Week September 5, 2021

This Weeks goal was to have general research on BLDC motors and research for more on our divided workload. My research is over testing. What type of testing we must do, how will we do it or who will do it for us.

Through my research I have gain a lot of questions to ask Jens from Textron. I have learned a lot about DO-160G, but most of the information, including how to preform the testing is all locked away behind a $500 book provided by RTCA. I plan to ask Textron multiple questions, mainly focusing on if they will do the testing for us, how frequently can they do these testing, and if they'll provide us the book or more information about testing. There is other restraints that are not given any DO-160G sections or any information on how Textron wanted us to test it or if they wanted us to test them, this would be another question for Textron.

All this information is needed for when designing circuits to ensure that our equipment passes all the regulations, and how to design the equipment to allow it to pass these regulations.

DO-160G resources:

https://do160.org/vibration/

https://keystonecompliance.com/rtcado-160/

https://www.wichita.edu/research/NIAR/Laboratories/environmental/do-160-testing.php

https://my.rtca.org/NC__Product?id=a1B36000001IcnSEAS

http://www.thermaxtesting.com/test-specs/rtca-do160-testing/

indirect effects of Lighting protection:

https://www.atrenne.com/assets/pdf/ACS-WP-DO-160-Lightning-Protection-510720Asmall.pdf (Page 7)

https://www.allaboutcircuits.com/industry-articles/an-introduction-to-device-level-esd-testing-standards// (ESD modeling)

Week September 19, 2021

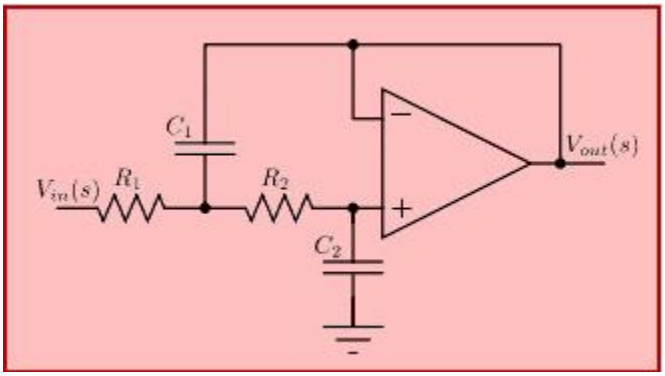
This week goal was research over:

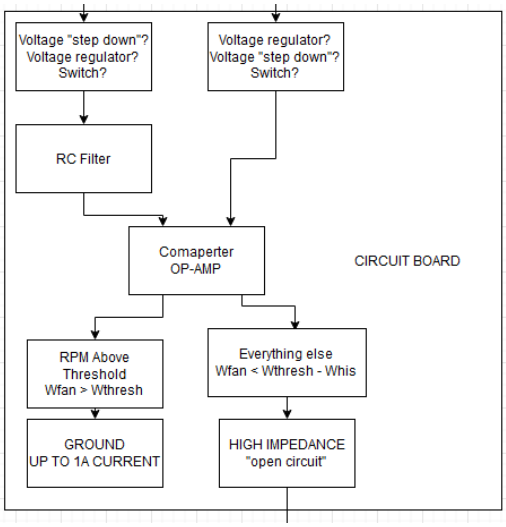
1. Voltage Regulator
2. Voltage "step down" but for DC
3. Capacitor filter
4. Op amps
5. Hysteresis effect

My research focused on voltage regulators and Capacitor filter. I learn about a few types of voltage regulators, but I focused my attention on Zener diode voltage regulators (VR) and IC voltage regulators as they are compact. Zener diode VR were inefficient, but for our usage, the loses shouldn't be significant. I liked the Zener diode VR as Zener diode are a general component and can't go obsolete. IC VR can possibly go obsolete but are super compact as well. The most common LM 317 IC VR cannot work in our temperature range. The Zener diodes I have investigated, cannot work in our Voltage range. More searching is needed, and more research is needed regrading this topic.

I shifted focus to Low pass capacitor filter (LPF). Voltage regulation can be researched after a working comparator is designed. I saw both passive and active LPF. The active Butterworth Filter Design using Sallen-Key Topology interested me as we can select a Voltage out at given threshold frequency by just changing the R and C values. This can also mean we can choice a value like 4.3V where the difference between reference voltage would be 0.7V, voltage drop across a diode, making a 'on' or 'off' state based on frequency.

$$H(s) = \frac{V_{out}(s)}{V_{in}(s)} = \frac{1}{1 + C_2(R_1 + R_2)s + C_1C_2R_1R_2s^2}.$$





I also asked about DO-160G documentation to the library in which the librarian could not find it. I will be emailing Textron for information about this document and motor for testing. I have also looked in to measuring frequency. The circuit seemed to become too large quickly, and it seemed to have to include memory as a countered was needed. I have investigated other things slightly, learning the basics of hysteresis effect and OP-AMP compactor circuit. I recreated our block diagram into a digit version.

Voltage regulators:

https://electronicspost.com/dc-voltage-regulator-circuit/

https://circuitdigest.com/electronic-circuits/voltage-regulators

http://www.farnell.com/datasheets/1639828.pdf (Page 2, Operation temperature NOT in range of our environment temperature)

Hysteresis:

https://www.homemade-circuits.com/what-is-hysteresis-in-electronic/

https://www.homemade-circuits.com/wp-content/uploads/2016/05/hysteresis-in-opamp.png

http://langster1980.blogspot.com/2014/12/using-op-amps-as-analogue-comparators.html

LPF:

https://www.allaboutcircuits.com/technical-articles/low-pass-filter-tutorial-basics-passive-RC-filter/

https://electronics.stackexchange.com/questions/234108/rc-filter-with-an-square-wave-input

https://www.ecstuff4u.com/2019/05/advantages-disadvantages-passive-filters.html

https://www.electronicshub.org/active-low-pass-filter/

https://lambdageeks.com/active-low-pass-filter-advantages-applications/

https://en.wikipedia.org/wiki/Butterworth_filter

https://www.elprocus.com/butterworth-filter-formula-and-calculations/

http://www.learningaboutelectronics.com/Articles/Low-pass-filter-calculator.php#answer4

https://www.electronics-tutorials.ws/filter/filter_5.html

Frequency:

https://www.elprocus.com/what-is-frequency-counter-circuit-diagram-its-working/

https://www.elprocus.com/crystal-oscillator-circuit-and-working/

http://www.hanssummers.com/sfreq.html

https://www.nutsvolts.com/magazine/article/march2015_Teixeira

Week September 14, 2021

Over I spent the week trying to figure out how to changed frequency to voltage. From my interviews I began looking into voltage to frequency converts but none really worked out. I also began looking in to LM2907 today (September 14) but haven't had much time over it much. Otherwise I spent most of my time trying to figure out how to make the integrator circuit work and I found a very helpful guide. Melvin found a guide that also help us modify our integrator circuit and currently it is worker better then ever before. However, we still do need to work on it and modify it to work perfect. We changed our integrator to a passive integrator and are now currently trying to find the best RC values for the circuit.

Group mate works that helped me build off:

https://www.electronics-lab.com/article/op-amp-integrator/

https://learnabout-electronics.org/ac_theory/filters85.php

Frequency to voltage:

http://www.seekic.com/circuit_diagram/Basic_Circuit/Frequency___voltage_conversion_circuit_composed_of_transistor.html

https://microcontrollerslab.com/frequency-to-voltage-converter-circuits/

LM2907:

https://www.ti.com/product/LM2907-N

RC Integrator theory:

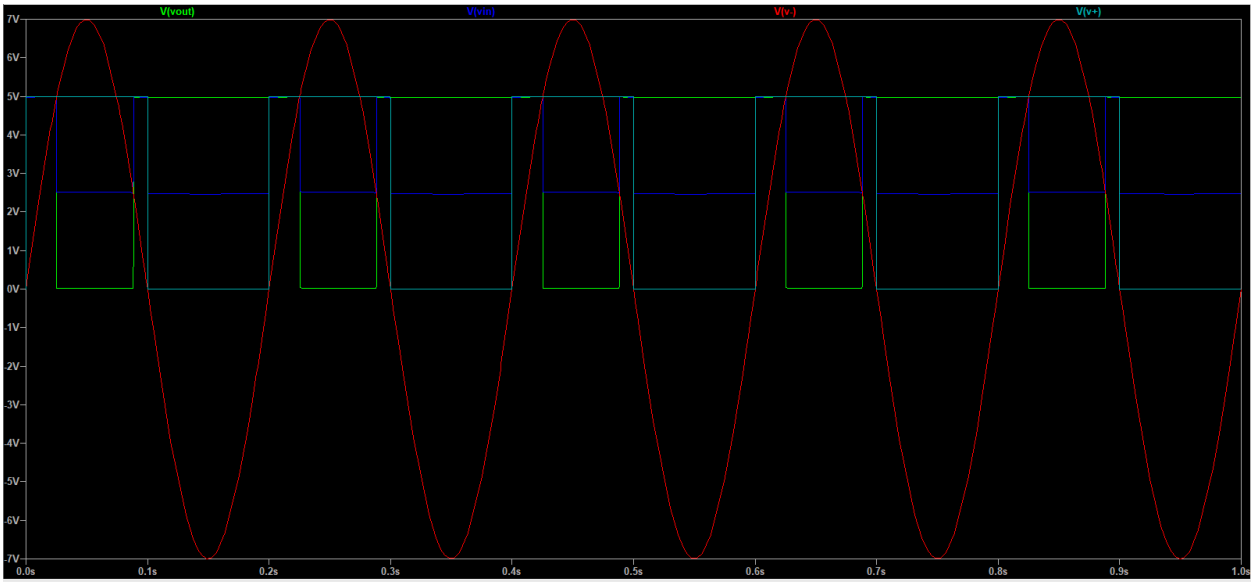
https://www.electronics-tutorials.ws/rc/rc-integrator.html

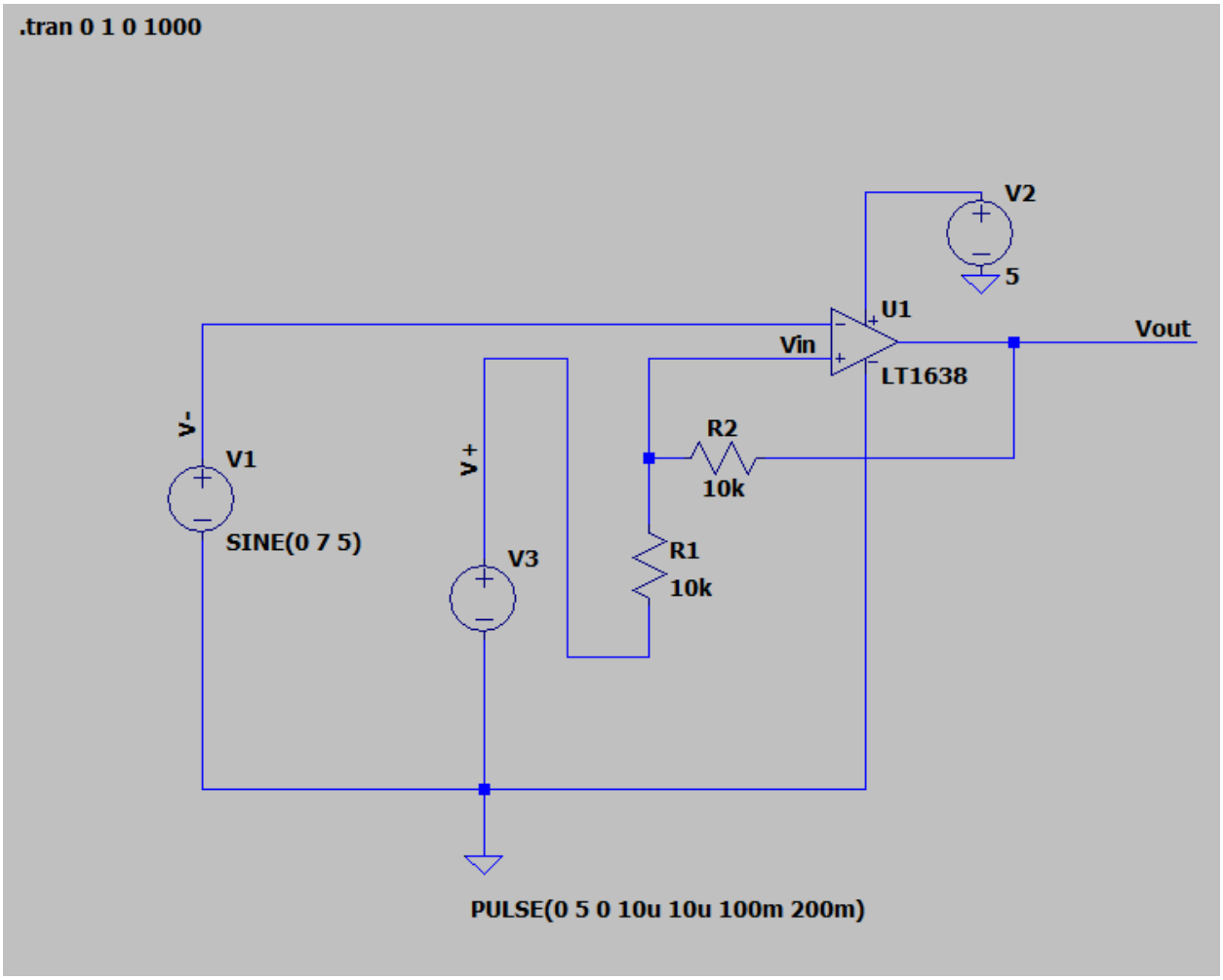
- Used to find some RC values and fix intergrator. Need to calculate better values.

Week September 26, 2021

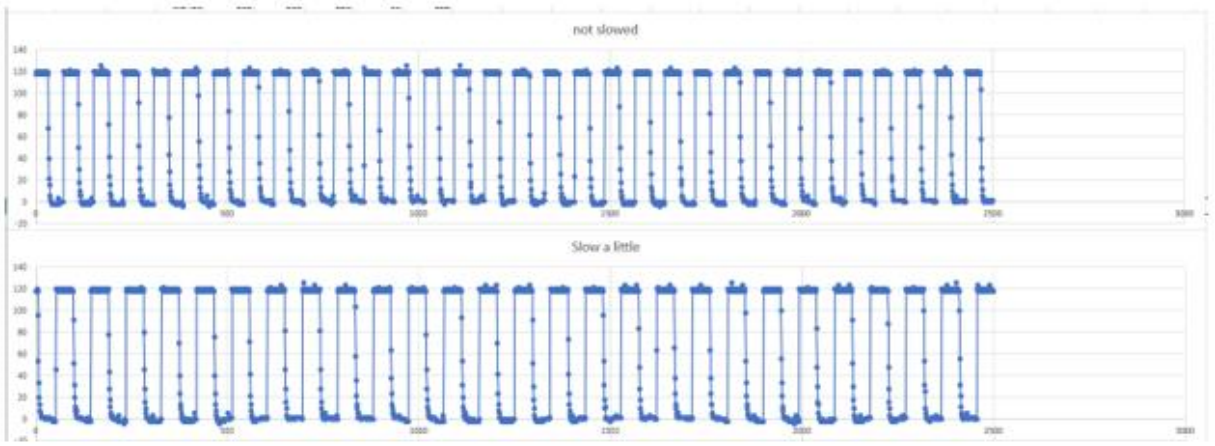
My focus for these weeks was creating simulations of the RC filter and the OP-AMP compactor circuit. I simulated both, with disappointing results in the RC filter part of the circuit. OP-AMP comparator on the other hand worked flawlessly. I would say at this point we have a fully working OP-AMP circuit and if we figure out how to create a filter that works with it, we will be done with a major part of the project.

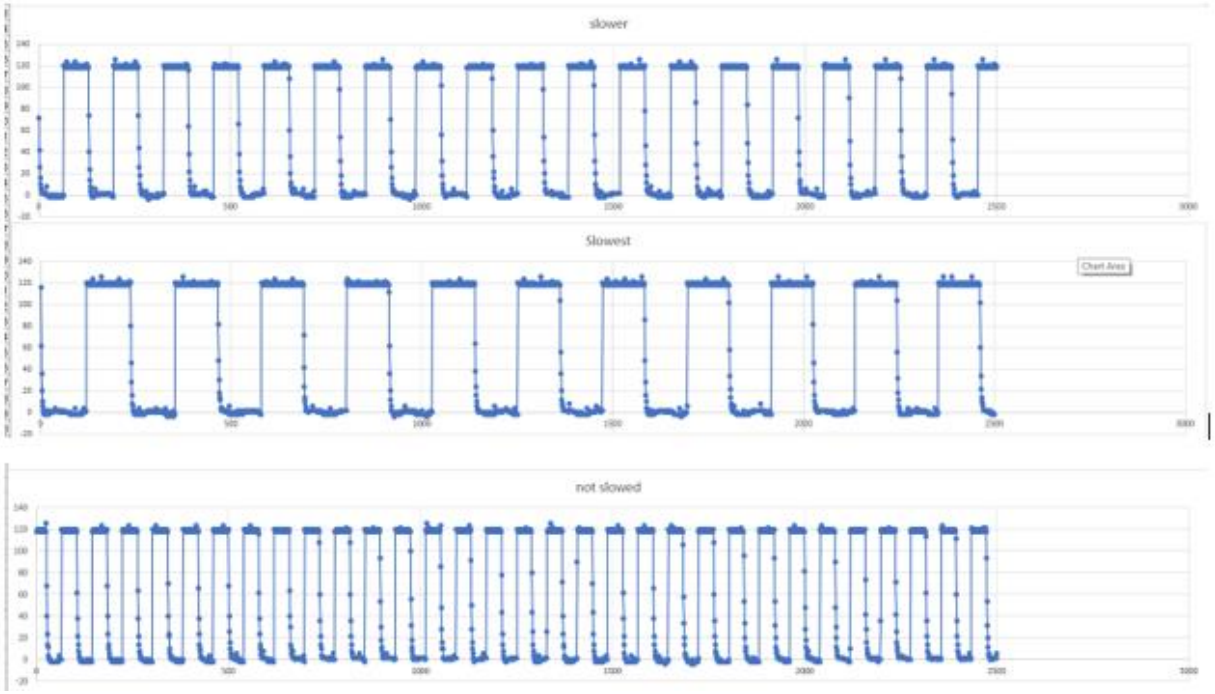
The simulation below shows an OP-AMP comparator circuit with a Hysteresis feedback loop. The results were perfectly as expected. Below is a picture of the simulation.





I and my group mates have also tested the reading of the tachometer on the fan. Below is pictures of some of the outputs I got. All data are in an excel sheet.





We will be trying a few new ideas. RC filters for all trimming the tops and Integral calculation with OP-AMP.

Otherwise, my focus of the last 2 weeks was the test and midterm project. I felt like I did great on both. Below is a link I used in this PowerPoint as a citation for my photograph. It is also the same fan we are using for the data collected above. My groupmate Melvin is the one who found this source.

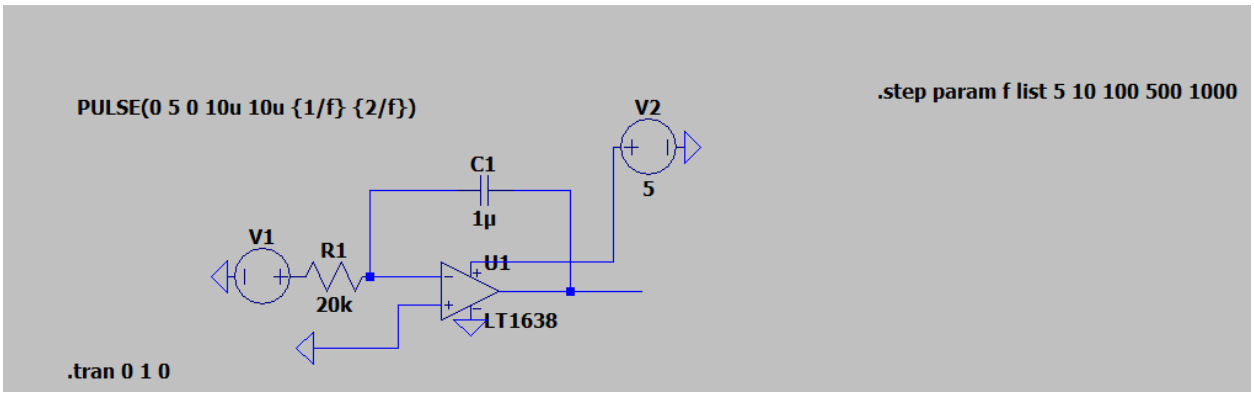
Fan:

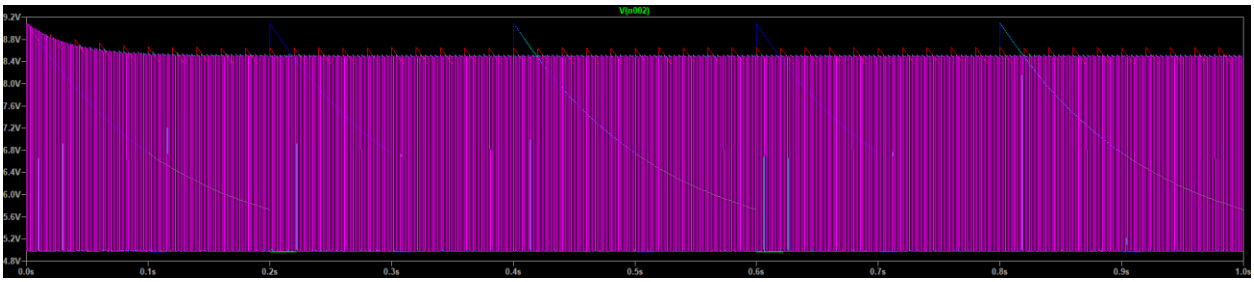
https://www.3ccooler.com/cooler-master-12025-a12025-20rb-3bn-f1-df1202512rfun-r4-l2r-20ac-gp-12v-0-37a-3-wires-led-cooler-fan.html#product-details-tab-specification

Week October 31, 2021

I have investigated integrators circuits and Fourier analysis for our fan signal. For Fourier analysis I had to measure the fan signal with oscilloscope. I didn't have many chances to go and measure the fan, but when I measured it, I measured a lot of signals. I have measurements for periods of 5ns, 100ns, 1ms, 2.5ms, 5ms, and 25ms all with 12V 9V 6V and 3V voltage input on the fan. I have tried to figure out the code for Fourier analysis in MATLAB, I still haven't figured it out fully. What more frustrating is I lost connection to one of the VPN connected computer to WSU after four hours of work, setting me back a day.

I did not look much into integrator, looked at some equations and set it up in LTspice. The results were disappointing (below, hard to understand). I passed what I had to Cody and let him continue research on this topic.





MATLAB FFT:

I looked a lot of notes from older classes.

https://electronics.stackexchange.com/questions/368909/getting-different-fft-results-in-ltspice-comparing-to-matlab-and-python

https://www.mathworks.com/help/matlab/ref/fft.html

https://www.youtube.com/watch?v=aUkCeNPYblY

https://www.youtube.com/watch?v=Rw3CqMrezp8

https://www.youtube.com/watch?v=ZvYGqYOyesk

https://www.youtube.com/watch?v=rVAvW1Jh2AE

Integrator:

https://www.electronics-tutorials.ws/filter/filter_5.html (integrator w/ feedback resistor)

https://www.ti.com/lit/an/sloa049b/sloa049b.pdf

https://www.ti.com/lit/an/sboa275a/sboa275a.pdf

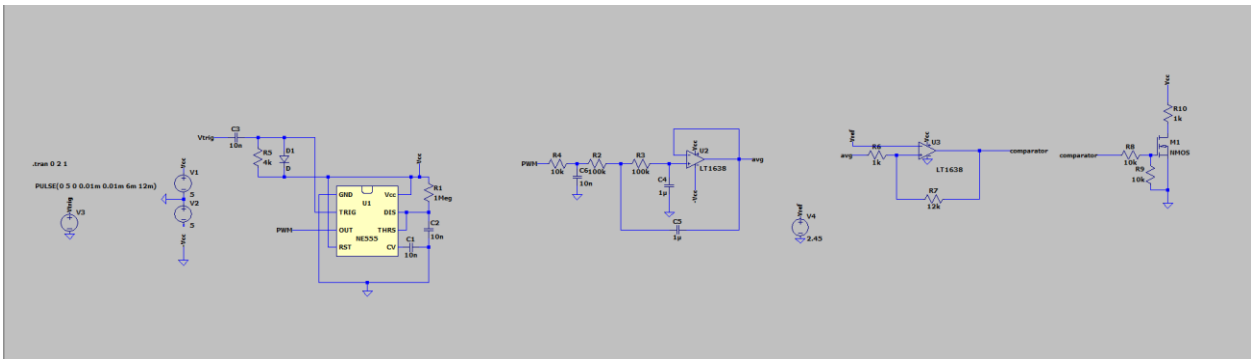
https://www.circuitstoday.com/integrator-circuit-using-opamp

https://www.allaboutcircuits.com/textbook/semiconductors/chpt-8/differentiator-integrator-circuits/

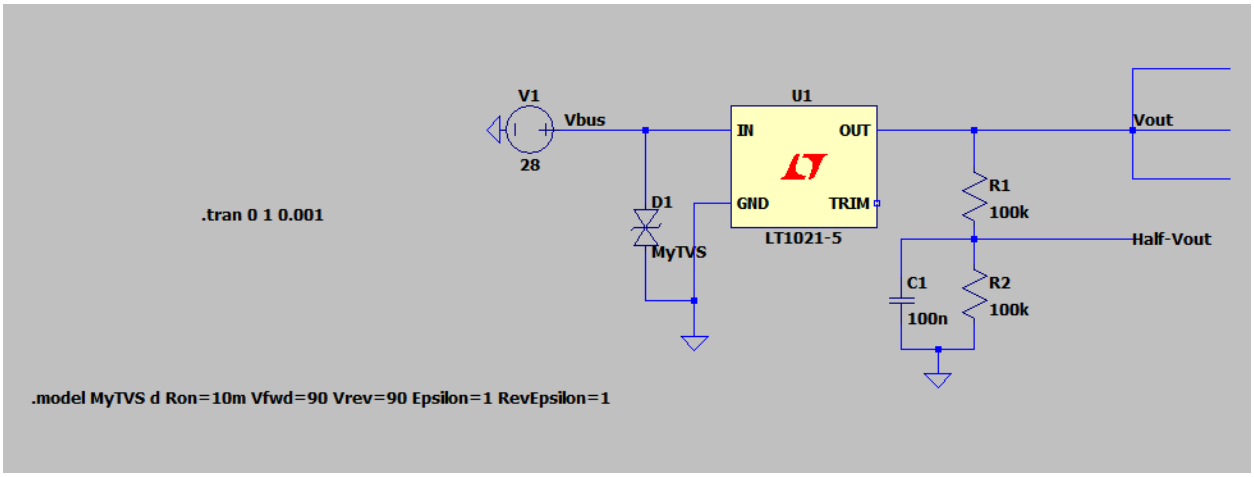
https://www.electronicshub.org/active-low-pass-filter/

Feb 13, 2022

A lot of things have happened in the past few months. As a group we have breadboarded our first prototype and are almost fully done with it. All that is left to do with the prototype is the output and power input (voltage regulator, and a mosfet output). Over those weeks I have research N555 timer, Sallen-key, relooked into schimitt trigger, investigated MOSFETs, and material packaging. Below is the current state of our circuit diagram on the tacho input:



And this will be power input (Cody's work):



Majority of the research I have done is on the tacho circuit. In the material, I have tried to find regulations on what materials can and can't be used on the plan. I have found some sources, but I am

still looking into it. Some materials I investigated Carbon fiber (at innovation hub we can 3D print Abs infused carbon fiber), and PTFE.

FAR/FAA (FAR Title 14) and materials:

https://www.ecfr.gov/current/title-14/chapter-I/subchapter-C/part-25/subpart-H/section-25.1701

https://www.faa.gov/newsroom/special-guidance-title-14-code-federal-regulation-14-cfr-part-141-pilot-school-regarding

https://www.faa.gov/training_testing/training/air_training_program/job_aids/media/ewis_job-aid_2.0_printable.pdf

https://cdn.techflex.com/assets/pdfs/archive/vw-1-test.pdf

http://fr.polymerinsights.com/testing/flammability/vw-1

https://www.fire.tc.faa.gov/2007conference/files/Fire_Resistant_Materials/WedPM/QuintiereACcomposites/QuintiereACcompositesPres.pdf

https://dielectricmfg.com/knowledge-base/teflon/

https://www.seniorcare2share.com/is-carbon-fiber-dust-flammable/#Does_carbon_fiber_catch_on_fire

MOSFET:

https://www.infineon.com/dgdl/Infineon-BTS3028SDL-DS-v01_00-EN.pdf?fileId=5546d4625a888733015aad9d497d4c29

https://www.infineon.com/cms/en/product/power/mosfet/

http://protorit.blogspot.com/2012/11/chopper-inverter-control-unit-chopper-modes.html

https://www.electrical4u.com/chopper-dc-to-dc-converter/

https://www.electrical4u.com/power-mosfet/

https://www.electrical4u.com/chopper-dc-to-dc-converter/

https://www.youtube.com/watch?v=UJkHL-6mn8s

Schmitt trigger (old source):

https://www.youtube.com/watch?v=5-ohKRWeod4

Sallen-key (used old sources as well):

http://radiosparks.com/schematics.asp?UID=Low-pass+Filters

http://www.testips.com/sallen_key.php

http://www.ecircuitcenter.com/Circuits/opsalkey1/opsalkey1.htm

https://www.vcalc.com/wiki/MichaelBartmess/Sallen-Key+Unity+Gain+Low+Pass+Filter+-+Transfer+Function

N555 timer:

http://www.seekic.com/circuit_diagram/Measuring_and_Test_Circuit/ANALOG_TACHOMETER_CIRCUIT.html

https://www.youtube.com/watch?v=2i0wSGda3AI

https://www.youtube.com/watch?v=ypV6gdIJJU4

https://en.wikipedia.org/wiki/Monostable_multivibrator

https://www.nutsvolts.com/magazine/article/555-monostable-circuits

https://www.eleccircuit.com/wp-content/uploads/2010/04/one-shot-timer-by-ic-ne555.jpg

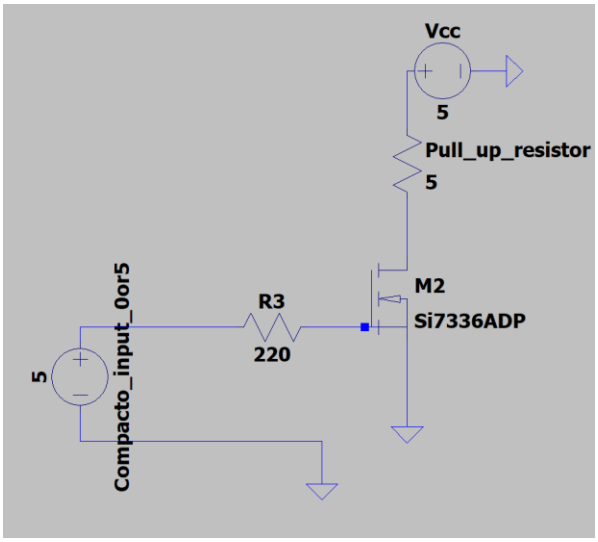
https://www.electronicshub.org/flip-flops/

https://cdn.discordapp.com/attachments/879786996434866310/910614575903281202/unknown.png (from groupmate)

http://i2.wp.com/www.circuitbasics.com/wp-content/uploads/2015/01/555-Timer.jpg

Feb 27, 2022

I have figured out the majority of MOSFET circuit. Its looks like last weeks circuit but values have changed.



This will output 1A. An open circuit and the drain of the MOSFET will be the output of our circuit.

My other focus in the last 2 weeks was learning how to use Github and setting it up for TPR package. I organized and uploaded everything I had to Github and helped my teammates to upload

there things too. I also built everything we have so far into a breadboard and have tested it. I had some weird results but for the most part it seems to be working. We also met with Clinton from Textron and gauge how much work we needed to do. We planning to finalize and print our first PCB in the next few weeks.