Virtuoso 23.1
Module 4 – Specifications, Corners, and Real-Time Tuning

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Contents

Module Objective

In this module, we will learn how to:

- add specifications to the design using the tool Calculator
- add sweeps and corners to the design
- run simulations across multiple corners under different process conditions
- use the Waveform Balloon feature
- use the Real Time Tunning feature

1. Adding Specifications to the Design

Adding Specs to the Design

Sweeps and Corners

Setting up Sweeps and Corners

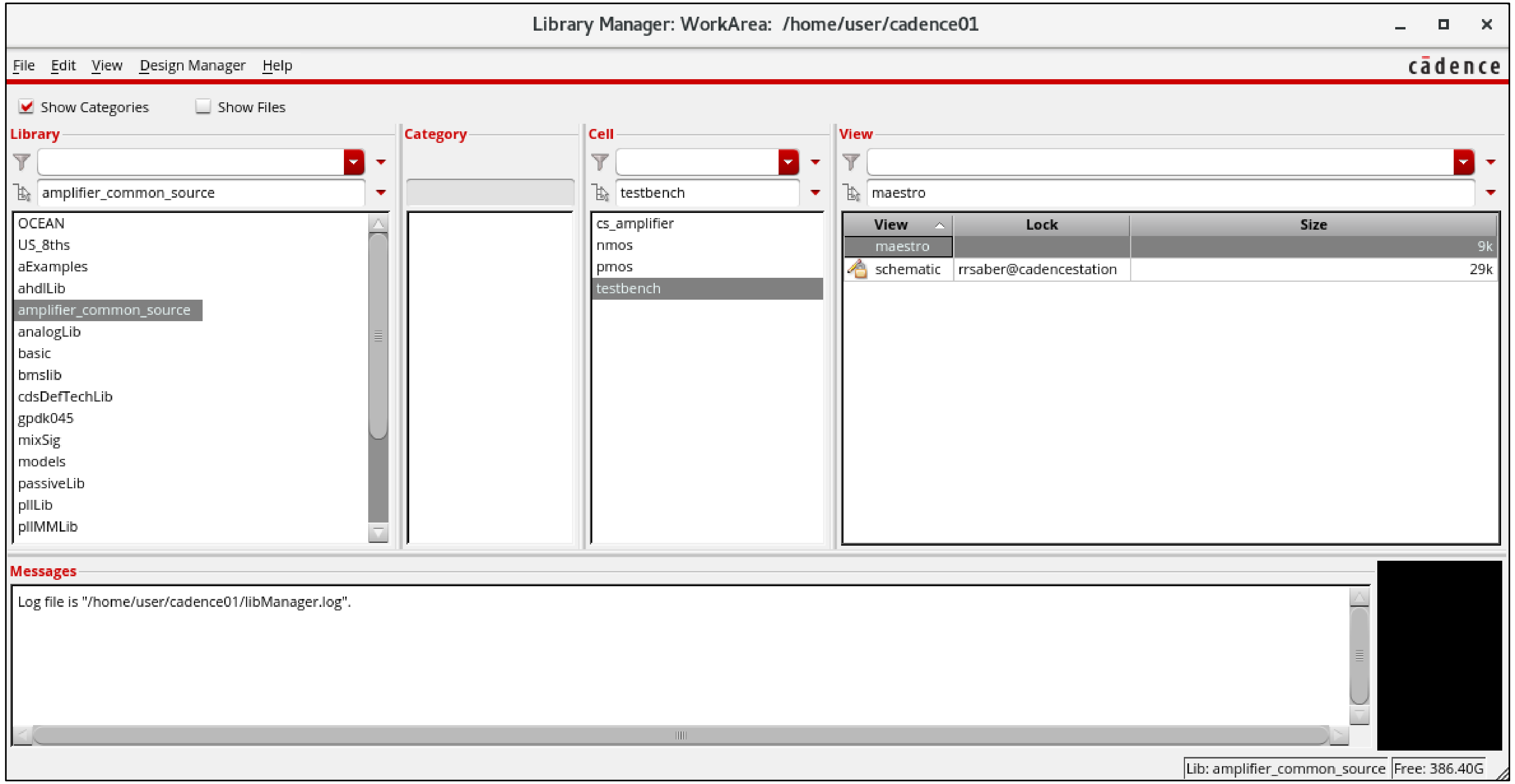
Running Simulations and Analyzing Results

Waveform Balloons

Real Time Tuning

1. Adding Specifications to the Design

- Select the “amplifier_common_source” library, the “testbench” cell, and double click on the maestro view.



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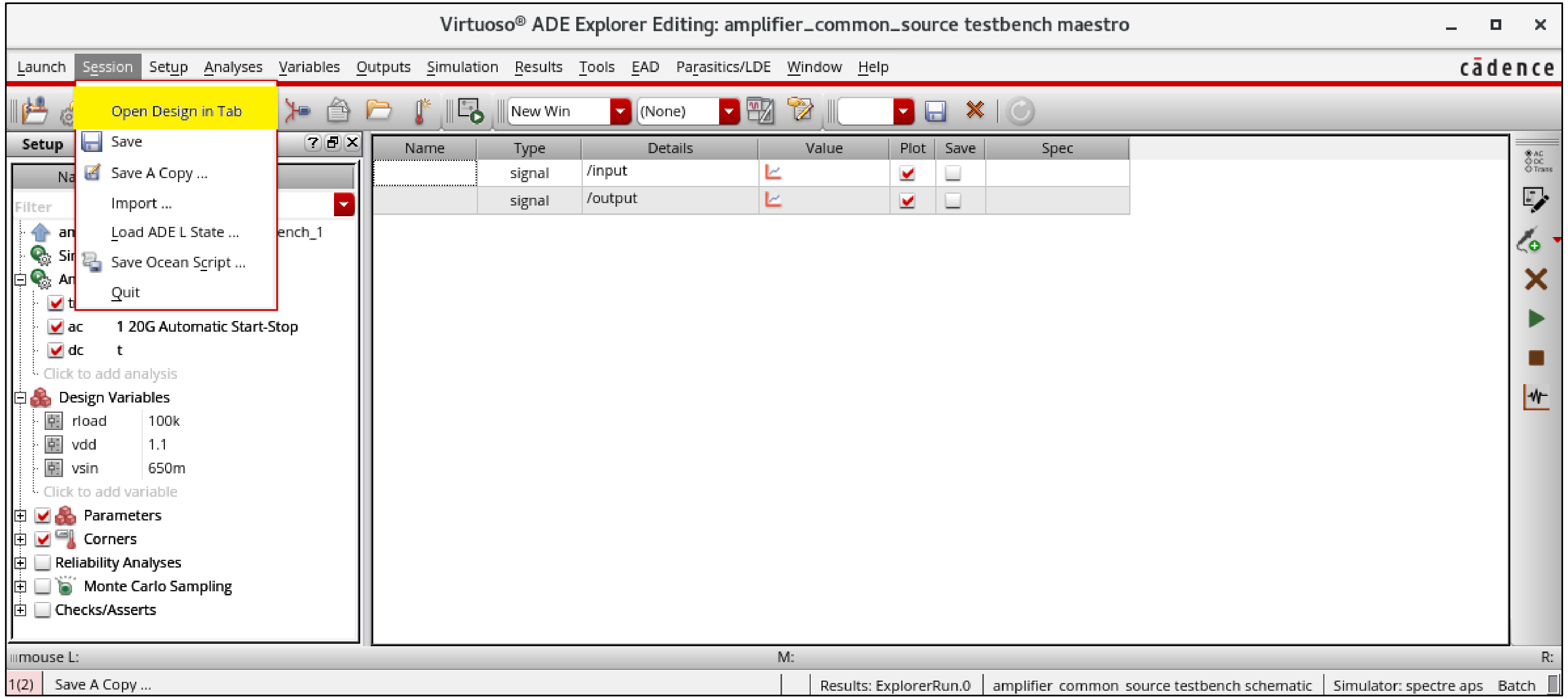
1. Adding Specifications to the Design

- To open the schematic view of the testbench, select Session → Open Design in Tab.



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1. Adding Specifications to the Design *(continued)*

- ADE Explorer provides us the option to set up specification limits for measured outputs. This option enables us to verify/check whether our design meets its designated specifications.
- After running each simulation, ADE Explorer compares the results to the specs that we have provided.
- ADE Explorer employs the following scheme to indicate the status of our results:
  - ➢ pass, near, or fail status for each simulation.
    - pass means that the measured value is within the limits defined by the specification.
    - near means that the measured value is no more than 10% outside the target value of the specification.
    - fail means that the measured value is greater than 10% outside the target value of the specification.
- The measured values with a pass status are displayed with a green background, those with a near status appear with a yellow background, and those with a fail status appear with a red background.

- This is a major time-saving feature.

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1. Adding Specifications to the Design *(continued)*

- We will test the voltage gain followed by the bandwidth, current consumption, and power consumption specifications.
- The specifications are on slide 2 of Module 2.
- First uncheck the “Plot” checkbox for the output and input expressions.
- We will start by setting up the gain specification.
- Open the Calculator (Tools → Calculator).
- The gain is the highest point in the steady part of the output voltage divided by the input voltage.
- If you recall, we plotted the gain in Module 3 by using the tool Calculator and by setting our function to `dB20(VF("/output")/VF("/input"))`.
- Here we need to add the “ymax” function which will give us the highest point, which will be our gain.
- Please check Module 3 if you need a refresher on how to write the equation on the next slide.

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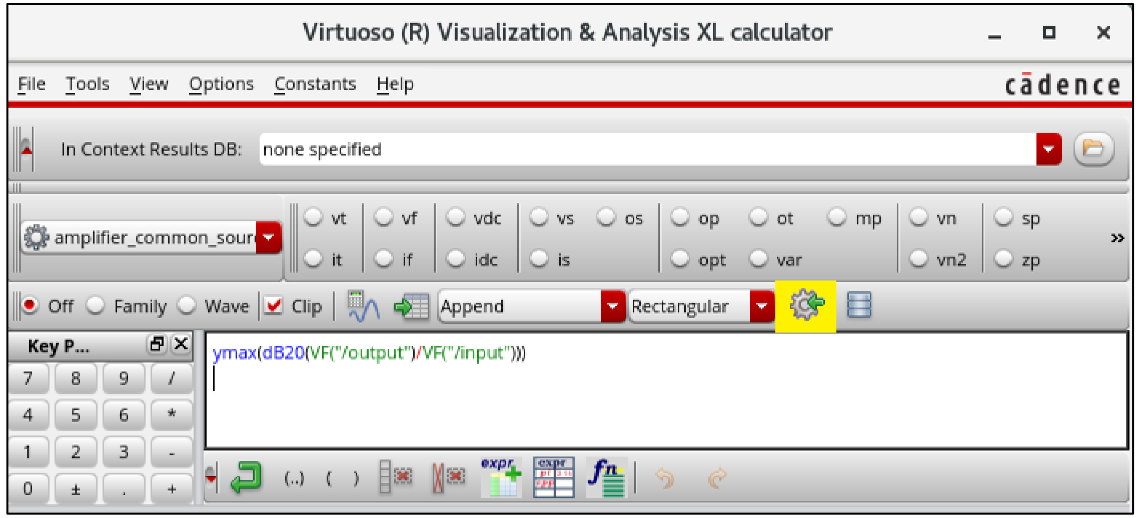
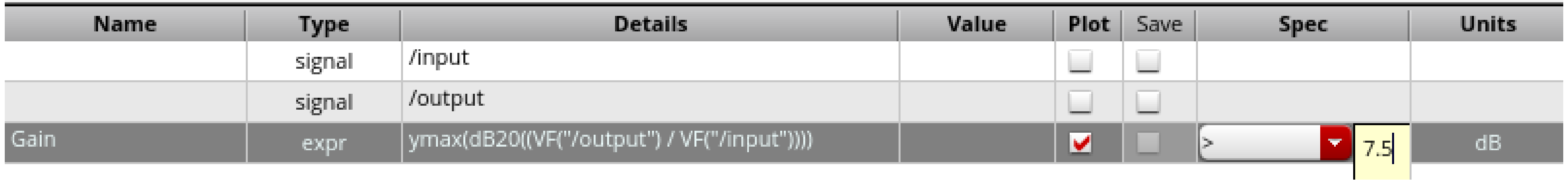
1. Adding Specifications to the Design *(continued)*

- The new equation will be: `ymax(dB20(VF("/output")/VF("/input")))`
- To send the output of our equation to the output setup window click on the button highlighted below.



- In the maestro tab, change the name to "Gain", the Spec to > 7.5, and Units to dB.



Name	Type	Details	Value	Plot	Save	Spec	Units
	signal	/input		☐	☐		
	signal	/output		☐	☐		
Gain	expr	ymax(dB20((VF("/output") / VF("/input"))))		☑	☐	> 7.5	dB

- Note if the Units column is not visible, right click on "Spec" and enable the Units column.

- Note if the Units column is not visible, right click on "Spec" and enable the Units column.
- Note that if the output isn't appearing in the setup window, it means that the syntax is wrong or there is an error.

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- **Adding Specs to the Design**
- Sweeps and Corners
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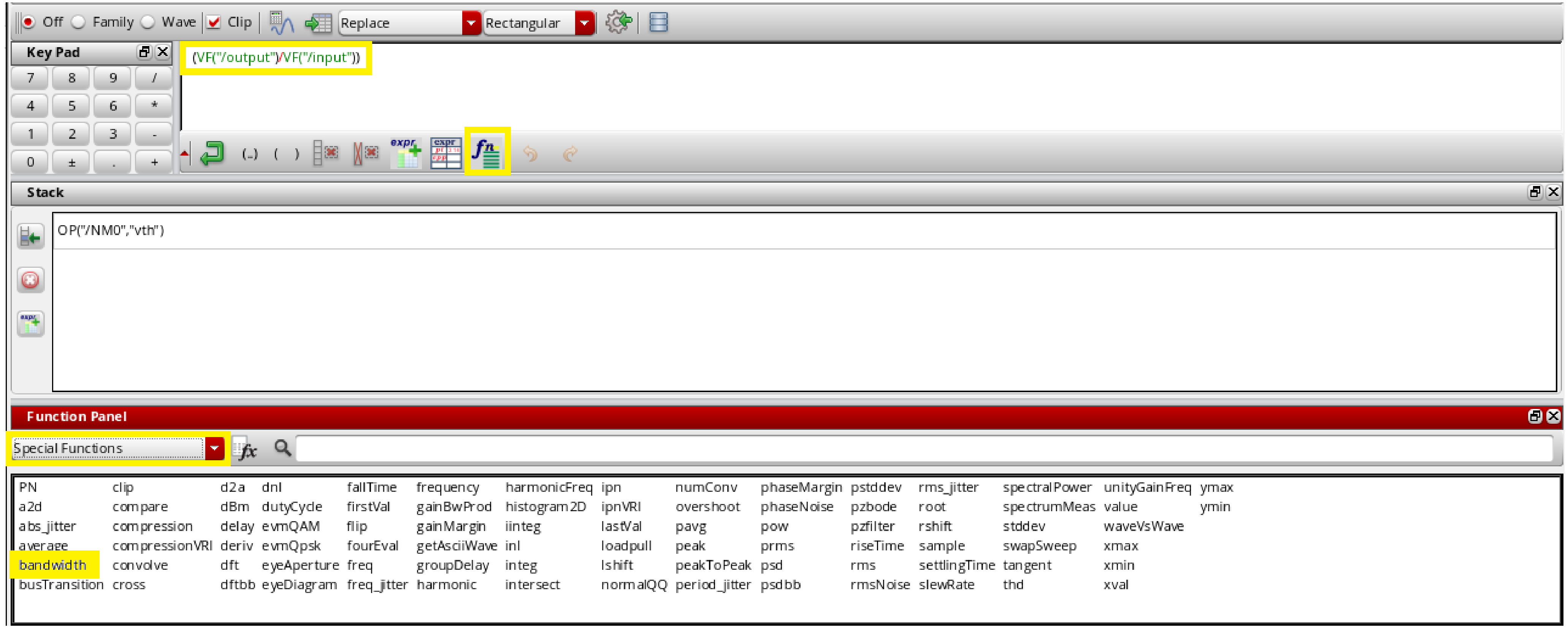
1. Adding Specifications to the Design *(continued)*

- For the bandwidth, open the calculator again and type `(VF("/output")/VF("/input"))` in the function space.
- Click on the "show function panel" button, choose "**Special Functions**" and click on "**bandwidth**".



- If the Function Panel isn't appearing, make sure to window Fullscreen the Calculator.

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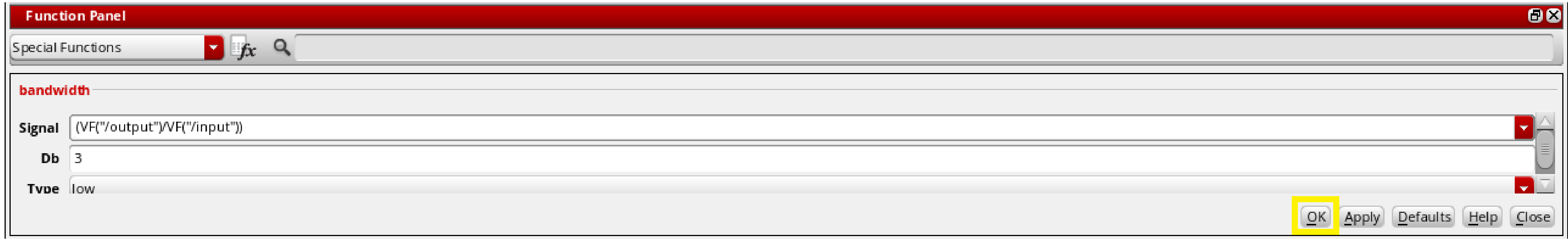
1. Adding Specifications to the Design *(continued)*

- After clicking on “bandwidth”, the following window should appear.



- Where “Signal” is the plot that we want to get the bandwidth for, “Db” is by how much we want to go down from the maximum. In our case we need the 3dB bandwidth.
- Type specifies the type of plot you have. If it is shaped like the output of a low pass filter choose “low”. If it resembles the output of a high pass filter choose “high”. If it is for a band pass filter choose “band”.
- Choose “low” for the Type and click OK.

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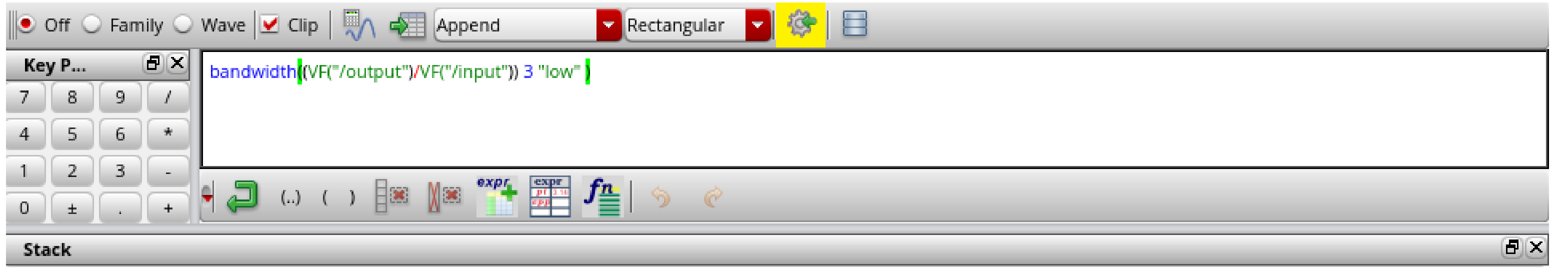
1. Adding Specifications to the Design *(continued)*

- Make sure that the written expression is the following:

```
bandwidth((VF("/output")/VF("/input")) 3 "low" )
```

- Click the highlighted button to send the output to the output setup window.



- Name your output “Bandwidth”, set the specification to > 4G and the Units to Hz.

Name	Type	Details	Value	Plot	Save	Spec	Units
	signal	/input		☐	☐		
	signal	/output		☐	☐		
Gain	expr	ymax(dB20((VF("/output") / VF("/input"))))		☑	☐	> 7.5	dB
Bandwidth	expr	bandwidth((VF("/output") / VF("/input")) 3 "low")		☑	☐	> 4G	Hz

- Note if the Units column is not visible, right click on “Spec” and enable the Units column.

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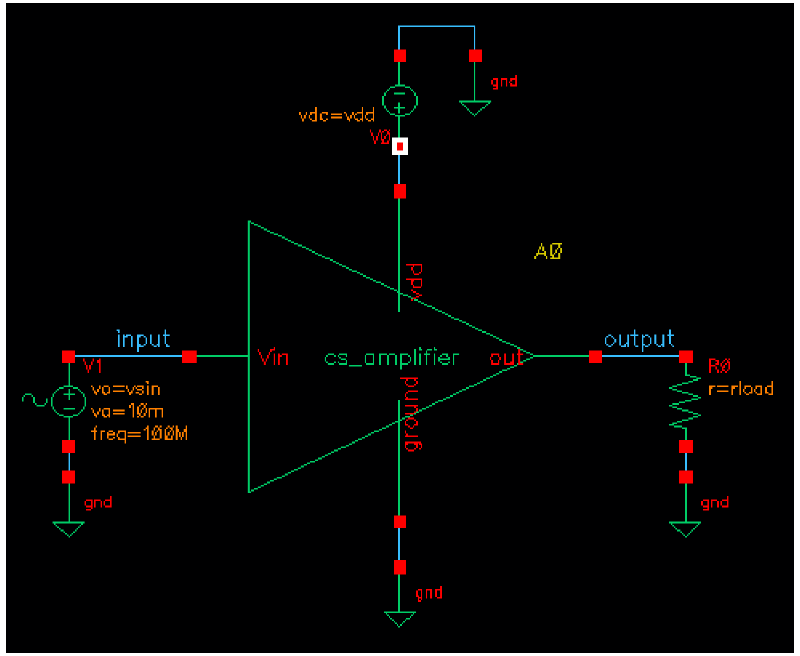
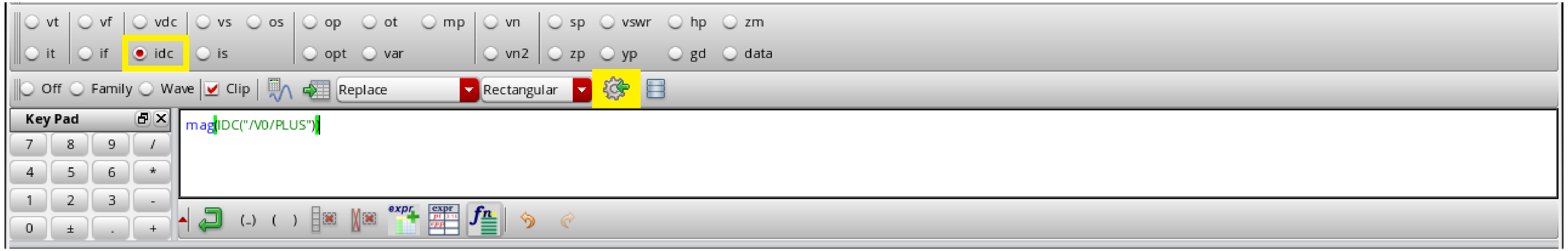
1. Adding Specifications to the Design *(continued)*

- The current consumption is the current at the voltage source. In the calculator type "**`mag(`** " and click on **idc** then click on the red terminal of the voltage source. Then close the "**mag**" parenthesis.
- The "mag" function represents magnitude. We use it to get the absolute value of our chosen output.
- Send the output to the output setup window by clicking the highlighted button.





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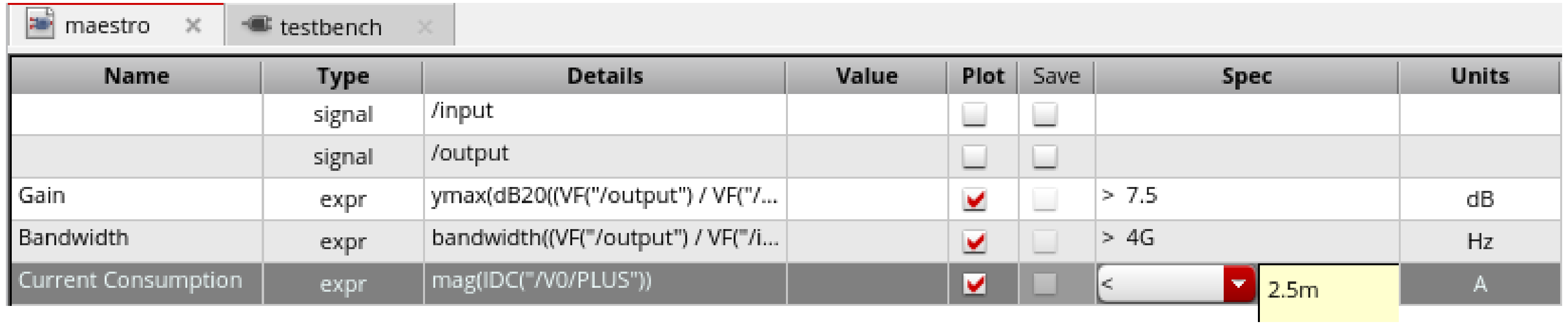
1. Adding Specifications to the Design *(continued)*

- Change the output name to “Current Consumption”, set the specification to < 2.5m, and the Units to A.



maestro | testbench

Name	Type	Details	Value	Plot	Save	Spec	Units
	signal	/input		☐	☐		
	signal	/output		☐	☐		
Gain	expr	ymax(dB20((VF("/output") / VF("/...		☑		> 7.5	dB
Bandwidth	expr	bandwidth((VF("/output") / VF("/i...		☑		> 4G	Hz
Current Consumption	expr	mag(IDC("/V0/PLUS"))		☑	☐	< 2.5m	A

- Note if the Units column is not visible, right click on “Spec” and enable the Units column.

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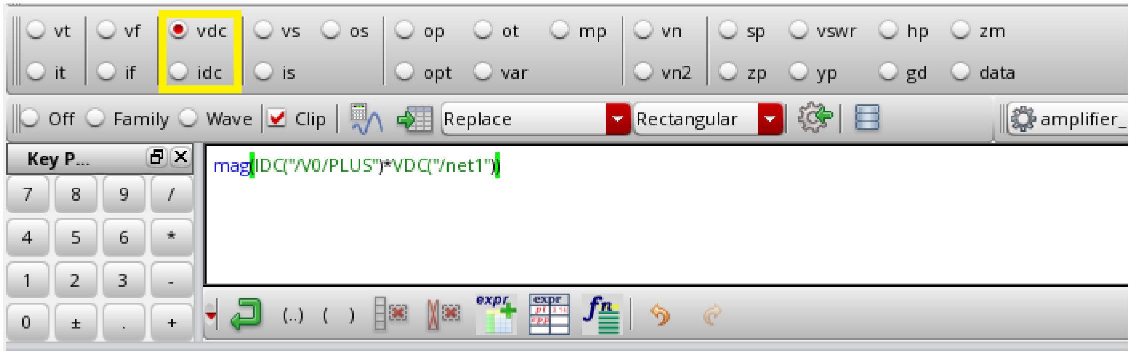
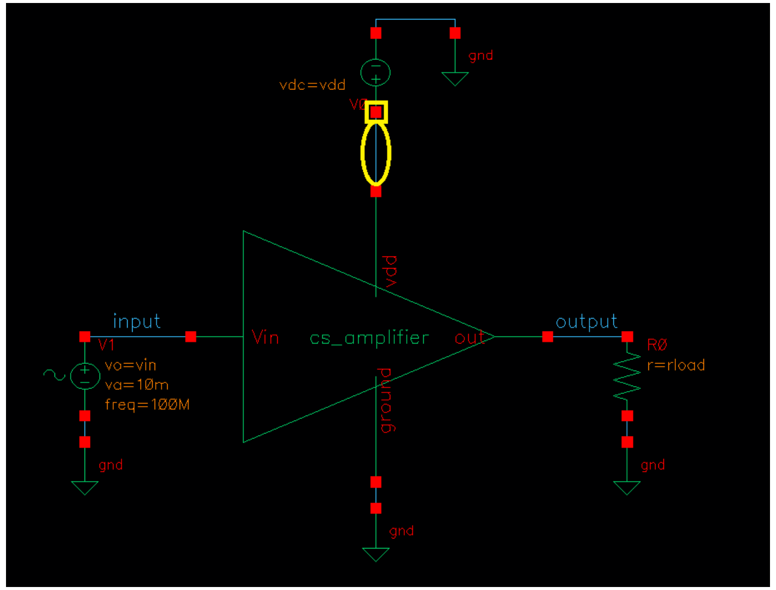
1. Adding Specifications to the Design *(continued)*

- Finally, the power consumption is the multiplication of the current at the source by the source voltage.
- In the calculator type "`mag(` " to get the magnitude, then click on **idc** and click on the red terminal of the voltage source. Add the multiplication sign "*****" and click on **vdc**, then choose the line at the voltage source to get the voltage.
- The final expression is: `mag(IDC("/V0/PLUS")*VDC("/net1"))`





- Send the expression to the output setup window by clicking on the Send Buffer Expression button.

- Note that the line representing the voltage source might have a different name than "net1" in your case.

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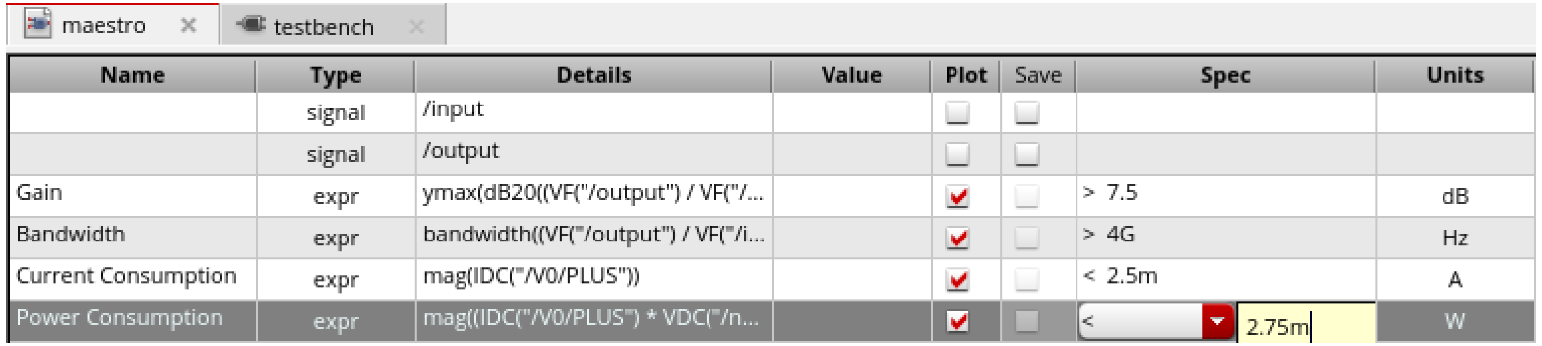
1. Adding Specifications to the Design *(continued)*

- Set the name of the output to “Power Consumption”, set the specification to < 2.75m, and the Units to W.

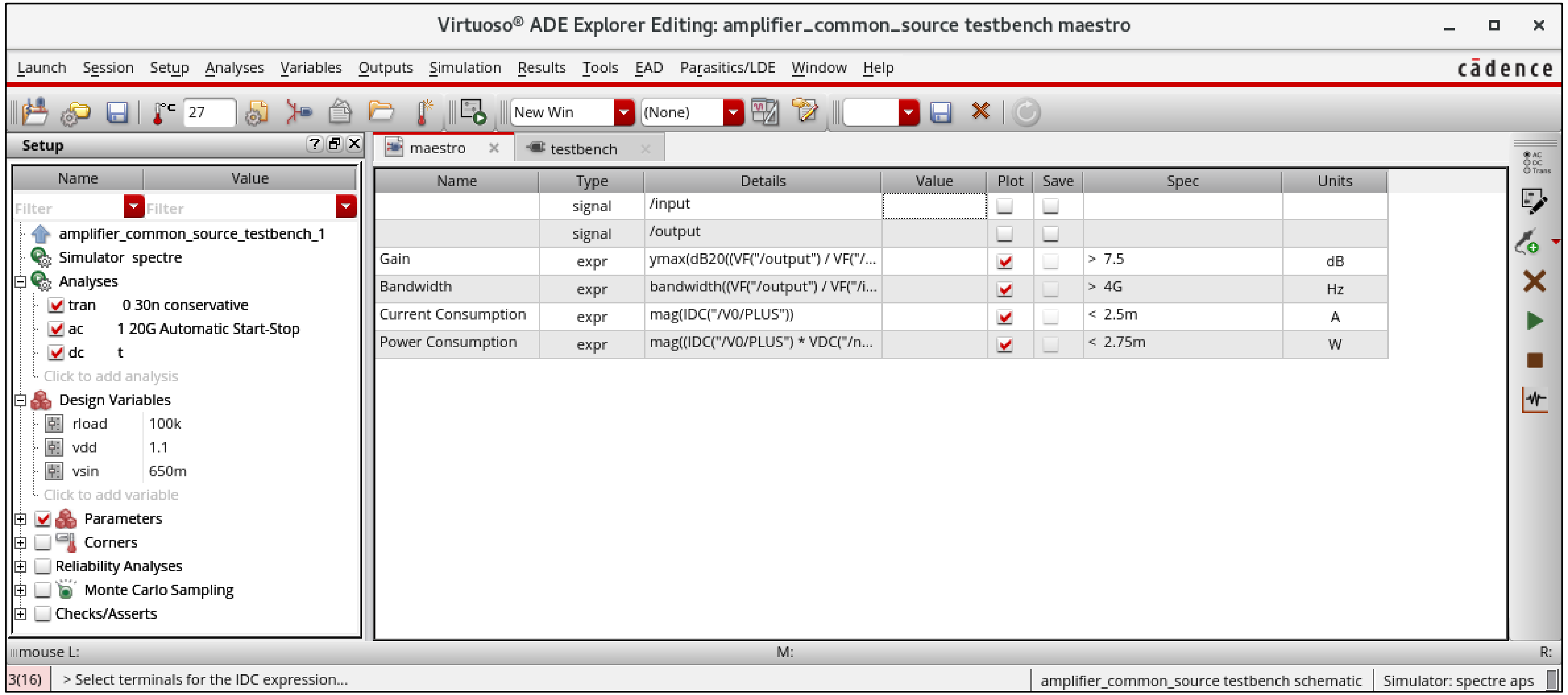


Name	Type	Details	Value	Plot	Save	Spec	Units
	signal	/input		☐	☐		
	signal	/output		☐	☐		
Gain	expr	ymax(dB20((VF("/output") / VF("/...		☑	☐	> 7.5	dB
Bandwidth	expr	bandwidth((VF("/output") / VF("/i...		☑	☐	> 4G	Hz
Current Consumption	expr	mag(IDC("/V0/PLUS"))		☑	☐	< 2.5m	A
Power Consumption	expr	mag((IDC("/V0/PLUS") * VDC("/n...		☑	☐	< 2.75m	W

- Note if the Units column is not visible, right click on “Spec” and enable the Units column.

1. Adding Specifications to the Design *(continued)*

- After adding the specifications, the maestro tab should be as shown below.



2. Sweeps and Corners

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2. Sweeps and Corners

- ***Sweeping*** model parameters and design variables enables designers to run several iterations while simulating their design.
- Thus, it enables the designer to investigate different scenarios, and run these scenarios in different types of analyses.
- This is very useful when you are trying to:
  - Meet your design with a set of required specifications
  - Verify your design

- Sweeps should be done for very specific purposes.
- Sweeps do not replace hand calculations.
- As a good practice, the results should be interpreted with care.

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2. Sweeps and Corners *(continued)*

- ***Corners*** define extreme variations of PVT:
  - Process
  - Voltage
  - Temperature

  in which you would like to analyze your circuit.
- You can set these extreme points, in your Corner analysis simulation setup.
- The output of each of these simulations should satisfy the set of specifications of this design.
- Process Corners are usually designated by ‘Fast’, ‘Typical’ and ‘Slow’, and these are related to MOS device carrier mobility.

- Corner simulations are pessimistic by nature since extreme process variation have a low probability of occurrence.
- Corner simulations deal with extreme variations.

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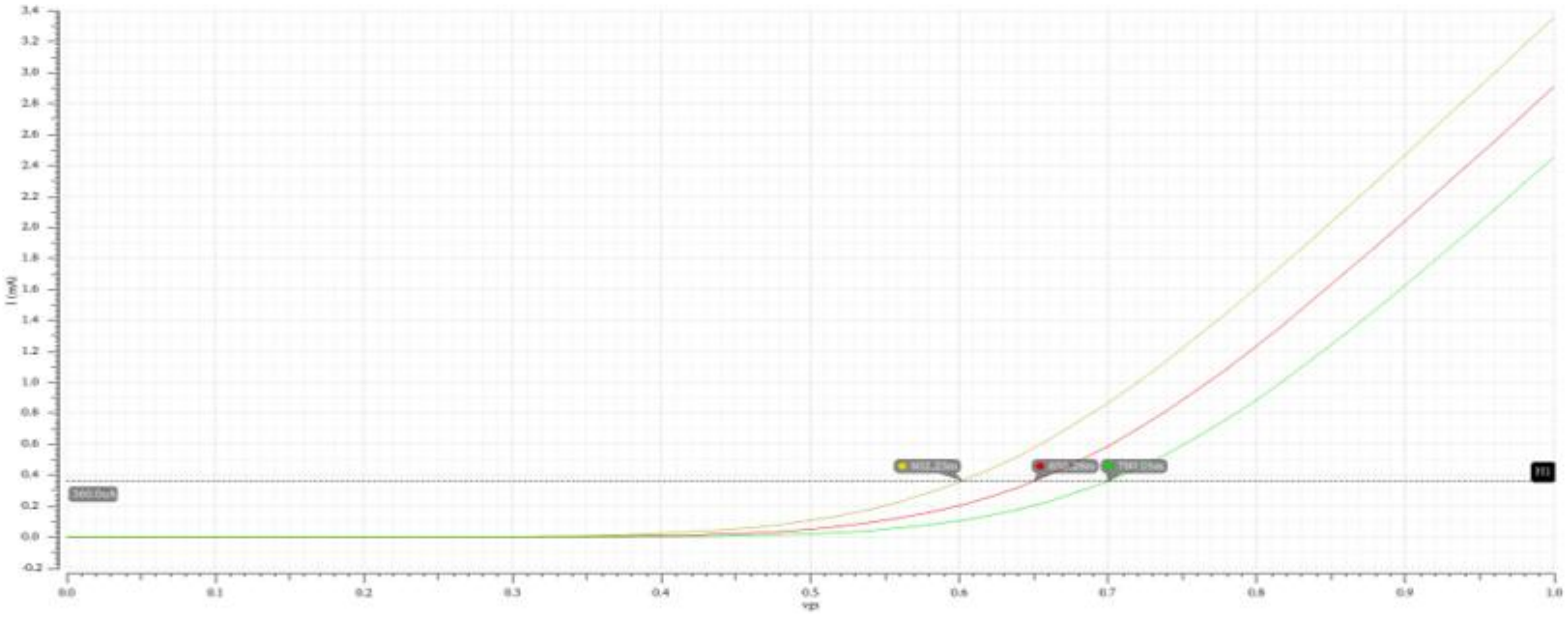
2. Sweeps and Corners *(continued)*

- Example of Process Corners for a MOS device:
  - If you simply study the behavior of one NMOS, and plot its characteristic (Id vs Vgs), you will notice that if this transistor has:
    Vth=650.28 mV, it is ‘Typical’
    Vth=602.23 mV, it is considered ‘Fast’
    Vth=700.05 mV, it is considered ‘Slow’.



Adding Specs to the Design

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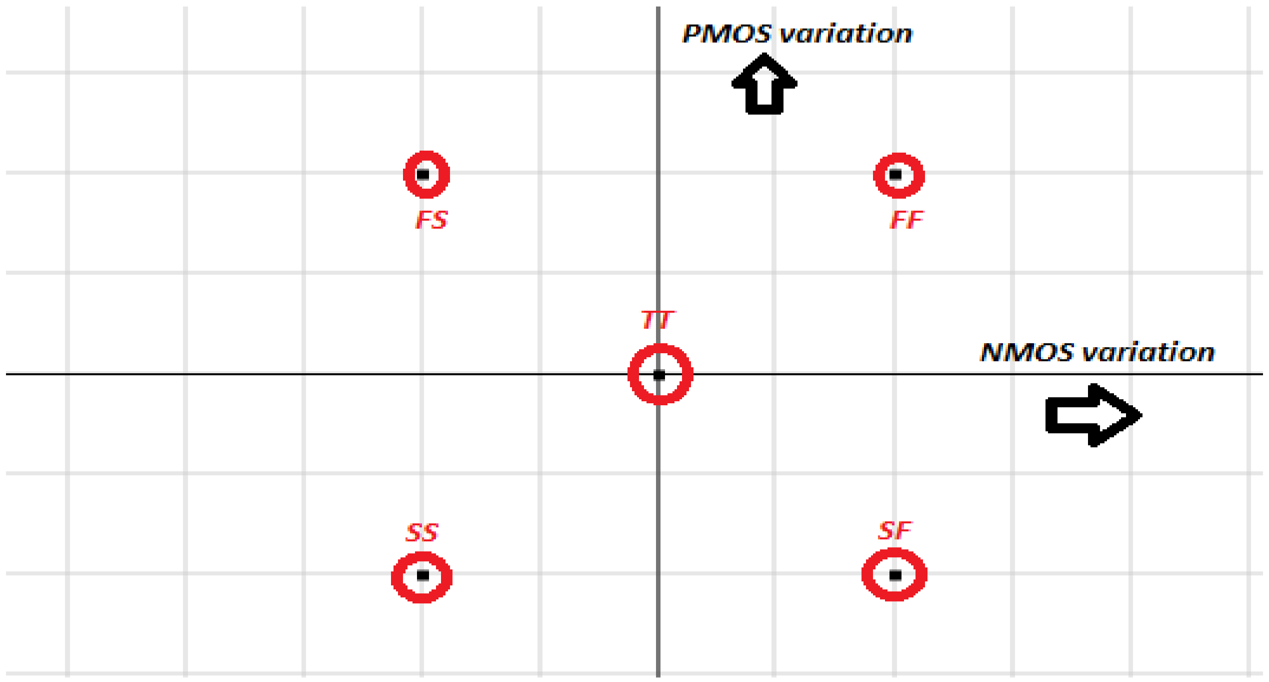
2. Sweeps and Corners *(continued)*

- If your schematic has an NMOS and a PMOS, the number of corners will increase from three to five as shown in the figure.

- The first letter designates the NMOS process condition, and the second letter designates the PMOS process condition.



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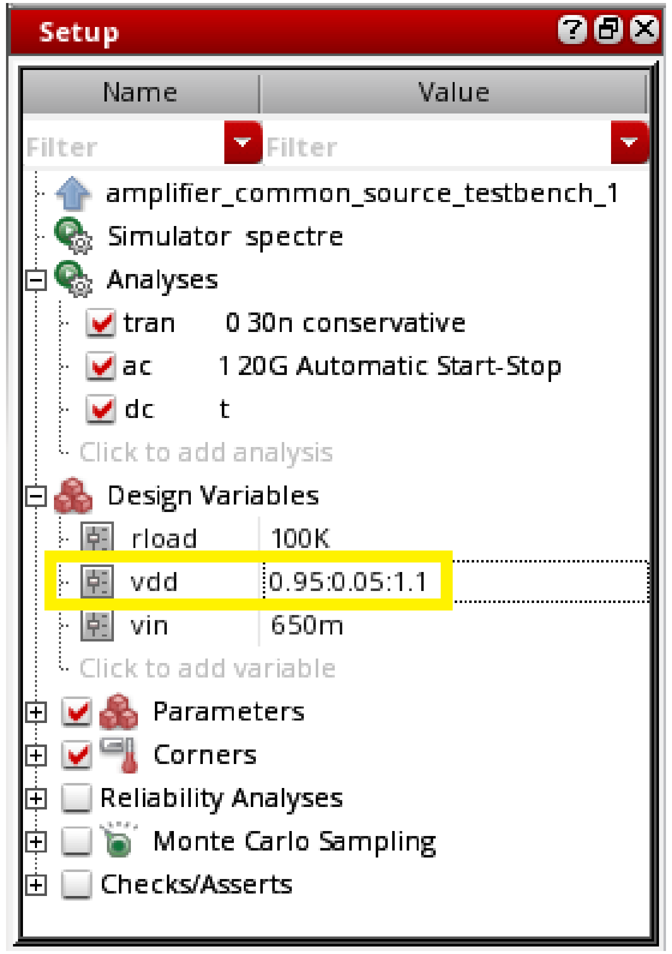
2.a. Setting up Sweeps & Corners

- ADE Explorer provides the tool to perform both ***Sweeps*** and ***Corners*** simultaneously, or each one at a time (depending on the preference of the designer).
- Sweeps can be set by defining a set of design variables in ADE Explorer.
- To define a range use the format: <start>:<step>:<stop> (you can also use space or comma separated lists).
- In this case, define a sweep for vdd type `0.95:0.05:1.1`. This means starting from 0.95V up to 1.1V with steps of 0.05V.



2.a. Setting up Sweeps & Corners *(continued)*

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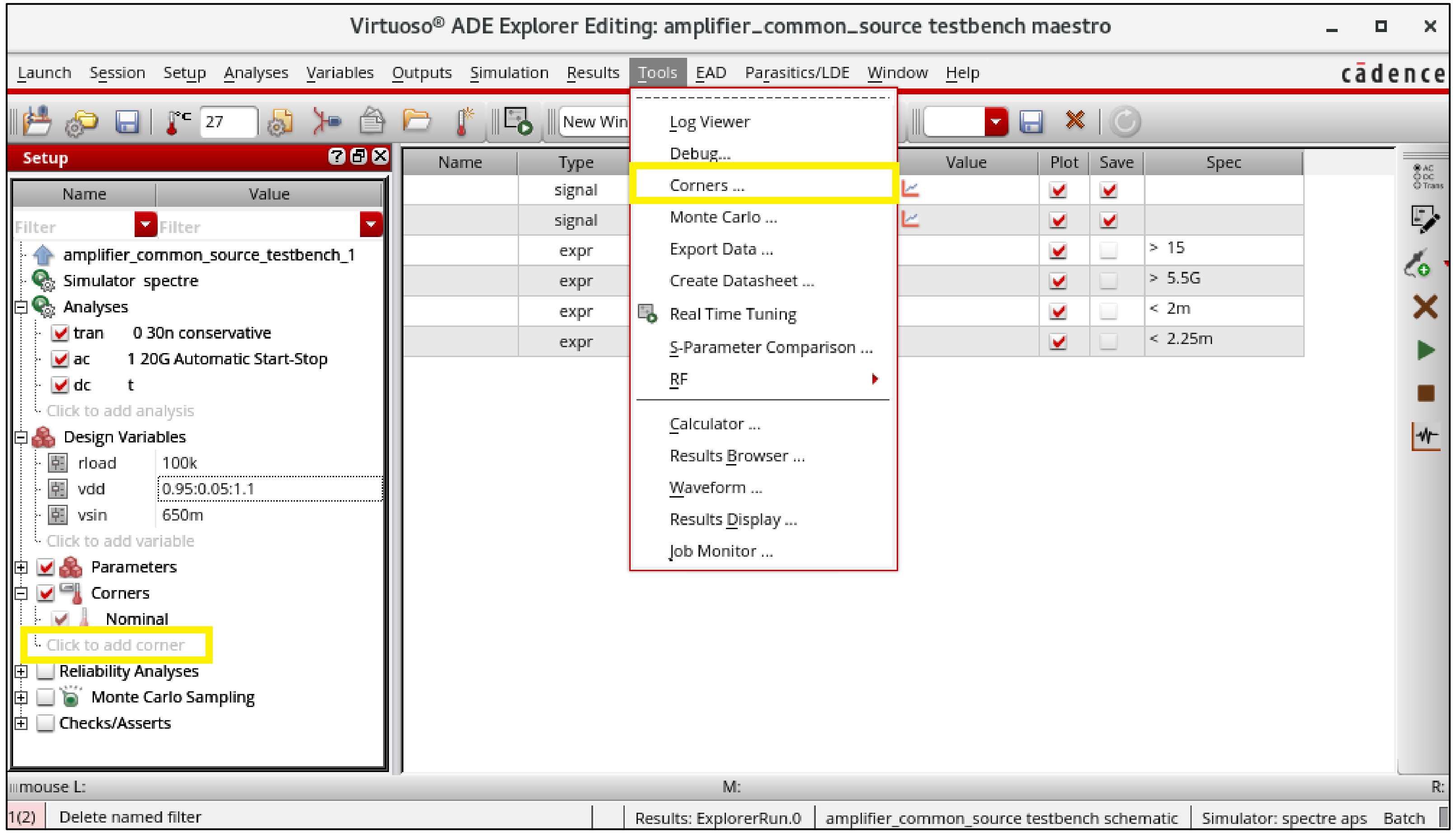
- To define Corners, open the Corners Setup by selecting **Tools → Corners** from the ADE Explorer menu, or simply by clicking on **Click to add corner**.



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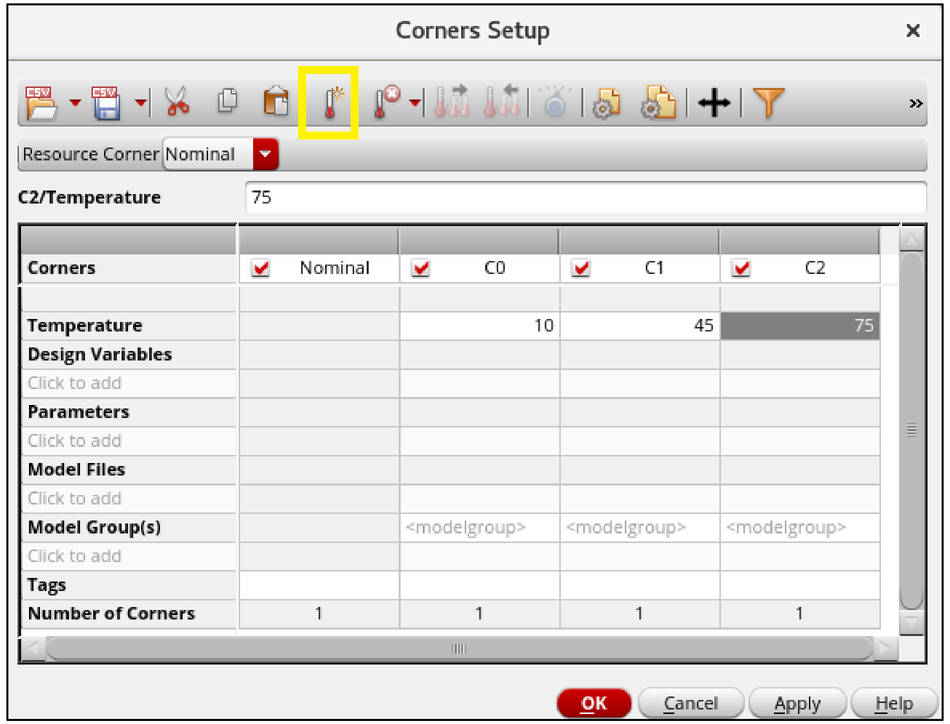
2.a. Setting up Sweeps & Corners *(continued)*

- The “Corners Setup” form pops-up, click on the **Add new Corner** icon in the toolbar.
- Enter “10” in the temperature field for C0 column. Add a new corner and enter “45” for C1, and “75” for C2. These temperature values are in degrees Celsius.
- Now that we have four values for Sweeps (0.95,1,1.05,1.1), and four Corners (10, 45, 75, and 27 which is the nominal temperature value) the simulation will run for a total of sixteen points, which are defined by the combinations of Sweeps and Corners.



- The temperature range is highly dependent on the application.
- Temperature is one dimension when considering corners.

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2.b. Running Simulations & Analyzing Results

- Adding Specs to the Design
- Sweeps and Corners
- Setting up Sweeps and Corners
- **Running Simulations and Analyzing Results**
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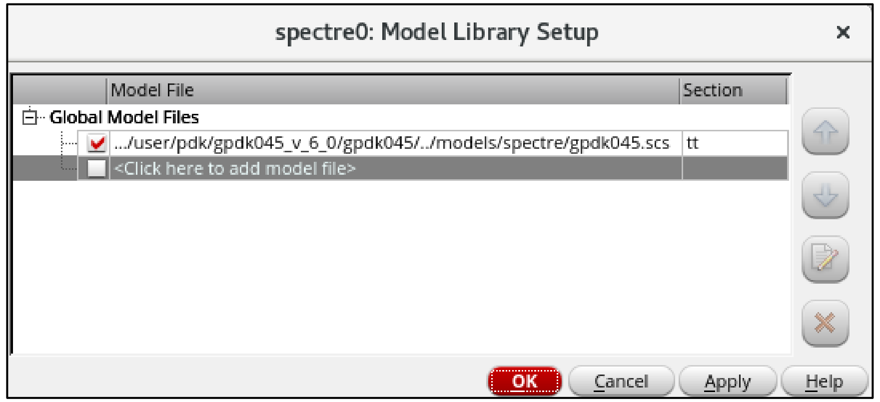
- Make sure the process corner “**tt**” is selected. Click on the green **Run Simulation icon** on the right side of your window, and check which outputs satisfy the specs defined earlier.
- Display your results in “**Detail-Transpose**”, this way, your sweeps and corners will be clearly shown.
- As you can see, all the results are within the limits defined by the specifications.



Outputs Setup | Results

Detail - Transpose

16 rows

Point	Corner	vdd	temperature	Pass/Fail	Gain	Bandwidth	rent Consumpt	wer Consumpti
1	nom	950m	27	pass	14.37 dB	6.385 GHz	1.364 mA	1.296 mW
1	C0	950m	10	pass	14.55 dB	6.634 GHz	1.362 mA	1.294 mW
1	C1	950m	45	pass	14.22 dB	6.129 GHz	1.364 mA	1.296 mW
1	C2	950m	75	pass	14.06 dB	5.709 GHz	1.36 mA	1.292 mW
2	nom	1	27	pass	15.26 dB	6.229 GHz	1.518 mA	1.518 mW
2	C0	1	10	pass	15.45 dB	6.48 GHz	1.518 mA	1.518 mW
2	C1	1	45	pass	15.11 dB	5.97 GHz	1.517 mA	1.517 mW
2	C2	1	75	pass	14.95 dB	5.543 GHz	1.51 mA	1.51 mW
3	nom	1.05	27	pass	16.02 dB	6.101 GHz	1.671 mA	1.754 mW
3	C0	1.05	10	pass	16.21 dB	6.352 GHz	1.672 mA	1.755 mW
3	C1	1.05	45	pass	15.86 dB	5.842 GHz	1.667 mA	1.751 mW
3	C2	1.05	75	pass	15.69 dB	5.412 GHz	1.658 mA	1.741 mW
4	nom	1.1	27	pass	16.64 dB	6.017 GHz	1.82 mA	2.002 mW
4	C0	1.1	10	pass	16.83 dB	6.266 GHz	1.823 mA	2.005 mW
4	C1	1.1	45	pass	16.47 dB	5.761 GHz	1.815 mA	1.997 mW
4	C2	1.1	75	pass	16.28 dB	5.337 GHz	1.803 mA	1.984 mW

- If you received a ‘sim error’ try checking if your model libraries are still as assigned previously. If not, please check Module 3 slide 14.

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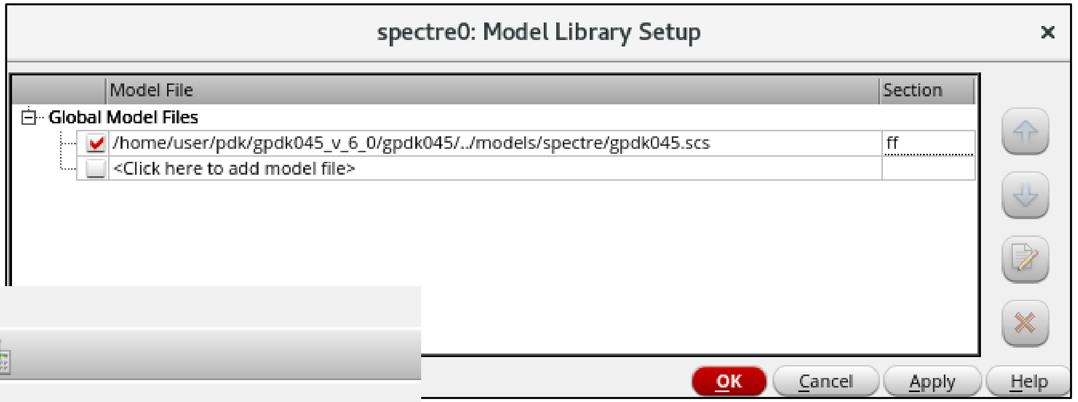
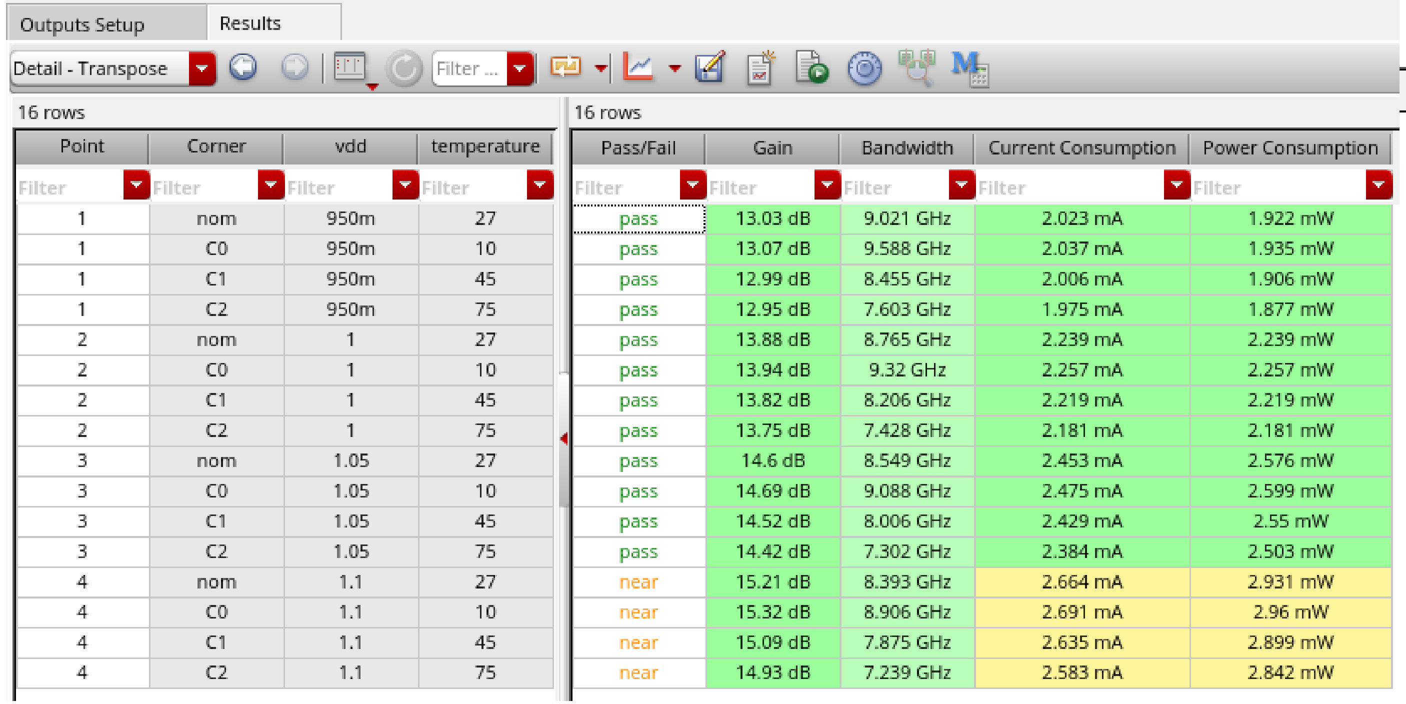
2.b. Running Simulations & Analyzing Results *(continued)*

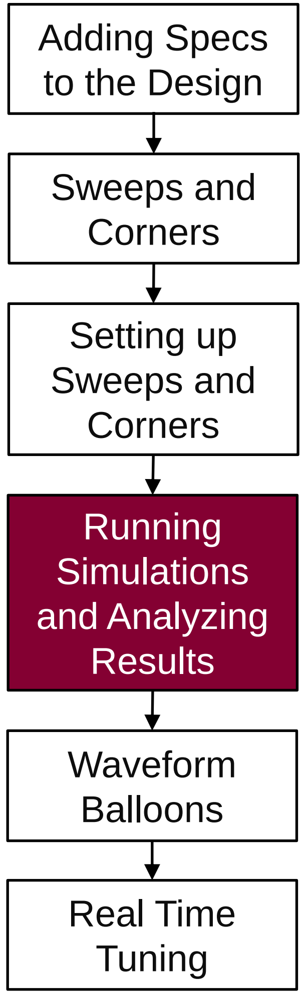
- Click on the green **Run Simulation icon** after changing the process corner to “**ff**”.
- When vdd is 1.1 in this instance, the results is within10% of the specified limits for the Current and Power Consumption.





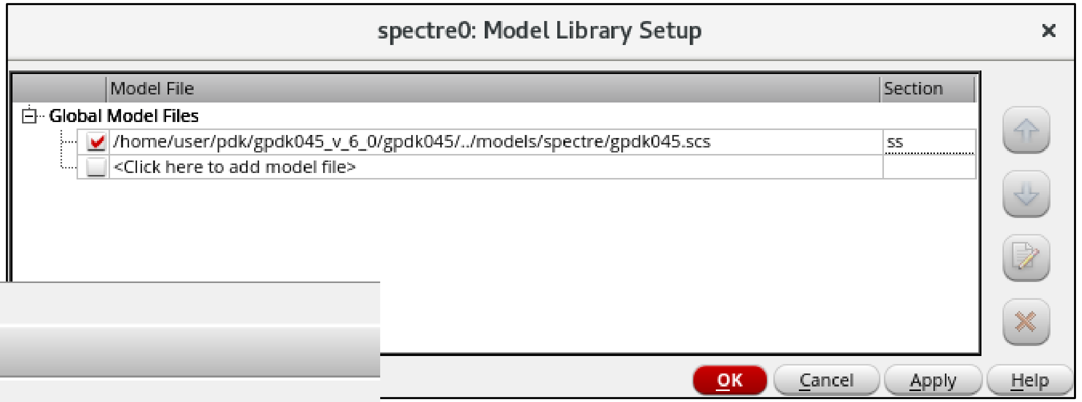
Point	Corner	vdd	temperature	Pass/Fail	Gain	Bandwidth	Current Consumption	Power Consumption
1	nom	950m	27	pass	13.03 dB	9.021 GHz	2.023 mA	1.922 mW
1	C0	950m	10	pass	13.07 dB	9.588 GHz	2.037 mA	1.935 mW
1	C1	950m	45	pass	12.99 dB	8.455 GHz	2.006 mA	1.906 mW
1	C2	950m	75	pass	12.95 dB	7.603 GHz	1.975 mA	1.877 mW
2	nom	1	27	pass	13.88 dB	8.765 GHz	2.239 mA	2.239 mW
2	C0	1	10	pass	13.94 dB	9.32 GHz	2.257 mA	2.257 mW
2	C1	1	45	pass	13.82 dB	8.206 GHz	2.219 mA	2.219 mW
2	C2	1	75	pass	13.75 dB	7.428 GHz	2.181 mA	2.181 mW
3	nom	1.05	27	pass	14.6 dB	8.549 GHz	2.453 mA	2.576 mW
3	C0	1.05	10	pass	14.69 dB	9.088 GHz	2.475 mA	2.599 mW
3	C1	1.05	45	pass	14.52 dB	8.006 GHz	2.429 mA	2.55 mW
3	C2	1.05	75	pass	14.42 dB	7.302 GHz	2.384 mA	2.503 mW
4	nom	1.1	27	near	15.21 dB	8.393 GHz	2.664 mA	2.931 mW
4	C0	1.1	10	near	15.32 dB	8.906 GHz	2.691 mA	2.96 mW
4	C1	1.1	45	near	15.09 dB	7.875 GHz	2.635 mA	2.899 mW
4	C2	1.1	75	near	14.93 dB	7.239 GHz	2.583 mA	2.842 mW

- Process Corners are usually designated by ‘Fast’, ‘Typical’ and ‘Slow.
- Process Corners is another dimension when considering corners.



2.b. Running Simulations & Analyzing Results *(continued)*

- Click on the green **Run Simulation icon** after changing the process corner to "**ss**".
- Some of the bandwidth results in this case are within 10% of the given limit.



Outputs Setup | Results

Detail - Transpose

16 rows

Point	Corner	vdd	temperature	Pass/Fail	Gain	Bandwidth	Current Consumption	Power Consumption
1	nom	950m	27	pass	16.48 dB	4.071 GHz	974.7 uA	925.9 uW
1	C0	950m	10	pass	16.71 dB	4.162 GHz	964.5 uA	916.3 uW
1	C1	950m	45	near	16.3 dB	3.969 GHz	983.1 uA	933.9 uW
1	C2	950m	75	near	16.1 dB	3.783 GHz	992.2 uA	942.6 uW
2	nom	1	27	pass	17.15 dB	4.066 GHz	1.087 mA	1.087 mW
2	C0	1	10	pass	17.34 dB	4.174 GHz	1.077 mA	1.077 mW
2	C1	1	45	near	16.98 dB	3.95 GHz	1.096 mA	1.096 mW
2	C2	1	75	near	16.82 dB	3.746 GHz	1.105 mA	1.105 mW
3	nom	1.05	27	pass	17.58 dB	4.115 GHz	1.197 mA	1.257 mW
3	C0	1.05	10	pass	17.75 dB	4.24 GHz	1.187 mA	1.246 mW
3	C1	1.05	45	near	17.44 dB	3.985 GHz	1.206 mA	1.267 mW
3	C2	1.05	75	near	17.29 dB	3.767 GHz	1.215 mA	1.276 mW
4	nom	1.1	27	pass	17.81 dB	4.223 GHz	1.304 mA	1.435 mW
4	C0	1.1	10	pass	17.95 dB	4.363 GHz	1.293 mA	1.423 mW
4	C1	1.1	45	pass	17.68 dB	4.08 GHz	1.313 mA	1.445 mW
4	C2	1.1	75	near	17.52 dB	3.853 GHz	1.322 mA	1.454 mW

- The first Letter 's' designates the NMOS process condition 'slow'.
- The second Letter 's' designates the PMOS process condition 'slow'.

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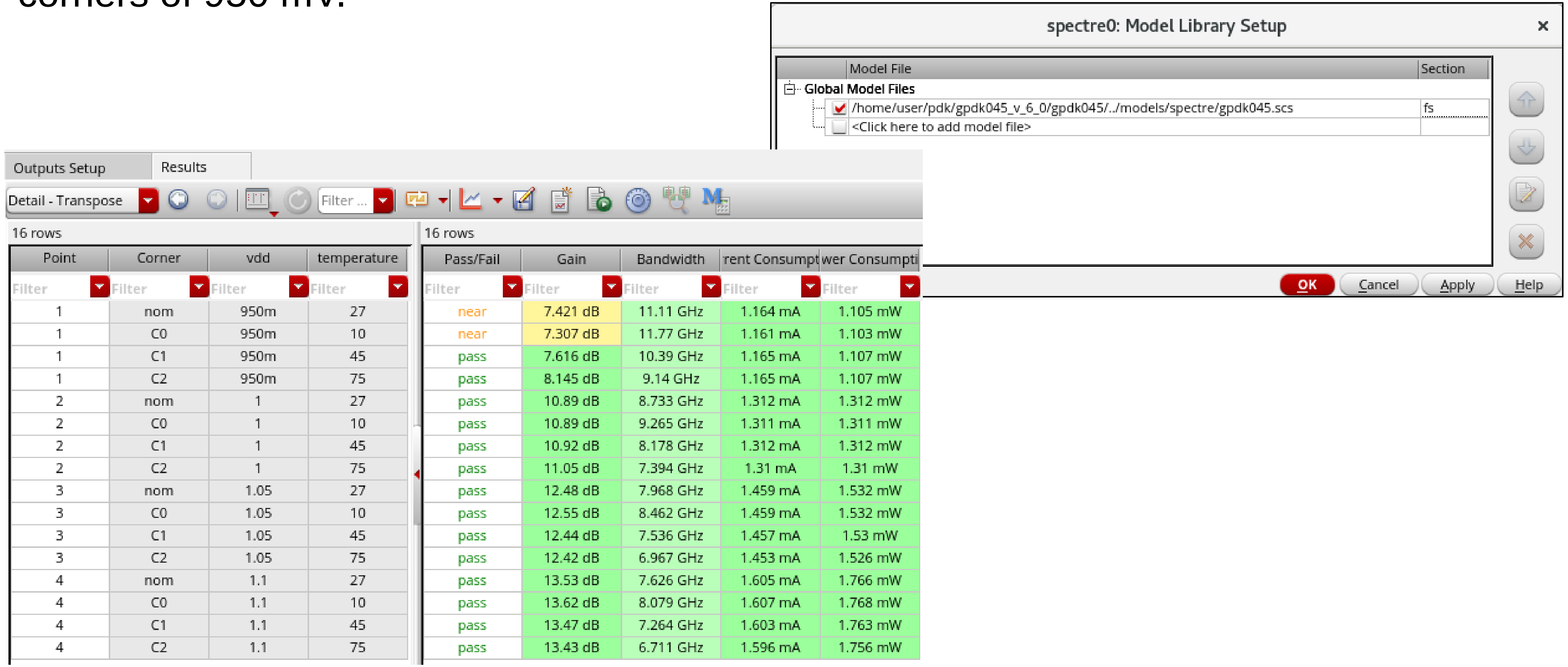
2.b. Running Simulations & Analyzing Results *(continued)*

- Click on the green **Run Simulation icon** after changing the process corner to “**fs**”.
- In this case, the Gain nearly fails to meet the specification for the nominal and C0 corners of 950 mV.



Point	Corner	vdd	temperature	Pass/Fail	Gain	Bandwidth	rent Consumpt	wer Consumpti
1	nom	950m	27	near	7.421 dB	11.11 GHz	1.164 mA	1.105 mW
1	C0	950m	10	near	7.307 dB	11.77 GHz	1.161 mA	1.103 mW
1	C1	950m	45	pass	7.616 dB	10.39 GHz	1.165 mA	1.107 mW
1	C2	950m	75	pass	8.145 dB	9.14 GHz	1.165 mA	1.107 mW
2	nom	1	27	pass	10.89 dB	8.733 GHz	1.312 mA	1.312 mW
2	C0	1	10	pass	10.89 dB	9.265 GHz	1.311 mA	1.311 mW
2	C1	1	45	pass	10.92 dB	8.178 GHz	1.312 mA	1.312 mW
2	C2	1	75	pass	11.05 dB	7.394 GHz	1.31 mA	1.31 mW
3	nom	1.05	27	pass	12.48 dB	7.968 GHz	1.459 mA	1.532 mW
3	C0	1.05	10	pass	12.55 dB	8.462 GHz	1.459 mA	1.532 mW
3	C1	1.05	45	pass	12.44 dB	7.536 GHz	1.457 mA	1.53 mW
3	C2	1.05	75	pass	12.42 dB	6.967 GHz	1.453 mA	1.526 mW
4	nom	1.1	27	pass	13.53 dB	7.626 GHz	1.605 mA	1.766 mW
4	C0	1.1	10	pass	13.62 dB	8.079 GHz	1.607 mA	1.768 mW
4	C1	1.1	45	pass	13.47 dB	7.264 GHz	1.603 mA	1.763 mW
4	C2	1.1	75	pass	13.43 dB	6.711 GHz	1.596 mA	1.756 mW

- The first Letter ‘f’ designate the NMOS process condition ‘fast’.
- The second Letter ‘s’ designates the PMOS process condition ‘slow’.

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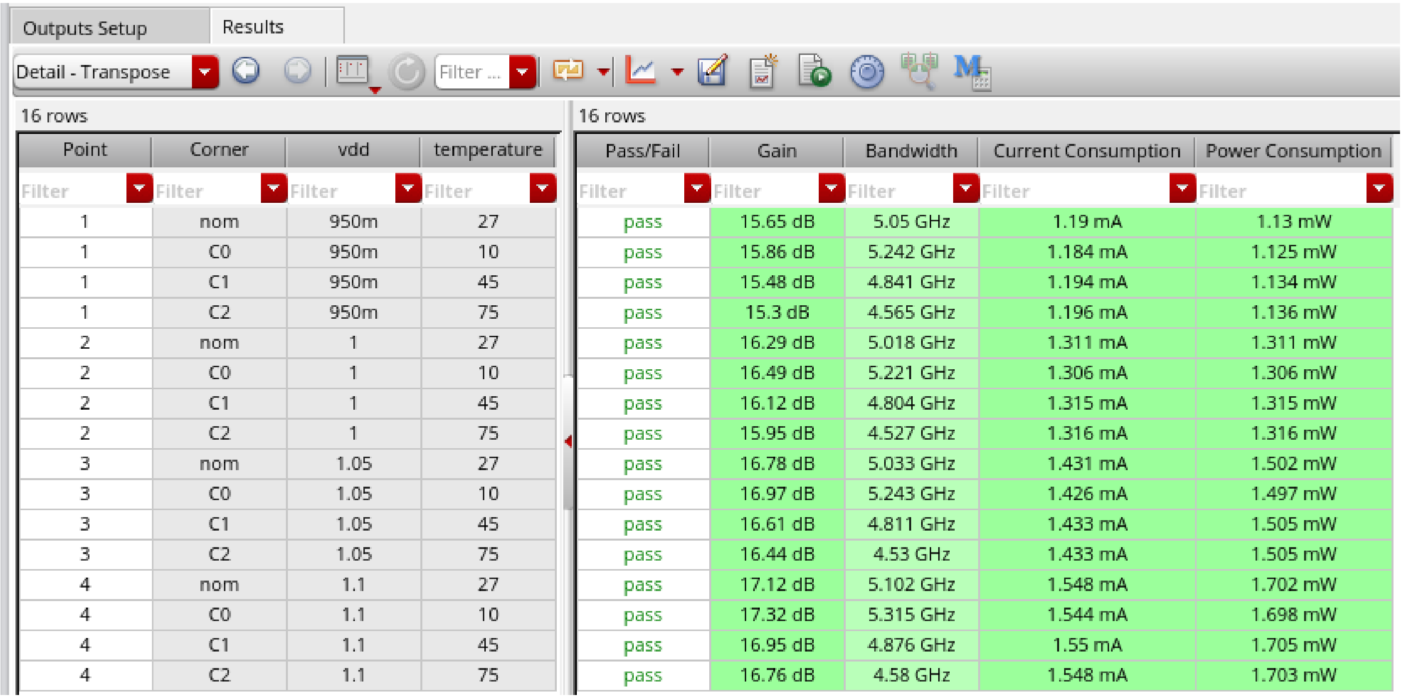
2.b. Running Simulations & Analyzing Results *(continued)*

- Click on the green **Run Simulation icon** after changing the process corner to "**sf**".
- All the results here passed the limits defined by the specifications.



Outputs Setup | Results

Detail - Transpose

16 rows

Point	Corner	vdd	temperature	Pass/Fail	Gain	Bandwidth	Current Consumption	Power Consumption
1	nom	950m	27	pass	15.65 dB	5.05 GHz	1.19 mA	1.13 mW
1	C0	950m	10	pass	15.86 dB	5.242 GHz	1.184 mA	1.125 mW
1	C1	950m	45	pass	15.48 dB	4.841 GHz	1.194 mA	1.134 mW
1	C2	950m	75	pass	15.3 dB	4.565 GHz	1.196 mA	1.136 mW
2	nom	1	27	pass	16.29 dB	5.018 GHz	1.311 mA	1.311 mW
2	C0	1	10	pass	16.49 dB	5.221 GHz	1.306 mA	1.306 mW
2	C1	1	45	pass	16.12 dB	4.804 GHz	1.315 mA	1.315 mW
2	C2	1	75	pass	15.95 dB	4.527 GHz	1.316 mA	1.316 mW
3	nom	1.05	27	pass	16.78 dB	5.033 GHz	1.431 mA	1.502 mW
3	C0	1.05	10	pass	16.97 dB	5.243 GHz	1.426 mA	1.497 mW
3	C1	1.05	45	pass	16.61 dB	4.811 GHz	1.433 mA	1.505 mW
3	C2	1.05	75	pass	16.44 dB	4.53 GHz	1.433 mA	1.505 mW
4	nom	1.1	27	pass	17.12 dB	5.102 GHz	1.548 mA	1.702 mW
4	C0	1.1	10	pass	17.32 dB	5.315 GHz	1.544 mA	1.698 mW
4	C1	1.1	45	pass	16.95 dB	4.876 GHz	1.55 mA	1.705 mW
4	C2	1.1	75	pass	16.76 dB	4.58 GHz	1.548 mA	1.703 mW

- The first Letter 's' designates the NMOS process condition 'slow'.
- The second Letter 'f' designates the PMOS process condition 'fast'.

Adding Specs to the Design

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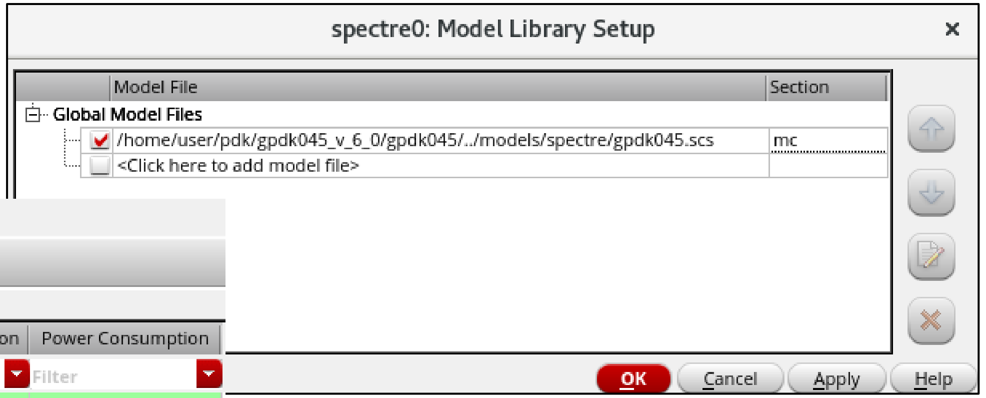
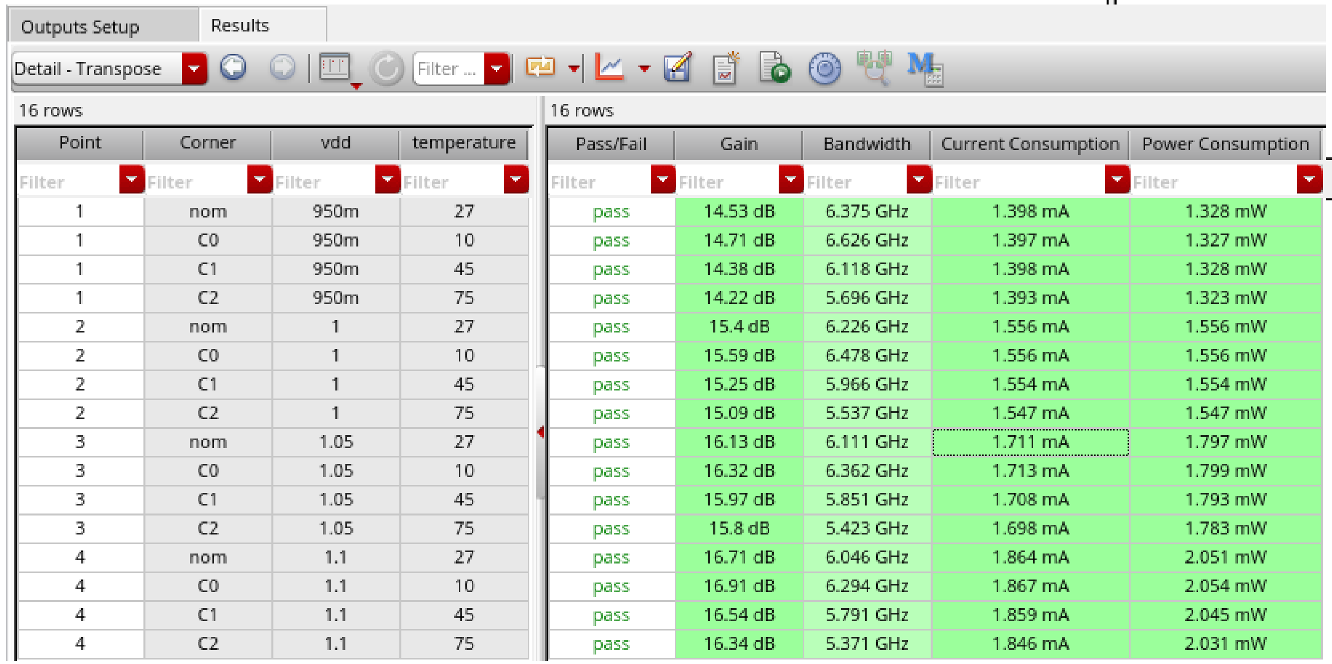
2.b. Running Simulations & Analyzing Results *(continued)*

- Click on the green **Run Simulation icon** after changing the process corner to “**mc**”.
- After choosing “mc”, which stands for “Monte Carlo”, the simulation will run with default process corner “tt” since we have not enabled the Monte Carlo Sampling.
- As expected, the results are as that of the “tt” case.





Point	Corner	vdd	temperature	Pass/Fail	Gain	Bandwidth	Current Consumption	Power Consumption
1	nom	950m	27	pass	14.53 dB	6.375 GHz	1.398 mA	1.328 mW
1	C0	950m	10	pass	14.71 dB	6.626 GHz	1.397 mA	1.327 mW
1	C1	950m	45	pass	14.38 dB	6.118 GHz	1.398 mA	1.328 mW
1	C2	950m	75	pass	14.22 dB	5.696 GHz	1.393 mA	1.323 mW
2	nom	1	27	pass	15.4 dB	6.226 GHz	1.556 mA	1.556 mW
2	C0	1	10	pass	15.59 dB	6.478 GHz	1.556 mA	1.556 mW
2	C1	1	45	pass	15.25 dB	5.966 GHz	1.554 mA	1.554 mW
2	C2	1	75	pass	15.09 dB	5.537 GHz	1.547 mA	1.547 mW
3	nom	1.05	27	pass	16.13 dB	6.111 GHz	1.711 mA	1.797 mW
3	C0	1.05	10	pass	16.32 dB	6.362 GHz	1.713 mA	1.799 mW
3	C1	1.05	45	pass	15.97 dB	5.851 GHz	1.708 mA	1.793 mW
3	C2	1.05	75	pass	15.8 dB	5.423 GHz	1.698 mA	1.783 mW
4	nom	1.1	27	pass	16.71 dB	6.046 GHz	1.864 mA	2.051 mW
4	C0	1.1	10	pass	16.91 dB	6.294 GHz	1.867 mA	2.054 mW
4	C1	1.1	45	pass	16.54 dB	5.791 GHz	1.859 mA	2.045 mW
4	C2	1.1	75	pass	16.34 dB	5.371 GHz	1.846 mA	2.031 mW

- The first Letter ‘t’ designates the NMOS process condition ‘typical’.
- The second Letter ‘t’ designates the PMOS process condition ‘typical’.

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2.b. Running Simulations & Analyzing Results *(continued)*

There are many ways to display the results, after you have run your simulation:

- Detail: Displays all the columns in details for each simulation point.
- Detail transpose: Displays the corners and sweeps on the left of your screen, and displays the results and the status (pass, near or fail) for your output expressions for each simulation point.
- Optimization: Displays the Test, Output, Value, Spec, Weight, Min, Max and corner related columns.
- Status: Displays the progress, status of your simulation and the contents of the run log file.
- Summary: Displays a summary of the results for output expressions across all corners and sweeps (Min, Max, Median, Stddev, Pass/fail status).
- Yield: Displays the overall yield estimate (based on pass or fail status) for Monte Carlo Analysis.

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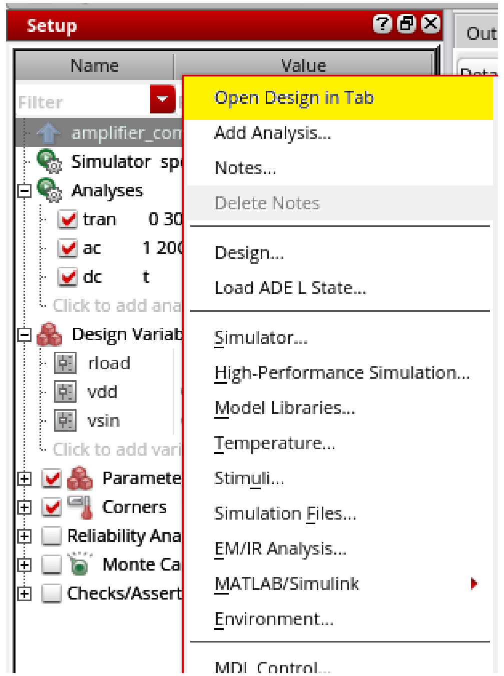
2.c. Viewing Waveform Balloons

- In order not to stay far from your schematic while performing your analysis, the waveform balloons tool can provide a quick overview on your circuit performance.
- To do so, right click on your test name (**amplifier_common_source:testbench:1** in this case) and select **Open Design in Tab**.



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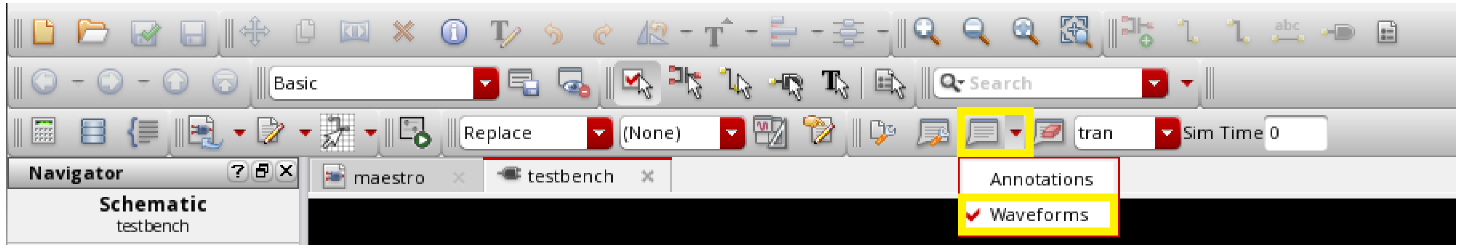
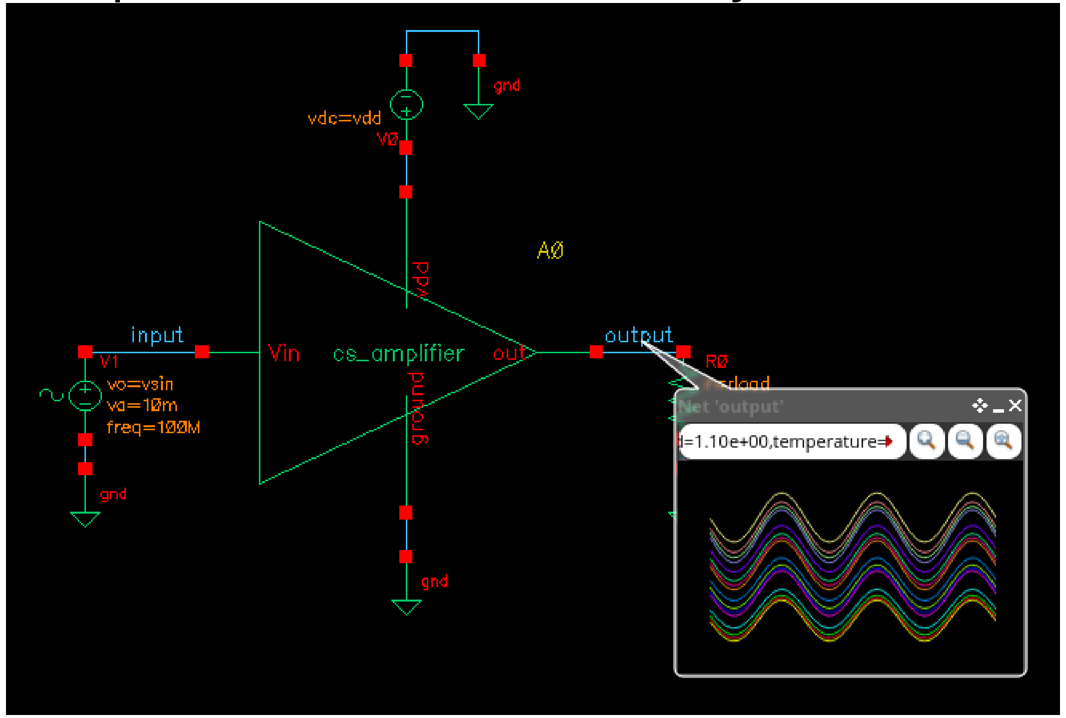
2.c. Viewing Waveform Balloons *(continued)*

- Make sure that “Waveforms” is checked.



- Now hover over a net and the Waveform should appear.
- To pin a certain Waveform to your schematic, click on the **Pin icon** in the upper right



3. Real Time Tuning Feature

Adding Specs to the Design

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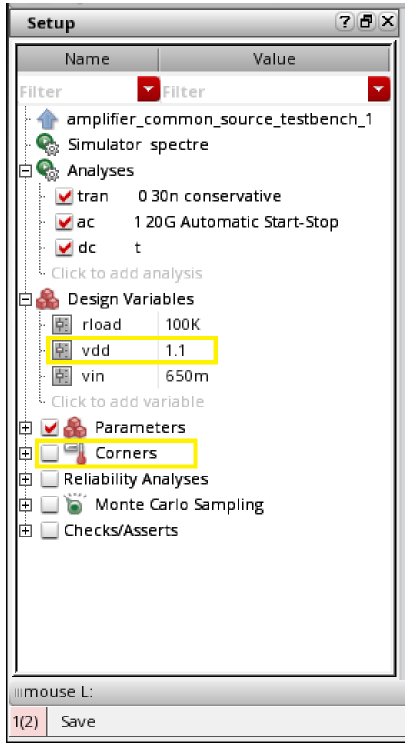
3. Real Time Tuning Feature

- The Real Time Tuning feature (RTT feature) is an interactive spectre job that keeps on running and waiting for changes to design variables and parameters.
- This feature avoids generating a netlist each time the variables or parameters are changed; thus, simulation begins immediately and requires a much shorter time.
- To explore this feature, uncheck the Corners checkbox and remove the Sweep.



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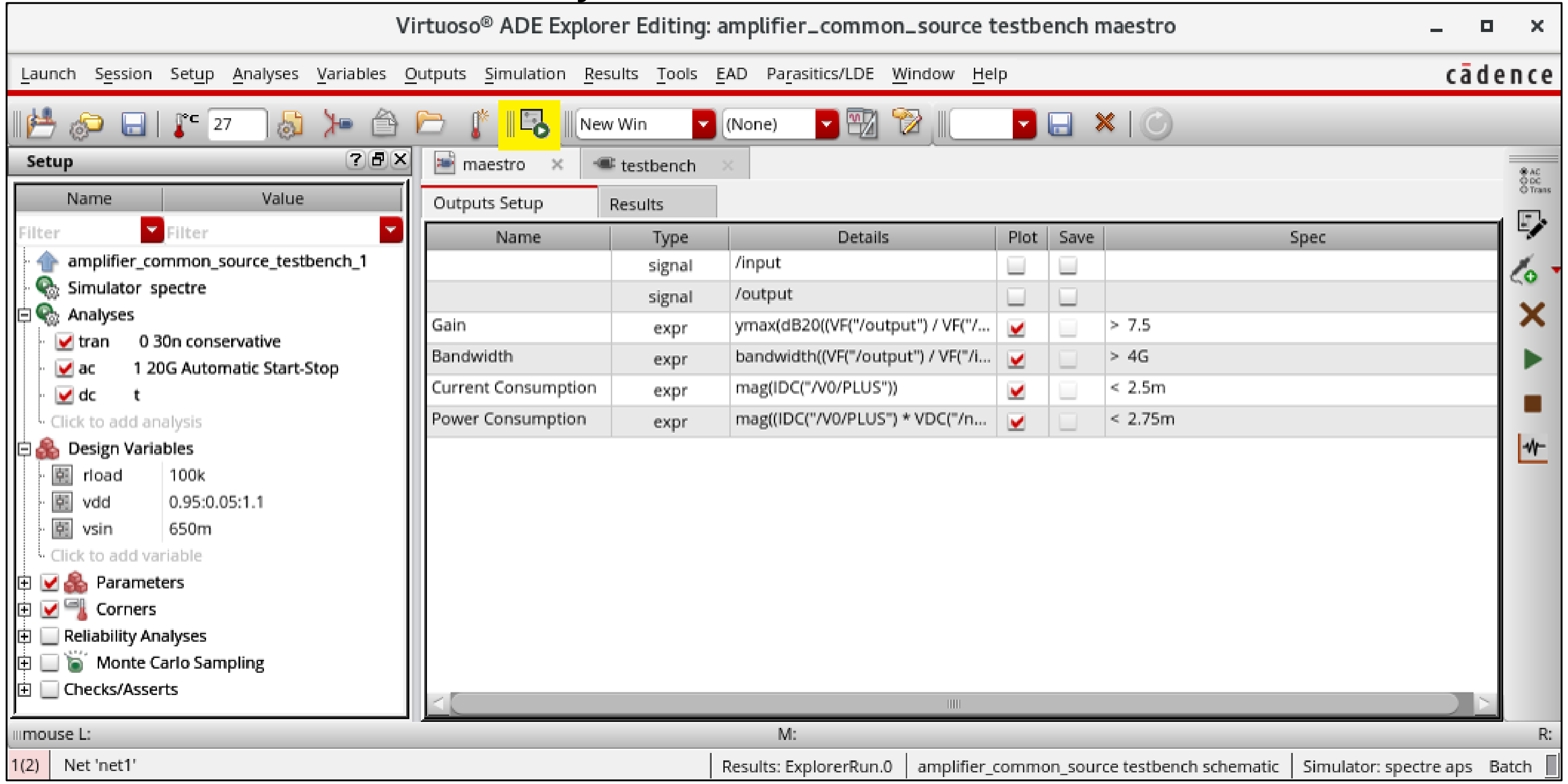
Real Time Tuning

3. Real Time Tuning Feature *(continued)*

- To view the input and output waveforms, check the “Plot” checkbox for the output and input expressions.
- To improve your design, you can vary your 3 design variables.
- To do so, first click on the **Real Time Tuning** icon in your toolbar, the Real Time Tuning assistant will be added to your schematic.



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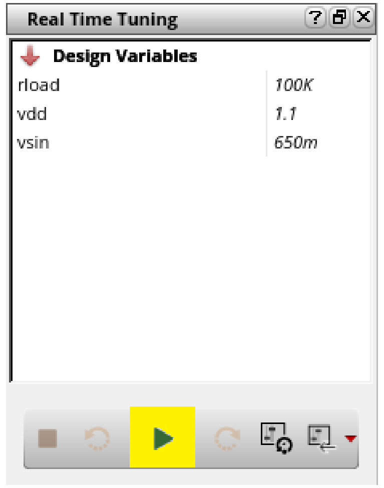
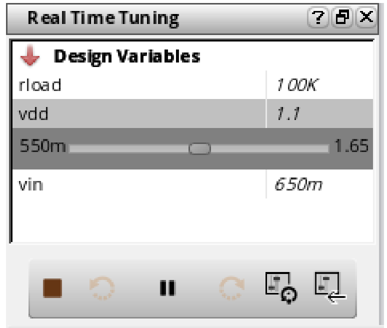
3. Real Time Tuning Feature *(continued)*

- To run your simulation, click on the green **Run Simulation** icon in the RTT assistant.
- The simulation is running with the default values of the design variables and parameters (notice the time taken to run the simulation).
- In the Real Time Tuning assistant, click and drag the slider of each design variable to modify it accordingly.





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- Adding Specs to the Design
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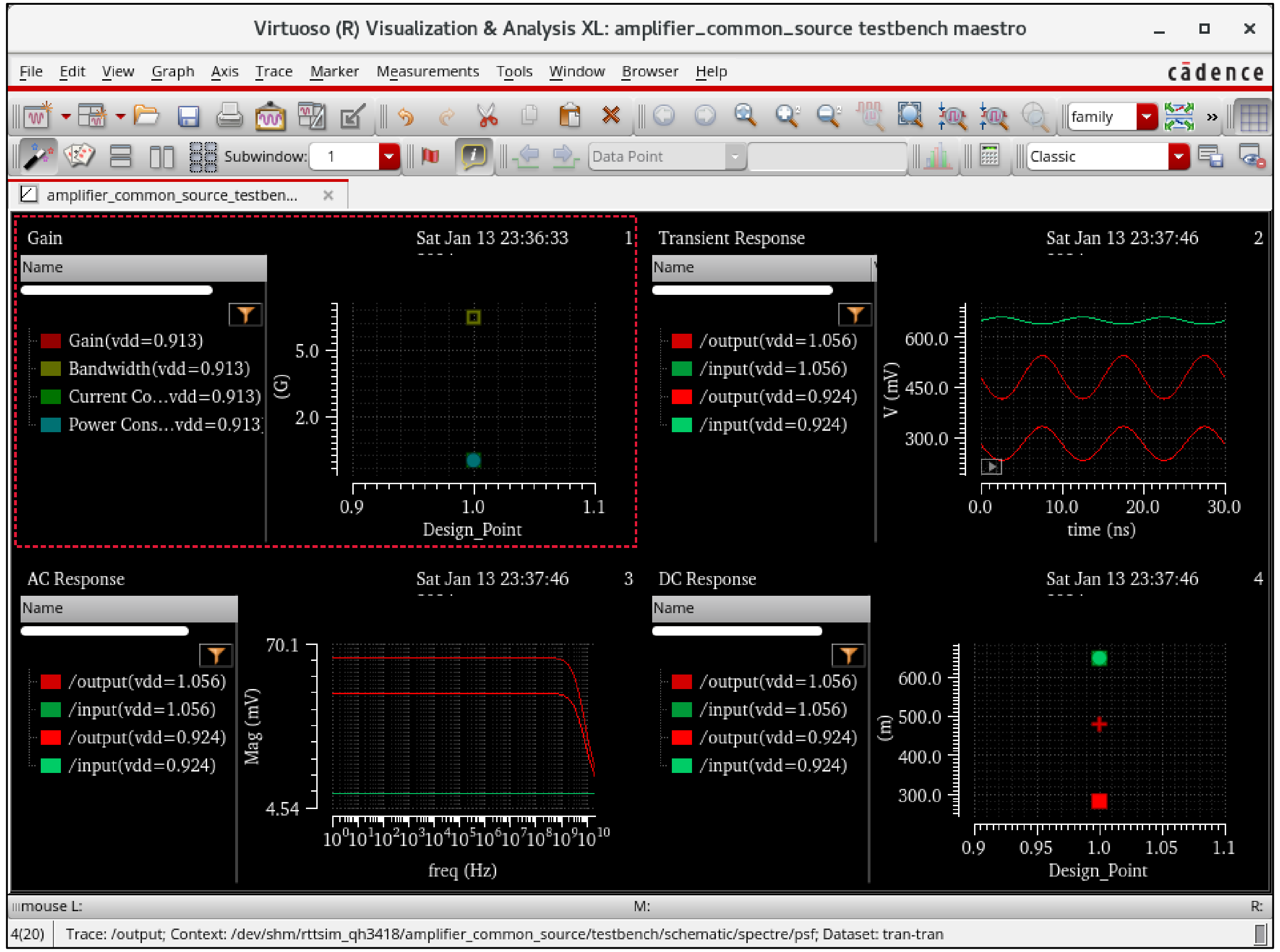
- Running Simulations and Analyzing Results
- Waveform Balloons
- **Real Time Tuning**

3. Real Time Tuning Feature *(continued)*

- After modifying each design variable, notice that the simulations are much faster because they rely only on value changes (the simulation time is barely one second).
- You can check the waveforms in the “Visualization & Analysis XL” window while changing the design variables.
- After comparing the waveforms, you now have more sense to tune your circuit so it can satisfy a given specification.



- Note that in order to check the waveforms, the plot option should be enabled in the maestro view.

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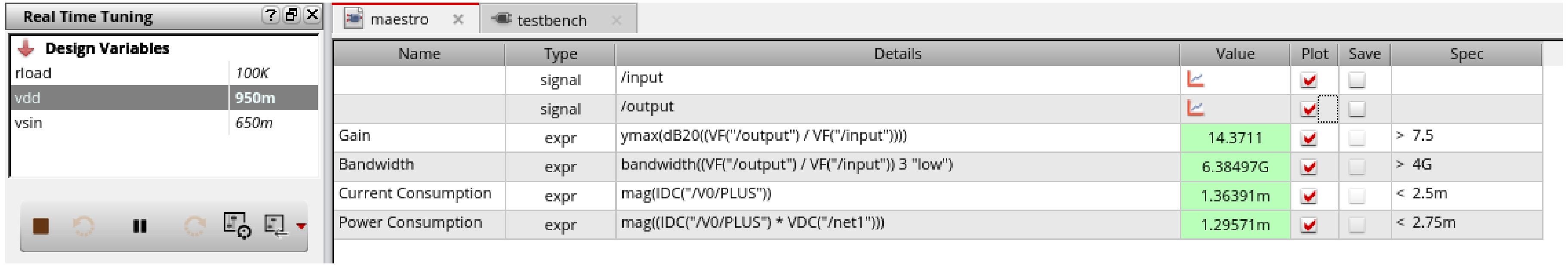
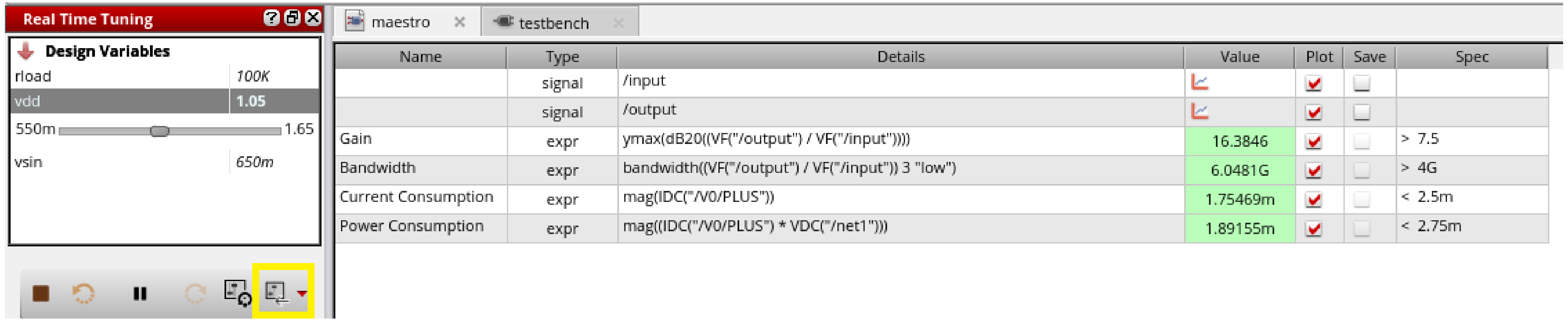
3. Real Time Tuning Feature *(continued)*

- To check the status of a given specification, click on the "maestro" tab, and keep on modifying your design variables to get to a combination that satisfies these specs.
- When vdd is equal to 950 mV, the gain is 14.37 dB, which is greater than the given spec (15 dB).



- When vdd is varied, we can find a value that makes the gain pass the given Spec.



- If you are done and want to transfer your new variable combination to ADE Explorer, click on the **Save back to ADE Explorer** icon.