

Advancing the
wireless revolution

Setting Up The AWR Design Environment: Part One

*Part One: Units, Global definitions, Advanced use of
the LPF, Component Libraries, Extraction (EM & ACE)*



- Agenda
 - Introduction
 - Units, Database, Snapping
 - Global definitions
 - Advanced use of the LPF
 - Component Libraries
 - Extraction
 - EM based (EMSight and AXIEM)
 - Circuit Based (ACE)

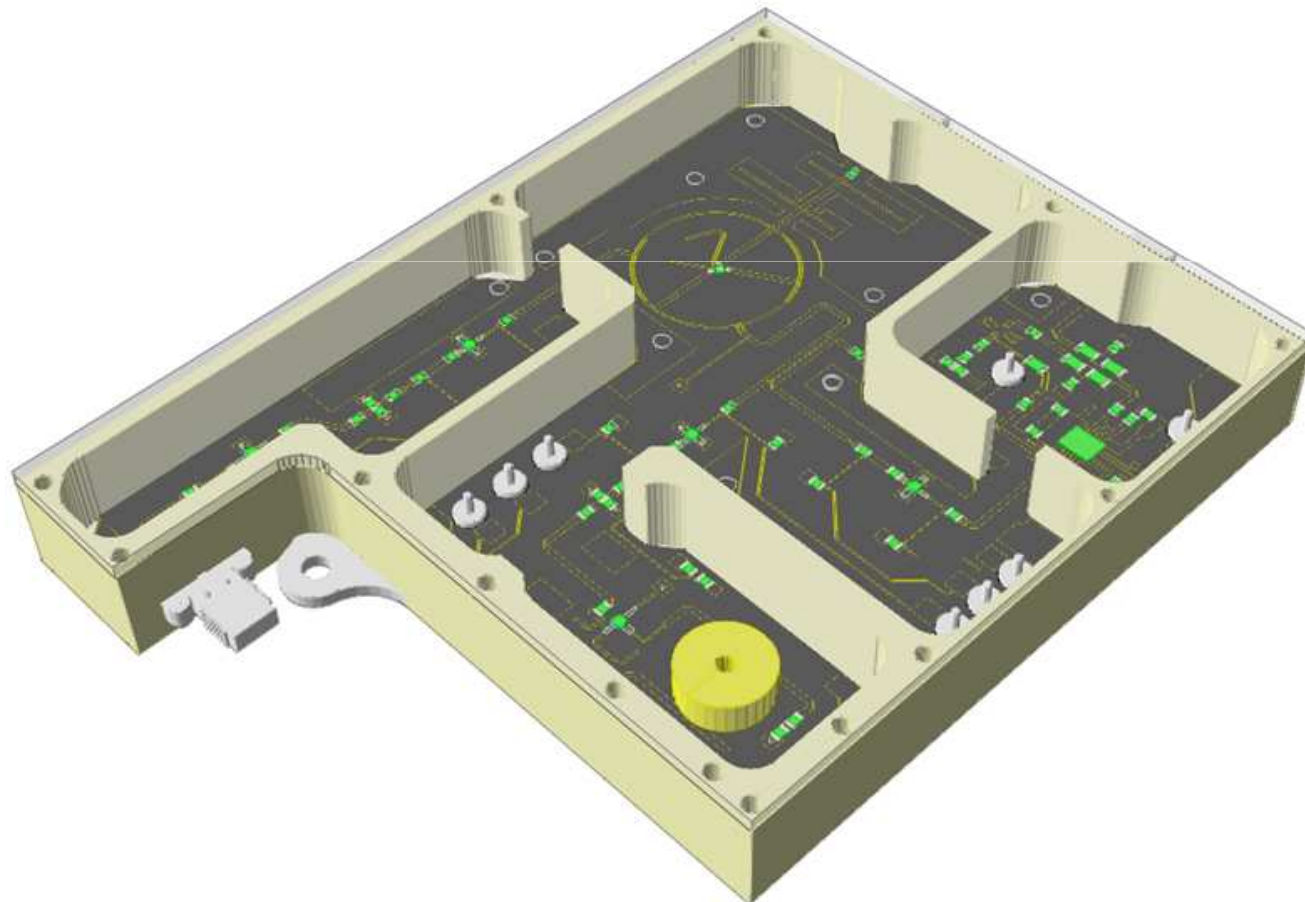
- Before embarking upon the design of a circuit it is advised that careful thought is given to the following topics ...
 - Units, configuration of MSUB, STACKUP elements
 - Schematic and Layout settings
 - Import of layout data
 - Layers (model and drawing)
 - Test benches
 - Export of manufacturing data
 - Directly from the AWRDE
 - Indirectly via a PCB tool
- This training is split into two sections and they will highlight the topics needed to be considered before designs are started
- These two training sessions only provide an overview
 - Please refer to Application Notes for a more exhaustive description!

Why do this initial work?

- Don't get to the point of exporting data for manufacture without testing the entire flow!!!
 - AWR gets a steady flow of support questions with engineers in a panic ...
 - “I have to get my data to the Mask maker for this weekend and I cannot seem to see how Gerber files are created” ;-(
 - “I have loaded a colleagues schematic into my project and the simulation results have changed!!”
 - “I imported my mechanical engineers DXF file to see how to lay out my circuit and I cannot see anything in the cell editor ... what am I doing that is wrong?”
- Hopefully after this brief introduction you will have the knowledge to take control of the AWR Design Environment and use it to its' maximum potential
- These two training sessions will concentrate on layout issues only.

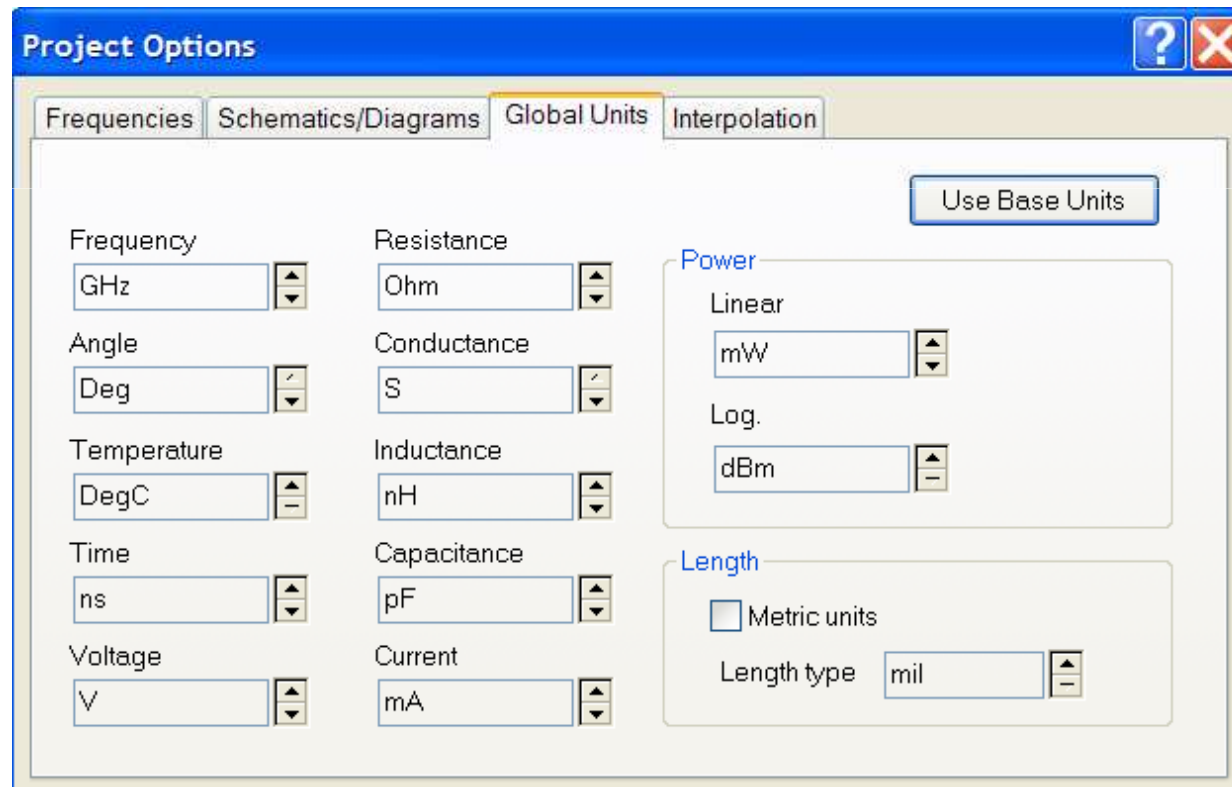
The target

- Manage the design a complex sub-circuit such as the unit illustrated below with ease.



Units: Electrical Simulation and Layout


- It is necessary for all users to have a sound strategy for dealing with units prior to designing in the AWR Design Environment.



Determine Your Data Base Resolution

- Determine Your Data Base Resolution
 - A sensible database resolution unit is important for all users setting up their own process. This is automatically taken care of for designers using Process Development Kits. A database unit is defined as the smallest unit of precision for a layout.
 - Grid Spacing
 - A good guideline is to set the grid to be greater than or equal to the database unit.

Grid Options

Grid spacing	<input type="text" value="0.1"/>	mm
Database unit size	<input type="text" value="0.01"/>	mm
Rotation snap angle	<input type="text" value="45 deg"/> 	

Snapping Mode

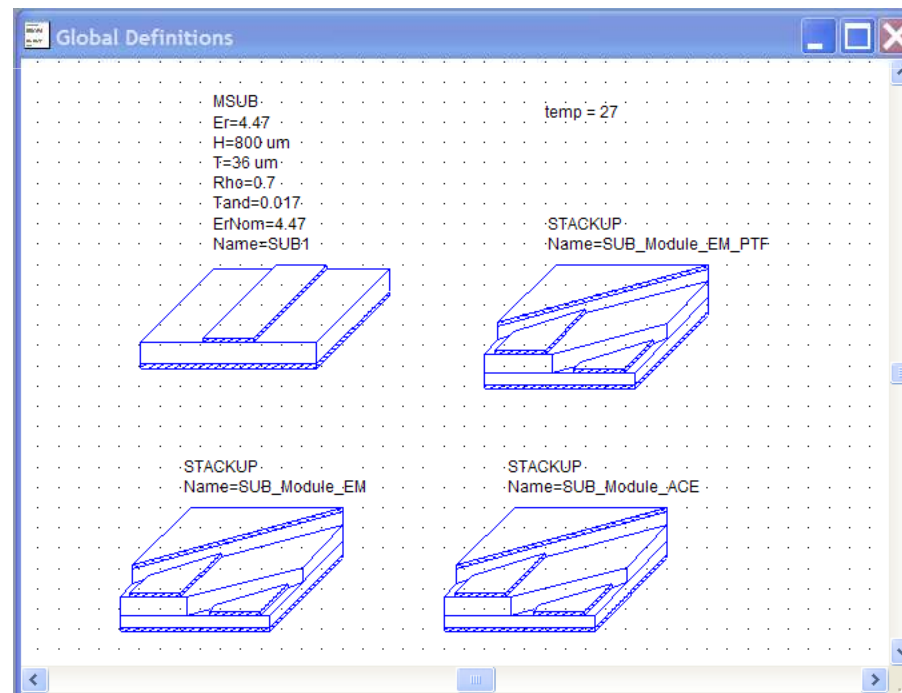
- Snapping Mode: Snapping functions connect the faces of layout cells in different ways. You can set snapping options from the Layout Options dialog box. It is recommended that you use manual snapping rather than automatic snapping for complex layouts.

Layout Cell Snap Options

Snap together	<input type="checkbox"/> Don't rotate shapes when snapping
Manual snap for selected objects only ▼	<input type="checkbox"/> Default connection to closest face
Auto face inset	<input checked="" type="checkbox"/> Fixed origin for subcircuits
Do not inset faces ▼	<input checked="" type="checkbox"/> Fixed origin for layout cells
	<input type="checkbox"/> Keep origin on grid

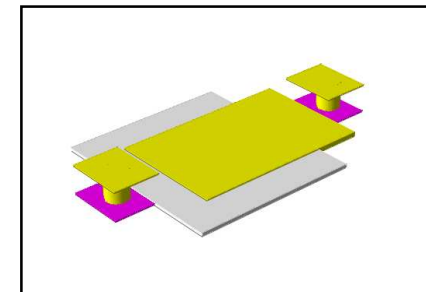
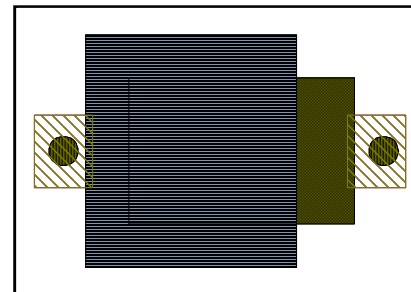
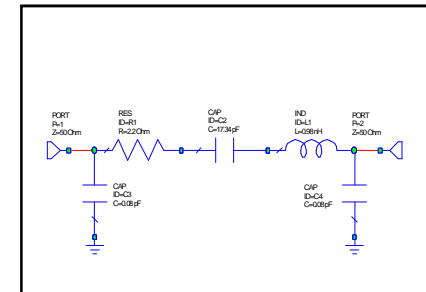
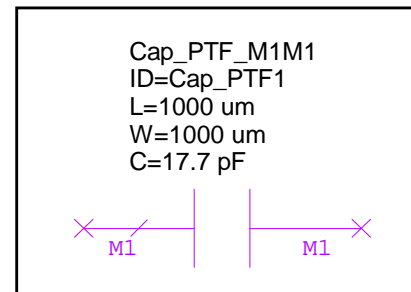
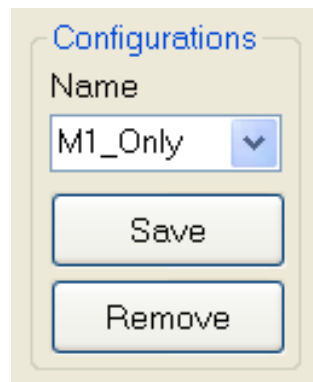
Global definitions

- Use Global Definitions to store ..
 - MSUB, STACKUP, SSUB
 - Variables, Equations
 - If required comments about these settings can be added as text ... important when this information is shared



What does the LPF define?

- The LPF defines
 - Model and Drawing layer mapping
 - Visibility and Cloaking
 - 2D Colours and Patterns ... includes negative layers!!
 - 3D setup
 - Drill Holes
 - Configurations

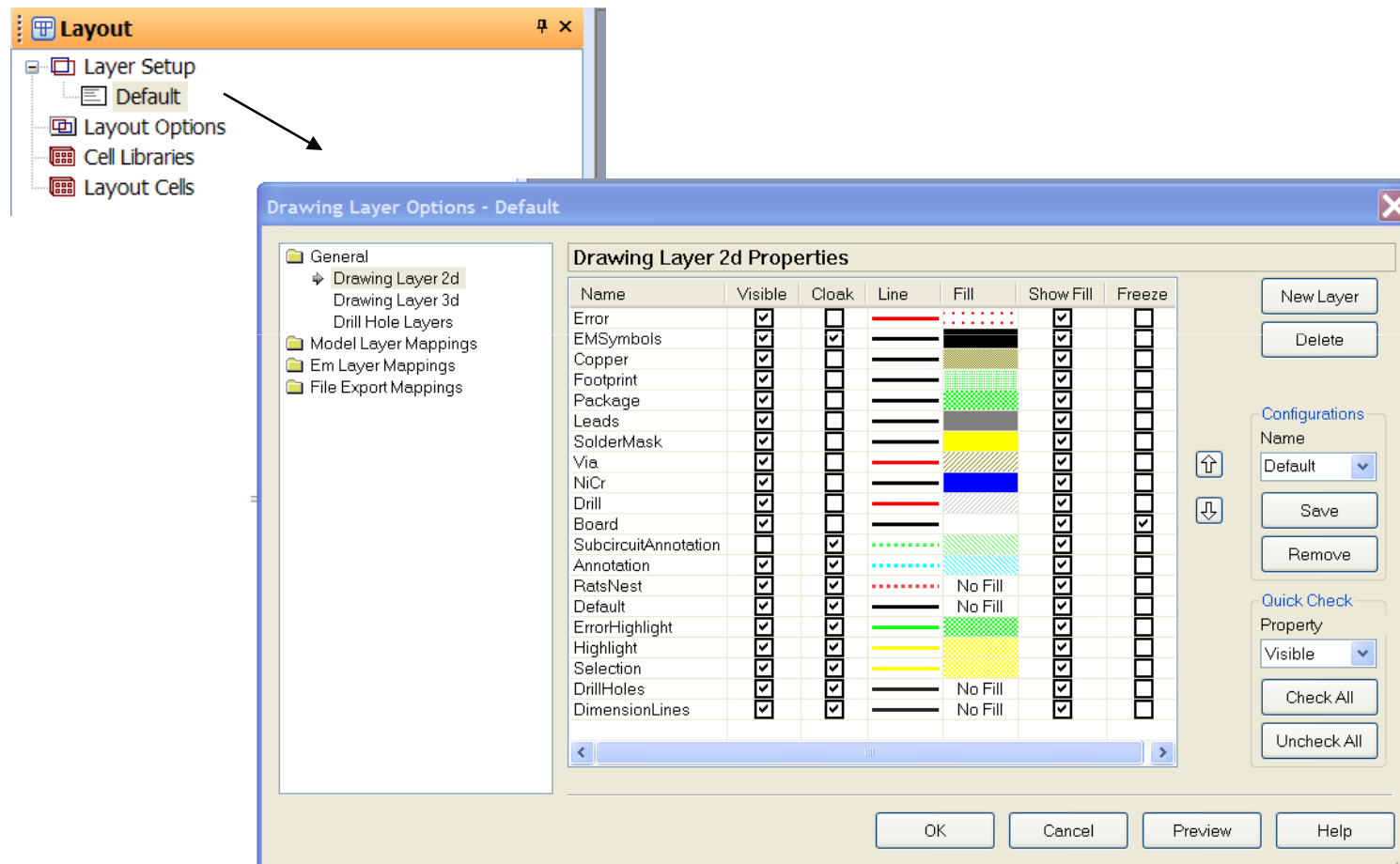


What does the LPF define?

- The LPF defines
 - Line Types
 - Default Units for simulation
 - Default Units for layout
 - Default values for width, length, height etc
 - EM settings
 - VIA Definitions
 - Simple VIAs
 - VIAs used by iNETs
 - STRUCTURE entries for GMCLIN etc

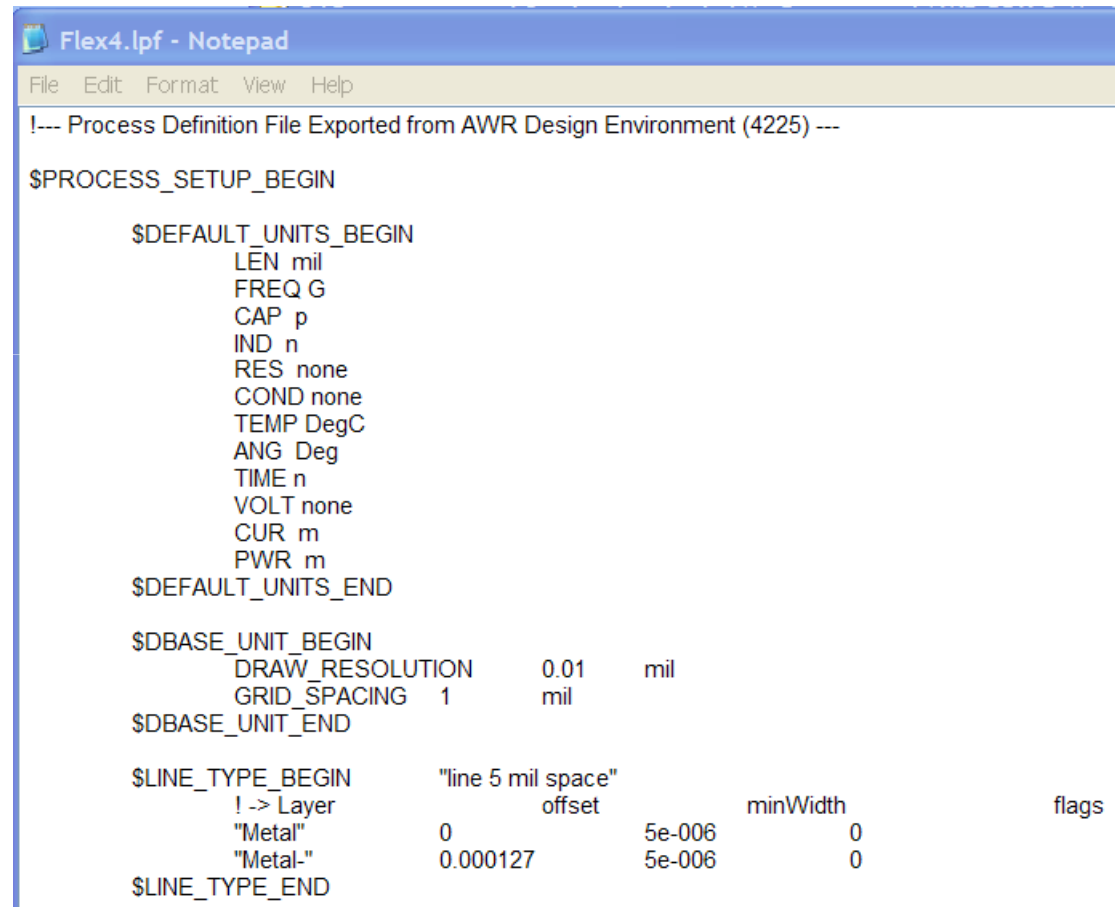
Editing the LPF

- For simple data ...



Editing the LPF

- For more advanced entries Edit using Notepad ...



```
Flex4.lpf - Notepad
File Edit Format View Help
!--- Process Definition File Exported from AWR Design Environment (4225) ---

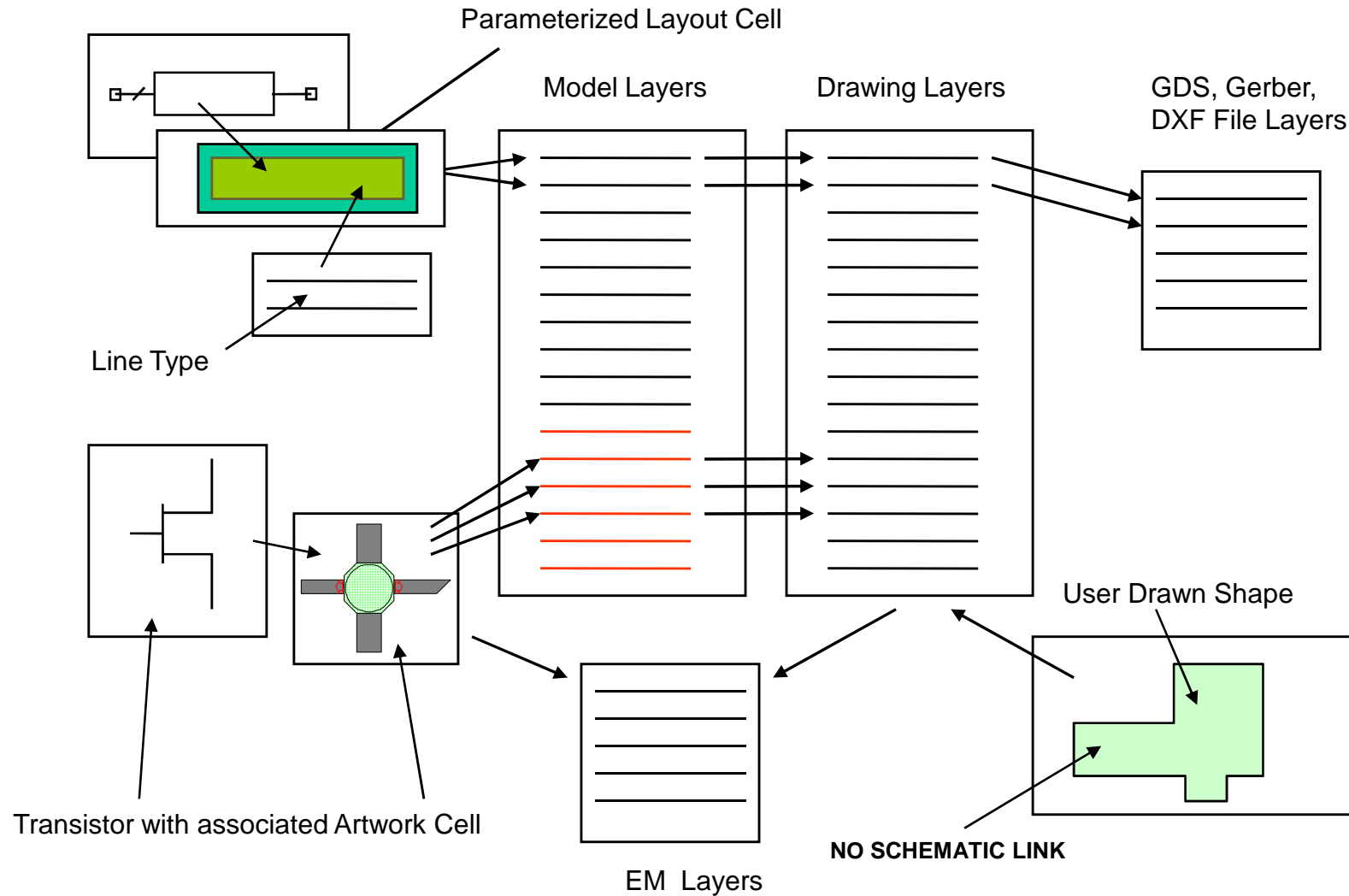
$PROCESS_SETUP_BEGIN

    $DEFAULT_UNITS_BEGIN
        LEN mil
        FREQ G
        CAP p
        IND n
        RES none
        COND none
        TEMP DegC
        ANG Deg
        TIME n
        VOLT none
        CUR m
        PWR m
    $DEFAULT_UNITS_END

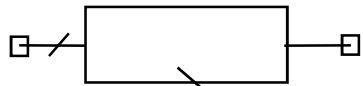
    $DBASE_UNIT_BEGIN
        DRAW_RESOLUTION 0.01 mil
        GRID_SPACING 1 mil
    $DBASE_UNIT_END

    $LINE_TYPE_BEGIN
        "line 5 mil space"
        ! -> Layer offset minWidth flags
        "Metal" 0 5e-006 0
        "Metal-" 0.000127 5e-006 0
    $LINE_TYPE_END
```


Model and Drawing Layers



- Microstrip etc ... use the concept of LineType



Line Type entry in LPF

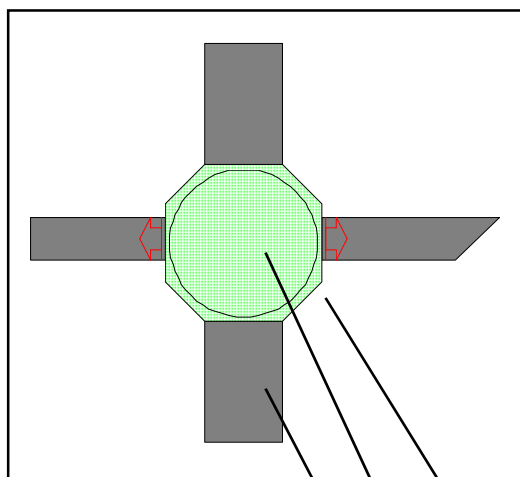
\$LINE_TYPE_BEGIN	"M_1"			
! -> Layer		offset	minWidth	flags
"M_1"		0	1e-008	0
"M_1-"		0.000254	1e-008	0
\$LINE_TYPE_END				



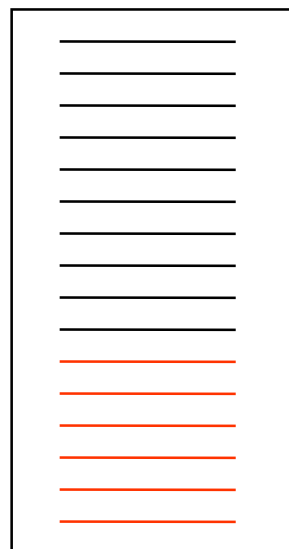
Model and Drawing Layers

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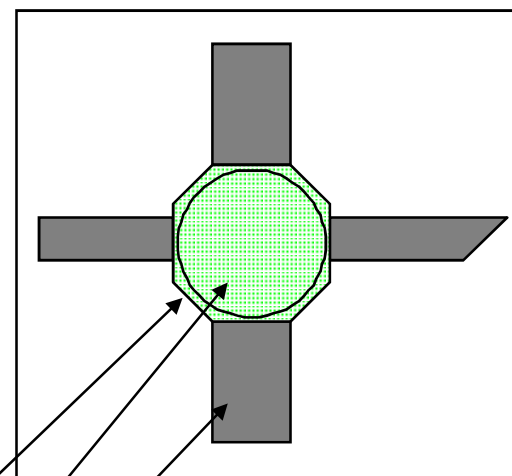
Cell View



Model Layers



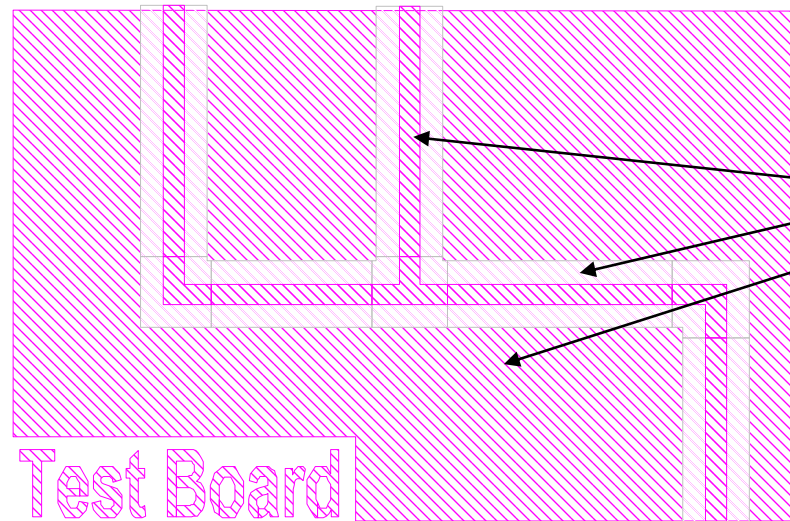
Schematic Layout View



11_0	Top_FET
12_0	Top_FET_Metal
41_0	Top_FET_Leads

2D Colours and Patterns ... for negative layers!!

- Ground Plane removal ...
 - With the AWRDE the designer draws a shape of metal to represent the ground plane flood and the tracks themselves carry the information in the form of negative layer information to 'cut out' the conductor region around the track.
 - Many PCB tools flood to the keep out region that surround the tracks. as an explicit command

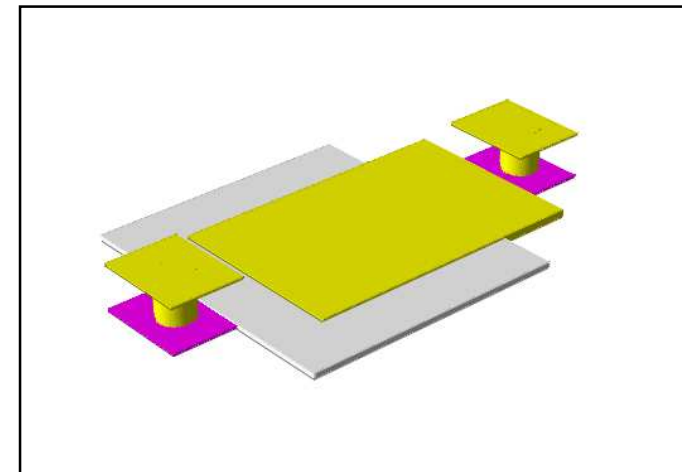


Drawing Layer 2d Properties							
Name	Visible	Cloak	Line	Fill	Show Fill	Freeze	
Error	<input type="checkbox"/>	<input type="checkbox"/>			<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
M_1	<input checked="" type="checkbox"/>	<input type="checkbox"/>			<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
M_1-	<input checked="" type="checkbox"/>	<input type="checkbox"/>			<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
M_1+	<input checked="" type="checkbox"/>	<input type="checkbox"/>			<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

3D Setup

- The 3D Drawing Layer information does not control circuit simulation!

Drawing Layer 3d Properties						
Name	Opaque	Thickness	Z-Position	Texture File	Texture Scale	Blend
Error	<input checked="" type="checkbox"/>	100	1000		0	0
EMSymbols	<input checked="" type="checkbox"/>	0	1000		0	0
M_1	<input checked="" type="checkbox"/>	12	796		0	1
M_1-	<input type="checkbox"/>	12	796		0	0.3
M_1+	<input type="checkbox"/>	12	796		0	0.5
Prepreg1	<input type="checkbox"/>	106	690		0	0.3
Via_12	<input type="checkbox"/>	106	690		0	0.3
Via_13	<input checked="" type="checkbox"/>	242	554		0	0.5
Res_2	<input checked="" type="checkbox"/>	22	672		0	0.5



3D Setup

- Since the Z dimension does not affect the simulation when used to define the 3D layout view one can apply a manual scale to the data.

Drawing Layer 3d Properties			
Name	Opaque	Thickness	Z-Position
Ag	<input checked="" type="checkbox"/>	3	586

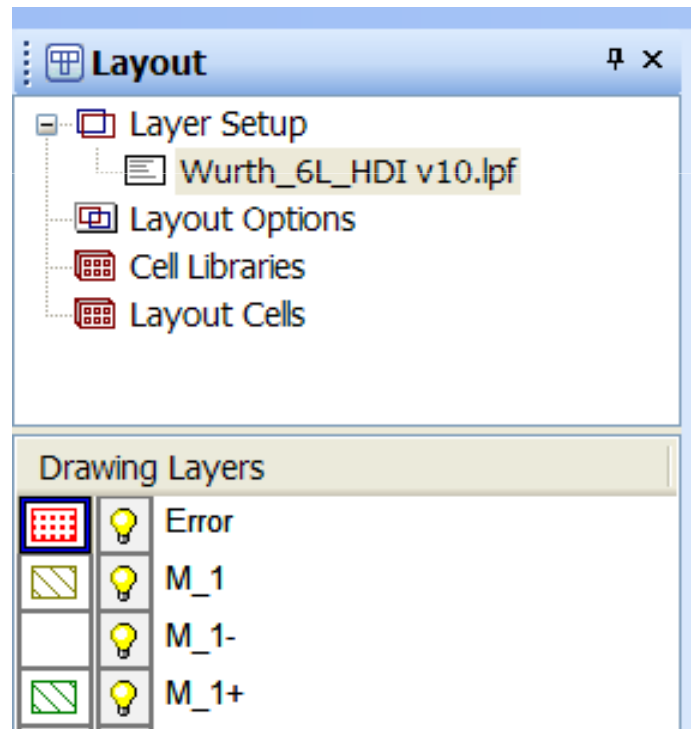
- Becomes ...

Drawing Layer 3d Properties			
Name	Opaque	Thickness	Z-Position
Ag	<input checked="" type="checkbox"/>	30	586

- Thus we have a 10X scale in the thickness of a Silver conductor (Ag).

Visibility and Cloaking

Visibility controls seeing the layer - it's the same as the light bulb on or grayed out



Cloaking - You won't see the layer in the layout browser

Useful for hiding System Layers that the user need no select and draw on.

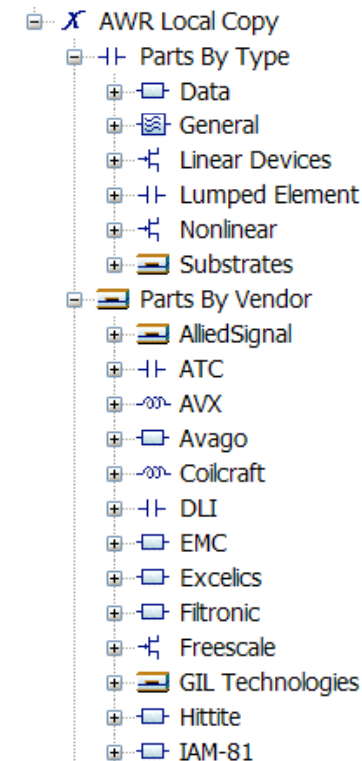
Drawing Layer 2d Properties						
Name	Visible	Cloak	Line	Fill	Show Fill	Freeze
Error	<input checked="" type="checkbox"/>	<input type="checkbox"/>			<input checked="" type="checkbox"/>	<input type="checkbox"/>
EMSymbols	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>	<input type="checkbox"/>
M_1	<input checked="" type="checkbox"/>	<input type="checkbox"/>			<input checked="" type="checkbox"/>	<input type="checkbox"/>
M_1-	<input checked="" type="checkbox"/>	<input type="checkbox"/>			<input checked="" type="checkbox"/>	<input type="checkbox"/>
M_1+	<input checked="" type="checkbox"/>	<input type="checkbox"/>			<input checked="" type="checkbox"/>	<input type="checkbox"/>

- XML
 - What is XML?
 - XML is a document standard that can be used to define documents and databases
 - Why use it?
 - The syntax is extensible
 - Internet Explorer uses XML and therefore can be used as a free XML tester
 - The AWRDE uses a set of XML files used to define ...
 - The main vendor component library
 - Elements found in Process Definition Kits (PDK) ... LTCC, GaAs, Si GaN, SiP
 - Adding a user library to the standard Vendor library is very straight forward

Component Libraries

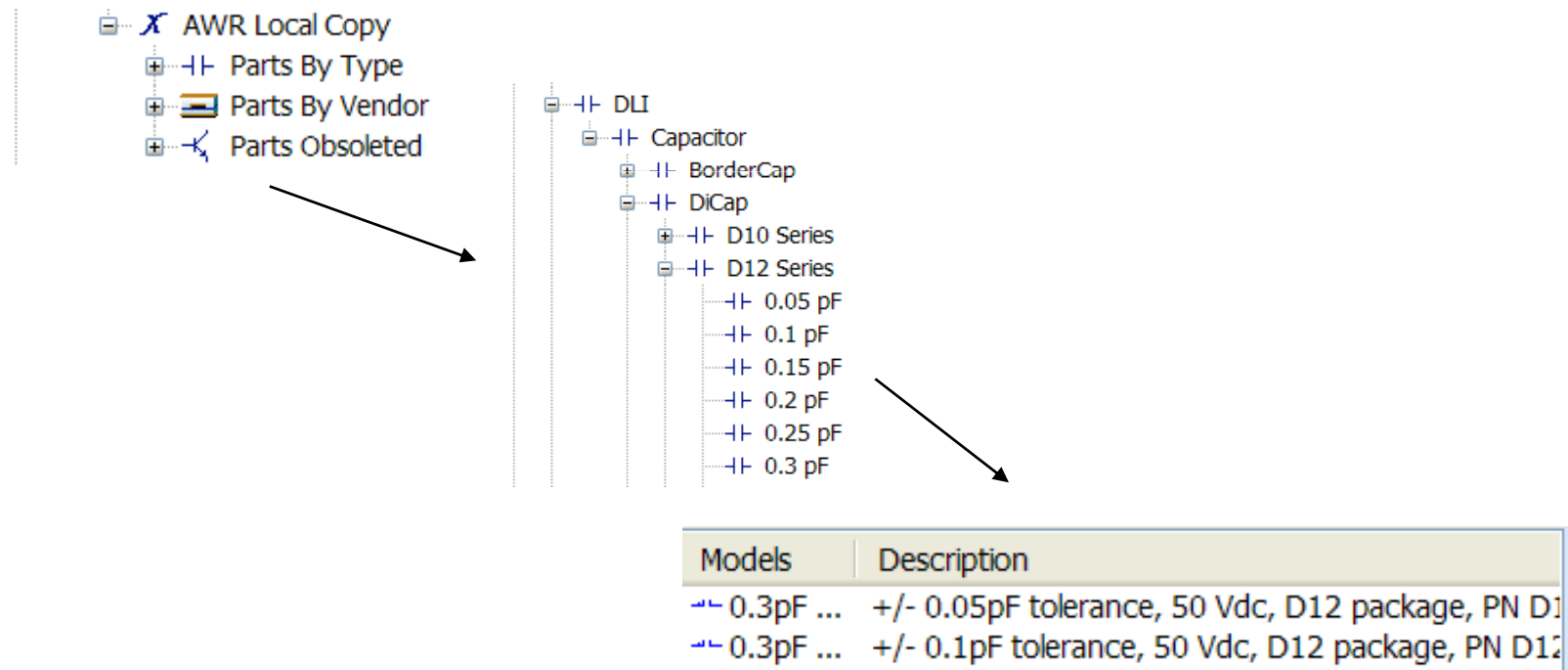
- Default settings ... used to find the XML library ...

```
<?xml version="1.0"?>
<XML_COMPONENT_DATA xmlns="urn:awr-lib-data">
  <COPYRIGHT>AWR</COPYRIGHT>
  <SUMMARY>Entry point XML file for circuit libraries</SUMMARY>
  <FILE Name="* AWR web site">http://www.awrcorp.com/weblibs/8_0/top_v8.xml</FILE>
  <FILE Name="AWR Local Copy">C:\Documents and Settings\All
Users\xml_local_8/top_v8_local.xml</FILE>
</XML_COMPONENT_DATA>
```



Component Libraries

- The library contains entries that define a set of parts (components)
- These can be broken into separate files (inductors, capacitors etc)
- The part types can be broken into sub-files ... tolerance etc



- User Library
 - An individual component has an XML entry such as ...

```
<COMPONENT Name="1.1 pF">  
  <MODEL>CAP</MODEL>  
  <DESC>1.1 pF 0201 Capacitor</DESC>  
  <SYMBOL>Capacitor@system.syf</SYMBOL>  
  <CELL>Cap_0201@..\Library\Generic_Module_Lib.gds</CELL>  
  <DATA DataType="awrmodel" Inline="yes">  
    <PARAM Name="ID">C</PARAM>  
    <PARAM Name="C">1.1e-12</PARAM>  
  </DATA>  
</COMPONENT>
```

This entry defines ...

The schematic symbol

Capacitor@system.syf

The Model

CAP

The footprint

Cap_0201@..\Library\Generic_Module_Lib.gds

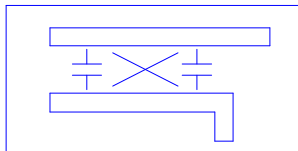
The major parameters

1.1e-12

- EM Based extraction
 - What does this mean?
 - What is the role of the EXTRACT element?
 - What is the role of the STACKUP element?
- When any of the following problems are suspected switch to an EM extracted model
 - The closed form models are inaccurate, or operate beyond their parameter range
 - Coupling that is not captured at the schematic level
 - The structure has been created as a graphical entity with no analytical or data based model

- The EXTRACT element (used with EM extraction)
 - Is responsible for defining the EM simulator, simulator settings and controlling the substitution of circuit simulator data with EM based data.

EXTRACT
ID=EX1
EM_Doc="EM_Extract_Model"
Name="EM_Extract"
Simulator=EMSight
X_Cell_Size=5 um
Y_Cell_Size=5 um
PortType=Default
STACKUP="SUB"
Extension=100 um
Override_Options=No
Hierarchy=Off



Element Options: EXTRACT - Extraction Control Block Properties

General Frequencies Mesh Interpolation/Passivity SPICE Model Generation **EMSight** Parameters Symbol

Solver Options

- ☒ De-embed ports/feed lines
- ☒ Compute loaded currents
- ☐ Use fast de-embed (1 port/side)

Matrix Solver

Select a Matrix Solver
Default Direct (Opt. for size)

Iterative solver tolerance: Medium

☐ Single Precision (Less memory)

Advanced Freq Sweep

☐ Enable AFS

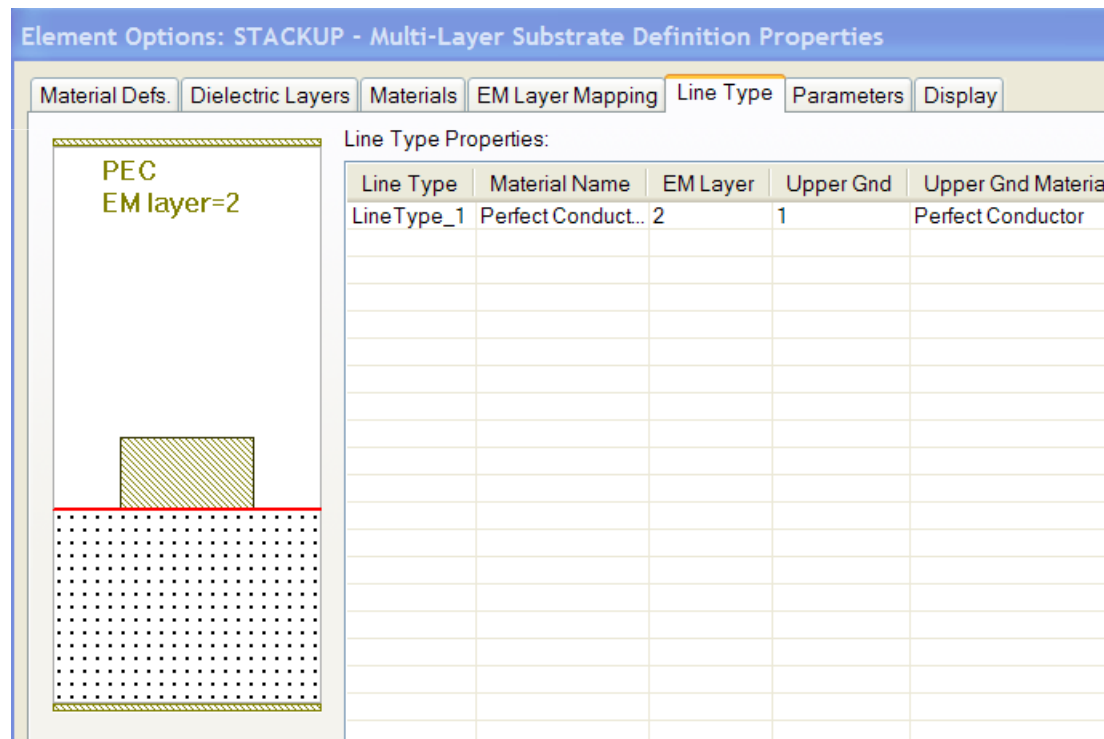
Specify AFS Band: ☐

Error Type	Error Tol (dB)	# Grid Pts	Max # Sim Pts	Start (GHz)	Stop (GHz)
Absolute	-40	200	200	40	60

EM Based Extraction

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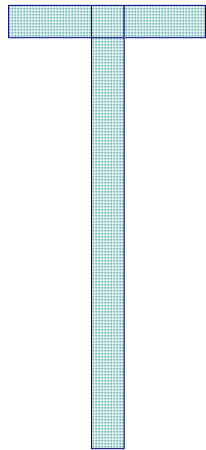
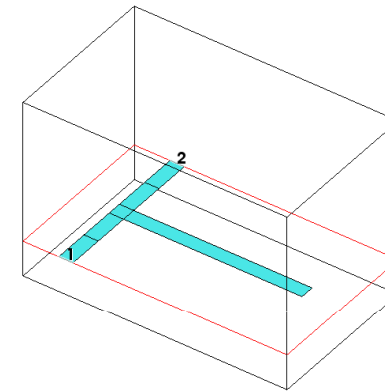
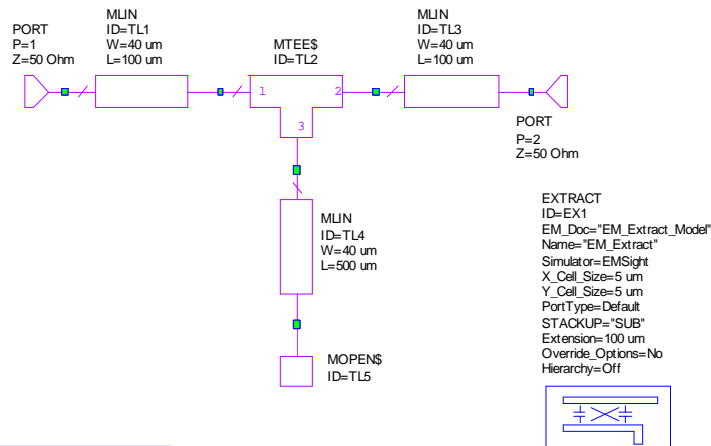
- The STACKUP element
 - Is responsible for defining ...
 - The dielectric and conductors
 - NOTE: Unlike CBE ...Ground planes need to be explicitly drawn!!!



EM Based Extraction

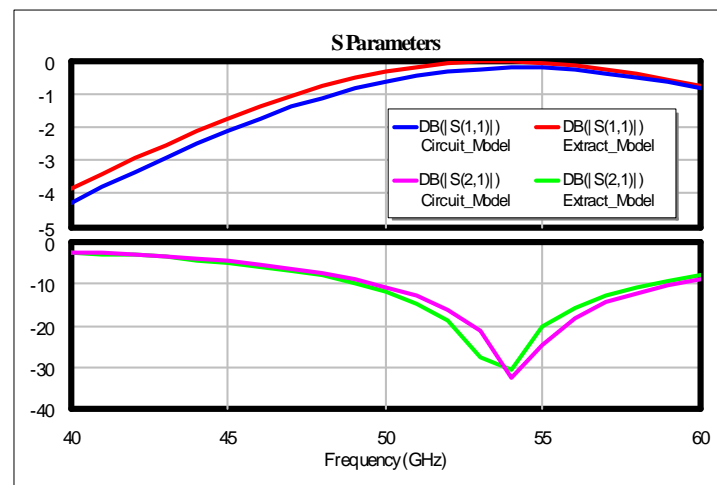
- With and without EM extraction ...

EM view



Without EM extraction

With EM extraction



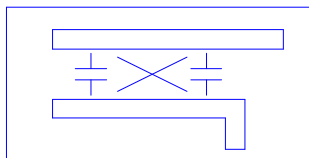
Layout view

- Circuit Based extraction
 - What does this mean?
 - What is the role of the EXTRACT element?
 - What is the role of the STACKUP element?
- When any of the following problems are suspected switch to an Circuit Based extracted model
 - When the non-critical tracks have been created using iNETs
 - When critical tracks modelled with MLINs are close enough that coupling is suspected
 - When critical tracks modelled with MLINs, MTRACEs etc are close to non-critical tracks

Circuit Based Extraction

- The EXTRACT element (used with CBE)
 - Is responsible for defining the extraction rules
 - Number of lines that are considered to be coupled
 - The maximum distance between line to consider before lines are ignored
 - The maximum space to length ratio to consider

EXTRACT
ID=EX1
EM_Doc="CBE_Doc"
Name="CBE_One"
Simulator=ACE
X_Cell_Size=0.0025 mm
Y_Cell_Size=0.0025 mm
STACKUP=""
Override_Options=Yes
Hierarchy=Off



Element Options: EXTRACT - Extraction Control Block Properties

General Frequencies Mesh Interpolation/Passivity SPICE Model Generation **ACE** Parameters Symbol

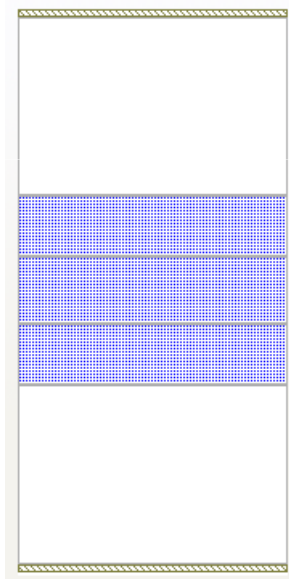
Reset Defaults

Discontinuities	
Extract Discontinuities	Yes
Extract Crossovers	Yes
Calculation Method	Planerized
Remove Short Lines	Yes
Min L/W Ratio	0.25
Coupling	
Extract Coupled Lines	Yes
Max Coupled Lines	20
Max Coupled Dist. (mm)	3
Max S/L Ratio	10
Model Preferences	

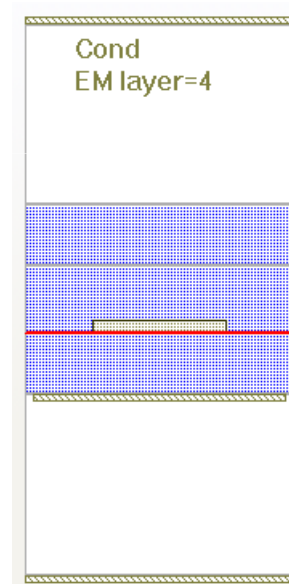
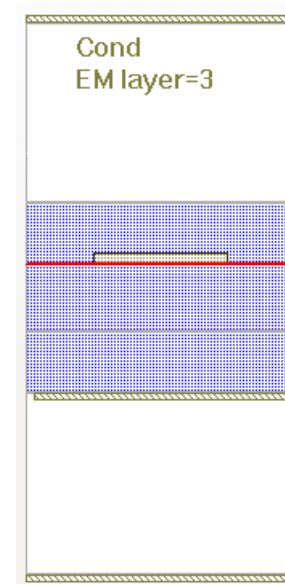
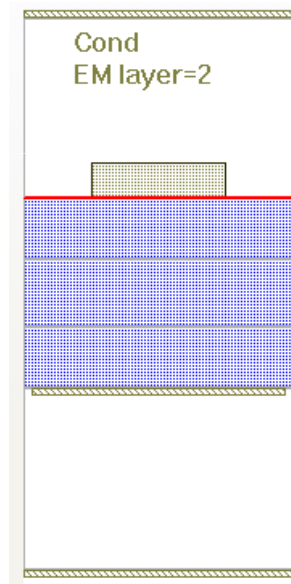
Max Coupled Dist. (mm)
Maximum coupled distance

Circuit Based Extraction

- The STACKUP element (used with CBE) defines ...
 - the dielectric stack (identical to the EM based approach)
 - the conductor layer and associated ground planes



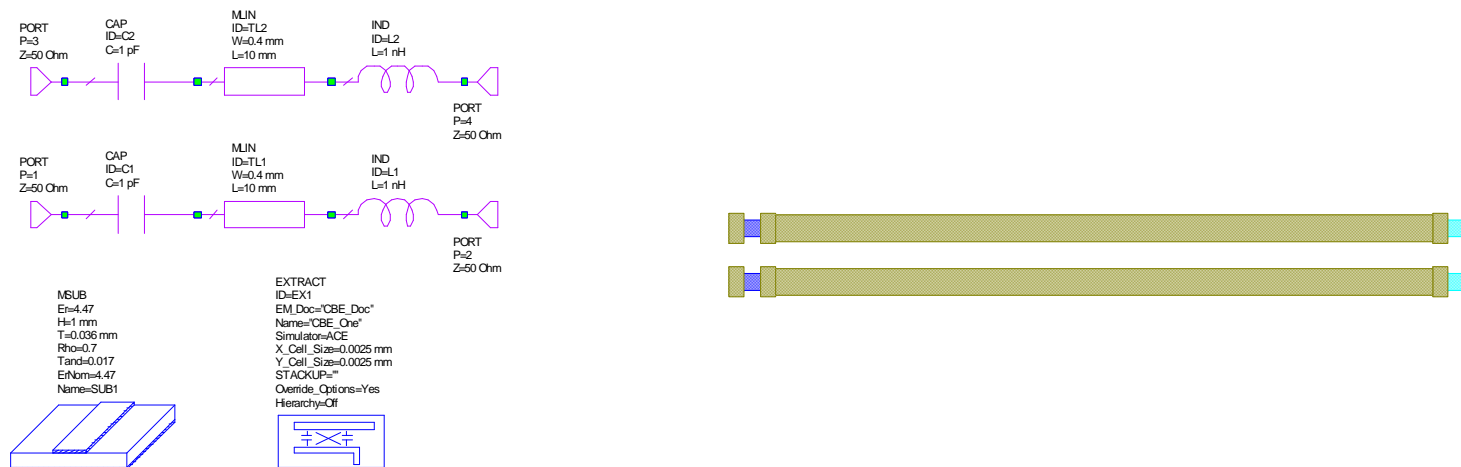
dielectric stack



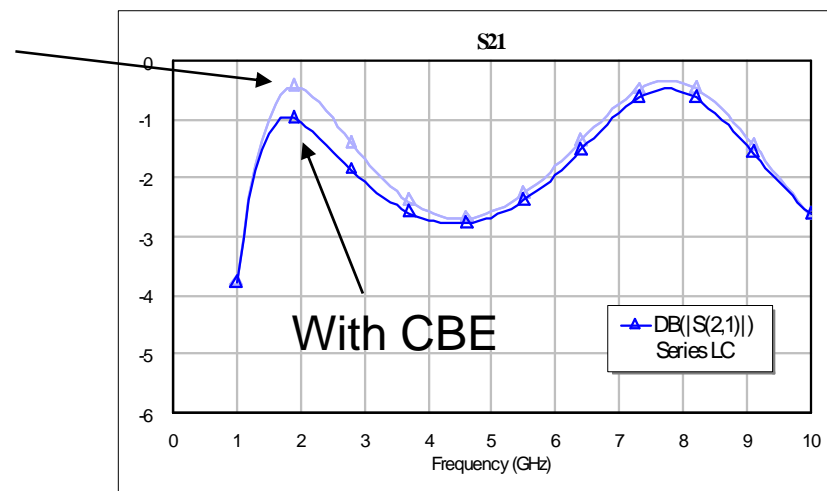
conductor layers

Circuit Based Extraction

- With and without CBE ...

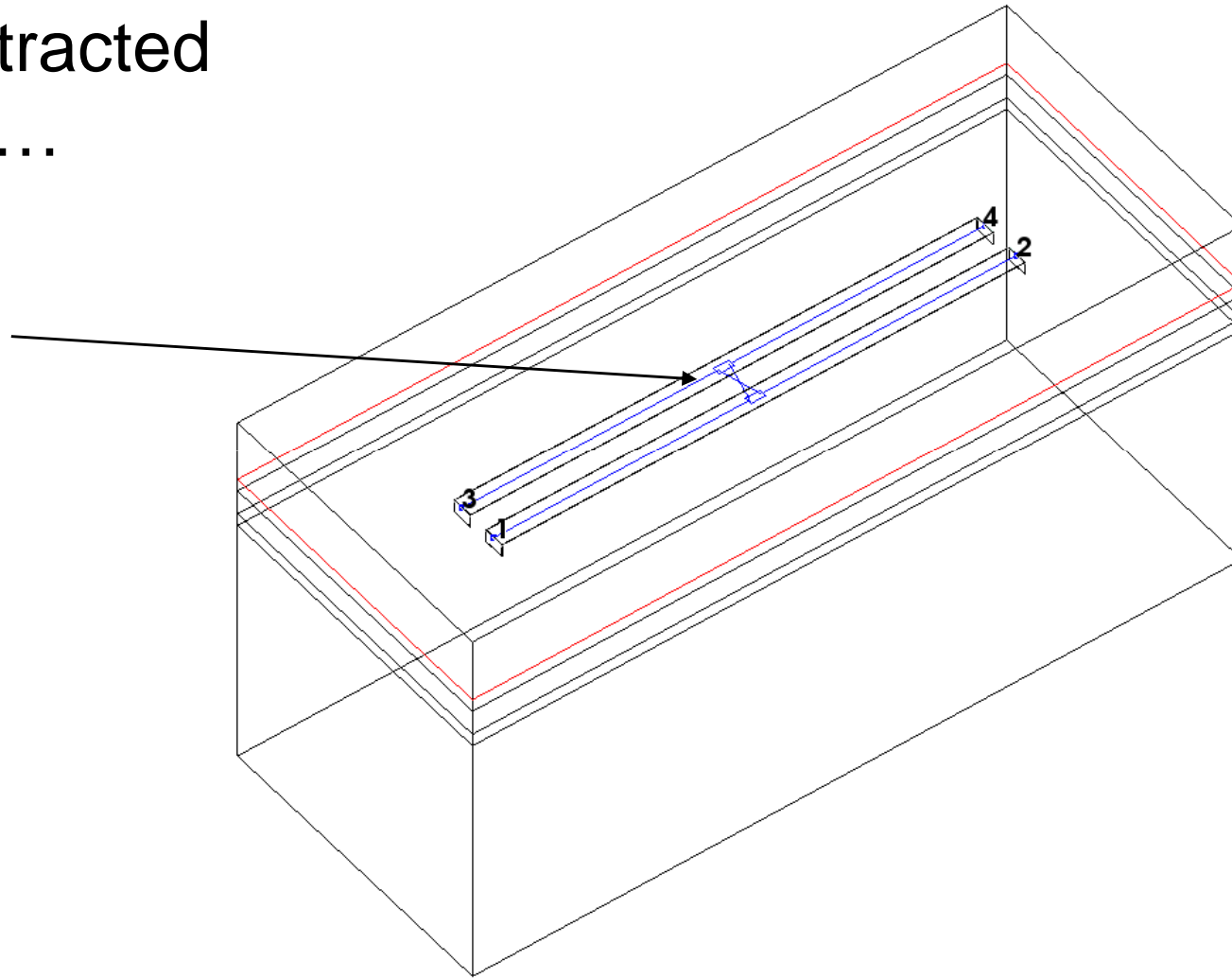


Without CBE



Circuit Based Extraction

- The extracted model ...



The coupling between tracks has been accounted for