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E344 Assignment 2

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.

18 August 2021

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   Plagiarism is the use of ideas, material and other intellectual property of another's work and to present is as my own.

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   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*	18 August 2021 Datum / *Date*

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Nomenclature

Variables and functions

$p(x)$	Probability density function with respect to variable x.
$P(A)$	Probability of event A occurring.
ε	The Bayes error.
ε_u	The Bhattacharyya bound.
B	The Bhattacharyya distance.
s	An HMM state. A subscript is used to refer to a particular state, e.g. s_i refers to the i^{th} state of an HMM.
$\mathbf{S}$	A set of HMM states.
$\mathbf{F}$	A set of frames.
$\mathbf{o}_f$	Observation (feature) vector associated with frame f.
$\gamma_s(\mathbf{o}_f)$	A posteriori probability of the observation vector $\mathbf{o}_f$ being generated by HMM state s.
μ	Statistical mean vector.
Σ	Statistical covariance matrix.
$L(\mathbf{S})$	Log likelihood of the set of HMM states $\mathbf{S}$ generating the training set observation vectors assigned to the states in that set.
$\mathcal{N}(\mathbf{x}\|\mu,\Sigma)$	Multivariate Gaussian PDF with mean μ and covariance matrix Σ.
a_{ij}	The probability of a transition from HMM state s_i to state s_j.
N	Total number of frames or number of tokens, depending on the context.
D	Number of deletion errors.
I	Number of insertion errors.
S	Number of substitution errors.

Acronyms and abbreviations

AE	Afrikaans English
AID	accent identification
ASR	automatic speech recognition
AST	African Speech Technology
CE	Cape Flats English
DCD	dialect-context-dependent
DNN	deep neural network
G2P	grapheme-to-phoneme
GMM	Gaussian mixture model
HMM	hidden Markov model
HTK	Hidden Markov Model Toolkit
IE	Indian South African English
IPA	International Phonetic Alphabet
LM	language model
LMS	language model scaling factor
MFCC	Mel-frequency cepstral coefficient
MLLR	maximum likelihood linear regression
OOV	out-of-vocabulary
PD	pronunciation dictionary
PDF	probability density function
SAE	South African English
SAMPA	Speech Assessment Methods Phonetic Alphabet

Chapter 1

Literature

The design makes provision for battery backup using a 6 V lead acid battery, which recharges from the two power sources. The design prevents charging too fast (charging V and I control) and must prevent overcharging of the battery (overcharge protection). The design ensures that the battery is not discharged beyond its recommended levels (undervoltage protection) and prevents high-current discharging (overcurrent protection).

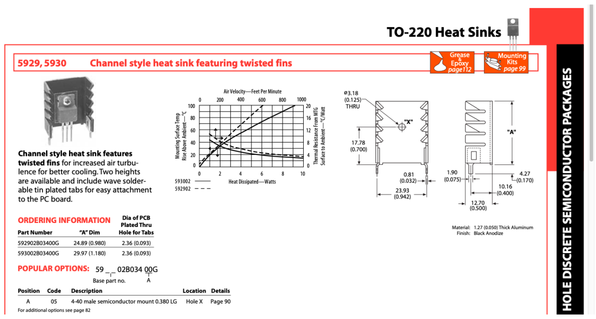
1.1. Charging lead acid batteries

The charging time will vary contingent upon how far the battery has been dispersed. A dependable guideline is that the battery charging current ought not be more than 0.1 C (10 percent of the battery limit). The lead corrosive battery I am utilizing has a limit of 4 Ah, in this manner the suggested charging current is 400 mA. The distinctive condition of charging can be characterized as far as the charging current and voltage.

Table 1.1: Example of a simple table.

	V_{OC} [V]	I_{CC} [A]	V_{pmax} [V]
Theroretical per cell	1.0	1.0	1.0
Datasheet per module	1.0	1.0	1.0
Measured dark 1.0	1.0	1.0	
Measured upside-down 1.0	1.0	1.0	
Measured oblique 1.0	1.0	1.0	
Measured facing 1.0	1.0	1.0	

1.2. Thermal analyses and heat sinking



TO-220 Heat Sinks

HOLE DISCRETE SEMICONDUCTOR PACKAGES

5929, 5930 **Channel style heat sink featuring twisted fins**

Grease & Epoxy page112

Mounting Kits page 99

Channel style heat sink features twisted fins for increased air turbulence for better cooling. Two heights are available and include wave solderable tin plated tabs for easy attachment to the PC board.

Material: 1.27 (0.050) Thick Aluminum
Finish: Black Anodize

ORDERING INFORMATION

Part Number	"A" Dim	Dia of PCB Plated Thru Hole for Tabs
592902B03400G	24.89 (0.980)	2.36 (0.093)
593002B03400G	29.97 (1.180)	2.36 (0.093)

POPULAR OPTIONS: 59 _ _ 02B034 00G
Base part no. A

Position	Code	Description	Location	Details
A	05	4-40 male semiconductor mount 0.380 LG	Hole X	Page 90

For additional options see page 82

Figure 1.1: Heat Sink Information [1].

Chapter 2

Design

2.1. Overview

The design provided gives provision for a battery support while making use of a 6 volt - lead acid battery, which is able to recharge from two power sources (given). The provided design was designed to prevent charging at a rate to fast (charging V and I control) and it must also prevent overcharging of the battery we call this "overcharge protection". The design makes sure that the battery will not be discharged further than its recommended levels (undervoltage protection) and it prevents a thing called "high-current discharging" (overcurrent protection). For this task the highlighted part in the flow diagram below will be designed.

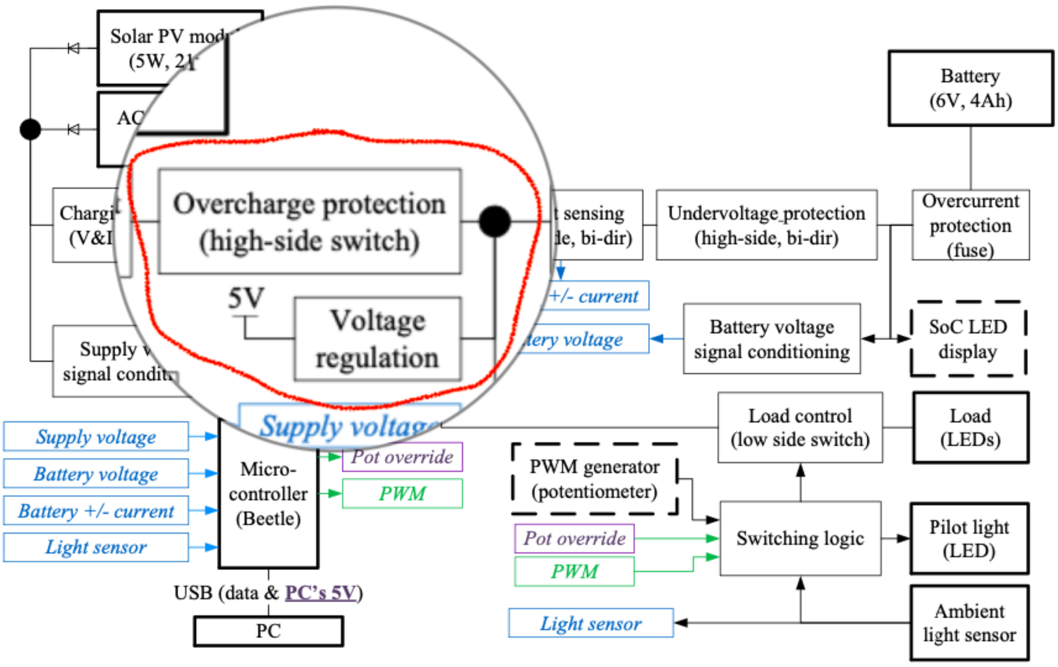


Figure 2.1: Project Flow Diagram.

2.2. High-side switch

The MOSFET's are voltage controlled and we use them to switch in this case. In the high side switch load is always connected to ground, so there will be no built up voltage over the load. We choose large resistors for the second MOSFET that no power is wasted - draws little current. We added the second transistor to allow the circuit to switch on and off easier.

2.3. Charging regulator

2.3.1. Voltage regulation

Show the design calculations, including resistor values, and justify design choices. Detail the range of valid input voltages for your designed regulator circuit.

2.3.2. Current limit

Explain why the charging circuit requires a maximum current limit, and how your choice of current limit was arrived at and implemented. Explain the limitations of this implementation.

2.3.3. Thermal analysis

Explain how the addition of a heatsink improves the performance of your charger. Back up your explanation with calculations. Explain the effect of the junction temperature of the LM317 on the output current for the range of battery voltages you may encounter in your device.

2.4. Circuit diagram

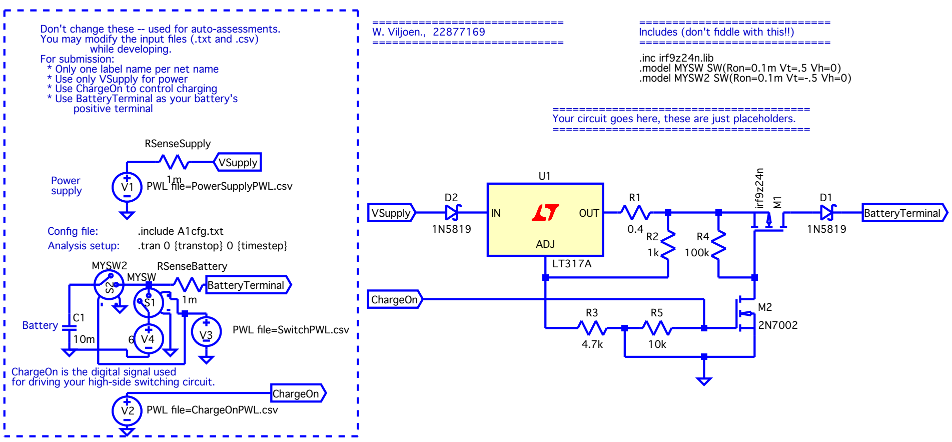


Figure 2.2: Voltage Regulator with High-side Switch.

Chapter 3

Results

3.1. Simulation results

The results measured from the simulations preformed resonates with the specified conditions for the circuit. The results proves the experimental simulations done in LTSpice agrees with theoretical calculation made.

	Functional checks (applied in sequence)	
	Input conditions	**Output**
1	Supply high enough ChargeOn = low	Battery does not charge
2	Supply high enough ChargeOn = high Battery depleted	Battery charges, current limits (<400 mA + 5% tolerance)
3	Supply high enough ChargeOn = high Battery fully charged	Battery voltage = 7.2V + 5% tolerance, no current
4	Supply too low ChargeOn = high	Battery does not discharge

Figure 3.1: Simulation conditions.

3.2. Measured results

The Supply Voltage was measured as it steps from high(12V) to low(0V), the Charge On Voltage was measured as it goes from low(0V) to high(5V), the Battery terminal Voltage was measured as it goes from low(6V) to high(+/- 7.5V) as a step response function depended on the Charge On Voltage step.

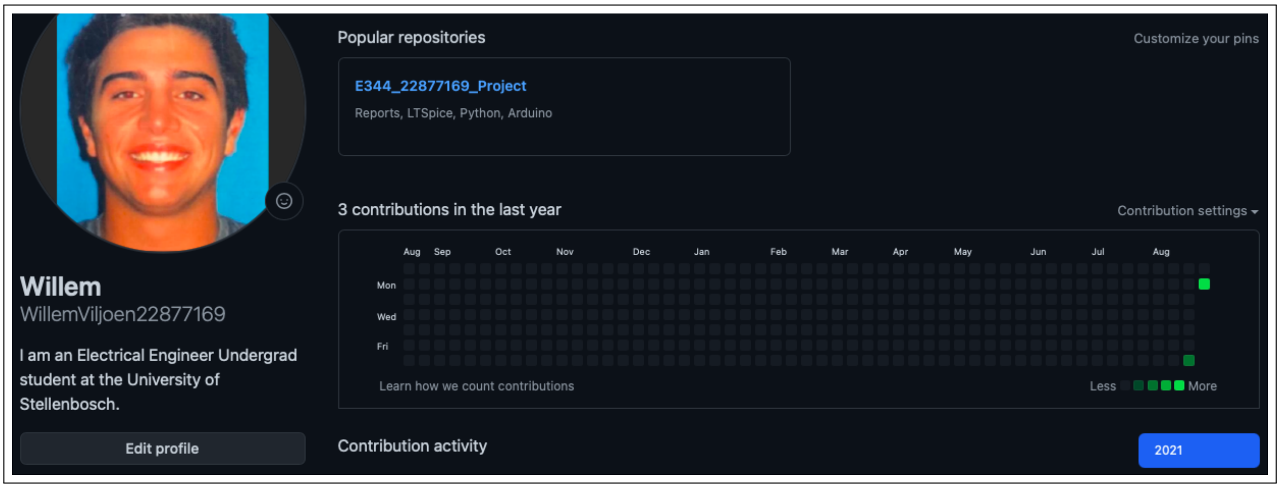
Figure 3.2: Simulation Results.

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

Digitally signed by MJ BOOYSEN
Date: 2021.08.04 22:12:45 +02'00'

Signature: ....

Date: 4 Aug 2021

Student number: ....22877169................

Signature: ....

Date: ....16 Aug 2021..........................

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