



RV College of Engineering®

Autonomous institution affiliated
to Visvesvaraya Technological
University, Belagavi)

Approved by AICTE, New Delhi,
Accredited by NAAC, Bengaluru.

Go, change the world

Cell balancing for serially connected lithium-ion batteries

A Project Report

Submitted by,

Shyamanth R H

Amrathesh

1RV17EC151

1RV17EC192

Under the guidance of

Dr.Govinda Raju M

Assistant Professor

Dept. of ECE

RV College of Engineering

In partial fulfillment of the requirements for the degree of
Bachelor of Engineering in
Electronics and Communication Engineering
2019-2020

RV College of Engineering[®], Bengaluru

(Autonomous institution affiliated to VTU, Belagavi)

Department of Electronics and Communication Engineering



CERTIFICATE

Certified that the minor project work titled *Cell balancing for serially connected lithium-ion batteries* is carried out by **Shyamanth R H (1RV17EC151)** and **Amrathesh (1RV17EC192)** who are bonafide students of RV College of Engineering, Bengaluru, in partial fulfillment of the requirements for the degree of **Bachelor of Engineering in Electronics and Communication Engineering** of the Visvesvaraya Technological University, Belagavi during the year 2019-2020. It is certified that all corrections/suggestions indicated for the Internal Assessment have been incorporated in the minor project report deposited in the departmental library. The minor project report has been approved as it satisfies the academic requirements in respect of minor project work prescribed by the institution for the said degree.

Signature of Guide	Signature of Head of the Department	Signature of Principal
Dr.Govinda Raju M	Dr. K S Geetha	Dr. K. N. Subramanya

External Viva

Name of Examiners

Signature with Date

- 1.
- 2.

DECLARATION

We, **Shyamanth R H , Amrathesh** students of seventh semester B.E., Department of Electronics and Communication Engineering, RV College of Engineering, Bengaluru, hereby declare that the minor project titled '**Cell balancing for serially connected lithium-ion batteries**' has been carried out by us and submitted in partial fulfilment for the award of degree of **Bachelor of Engineering in Electronics and Communication Engineering** during the year 2019-2020.

Further we declare that the content of the dissertation has not been submitted previously by anybody for the award of any degree or diploma to any other university.

We also declare that any Intellectual Property Rights generated out of this project carried out at RVCE will be the property of RV College of Engineering, Bengaluru and we will be one of the authors of the same.

Place: Bengaluru

Date:

Name

Signature

1. Shyamanth R H(1RV17EC151)
2. Amrathesh(1RV17EC192)

ACKNOWLEDGEMENT

We are indebted to our guide, **Dr. Govinda Raju M**, Assistant Professor, RV College of Engineering . for the wholehearted support, suggestions and invaluable advice throughout our project work and also helped in the preparation of this thesis.

We also express our gratitude to our panel members **Dr. Kariyappa**, Professor and **Prof. P N Jayanthi**, Assistant Professor, Department of Electronics and Communication Engineering for their valuable comments and suggestions during the phase evaluations.

Our sincere thanks to **Dr. K S Geetha**, Professor and Head, Department of Electronics and Communication Engineering, RVCE for the support and encouragement.

We express sincere gratitude to our beloved Principal, **Dr. K. N. Subramanya** for the appreciation towards this project work.

We thank all the teaching staff and technical staff of Electronics and Communication Engineering department, RVCE for their help.

Lastly, we take this opportunity to thank our family members and friends who provided all the backup support throughout the project work.

ABSTRACT

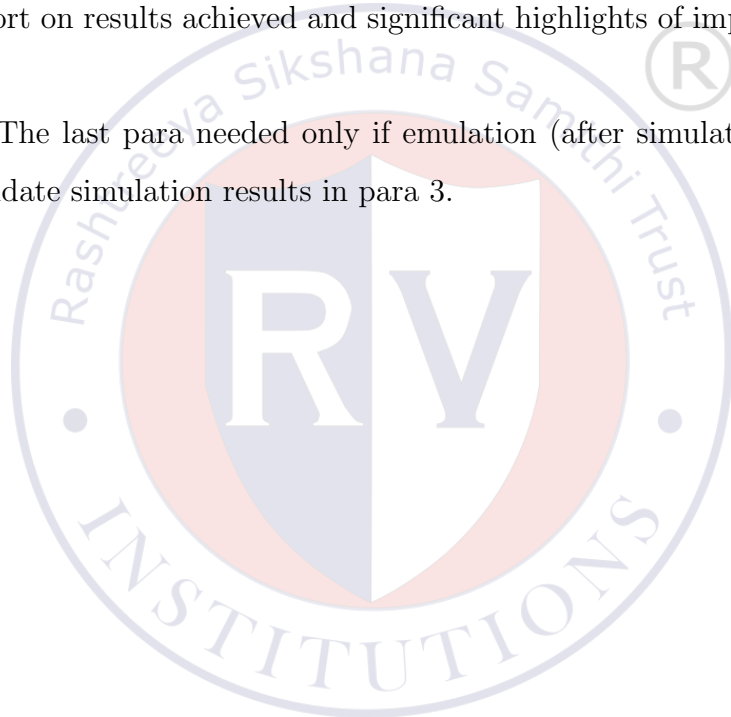
Highlights of significant contributions: One page with 3 to 4 paragraphs

Paragraph 1: Importance of Topic, Present shortcomings in performance or computation etc, issues involved in the shortcomings, short on what is done in this report addressing shortcomings

Paragraph 2 Objectives of this work, short on algebraic methods used and formulations achieved, computational procedures developed. Integrated Circuit (IC).

Paragraph 3: Description of simulation procedure including SW tools used and choice of test cases. Short on results achieved and significant highlights of improvements if any. IC

Paragraph 4: The last para needed only if emulation (after simulation) or Hardware developed to validate simulation results in para 3.



CONTENTS

Abstract	i
List of Figures	iii
List of Tables	iv
Abbreviations	v
List of Symbols	vi
1 Introduction to Analog and Digital converters	1
1.1 Introduction	2
1.2 Motivation	3
1.3 Problem statement	3
1.4 Objectives	3
1.5 Literature Review	3
1.5.1 Sample	3
1.6 Brief Methodology of the project	5
1.7 Assumptions made / Constraints of the project	5
1.8 Organization of the report	5
2 Theory and Fundamentals of Analog to Digital converter	6
2.1 Contents of this chapter	7
2.2 Contents of this chapter	7
2.3 Contents of this chapter	7
2.4 Contents of this chapter	7
2.5 Use of Acronyms and Glossaries	7
3 Design of Pipelined Analog to Digital converter	9
3.1 Contents of this Chapter	10
3.2 Paraphrasing	10
3.3 Quotations	10

4	Implementation of Pipelined Analog to Digital converter	12
4.1	Contents of this chapter	13
5	Results & Discussions	14
5.1	Contents of this chapter	15
5.2	Tables in thesis	15
5.3	Math equation in thesis	16
6	Conclusion and Future Scope	18
6.1	Conclusion	19
6.2	Future Scope	19
6.3	Learning Outcomes of the Project	19

LIST OF FIGURES

1.1	Sample picture of universe	2
-----	--------------------------------------	---

LIST OF TABLES

5.1	Country List	16
-----	------------------------	----

ABBREVIATIONS

IC Integrated Circuit

LIST OF SYMBOLS

τ Time constant

The logo of RV College of Engineering is a circular emblem. It features a central shield divided into four quadrants, with the letters 'RV' prominently displayed in the center. The shield is set against a background of a red and white circular pattern. The outer ring of the emblem contains the text 'Rashtreeya Sikshana Samithi Trust' at the top and 'INSTITUTIONS' at the bottom. A registered trademark symbol (®) is located to the right of the emblem.

Chapter 1

Introduction to Analog and Digital converters

CHAPTER 1

INTRODUCTION TO ANALOG AND DIGITAL CONVERTERS

Every chapter should start with an introduction paragraph. This paragraph should brief about the flow of the chapter. This introduction can be limited within 4 to 5 sentences. The chapter heading should be appropriately modified (a sample heading is shown for this chapter).

1.1 Introduction

The title of the project can be introduced in this section. This section should neatly elaborate the context of the project, the relevance of the area chosen and the title. You can bring a brief history and arrive at the title of the project. Use appropriate number of paragraphs within this section.

You are allowed to use figures or diagrams which can help in introducing the topic acknowledging the source. For example , if you are introducing a particular topic, an appropriate figure can be used. The figure should be referenced in the text as Figure. 1.1



Figure 1.1: Sample picture of universe

These guidelines are provided to formally expose you to the various ethical and technical issues involved in writing up your work and the format you are required to adhere to while submitting your project report.

1.2 Motivation

Brief the motivation of selecting your project title. You can elaborate the challenges in the specific area, relevance and importance of the chosen topic.

1.3 Problem statement

Define the problem statement in this section, in one paragraph.

1.4 Objectives

The objectives of the project are

1. To design a pipelined ADC for audio frequency range
2. List all the objectives in the above format , starting with "To"
3. Limit the number of objectives to a maximum of three

1.5 Literature Review

A literature review is a text of a scholarly paper, which includes the current knowledge including substantive findings, as well as theoretical and methodological contributions to a particular topic. Literature reviews are secondary sources, and do not report new or original experimental work. Most often associated with academic-oriented literature, such reviews are found in academic journals, and are not to be confused with book reviews that may also appear in the same publication. Literature reviews are a basis for research in nearly every academic field . A narrow-scope literature review may be included as part of a peer-reviewed journal article presenting new research, serving to situate the current study within the body of the relevant literature and to provide context for the reader. In such a case, the review usually precedes the methodology and results sections of the work.

1.5.1 Sample

The main types of literature reviews are: evaluative, exploratory, and instrumental. A fourth type, the systematic review, is often classified separately, but is essentially a literature review focused on a research question, trying to identify, appraise, select and synthesize all high-quality research evidence and arguments relevant to that question. A meta-analysis is typically a systematic review using statistical methods to effectively combine the data used on all selected studies to produce a more reliable result.

Review types

The main types of literature reviews are: evaluative, exploratory, and instrumental. A fourth type, the systematic review, is often classified separately, but is essentially a literature review focused on a research question, trying to identify, appraise, select and synthesize all high-quality research evidence and arguments relevant to that question. A meta-analysis is typically a systematic review using statistical methods to effectively combine the data used on all selected studies to produce a more reliable result.

Process and product

Distinguish between the process of reviewing the literature and a finished work or product known as a literature review. The process of reviewing the literature is often ongoing and informs many aspects of the empirical research project. All of the latest literature should inform a research project. Scholars need to be scanning the literature long after a formal literature review product appears to be completed.

Page limitation

A careful literature review is usually 15 to 30 pages and could be longer. The process of reviewing the literature requires different kinds of activities and ways of thinking and link the activities of doing a literature review with Benjamin Bloom's revised taxonomy of the cognitive domain (ways of thinking: remembering, understanding, applying, analysing, evaluating, and creating).

This section should contain the review of the literature in the past. You should review a minimum of 10 papers from standard reference journals. Kindly avoid local conference papers and papers from predatory journals. Kindly consult with your guide and finalize papers to be considered for review before adding in this section. Report the major observations and findings from each paper in one paragraph in the format given below.

proposed various techniques for adders and multipliers. Add the reference papers to the bibliography section using Jabref and cite it here using the instructions given in further chapters.

Plagiarism

To use someone else's exact words without quotation marks and appropriate credit, or to use the unique ideas of someone else without acknowledgement, is known as plagiarism. In publishing, plagiarism is illegal; in other circumstances, it is, at the least, unethical.

You may quote or paraphrase the words or ideas of another if you document your source. Although you need not enclose the paraphrased material in quotation marks, you must document the source.

Paraphrased ideas are taken from someone else whether or not the words are identical. Paraphrasing a passage without citing the source is permissible only when the information paraphrased is common knowledge in a field. (Common knowledge refers to historical, scientific, geographical, technical, and other type of information on a topic readily available in handbooks, manuals, atlases and other references).

How to add Reference

Use **Jabref** which will help in adding the reference in a separate file, from which one can use `\citep{\}` command to add reference. A sample, referring to a textbook would look something like this,[1].

1.6 Brief Methodology of the project

Discuss about the methodology you identified to execute the objectives of your project in brief. Methodology is a system of practices, techniques, procedures, and rules used to execute a particular project. You can elaborate the methodology in a later chapter. Here you can present in the form of a flow diagram and explain the methodology in a paragraph.

1.7 Assumptions made / Constraints of the project

List the assumptions made for the execution of the project in this section. You can also elaborate on the major constraints of the project. This section should clearly state under what conditions your project is valid. It is mandatory to have this section in your project report.

1.8 Organization of the report

This report is organized as follows. Write the discussions in each chapter. A sample is as follows.

- Chapter 2 discusses the fundamentals of ADC and the performance parameters for evaluation.

In a similar way, write briefly about each chapter in one or two sentences.

Chapter 2

Theory and Fundamentals of Analog to Digital converter

CHAPTER 2

THEORY AND FUNDAMENTALS OF ANALOG TO DIGITAL CONVERTER

Every chapter should start with an introduction paragraph. This paragraph should brief about the flow of the chapter. This introduction can be limited within 4 to 5 sentences. The chapter heading should be appropriately modified (a sample heading is shown for this chapter).

2.1 Contents of this chapter

This chapter should discuss about the prerequisite learnings before the execution of the project. Organise and elaborate the theory and necessary fundamentals required for the execution of the project. You can use `\subsections` and `subsubsections` in this chapter.

2.2 Contents of this chapter

If a specific programming language is required for the project, a section can be allotted in this chapter to discuss it.

2.3 Contents of this chapter

Tools used could be another possible section to discuss about the software tools used in the work.

2.4 Contents of this chapter

The details in this chapter can be added in consultation with the project guide. For an internship based projects, subsections can be modified accordingly.

2.5 Use of Acronyms and Glossaries

Acronyms are nothing but the short form of regular repeated word. Say for example, you have a repeat word "Integrated Circuits" and you want to use a short form for it as "IC". For which you have to first define the word and use it wherever you wanted to refer it.

First, let's look at the definition, which has to be entered in `Glossaries.tex` under `CoverPages` directory.

```
%\newacronym{<Ref>}{<Short-Form>}{<Expanded word>}  
\newacronym{ic}{IC}{Integrated Circuits}
```

In order to use the defined acronym, use the commands `\gls{<Ref>}` as shown below

As an example, call the definition with `\gls{ic}` and the outcome of it is reflected as, Integrated Circuit (IC).

Note: For the First time, the expanded form appears along with the Short-form definition inside parenthesis. But when the `\gls{}` is repeated, only Short-form appears inside the parenthesis.

Now, let's look at the definition of symbols. Follow the syntax to define the symbol first, inside `Glossaries.tex` under `CoverPages` directory.

```
%\newglossaryentry{<Ref>}{name=<Symbol>, description={<description about the symbol>}}  
\newglossaryentry{rc}{name=$\tau$, description={Time constant}, type=symbolList}
```

As an example, the rate of change is defined with `\gls{rc}` and the outcome of it is reflected as, the rate of change is defined with τ .

After elaborating the various sections of the chapter, a summary paragraph should be written discussing the highlights of that particular chapter. This summary paragraph should not be numbered separately.

Chapter 3

Design of Pipelined Analog to Digital converter

CHAPTER 3

DESIGN OF PIPELINED ANALOG TO DIGITAL CONVERTER

Every chapter should start with an introduction paragraph. This paragraph should brief about the flow of the chapter. This introduction can be limited within 4 to 5 sentences. The chapter heading should be appropriately modified (a sample heading is shown for this chapter).

3.1 Contents of this Chapter

This chapter should contain the following sections and subsections in detail.

1. Specifications for the Design
2. Pre analysis work for the design or Models used
3. Design methodology in detail
4. Design Equations
5. Experimental techniques (if any)

Apart from the aforementioned sections, you can add sections as per the requirements of the project in consultation with your guide.

3.2 Paraphrasing

When you paraphrase a written passage, you rewrite it to state the essential ideas in your own words. Because you do not quote your source word for word when paraphrasing, it is unnecessary to enclose the paraphrased material in quotation marks. However, the paraphrased material must be properly referenced because the ideas are taken from someone else whether or not the words are identical.

Ordinarily, the majority of the notes you take during the research phase of writing your report will paraphrase the original material. Paraphrase only the essential ideas. Strive to put original ideas into your own words without distorting them.”

3.3 Quotations

When you have borrowed words, facts, or idea of any kind from someone else’s work, acknowledge your debt by giving your source credit in footnote (or in running text as cited

reference). Otherwise, you will be guilty of plagiarism. Also, be sure you have represented the original material honestly and accurately. Direct word to word quotations are enclosed in quotation marks.”

After elaborating the various sections of the chapter, a summary paragraph should be written discussing the highlights of that particular chapter. This summary paragraph should not be numbered separately.

Chapter 4

Implementation of Pipelined Analog to Digital converter

CHAPTER 4

IMPLEMENTATION OF PIPELINED ANALOG TO DIGITAL CONVERTER

Every chapter should start with an introduction paragraph. This paragraph should brief about the flow of the chapter. This introduction can be limited within 4 to 5 sentences. The chapter heading should be appropriately modified (a sample heading is shown for this chapter).

4.1 Contents of this chapter

This chapter should elaborate the following in detail.

1. Implementation details for hardware based projects
2. Top level Design for software based projects

You can add sections and sub sections to elaborate your project work done.

After elaborating the various sections of the chapter, a summary paragraph should be written discussing the highlights of that particular chapter. This summary paragraph should not be numbered separately.

Chapter 5

Results & Discussions

CHAPTER 5

RESULTS & DISCUSSIONS

Every chapter should start with an introduction paragraph. This paragraph should brief about the flow of the chapter. This introduction can be limited within 4 to 5 sentences. The chapter heading should be appropriately modified (a sample heading is shown for this chapter).

5.1 Contents of this chapter

All the results obtained for your objectives should be discussed in this chapter. This chapter should contain the following sections as per the project.

1. Simulation results
2. Experimental results
3. Performance Comparison
4. Inferences drawn from the results obtained

All the figures should be properly explained by bringing the scenarios of the design done in the project. A detailed discussion of results obtained should be done in this chapter.

5.2 Tables in thesis

- All Table Caption should be in Sentence Case, TNR 10 Pt. It should be of the Format:
 - Table 1.1 Results of the experiment ... (Centered)
- It should be cited as Table 1.1.
- Caption should appear above the Table.
- Table Header and the entries should be of Font TNR 10 Pt, Justified.
- For wider Table, the page orientation can be Landscape.
- For Larger Table, it can run to pages and the header should be repeated for each page of the Table.

- Table must be adjusted to fit in the page and no single row is left out for a new page.

Sample Table 5.1 and Table ?? are given below for your reference,

Table 5.1: Country List

Country Name or Area Name	ISO ALPHA 2 Code	ISO ALPHA 3 Code	ISO numeric Code
Afghanistan	AF	AFG	004
Aland Islands	AX	ALA	248
Albania	AL	ALB	008
Algeria	DZ	DZA	012
American Samoa	AS	ASM	016
Andorra	AD	AND	020
Angola	AO	AGO	024

5.3 Math equation in thesis

All equation should be written using equation editor or using an equivalent tool.

- Equations should be numbered as : 1.1, 1.2 ...
- Equation should be Centered, 12 Pt, TNR.
- Equation number should be right Justified
- It should be cited as Eqn. 1.1.
- If the sentence starts by citing an equation, then it should be written as Equation 1.1 For example, Equation 5.1 states the Pythagoras theorem.

For example in Eqn. 5.1, The well known Pythagorean theorem $x^2 + y^2 = z^2$ was proved to be invalid for other exponents. Meaning the next equation has no integer solutions:

$$x^n + y^n = z^n \quad (5.1)$$

The mass-energy equivalence is described by the famous equation in Eqn. 5.2

$$E = mc^2 \quad (5.2)$$

discovered in 1905 by Albert Einstein.

After elaborating the various sections of the chapter, a summary paragraph should be written discussing the highlights of that particular chapter. This summary paragraph should not be numbered separately.

Chapter 6

Conclusion and Future Scope

CHAPTER 6

CONCLUSION AND FUTURE SCOPE

6.1 Conclusion

This chapter should not contain an introduction paragraph like other chapters. You can directly write conclusion of the work done under this section. Typically this section can have 3 to 4 paragraphs.

First paragraph should bring in the scenario of the project and every objective should be explained here.

Second paragraph should say how the objectives are implemented and achieved.

Last paragraph should draw the conclusions from each objective with quantitative results, performance improvement etc.

6.2 Future Scope

Briefly discuss the constraints and limitations of the project and state the possibilities of extending the work in future.

6.3 Learning Outcomes of the Project

- List the learning outcomes here
- List a minimum of 5 learning outcomes

BIBLIOGRAPHY

- [1] B. Razavi, *Design of Analog CMOS Integrated Circuits*. McGraw-Hill Education, 2000, ISBN: 978-0072380323.