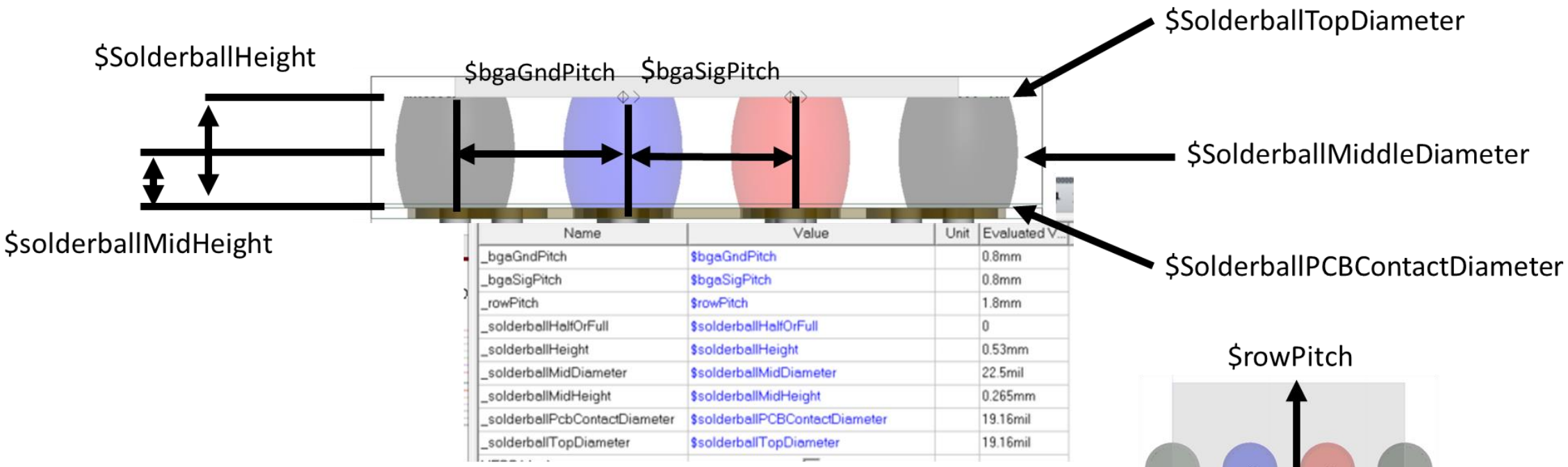
Electromagnetic Shadow

PlaneAboveTrace

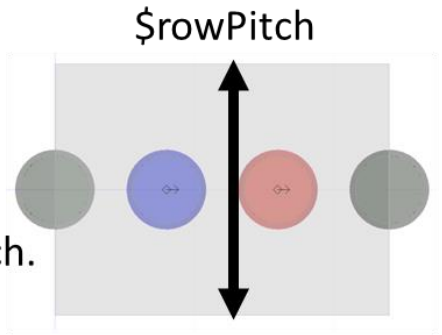
Trace

PlaneBelowTrace

Solderball Parameters

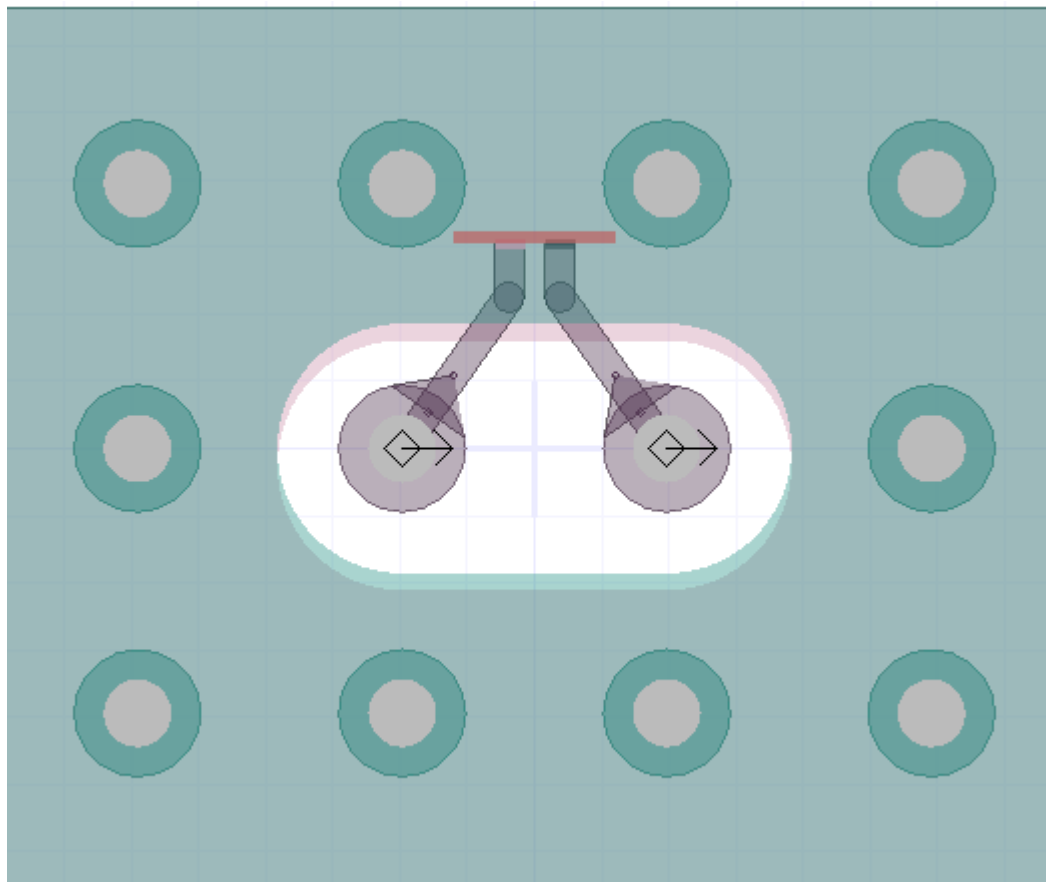


Name	Value	Unit	Evaluated V...
_bgaGndPitch	$bgaGndPitch		0.8mm
_bgaSigPitch	$bgaSigPitch		0.8mm
_rowPitch	$rowPitch		1.8mm
_solderballHalfOrFull	$solderballHalfOrFull		0
_solderballHeight	$solderballHeight		0.53mm
_solderballMidDiameter	$solderballMidDiameter		22.5mil
_solderballMidHeight	$solderballMidHeight		0.265mm
_solderballPcbContactDiameter	$solderballPCBContactDiameter		19.16mil
_solderballTopDiameter	$solderballTopDiameter		19.16mil

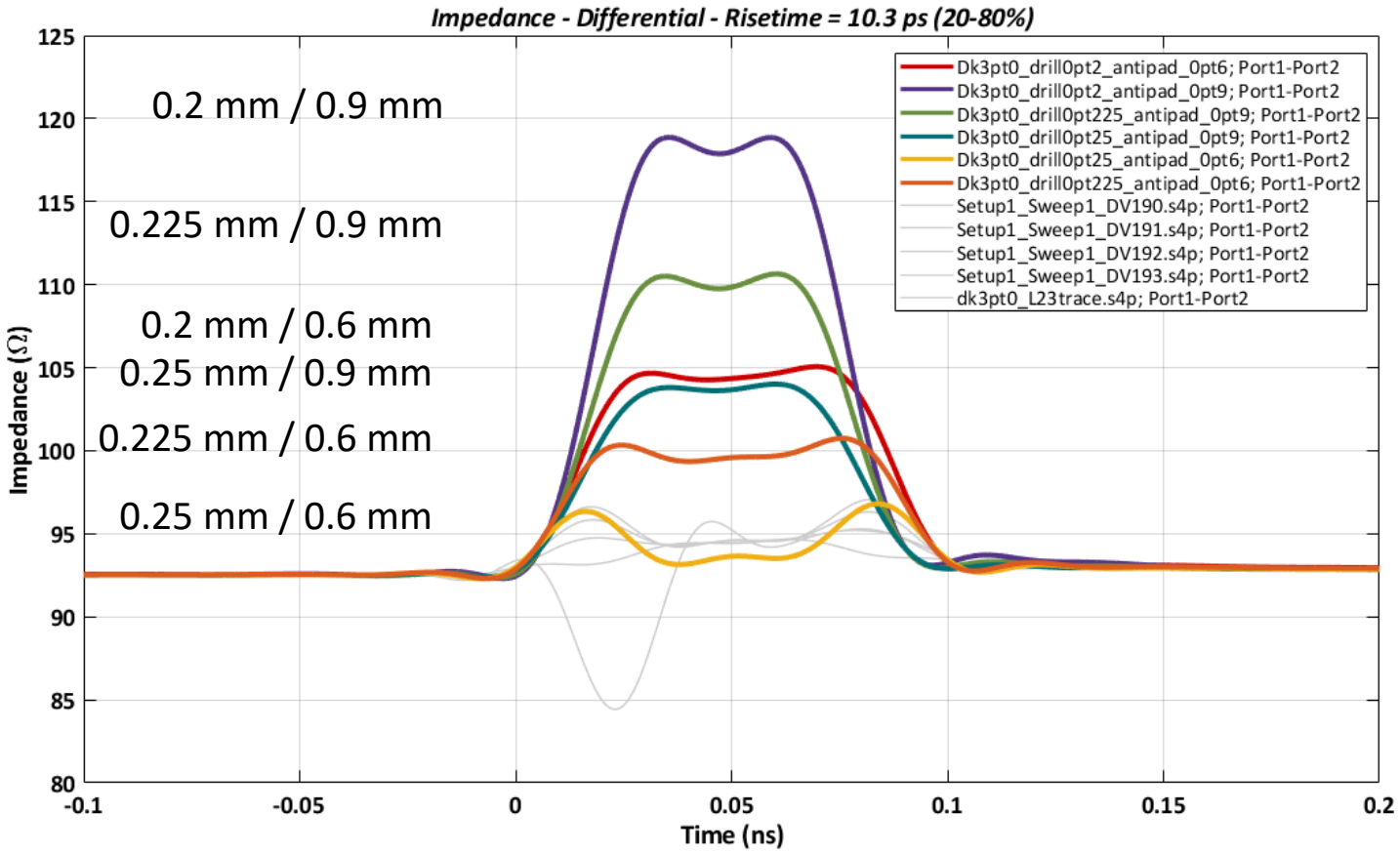


PEC Waveport metal is sized to be the width of the ball row-to-row pitch.
Length is from middle of gnd balls.
This facilitates “tiling” of multiple launches on a board.

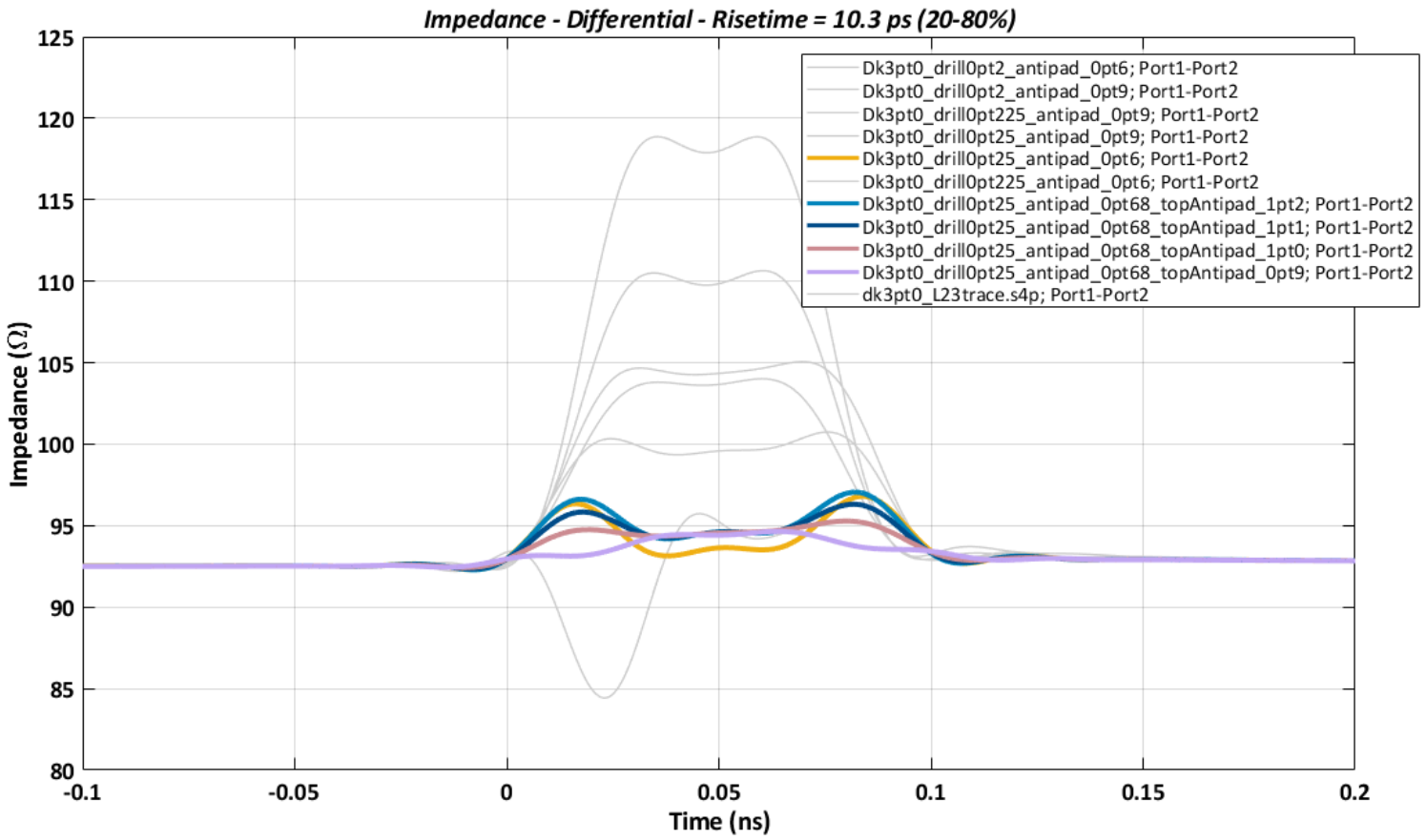
1 mm Pitch BGA



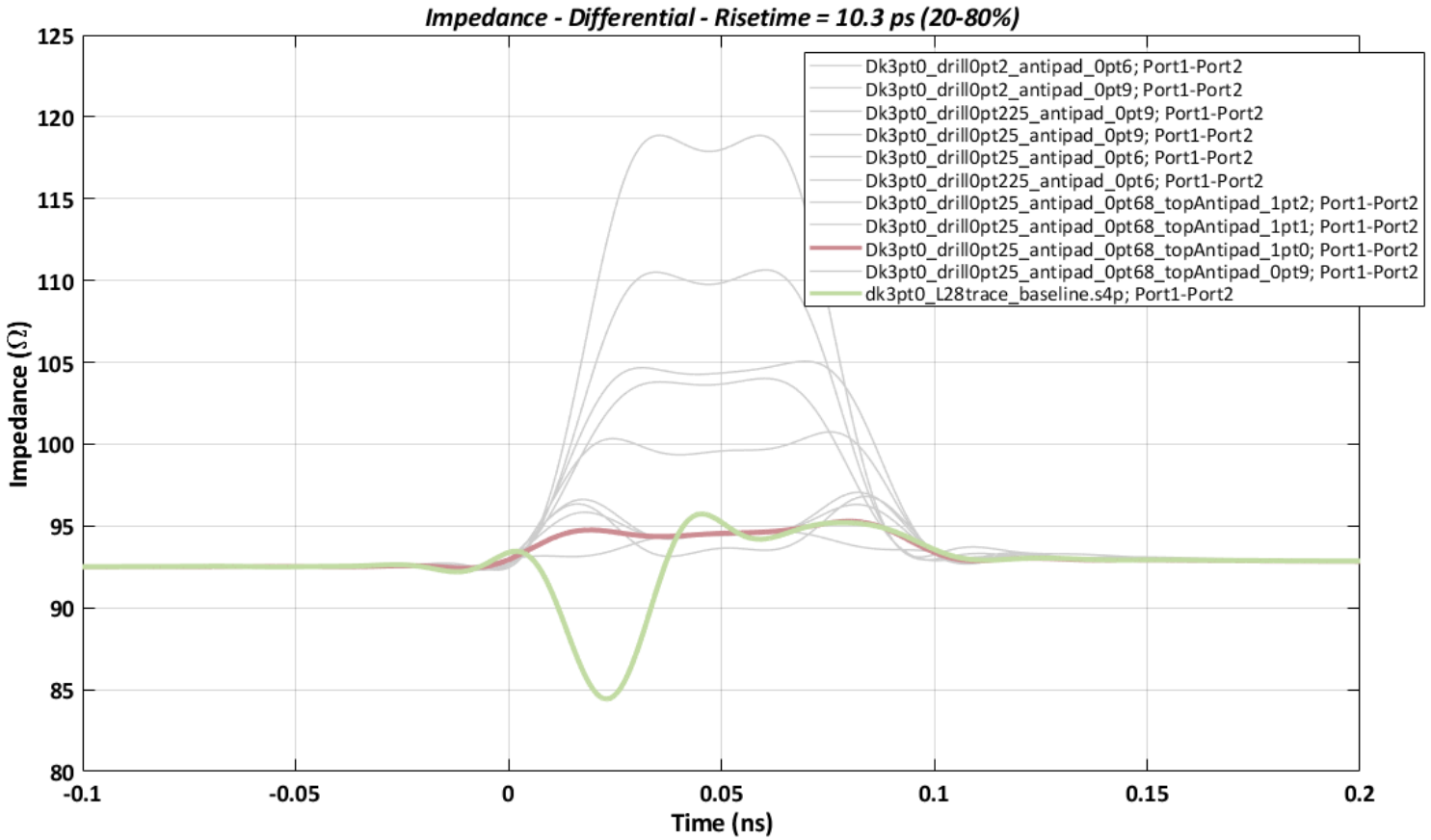
Dk 3.0
Vary Drill Size (0.2 to 0.25 mm)
Vary Antipad (0.6 to 0.9 mm)



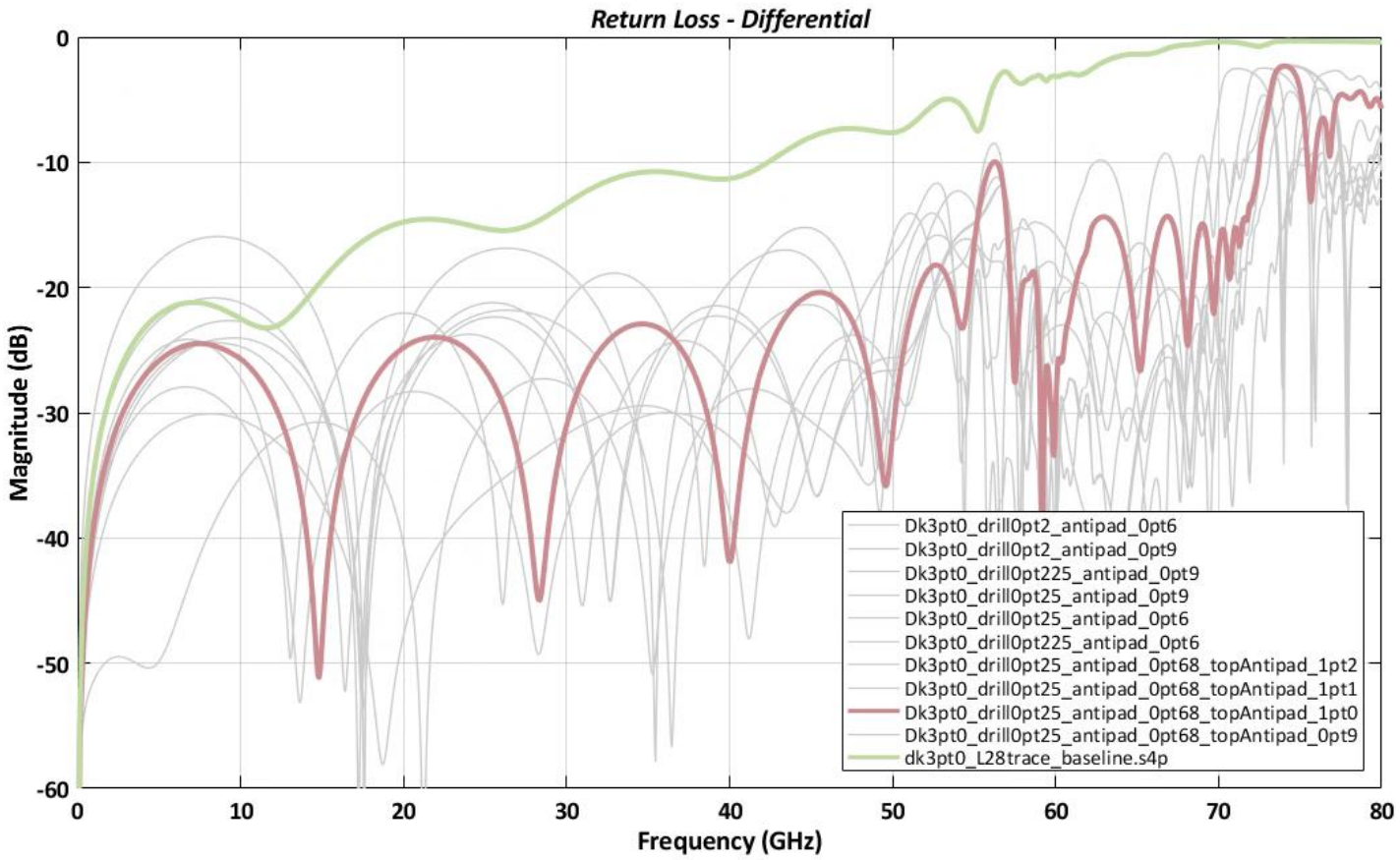
Dk 3.0
Drill Size (0.25 mm), Thin Layer Antipad (0.68 mm)
Vary Top Antipad (0.9 to 1.2 mm)



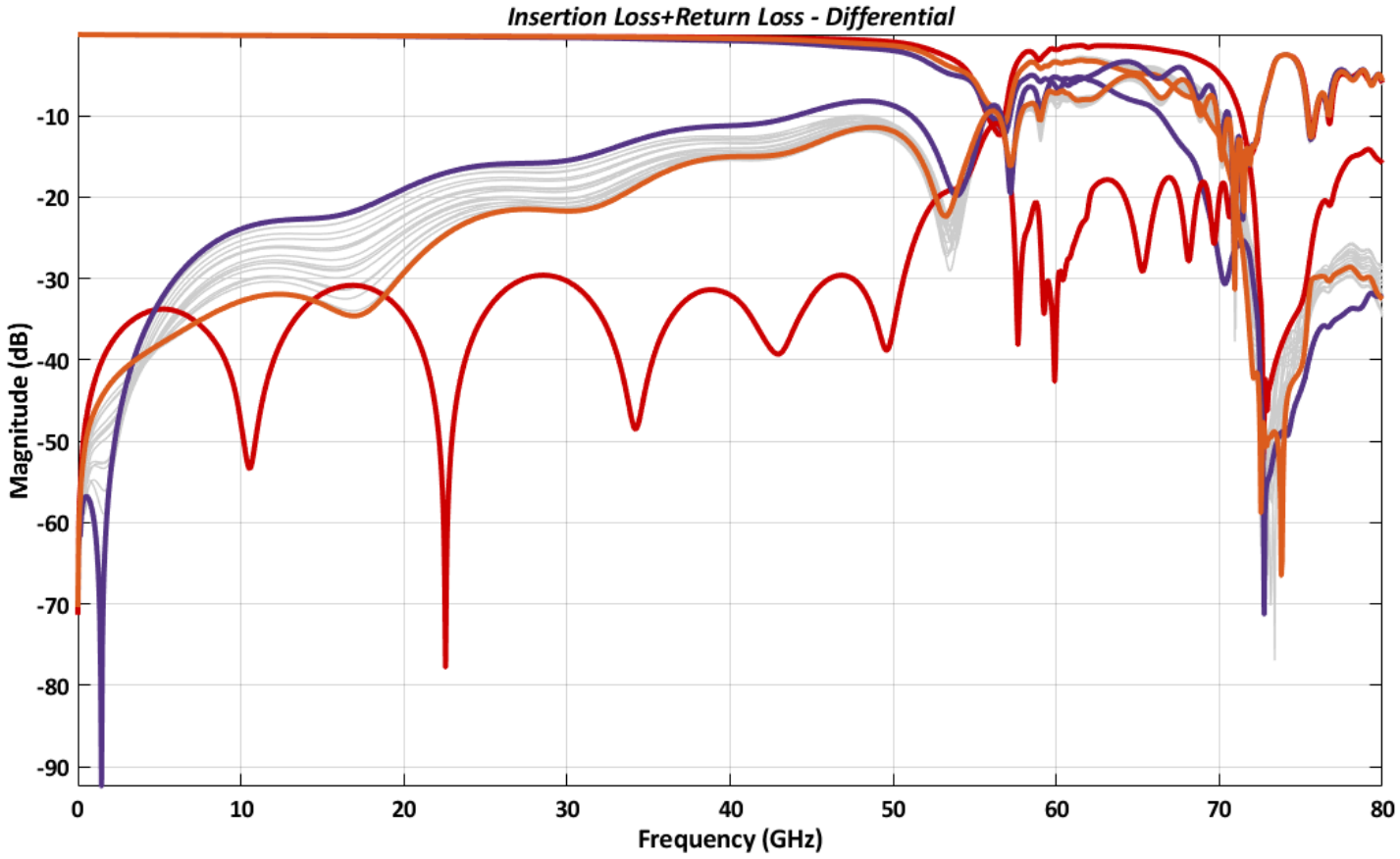
Baseline Trace Escape
Drill (0.25 mm), Top Antipad (1 mm)
Thin Layer Antipad (0.68 mm), Backdrill Stub (6 mil)



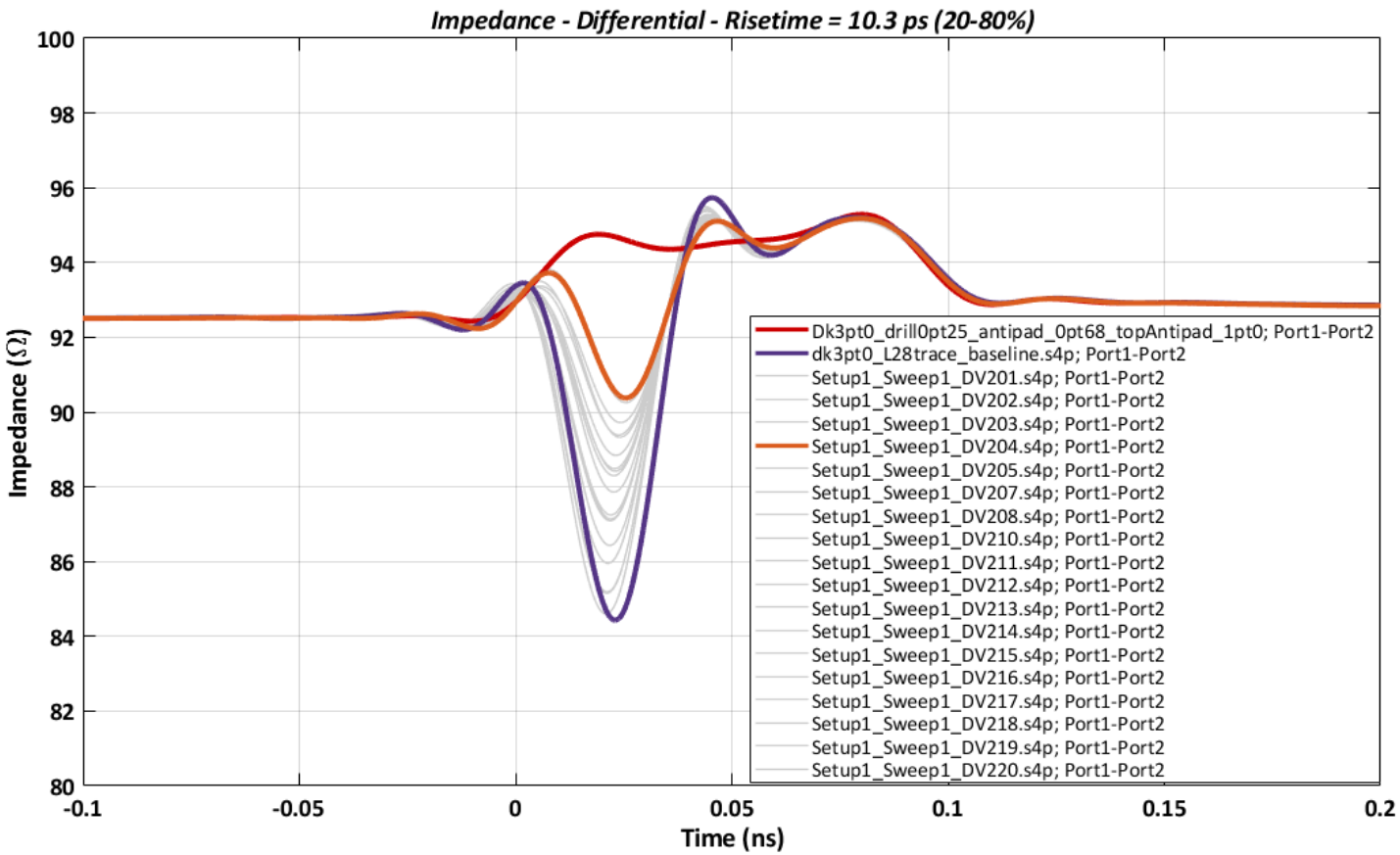
Baseline Trace Escape
Drill (0.25 mm), Top Antipad (1 mm)
Thin Layer Antipad (0.68 mm), Backdrill Stub (6 mil)



Optimized Trace Escape
Antipads Above and Below Trace Varied



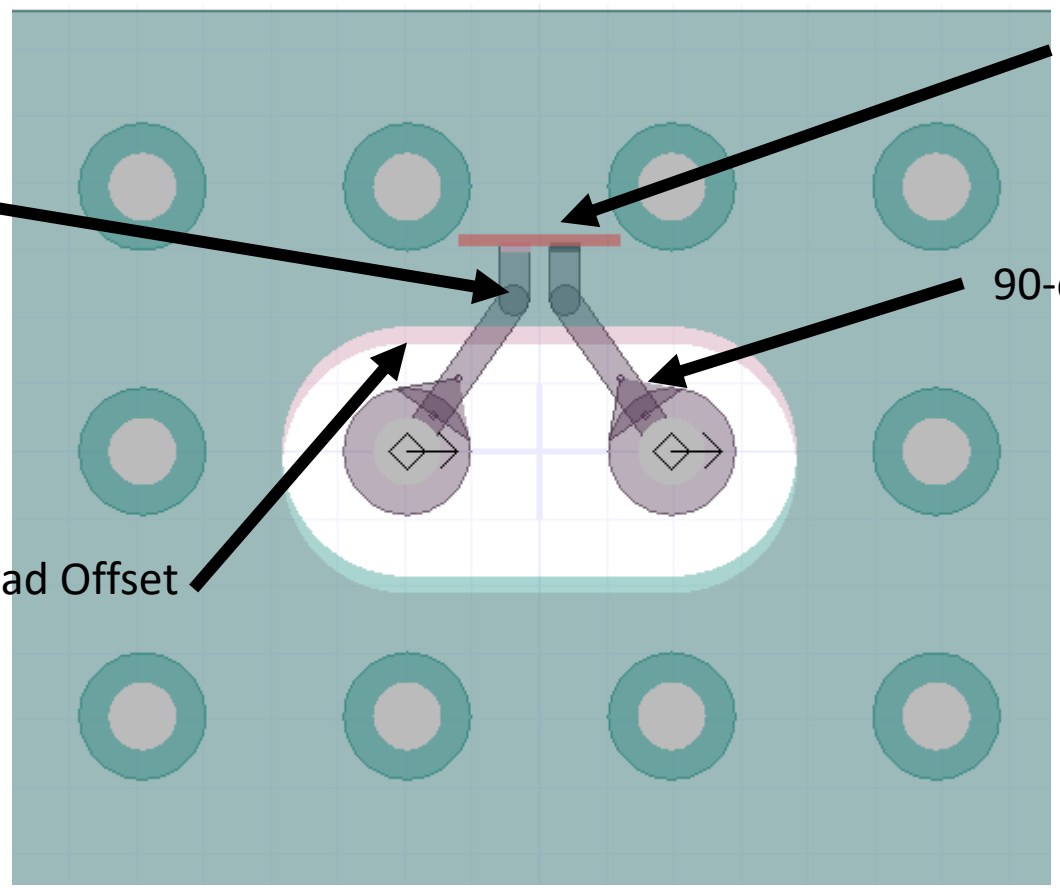
Optimized Trace Escape
Antipads Above and Below Trace Varied



Optimized BGA Launch
Trace Width/Pitch (4.5 / 7.6 mil)
Trace Antipad (0.94 mm), LowerAntipadOffset (0.06 mm)

Trace Geometry modified to route through 1 mm via field

Trace SE-to-Diff transition 0.1 mm after Antipad Crossing to accommodate manufacturing variation



90-degree filet

Lower Antipad Offset

samtec

gEEk® spEEk

Summary

- Create trace designs that maximize area between vias for various via drill diameters and annular ring requirements.
- Optimize using “Zones of Control” and simple thru structure with BGA ball/waveport model.
- Use step-by-step process to create near-optimal transitions
  1. Create a through design with launch on top and bottom
  2. Use this to adjust
     a. Via Drill Size
     b. Antipads
- Remove bottom launch and add trace escape
  - Optimize plane antipads above and below the trace escape layer
  - Optimize lower trace antipad offset
- Rinse and repeat

samtec | gEEk® spEEk

samtec.com/geekspeek

geekspeek@samtec.com

SIG@samtec.com