A/D For 2-Photon Microscopy

James Ridgers

Motivation

A Photomuplier is used in 2-Photon microscopy to convert photon's into voltage signals. The voltage signal must be converted into a digital signal to be read by the computer.

- Using a sample and hold requires time for discharging the capacitor of the buffer Op-Amp
- Simple signal conditioning is limited by its inability to deal with fast preamplifiers due to the increase of samples needed
- Using a low-pass filter requires the cutoff frequency of the filter to be set to 2/(πζ) ; ζ = Pixel Period

Dual Phase Integrator

Using alternating switched integrators to prevent blanking-off time. Dual Phase Integration allows better quality thanks to an overall variance of the image.

- Allows integration when an integrator needs to be reset
- Does not require multiple samples per pixel
- Suppression of correlation between adjacent pixels
- No need for cut-off frequency adjustment whenever the pixel dwell time changes

Photomultiplier Tube

Photomultiplier Tubes (PMTs) are special vacuum tubes that enable individual photons to be detected.

- The PMT multiplies the current produced by the incident light
- The output of the PMT is a voltage signal by multiplying the current produced by the incident light

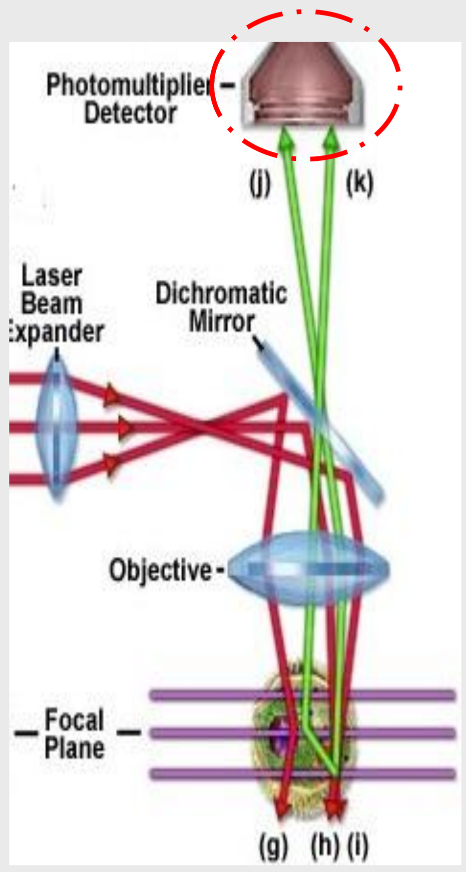

Figure 1 Overview of Two Photon Microscopy [1]

Output = (Current from Incident Light) * (Constant)

Circuit

First created the dual phase integrator in PSpice to test different resistive and capacitive values and to measure the theoretical output of the circuit

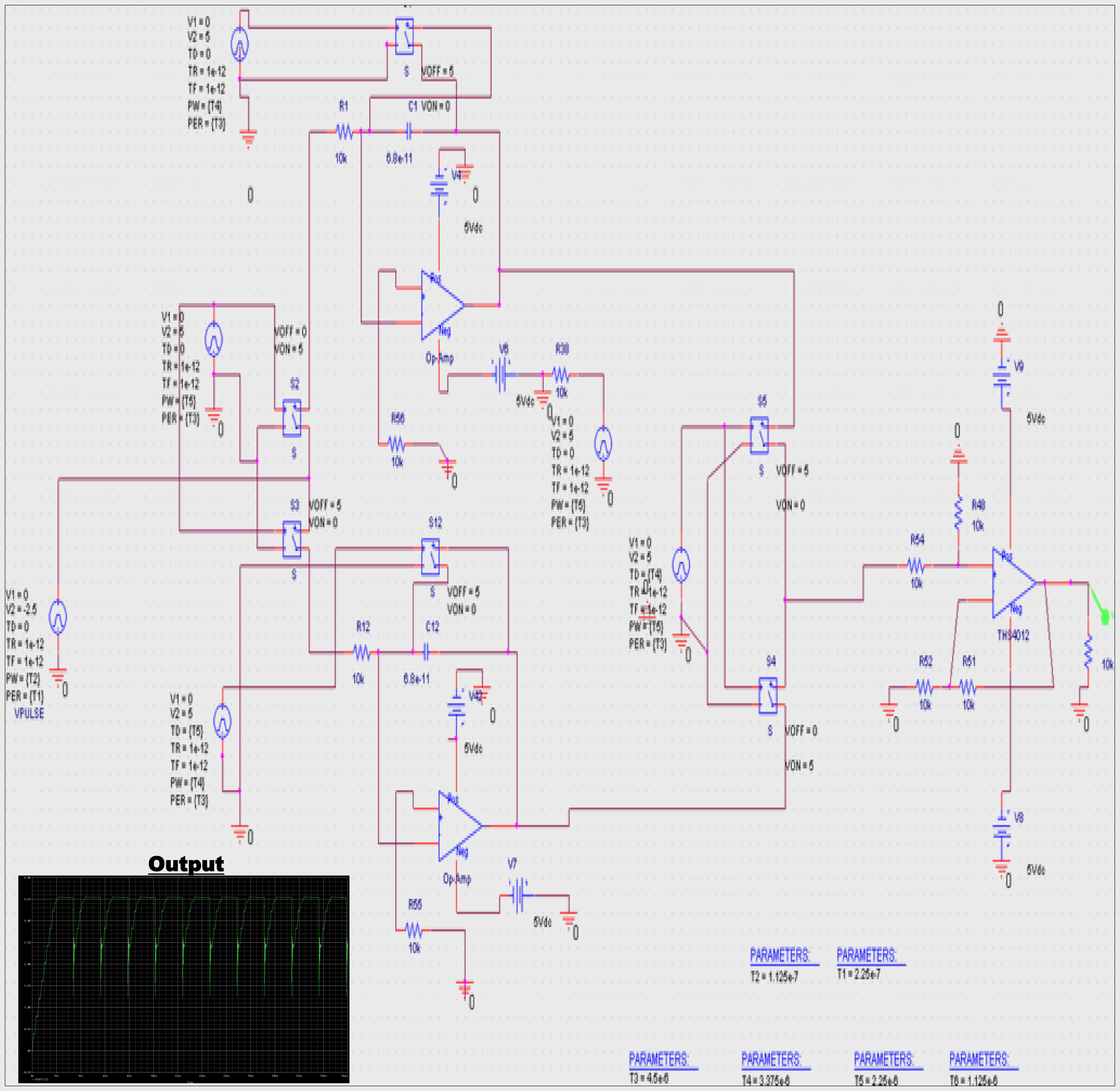

Figure 2 PSpice schematic and output [2]

Timing

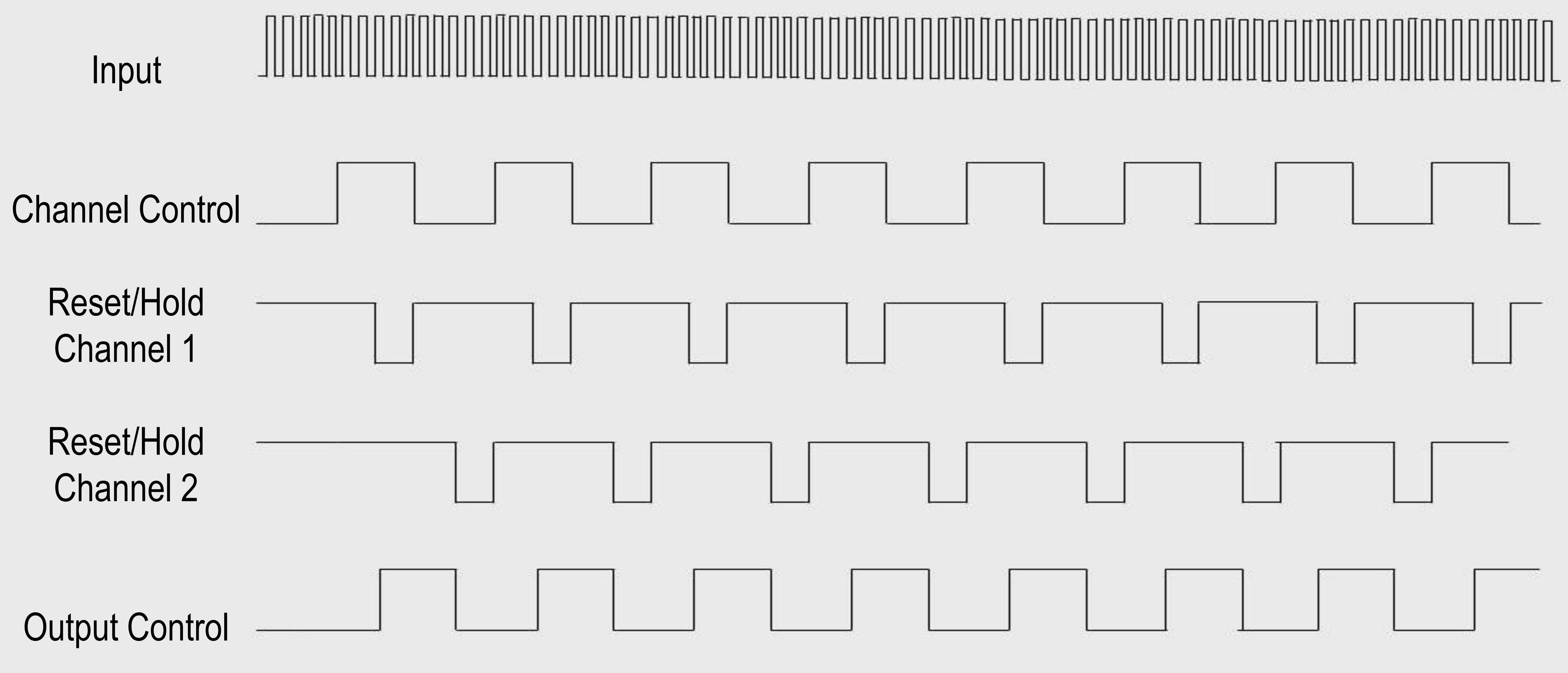

Figure 8 Timing used for the dual phase integrator [2]

Testing

Tested multiple op-amps and switches to measure the noise and power dissipation.

- The LM838 will be used as the op-amp for the final circuit for its low input noise and for its high slew rate and large bandwidth.
- The ADG1236 and ADG611 for their fast switching time and low noise

Output of Single Channel Using Different Op-Amps

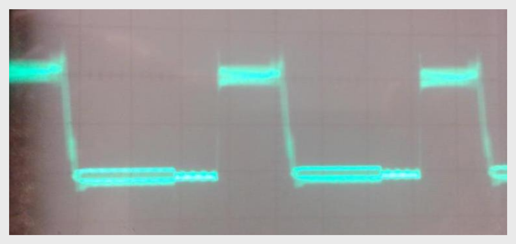

Figure 3 Single Channel Output using an LM833 [2]

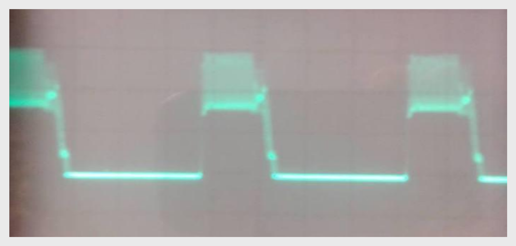

Figure 4 Single Channel Output using an LF412CN [2]

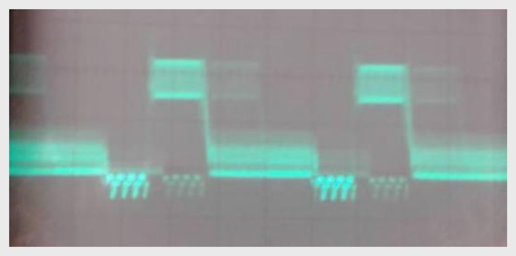

Figure 5 Single Channel Output using an LT1358 [5]

Switches Output with Pulse Input

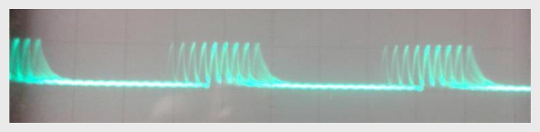

Figure 6 Output of the ADG1236 [6]

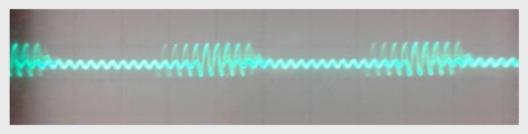

Figure 7 Output of the DG201AAK [2]

Progress and Future Work

Have currently succeeded in creating a prototype off each channel of the dual phase integrator

- The power dissipation for the single channel was slightly greater than the PSpice model
- Still trying to limit the amount of noise generated by the dual phase integrator prototype
- After finishing the prototype, the final circuit will need to be put together. The noise and power dissipation will then be measured and recorded

References

Acknowledgements

- Professor Joel Kubby, UCSC
- Postdoctoral Scholar Xiaodong Tao, UCSC
- Baskin Engineering, UCSC

Citations

1) David W. Piston, "Fundamentals and Applications in Multiphoton Excitation Microscopy" Internet: http://www.microscopyu.com/articles/fluorescence/multiphoton/multiphotonintro.html, April 23, 2007 [8/09/13]
2) Ridgers, James