

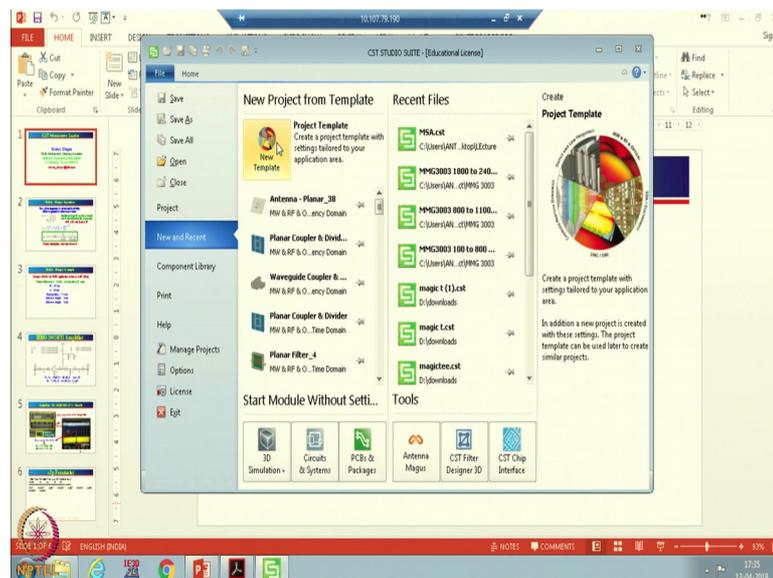
Microwave Theory and Techniques
Prof. Girish Kumar
Electrical Engineering Department
Indian Institute Of Technology, Bombay

Module - 12
Lecture - 58
Antenna Design and Amplifier Simulation in CST

Hello, in the previous lectures we discussed about micro strip circuits, we started with micro strip band pass filter, then we tried to design micro strip band reject filter. After that we tried to design two-way power divider. And then we saw by inserting a isolator how we can use the power divider is a power combiner. After that we tried to design four port rat-race coupler. And then we saw that using this four port rat race coupler. If we feed a power at port one, how we can measure half power at two ports and the third port is isolated.

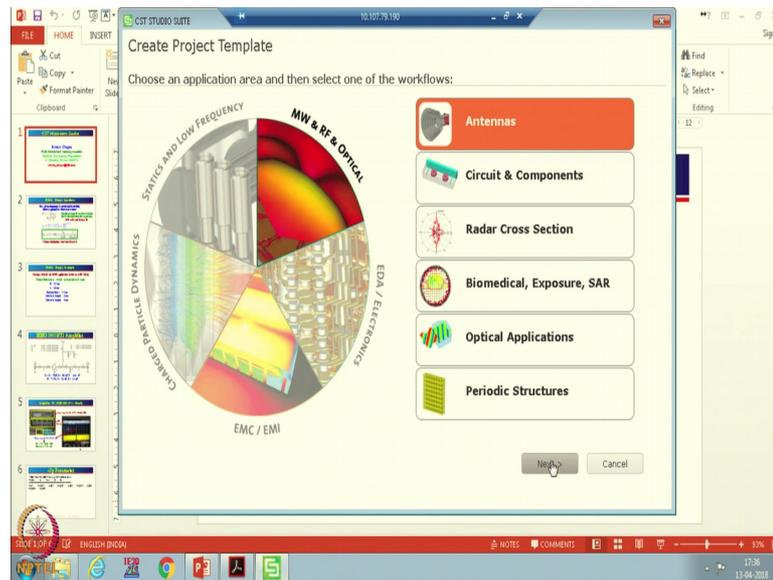
So, up to now we discussed about Micro Strip Circuits only. Since, we know in this course we are also covering antennas. So, in this particular lecture we will be firstly taking antenna. So, we will design micro strip antenna first. After that we will try to design active circuits. So, let us start CST microwave studio, and try to design micro strip antenna.

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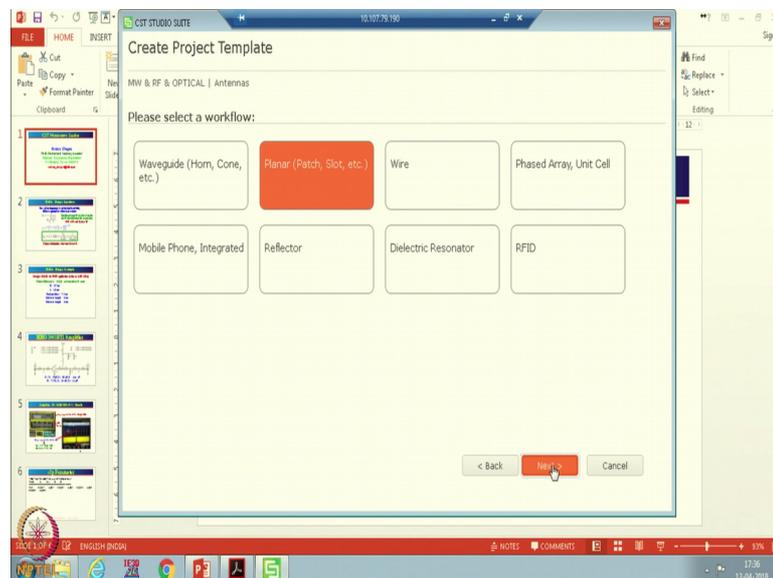
So, for that open CST, and create a new project.

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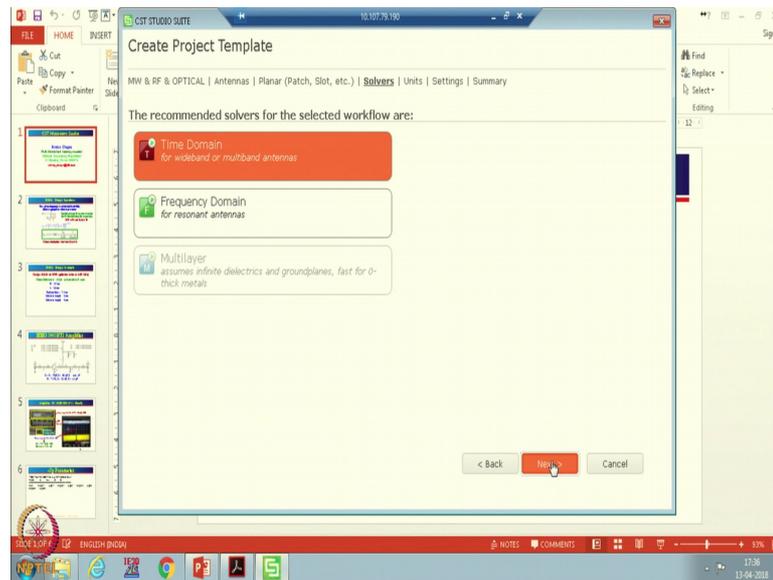
Use microwave and RF optical option and then select antenna.

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And since we know micro strip antenna is a planar structure. So, select the planar module only and create a template.

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I have already discussed these things in previous lecturer. So, I will not talk more in detail about these things.

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RMSA: Design Equations

For a given frequency f_0 and desired bandwidth,
choose appropriate substrate parameters

$$W = \frac{c}{2f_0\sqrt{\frac{\epsilon_r + 1}{2}}}$$

Smaller or larger W can be taken than
the W obtained from this expression.
 $BW \propto W$ and $Gain \propto W$

$$\epsilon_e = \frac{\epsilon_r + 1}{2} + \frac{\epsilon_r - 1}{2} \left[1 + \frac{10h}{W} \right]^{-1/2}$$

$$L_e = L + 2\Delta L = \frac{\lambda_0}{2\sqrt{\epsilon_e}} = \frac{c}{2f_0\sqrt{\epsilon_e}}$$

Choose feed-point x between $L/6$ to $L/4$.



So, in the previous lecture you already know how to calculate the length and width of micro strip antenna. So, I have given here the expression of length and width of micro strip antenna. In this particular lecture, we will try to design micro strip antenna for Wi-Fi frequency band that is 2.4 to 2.483 gigahertz. Now, if you use a previous expression that is L equals to c upon $2 f$ naught under root ϵ_r plus 1 by 2, and other

expression whatever is given in this particular slide. So, by using these expressions you can calculate these dimensions.

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RMSA: Design Example

Design a RMSA for Wi-Fi application (2.400 to 2.483 GHz)

Choose Substrate: $\epsilon_r = 2.32$, $h = 0.16$ cm and $\tan \delta = 0.001$

$W = 4.7$ cm

$L = 3.8$ cm

Feed position $x = 7.5$ cm

Substrate Length = 6 cm

Substrate Length = 6 cm

NPTEL

So, these are the dimensions we have calculated using the expression for micro strip antenna. So, the W for patch will be 4.7 centimeter, and the length of the patch will be 3.8 centimeter. And the substrate length and width we will be taking 6 centimeters. So, let us try to design in CST. So, we have created a project open CST.

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The screenshot shows the CST Studio Suite software interface. The main workspace displays a 3D model of a rectangular microstrip antenna patch on a substrate. The patch is highlighted in red. The software interface includes a top menu bar, a toolbar, and a left-hand navigation tree. A 'Parameter List' window is open at the bottom, showing the following parameters:

Name	Expression	Value	Descriptor
lsub	60	60	
wsub	60	60	
lsub	3.8	3.8	
t	0.035	0.035	

The 'Etrude Face' dialog box is also visible on the right side of the screen, showing the 'Name' field set to 'ground' and the 'Material' dropdown menu set to 'Progress #132070 (base)'. The 'Material' dropdown menu is open, showing options like 'New Material...', 'PEC', 'Progress #132070 (base)', and 'Vacuum'.

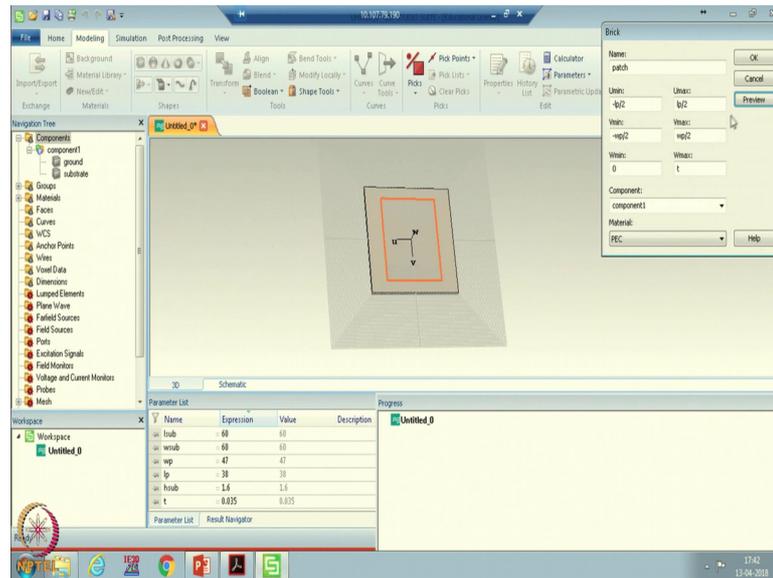
And firstly just design substrate. So, to design a substrate, select the brick name it as substrate. And define all the parameters in terms of variables. So, we have given the parameter l_{sub} for substrate length, and w_{sub} for substrate width, and h_{sub} for substrate thickness. And the substrate that we are taking here is RT duroid 5870. Its dielectric constant is 2.32, and the thickness that we are taking is 1.6 mm. So, we will try to just find out whether the substrate is available in this particular CST library or not.

So, just to check the substrate, check in the library option. If you see here, you can see RT5870. So, this sub load this particular substrate, and then you give the dimension l_{sub} substrate we have taken 60 mm, w_{sub} substrate again we have taken 60 mm, and thickness of the substrate we have taken 1.6 mm. So, just enter all the values, and you can see this polygon created corresponding to the substrate dimension.

Now, we should design ground plane. So, if you try to recall, what is micro strip antenna. So, basically if you try to visualize this is a substrate then at the bottom you have a ground plane, and on the top you make the patch of your desired dimension, then you try to feed using co axial feed. So, in previous lectures whatever type of feed we use that feed is micro strip feed. So, in this particular antenna design we will be using co axial feed. So, we will show you how to design the co axial feed also. So, now, to make ground plane just select this layer.

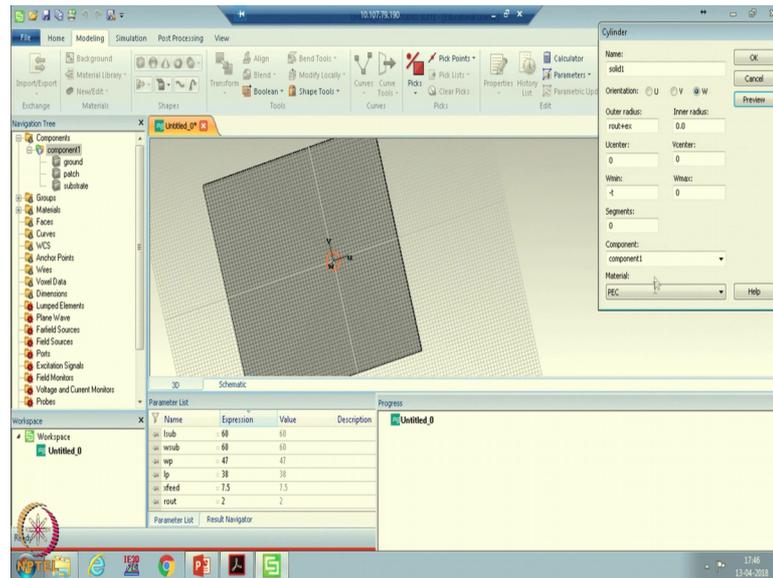
And then use extrude option to make ground and name it as ground. And give some thickness for ground plane. Here, we will give the substrate thickness of 0.035 mm and select this material is PEC. So, so far we have made the ground plane and the substrate. Now, you enable local coordinate system to make the geometry of micro strip patch. Select this particular upper layer and align your WCS to the upper layer. Now, you try to make the dimensions of patch.

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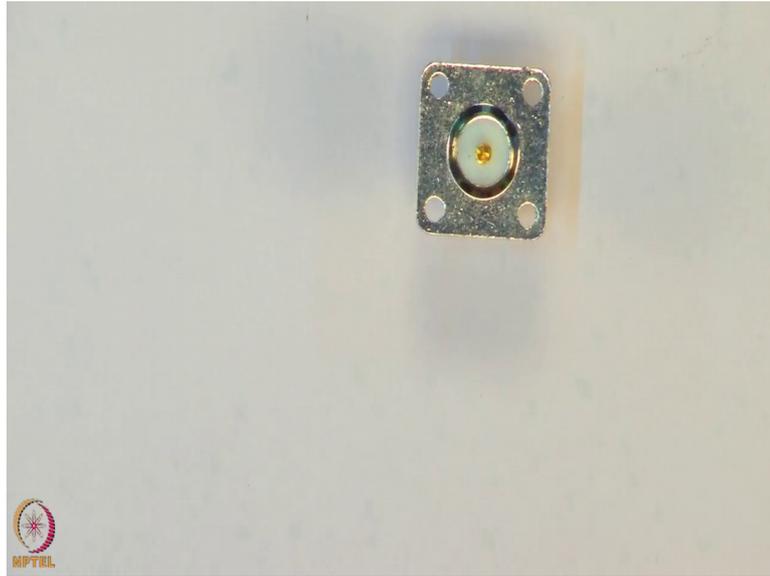
Again select break press escape and then give variable corresponding to the patch dimension. So, we are making it along the origin. So, we are keeping the origin of local coordinate system as the centre point, and we are making the geometry symmetric along the centre point. Again the thickness of copper you take 35 micron that is t in this case the variable name is t and name it as patch. So, as I calculated this is 38 mm, the length of the patch is 38 mm, and width of the patch is 47 mm and to see. Now, if you try to see here, this is the patch dimension. So, far we have made the ground plane substrate and the patch. Now, we need to feed. So, we know from the conventional theory of micro strip antenna that feed should be placed between L by 4 to L by 6 where L is the length of the substrate. So, we will see how to play this feed.

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So, just to make a feed select the bottom side that is ground plane. Align a WCS with this particular phase and then you give a offset. So, in this particular case we will take the feed position at 7.5 mm. It lies between 1 by 4 to 1 by 6 you can try by calculating these dimension you can check. So, just transform this local coordinate system. So, you can see here, this is length and this is width. So, we need to move along u coordinate. So, in u coordinate you gave some parameter x feed and just give the value as 7.5. So, you can see we have transformed. Now, we need to make the co axial feed over here. Now, I just want to tell you little bit about the connectors. So, in this particular case we will be using SMA connector. So; firstly I will tell you the various type of connectors one of the connector is n type connector.

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You can see in this geometry this is n type of connector. Here, if you see the inner diameter of this conductor is 3 mm, whereas the outer diameter of this conductor that is this one is 10 mm. So, you need to select the dimensions accordingly, because this inner and outer diameter corresponds to 50 Ohm, whereas in the middle you can see this white colour this is Teflon. So, these dimensions you can calculate using the line calculator that I have already told you in the first class.

This connector is generally used when we want to feed with high power or if you want to make the antennas at lower frequency, then obviously the dimension will be lie. So, this particular connector will provide better support. So, that in lower frequency range we use n type of connectors. Another type of connected is SMA type of connector.

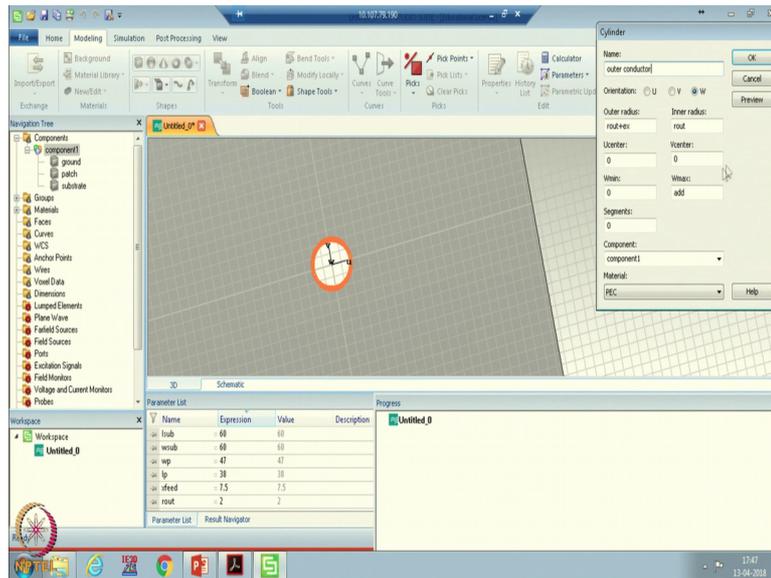
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So, this is SMA type of connector. Here you can see this inner conductor inner cylinder metallic one. The diameter of this particular conductor is 1.2 mm. And the outer diameter is 4 mm approximately, and in between the Teflon is inserted. So, we will try to make this geometry. So, when we use this particular connector to feed it, so this particular inner conductor will be connected to the patch, and the outer conductor this should be connected to the ground plane. So, in the similar way we will try to make this geometry in CST microwave studio.

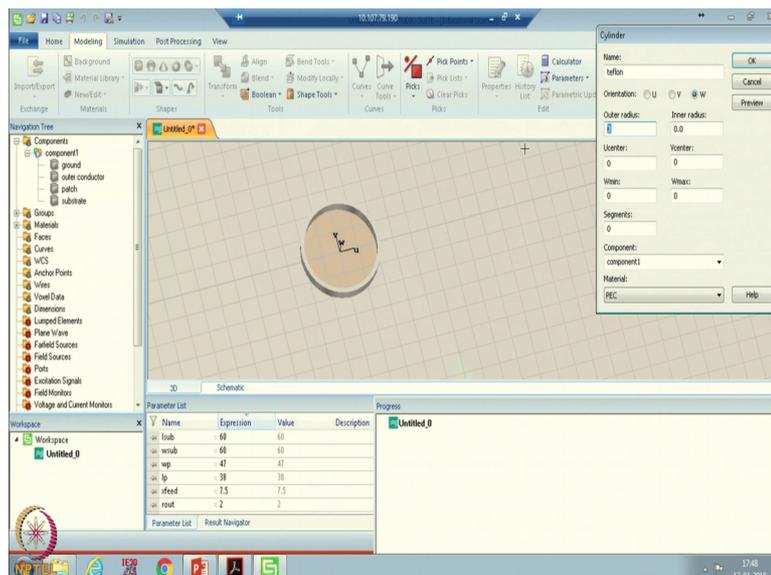
So, to make this again go to CST and make a cylinder here. So, let us take the outer dimension plus take some extra lengths. So, if you see in this particular connector, so this inner diameter of outer conductor is 4 mm, and the outer dimension will be little more. So, we will take some extra dimension may be take the variable as extra and then thickness is minus t . So, this variable name it as r_{out} , and take r_{out} as 2 mm, and extra maybe 0.2 mm, and make this conductor. So, Firstly you need to make this particular place. So, you need to subtract this from the ground plane to select ground plane. Then use Boolean option and then subtract and then cut this alright.

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So, you can see we have cut the slots here. Now, we should make conductor here. So, to make the conductor firstly we will be making outer conductor. So, to make outer conductor go to cylindrical option go to cylinder select r out plus extra is outer radius, and r out is inner radius. And w you take little extra. So, maybe give the variable name as add and use r out ok. So, give the value of add variable as may be 0.5 mm name it as outer conductor. So, you can see here we have made outer conductor.

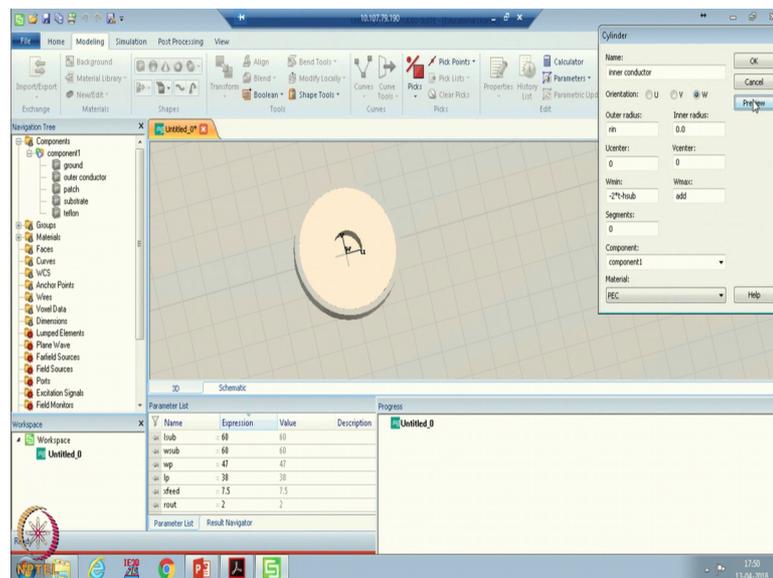
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Now, we need to make the Teflon. So, to make Teflon again select circular cylinder escape name it as Teflon give the variables. So, we know the inner radius of Teflon should be equivalent to the radius of inner conductor and outer radius should be equivalent to the inner radius of the outer conductor. So, name it as r_{out} and r_{in} and for Teflon again give the same thickness and then this is minus t .

So, this r_{in} will be 0.6 mm, because I told you the diameter of the inner conductor in case of SMA connector is 1.2 mm. So, the radius will be 0.6. Now, for the Teflon we need to select the material. So, select here and then try to search whether Teflon is available in the library or not. So, we can see Teflon is available we will try to load this one and then press ok.

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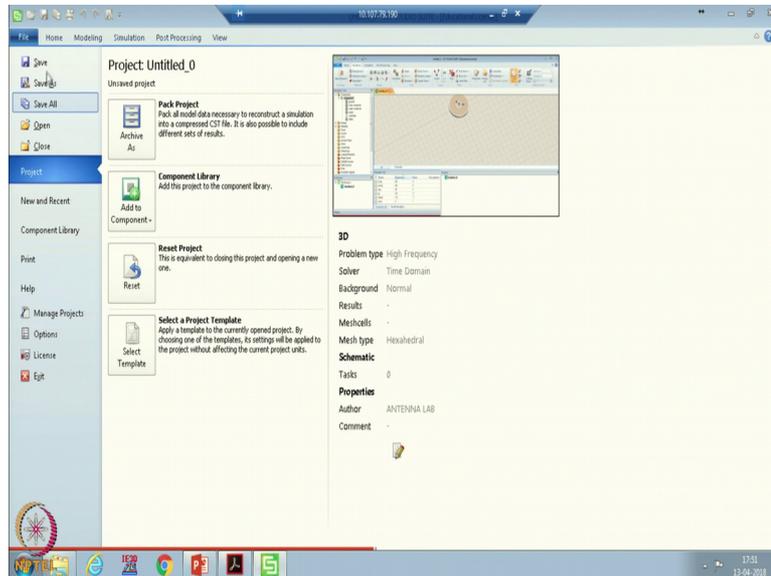


So, far we have made the Teflon and the outer conductor. Now, we should make the inner conductor and we know, now that the inner conductor should be between the ground plane and the patch that is on the other side of the substrate. So, again make cylinder name it as inner conductor. Then the outer radius of inner conductor will be r_{in} that is 0.6 mm radius. Now, if you try to notice, that this W minimum will be W coordinate which corresponds to patch. So, that will be minus twice of t minus h substance.

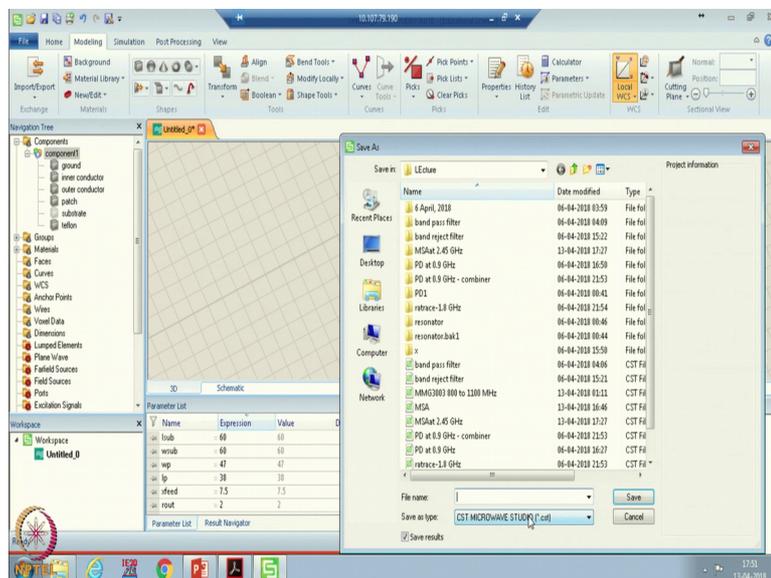
So, this contains the substrate thickness, and the thickness of both copper. So, just enter these values and then add, and select the material as PEC. Now, you can see we have created inner conductor, outer conductor and the Teflon. And we have made the coaxial

connector. So, you can see if you hide this particular, you can see this, your inner conductor is making the connection with the outer patch. You can see it is going inside this particular substrate Now, we need to provide the feed or before this just save it.

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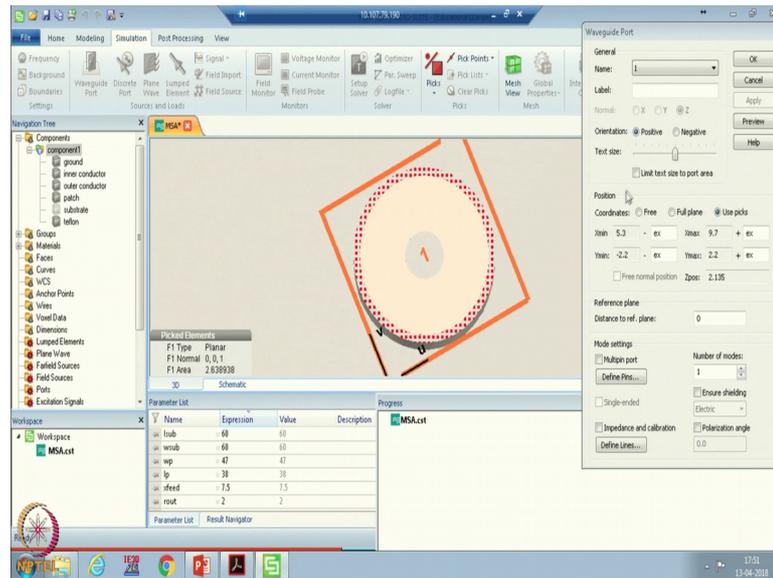


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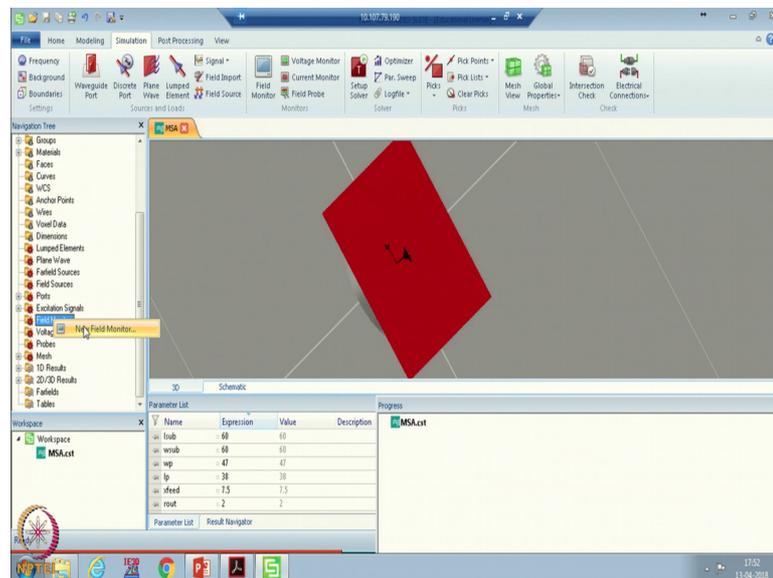
So, to save select option, give name as maybe antenna or MSA. Then we need to excite it. So, to excite it again select this particular phase.

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And give some extra dimension to waveguide port. So, maybe take the variable x and give that much of extra length. So, basically when you want to excite a port, the dimension correspondingly port should be such that it should cover the whole geometry. So, we just to ensure this we take little extra dimension.

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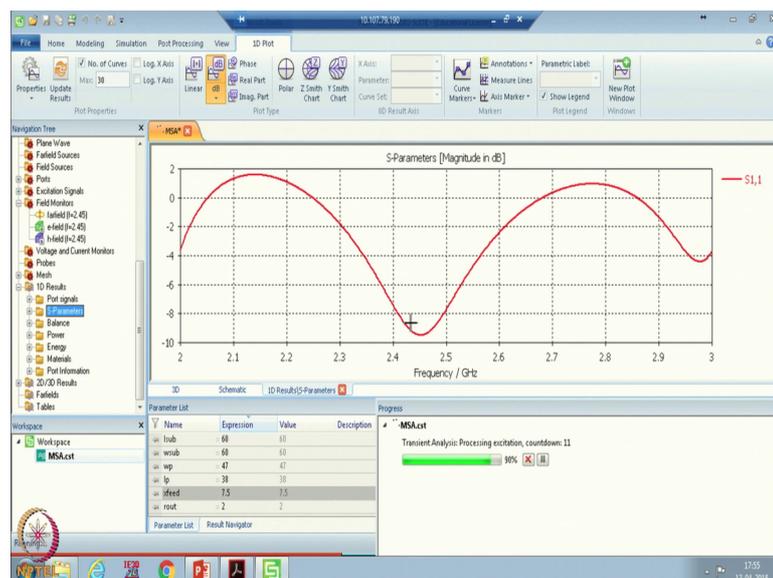
So, this is given so far we have created the geometry, and we have made the port. Now, we need to give other details like frequency give frequency. So, we designed this antenna for 2.45 gigahertz. So, we will take the dimension between 2 and 3. And will see where it

resonates then we need to see the ground properties it is normal. So, we need not to change it again for boundaries, again we need to check it is open add space in all the directions. So, we need not to change anything. Next part is we should place the monitor just to see its behavior and far field.

So, we will put far field monitor. So, click on this right click new field monitor put the far field monitor at 2.45 gigahertz, E field monitor then H field monitor, and far field monitor also. So, we have made 3 monitors at 2.45 gigahertz. One corresponds to far field and other two corresponds to e fields and h fields. So, you can see there were too many options. You can select the option according to your requirement. Now, start the simulation, so you can see here again in the progress window it is showing you what things it has already simulated. And what is the process that is going on. One more thing I want to emphasize in this window you can see all the parameters whatever we entered.

So, if at later stage, if you want to change these parameters, you can change. So, suppose if my feed point is not at the proper location, and if I want to change I can simply change it here, it will automatically update. We need not to go to that particular component just to make the change. We will simply change here, and it will automatically update, so that is the advantage of using the parameters instead of constant values.

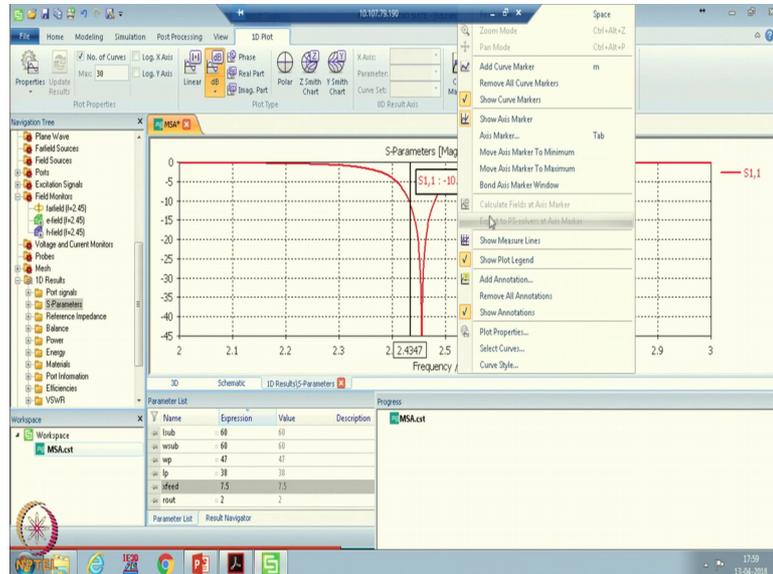
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So, it will take some time. So, in between if you want to see the results, you can see from here. It is showing you, it cannot rely on these results, because it is showing you the

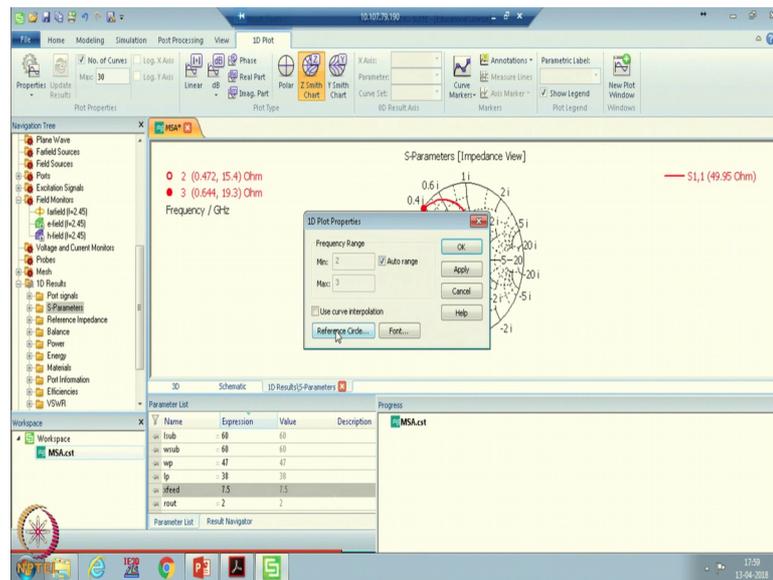
results of the middle stage. So, there are many conditions which it has not incorporated. So, now, simulation is over.

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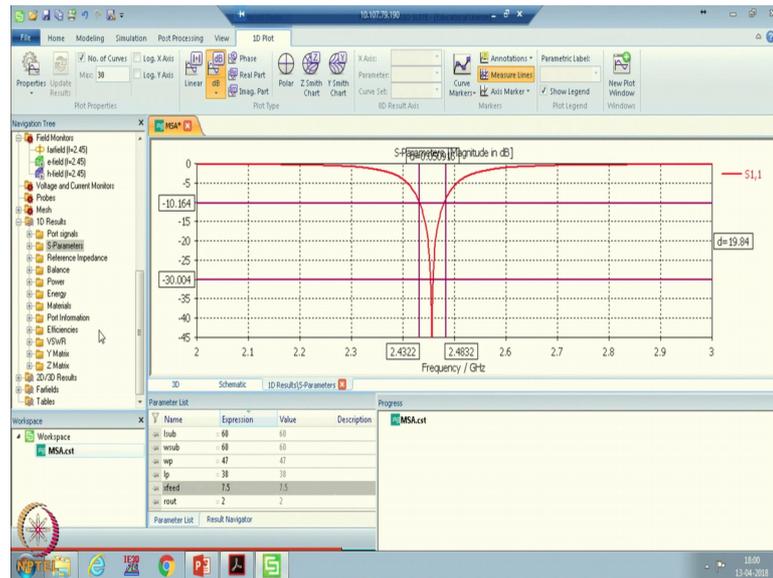
Now, we will try to analyze the results. And we will see in what manner this particular antenna is behaving. So, just go to one day results and then go to S parameter. When you go to S parameter, you will see this window just see here it is resonating at this frequency. Now, if you want to locate this particular frequency right click show axis marker to minimum you see this frequency is 2.456 gigahertz. So, we design what this antenna for 2.45 gigahertz. Now, it is resonating at approximately at the same frequency. There is one more thing that I want to show you there are too many options. So, you can select the option according to your requirement. So, suppose if you want to see these S parameters in linear scale, you can select this option. If you want to check the real part, you can select this option for imaginary and for phase you can select the relevant option.

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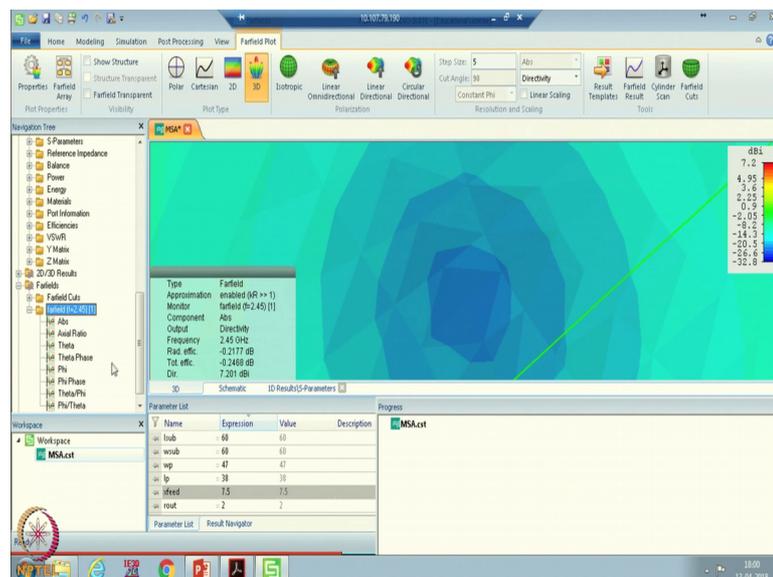
There is one more options Z Smith chart. So, I want to highlight here you can see this is Smith chart. And this point corresponds to 50 Ohm, whereas this corresponds to open circuit and this corresponds to short circuit. Now, if you want to match your antenna. So, your target is to match with this particular point. Now, if you want to see the bandwidth, we know that in general almost everywhere we consider VSWR less than 2 frequencies. So, to locate that frequency right click, plot properties then reference circle you show circle, and go to VSWR and then put 2. So, you see here corresponding to VSWR 2 the circle is created. So, these are the frequency points, and we are getting the band width between these points. The same thing you can see in S parameter plot in dB scale also.

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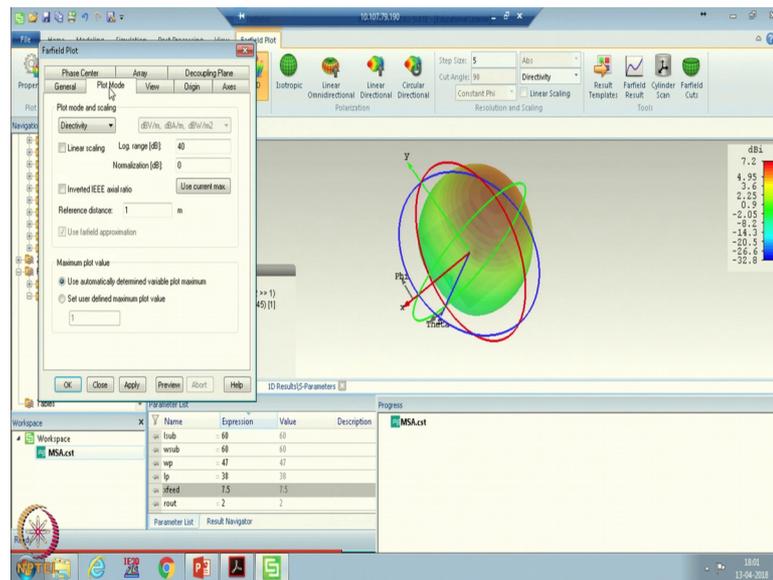
Here, if you try to put the 10 dB markers use this option show measure line. And then try to use this 10 dB point. So, this is bandwidth that you are getting between 2.4322 to 2.483. This particular point will corresponds to VSWR equals to 2 circle. The next thing is how will it behave in far field. So, how will be its radiation pattern. So, two see the radiation pattern go to far field.

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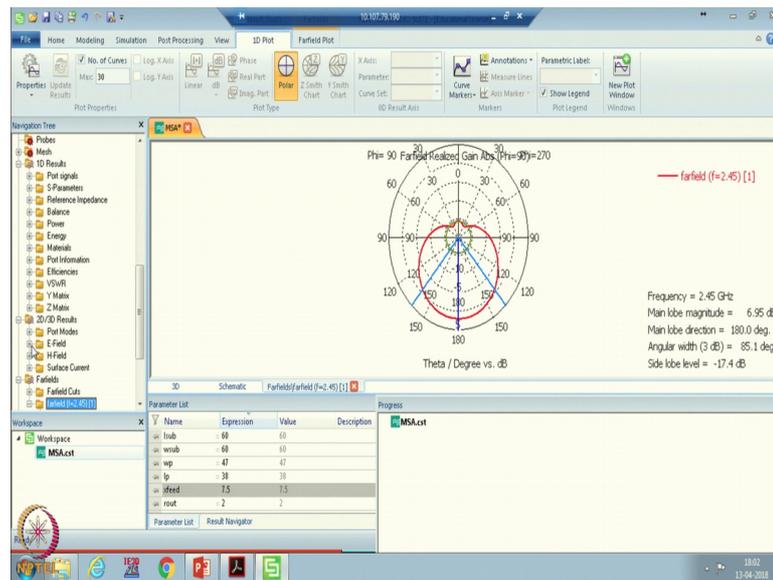
Select this option, and try to see.

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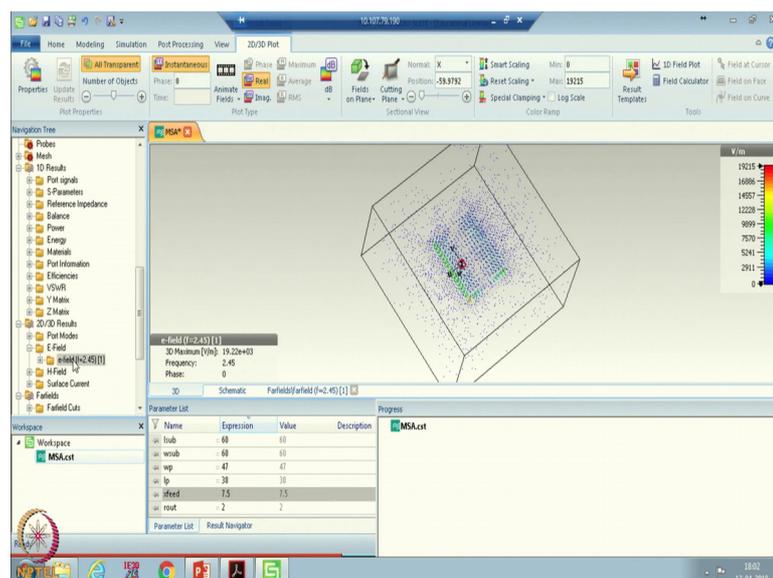
So, this is the radiation pattern you can see for the micro strip antenna. Now, if you see here just enable this show structure then structure transparent and then far field transparent. So, if you try to visualize here, you can see this here the structure is shown. So, this is radiating in the broadside direction. So, in the plane perpendicular to this substrate. So, this radiates at it is a broadside antenna. Here, you can also see that the directivity is 7.2. Now, if you want to see the gain, you can right click far field properties go to plot mode select realized gain and then apply. So, you see the gain is 6.95 dB. Now, if you want to check this radiation pattern in 2D plot right click then go to general select polar plot.

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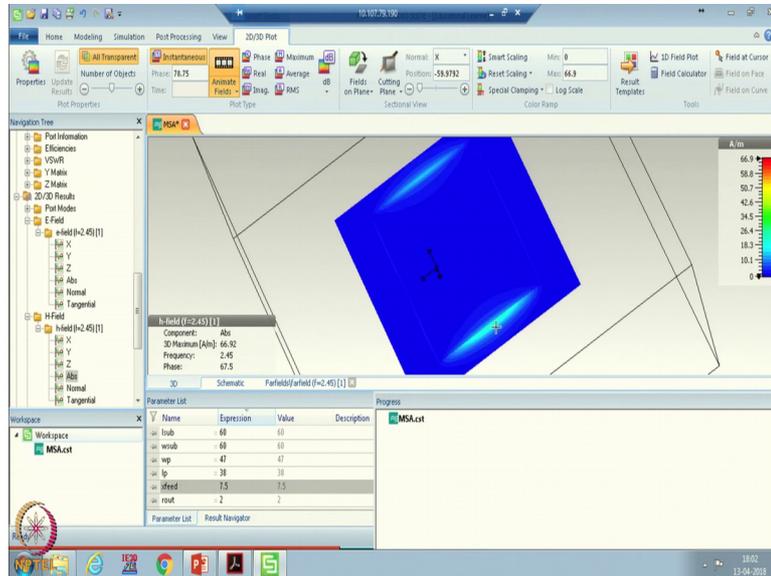
You can see this radiates in broadside direction. So, the frequency is to 0.45 gigahertz, because we have put the monitor at 2.45 gigahertz, and the beam with corresponding to this is 85.1 degree. And the side lobe level is minus 17.4 dB. This is how we try to check the parameters of the antenna. Now, suppose if you are interested to it is see it is current behavior and other things, so to see the current behavior go to 2D results go to this option and check here.

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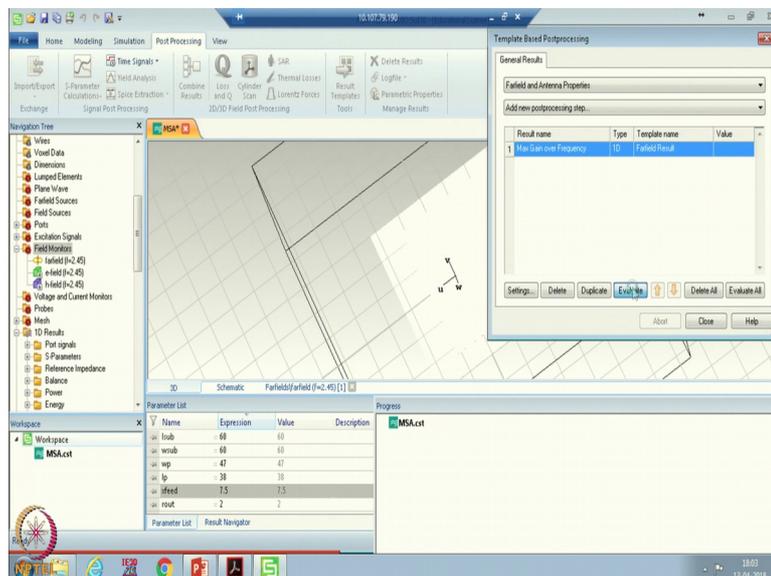
If you see here, and just try to see try to animate this. If you see in absolute scale, so this is how it will look like. Now, if you animate this, this is how it will behave.

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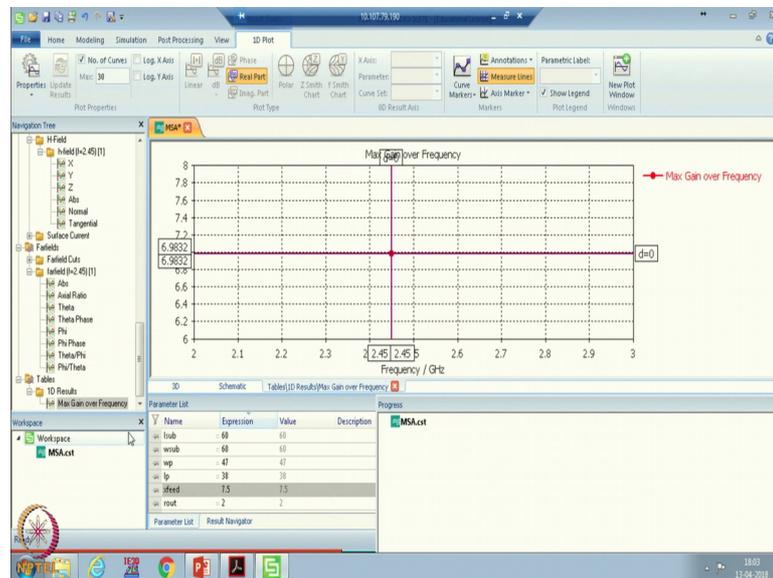
If you see in h field, you see here just try to see absolute scale. Along the length we know that the middle them current is maximum, on the edges the current is minimum. So, it is validating our concept of micro strip antenna. So, now, if you want to plot the gain of this particular antenna, you can go to this particular option post processing, then use result template then select far field and antenna properties.

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Then select far field results, then select maximum gain over frequency and then evaluate.

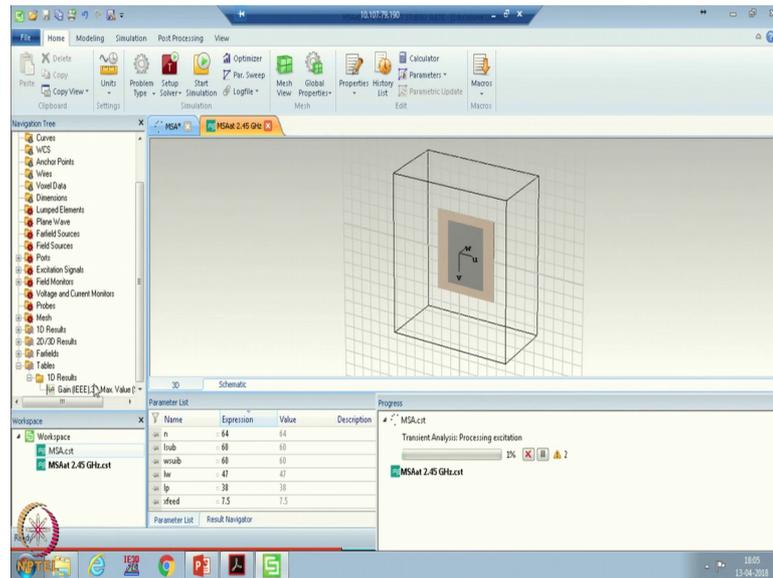
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Since, we put the monitor at only one point this is showing me the gain at particular one point. Now, in simulation if you give the frequency range, then it will use those points, and it will plot the gain. So, in this way you can plot the gain versus frequency plot, similarly directivity versus frequency plot and other things. Now, just to show you the gain versus frequency plot I will simulate it over the frequency range go to far field monitor. And then use this step option step width.

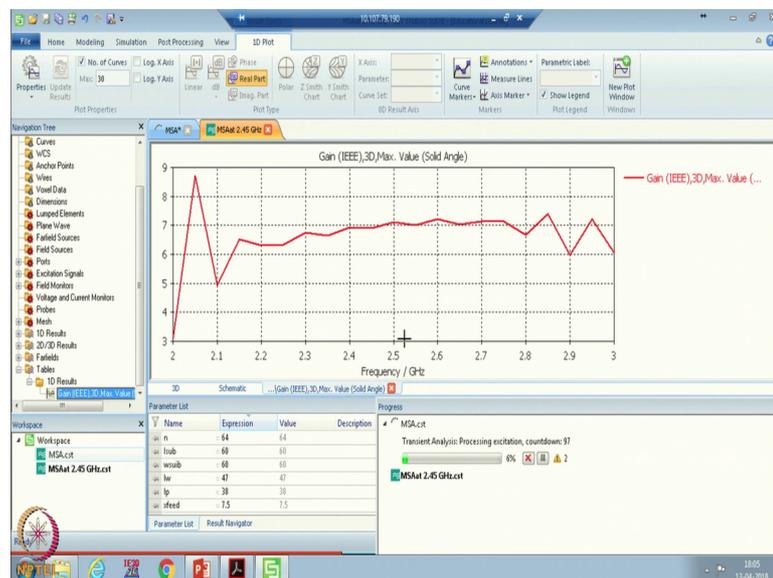
And give the range we take the step size of 0.05 and then press ok. You can see it has created number of monitors or you can also use the broadband monitor then you start the simulation. Now, it will take some time, so wait for the simulation to be over.

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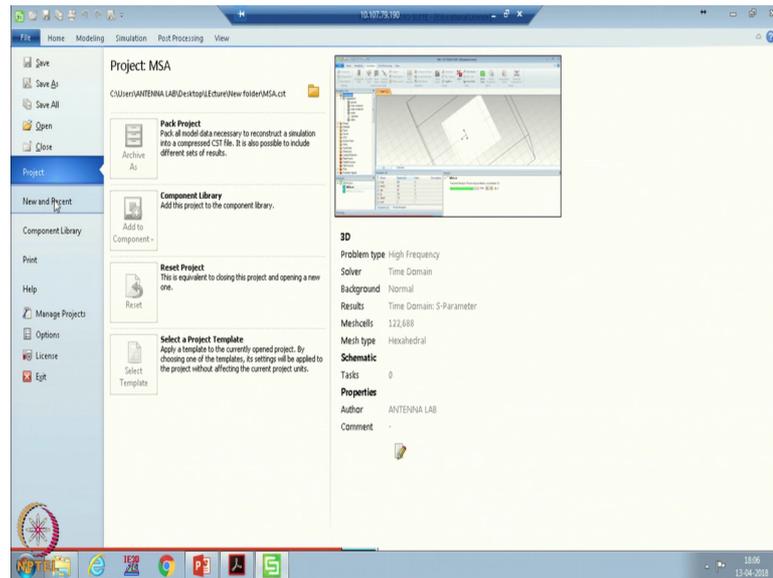
Now, you try to see the gain. So, you can see here.

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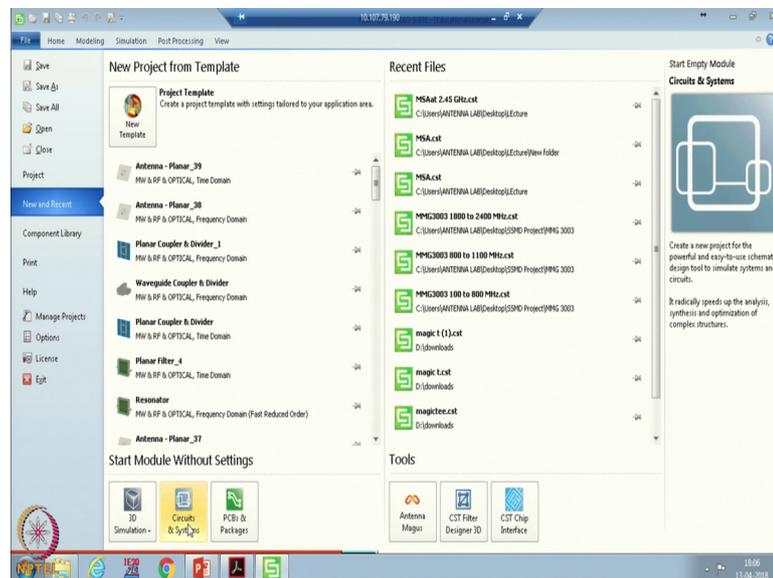
When we took the frequency point, this gain will look like this curve. So, it has calculated with gain at all the frequencies. So, this is how we plot the gain versus frequency curve. Now, we will try to make active circuits in CST. And we will see how we will design these active circuits in CST.

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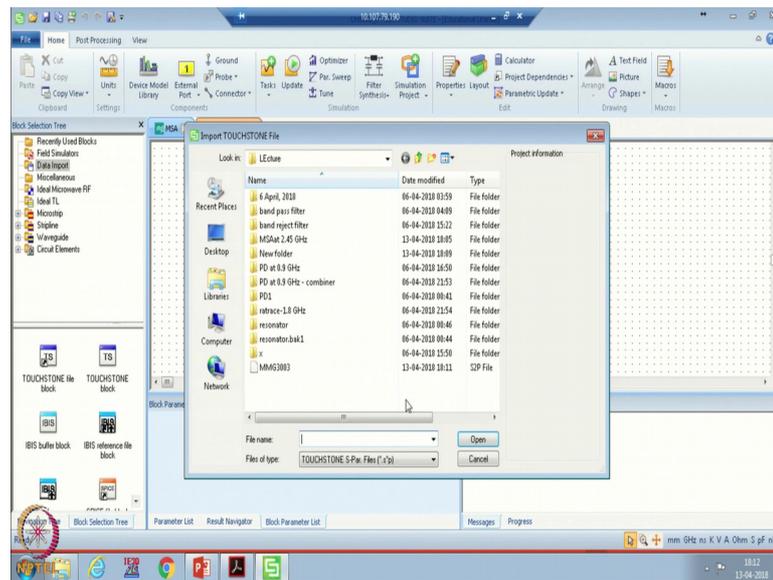
Then we will to analyze the results of CST. So, to simulate CST go to file select new and recent.

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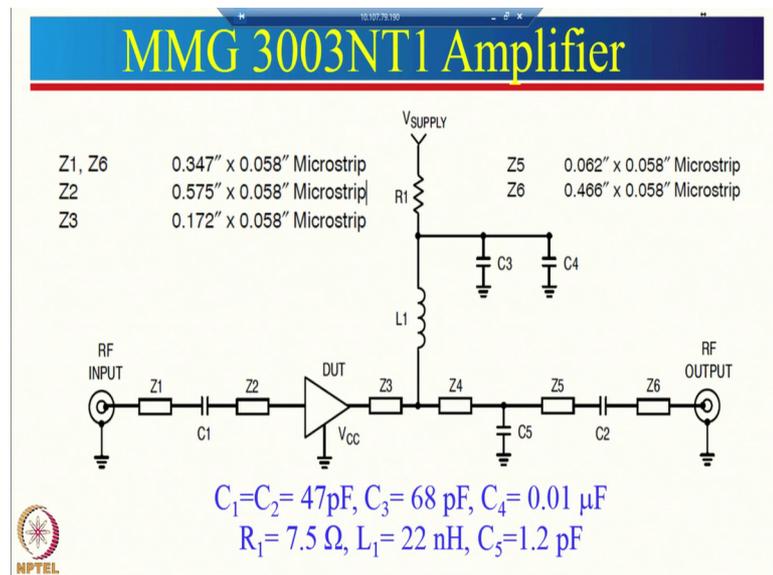
And use this circuit and system option.

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When you see this, you will see window like this. Now, if you see here, there are various options ok. Now, if you want to make normal RLC component, you can use these options. Now, if you want to use some IC or other things, you can accordingly select the proper options.

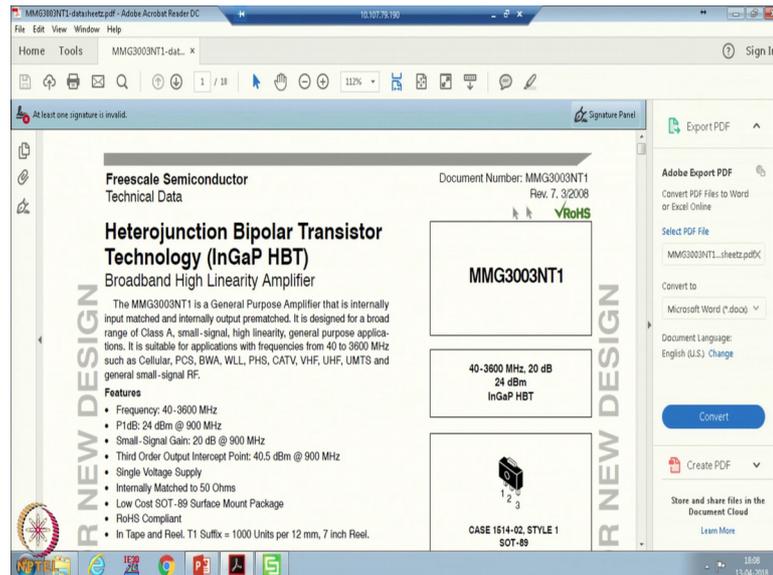
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So, today we will try to design this MMG 3003NT1 amplifier. We will try to incorporate the S2p file of this particular amplifier. And then we will try to observe the result. Now, if you see here, so in general whenever we try to design any amplifier using the IC, most

of the manufacturers provide S2p file. If they do not provide, they provide you S parameters. So, here if the S2p file is already available, we can directly use that particular file, but if the file is not available, only S parameters are available. I will tell you how to make the S 2 p file. So, we will just open the data sheet of this particular amplifier.

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If you see here, this is the data sheet of this particular amplifier. If you see here, they have not given the s2p file. If you try to Google it, you will not find the s2p file, but if you see in data sheet they have provided you the S parameter file, you can see. All the biasing conditions they have given, and the S parameters they have given. So, we will try to make the s2p file using this option.

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50 OHM TYPICAL CHARACTERISTICS

Table 14. Common Emitter S-Parameters ($V_{CC} = 6.2 \text{ Vdc}$, $I_{CC} = 180 \text{ mA}$, $T_C = 25^\circ\text{C}$, 50 Ohm System)

f MHz	S_{11}		S_{21}		S_{12}		S_{22}	
	S ₁₁	$\angle \phi$	S ₂₁	$\angle \phi$	S ₁₂	$\angle \phi$	S ₂₂	$\angle \phi$
0100	0.141	178.297	12.885	173.850	0.057	0.785	0.087	-167.704
0150	0.153	175.556	12.854	168.9	0.057	-0.913	0.136	-137.479
0200	0.155	180.177	13.067	164.046	0.059	-2.423	0.125	-131.387
0250	0.152	159.068	12.851	180.334	0.058	-2.897	0.159	-130.233
0300	0.147	156.309	12.885	156.518	0.058	-3.227	0.187	-128.649
0350	0.139	153.853	12.519	152.664	0.058	-3.971	0.212	-128.651
0400	0.135	150.838	12.327	149.087	0.057	-4.471	0.239	-129.263
0450	0.129	148.378	12.124	145.521	0.057	-4.799	0.263	-130.237
0500	0.123	145.160	11.915	142.009	0.057	-5.285	0.285	-131.837
0550	0.117	142.332	11.694	138.634	0.057	-5.623	0.306	-133.294
0600	0.112	139.394	11.470	135.366	0.057	-6.012	0.326	-135.284
0650	0.106	136.789	11.238	132.083	0.057	-6.295	0.345	-137.146
0700	0.101	133.592	11.004	128.948	0.057	-6.705	0.362	-139.07
0750	0.096	131.187	10.770	125.882	0.057	-7.044	0.378	-141.171
0800	0.090	128.979	10.532	122.88	0.056	-7.277	0.394	-143.273
0850	0.086	126.711	10.298	119.942	0.056	-7.495	0.408	-145.372
0900	0.081	124.541	10.066	117.117	0.056	-7.847	0.422	-147.518
0950	0.076	122.189	9.841	114.276	0.056	-8.05	0.435	-149.849
1000	0.073	121.191	9.611	111.625	0.056	-8.311	0.447	-151.947

So, to make the s2p file, we need to just provide some basic information. I will tell you. Just open the notepad and then just give this information.

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s2p Parameter

! VCC = 6.2 Vdc, ICC = 180 mA, TC = 25°C, 50 Ohm!

MHz S MA R 50

!Freq MagS11 AngS11 MagS21 AngS21 MagS12 AngS12
 MagS22 AngS22

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So, the important information here if you see, these are the biasing conditions. So the VCC equals to 6.2 Vdc, ICC, and other things these are biasing conditions. You use this colon they are in comment form. So, you need not to provide these things that is necessary for s2p file is this. If you see here, the first part corresponds to the frequency. So, if you are using the frequency in megahertz range or Hertz range or whatever type of

data is given in data sheet, so whatever type of data is given in data sheet, you can give the parameter accordingly. So, in our data sheet the data is given in megahertz Ohm. So, we have written here the megahertz. Then the next is corresponding to the parameter, which type of parameter you are trying to analyze.

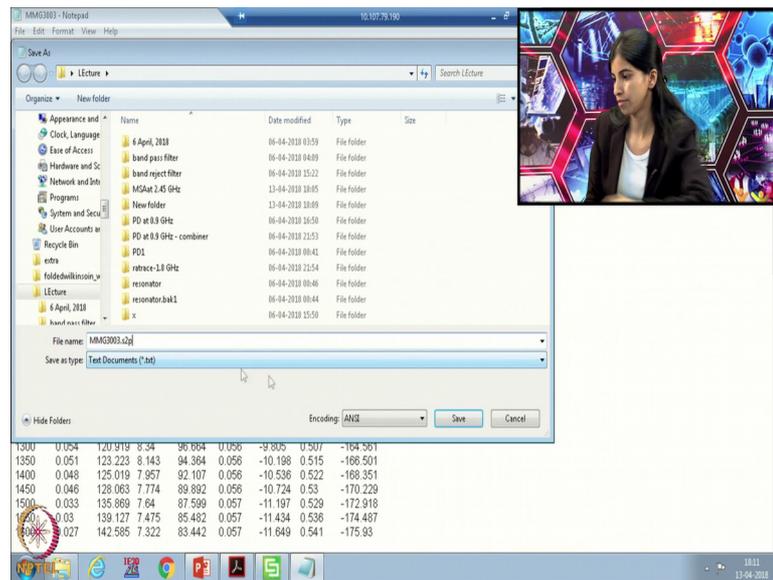
So, in a data sheet the S parameters are given. So, the second variable will be S parameter. And the next part is the corresponding to the magnitude. So, we are trying to check the magnitude of S parameters so it is a corresponds to magnitude. And the next part is the resistance the next is the value of that particular resistance. So, we are trying to normalize an amplifier with 50 Ohm that is why these parameters are selected. So, you can escape all those lines, because those are just comment to make the person familiar with what type of parameters are given. So, like we will be giving a frequency and then magnitude and angle. So, just to make it easy for other users we have written these comments it is not mandatory. So, these are the lines that you need to put. So, I will show you the s2p file of MMG just open notepad. And I will just open the s2p file, yes.

(Refer Slide Time: 29:06)

# Mhz	S	MA	R	50	fFreq	MagS11	AngS11	MagS21	AngS21	MagS12	AngS12	MagS22	AngS22
100	0.141	178.297	12.985	173.85	0.057	-0.785	0.087	-167.704					
150	0.153	175.556	12.654	168.9	0.057	-0.913	0.136	-137.479					
200	0.155	160.177	13.067	164.046	0.059	-2.423	0.125	-131.397					
250	0.152	159.068	12.851	160.334	0.058	-2.897	0.159	-130.233					
300	0.147	156.309	12.885	156.518	0.058	-3.227	0.187	-128.849					
350	0.139	153.853	12.519	152.804	0.058	-3.971	0.212	-128.851					
400	0.135	150.838	12.327	149.087	0.057	-4.471	0.239	-129.263					
450	0.129	148.378	12.124	145.521	0.057	-4.799	0.263	-130.237					
500	0.123	145.16	11.915	142.009	0.057	-5.285	0.285	-131.637					
550	0.117	142.332	11.694	138.634	0.057	-5.623	0.306	-133.294					
600	0.112	139.364	11.47	135.366	0.057	-6.012	0.326	-135.284					
650	0.106	136.769	11.238	132.093	0.057	-6.295	0.345	-137.146					
700	0.101	133.592	11.004	128.948	0.057	-6.705	0.362	-139.07					
750	0.096	131.187	10.77	125.882	0.057	-7.044	0.378	-141.171					
800	0.09	128.979	10.532	122.88	0.056	-7.277	0.394	-143.273					
850	0.088	126.711	10.298	119.942	0.056	-7.495	0.408	-145.372					
900	0.081	124.541	10.068	117.117	0.056	-7.847	0.422	-147.618					
950	0.078	122.189	9.841	114.276	0.056	-8.05	0.435	-149.849					
1000	0.073	121.191	9.611	111.625	0.056	-8.311	0.447	-151.947					
1050	0.069	119.451	9.383	108.982	0.056	-8.582	0.458	-154.142					
1100	0.065	118.827	9.17	106.412	0.056	-8.89	0.47	-156.289					
1150	0.062	118.851	8.957	103.879	0.056	-9.079	0.48	-158.481					
1200	0.059	118.882	8.742	101.417	0.056	-9.405	0.49	-160.544					
1250	0.056	119.703	8.541	99.039	0.056	-9.615	0.498	-162.608					
1300	0.054	120.919	8.34	96.894	0.056	-9.805	0.507	-164.561					
1350	0.051	123.223	8.143	94.984	0.056	-10.108	0.515	-168.501					
1400	0.048	125.019	7.957	92.107	0.056	-10.538	0.522	-168.351					
1450	0.046	128.063	7.774	89.892	0.056	-10.724	0.53	-170.229					
1500	0.033	135.869	7.64	87.599	0.057	-11.197	0.529	-172.918					
1500	0.03	139.127	7.475	85.482	0.057	-11.434	0.538	-174.487					
1500	0.027	142.585	7.322	83.442	0.057	-11.649	0.541	-175.93					

If you see here, these are the comments. This is the parameters which I was talking about and then these are again comments. And these are the values which I have taken from the data sheet. So, all you need to do is you need to just put these values and then save this file is not s2p file.

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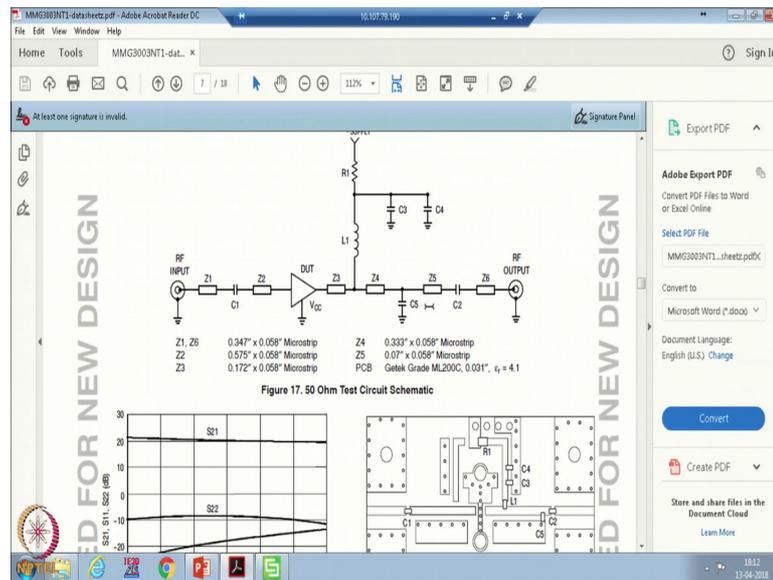
Now, you come to again CST simulator use this options data import. Then use this touchstone block. When you drag this into the layout window, it will ask for the S parameter file. So, we will select the element s parameter file.

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So, in this particular block we have imported the s2p file of MMG. Now, we will try to make the geometry that is given in the data sheet for this particular I C.

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So, in general most of the IC provides you the supporting biasing circuits and the coupling circuits. So, this is a geometry that we will try to make out. Now, you see here, this is a geometry I have given here all the dimensions. So, this is our DUT, and it contains the S parameter file then we need to make the transmission line. So, we will just make the transmission line go to micro strip, and use this option micro strip and drag it here.

When you drag it, you see this option. Here you can see various parameters. And you can select the parameters according to your requirement whatever is given in the data sheet. Here in our datasheet is in the datasheet of MMG 3003. They have taken the epsilon as 4.1, and the thickness we have taken 0.8 mm. So, we will change the thickness, and epsilon is epsilon accordingly. Then for the micro strip line we will just simply use the dimensions whatever I have given in this particular datasheet.

So, you see this Z 2 is 0.575 inches, and 0.058 inches. So, all the tracks they have the width corresponding to 50 Ohm, so that is why you can see in all the tracks the width is 0.058 inch. If you see here, just give his dimensions, and you select this you can see this length and width options are enabled. I will just change here it 2 inch. If you have the information in mm you can put it directly. And then I will edit it so, I will give the width as 0.058 and then sorry then the length is 0.575.

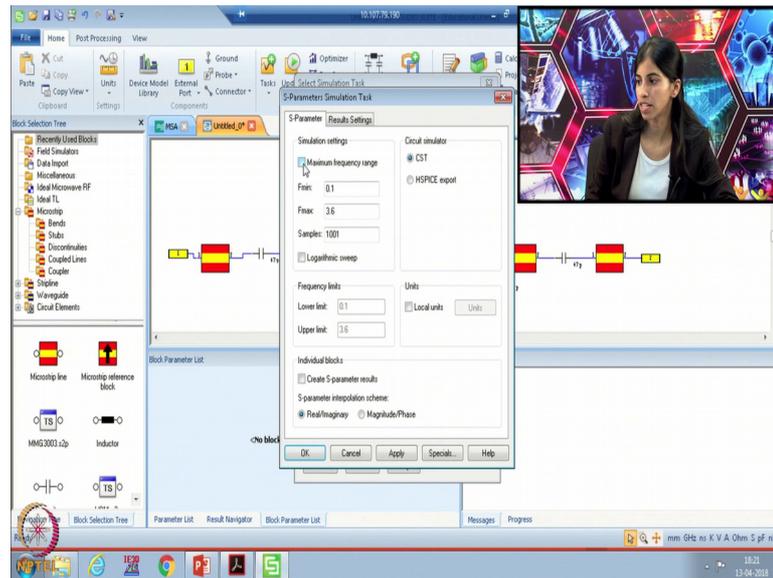
Similarly, you have roughly 4 or 5 steps. I just simply copy paste and further I will change you can see here 1, 2, 3, 4, 5, 6 micro strip lines you have. So, I will just simply copy paste it here 1, 4, 5. And I will just try to locate it and then I will change the dimensions accordingly. So, for first block this z. First block and the last block the length is 0.347 inches. So, I will change it 0.347. Similarly, for last block it 0.347, for the second block if you see it is 0.575, we have already given that. This was third block it is 0.172 inches. Just enter the value whatever I have given.

And then for the next block it is 0.06262. Then you see that they have use some decoupling capacitors. So, I just want to tell you in the s2p file the incorporate the biasing condition. So, it is not necessary for you to make this particular layout. So, in s2p file they use the biasing circuits. So, they incorporate all the biasing rated criterias. So, you need not to use this particular component, because these are the biasing components. So, the all information that you need to use is this these micro strip line, and the decoupling capacitor.

So, we will just make these components and then we will use the s2p file in DUT. So, the C value of C 1 and C 2 is 47 Pico farad. So, we will use this to use this components. So, like this and just bring it here, when is this again copy paste. So, before Z6 you put another capacitor, and third capacitor is placed between Z 4 and Z 5 and rotate this. Now, you try to make the connection make this connection connected here. Similarly, use this connector connect it here. Again use connector and make the connection between different components and then put ground here.

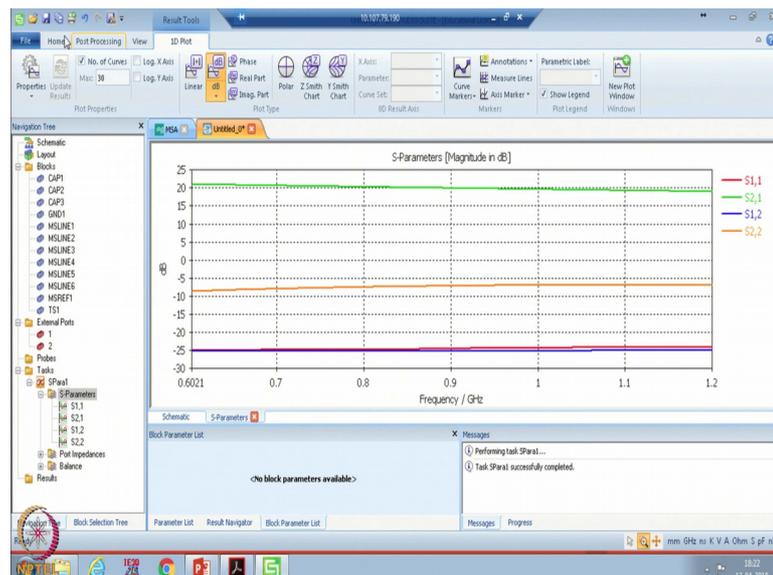
And change these values of these capacitors you can change the value here. So, the value of decoupling capacitor was 47 Pico farad. Similarly, for this capacitor 47 Pico farad and for this value was 1.2 Pico farad. So, put these values make all the connections and at this port you use the external connector. And then make the connection between these connector, and the first step, similarly use this second connector at this end, and make the connection between these. So, we have made all the connections you can see. Now, we need to set the task.

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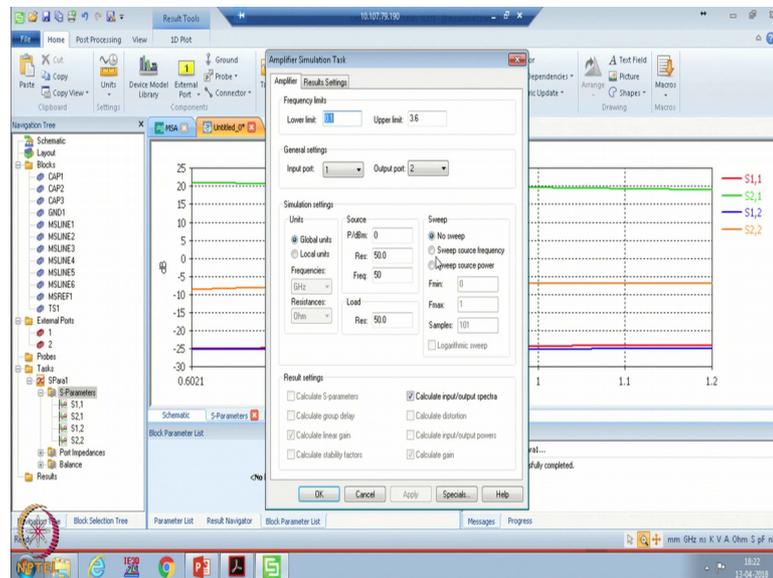
So, to set the task again go to this option, go to S parameter ok. Then you give here the frequency range. So, if we give the frequency range, the data that was given S parameter file s2p file was from 0.1 to 3.6 gigahertz, but these conditions we have taken for 800 to 1100 megahertz. So, we will select the frequency range accordingly. So, in this case we will take the frequency range between 0.6 and 1.2 gigahertz and this ok. And then update, when you updated go to navigation tree, and then see the parameters.

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If you see here, just try to analyze these results so, you can see this is showing as the gain above 20 degrees. This is S2, 2 and this one is S1, 1. So, you can see it is well matched in this frequency range. You can also set other parameters in the task window itself.

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I will just show you here select this amplifier option select this option. And you can sweep the frequency range of your interest. And you can analyze the results in this way ok. So, this is what you need to do for active circuit simulation. So, in this lecture, we tried to design micro strip antenna, then we tried to see the behavior of micro strip antenna. We tried to see how does it behave in far field region, then we tried to see the gain versus frequency plot, we also saw how to see the radiation pattern in 2D and 3D plot, we also saw how we should analyze S parameter results in Smith chart and in dB plot. After that we tried to design the amplifier, we use the MMG amplifier to simulate. In the similar way you can use other amplifiers.

So, in general most of the manufacturers provide you s2p file. If they do not provide you s2p file, they provide you S parameters. So, you can use those S parameters to make the s2p file. Then you can provide the supporting connections and accordingly you can do the active circuit simulations. And you can analyze the results accordingly. So, in the next lecture, my colleague will show you the simulation of mixers in a different software that is AWR.

Thank you very much. We will see you in the next lecture.