ECEN 489: Data Conversion Systems & Circuits

Lab 3: Sampler Error Modeling and Correction

Joseph Nguyen
03/21/2025
931006629
https://github.com/josephknguyen02/ECEN489/tree/main

Lab Experiment:

For the lab experiment I began by building the sampling circuit in the lab manual shown below.

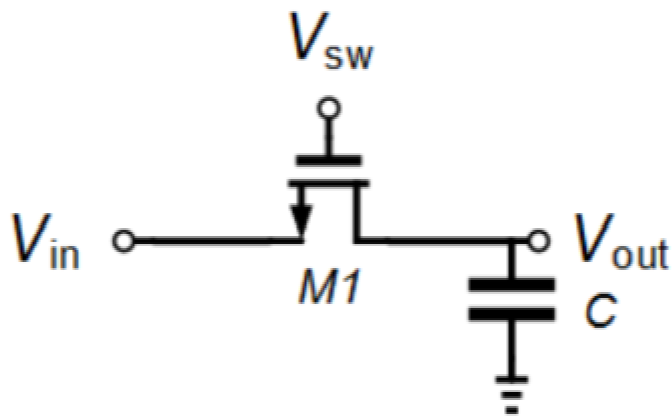
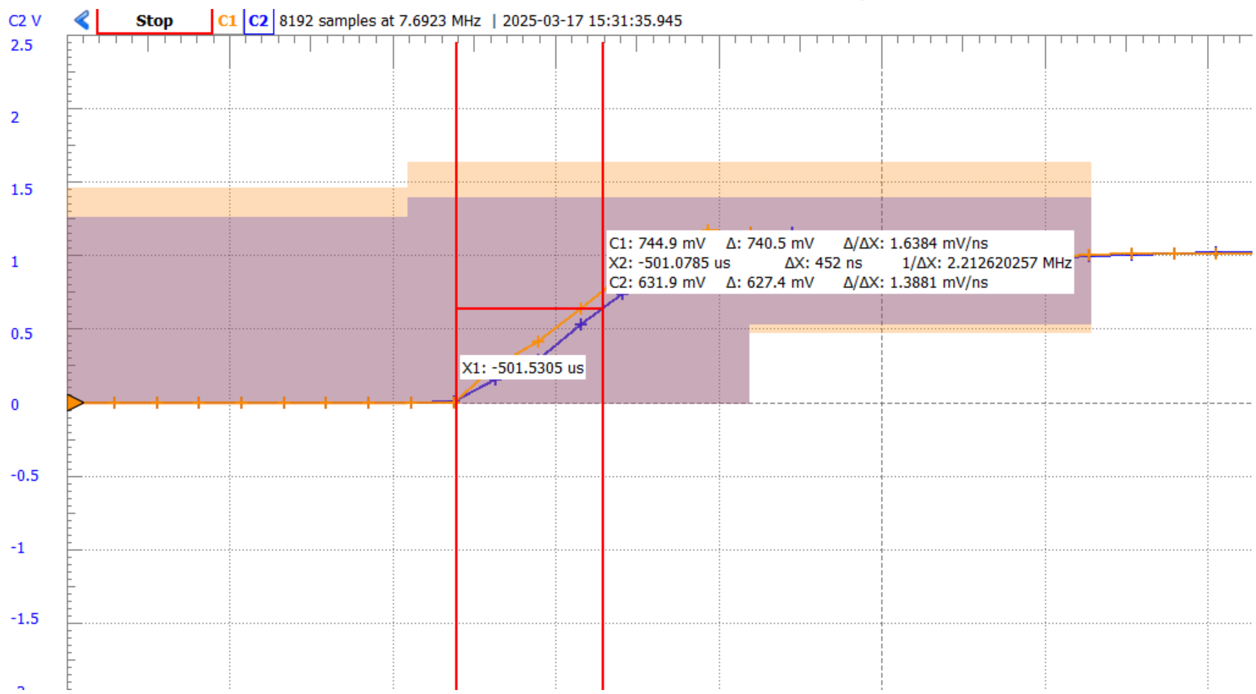


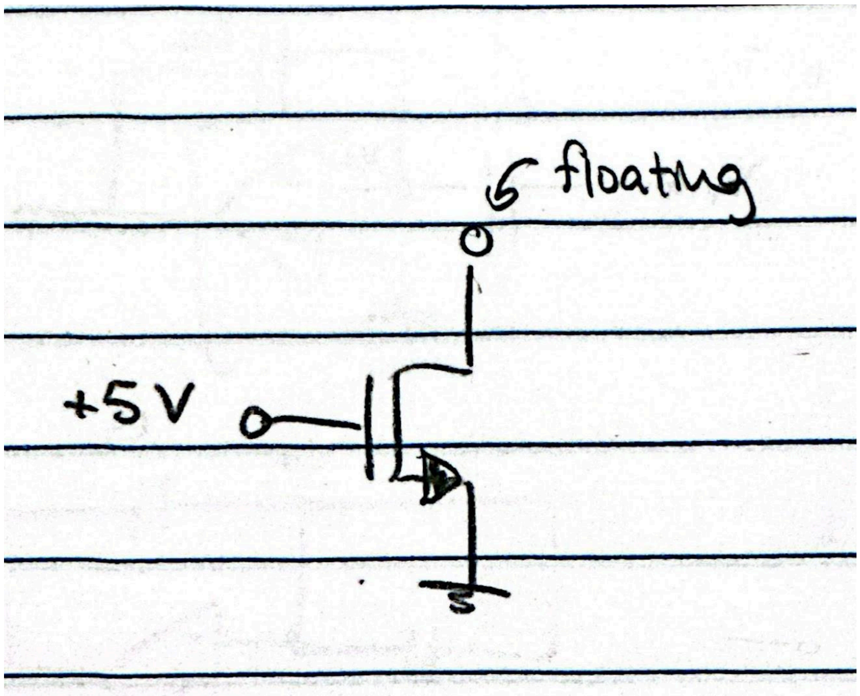
Figure 1: Sampling Circuit

To calculate the Ron, I used the AD2 to drive a square wave at the input and biased the gate of M1 with 5V. I then plotted the transient response of the circuit using the AD2 waveform.



As we can see here, the time constant is about 452 ns. Since the equation for the time constant, tau, is Ron*C, we can solve for Ron by dividing tau by the load capacitance which is 33nF. This resulted in a calculated Ron of 13.7Ω.

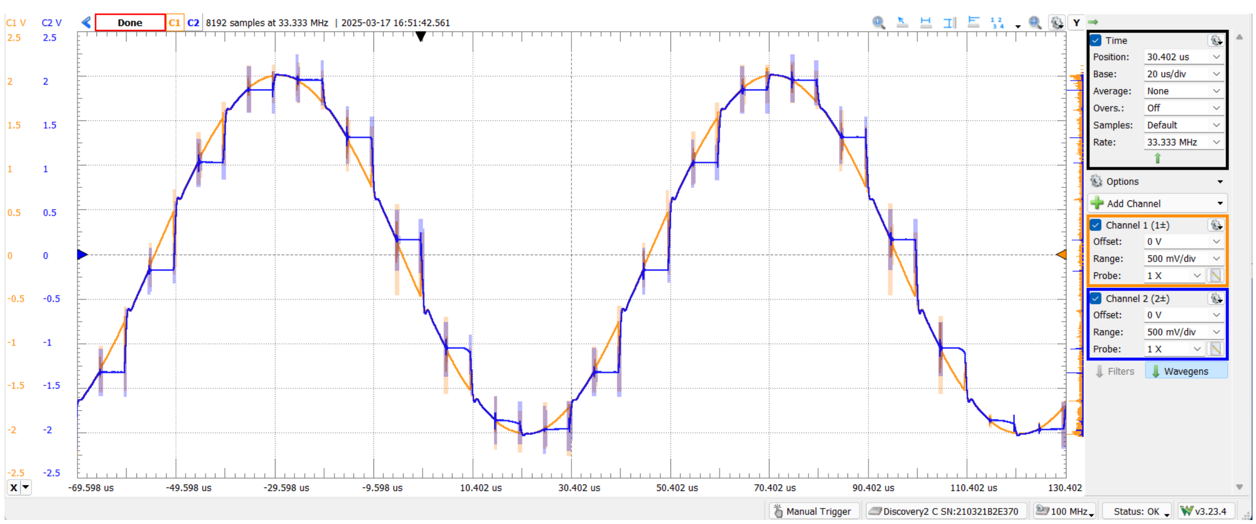
For the measured value of Ron, I used a simple circuit configuration shown below.



Using the DMM, I measured the resistance across the source and drain which resulted in an Ron of 1.749Ω. From this we can derive the value for tau by multiplying Ron by the load capacitance (33nF) to get a time constant of 57.7ns.

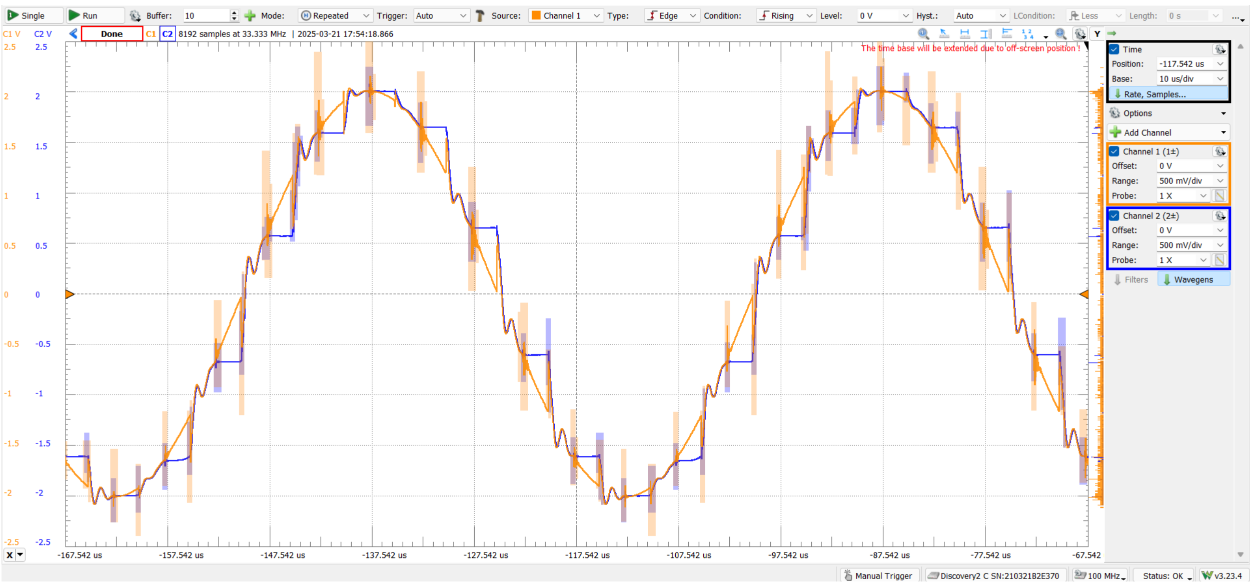
Since Ron is supposed to be within 1-10Ω, we can see that the measured value is more accurate than the calculated value.

For the next part of the experiment, I used the AD2 to generate a 10 kHz sine wave with an amplitude of 2V and a 50% duty cycle square wave with a frequency of 100 kHz that swings from 0V to 5V to drive the gate of the MOSFET switch with the square wave, and input the sine wave into the sampler.



Here is the output waveform of the sampled circuit. As we can see the ZOH behaves as expected with about 10 samples per period. In order to find the sampling error, I collected the error between the two channels and used the mean square error formula. For this implementation, the sampling error was about 40.3mV.

Next, I increased the frequencies of both signals to 20kHz and 200kHz for the sine and square waves respectively.



Here is the resulting output waveform. As we can see, the sampling is not as smooth as before. We can visibly see that the sampling error has increased significantly with a measured value of about 54.9mV