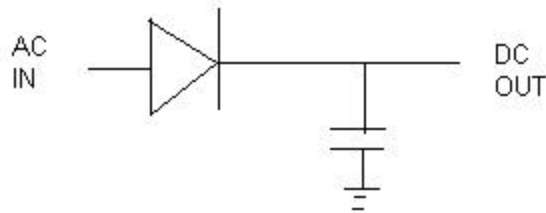


# How to use S-parameter data files in Libra

Ray Woodward

This tells how to design a diode detector circuit to convert AC to DC voltage



**Read through the whole tutorial before you start.  
You will go through two sections:  
Simulation and Layout**

# Simulation

- Use this (as you have in previous tutorials) to simulate the RF performance of your circuit. You need to include the lengths of all lines (including the pads for soldering elements to). These are found in the layout section, so you will do some back-and-forth between layout and simulation.
- Some elements are available in the standard libraries (the cap in this lab), others are not (the diode in this lab). When they are not available, you will have to “create” them using user-defined S-parameters and lines (MLIN). These can come from data sheets (like the HP website) or from measurements (like for this lab).

# Layout:

- “Artwork” is used to define the size and shape of solder connects for components like capacitors, diodes, RF chips, etc.
- The dimensions of solder pads (where you actually connect your circuit) are specified on data sheets. They are also available in the libra “library” for many standard elements.
- The size of pads add length to your lines, so you will need to include them in your simulation for most accurate results. This means you need to figure out their size before you simulate the circuit, so you will do some back-and-forth between layout and simulation.

# Simulation:

**First you need the S-parameters of your diode....**

# There are two ways to get your S-parameters:

- Measure them (most accurate)
- Find them on the web or other data sheet (we'd like this to be most accurate, but for this lab it isn't)
- These methods are described below, for your reference. Measured values are given at the end.

# To measure S-parameters of the diode

- Build the circuit with just a length of line attached to the device.
- Measure the input impedance using the network analyzer
- Compensate for the length of the line to find the S-parameters of your device (matlab code to do this is included)

OR: To find the S parameters of your HP diode, Look on this web page:<http://www.hp.com/HP-COMP/rf/hprfhelp/products/diodes/hsms285x.htm#s-data>

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Bookmarks Location: <http://www.hp.com/HP-COMP/rf/hprfhelp/products/diodes/hsms285x.htm#s-data>

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N	-	1.06
RS	ohms	25
PB (Vj)	V	0.35
PT (XTI)	-	2
M	-	0.5

---

**HSMS-285x Series S Parameter Data** [\[top\]](#)

file name	description	
hs0005v0.s1p	HSCH-0005 s parameters at 0 V	 <a href="#">view</a>
hs2850v0.s1p	HSMS-2850 s parameters at 0 V	 <a href="#">view</a>

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**Applications Literature**

[General Information](#)  
[As Detectors](#)  
[Assembly Information](#)  
[Reliability Information](#)

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**Demonstration Circuit Boards**

Document: Done



Copy and Paste the data into a text file (diode.txt). Put this text file into your project directory.

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Location: <http://www.hp.com/HP-COMP/inf/hprfhelp/design/spar/hs2850v0.htm>

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then copy to the clipboard (in most browsers, do this using the Edit pull down menu or enter CTRL+C).

```
!HSMS-2850 zero bias Schottky diode  
!S-parameters at zero bias. Last updated 6/7/94  
  
# ghz s ma r 50  
0.1 0.989 -0.9  
0.5 0.988 -4.3  
1.0 0.987 -8.8  
1.5 0.984 -13.4  
2.0 0.980 -18.5  
2.5 0.974 -24.0  
3.0 0.965 -30.3  
3.5 0.953 -37.7  
4.0 0.936 -46.4  
4.5 0.912 -57.1  
5.0 0.880 -70.3  
5.5 0.839 -87.1  
6.0 0.790 -108.2
```

S11 (Mag, Phase(degrees))

312 HPRFhelp HEWLETT PACKARD  
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Document: Done

You may have measured or acquired only the S11 values of a diode.

Find the other S-parameters (such as with the included matlab code), and create a text file that has 2-port S-parameters as shown on the next slide.

S11 = reflection coefficient

S21 = 1+S11

S22 = reflection coefficient (1+j0 for a diode)

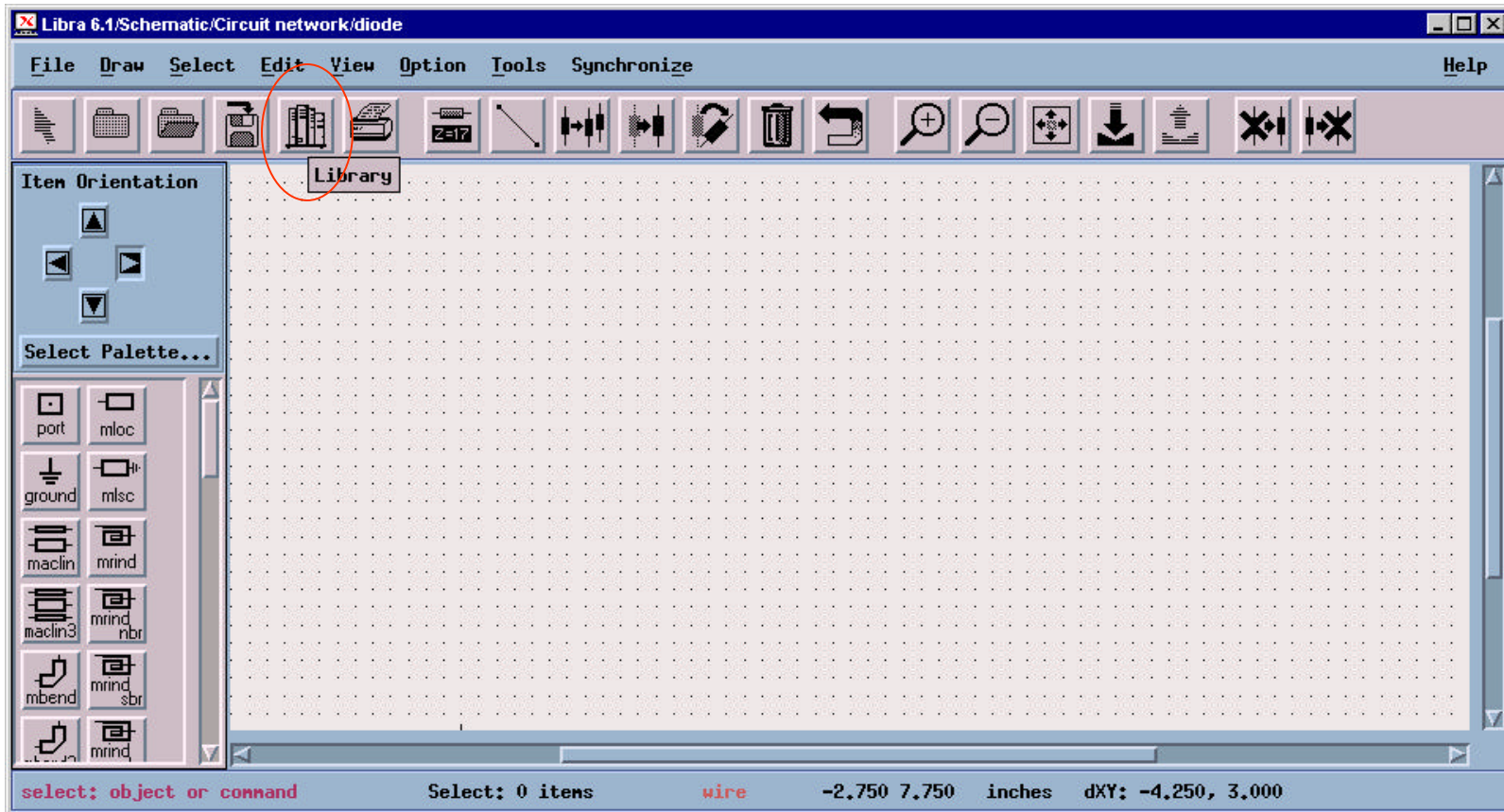
S12 = 1 + S22 (or in this case, for a diode, it is zero)

# Measured 2-port S-parameters of your diode *including* the pads: filename is diode2pt.txt

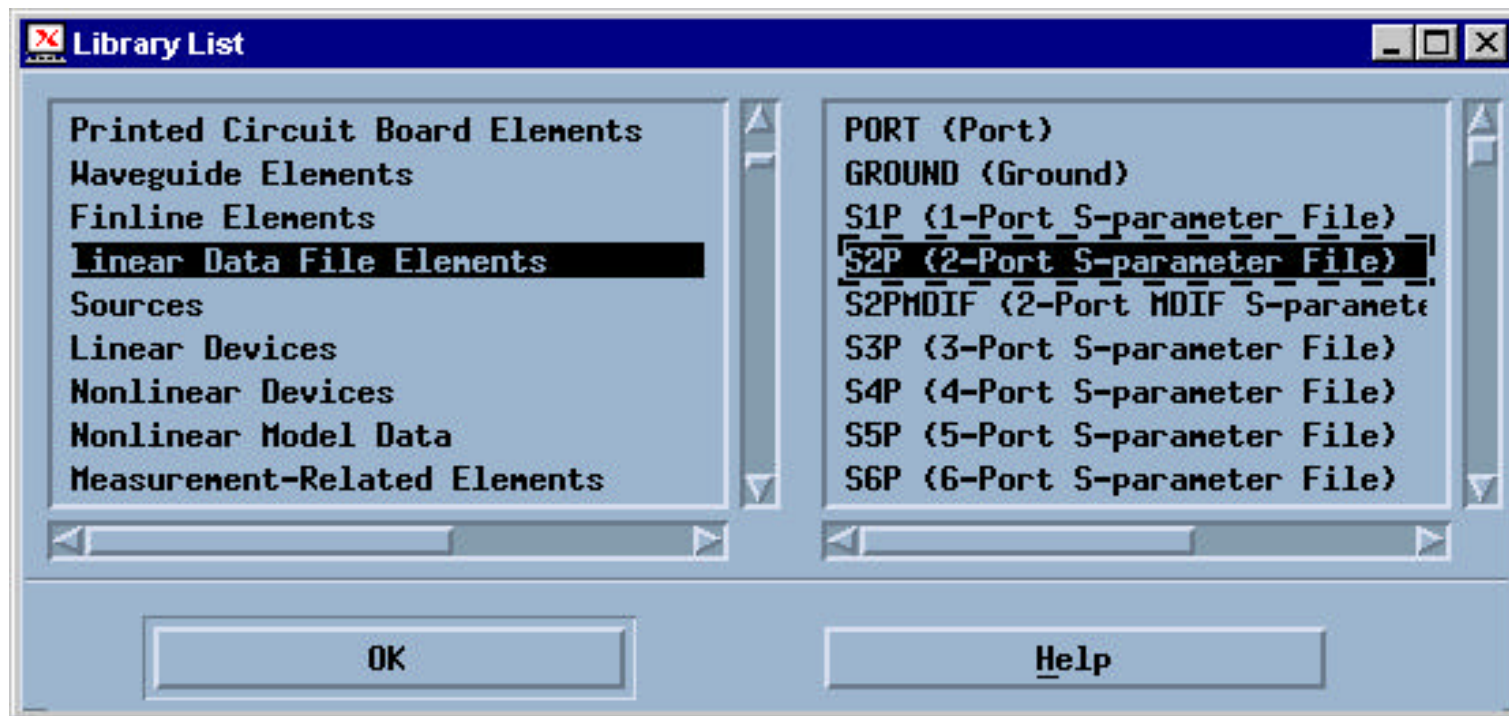
```
!BEGIN ACDATA
#          GHz          S          MA          R 50.0
!% F n11x n11y n21x n21y n12x n12y n22x n22y
1.75 0.9683 -23.8255 1.9259 -11.7179 0 0 1.0000 0
2.0 0.9683 -29.8098 1.9021 -14.6593 0 0 1.0000 0
2.4 0.9521 -35.1478 1.8610 -17.1282 0 0 1.0000 0
2.6 0.9529 -35.7572 1.8586 -17.4327 0 0 1.0000 0
3.0 0.8956 -44.0234 1.7578 -20.7357 0 0 1.0000 0
!END
```

Copy diode2pt.txt to the data folder in your current project directory.

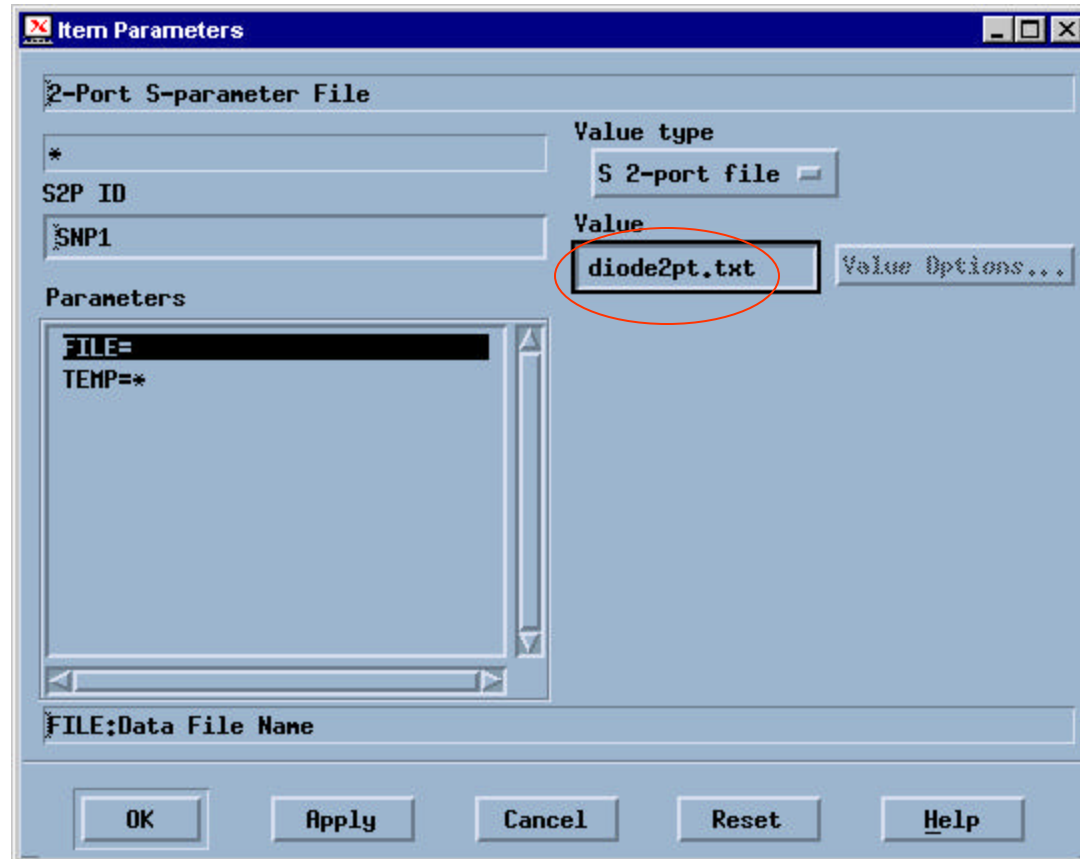
# Click on the Element Library



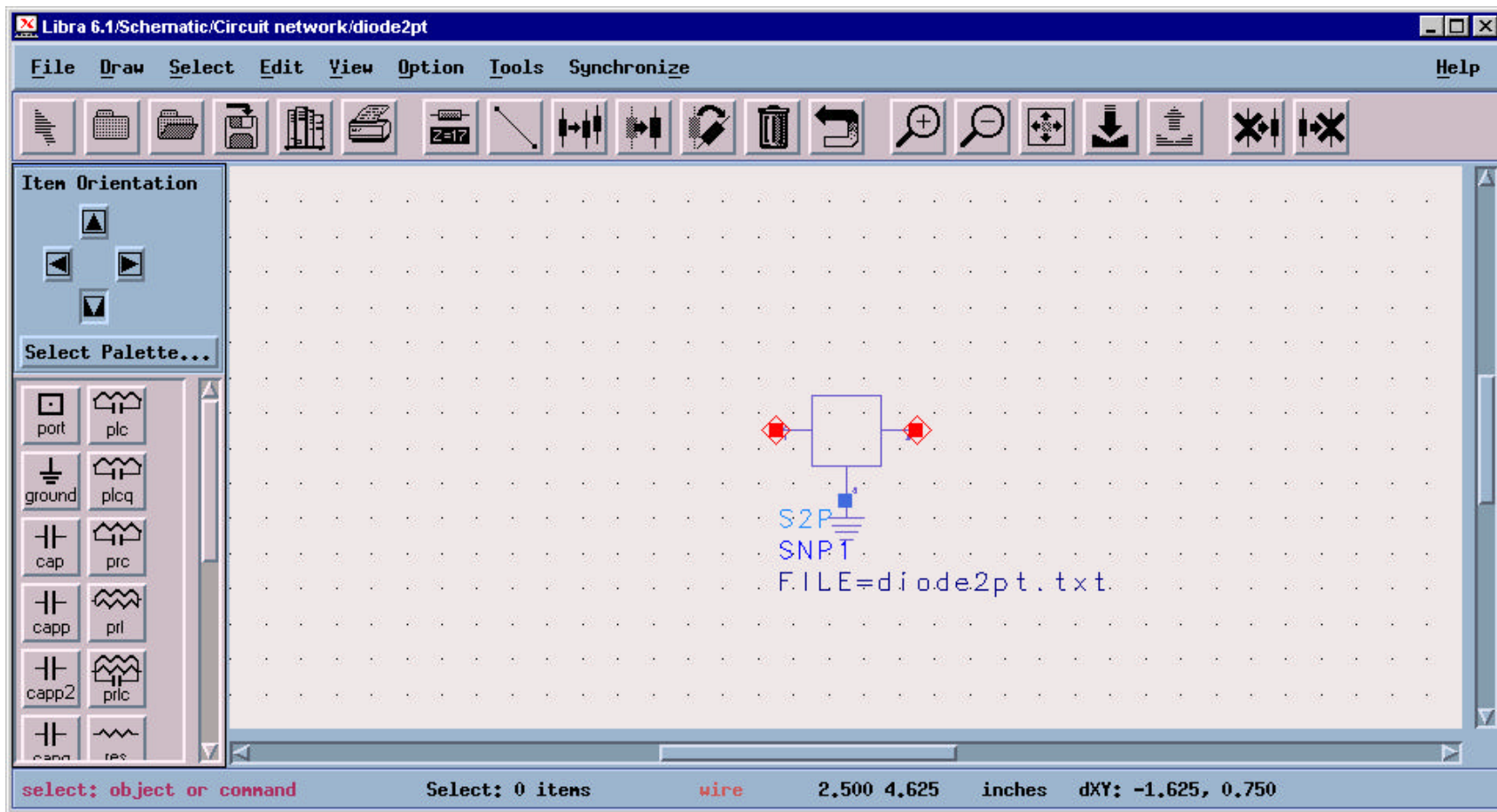
# Choose Linear Data File, 2-Port S-parameters



# Insert Filename



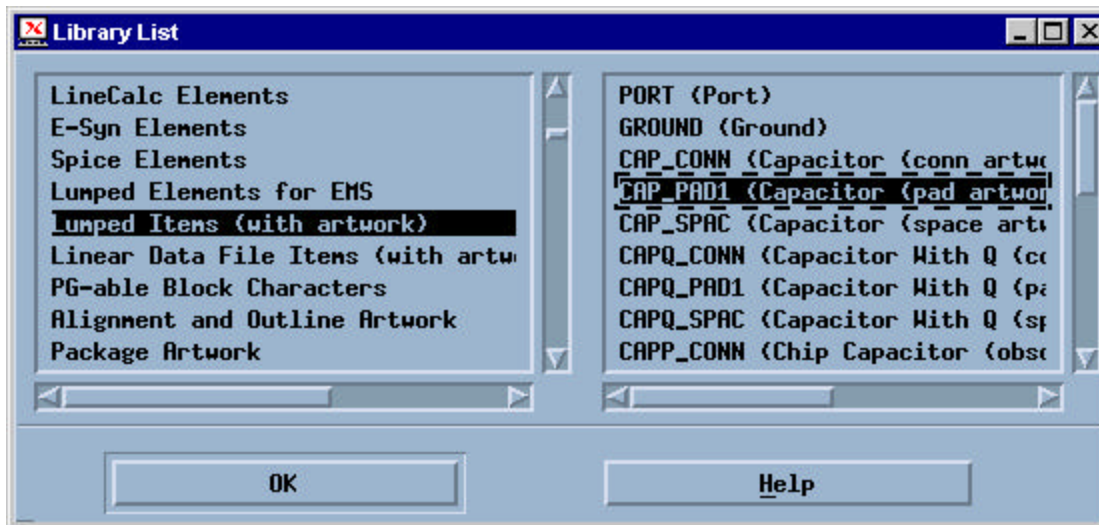
You will get a 3-port picture of a diode. Add a ground to the extra port on the bottom.





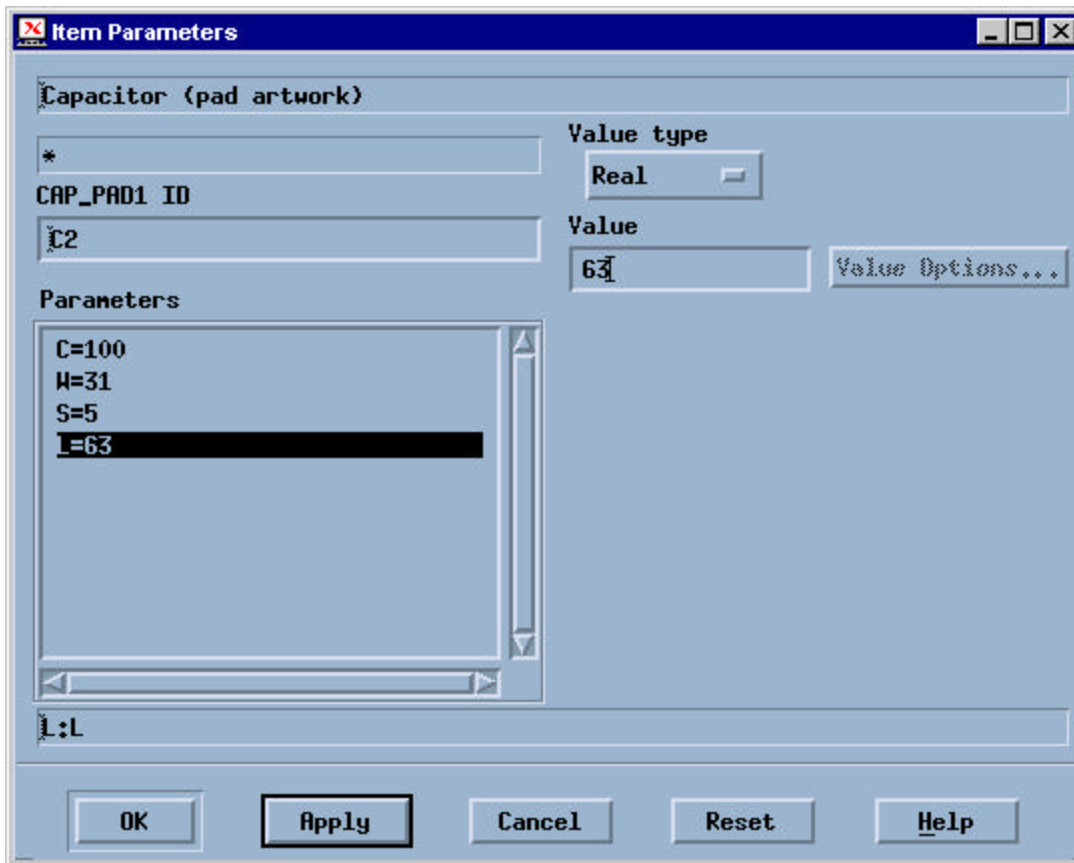
Now add a capacitor pad for soldering.  
Cap\_pad1 represents a capacitor WITH its  
solder pads.

Use the library again:

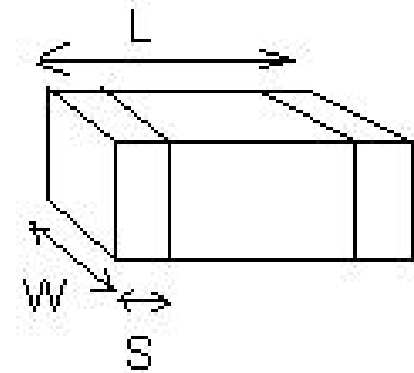




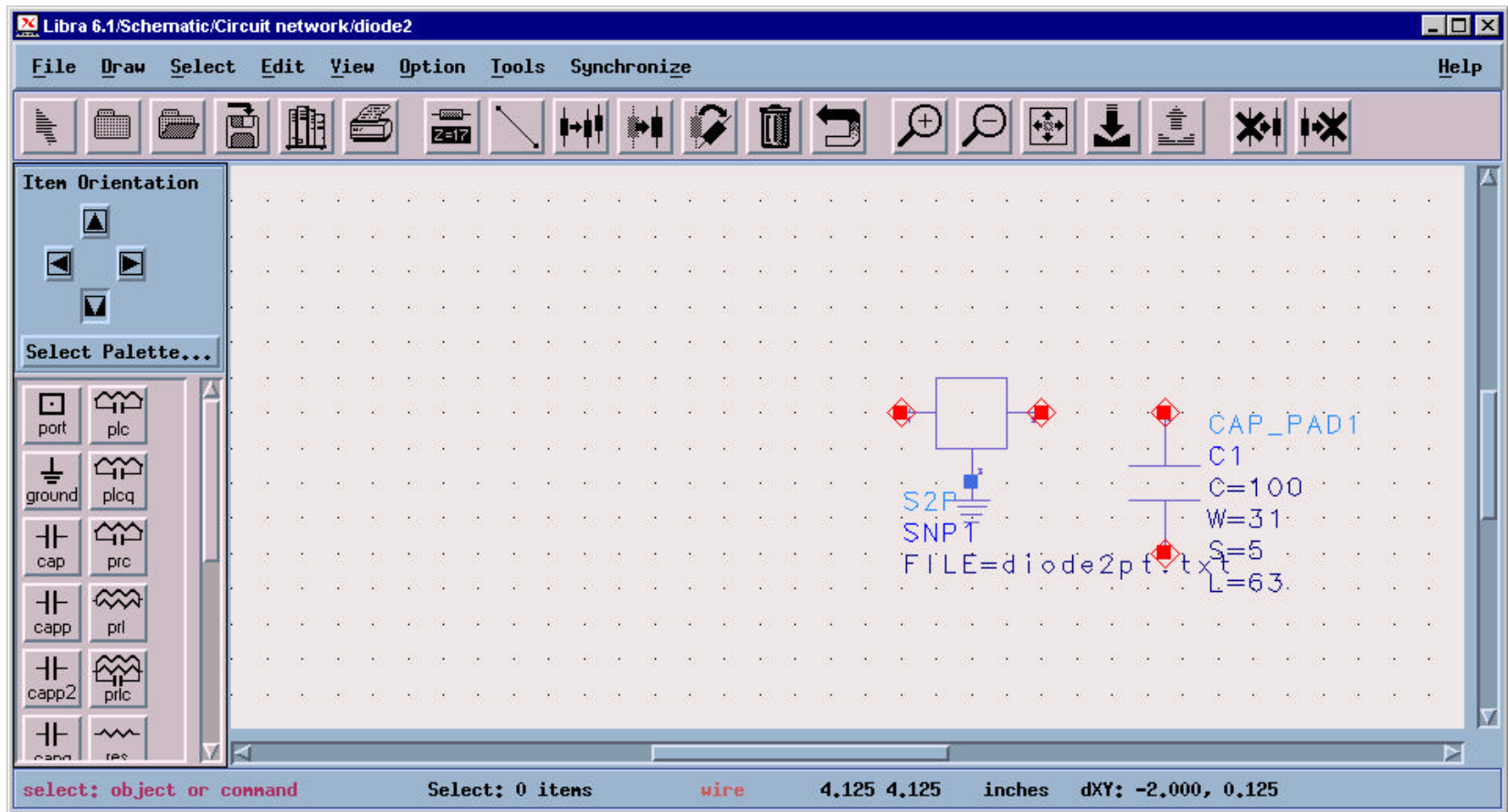
Define C, W,S,L from the data sheet. Units are from your default.



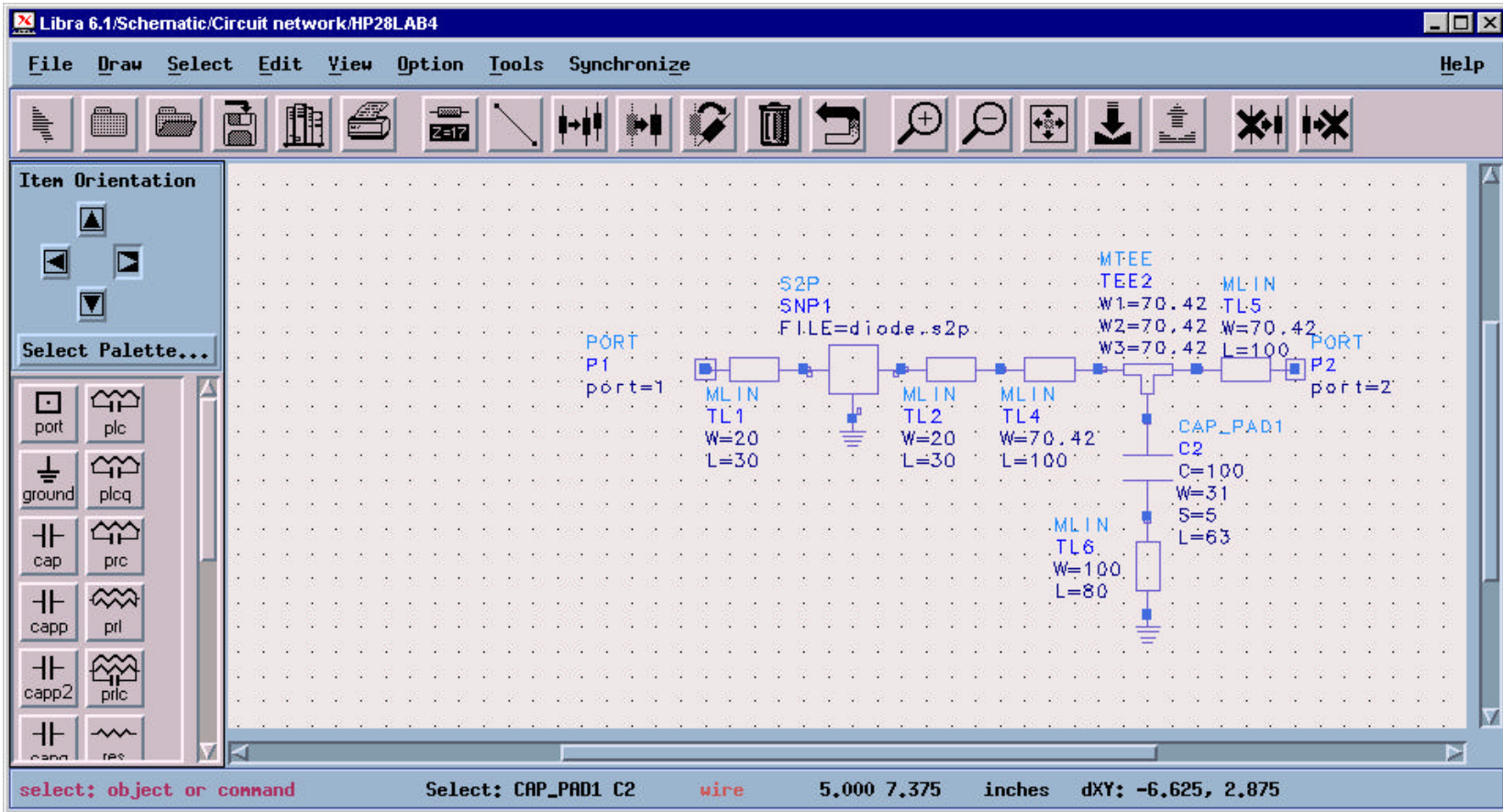
Units here are pF and mils



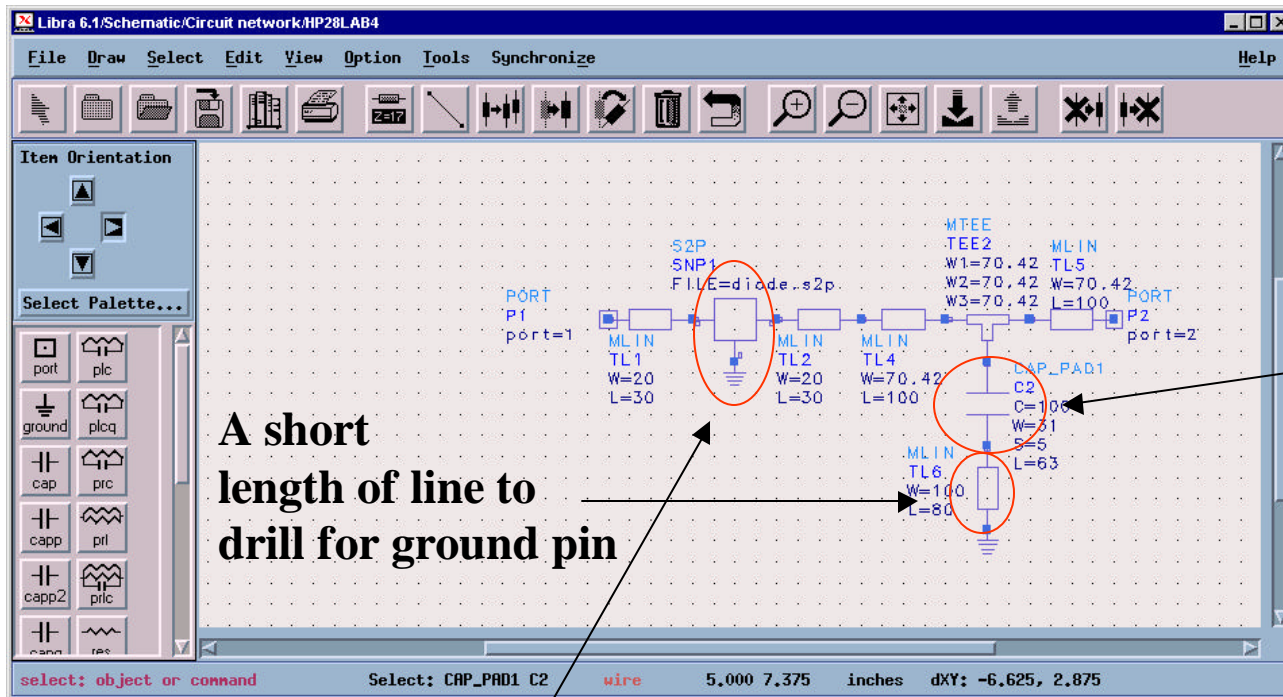
Put the capacitor on the circuit.  
Cap\_pad1 is the artwork for the capacitor  
(pads that will be used for soldering and  
sufficient space between them.



# Add components as needed: (Explanations follow)



# Diode and Capacitor



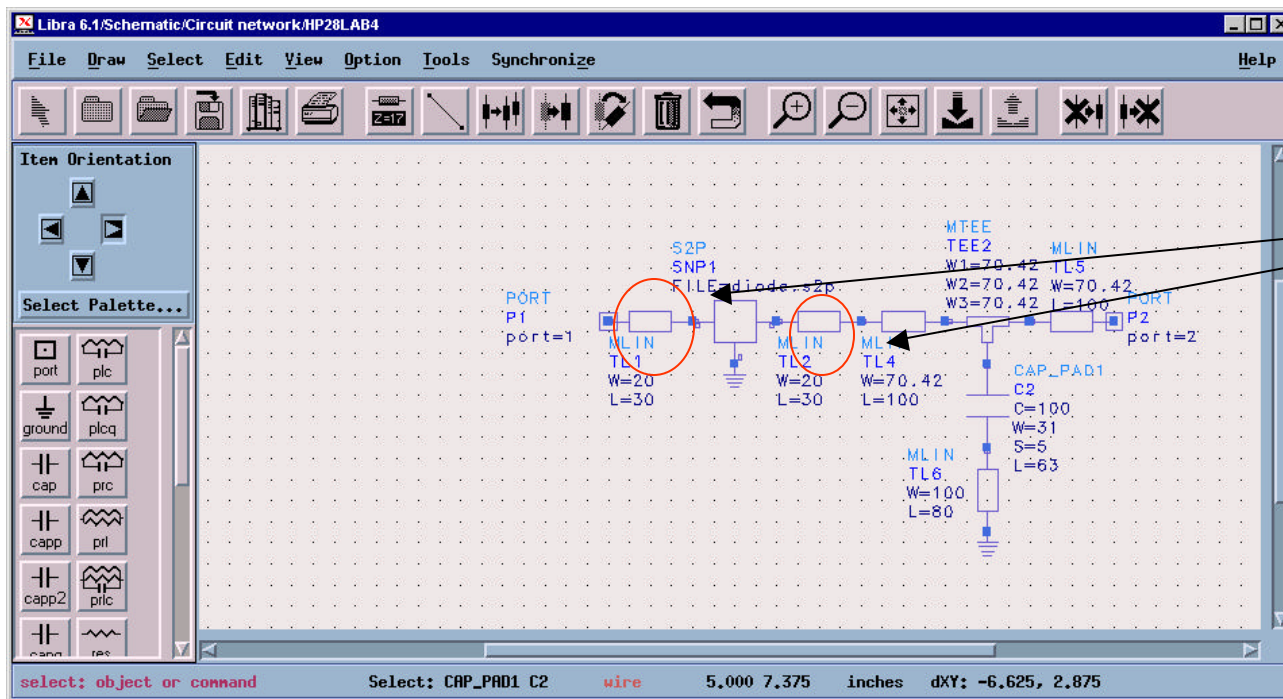
A short length of line to drill for ground pin

Capacitor with layout artwork for solder pads, good for simulation and milling.

Your diode S-parameters for simulation.  
For milling, you will need artwork instead.

# Diode Solder pads

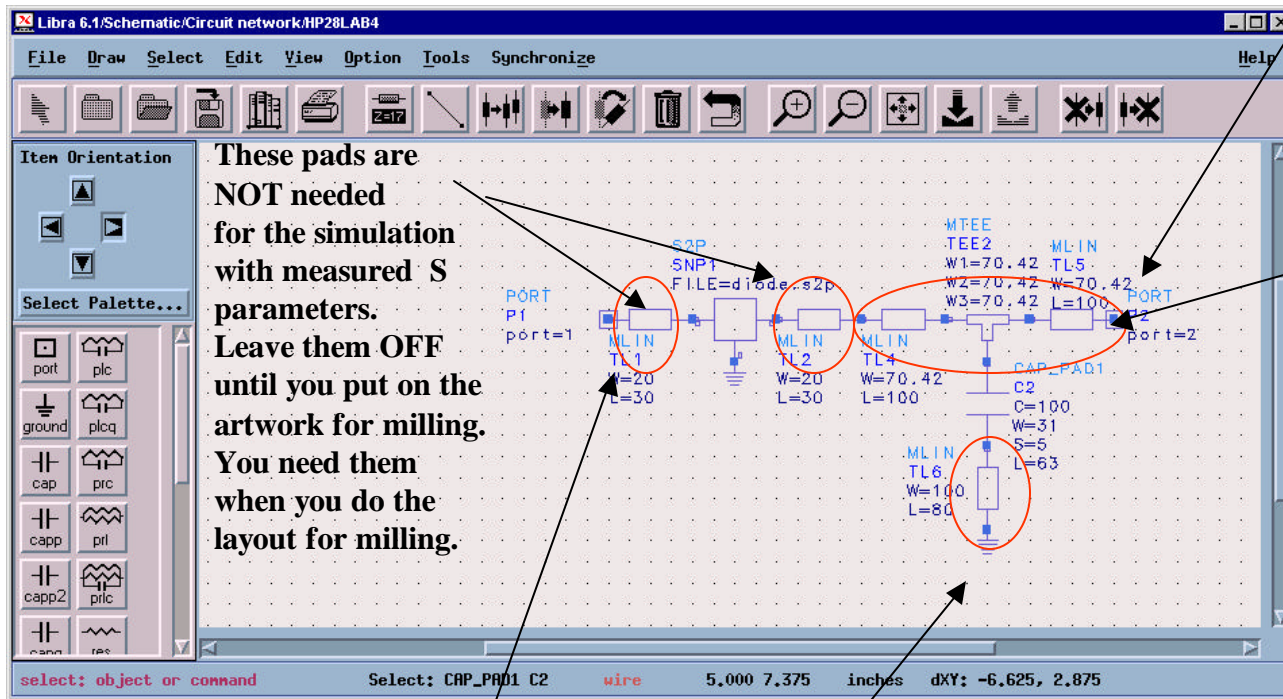
IF you use diode S-parameters from the HP website, you will need to add the solder pads (which add length of lines). Find the size of solder pads in the data sheets OR the diode artwork. (See layout slide # 27 below.) Do NOT add these pads if you are using measured data, because they are already part of the measurements.



**Pads for soldering your diode. See artwork (slide #27) to determine the size.**



# Physical connection of capacitor



These pads are NOT needed for the simulation with measured S parameters. Leave them OFF until you put on the artwork for milling. You need them when you do the layout for milling.

You will attach your DC voltmeter on this port.

DC output line Long enough to get some separation between diode and cap (so they aren't on top of each other). Doesn't matter much how long this is, as long as you account for it in the simulation, which is what you are doing here.

Remember a port

Ground pad (in Circuit Cam you will need to drill a hole for milling).

## Now:

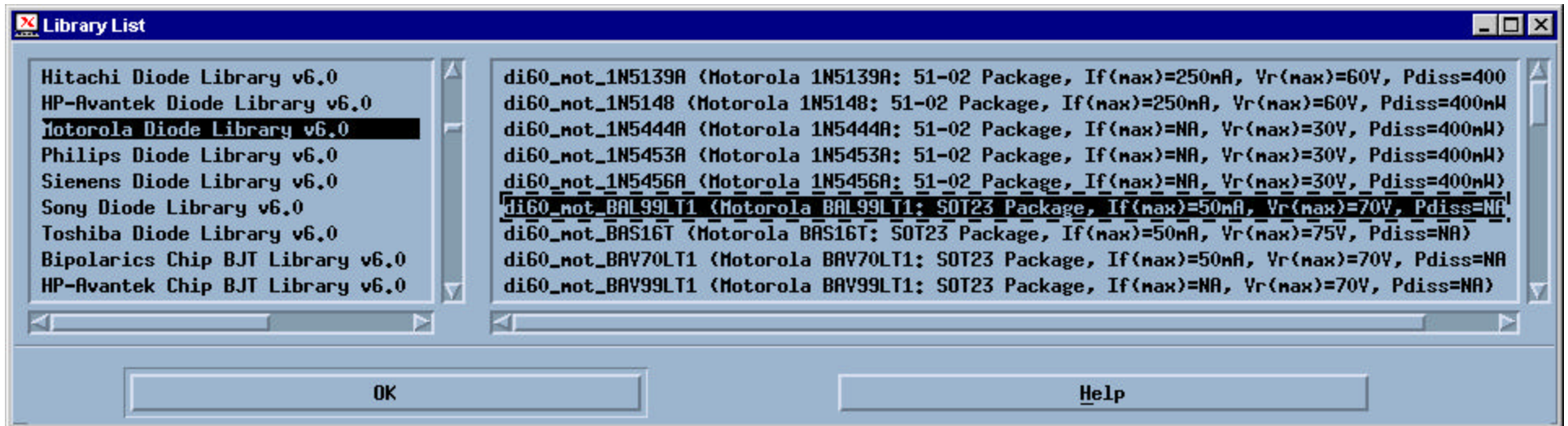
- Simulate the circuit in testbench and find  $Z_{11}$  for both frequencies (2.4 and 2.6 GHz)
- Use Tline or Smith Chart to design a stub-matching network. A short circuited stub is preferred.
- Follow the single-stub tutorial from here to add a stub matching network to the front of your circuit.
- Check your circuit (in testbench) to be sure your matching is good.

# Layout:

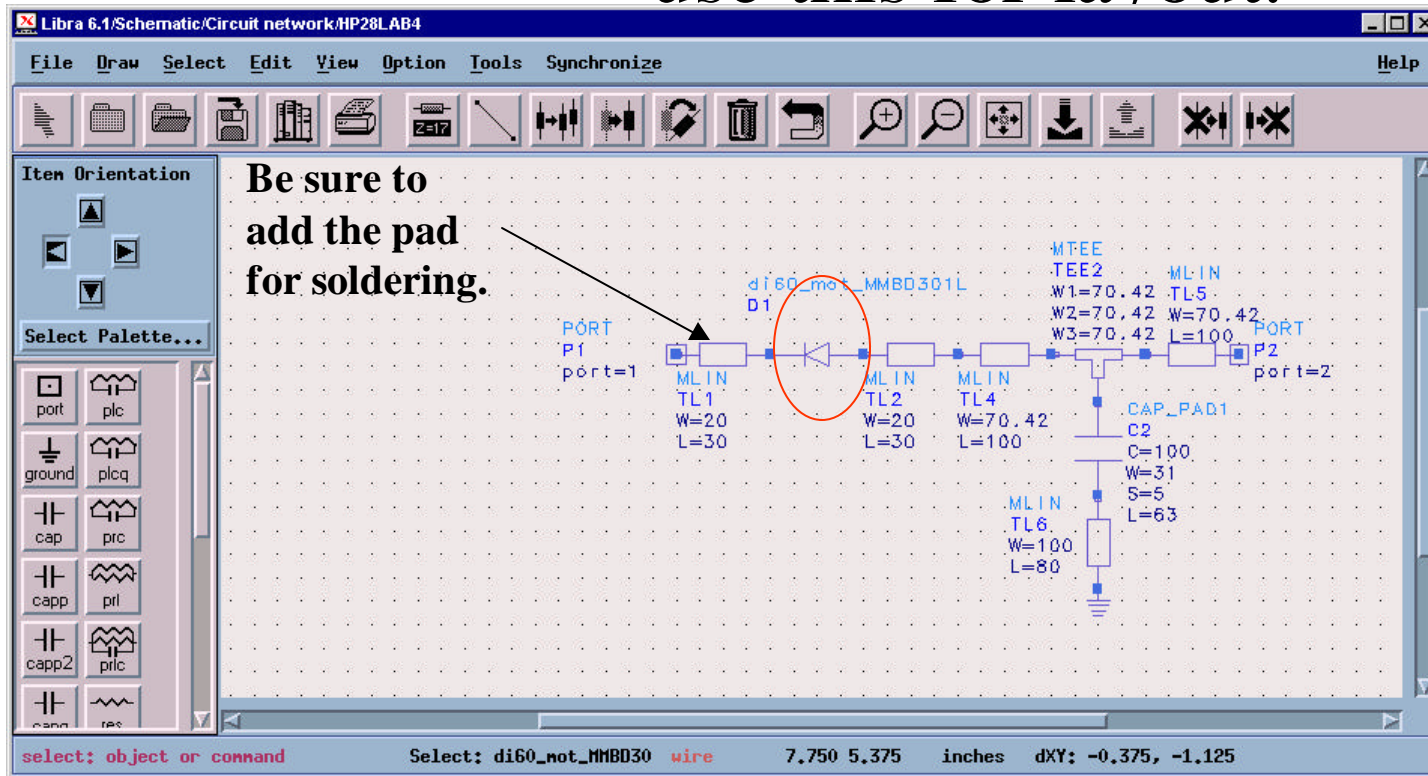
**Everything is OK for the layout except for your diode, which does not yet have proper artwork.**



Choose any diode with an SOT23 package from the library

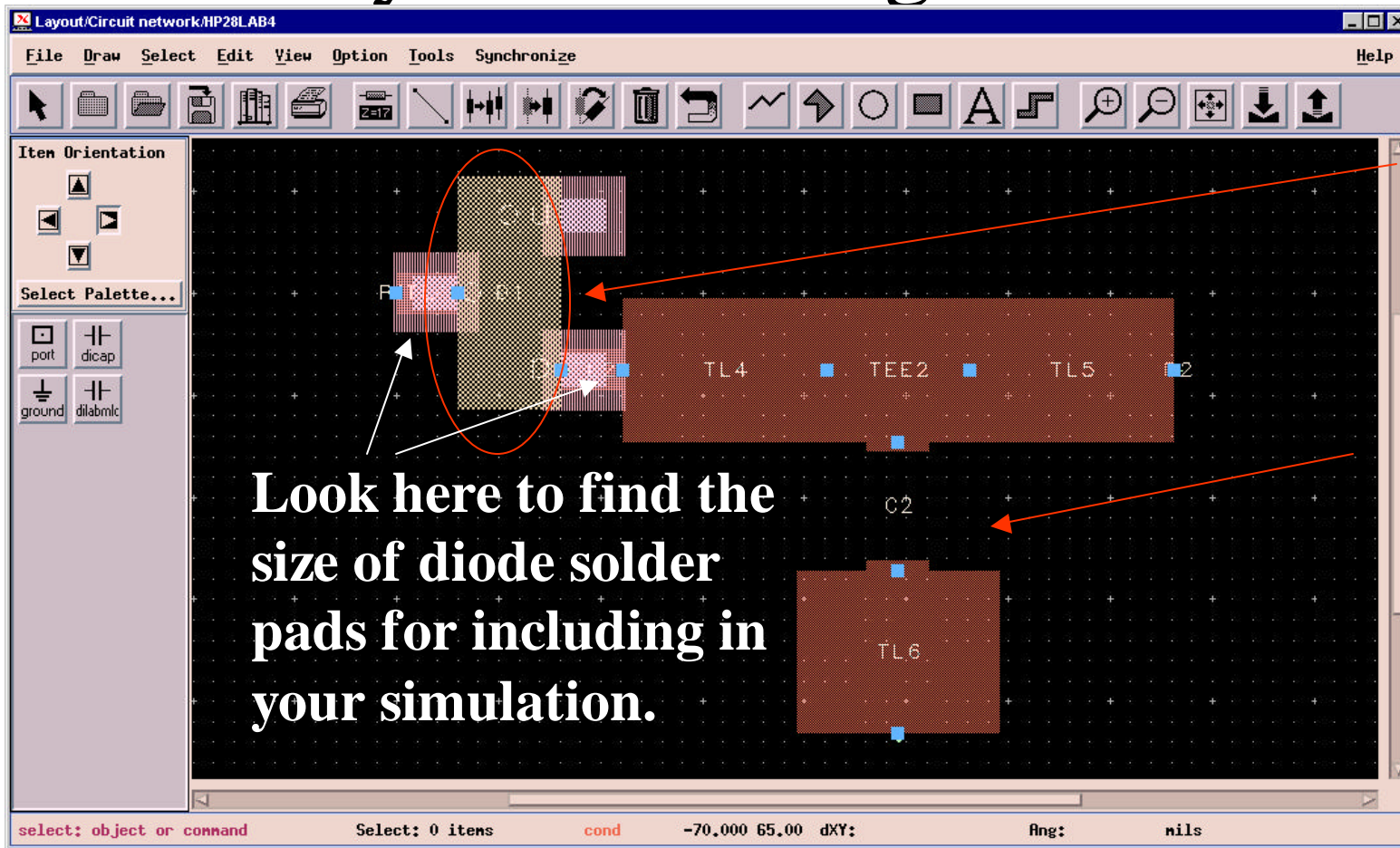


Remove the S-parameter diode, and replace with the artwork diode. Don't simulate it, just use this for layout.



The diode you will use in your lab (HP 2850) is **BACKWARDS** from the standard package, so turn the artwork around.

Synchronize, and take to layout.  
This is what it looks like without  
your matching circuit



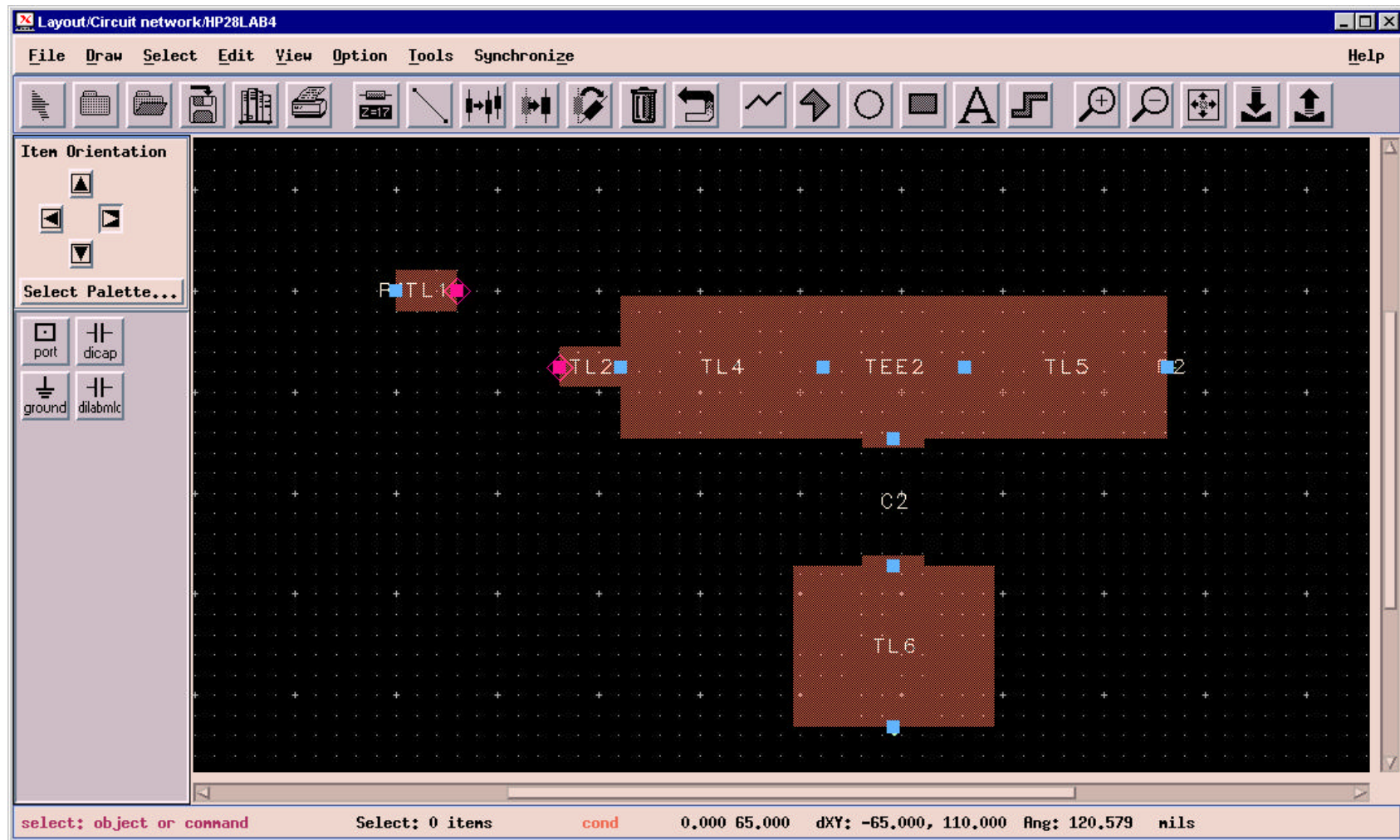
Diode

Cap  
space

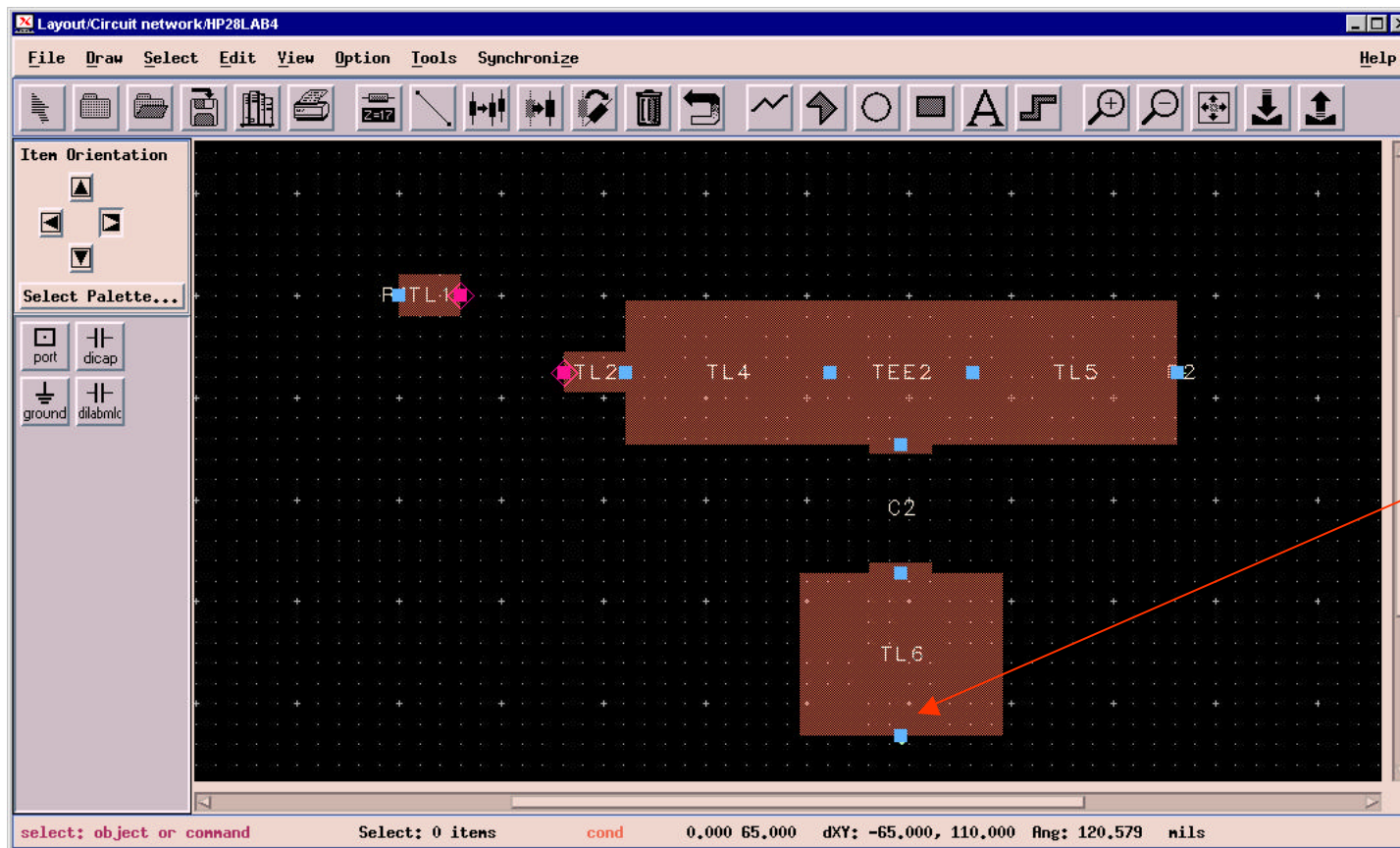
Look here to find the  
size of diode solder  
pads for including in  
your simulation.



Delete the diode from the picture to be milled, but remember what it looks like for soldering the diode.



Remember to put holes for all the shorts (ground, short ckt. stubs, etc.) when you mill the circuit



That's it! You are done!