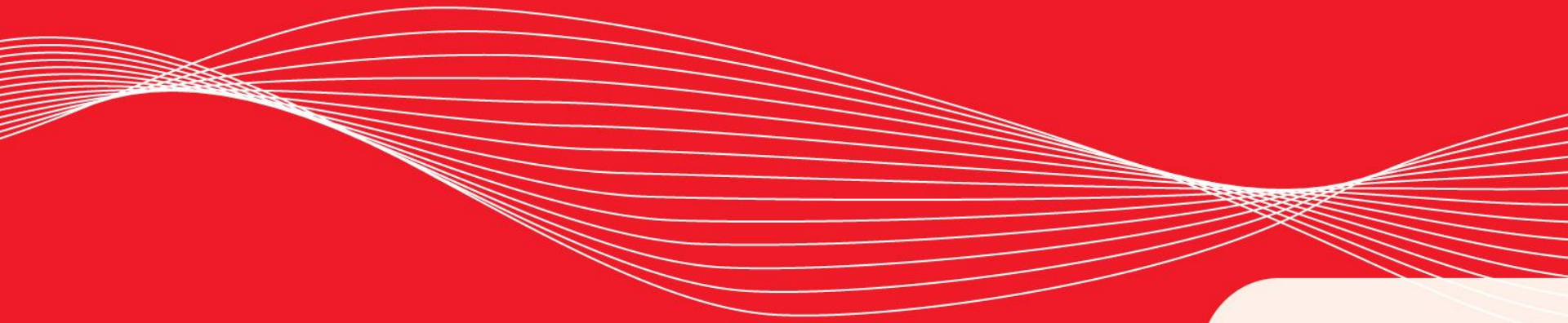
EMPIRE XPU Tutorial

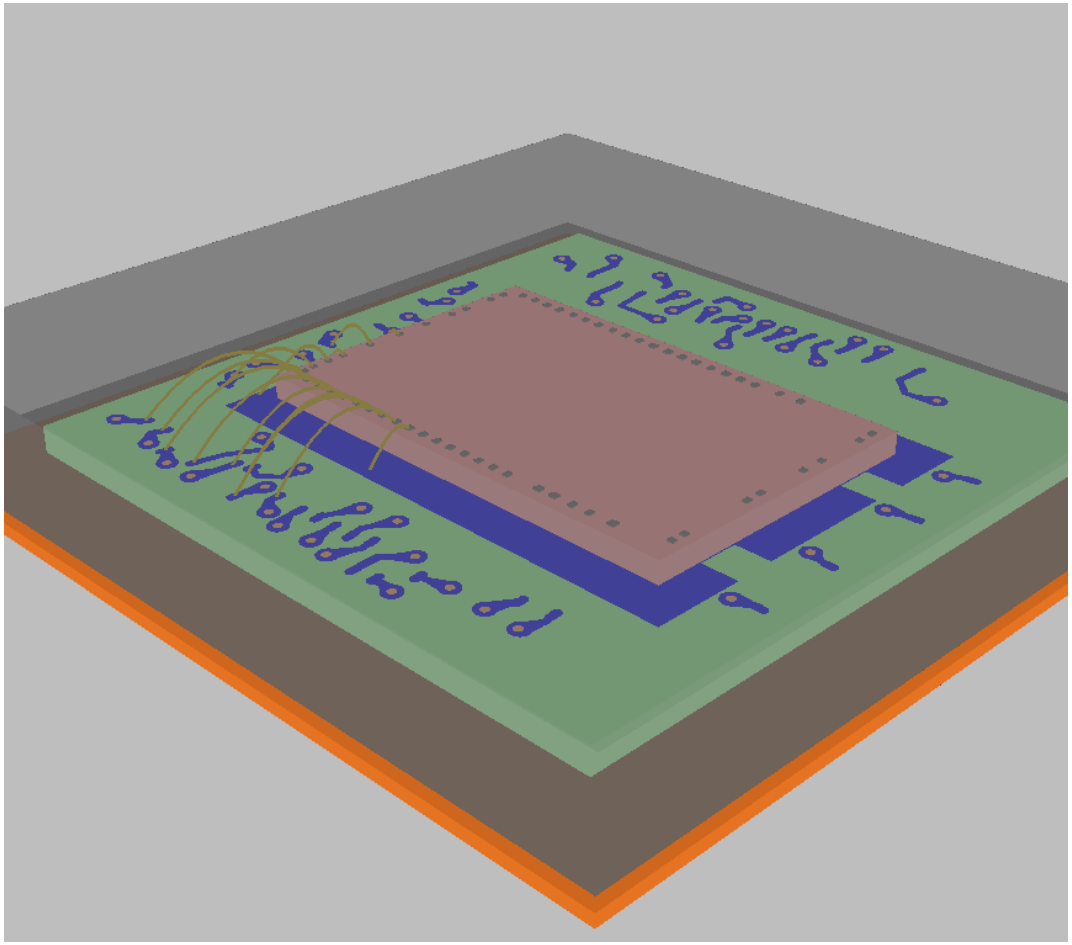
Signal Integrity of a BGA Package



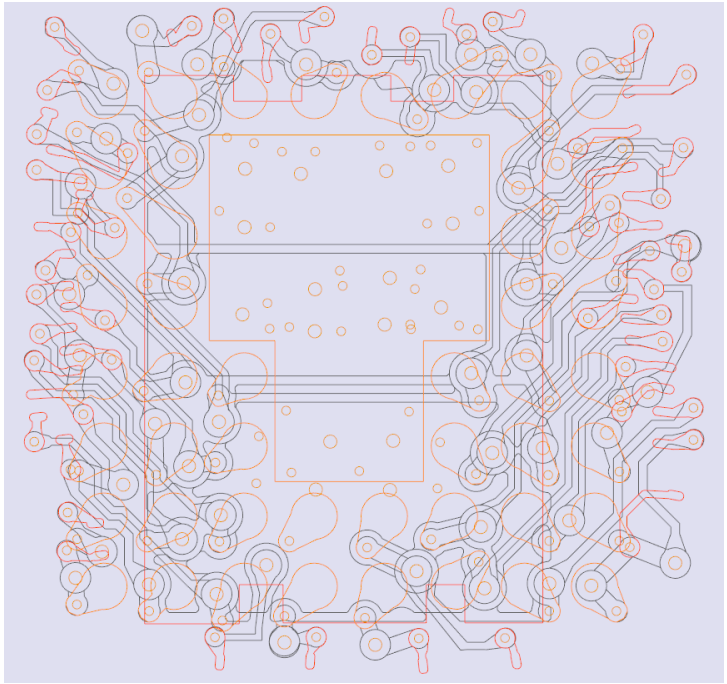
Overview: Topics

- Basic Features
- Layout import
- Bond wires
- Array generation

- Preprocessing
- Pulse definition
- Simulation Control
- Postprocessing



Step 1: Layout Import



- Open Empire XPU on Desktop
- Select “New Project”, OK

- Select File - Save As
- Create new folder “bga”
- Switch to “2D Design” Tab

- Select File → Import → 2D Layout → Import DXF (2D)
- Select data\layout.dxf *

** C:\EMPIRE XPU 8.00\Tutorials\2D Design\07 Ball Grid Array Package*

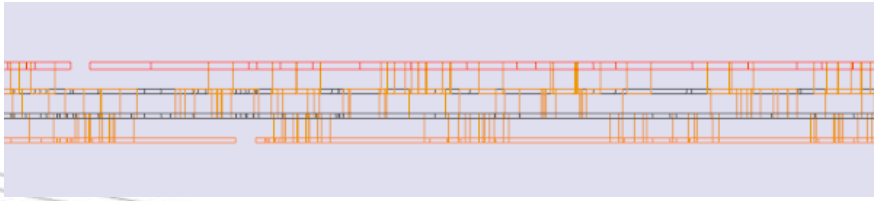
Comment: Layout data does not contain height information.

Step 2: Layer Stack

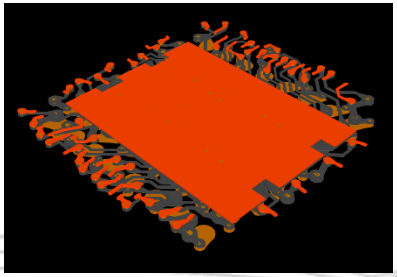
2D Layout Import

Name	Orig. Name	New	Type	Obj./Vias	Dir.	Start	Stop	Physical Property
Groups								
V34	V34	✓		64/0	z	200	330	conductor
V23	V23	✓		64/0	z	100	220	conductor
V12	V12	✓		64/0	z	0	120	conductor
L4	L4	✓		49/0	z	300	330	conductor
L3	L3	✓		51/0	z	200	220	conductor
L2	L2	✓		50/0	z	100	120	conductor
L1	L1	✓		49/0	z	0	20	conductor
#001				0	z	0	1000	conductor

- Set Start / Stop according to image
- Click OK at the bottom



2D Design: Front view after layer stack definition (detail)



3D Result: Iso-z-view

Step 3: Setup

- Click “Simulation Setup“

Tab: „EM Setup“

- Set „Limit for Number of Steps“: 8000

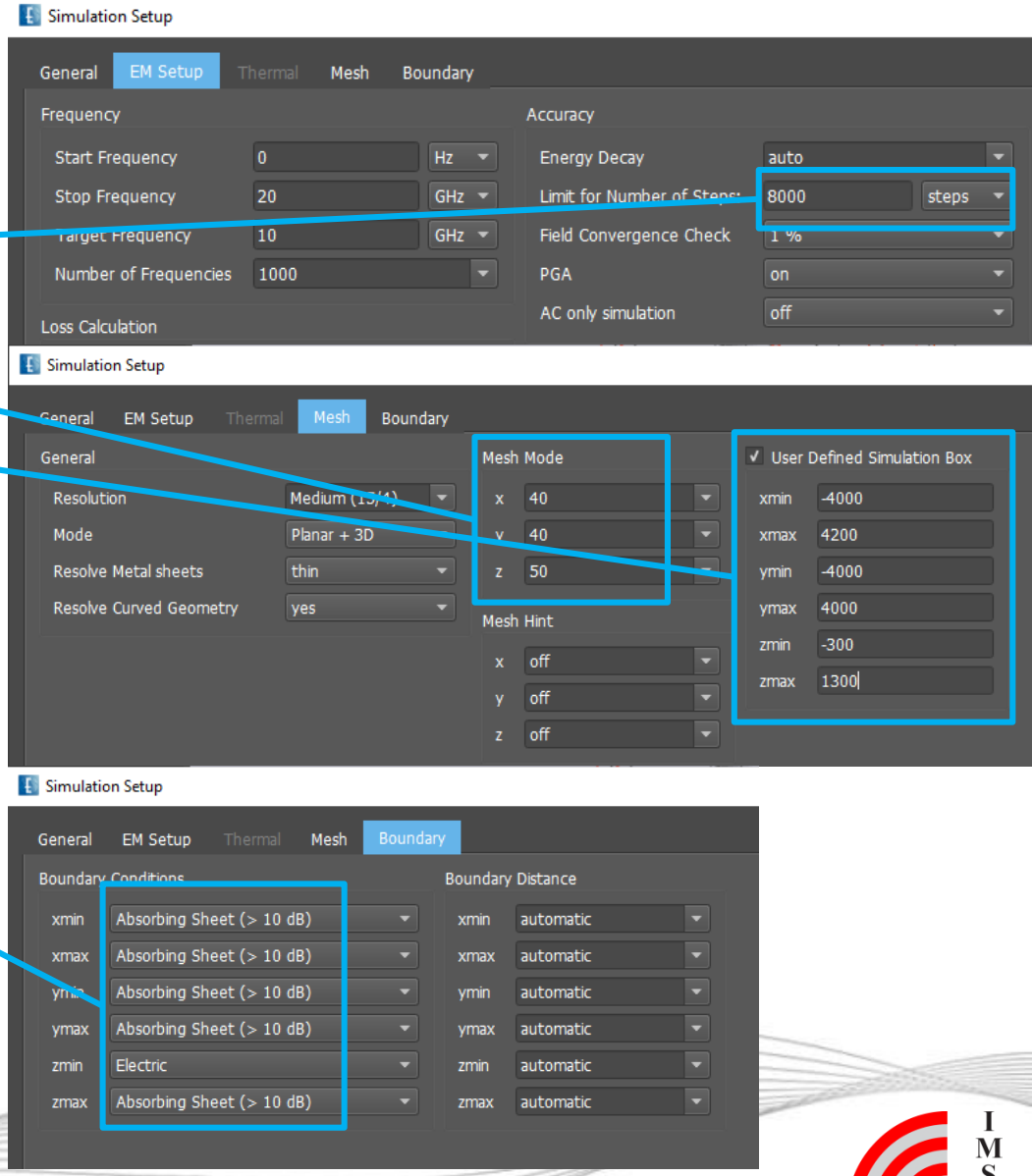
Tab:“Mesh“

- Set „Mesh Mode“: x=40, y=40, z=50
- Enable „User defined Simulation Box“
- Set Xmin = -4000 Xmax = 4200
  Ymin = -4000 Ymax = 4000
  Zmin = -300 Zmax = 1300

Tab: „Boundary“

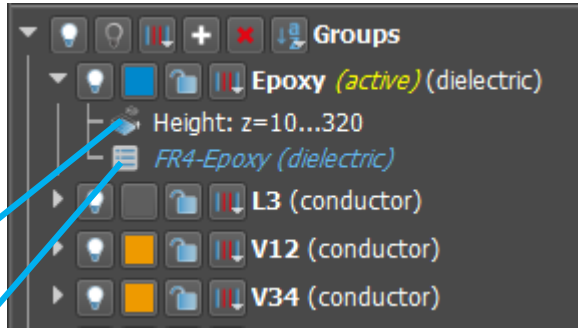
- Set xmin: Electric
- Set others: Absorbing sheet
- OK
- Click Create Mesh

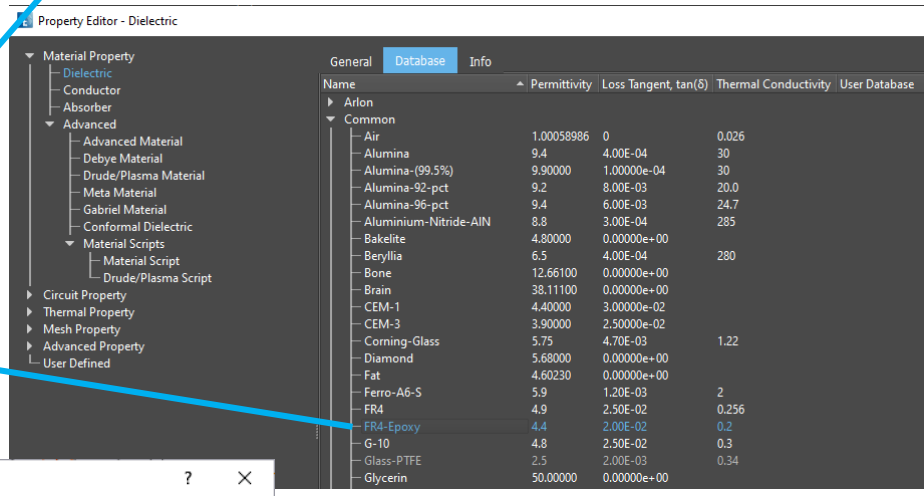
Comment: An equidistant grid is created

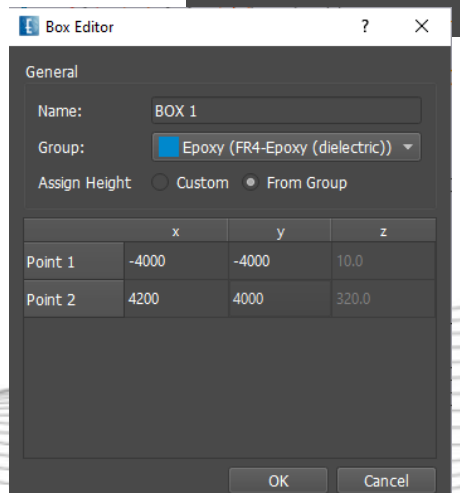


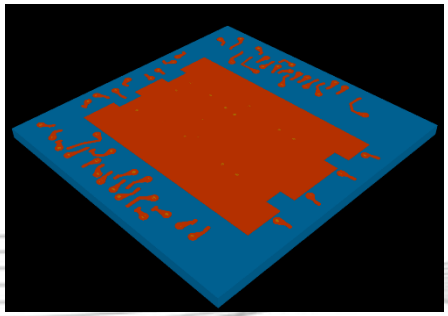
Step 4: Substrate

- Right click on group #001 – “Set Active”
- Right click on group #001 – “Edit Name”: Epoxy
- Open group, double click “Height”, Set z=10…320
- Double click on “conductor” to change Property
- Select Dielectric → Database Common → FR4-Epoxy
- OK
- “Create Box“ 
- Point 1: x=-4000, y=-4000
- Point 2: x=4200, y=4000
- OK

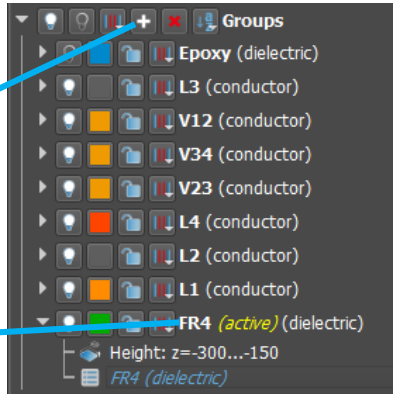




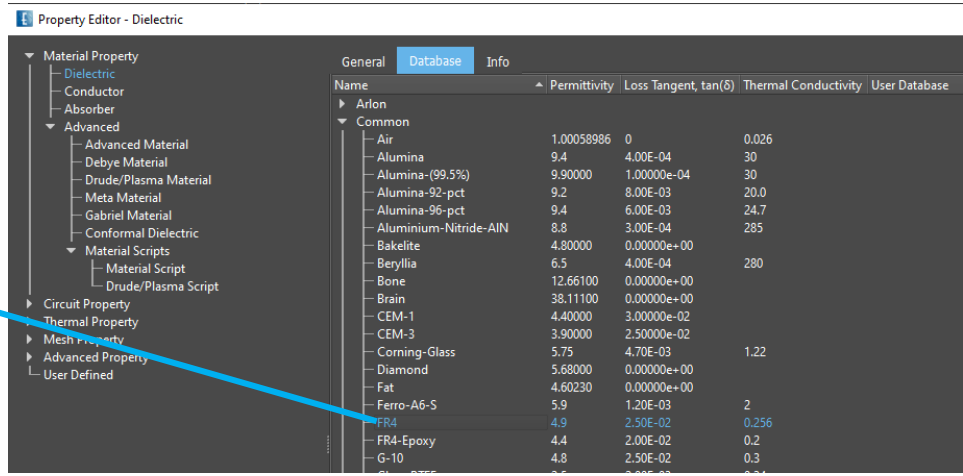


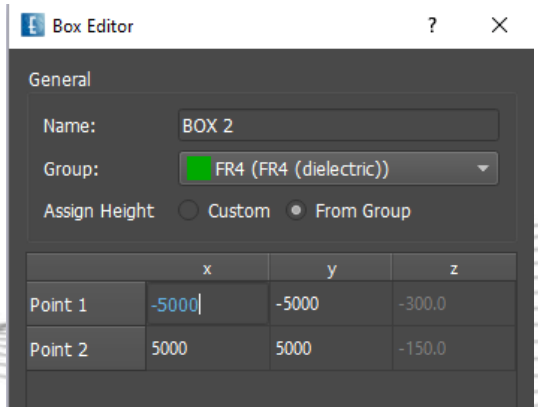


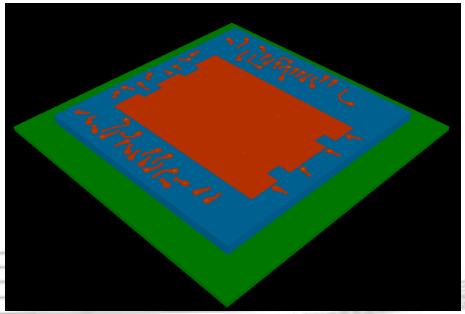
Step 5: Board



- Create new group
- Name: “FR4”
- Double click Height: z=-300…-150
- Double click “Conductor”:
- Select Dielectric → Database → Common → FR4
- OK, close groups
- Click “Create Box”
- Point 0: x=-5000, y=-5000
- Point 1: x=5000, y=5000
- OK

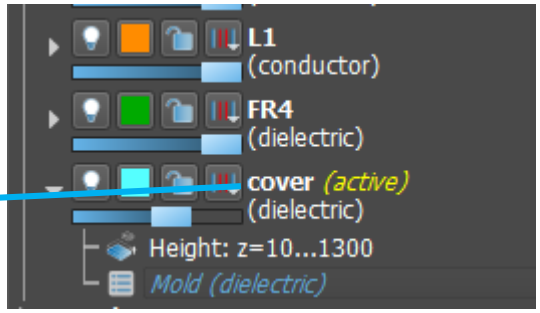


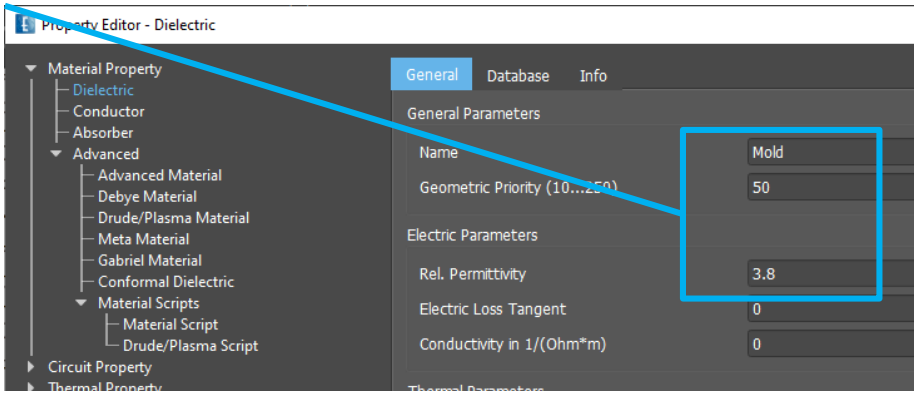




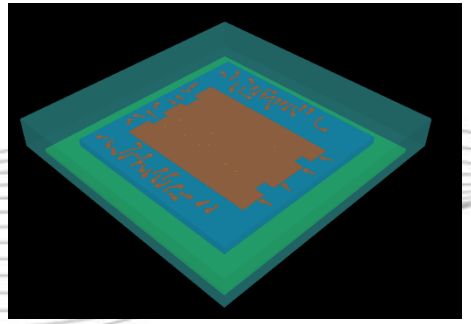
Step 6: Cover

- Create and open new group ‘cover’
- Double click Height: z=10…1300
- Double click “conductor”
- Select Dielectric, enter Name: Mold
- Set Geometric Priority 50
- Rel. Permittivity 3.9
- OK, close groups
- Click “Create Box”
- Point 0: x=-5500, y=-5500
- Point 1: x=5500, y=5500
- OK

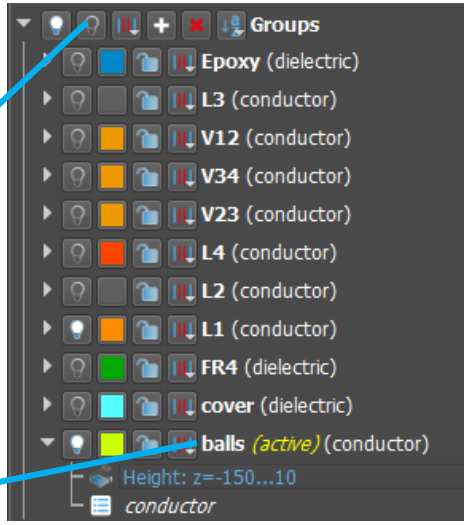




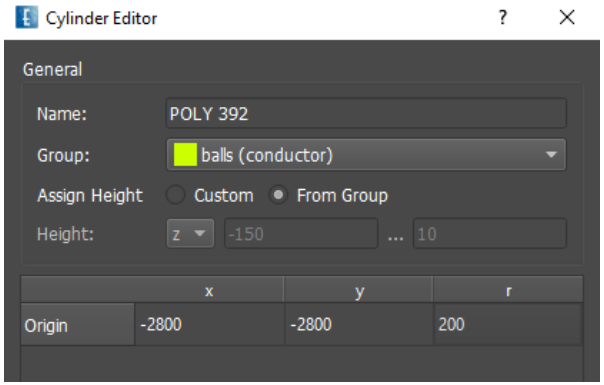
Comments: Intersecting Dielectrics need priority specification.

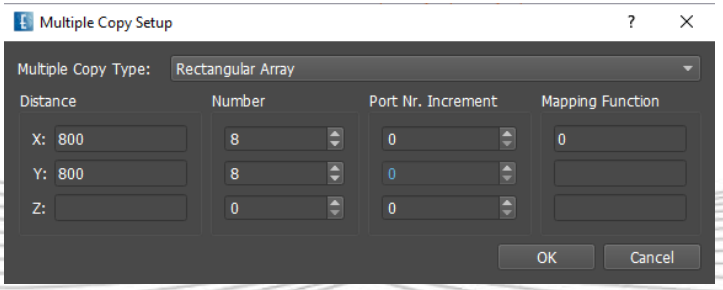


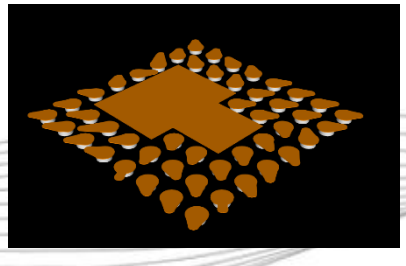
Step 7: Ball Grid



- Create and open new group “balls”
- Set height z=-150…10
- Switch off all groups but ‘L1’, ‘balls’
- Click “Create Cylinder” (default circular)
- Point 0: x=-2800, y=-2800 , r=200, OK
- Select new object (left click on lower left circle)
- Click “Multiple Copy”
- Enter ‘Distance‘ x,y = 800,800 and ‘Number‘ for x,y = 8,8 , OK

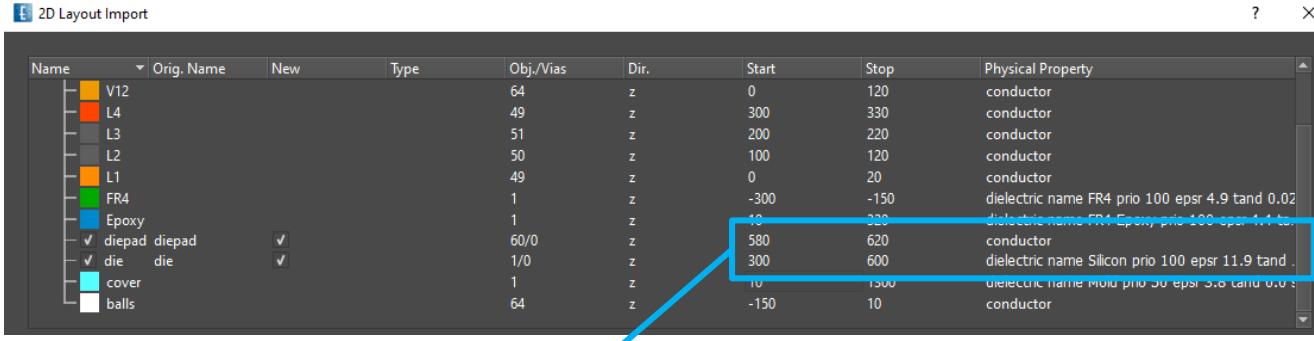






Only groups L1 and balls visible

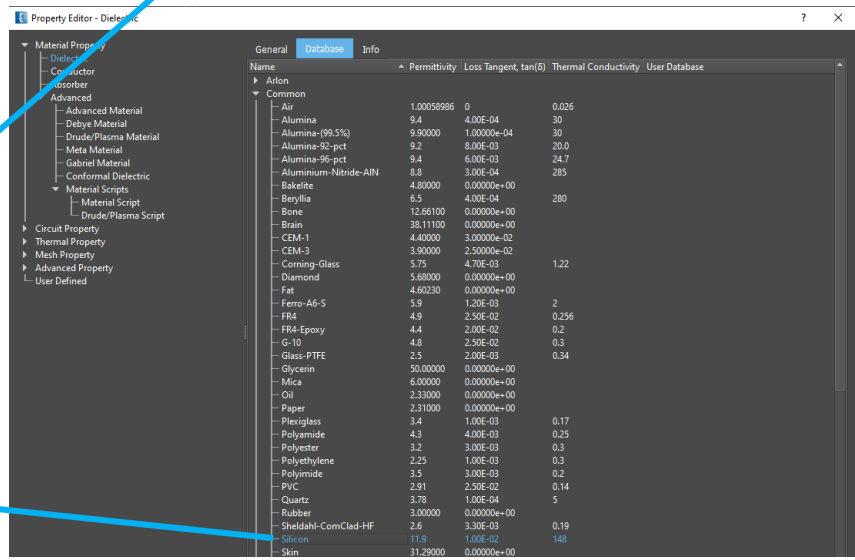
Step 8: Die and Pads

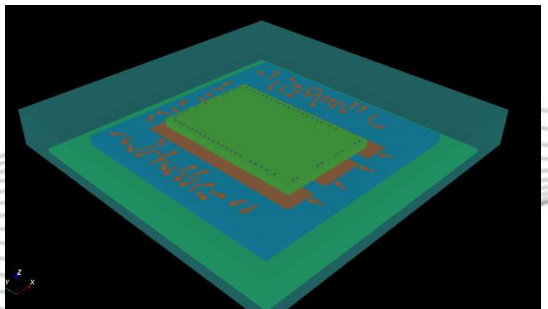


- Select File → Import → 2D Layout → Import DXF (2D)
- Select “data/die-pad.dxf”
- In “2D Layout Import” window:
- Group “die”:

  “Start” = 320 “End” = 600, “Property “conductor” → Select Dielectric, browse Common database for “Silicon”
- Group “diepad”:

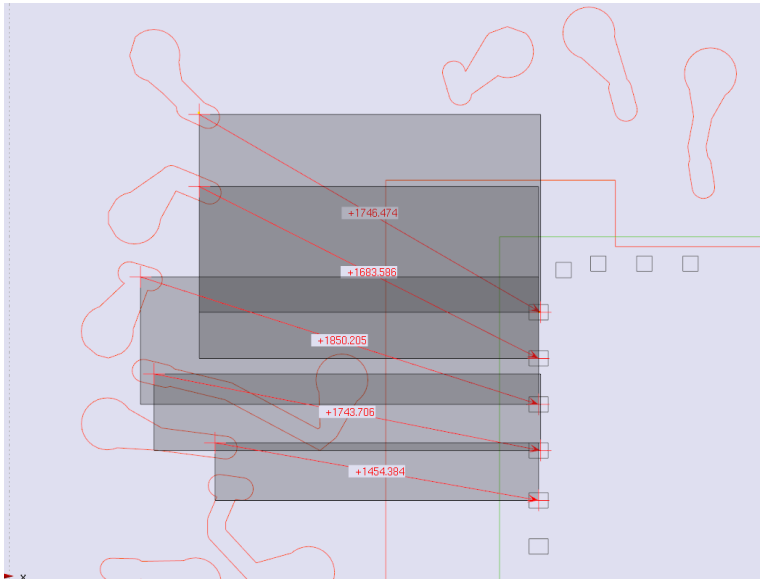
  “Start” = 580 “Stop” = 620
- OK



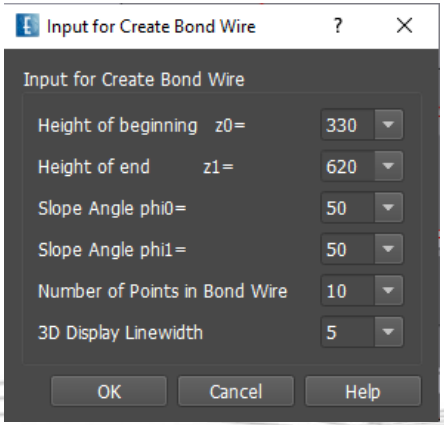


Step 9: Bond Wires

- Create new group “wires”
- Switch off all groups but
- L4, die, diepad, wires
- Zoom into upper left corner
- Draw arrows to die pads*
- Press “Advanced”
  → “Linpolys-Bondwire“
  → “Create Bondwire“
- Height of beginning = 330
- Height of end = 600, OK
- Switch off all groups but
- L1, balls, die, diepad



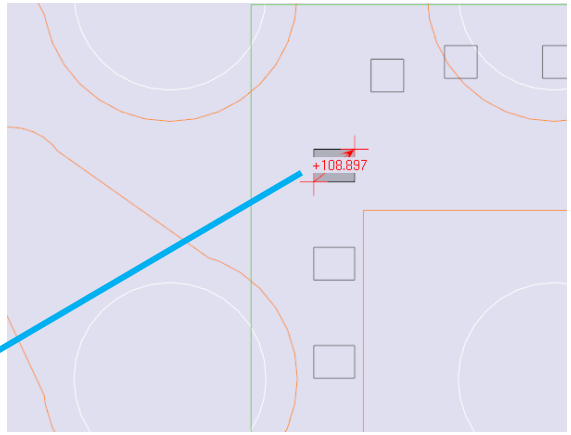
*Comment: * Press and drag left mouse button, start at L4 pads, end at die pads. Only do this for 5 pads.*

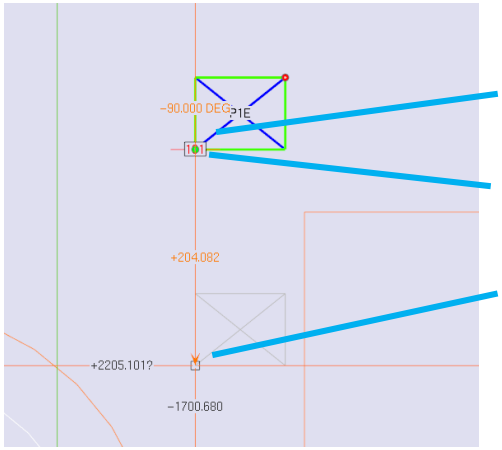


Step 10: Inner Ports

- Create and Open new group “iports”
- Set height z=330...580, close Groups list
- Create diagonal arrow in top pad
- Create “Perpendicular port” → , OK
- Copy* port to other pads (5 ports)

- Create and Open new group „oports”
- Set height z=-300...-150, close group list



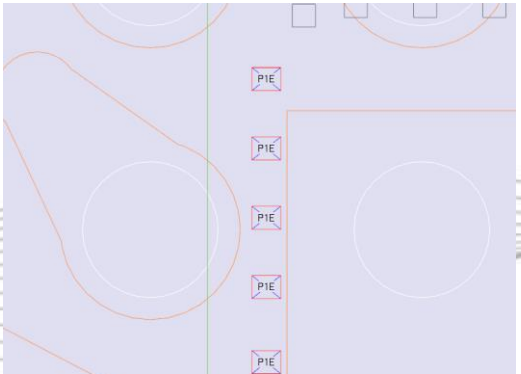


** Copy port:*

- Select port (left mouse button)

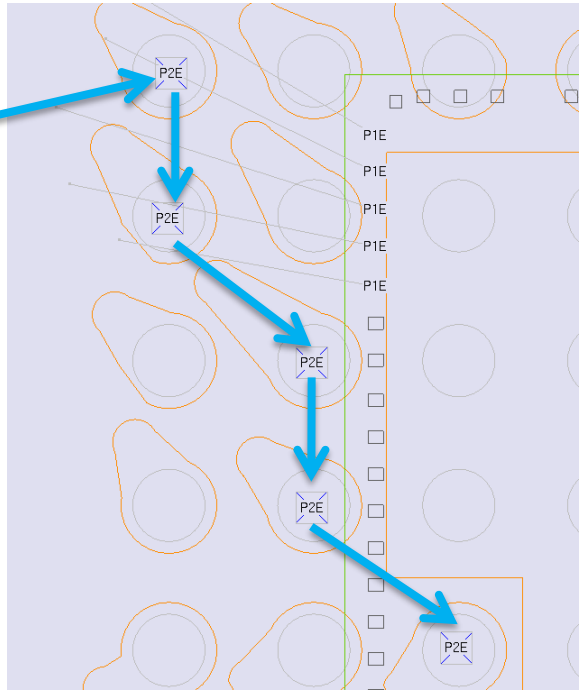
- Move cursor to green handle

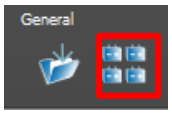
- Drag middle mouse button

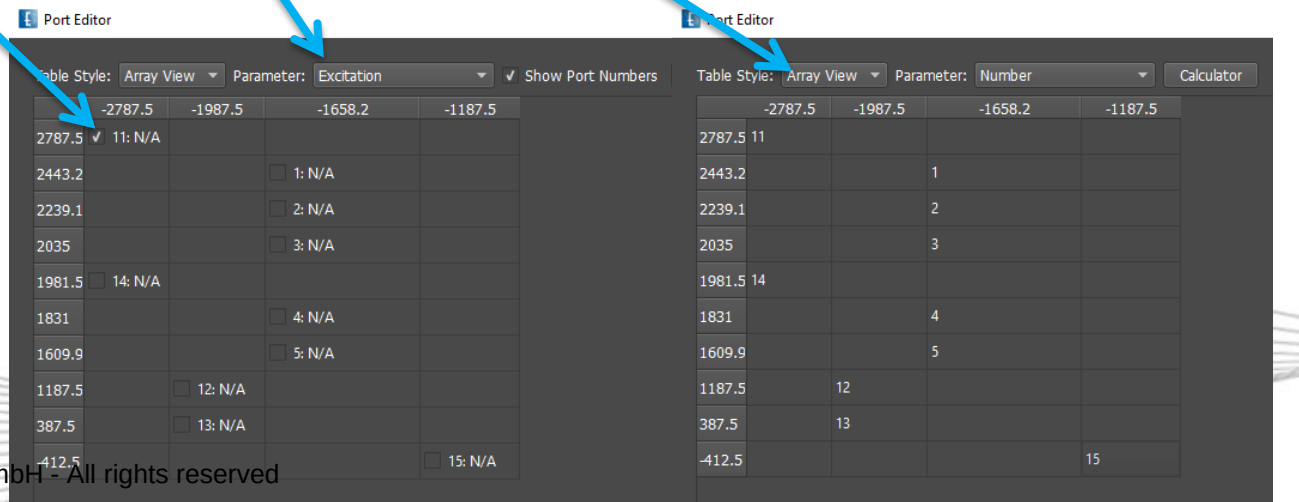


Step 11: Outer Ports

- Create “Perpendicular port” →
- Point 0: x=-2875, y=2875
- Point 1: x=-2700, y=2700, OK
- Copy port to other pads (as before, see picture)
- Click Port Setup Wizard
- Select “Array View”
- Enter new port numbers as shown
- Select Excitation
- Keep excitation port 11, deselect others
- OK

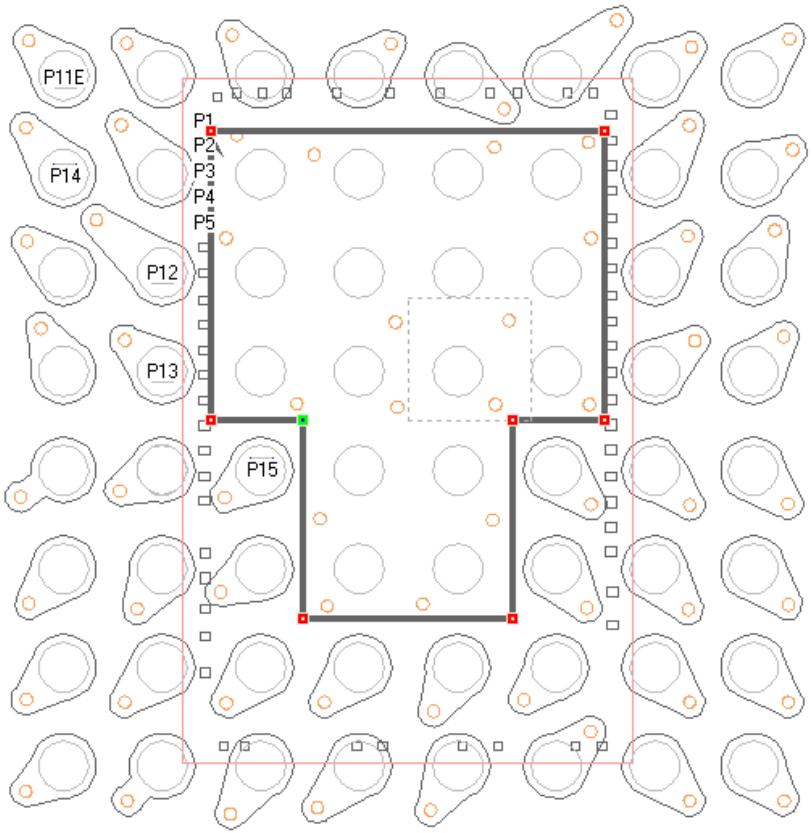




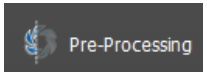


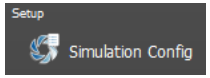
Step 12: Ground Connection

- Create and Open new group “gnd”
- Keep property conductor
- Set group height z=-300...-150
- Select large polygon (see picture)
- Right click on Group – Select  “Copy and set height for selected Objects”
- Press Esc

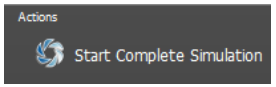


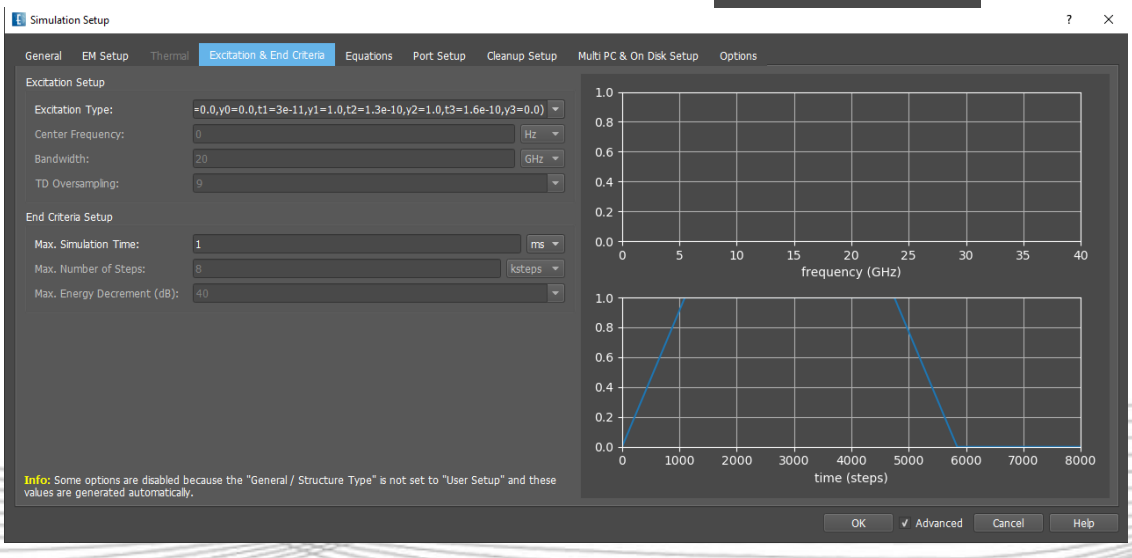
Step 13: Simulation Setup

- Switch to Simulation Tab
- Click “Pre-Processing” 

- Click “Simulation Config” 

- Select “Excitation & End Criteria”
- Excitation Type: Select “linear” and edit t1,t2,t3:

  linear(t,t0=0,y0=0,t1=**3e-11**,y1=1,t2=**1.3e-10**,y2=1,t3=**1.6e-10**,y3=0)
- OK, Click “Start Complete Simulation“ 



Step 14: Simulation Results

- After Simulation: Switch to 2D Results
- Plot Type: Voltage (Time Domain)
- Right click on Curves: Show all
- Reload Data, Autoscale

Pulse on FR4 board
Pulse on chip