Lab 7: The MOS Differential Pair

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Experiment 1: Differential Pair Current-Voltage Characteristics

In this experiment, we constructed an nMOS different pair with a bias voltage that set the bias current right at threshold (0.6 V) and a V2 far enough away from the power supply rail such that the bias transistor is saturated. We measured I1 and I2 and the common-source node voltages as a function of V1 (swept from slightly below V2 to slightly above V2). We also repeated this procedure for two more values of V2 that satisfied the criteria established above.

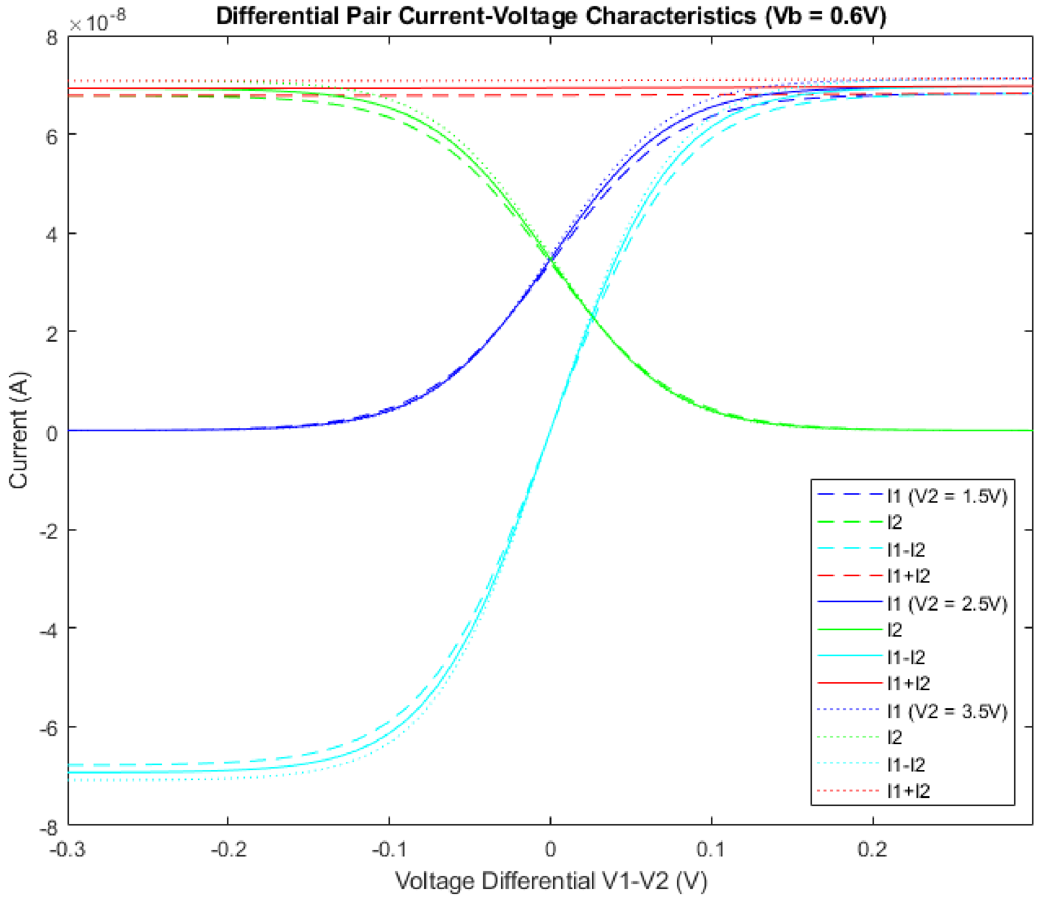

Figure 1: The current outputs as a function of the voltage differential (V1 - V2) for several values of V2 and a swept V1 with the bias current below threshold.

Referring to figure 1, the current voltage characteristics do not change significantly with different values of V2. In fact, they stick pretty closely together. As expected, V2 values don't impact the output current proportionally.

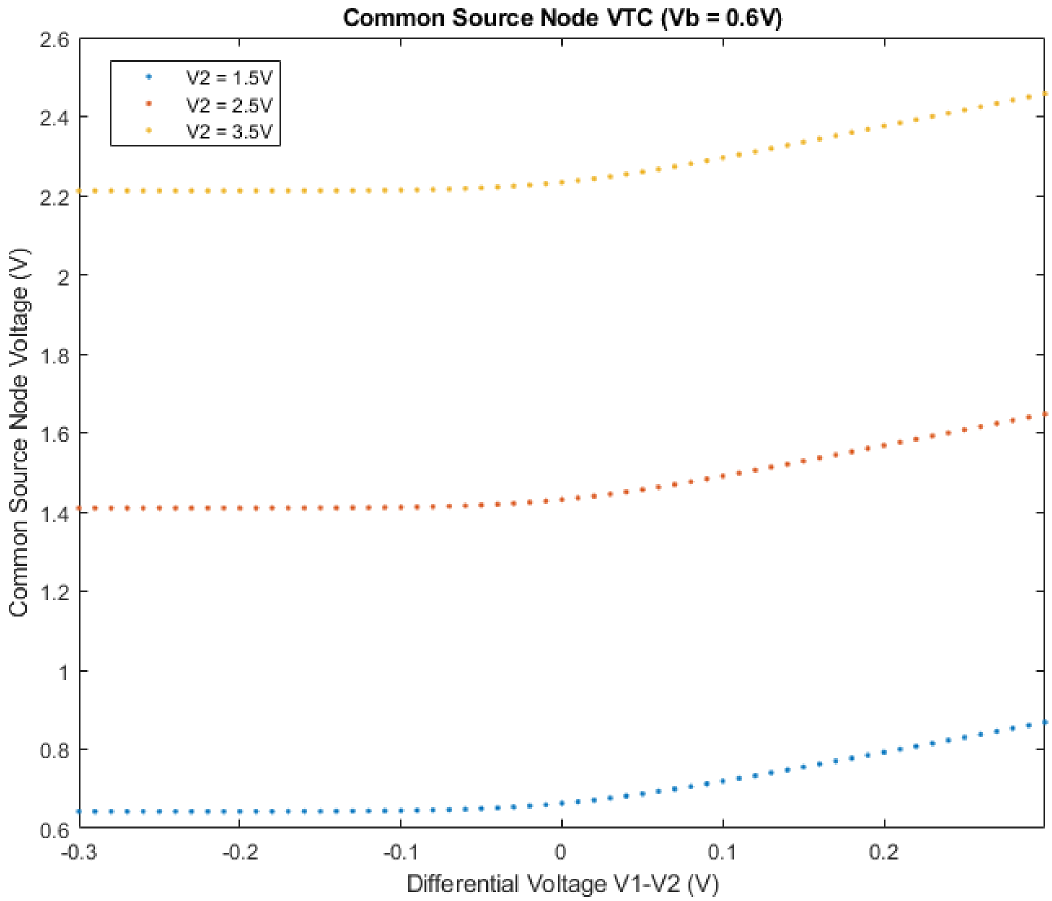

Figure 2: The common-source node voltage as a function of the Vdm for 3 separate values of V2 with the bias current below threshold.

The slope of the common source node voltage increases once the differential mode voltage is positive. This trend is followed equally at all three V2 values.

Table 1

V2 Value	Differential-Mode Transconductance Gain (Mhos)
1.5 V	8.565e-7
2.5 V	9.121e-7
3.5 V	9.521e-7

At the three V2 values, the differential-mode transconductance gain does increase slightly with V2, but, as expected, it doesn't change it even remotely proportionally to how much V2 is changing.

For the latter half of this experiment, we set the bias voltage (1.0 V) such that the bias current is above threshold. We used a value of V2 that is far enough from the power supply rail to keep the bias transistor saturated (1.5 V, 2.5 V, 3.5 V).

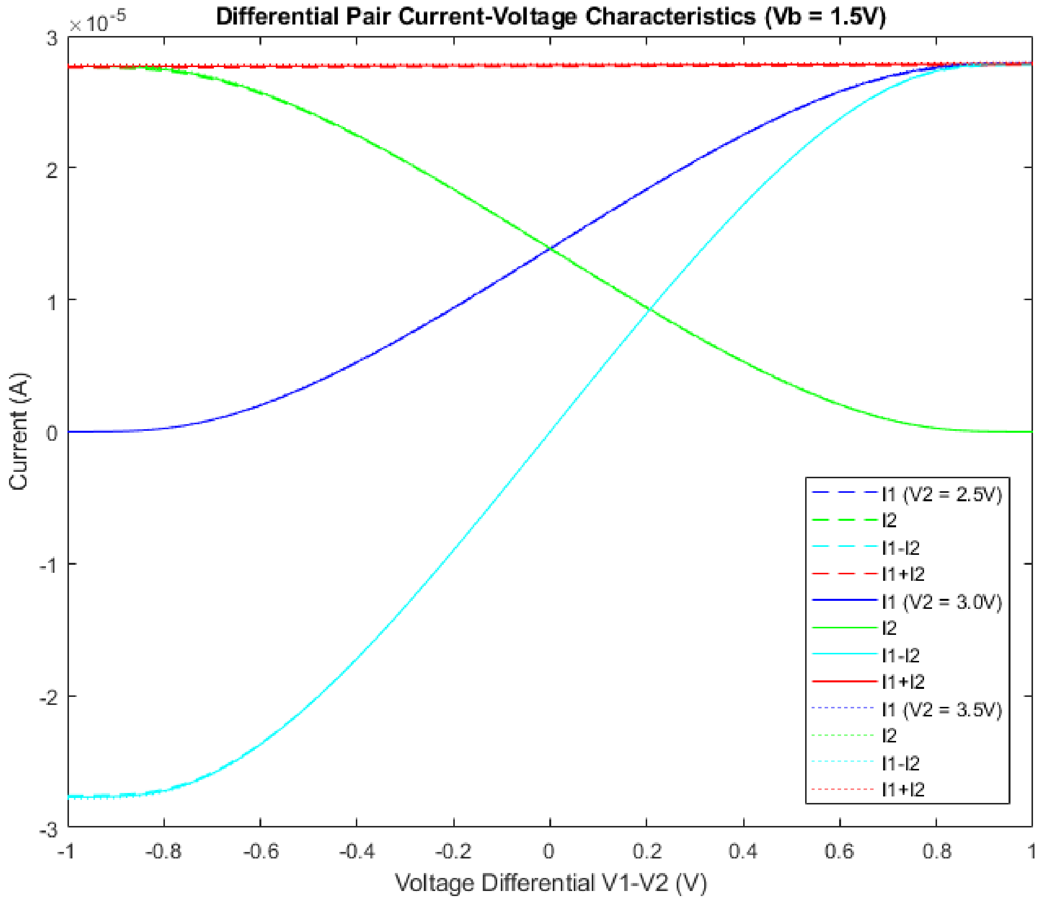

Figure 3: The current outputs as a function of the voltage differential (V1 - V2) for several values of V2 and a swept V1 with the bias currents above threshold.

Table 2

V2 Value	Differential-Mode Transconductance Gain (Mhos)
1.5 V	4.549e-5
2.5 V	4.550e-5
3.5 V	4.545e-5

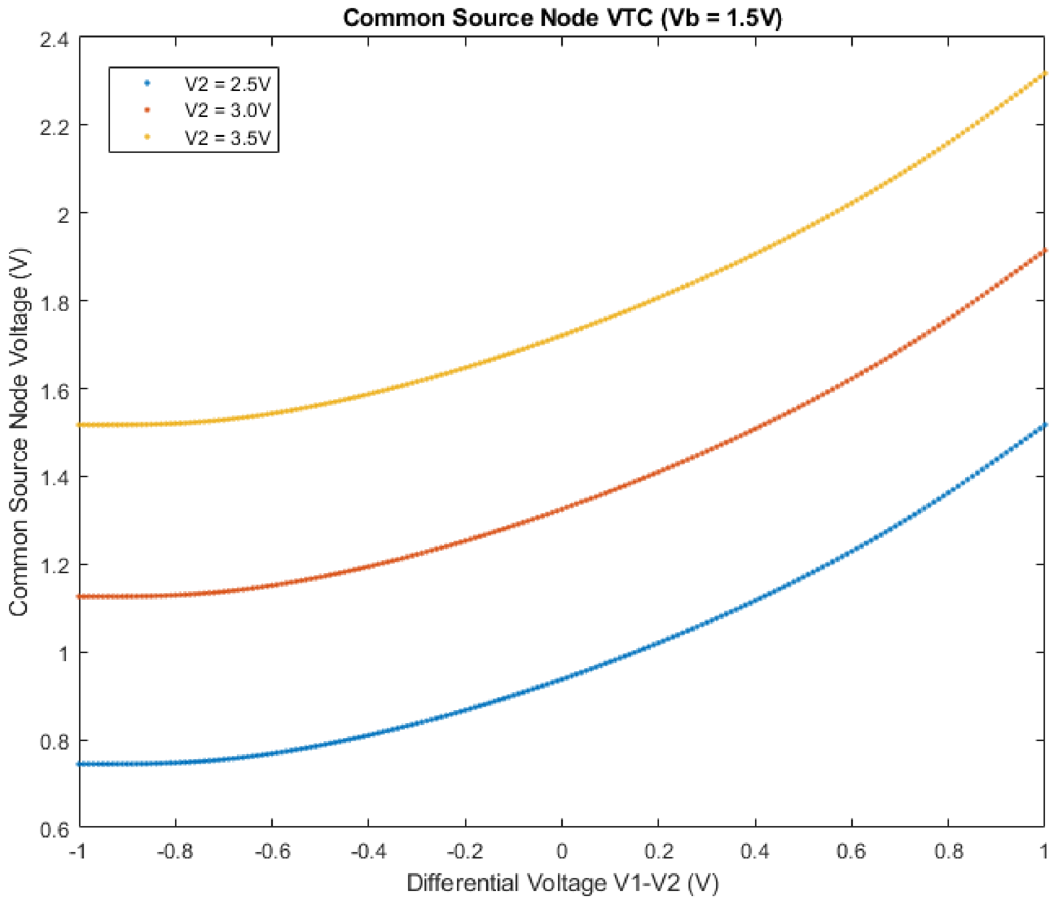

Figure 4: The common-source node voltage as a function of the Vdm for 3 separate values of V2 with the bias current above threshold.

The current-voltage characteristic plots for the bias currents below and above threshold are very similar. It seems that V2 affects the differential-mode transconductance gain in a similar way at bias currents above and at threshold. In addition, the behavior between are similar in both.

The common source node voltage transfer characteristics were similar at bias currents above and at threshold. However, at the bias current just below threshold, there was a clear change in the behavior at the differential mode voltage 0. At the bias current significantly above threshold, the common source node voltage plot follows a much smoother and exponential curve.

Lastly, although the trends followed are similar, the range of V1s needed to sweep through to capture all of the trends was larger. This is because the transition range to saturate is much larger at strong inversion.