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E344 Assignment 2

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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.

August 23, 2021

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00024601 Studentenommer / *Student number*	Egor Handtekening / *Signature*
E. Stewdent Voorletters en van / *Initials and surname*	August 23, 2021 Datum / *Date*

Contents

List of Figures

List of Tables

Nomenclature

Update this list to make it applicable to your project.

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

Update this list to make it applicable to your project.

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

1.1. Charging lead acid batteries

Lead Acid Battery

Lead acid battery is a type of rechargeable battery. The voltage rating of my battery is at 6V. There are 3 cells in a unit and the nominal voltage per unit is 6V and nominal voltage per cell is 2V. The advertise capacity of the battery is 4.0Ah. The expected capacity of the battery is 7.2 MW. The open circuit voltage of my battery is measured to be 6.43V. Resistance is defined by the opposition to the flow of current and therefore, internal resistance of a battery is the opposition to the flow of current within the battery.
There are three stages into which the lead acid battery's charging process takes place and they are listed below:

- Constant charge or bulk stage
- Topping charge or absorption stage
- Float charge

The battery is charged up to about 70% in 5-8 hours during the constant current stage wherein the charger current is held constant and voltage increases.
During absorption stage, the voltage is held constant and the current decreases while the rest of 30% charging occurs and this stage is essential for the well-being of the battery as it ensures that the battery is gradually charged to almost full capacity at a descending rate.
During float charge stage the voltage and current are kept low to maintain a low power into the battery. The current used to charge the battery should not be higher than 1.2A and the battery must only draw about 100mA current during the float charge stage. The maximum voltage of the battery is 7.2V and it is the voltage at which the battery i considered to be fully charged. Figure 1 illustrates the lead acid battery's charging behaviour in terms of current and voltage.

1.2. Voltage regulation

Voltage regulator is a device that operates on DC voltage and converts unstable voltage from a power source to stable and usable voltage.

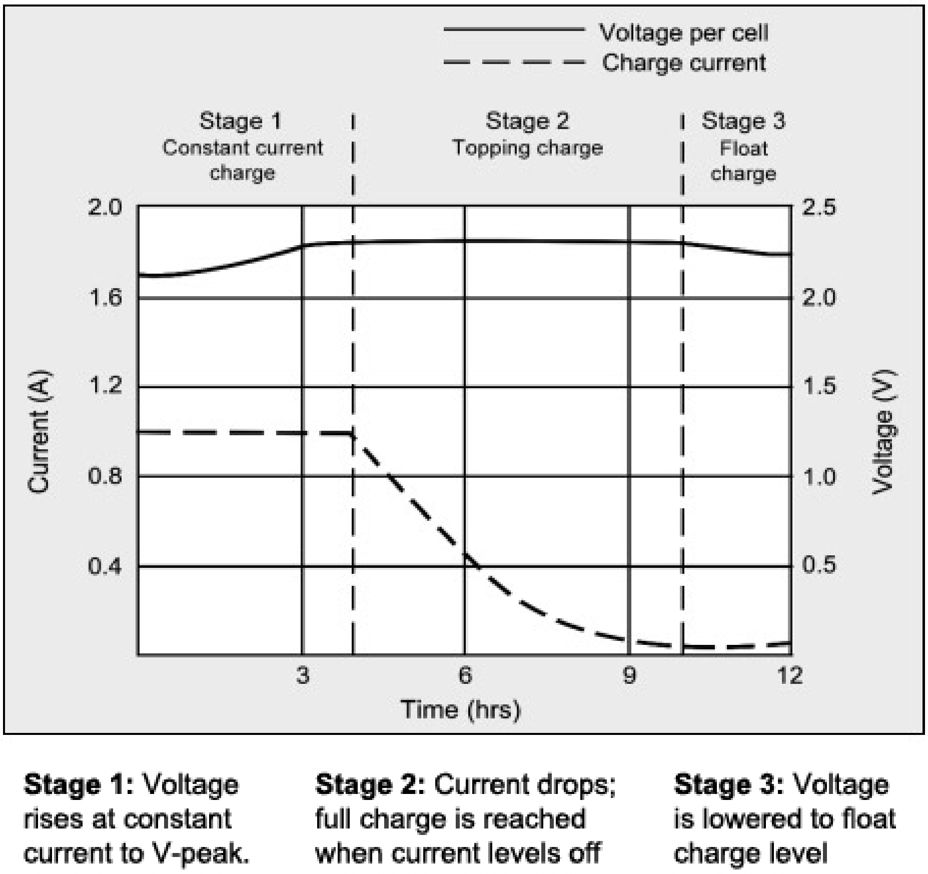


Figure 1.1: Charge stages of Lead acid battery

There are two types of voltage regulator: Linear and Switching regulators.
Linear regulators are used for low powered devices and they are easy to use, simple and cheap which comes at of cost of overheating and being inefficient. It however generates low ripple voltage. Voltage input is also narrow.
Switching regulators on the other hand are highly efficient and available as modular chips which are compact. They produce more ripple but less heat, can be complex, expensive and has a wide voltage input range.

1.3. Switching with MOSFETs

For high side switching the MOSFETs provided are p-type and n-type.The maximum drain current of n-type MOSFET is 0.5A which is much lower than 12A of p-type MOSFET. Therefore, p-type can be used to switch the supply voltage and the n-type to activate p-type. The n-type will be turned on using 5V signal connected to its gate terminal. Moreover, the Schottky diode is added to prevent the back-flow of current from the discharge of the battery.

1.4. Thermal analyses and heat sinking

A heat sink is a passive heat exchanger that transfers the heat generated by an electronic device to a decrease temperature fluid medium. The main role of the heat sink is to maximizes the surface area of contact between the processor and the surrounding cooling medium, by the use of fins. In this case, heat sink will be attached to the regular to prevent it from overheating should it be turned on for a longer period. The heat sink will prevent any damage happening to the regulator.

Chapter 2

Design

2.1. Overview

Explain your charging circuit layout and functional-level choice of component types. Include the high-side switch and charging regulator. You do not want to give any detail of the design, like resistors and capacitor values, just an overview of how your charging circuit "hangs together" - similar to that part of the diagram in the Project Overview file provided. You will probably use a block diagram here and describe in in text.

2.2. High-side switch

Here you describe the design choices made for the switch (which you partially built in Assignment 1, and now forms part of Assignment 2).

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

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.

Chapter 3

Results

3.1. Simulation results

The LTspice circuit and graphs shown below will demonstrate that the simulations results are working perfectly.
From the graphs we can see, the input voltage is 12V, output voltage at the battery is about 7.3V and the current at the diode is about 0.32A which align with the expected values. We can also see that voltage at the battery only rises after the chargeon rises.

3.2. Measured results

The pictures below will show that measured values align with simulation.

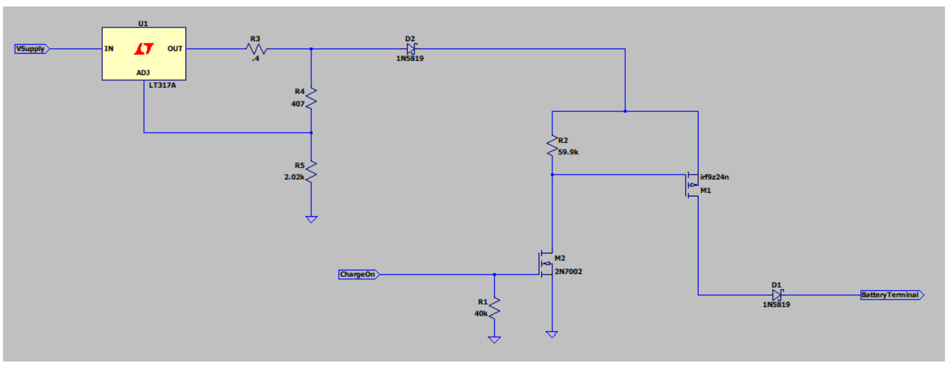


Figure 3.1: Spice circuit

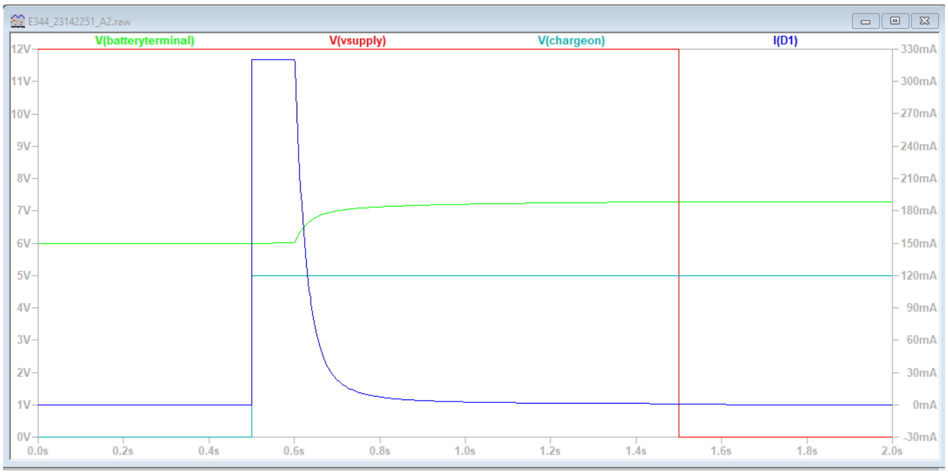


Figure 3.2: Spice graphs

Figure 3.3: Spice circuit

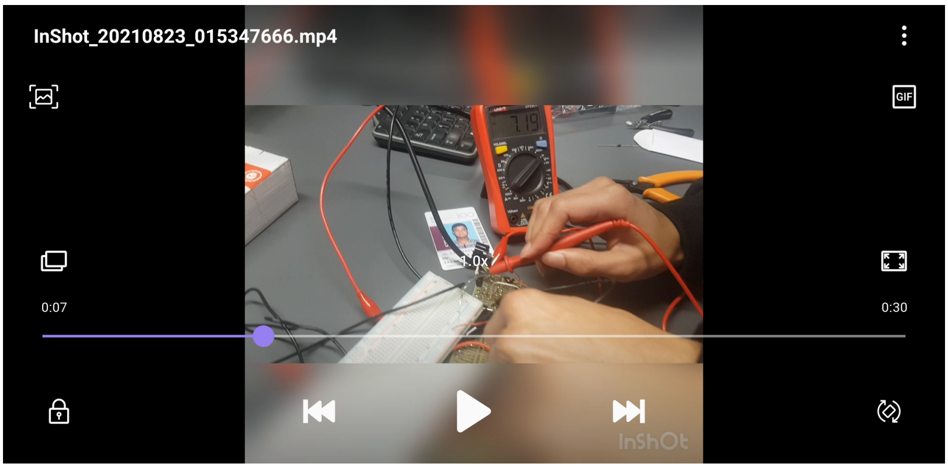


Figure 3.4: Spice circuit

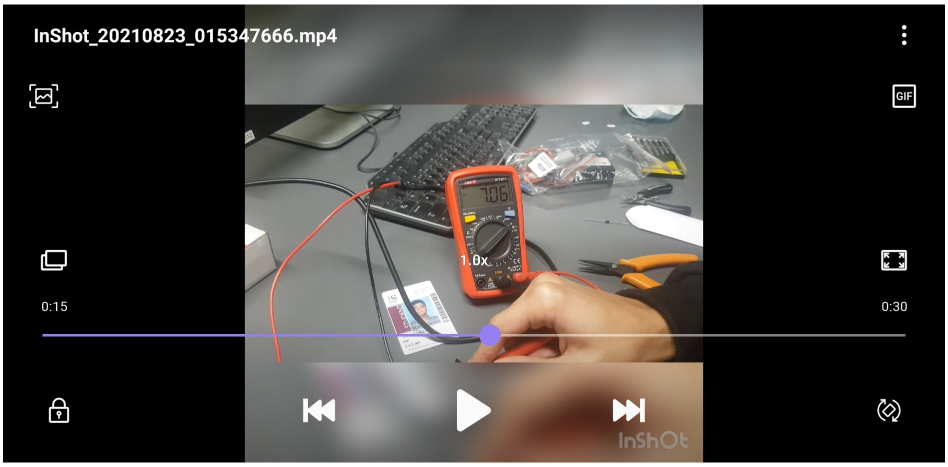


Figure 3.5: Spice circuit

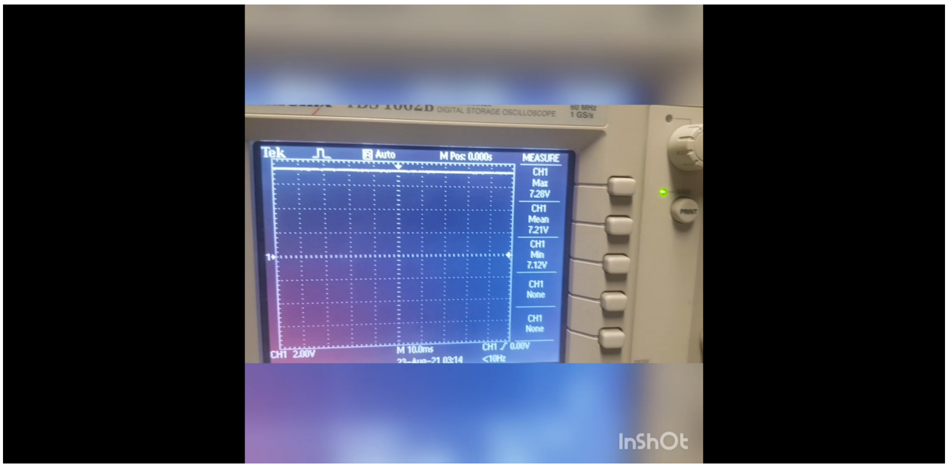


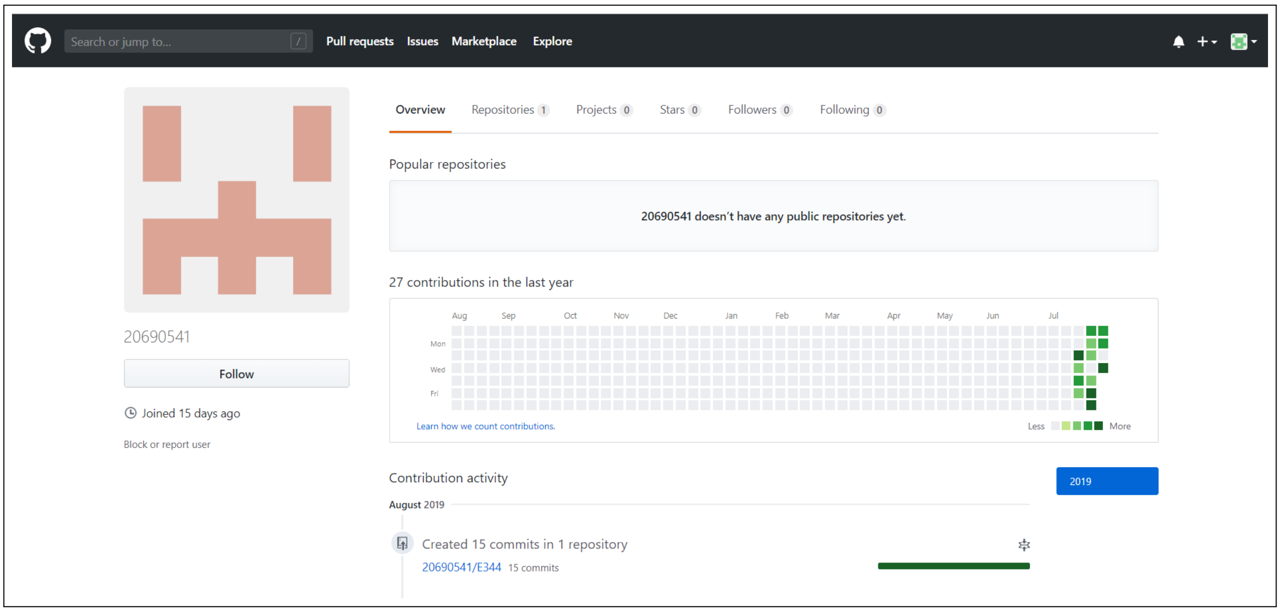
Figure 3.6: Spice circuit

Bibliography

Appendix A

GitHub Activity Heatmap

Take a screenshot of your github version control activity heatmap and insert here.



Appendix B

Stuff you want to include

remove this!!

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