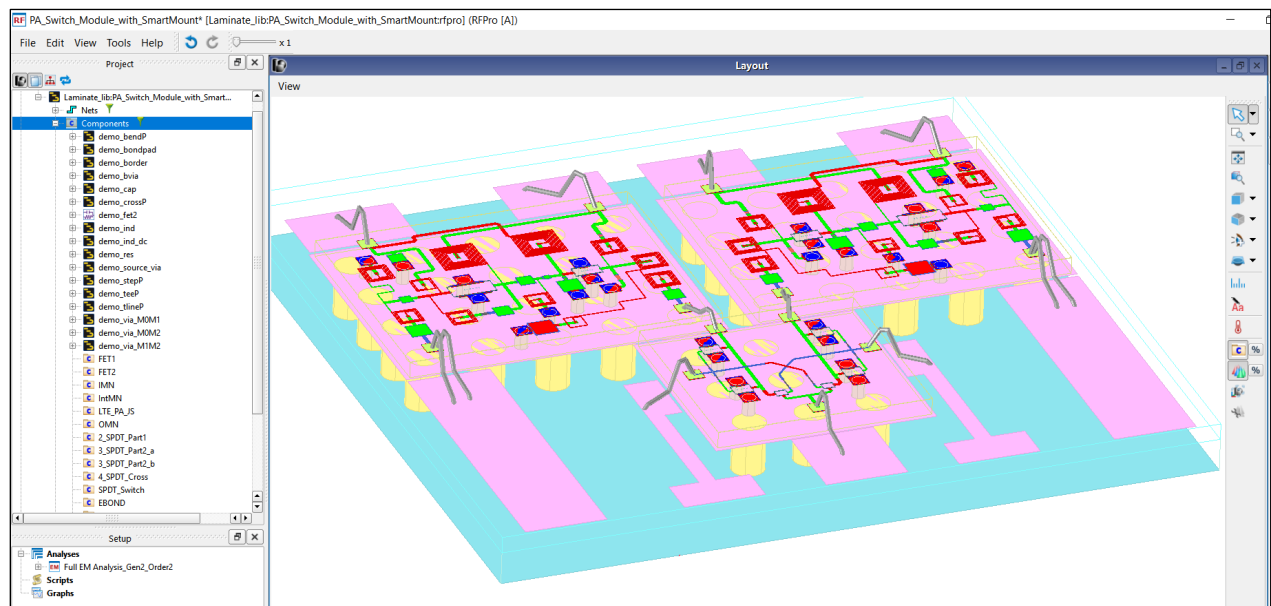
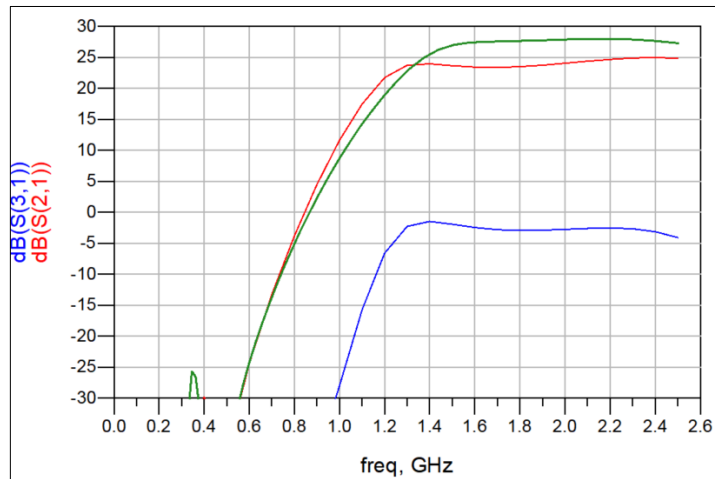
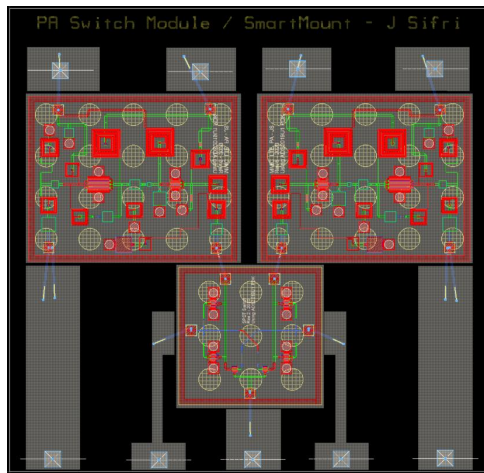


Hands-on Workshop – Short version

Smart_Mount and RFPro



Smart_Mount/RFPro Workshop

We want to build a Two-PA's/Switch Module on a two-Layer Laminate Board

- Board Two-Layer Laminate Board
- IC #1 LTE MMIC PA
- IC #2 LTE MMIC PA
- IC #3 SPDT MMIC Switch
- Design kit used: DemoKit_Non_Linear_v2.0

This is the 2-layer Laminate board (Fig1a and Fig1b) - The gray area is the top metal layer, pc1

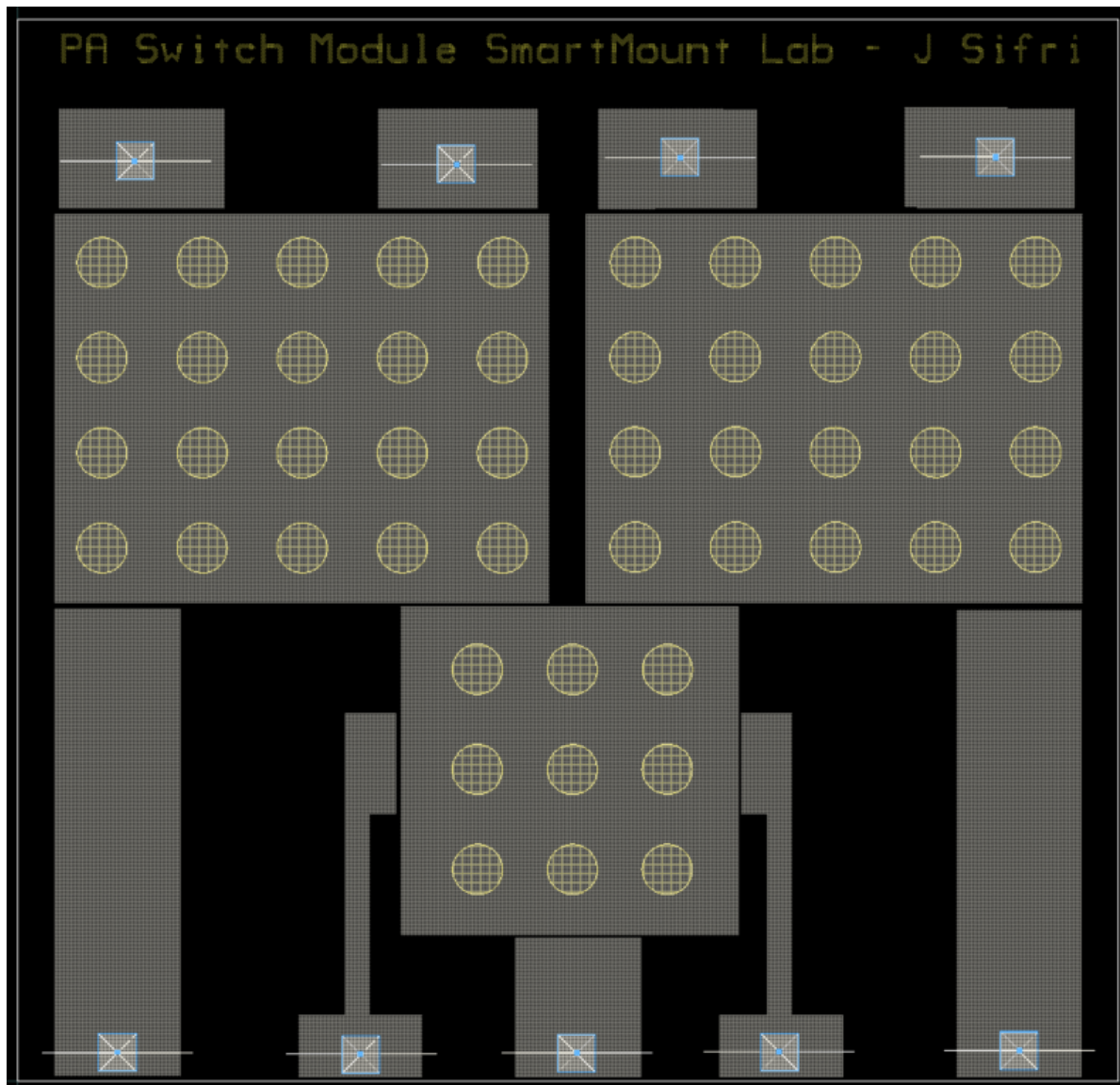


Figure 1a: Laminate Board with 3 Pedestals to place 2 MMIC PA's and a Switch

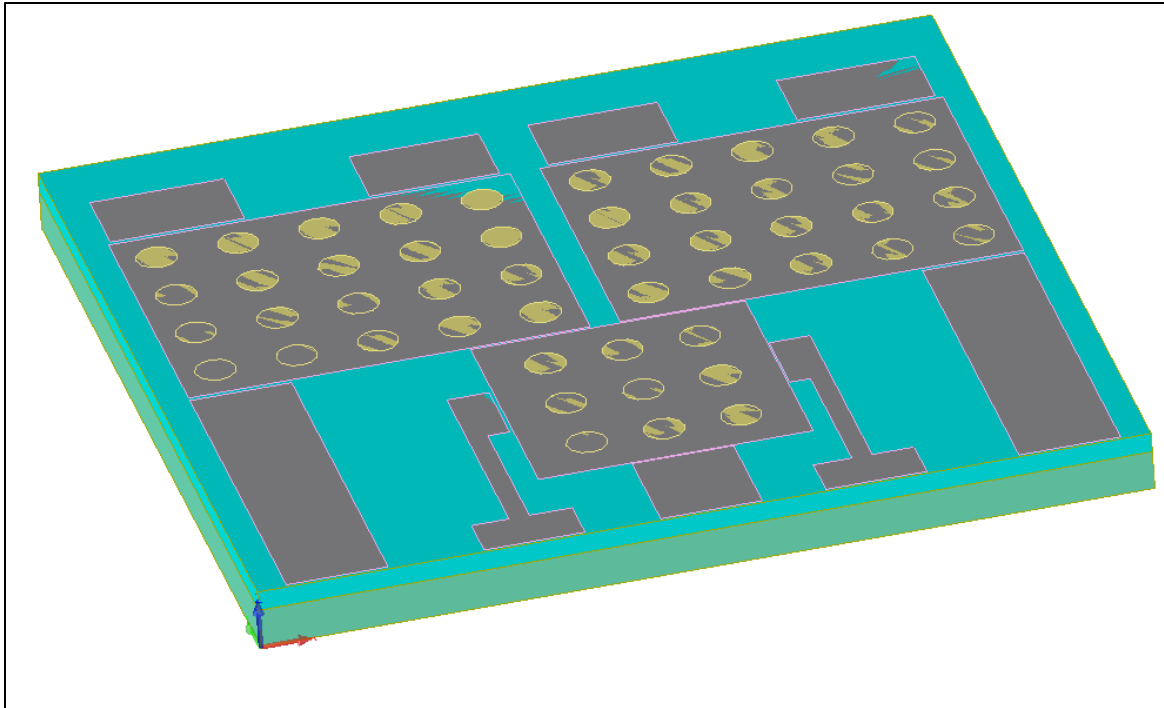


Figure 1b: Laminate Board with 3 Pedestals to place 2 MMIC PA's and a Switch

From the main ADS window, I used the “Manage Libraries” from the DesignKits pull down menu item (Fig 2a) to import the MMIC PA and Switch and Design Kit. This has been already done for you in this Lab (shown in Figure 2b).

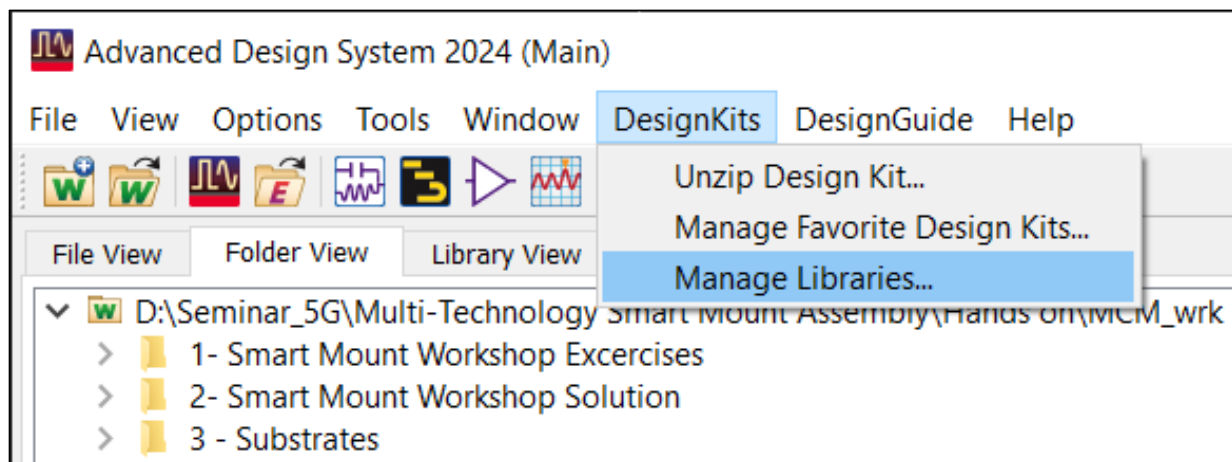


Figure 2a – From Mange Libraries you can import and include designs in your workspace to build the whole Module.

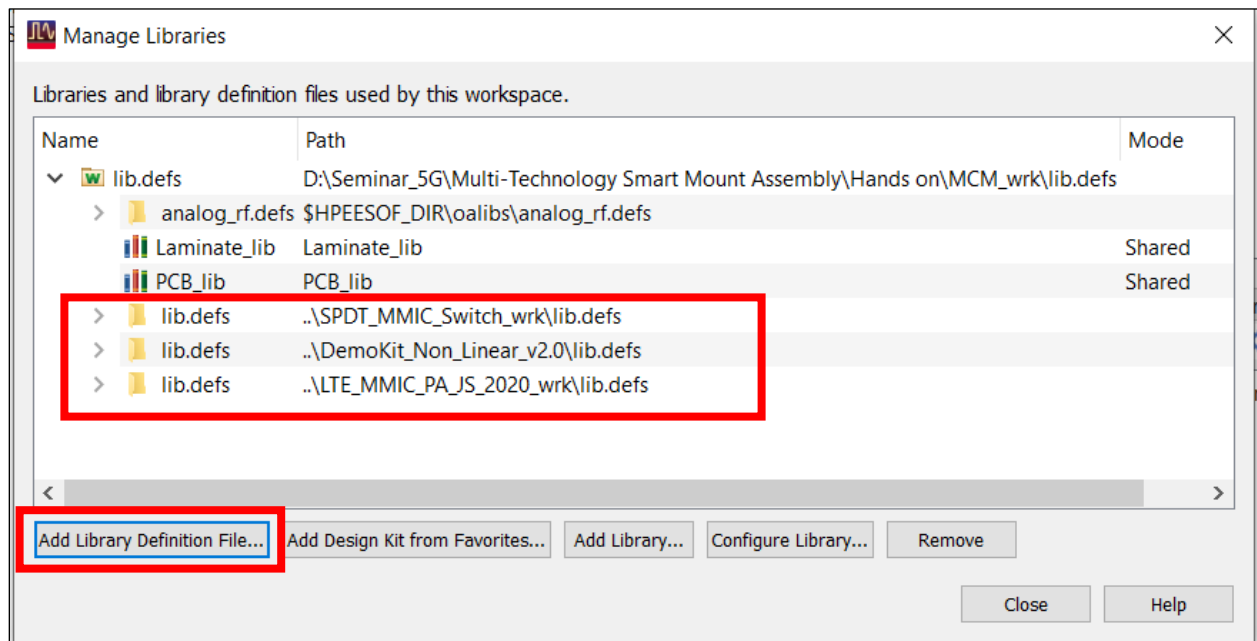


Figure 2b – Using “Add Library Definition File”, the MMIC Switch and PA and PDK were imported into this workspace as shown.

Here is our Plan to build the whole Module:

First we start with the Laminate board Layout (shown in Fig 1a and 1b) and then add/place the two PA’s and the Switch onto the pc1 layer of the board as shown on Figure 3. The IC’s will be placed on the top conductive pc1 layer (you can see this pc1 layer in Figure 4 – the substrate stack-up).

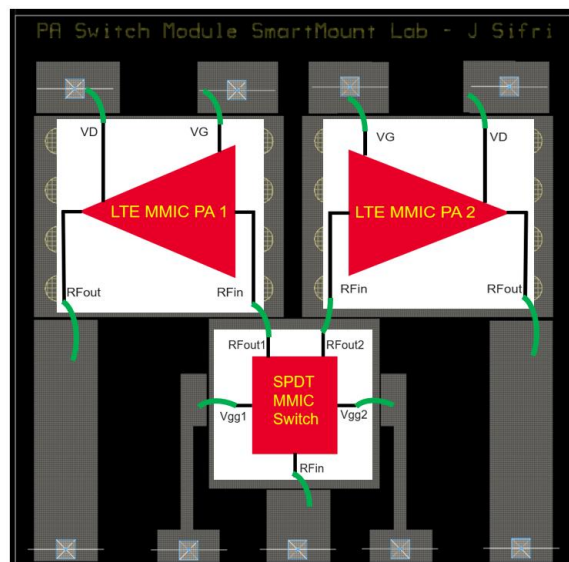


Figure 3: Placing three ICs on the Board and make Bondwire connection (shown in Green)

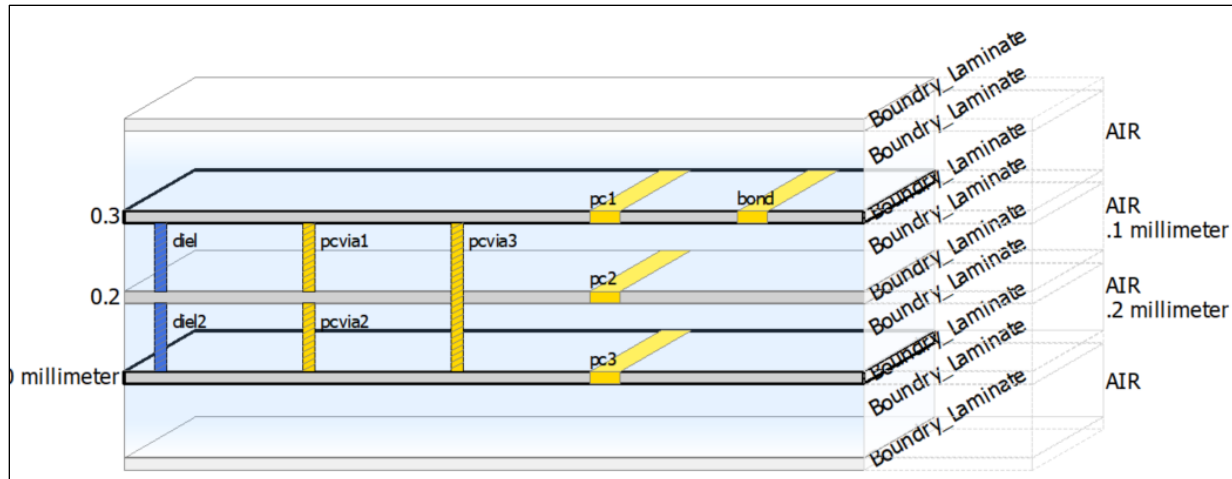


Figure 4: Substrate Stackup. Pc1 is the top conductive layer; pc3 is the Ground layer.

Building up the Module with Smart Mount

STEP #1 – Creating a tech.subst

We must create tech substrates (tech.subst) for all the designs

Two ways to create tech substrates:

1. Open the Layout; click “3” to launch the 3D view; ADS creates it for you

“OR”

2. Open the Layout; Click on Options/Technology/Edit Stackup (tech.subst)...

STEP #2 – Setting up the Designs’ layouts for Smart Mount

Default Setting for the whole Library:

For the IC’s (PA and Switch) which will be placed on the Board, open their Layout pages and Click on Options/Technology/Nested Technology from the pull-down menu.

Select Smart Mount as the default technology for the whole library as shown in the figures 5a and 5b below:

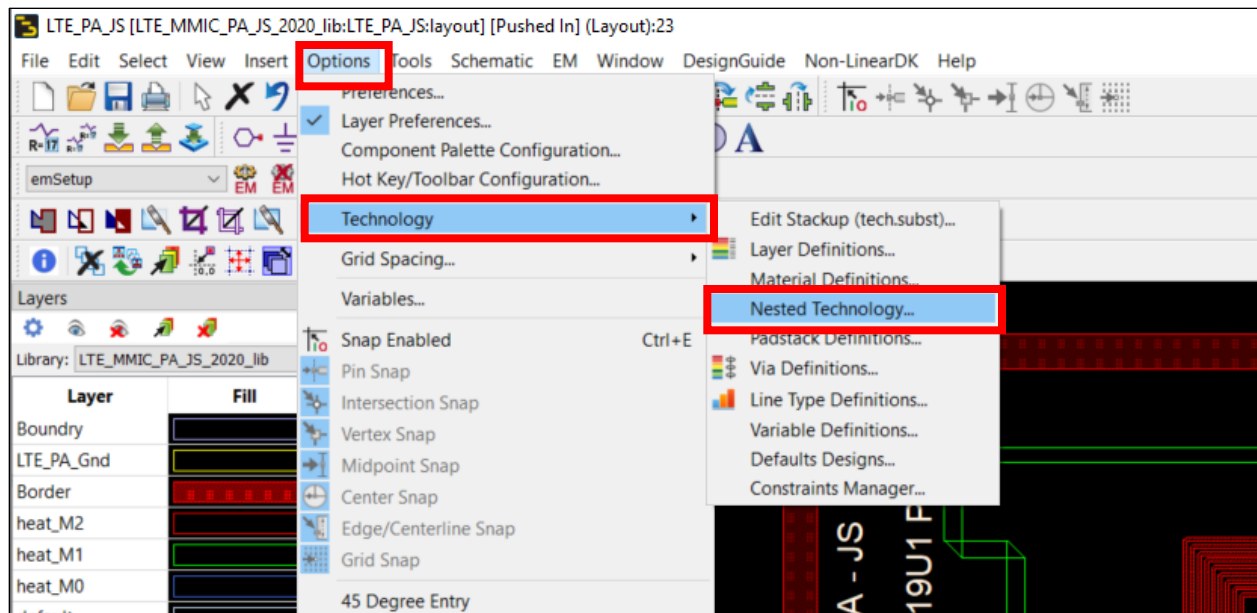


Figure 5a: Smart Mount Setup for the entire library

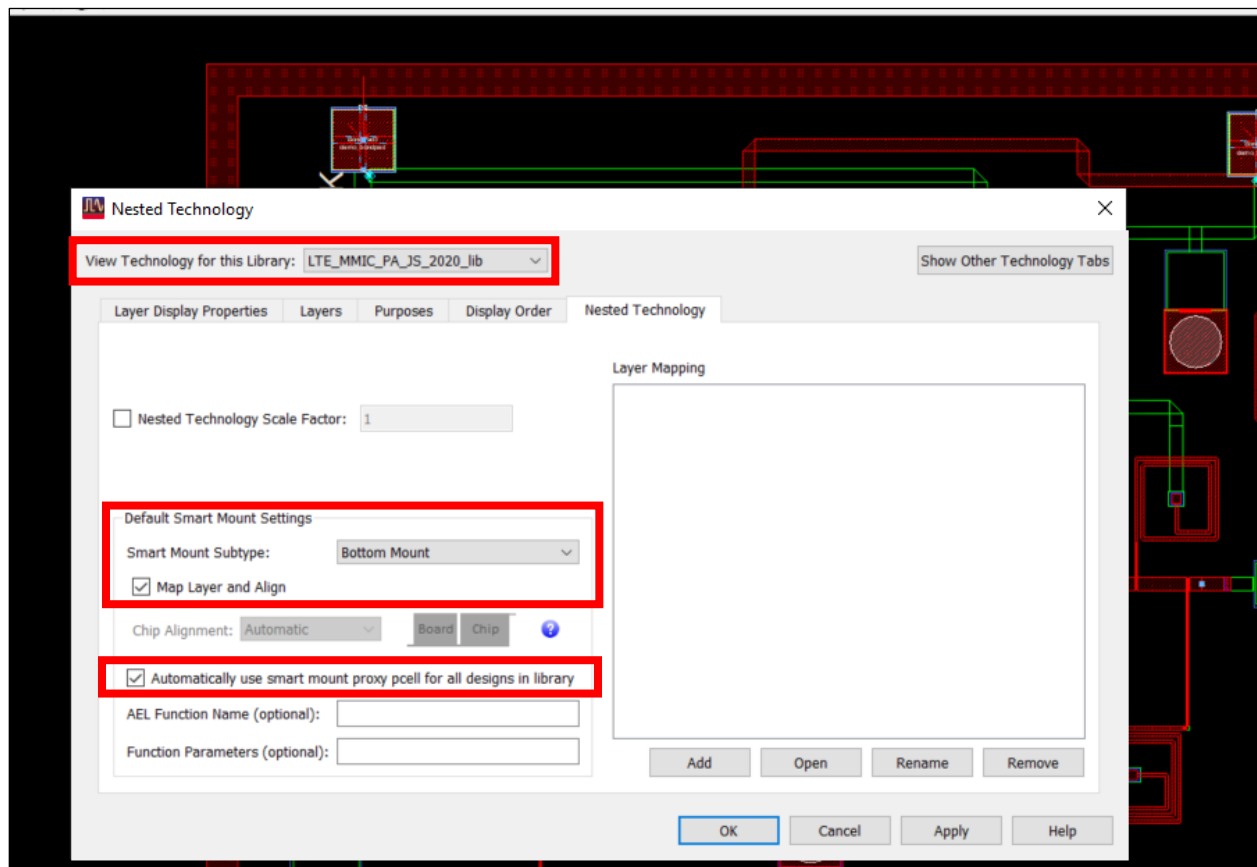


Figure 5b: Smart Mount Setup for the entire library

STEP #3 – Inserting the MMIC designs onto the Board

Drag and drop the designs onto the Pedestals and align them to fit on the pedestals as shown in figure 6 below.

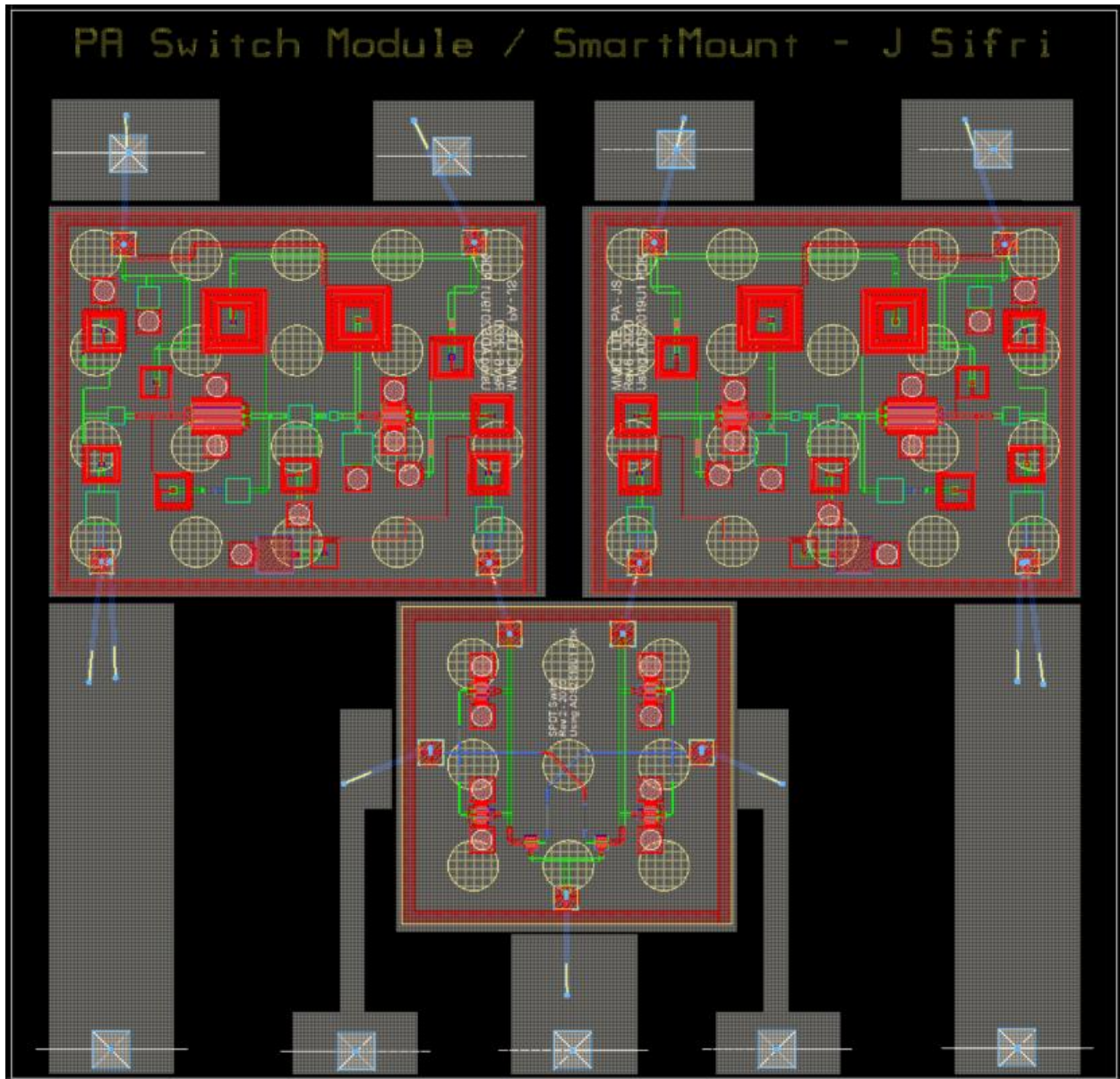


Figure 6: Dragging and dropping the Switch and PA's on the "pc1-layer pedestals" of the Board

Step 4 – Placing the IC's on the right conductive layer

We can vertically position the ICs to be placed on any conductive layer in the z-axis. To place our three ICs on the right conductive Layer (pc1 layer), first select the IC, followed by “right-clicking” the mouse, and then selecting the proper “Mount-Layer” - in our case it is the pc1 layer – as shown in Figure 7a and Figure 7b.

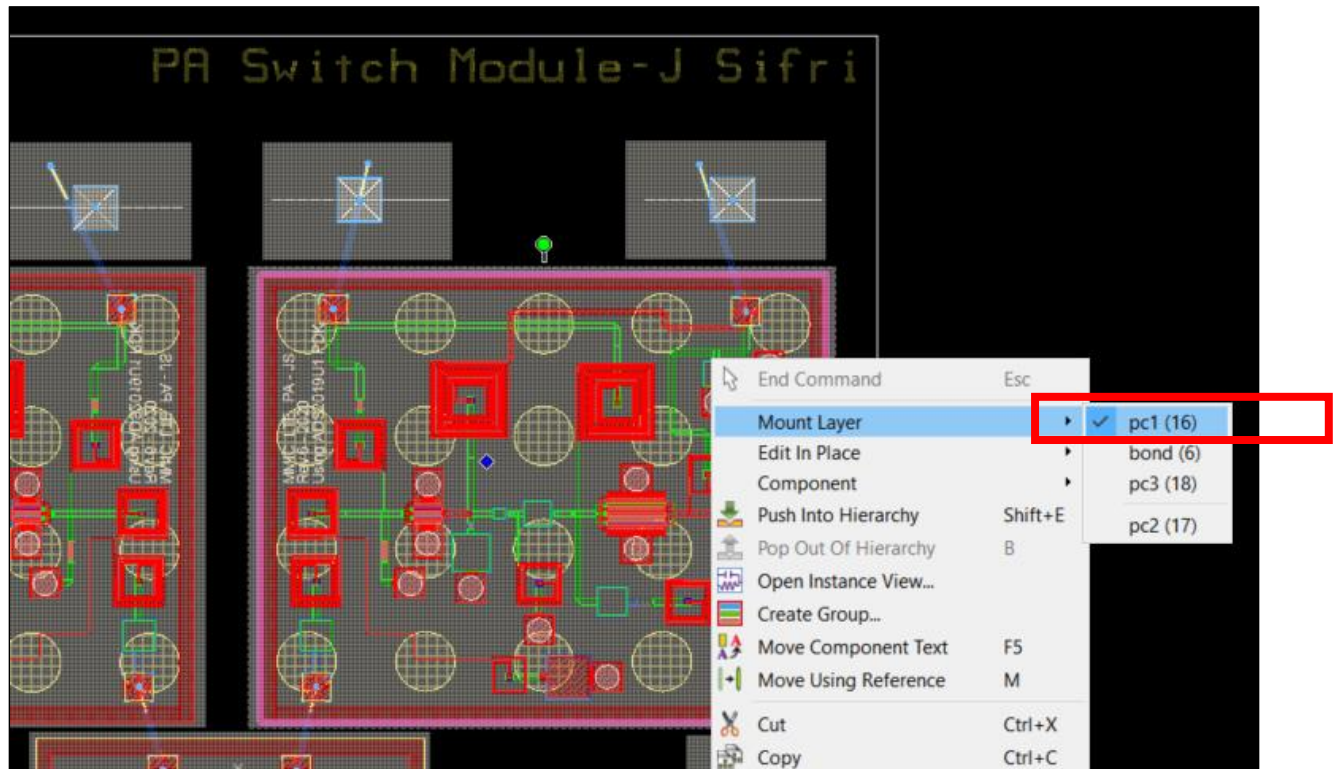


Figure 7a: Select any IC, then right-click the mouse, followed by selecting the proper layer where you want the IC to sit on - in our case it is the “pc1” layer.

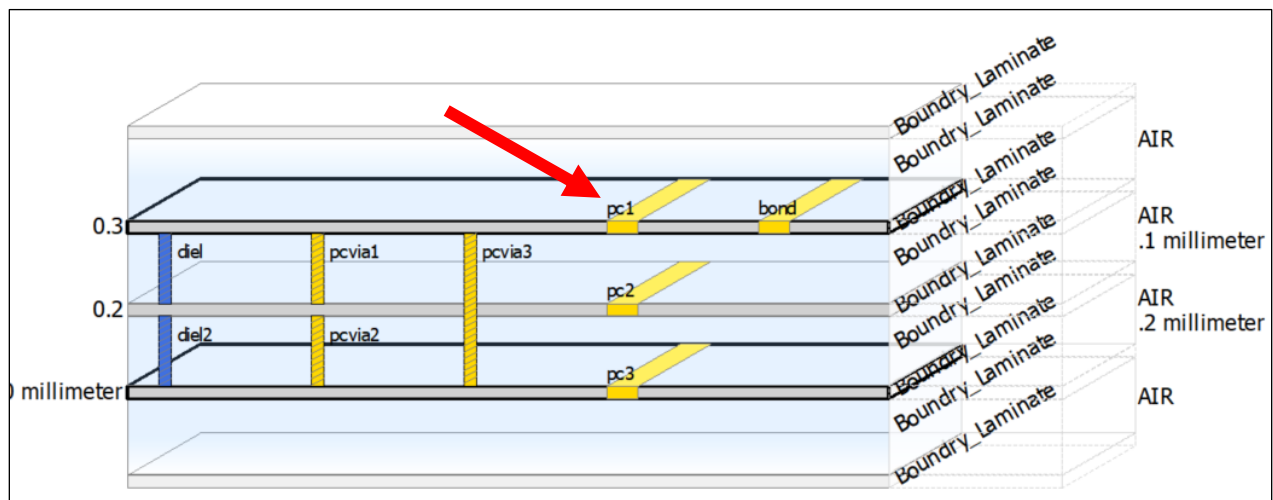


Figure 7b – The substrate stack. IC's will sit on the top “pc1” conductive layer.

Step 5 – Placing the Bondwires

Notice in the Project, IC#1 and IC#2 (the PA's) are named X1 and X2

IC#3 (the switch) is named X3 as shown in Figure 8

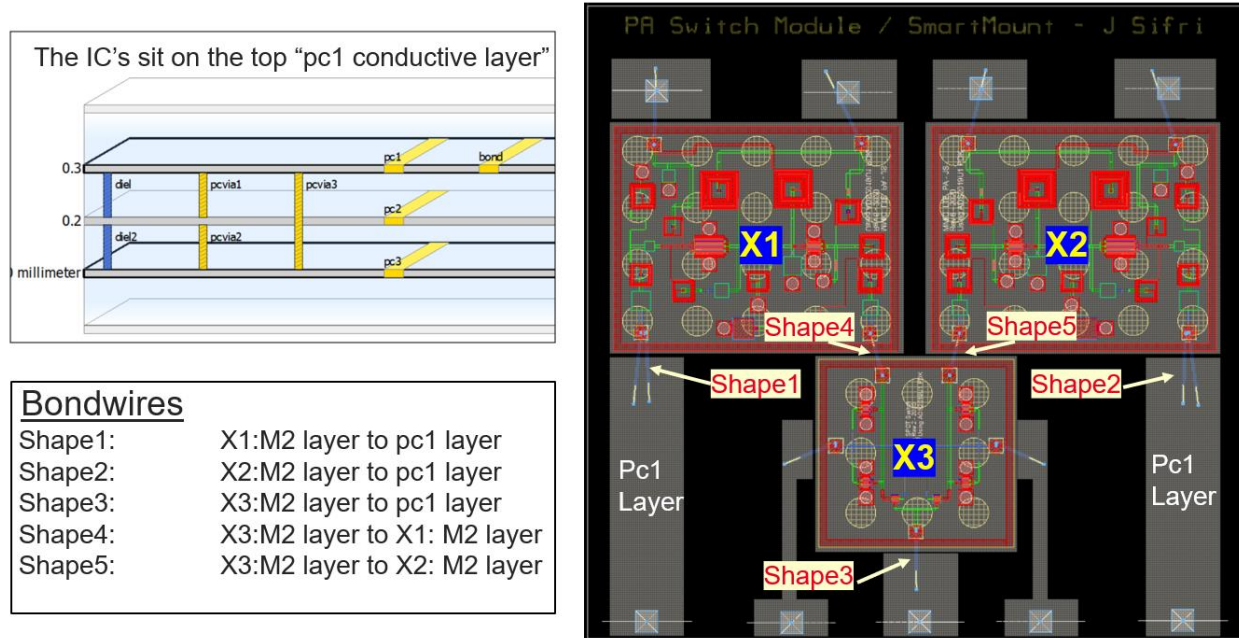


Figure 8- Three ICs (X1, X2, X3) with Bondwire connections. Each Bondwire has a shape associated with it.

From the Insert Pull down menu, Insert a Bond wire. Start the Bond wire from the pad at the MMIC and end the Bond wire on the pad at the Laminate Board.

Some Bondwires start from the MMIC pads and end at the Laminate pads and could have different height offset. Other Bond wires start from the MMIC pads and end on the MMIC pads and their shape will be of equal heights at both ends as shown in Figure 9.

Therefore, each bond wire placed must be associated with a shape. Figure 9 displays for you an example for Shape1 and Shape4

- Shape1 EBOND starts at "X1:M2:drawing" on the MMIC and ends at "pc1:drawing" on the laminate board - as shown on the figure below
- Shape4 EBOND starts at "X3:M2:drawing" on the MMIC Switch and ends at "X1:M2:drawing" on the MMIC PA – as shown on the figure below

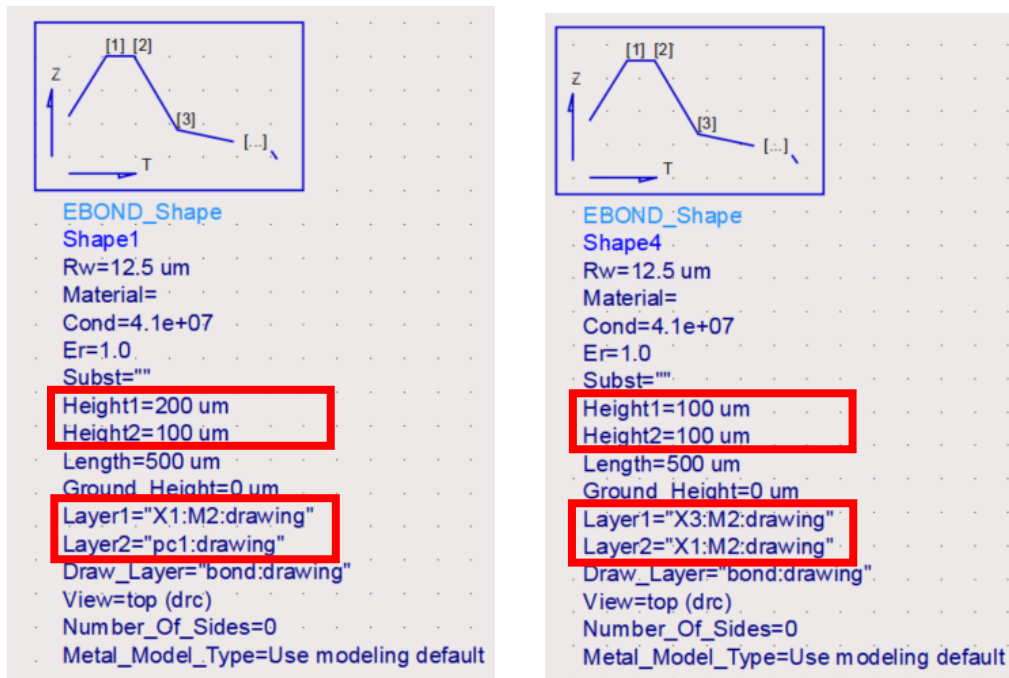


Figure 9 - Sample Bondwires setup for Shape1 and Shape4

To see all Five shapes setup schematic, open the schematic of the MCM module Layout page. One way to quickly open the schematic is to click on Windows/Schematic from the Top Pull down menu items as shown in Figure 10 below.

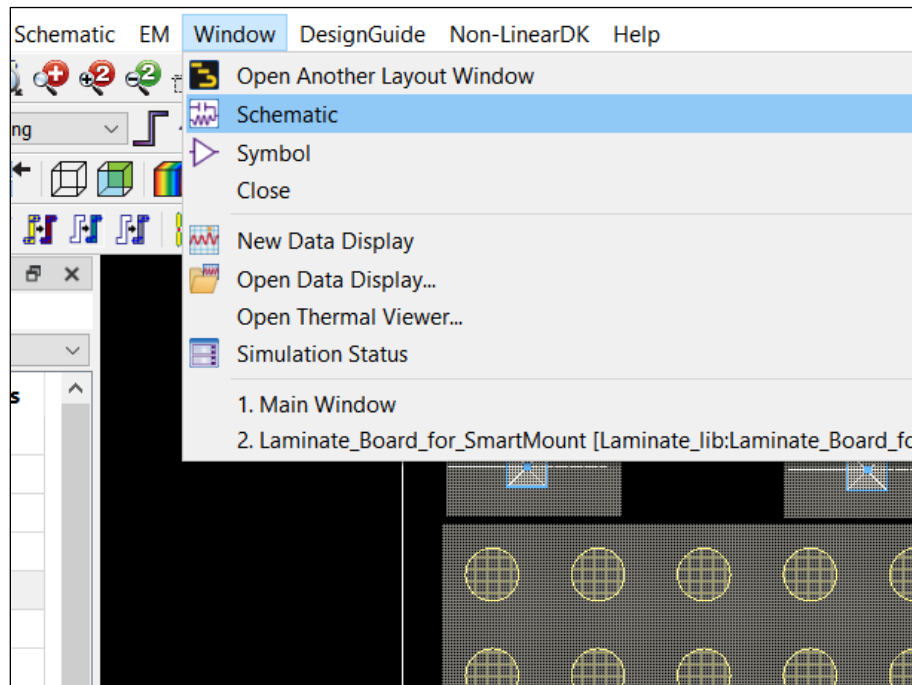


Figure 10 – Opening the schematic page from the Layout page.

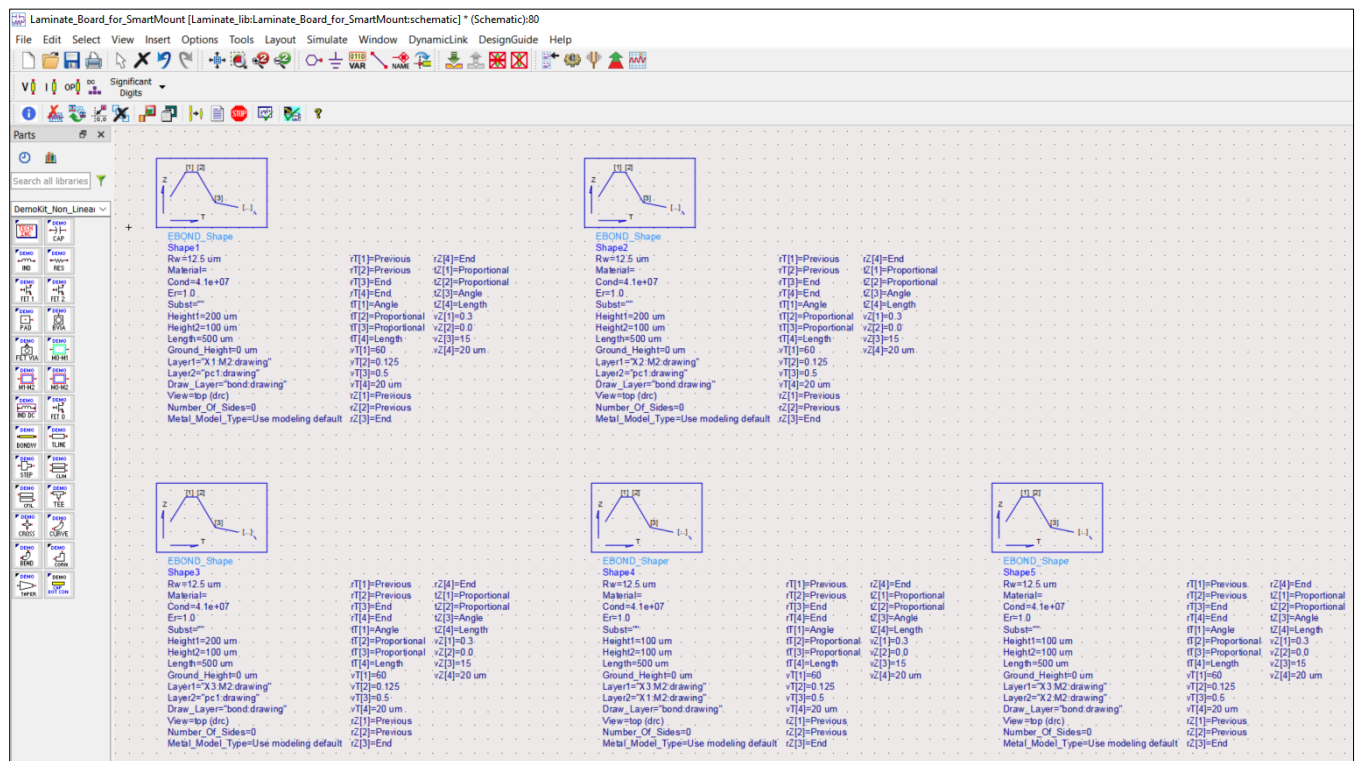
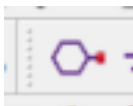


Figure 10b – MCM Layout schematic page shows the 5 different Bondwires shapes used in the Layout to connect various ports on the whole module

Step 6 – Defining the Ports for FEM Simulation

FEM simulation require RF and DC pins with reference grounds.

To insert a pin, just click on the pin icon on the tool bar



I have already included all pins on the layout provided to you in this exercise.

For example, Look at Figures 11a and 11b below:

the RF_In Rectangular area Pin of .15 mm X .15 mm is on the pc1 layer.

Its reference Ground pin RF_In_Gnd is on the pc3 layer.

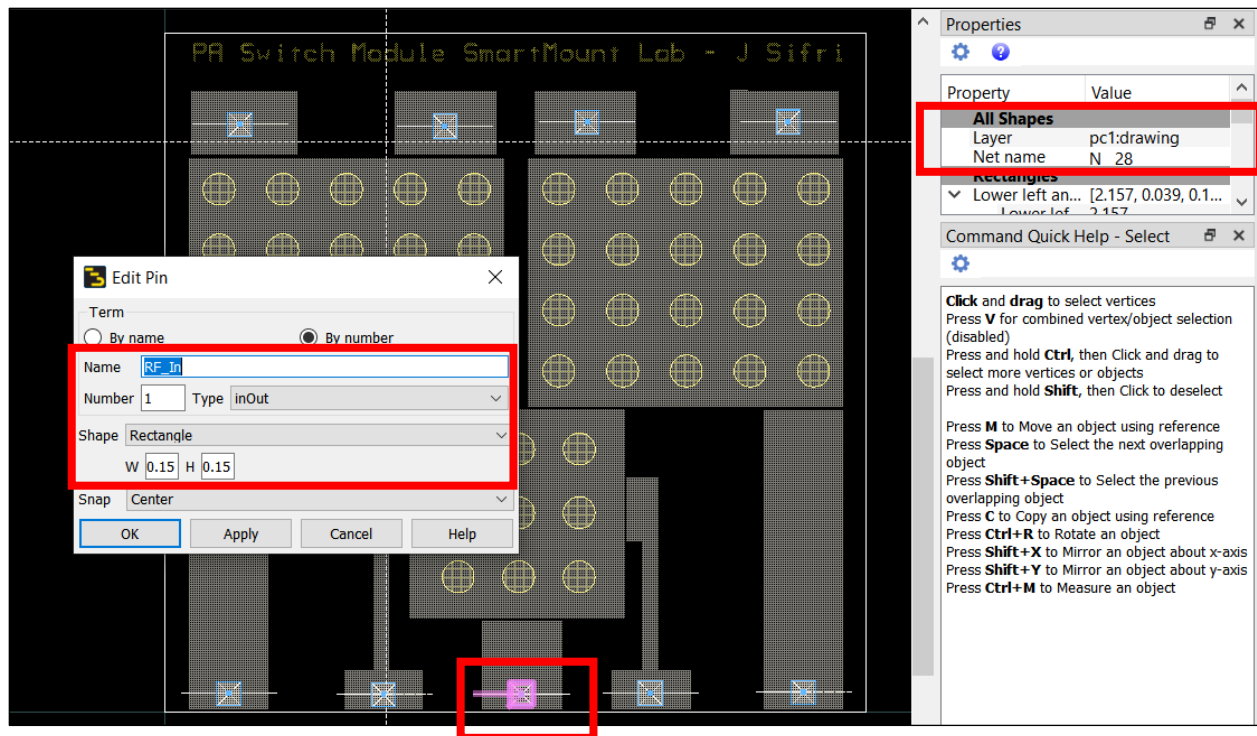


Figure 11a- RF_In area pin is on the layer pc1

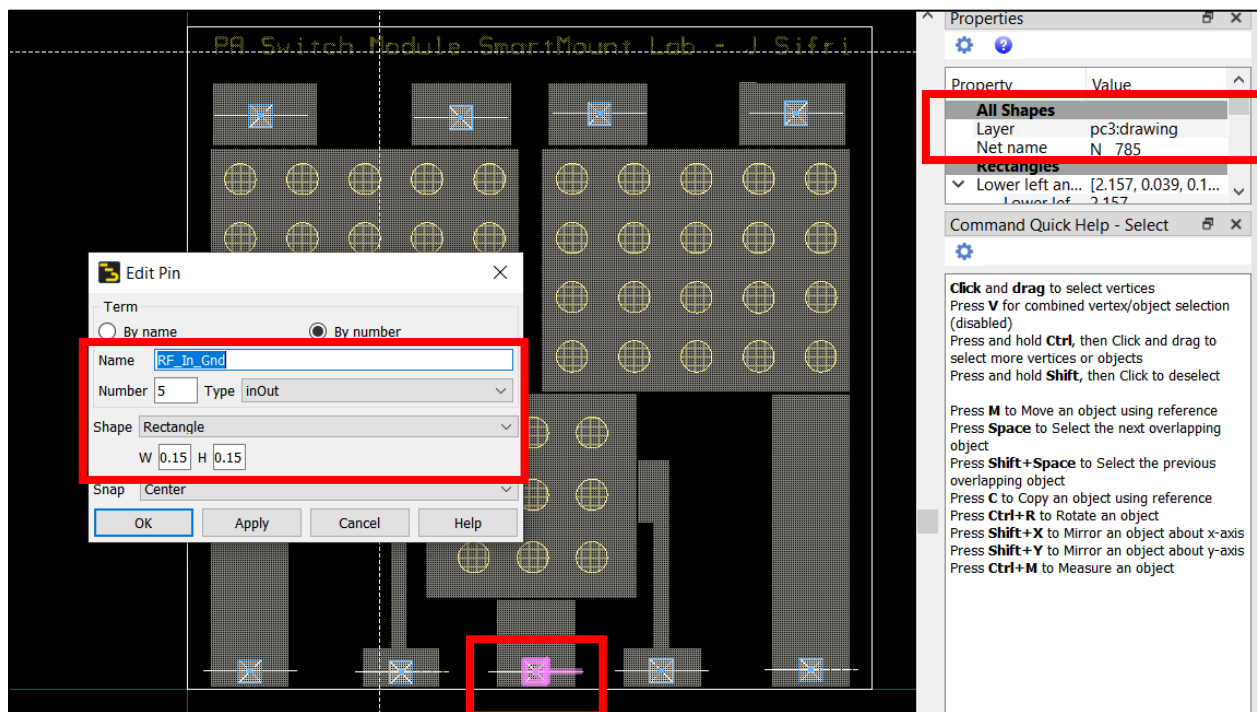


Figure 11b- RF_In_Gnd area pin is on the layer pc3

Step 7 – Launching RFPro for FEM Simulation

From the Tools menu,

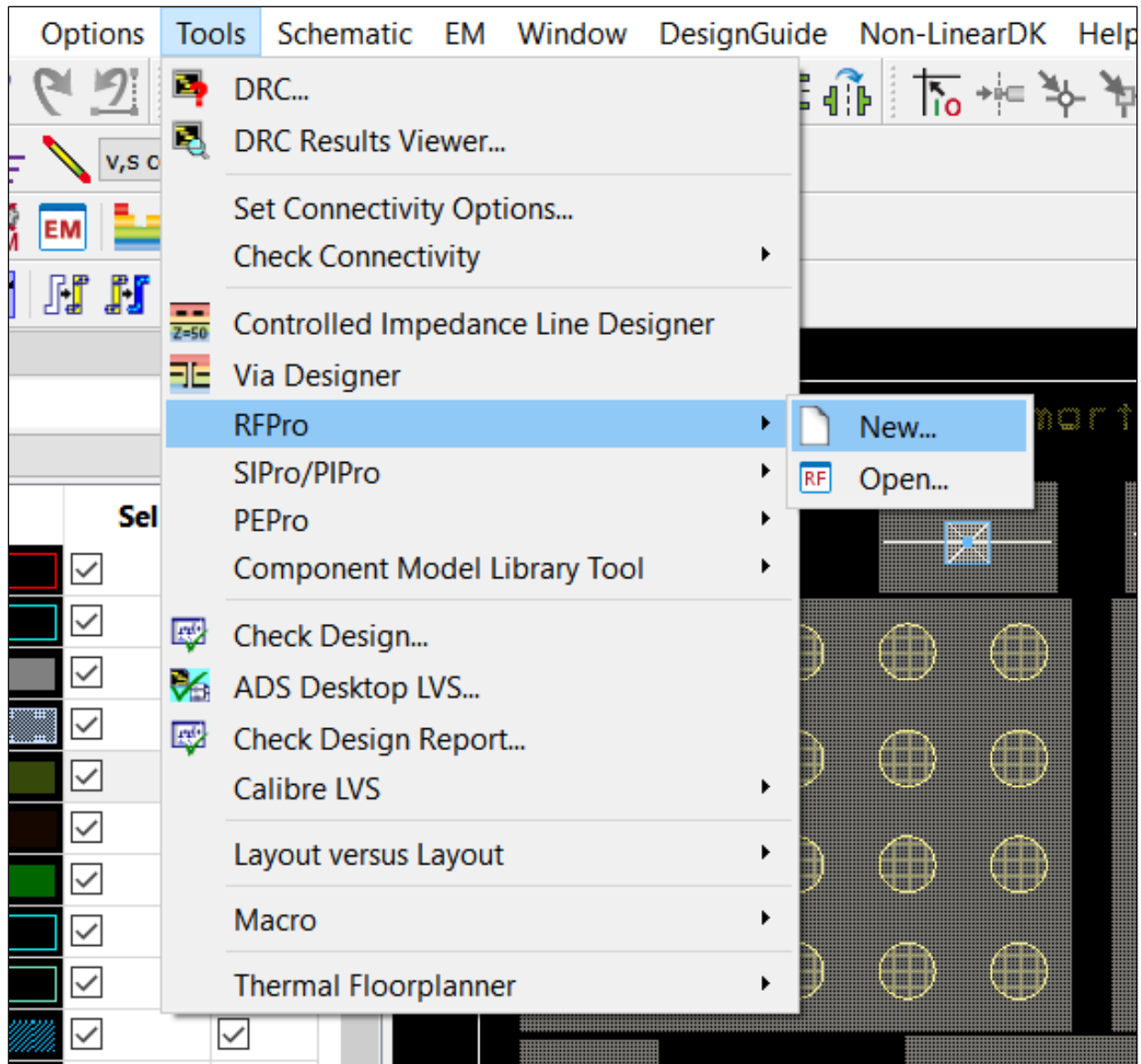


Figure 12a – Launching RFPro from the Tools menu in the Layout page

Make sure the Substrate used is the tech.subst you have generated in Step 1 above, as shown below in Figure 12b.

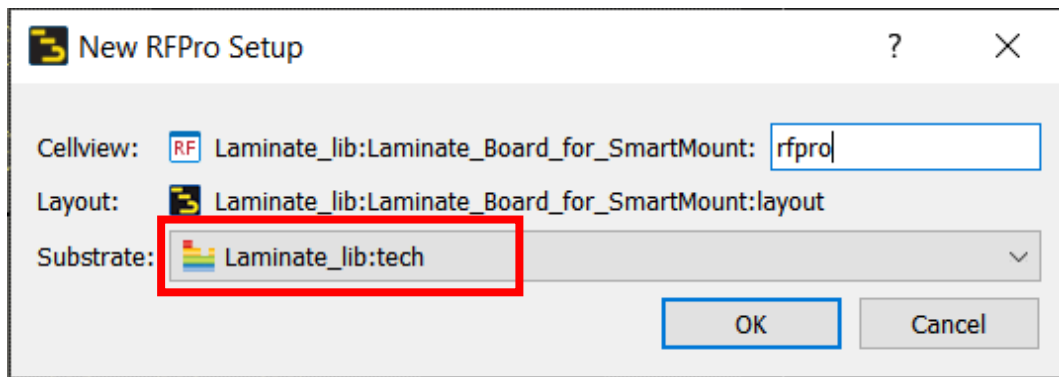


Figure 12b –Cellview name “rfpro” and must use substrate “tech. subst” in the simulation

RFPPro will automatically assemble and display all the design. Make sure that all Layout elements, circuit models elements, and subnetworks are assigned appropriately. If they are not assigned properly and the Layout doesn't show as in the picture of Figure 13 below, just right click the mouse on any element at the left side Components column and change the Role of that element. Notice in Figure 13, the MMIC elements are assigned Layout views for EM simulation and the FET models are assigned schematic view for Circuit Models and the sub designs Networks from ADS Layout are assigned the Role of Subnetwork.

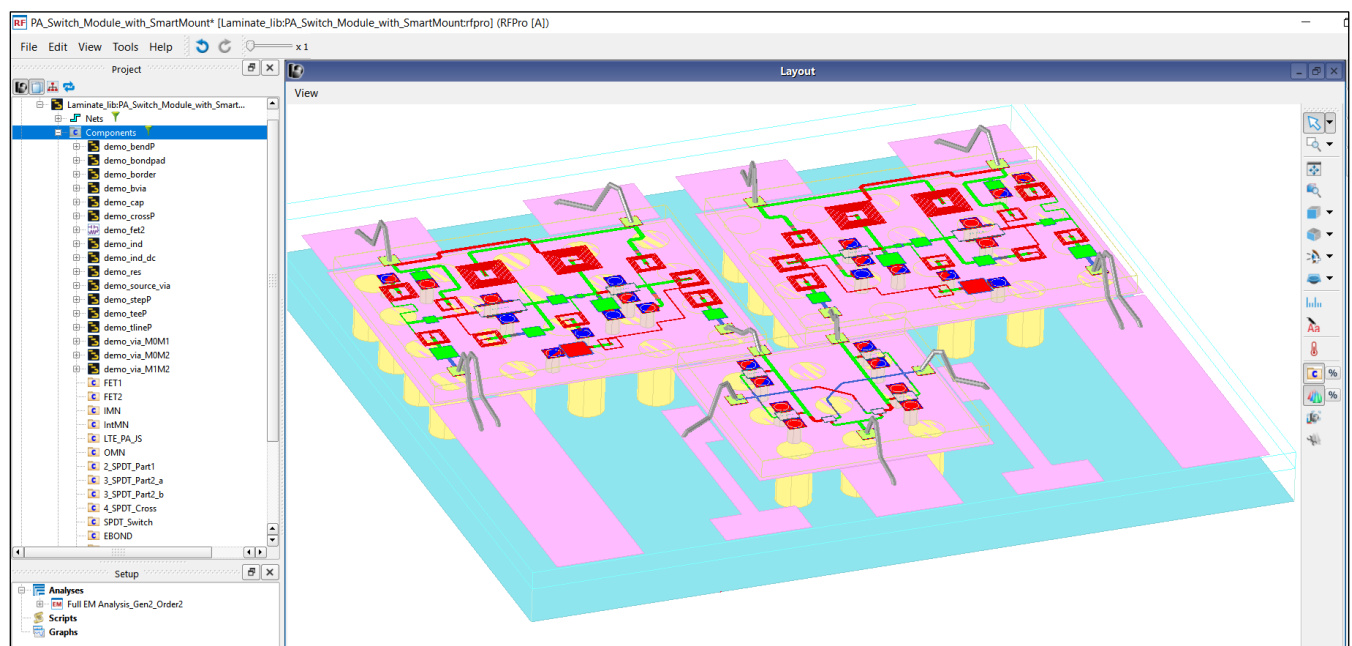


Figure 13 – The Assembly in RFPPro with proper Components Views assignment on the Left Column (Layout View, Schematic View, and Subnetwork view)

Figure 14 below, displays all the Pins in the Layout. There are 9 pins and 9 Reference Ground pins. Each Pin and its reference ground form a port. Drag all the RF and DC pins down in the

Ports section of the analysis and then drag down each reference ground pin and assign it to the proper RF or DC pin to form the Ports.

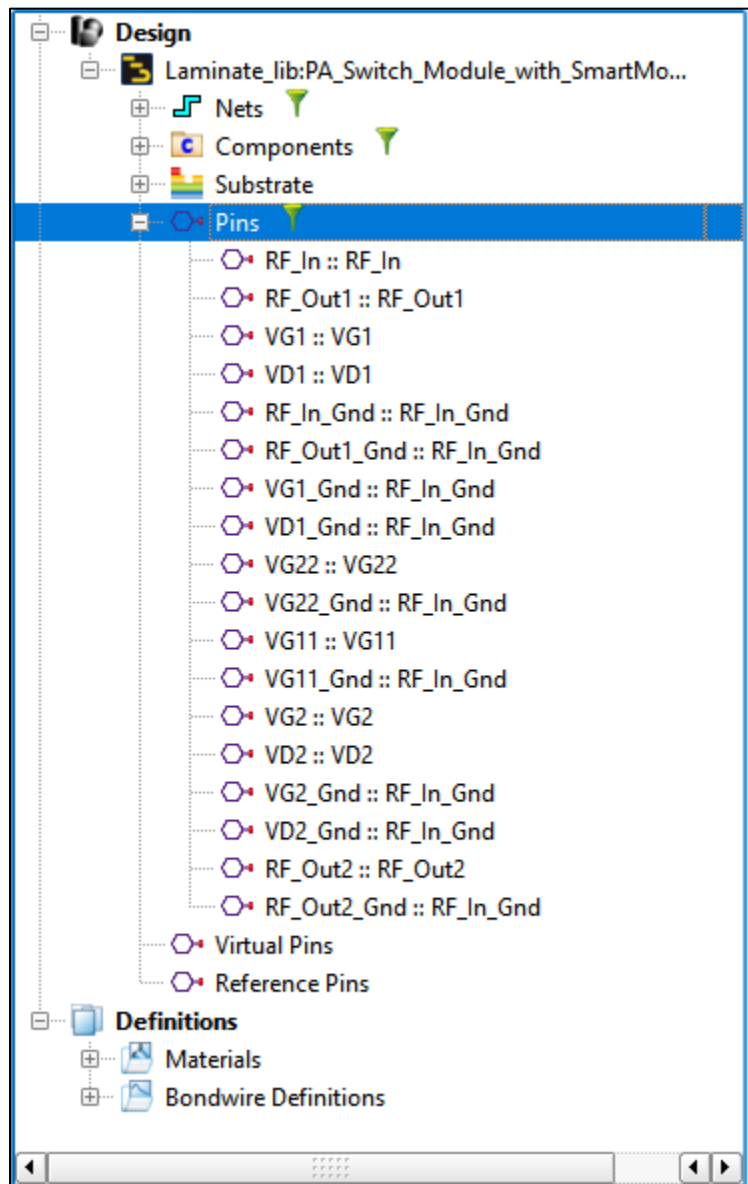


Figure 14 – These are 9 RF and DC pins from the Layout along with their Reference Ground pins. Notice the naming of the pins make it easier to find the Pin name and its Ground reference.

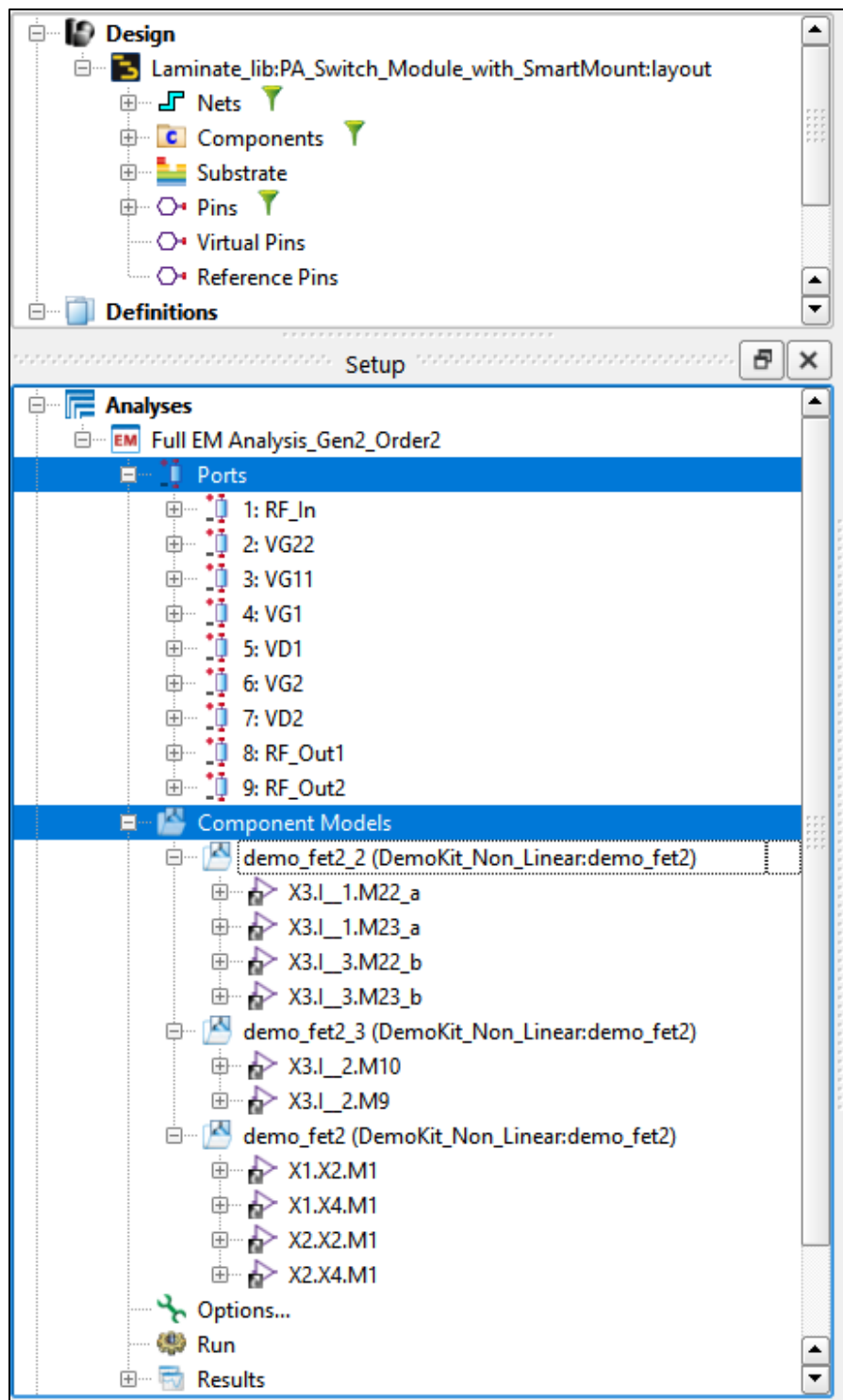
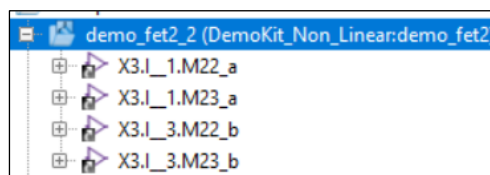
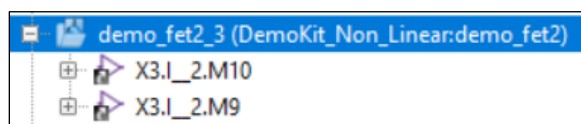


Figure 15 – The Components in the Analysis section are those Circuit models of all the FET devices in the project. By dragging the components down to the analysis section pick up all the Circuit models to be co-simulated with the EM results of the whole module and display the Module simulated results in ADS.

Note: There are two FETs on the switch that has one source connected to interconnect lines and not grounded. Double click on demo_fet2_3 as shown below on the left side and deactivate the S2 pin since it is not used in the Layout. All other FETs are set as shown on the right.



Port Editor

Pin #	Pin Name	Net Type	
1	D	Undefined	1
2	G	Undefined	2
3	S1	Undefined	0
4	S2	Undefined	

Port Editor

Pin #	Pin Name	Net Type	
1	D	Undefined	1
2	G	Undefined	2
3	S1	Signal	3
4	S2	Signal	0

Next click on the options tab to set up the Frequencies and the FEM simulator setup as shown on Figures 16 and 17

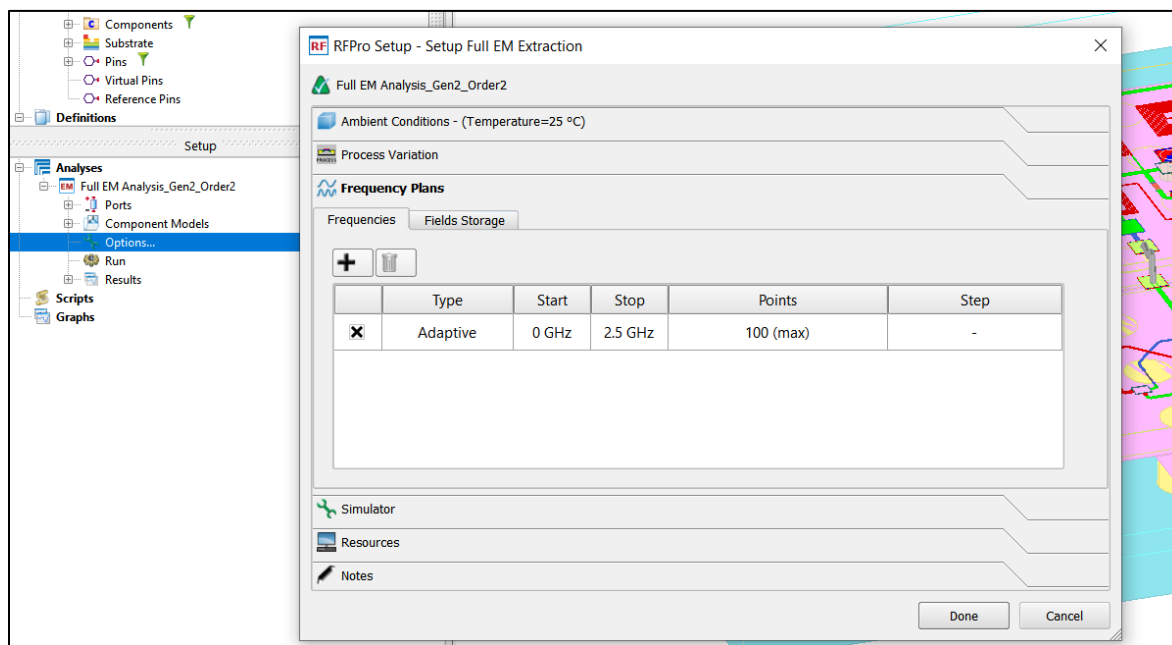


Figure 16 – Setting up the simulation frequencies

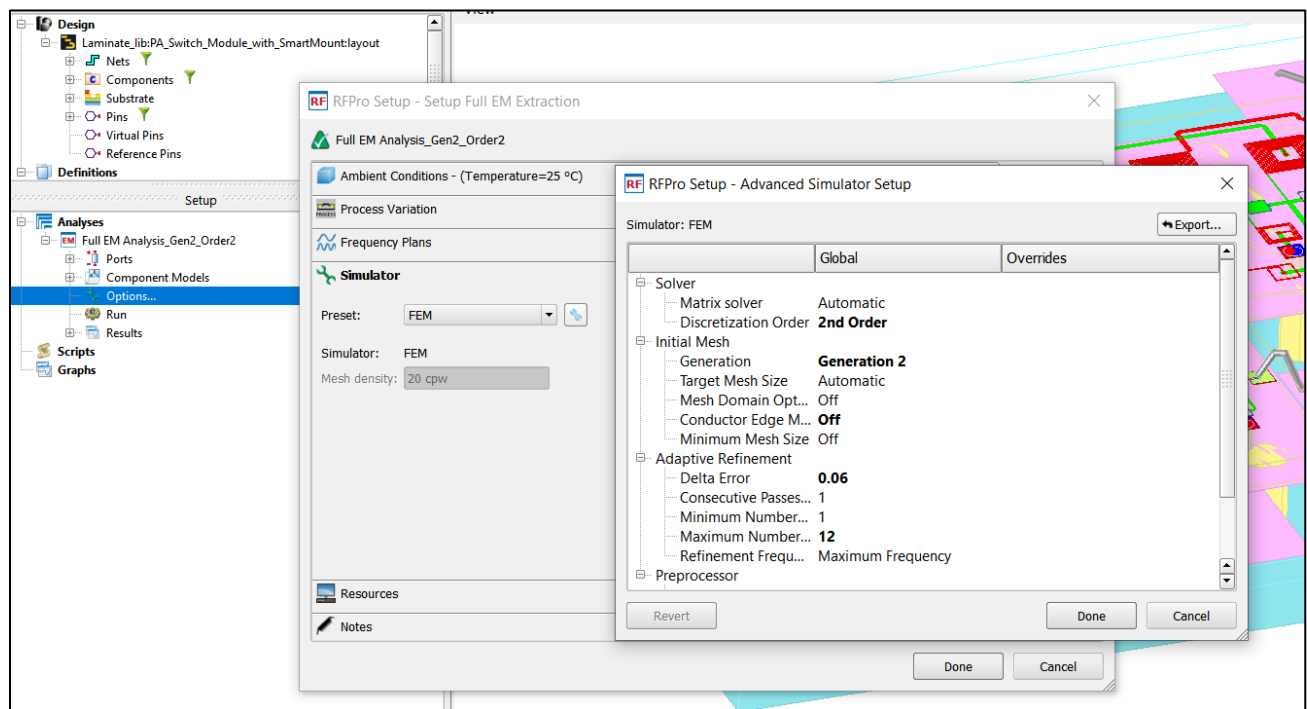


Figure 17- Setting up the FEM simulation parameters

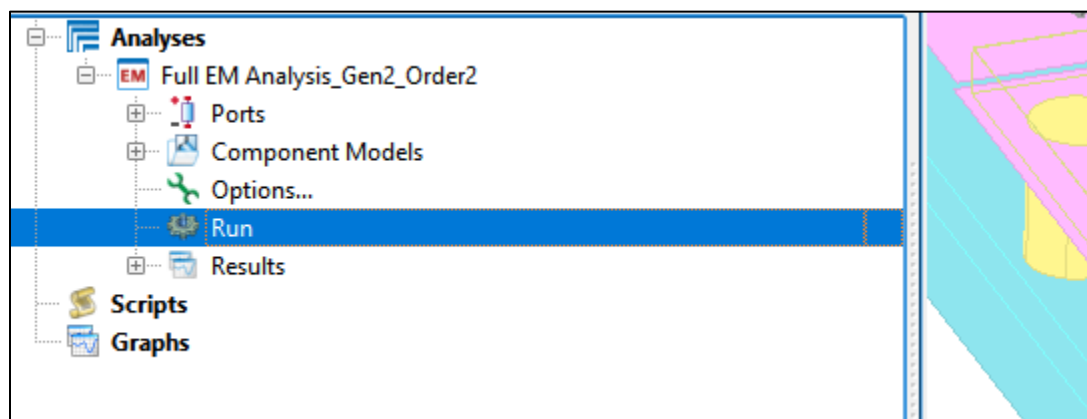


Figure 18 – Run the Simulation

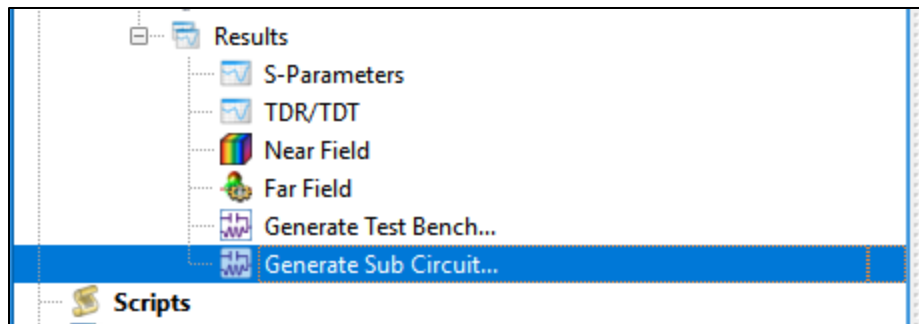


Figure 19- Generating a Sub Circuit EM Model for ADS to use and display the results

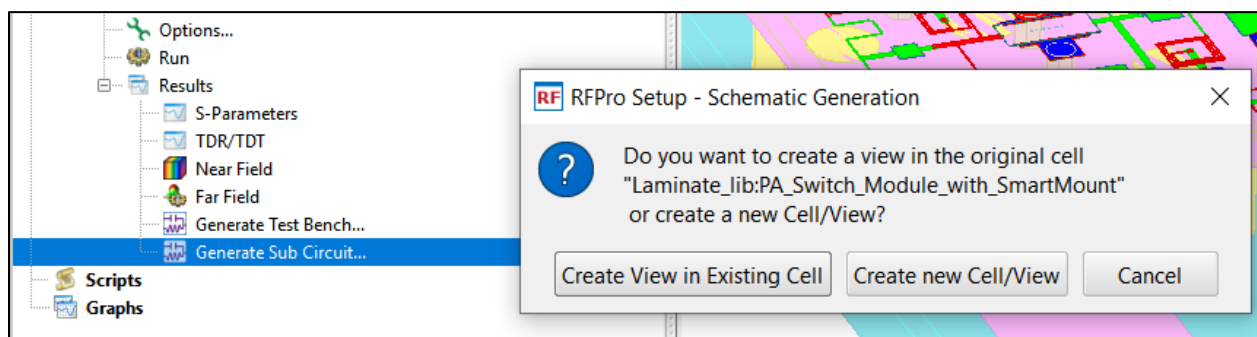


Figure 20a – Creating a View in Existing Cell would allow ADS to select and simulate from different views within the same Cell as shown in Figure 20b

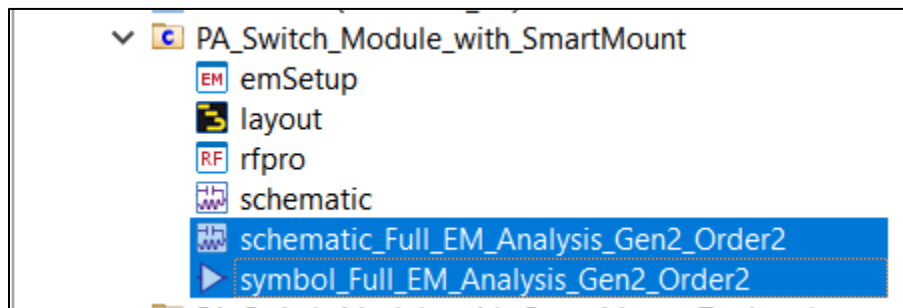


Figure 20b – The EM model view has been inserted in the same design Cell so that we can select the views and display results.

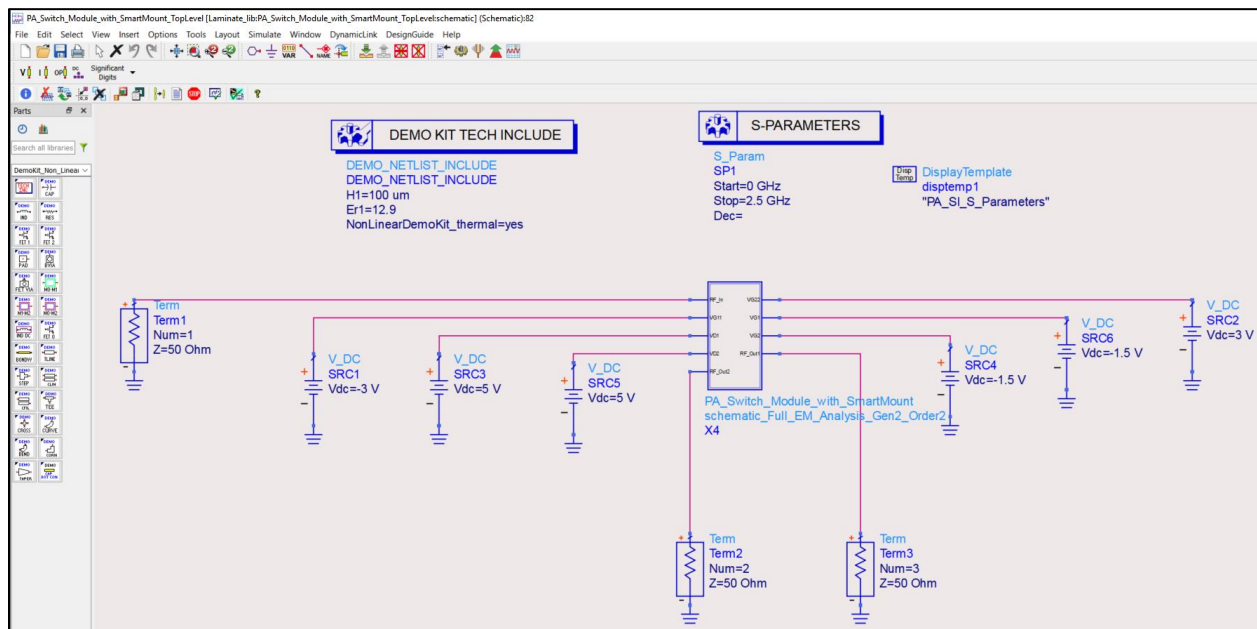
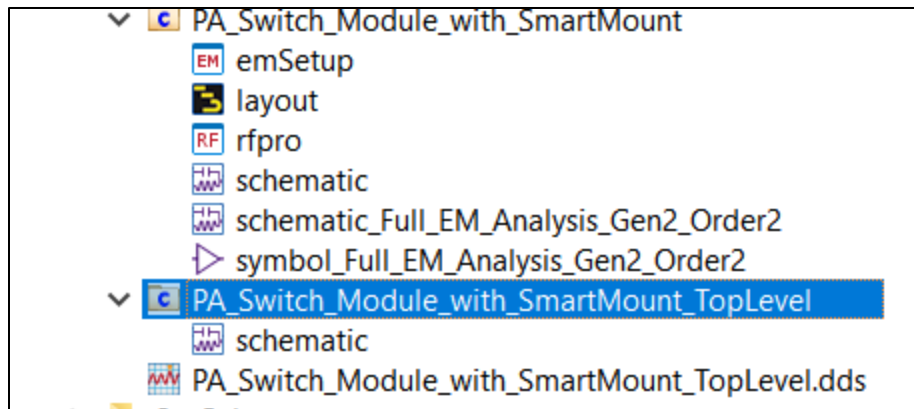


Figure 20c – Top Level Schematic where the Symbol is inserted, and different views can be simulated and compared.

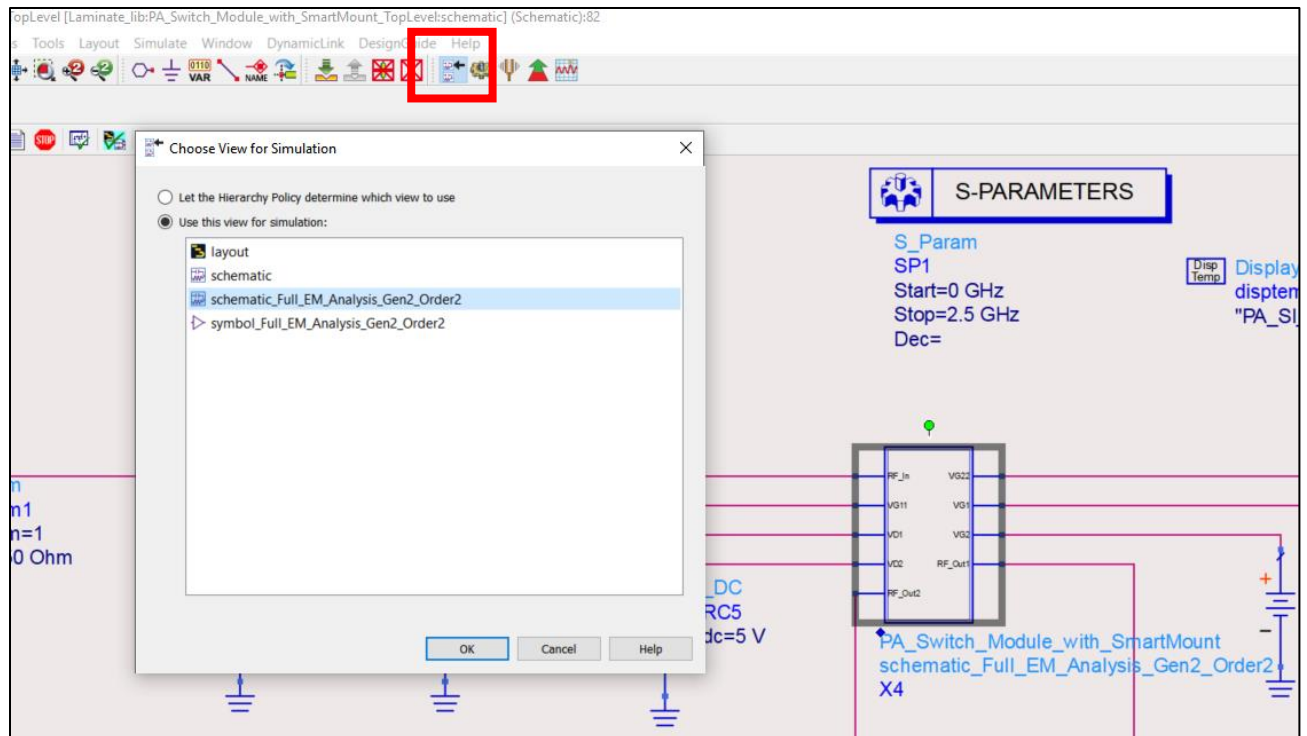


Figure 20d – EM view from RFPPro is selected from the Views list

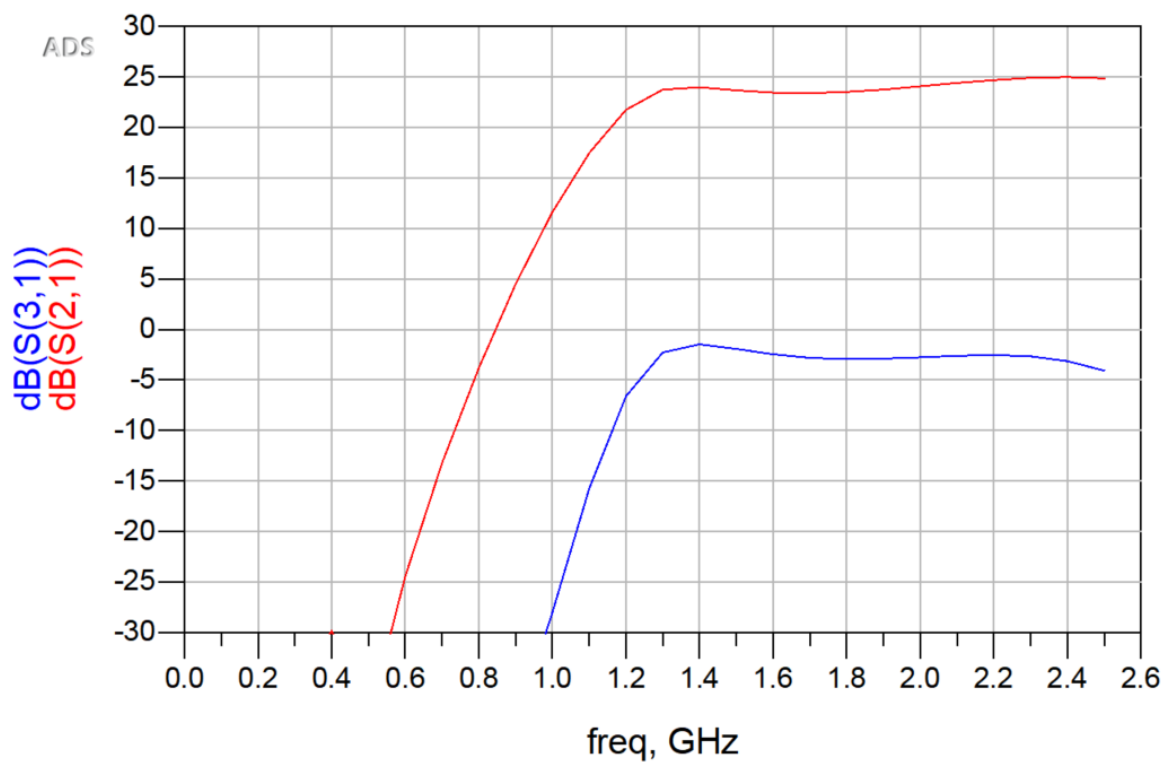


Figure 21a – Simulation results dB(S21) shown in RED from the switch pass-through port. The other port of the switch is off, and the signal is 30 dB lower (shown in Blue).

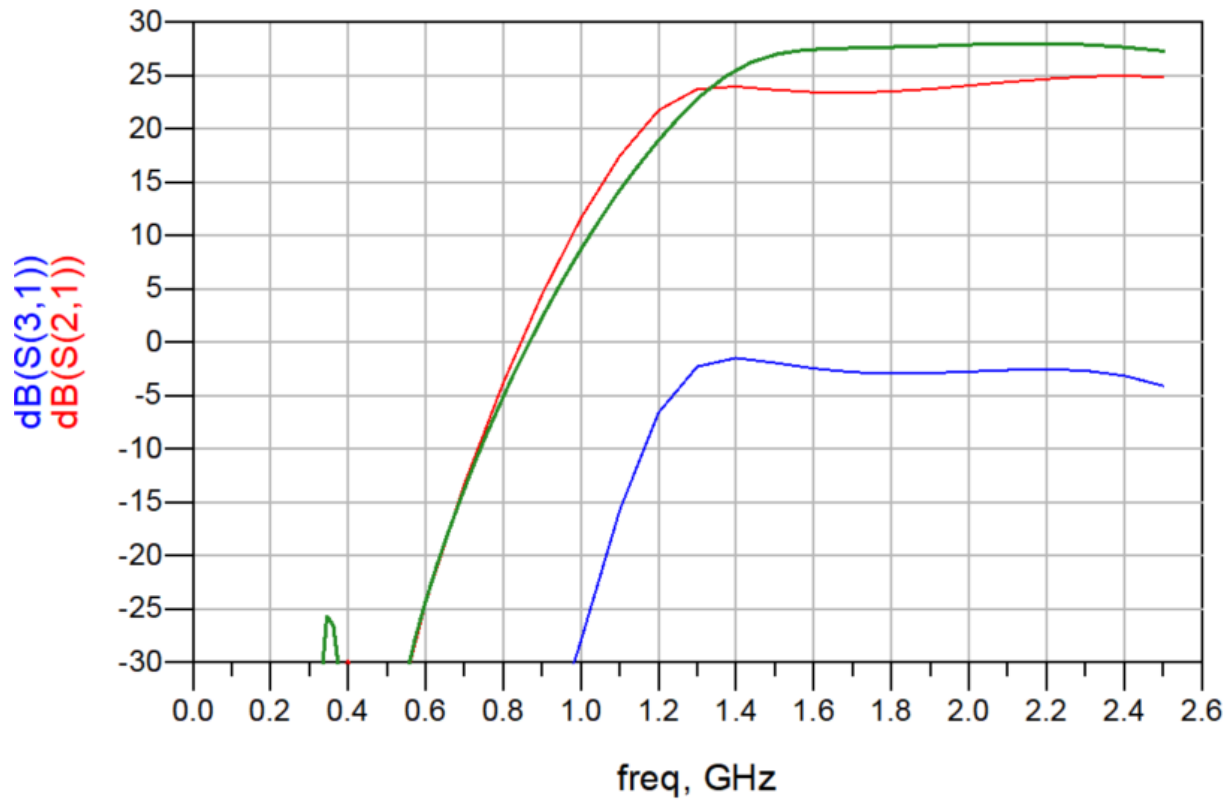


Figure 21b – Same as Fig 21a but adding the MMIC PA standalone response (Green). The reduction in gain and shift in Frequency is due to the Bondwires and substrate loss effects.