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E344 Assignment 3

Willem Viljoen

22877169

Report submitted in partial fulfilment of the requirements of the module Design (E) 344 for the degree Baccalaureus in Engineering in the Department of Electrical and Electronic Engineering at Stellenbosch University.

24 August 2021

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5. Ek verklaar dat die werk in hierdie skryfstuk vervat, behalwe waar anders aangedui, my eie oorspronklike werk is en dat ek dit nie vantevore in die geheel of gedeeltelik ingehandig het vir bepunting in hierdie module/werkstuk of 'n ander module/werkstuk nie.
   I declare that the work contained in this assignment, except where otherwise stated, is my original work and that I have not previously (in its entirety or in part) submitted it for grading in this module/assignment or another module/assignment.

22877169 Studentenommer / *Student number*	Handtekening / *Signature*
W. Viljoen Voorletters en van / *Initials and surname*	24 August 2021 Datum / *Date*

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Nomenclature

Variables and functions

V_OC	Open circuit voltage.
I_SC	Short circuit current P Power.
V	Voltage.
I	Current.
P_MAX	Maximum power.
V_MPP	Voltage at maximum power point.
I_MPP	Current at maximum power point.
C	Battery's C-rating (4A).
V_GS	Gate-Source voltage of a NMOS.
V_SG	Source-Gate voltage of a PMOS.
V_TH	Threshold voltage of a MOSFET.

Acronyms and abbreviations

PV	Photovotalic.
STC	Standard Testing Conditions.
$MPPT$	Maximum Power Point Tracker.
$NMOS$	Negative-channel Metal-Oxide Semiconductor.
$PMOS$	Pegative-channel Metal-Oxide Semiconductor.
$MOSFET$	Metal–Oxide–Semiconductor Field-Effect Transistor.

Chapter 1

Fuse

1.1. Literature

The average temperature in South Africa is 27°C in according to weather-and-climate.com, but tests done by sustainable.org suggests that maximum temperatures of 40°C is reached during summertime Considering that the circuit will be mounted on a rooftop within a casing where components such as resistors and operational amplifiers also resides, it is viable to assume that temperatures of up to 50°C can be reached. The operating temperature of the battery also suggests that the circuit should be kept under 50°C. The RS-pro fuse is affected by ambient temperature, and this parameter should therefor be considered when choosing an applicable fuse. The battery discharge rate, according to docs.rs should not exceed 1.85V/cell and 2.36A when discharged over a 45 min period. This should also be considered when choosing the fuse. Considering that the circuit will not exceed 1A of current under normal load conditions, a viable fuse can be chosen.

1.2. Design

Assuming that a maximum temperature of 50°C will be reached, the following calculation can be made: According to littlefuse.com, Catalog Fuse Rating = $\frac{NormaloperatingCurrent}{0.75 \times PercentofRatingattemperature}$. Considering a normal operating current of 1A at 50°C (Worst case scenario) : $\frac{1}{0.75 \times 0.96} = 1.4$

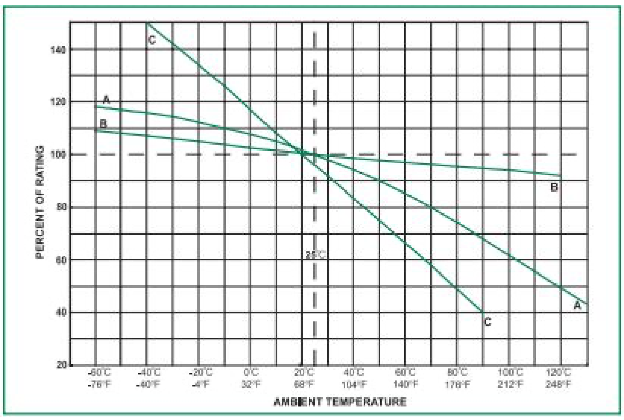


Figure 1.1: Following the graph of B for blade fuses: [1].

A . A fuse of at least 1.4A is needed, considering that a fuse smaller than this will blow with normal operation. The fuse size must therefor be in the range of 1.4A to 2.36A to protect the battery without blowing under normal operation. Therefor I have chosen to use the RS-pro 2A Fuse.

Chapter 2

Undervoltage battery protection

This chapter answers the question: "Did the student follow a systematic approach to design the sought solution?". You therefore need to follow a systematic/logic path, and did you clearly communicate it.

2.1. Literature

Here you can include stuff you learnt that you will use in the design - e.g. operational amplifiers as comparators, hysteresis, rail-to-rail comparators. If you feel there was nothing you had to learn to do this, feel free to leave this section out.

2.2. Overview

The undervoltage protection principle is based on the circuit protecting the battery against deep discharge, this discharge is known as the discharge below the minimum voltage and load against the given undervoltage. After discharging a battery to the lowest supply voltage circuit disconnects the load from the battery and does not draw any current. Undervoltage protection is applicable for the protection of batteries such as lead-acid (Pb), NiCd, NiMH, Li-Ion and Li-Pol accumulators. The important weaknesses that the batteries must be protected from are overvoltage conditions because it can place the batteries in a dangerously unpredictable state. The equivalent is valid for undervoltage conditions. Therefore, undervoltage protection is frequently only included in the primary layer of protection, but not the secondary layer. In the greatest given case, when the voltage falls only marginally below the minimum, there will be a small loss in capacity and the self-discharge rate will rise. The smaller the cell voltage gets, the more prominent these effects become. If the cell voltage gets too low, then it grows to be hazardous to try and attempt to recharge the cell because it may create a short and involve severe damage to its environments.

2.3. 5V rail

Here explain your selection of 5V regulator.

2.4. High-side switch

Here you describe the design choices made for the switch (Note, this is not the switch we use to control the LM317 output, it is similar switch that controls the supply from the battery to the same regulated line, but it does not have a blocking diode).

2.5. Voltage monitoring with hysteresis design

Explain your design of the comparator with hysteresis, taking into account things like common mode voltages, differential voltages, input-to-rail voltages, hysteresis deadband, resistor values and current consumption, etc.

2.6. Circuit diagram

Show your circuit diagram (the one you will submit). Ensure that it is of good quality, and preferably a vector (metadata) plot, not a raster (pixel) plot, so you can zoom in and select text from it.

2.7. Results

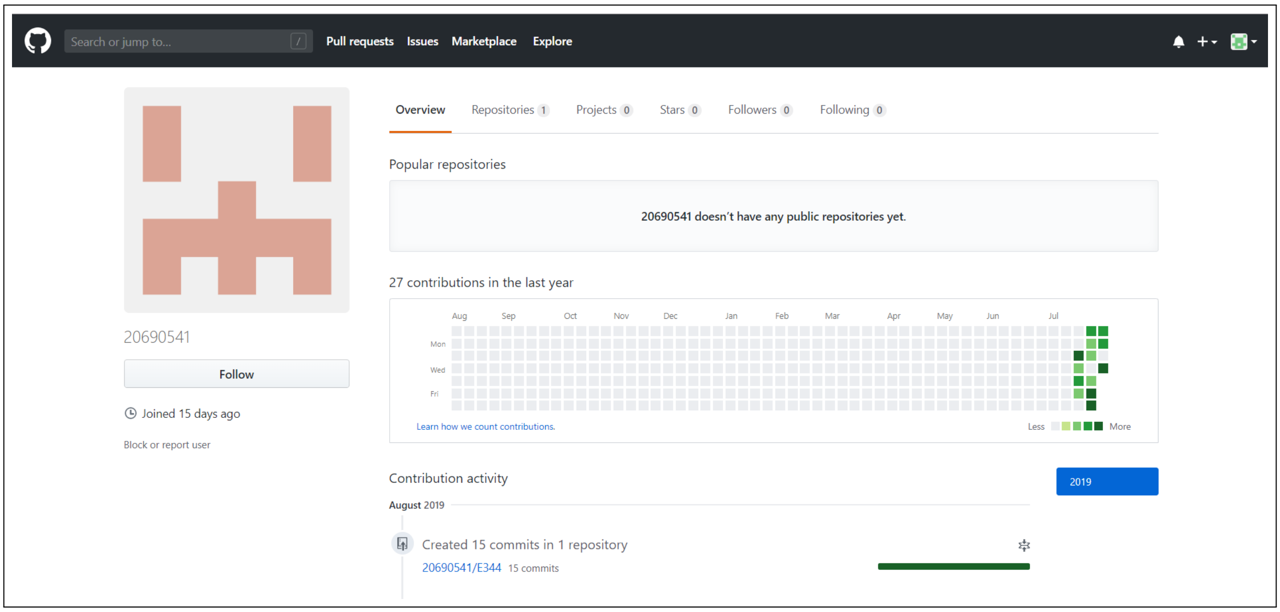
Here you include your simulation results and your measured results. For the measured results, it would be most beneficial to show on the same oscilloscope screen-grab (or CSV plot), how the switch went through the stages of the hysteresis loop (similar to what you had to do for the video). You are welcome to use subplots to save space.

Bibliography

[1] BBC, "How to make opamps amp op," 2018. [Online]. Available: www.electronics-tutorials.ws

Appendix A

GitHub Activity Heatmap



Appendix B

Social contract

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E-design 344 Social Contract

2021

The purpose of this document is to establish commitment between the student and the organisers of E344. Beyond the commitment made here, it is not binding.

In the months preceeding the term, the lecturer (Thinus Booysen) and the Teaching Assistant (Kurt Coetzer) spent countless hours to prepare for E344 to ensure that you get your money's worth and that you are enabled to learn from the module and demonstrate and be assessed on your skills. We commit to prepare the assignments, to set the tests and assessments fairly, to be reasonably available, and to provide feedback and support as best and fast we can. We will work hard to give you the best opportunity to learn from and pass analogue electronic design E344.

I, ...Willem Viljoen...................... have registered for E344 of my own volition with the intention to learn of and be assessed on the principals of analogue electronic design. Despite the potential publication online of supplementary videos on specific topics, I acknowledge that I am expected to attend the scheduled lectures to make the most of these appointments and learning opportunities. Moreover, I realise I am expected to spend the additional requisite number of hours on E344 as specified in the yearbook.

I acknowledge that E344 is an important part of my journey to becoming a professional engineer, and that my conduct should be reflective thereof. This includes doing and submitting my own work, working hard, starting on time, and assimilating as much information as possible. It also includes showing respect towards the University's equipment, staff, and their time.

Prof. MJ Booysen	Student number: ....22877169................
Signature: .... Digitally signed by MJ BOOYSEN Date: 2021.08.04 22:12:45 +02'00'	Signature: ....
Date: 4 Aug 2021	Date: ....16 Aug 2021..........................

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