# AC Frequency Analysis For Low Power Operational Amplifier Comparator Using Mentor Graphics Design Architect (DA-IC)

1. Up to now we have finished DC analysis. Now let's move on to AC analysis. The testbench circuit structure for AC analysis is shown in Figure 1 below:

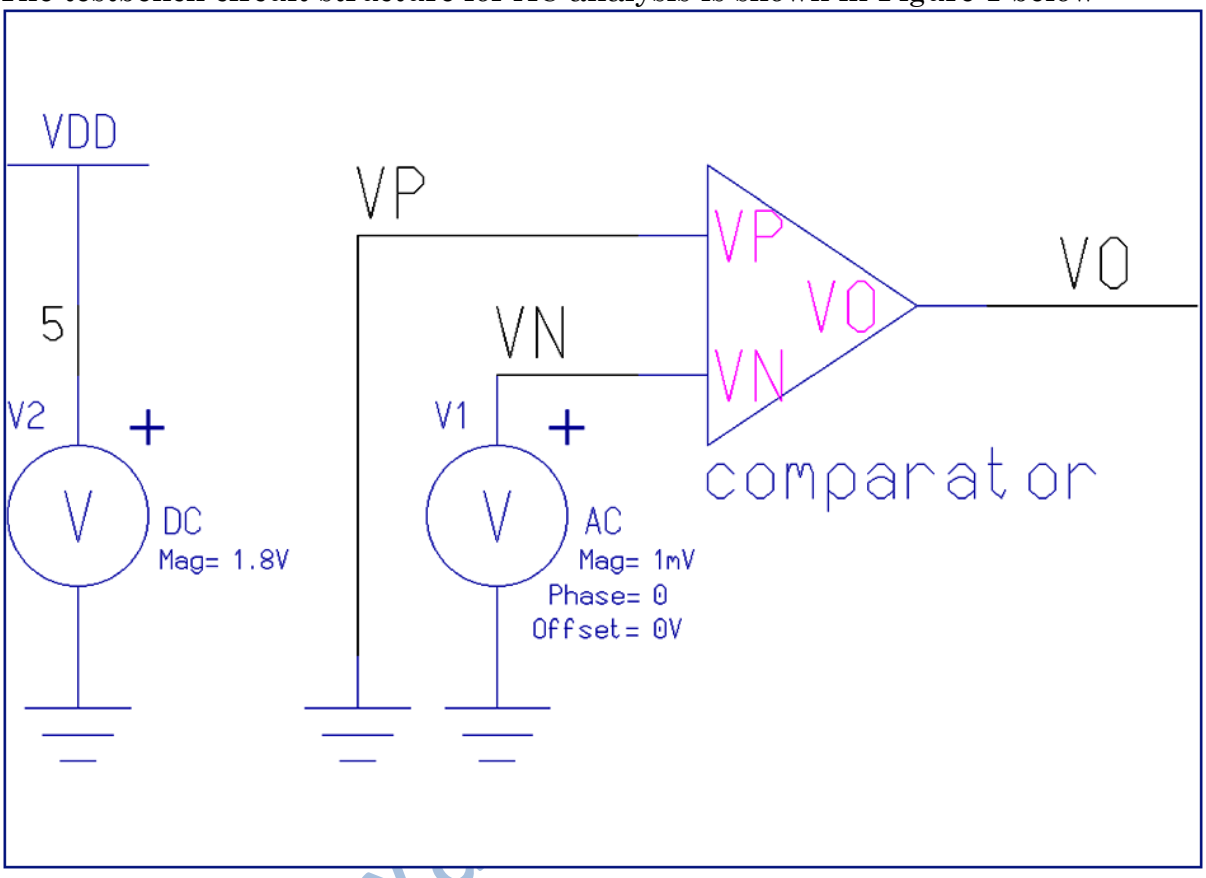



**Figure 1**: Comparator Testbench

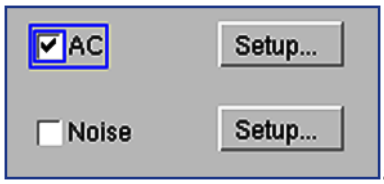
2. Click the properties for DC voltage and AC voltage to change each parameter values as shown in the Table 1 below:

**Table 1**: Parameter

| Instrumental | Component | Parameter |
|---|---|---|
| V1 | AC Voltage | Mag=1mV |
| V2 | DC Voltage | DC=1.8V |

3. Next, click on **Analysis** 

on the right hand palette.

4. Choose **AC** 

and click **Setup** then configure the popup with detail in Figure 2 as shown below:

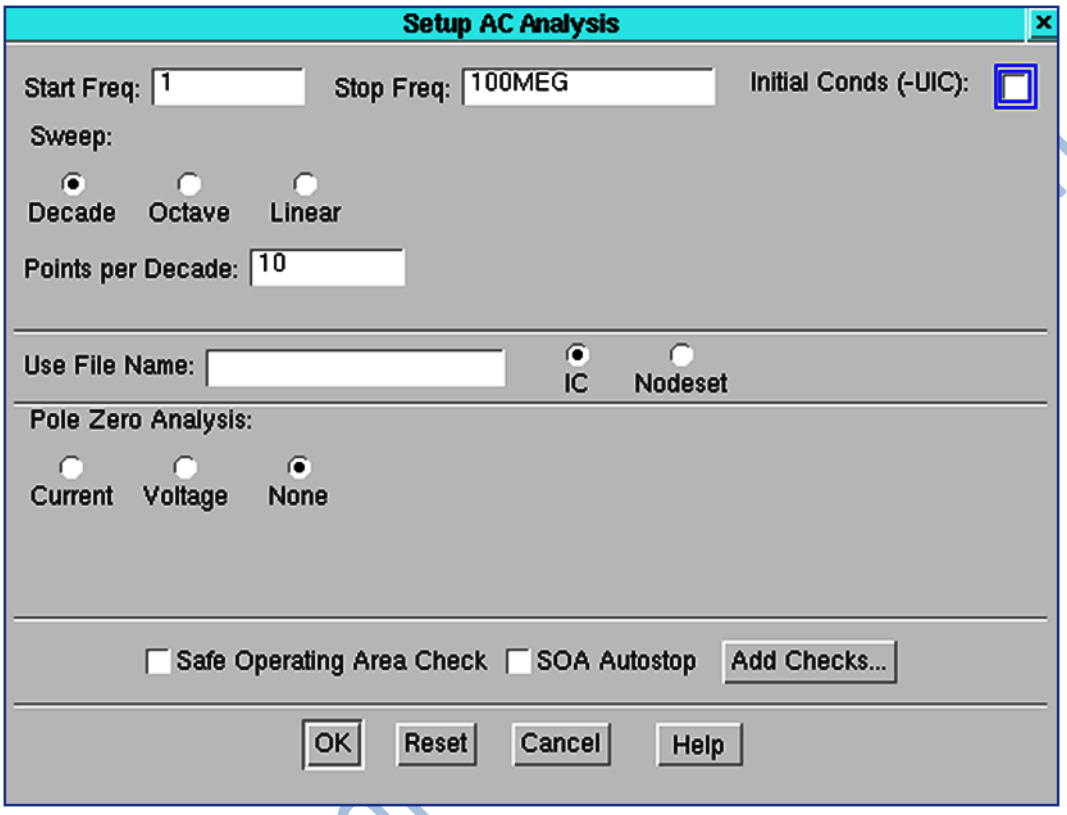
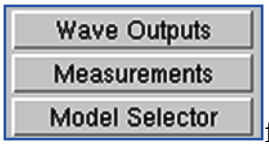


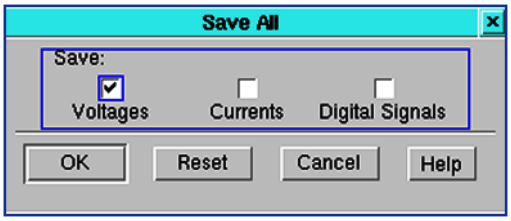

**Figure 2:** Setup AC Analysis

5. Then choose the **Wave Output** 

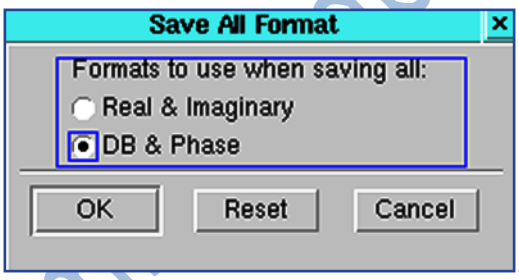
from the right hand site palette.

6. Select **Save All** 

and choose **Voltages**



. Then click OK.

7. Next, choose **DB & Phase** 

and click OK.

8. Now, run the simulation by clicking on **Run Eldo** 

from the palette.

9. Two windows will pop-up. One window for netlist design and another for simulation design as shown in Figure 3 and Figure 4.

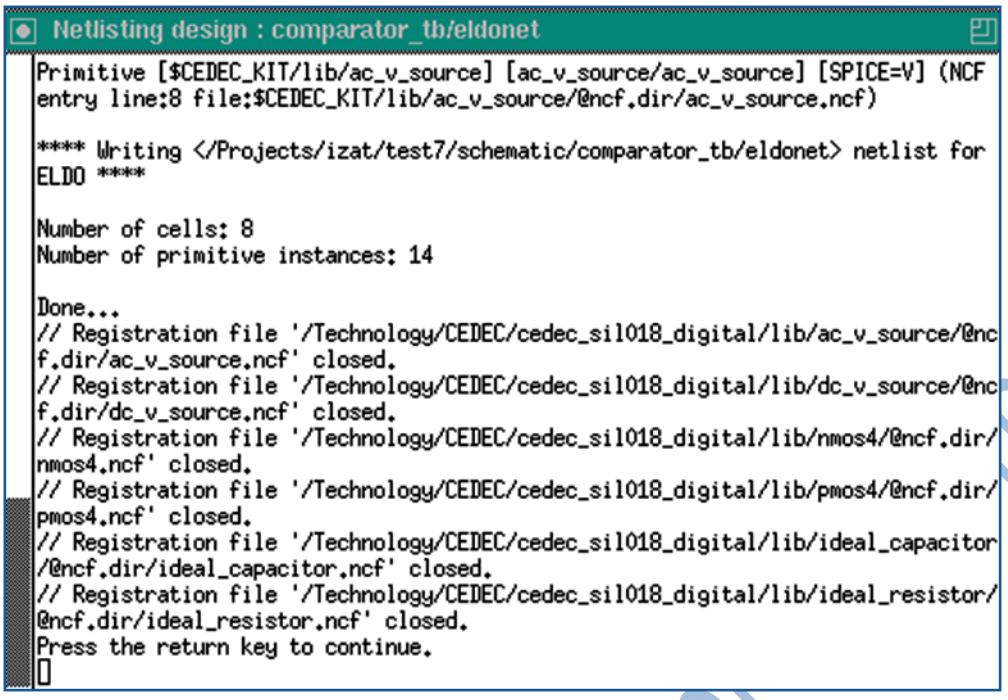



**Figure 3**: Netlist Design

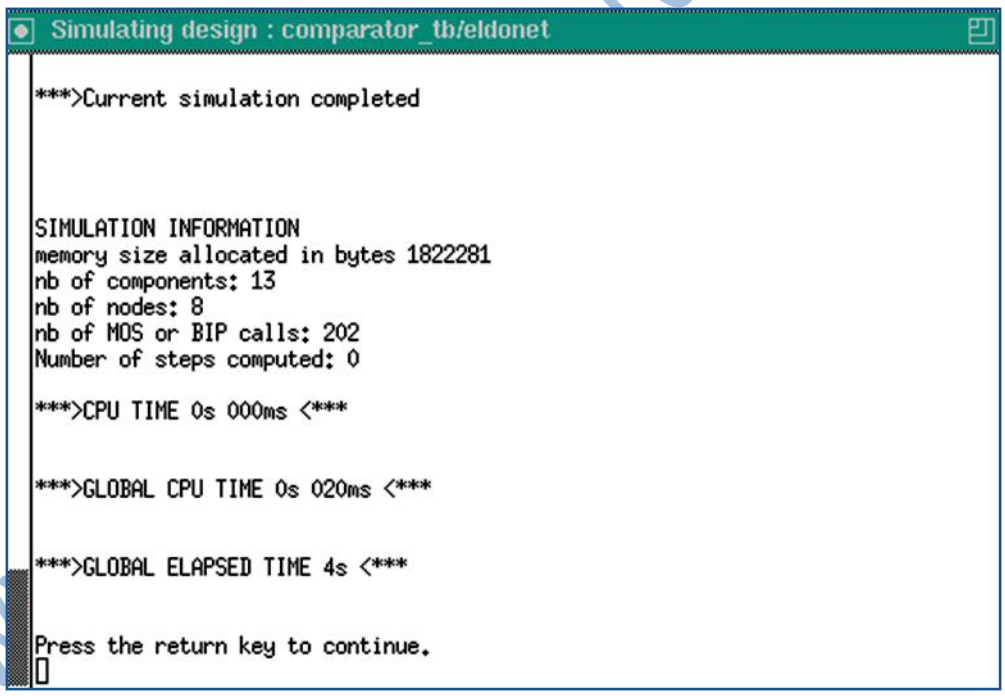



**Figure 4**: Simulation Design

10. Click **View Waves** 

to view the result simulation.

11. An EZwave viewer will pop-up. Next, drag the VDB(VO), VDB(VN), VP(VO) and VP(VN) into the Wave Window.

12. The simulation waveform will appear as shown in Figure 5, Figure 6, Figure 7 and Figure 8 respectively.

13. The simulation waveform is not finish yet because we want the VDB(VO) is minus with the VDB(VN) to get a gain waveform by using **Waveform Calculator**.

14. Same goes for VP(VO) and VP(VN) too. Minus VP(VO) with VP(VN) will get a phase waveform.

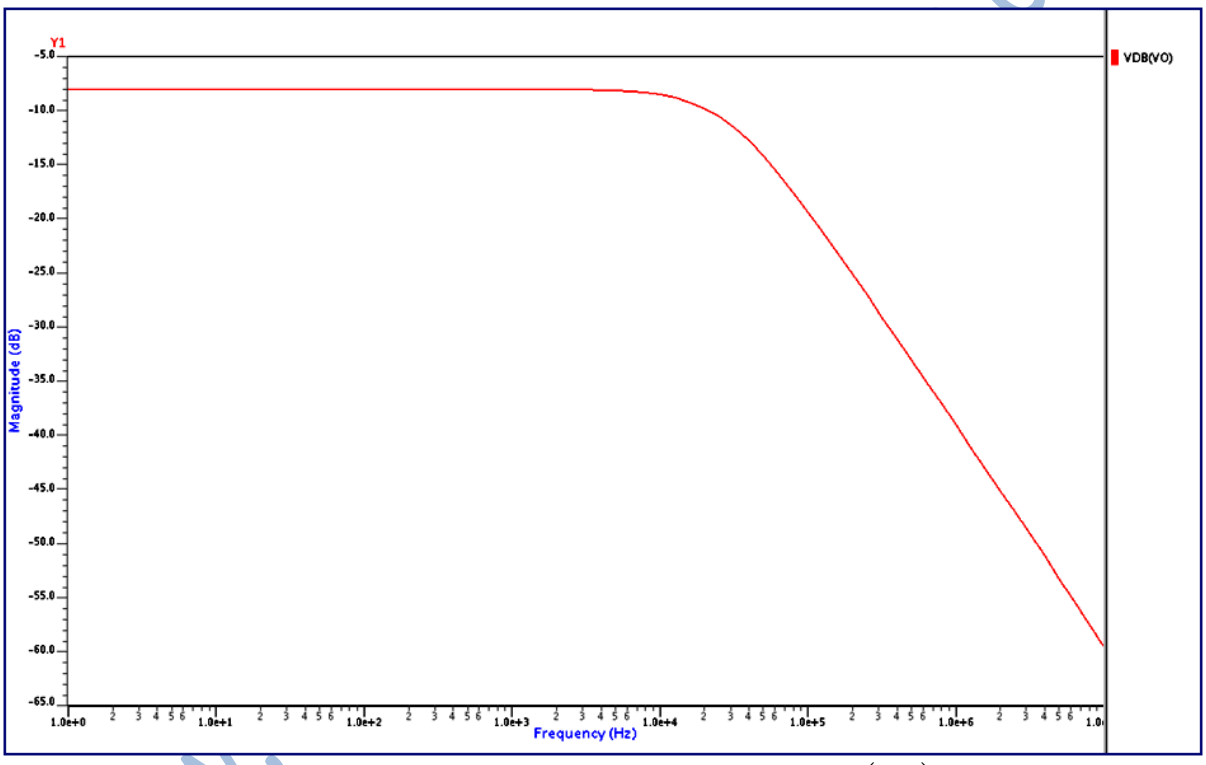



**Figure 5:** Simulation Waveform for VDB(VO)

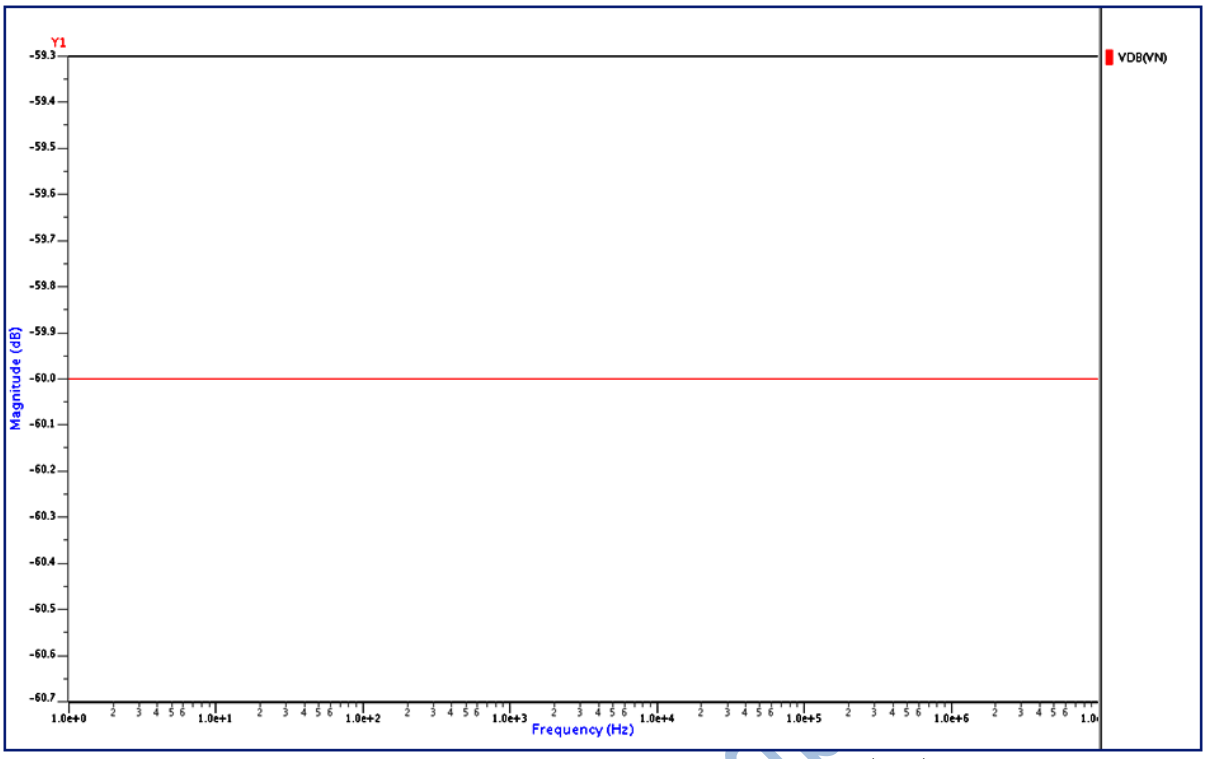



**Figure 6:** Simulation Waveform for VDB(VN)

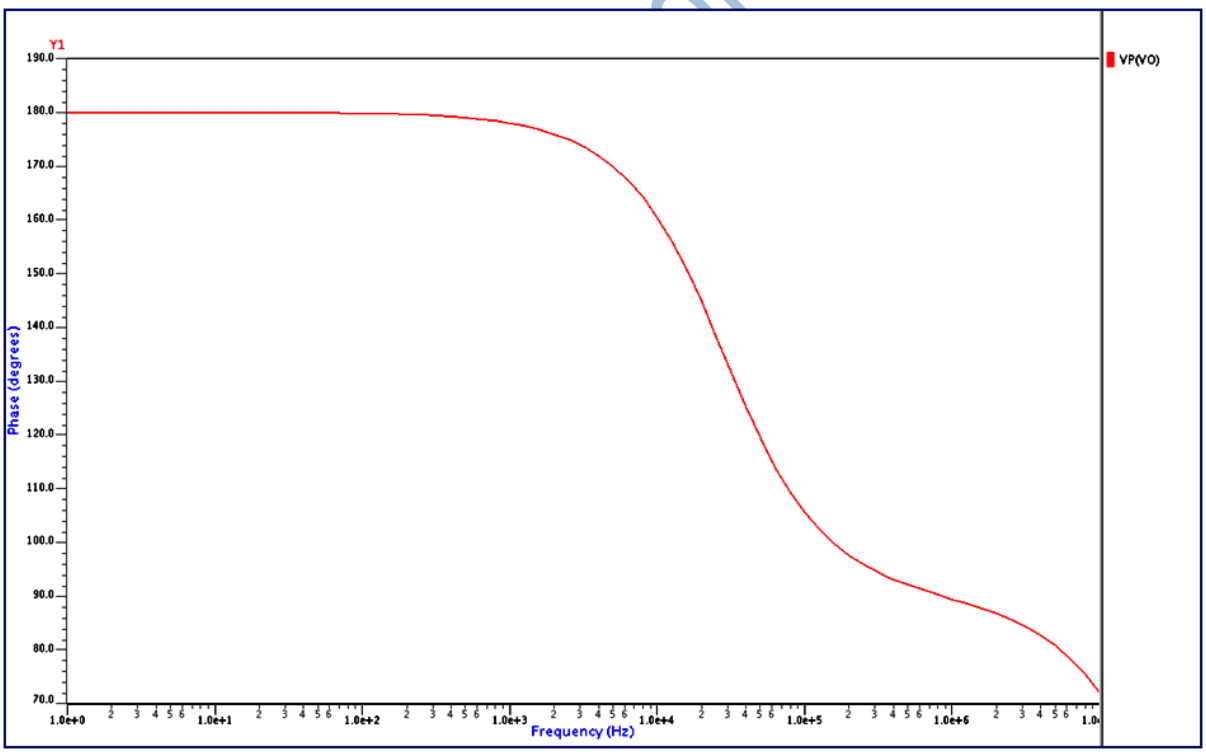



**Figure 7:** Simulation Waveform for VP(VO)

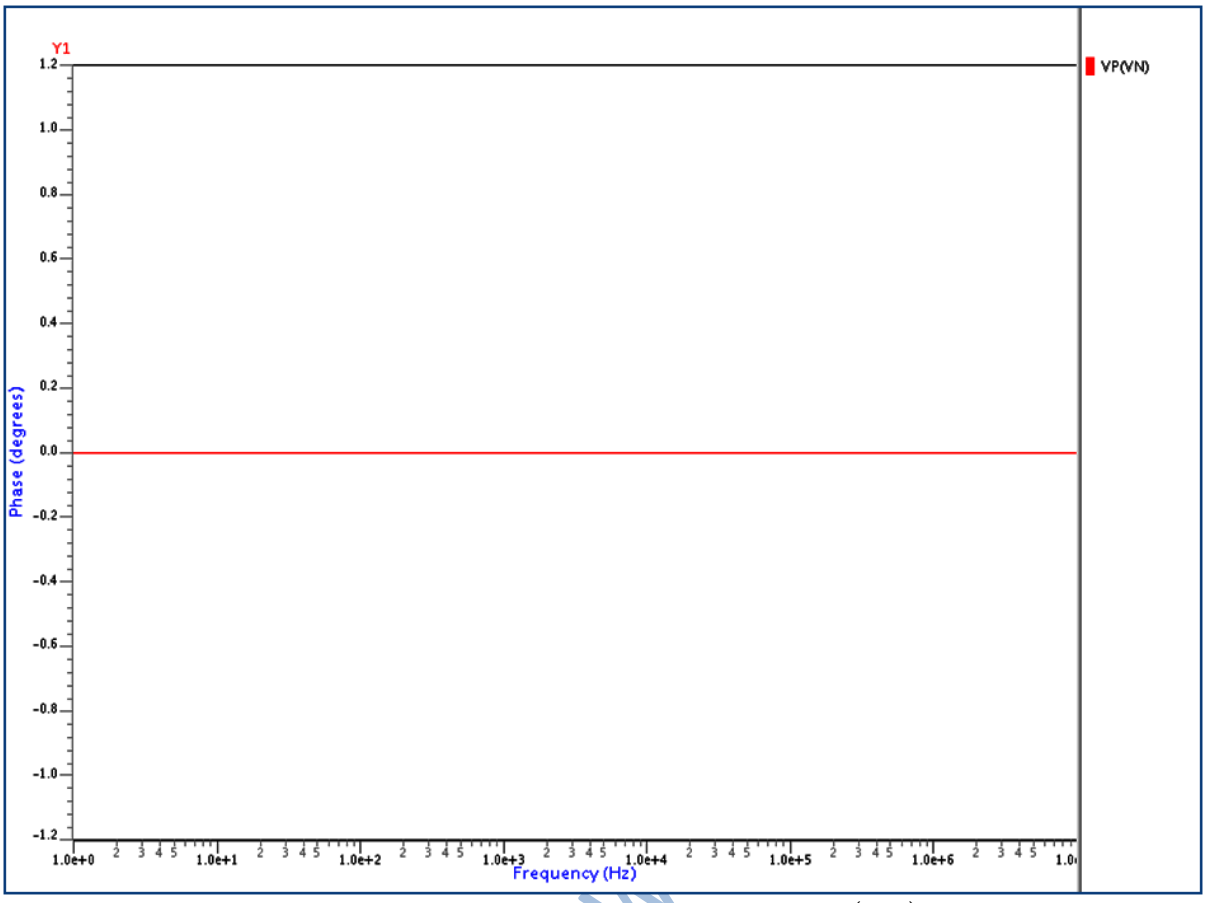



**Figure 8:** Simulation Waveform for VP(VN)

Waveform Calculator

15. Click **Waveform Calculator** on EZwave viewer and the **Waveform Calculator** will pop-up as shown in Figure 9.

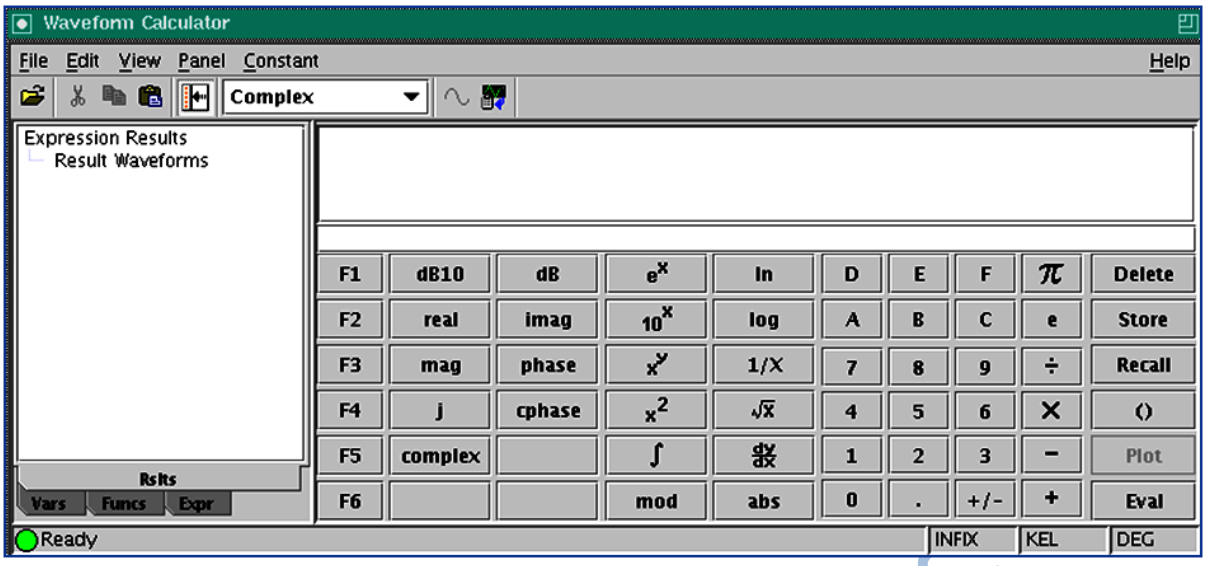
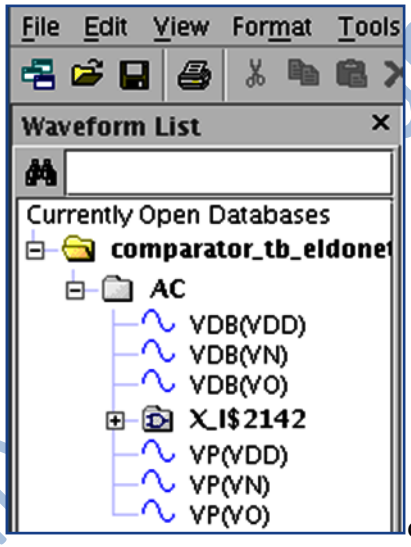
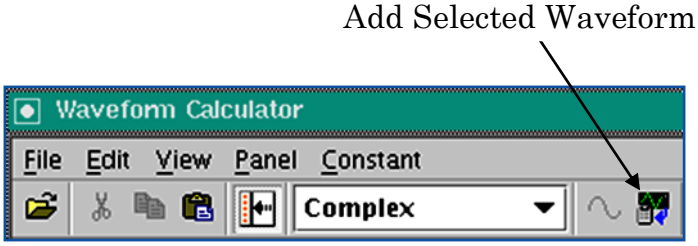



**Figure 9**: Waveform Calculator

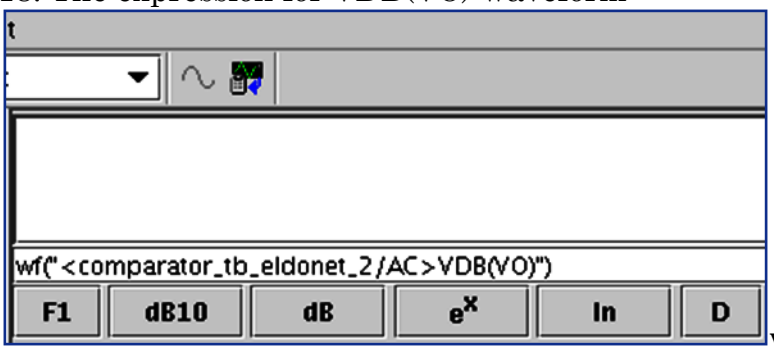
16. At the **Waveform List** 

click VDB(VO).

17. Click **Add Selected Waveform** on **Waveform Calculator.**



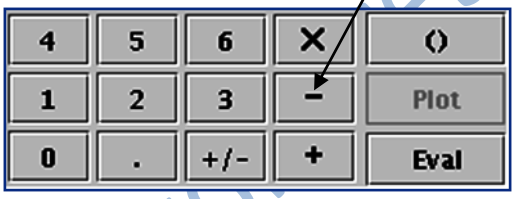
18. The expression for VDB(VO) waveform



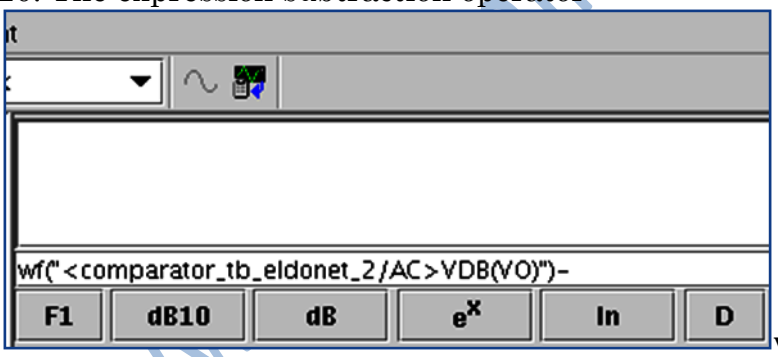

will appear at display **Waveform Calculator.**

Subtraction Operator

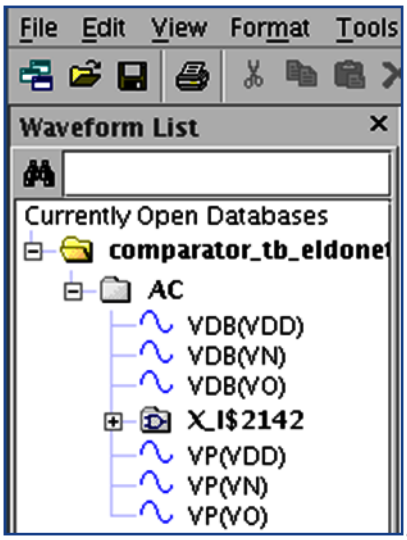
19. Click **Subtraction Operator**.




20. The expression subtraction operator

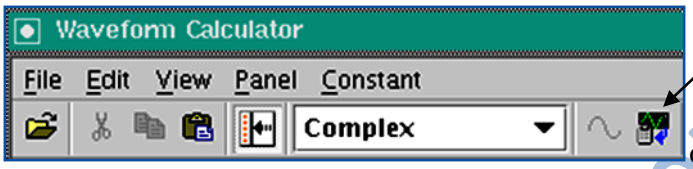



will appear at display **Waveform Calculator.**

21. Click VDB(VN) 

at the **Waveform List.**

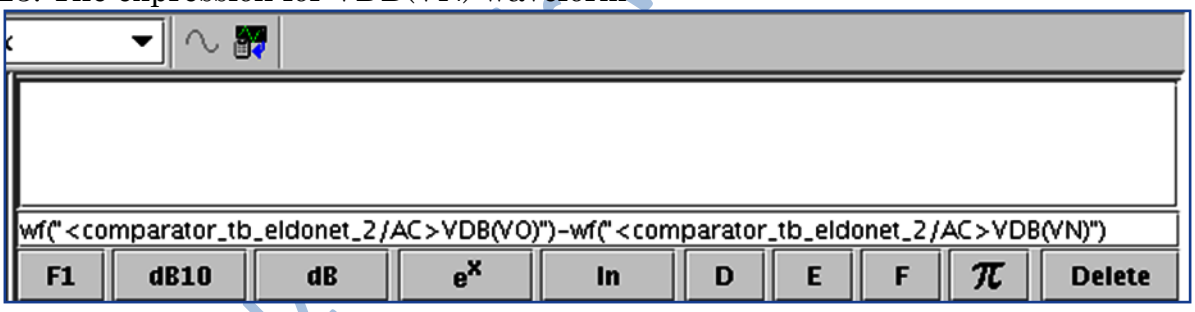
22. Then click **Add Selected Waveform**




Add Selected Waveform

on **Waveform Calculator.**

23. The expression for VDB(VN) waveform




will appear at display **Waveform Calculator**.


Evaluate the Expression

24. Click **Evaluate the Expression** at the wave **Waveform Calculator.**


Plot the Last Created Waveform

25. Then click **Plot the Last Created Waveform** to get the result of the gain waveform.

26. The waveform simulation for gain is shown in Fig 10 below and the gain we get is 51.96dB.

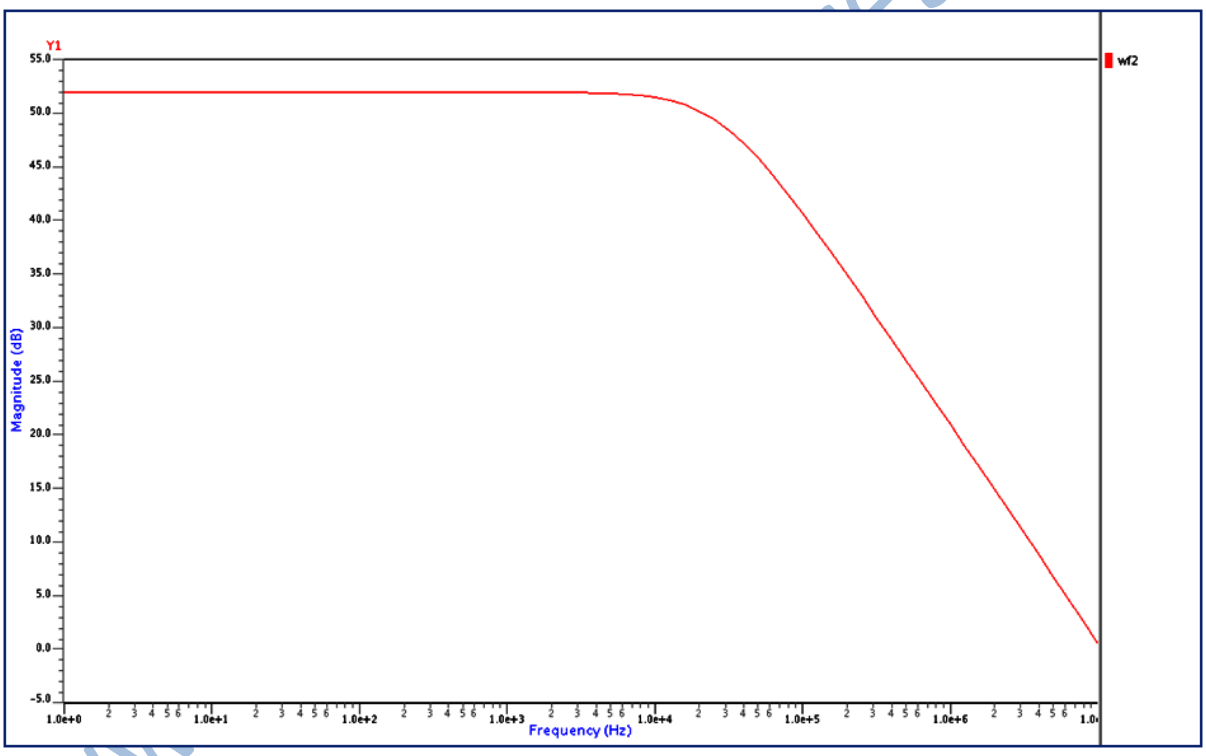



**Figure 10**: Gain waveform

27. Repeat *Step 15 until Step 25* to get the phase waveform. Use the same method also, minus it with VP(VO) and VP(VN) by using **Waveform Calculator.**

28. The waveform simulation for phase is shown in Fig 11 below and the phase we get is $180^0$.

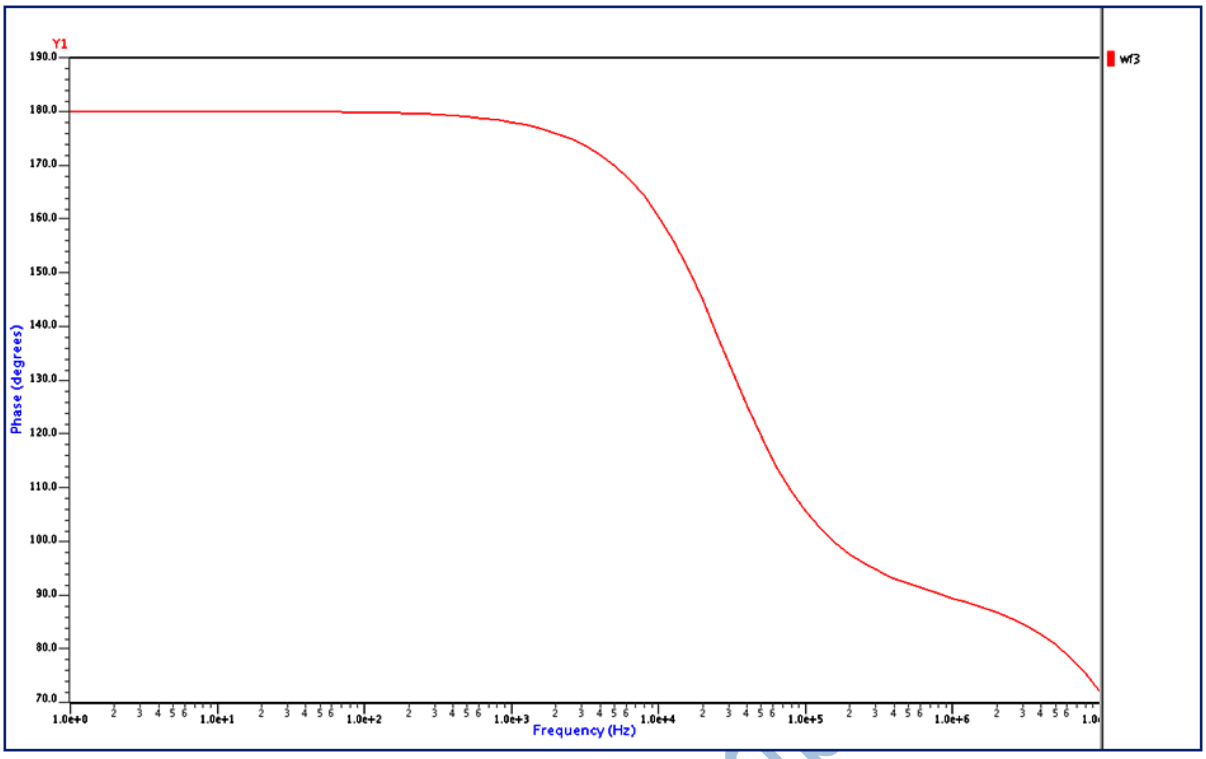



**Figure 11**: Phase waveform