# Op Amp Analysis on ADS Keysight

The operational amplifier (op-amp) circuit on the left is made of many stages, each contributing to different aspects of the amplification process with a clear input-output relationship. The input differential stage is the first to make use of two NMOS transistors that constitute a differential amplifier. The differential pair increases the voltage difference between the input terminals P1 and P4, which is the reason for the very high input resistance and gain of the op-amp configurations. For more effective power consumption, a current mirror, consisting of PMOS transistors, is linked to this differential pair. The current in the mirror's PMOS transistor assists in establishing the operating point for the differential pair, which boosts gain while conserving energy resources.

The next section in this design focuses on the current mirror load, which consists of diode-connected PMOS transistors. This current mirror functions as a high-impedance load for the differential stage, which is critical for enhancing the amplifier's gain. By reflecting the current, it boosts the differential signal while ensuring power efficiency is maintained. Next, we move on to the gain stage, where additional PMOS and NMOS transistors are used to further amplify the signal prior to reaching the output. A compensation capacitor, C1, is incorporated in this stage to stabilize the amplifier and enhance the phase margin, which is an important factor for ensuring stability in operational amplifier circuits. To review, the output stage is a buffer, making sure that the amplified signal is transmitted to the output terminal with minimal distortion and power loss. This stage is essential for effectively driving loads and preserving the linearity of the output signal.
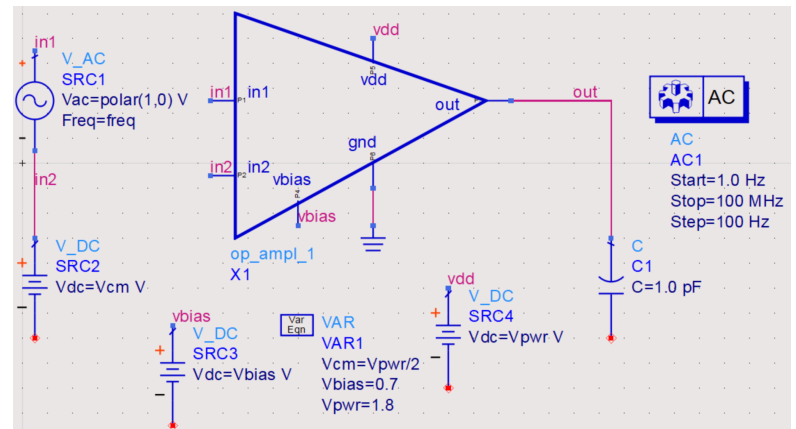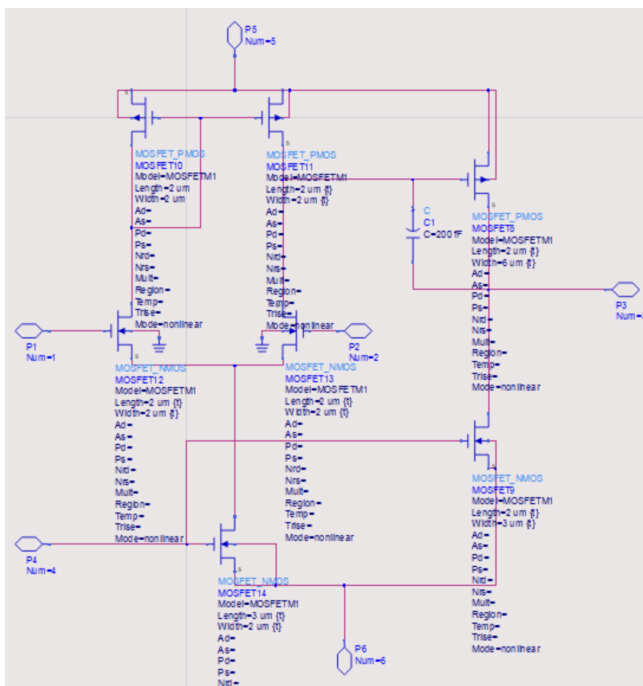
On the right side, there is a simplified schematic created for AC analysis of an op-amp circuit. By adjusting this configuration, various frequency responses can be achieved, displaying different operational modes. To observe the non-inverting configuration, you can connect the input signal to in1 while grounding in2. This arrangement will yield an output signal that is in phase with the input, providing a non-inverting gain that can be assessed for frequency response during an AC sweep. For the inverting configuration, the input signal is directed to in2, with in1 grounded. In this scenario, the output will be 180 degrees out of phase with the input, resulting in an inverting gain that can also be analyzed for frequency behavior.

For situations that necessitate common-mode noise rejection, the differential configuration proves beneficial. In this arrangement, input signals are applied to both in1 and in2, enabling the op-amp to amplify only the difference between the inputs. This configuration is essential in settings where differential gain is required, and the AC analysis will reveal how the circuit reacts to frequency changes in differential mode. Finally, by applying multiple input signals to either in1 or in2 using separate resistors, the circuit can function in a summing configuration. This setup is frequently used in audio mixers or signal combiners, where the output represents the sum of the input voltages. Through AC analysis in ADS, you can investigate how this summing behavior influences the frequency response, aiding in the understanding of the op-amp's adaptability across different configurations. Each of these configurations provides distinct insights into the op-amp's performance, and ADS simulations can offer valuable information on gain and phase response for each configuration.