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Experiment 3 Lab Report
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Experiment #11: MOSFET Characteristics and Applications

The MOSFET as a Switch

The use of a MOSFET transistor as a switch can be verified through use of specifically designed integrated circuits such as the CD4066B CMOS Quad Bilateral Switch. In verifying the use of the CD4066B, a voltage of ±2V can be applied to the switch, resulting in an open switch at +2V and a closed switch at -2V. This behavior can be verified in *Figure 1*.

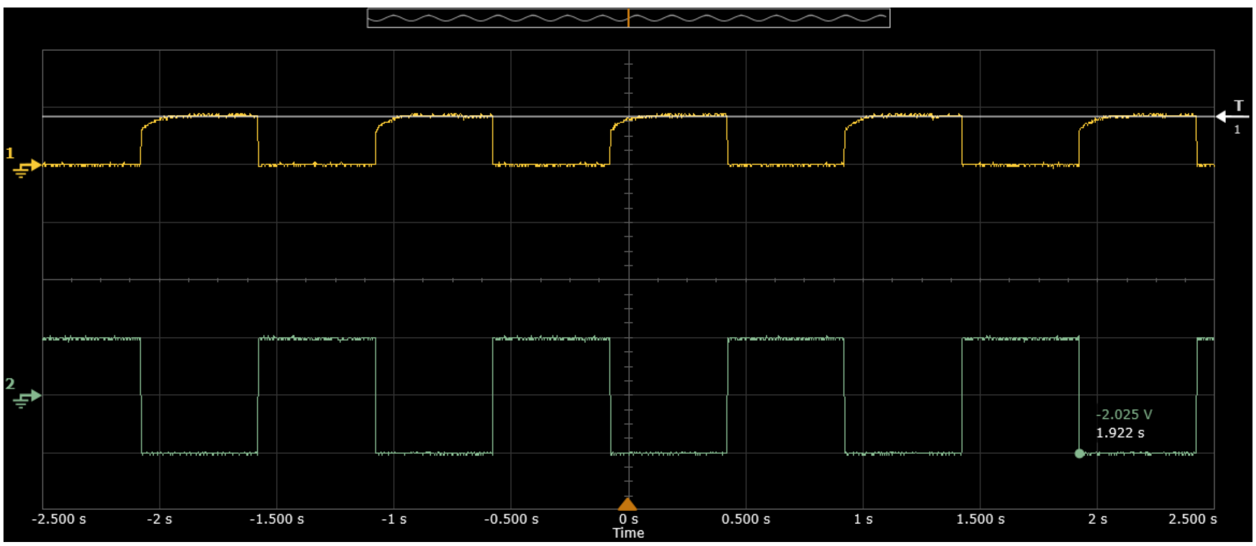

Figure 1: Behavior of the CD4066B as a switch.

Further, the resistance of the output can be measured to confirm the behavior of the switch. At +2V the resistance measured between the output and ground is 0.00Ω, while the resistance at -2V is 1000MΩ.

A Chopper

A chopper circuit can be built to sample an input signal at a given control frequency—it's important to sample at a frequency equal or greater than the Nyquist Sampling Frequency. The expected output can be observed in *Figure 3*, which matches the output of *Figure 2*.

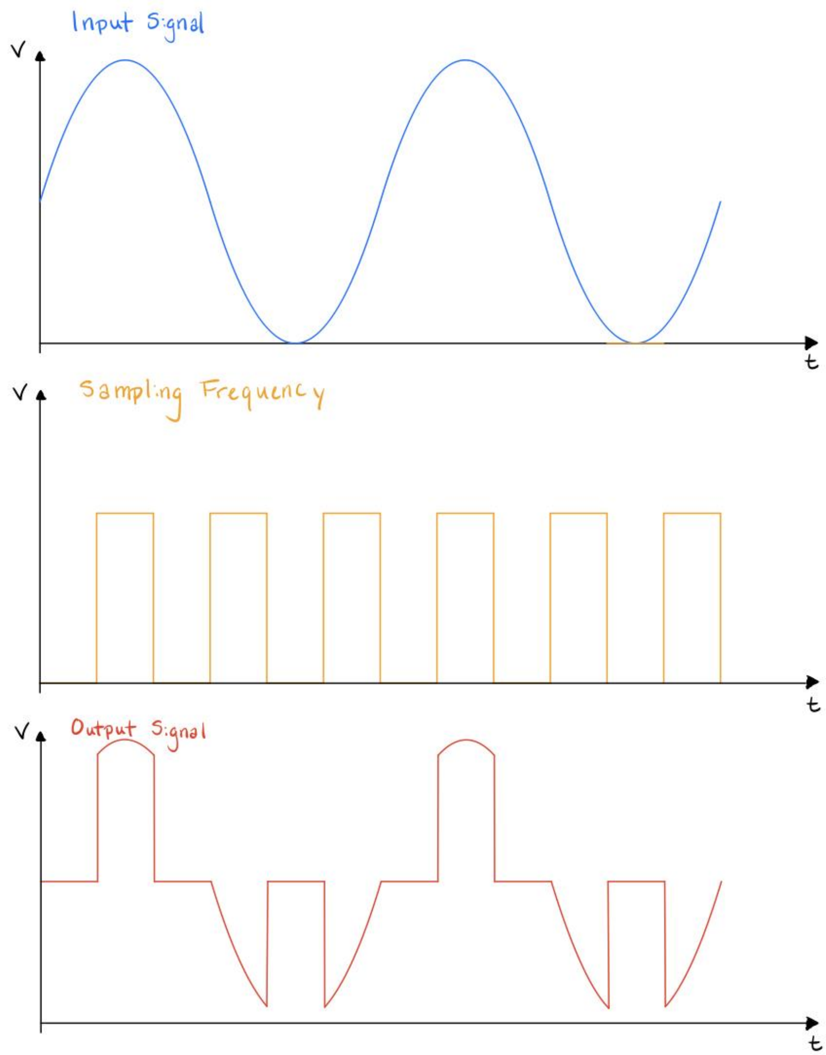

Figure 2: Expected output of the chopper circuit.

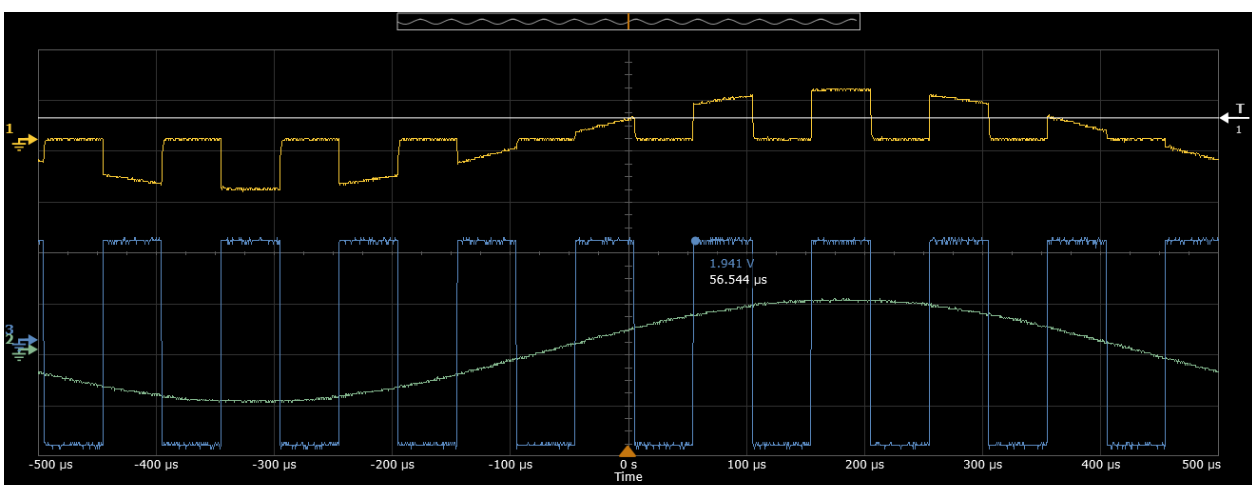

Figure 3: Sampling of the sinusoidal signal can be observed.

A Track-and-Hold Circuit

A Track-and-Hold circuit can be built to sample an input signal at a given control frequency—it's important to sample at a frequency equal or greater than the Nyquist Sampling Frequency. The expected output can be observed in *Figure 5*, which matches the output of *Figure 4*.

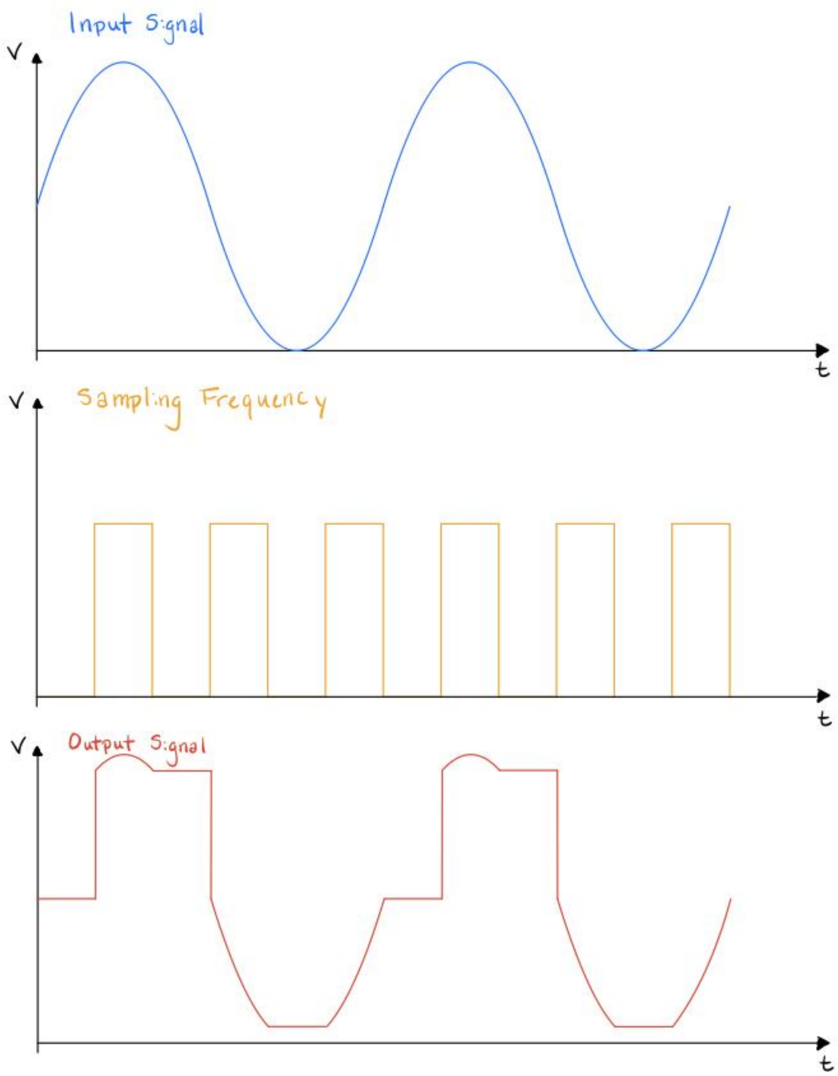

Figure 4: Expected output of the Track-and-Hold circuit

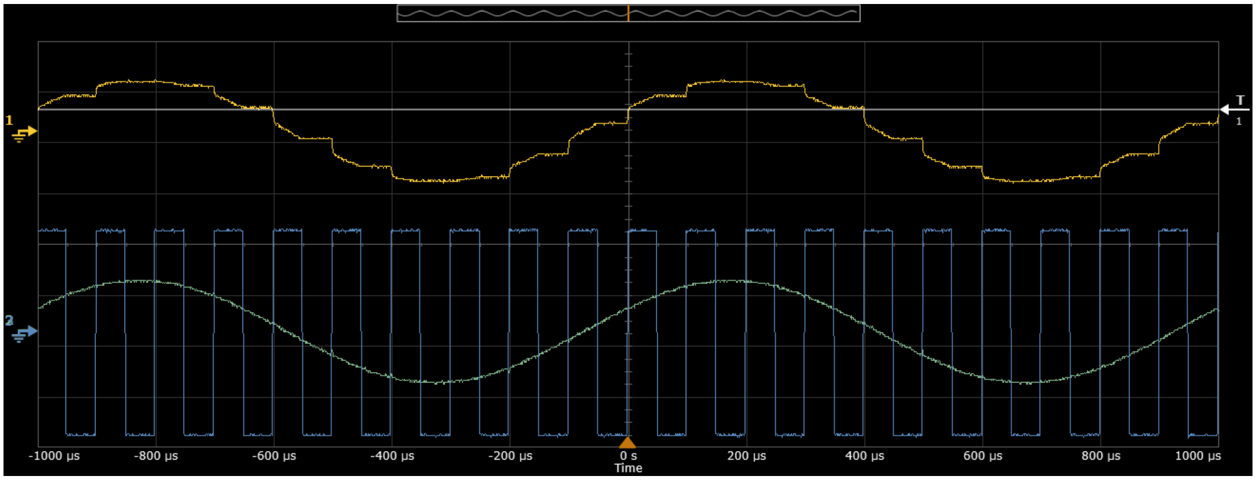

Figure 5: Sampling of the Track-and-Hold circuit

Sample and Hold

The Track-and-Hold circuit can be modified by adding a unity gain buffer to the output—resulting in a Sample and Hold circuit. This new circuit would sample the input signal at a positive edge and hold this value until sampled again.

High Output Current Drive Capability

The unity gain buffer can be used with a load resistor of 1kΩ to obtain the output voltage seen in *Figure 6*. With a maximum of 4V the current through this load resistor is 4mA. Similarly, we can use a smaller load resistor of 20Ω to obtain the output seen in *Figure 7*. Here, with a maximum of 625mV, we see 31.25mA.

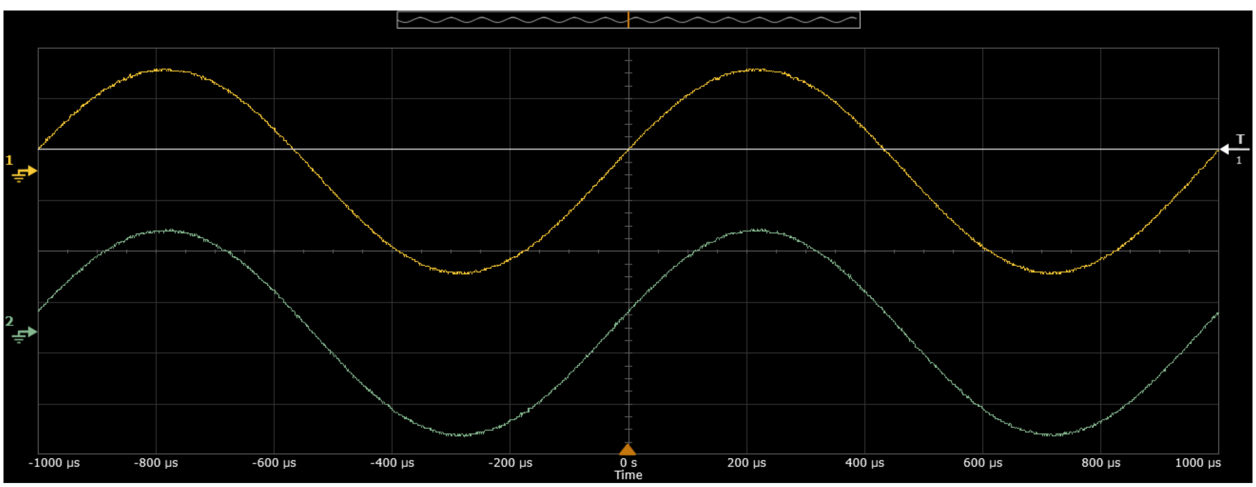

Figure 6: Unity gain buffer output with a 1KΩ load resistor.

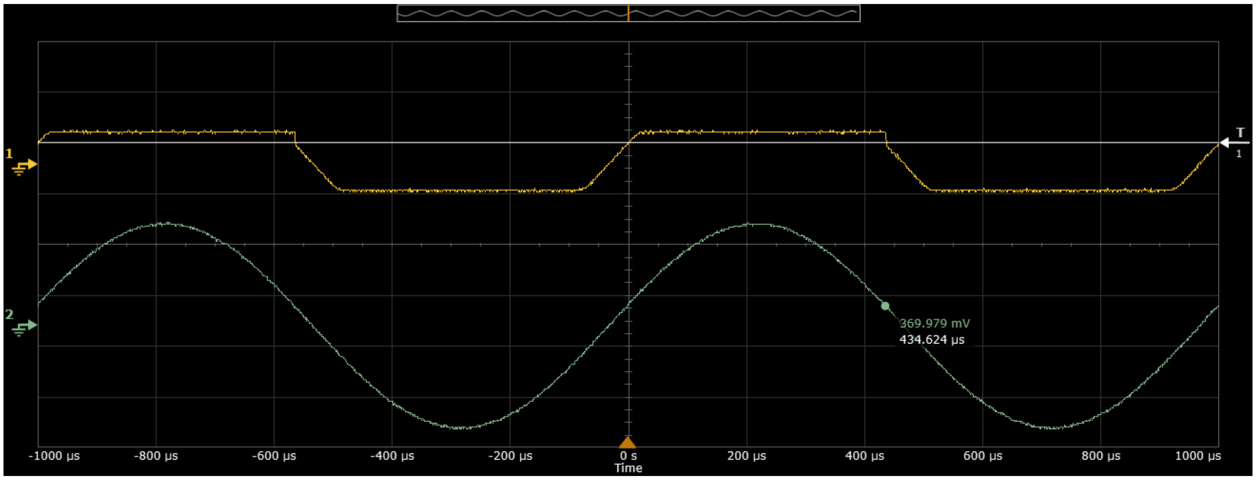

Figure 7: Unity gain buffer output with a 20Ω load resistor.

We can include two power MOSFETs in a circuit like that used to drive a higher current in the op-amp output. This is a result of the behavior of the transistors—when the output voltage of the opamp swings positive, one of the transistors turns on and sources the current. When the output voltage of the opamp swings negative, the other transistor turns on and sinks the current. This allows the current to be matched, and the load to be driven. We can see an interesting behavior when the signal crosses 0V—this is the point at which neither transistor has reached saturation. We expect that the transistors will turn on and off for BJTs following the input as seen in *Figure 9*. The actual current in each transistor can be seen in *Figure 10* and *Figure 11*. Finally, by directly connecting the function generator(signal) to the gates of the transistors, we can observe the outputs seen across the load in *Figure 12* and *Figure 13*. In *Figure 12*, there is a period of time where no voltage is observed across the resistor. This is a result of the BJTs operating in cutoff. This is not observed for the MOSFETs in *Figure 13*.

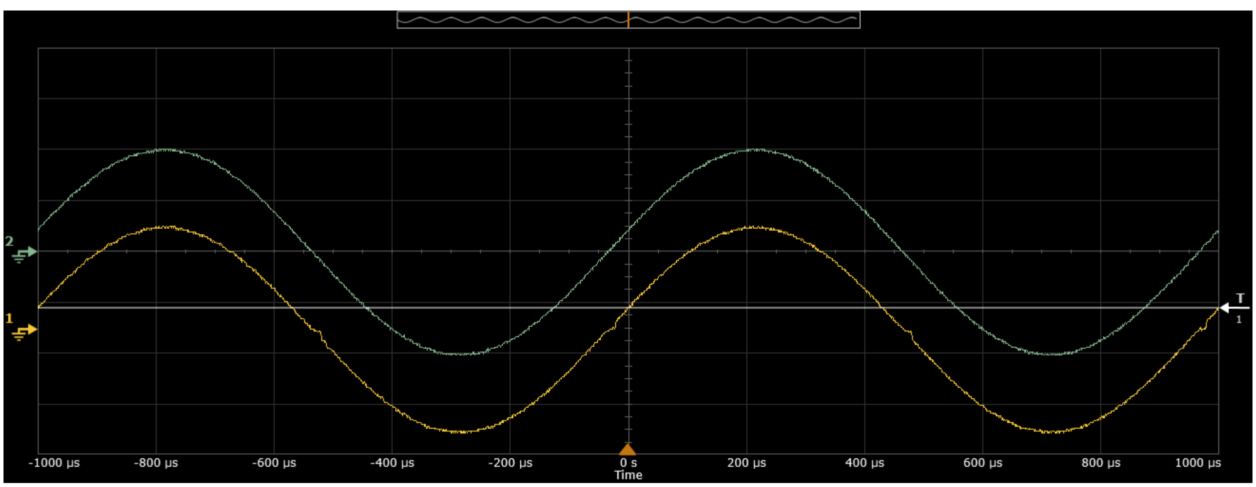

Figure 8: Higher output current for op-amp.

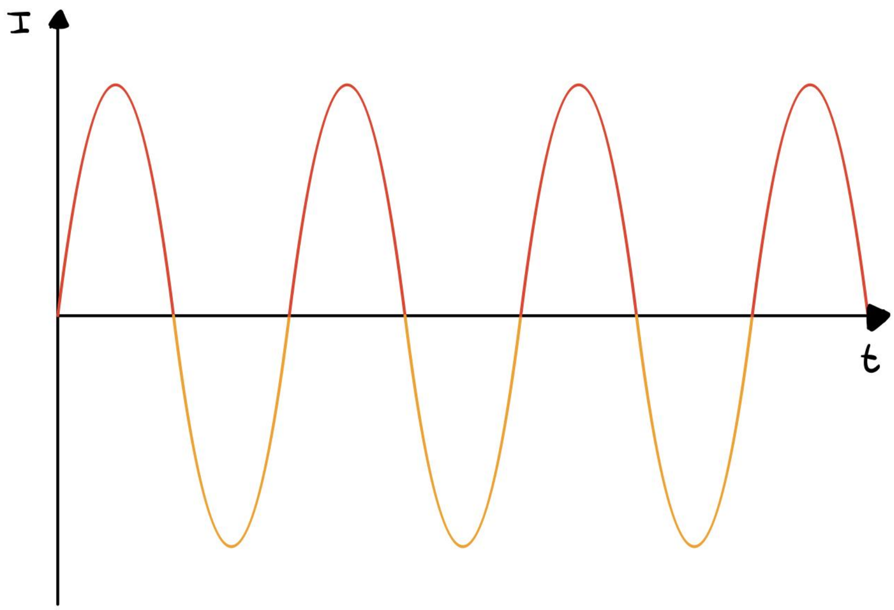

Figure 9: Expected current for each BJT transistor.

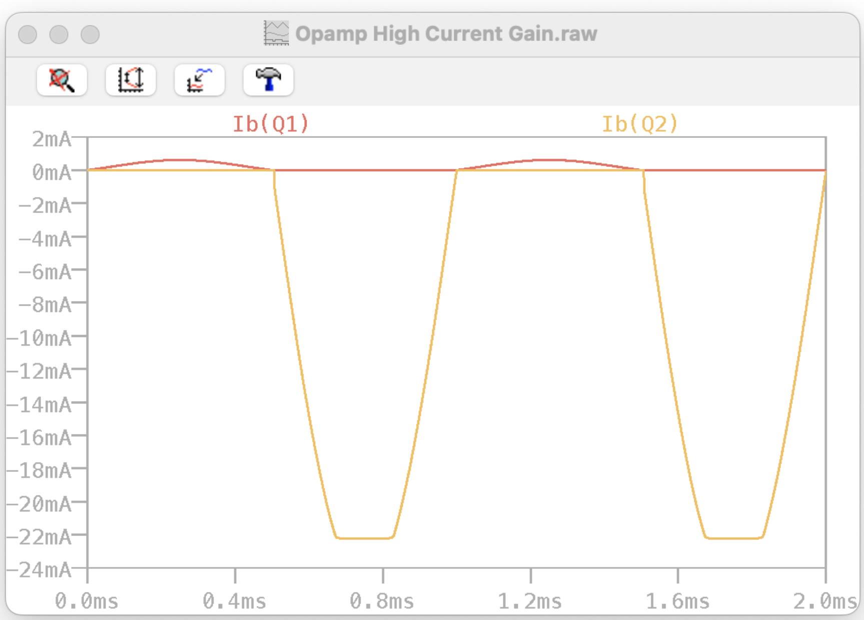

Figure 10: Actual current for each BJT transistor.

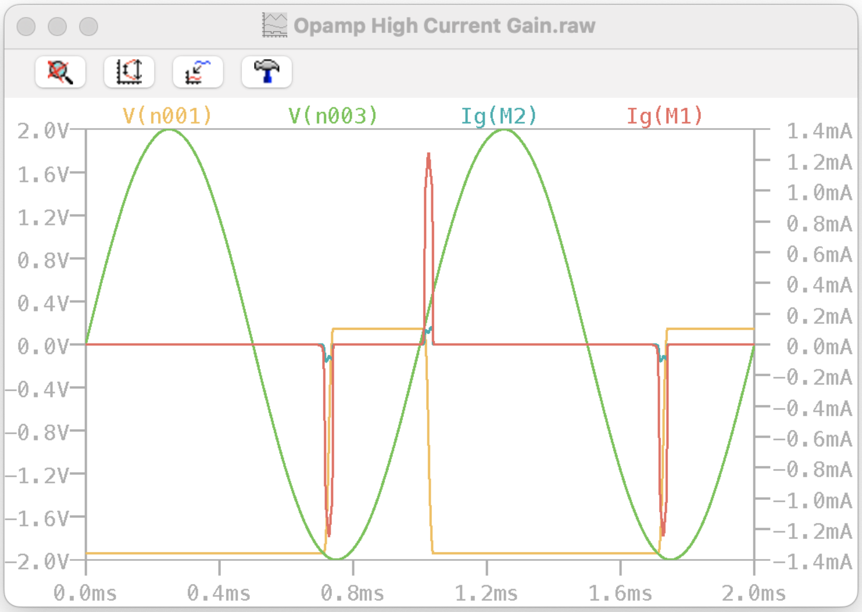

Figure 11: Actual current for each MOSFET transistor.

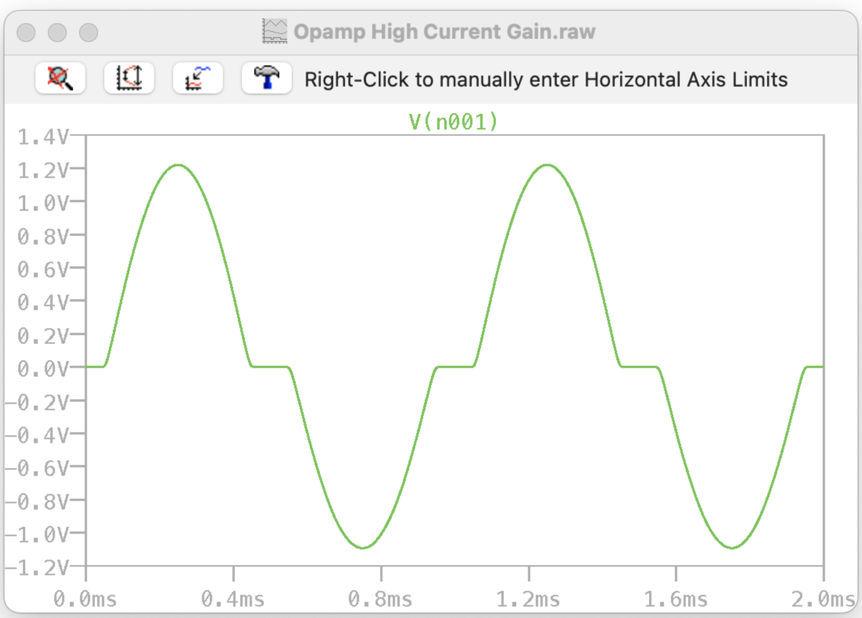

Figure 12: Load output across BJTs.

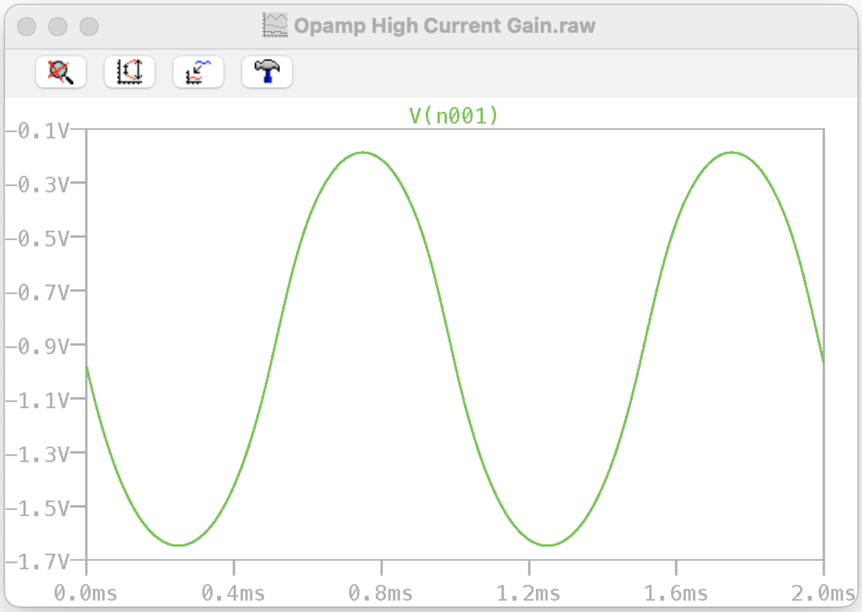

Figure 13: Load output across MOSFETs.