

**DUBLIN CITY UNIVERSITY**

**SCHOOL OF ELECTRONIC ENGINEERING**

A Final Project report in

Simulation and exploration of THz TRNASMISSION LINES

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IN

ELECTRONIC AND COMPUTER ENGINEERING

MAJORING IN

THE INTERNET OF THINGS

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# Acknowledgements

# Declaration

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# Abstract

This final report presents the simulation and exploration of terahertz (THz) transmission lines, focusing on the development and validation of numerical models for high-frequency applications. The project addresses the challenges of accurately modeling THz transmission lines, which are essential for next-generation technologies such as 6G networks, wireless data centers, and biomedical imaging. The primary goal is to create computationally efficient and precise models capable of simulating time-domain behavior at THz frequencies. Three key methods were employed: the Finite-Difference Time-Domain (FDTD) approach for initial approximations, the Numerical Inverse Laplace Transform (NILT) for exact s-domain solutions, and RLC ladder approximations for efficient time-domain modeling. The FDTD simulations provided a baseline for understanding transient and steady-state behaviors, while the RLC ladder method, combined with NILT, demonstrated the ability to closely match exact solutions when sufficient sections were used. The results highlight the importance of optimizing the number of sections in the RLC ladder to balance accuracy and computational efficiency. The report concludes with a validated time-domain model suitable for THz transmission line simulations, supported by iterative testing and comparison with exact solutions. This work contributes to the advancement of THz communication systems by providing reliable modeling tools for future research and development.

The abstract should briefly tell me, the reader, about this document. Basically, having read the abstract, the reader should be able to determine if it is worthwhile reading any further. The abstract should concentrate on the content of this document, not on the state of the art, or the wider implications of the research work of which this is a part. It should delimit the scope of the work by indicating how far you have gone. It should not, however, detail the document on a chapter-by-chapter basis. After looking at the abstract, a reader is likely to read the conclusions to see exactly what has been achieved. Abstracts are generally 100-250 words, and address a more technical audience. The abstract should include

* An introductory sentence that create interest and draws attention to the topic;
* The project definition and goals;
* The method of solution;
* The results; and,
* The conclusions.

Place the abstract on a separate page single spaced with no indentions.

(Even though the remainder of the document uses 1.5-line spacing, the text in this Roman numeral section is usually single-spaced). This is revision 2.0 of this document. We hope to continue to make improvements to this document as we gain experience of its use.

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# Chapter 1 - Introduction

* The growth of communication technologies has led to the exploration of terahertz (THz) frequencies (0.1 to 10 THz) for applications like 6G networks, wireless data centers, and biomedical imaging, but accurate THz transmission line models remain a challenge.
* This project aims to develop and validate efficient numerical models for THz transmission lines to predict signal behavior and optimize system performance, addressing key propagation challenges such as high attenuation and dispersion.
* Three primary methods are employed: Finite-Difference Time-Domain (FDTD) for transient analysis, Numerical Inverse Laplace Transform (NILT) for exact s-domain solutions, and RLC ladder approximations for computational efficiency.
* The motivation comes from the demand for high-speed THz communication systems, which are crucial for future technologies, but currently lack reliable and efficient modeling tools.
* The report includes a literature review, implementation details of the three modeling methods, simulation results, challenges faced, and future work plans.
* This research contributes to THz transmission line modeling by providing a validated numerical framework that can aid in the advancement of THz communication technologies.

It is also useful to use the numbering format above for figures where the chapter number is first, then the image number within the chapter. If your document becomes large and unworkable with Word then you can break down the document into a single document for each chapter. This numbering format allows you to insert figures into an early chapter without having to modify each subsequent chapter.

If you are inserting figures into a report, something to keep in mind is the image format when creating the image (It does not matter once inserted into Word):

* JPG/JPEG – Perfect for photos and spatially detailed images. Do not use for screen grabs or for line art figures or diagrams, as they will appear blocky.
* GIF – suitable for compression of low colour diagrams, such as figures, screen grabs etc. It should not cause any block effects on your images.
* BMP – fine for all diagram types – but usually very large images.
* EPS – excellent for line art/diagrams. Word does not display the high quality version on the screen, but they will print perfectly. Can be large if they contain images (use insert->picture->from file for this format).

## 1.1 Equipment and Software (MATLAB, pspice )

### 1.1.1 Why MATLAB?

The intelligent camera is a highly complicated piece of image processing equipment. It allows images to be captured into framestores and various image-processing operations to be …

### 1.2.4 Summary

In this section we try to present a personal view of important technical and structural aspects of writing an engineering dissertation. I suppose the most important thing to keep in mind is the mechanism of reading: the eye flows across the text, picking out familiar patterns for the brain to interpret. Anything you do to disrupt that flow will slow the reader down and allow them to lose their train of thought. On the other hand, if you feed the brain too much dense material, it will suffer from indigestion. Write with the intention of most effectively communicating with your audience, considering their interest, motivation, background and ability to assimilate your ideas.

In the next chapter, some of the Word styles that are used in this template to assist in giving an appropriate presentation of the text are treated.

# Chapter 2 - Technical Background

In this chapter, the basis structure of the heading system used in this prototype is presented. The approach is based on the style functionality of Microsoft Word. You are free to adapt these styles to your own use, but the ones selected are quite clear and sufficient for most purposes. Only three levels of numbered headings are described here, as the convention is that you do not number headings at deeper levels than this. If you need more than three levels, perhaps you need to rethink your chapter structure.

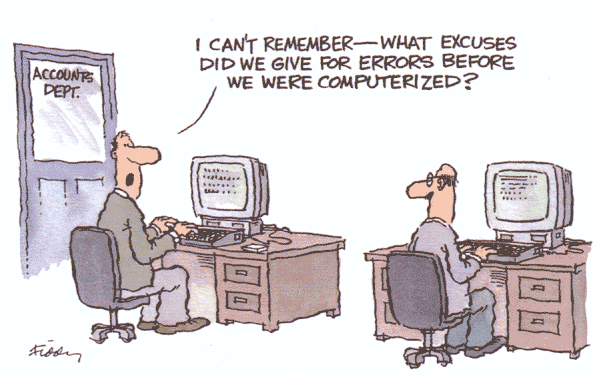


Figure 2.1 A Sample Figure

Defining numbered headings as Word headings makes them available for the automatically generated table of contents. This is an important factor in the generation of a complex document where a small change near the beginning of a chapter or document can have very substantial knock-on effects. It is also possible to automate other aspects of your document generation, such as tables of figures, references and the index. Consult the Help information for more information on these.

## 2.1 Using Heading Styles

### 2.1.1 Heading 1 Style

The “Chapter 2” which appears at the top of this page is part of the heading system but does not need to appear in the table of contents (TOC). Consequently, it is just formatted as normally. The heading is formatted as style Heading 1 and this means that it will appear in the TOC. (This is an example of a correct, but inappropriate use of a TLA).

### 2.1.2 Heading 2 Style

The “2.1 Using Heading Styles” text at the start of this section is an example of the Heading 2 style. It is slightly smaller than the Heading 1 style and it appears indented in the TOC.

### 2.1.3 Heading 3 Style

The text “2.1.3 Heading 3 Style” which is the heading for this subsection, is an example of the Heading 3 style. Again it is slightly smaller than the previous one, though still bigger than the twelve point main text.

### 2.1.4 Other Headings

Notice that in the previous chapter, un-numbered headings are also used. It is sufficient to use 12 point bold for these headings, where required.

## 2.2 Summary

Some important points on headings

* You can update the tables in this document by pressing on the table and pressing the “F9” key and choosing update table.
* In this document Abstract, TOC, Appendices etc. are defined as “Heading” so that the chapter number is not placed in front of those titles.
* Be careful when you type a new heading that the body of text that you are writing after the heading is defined as “normal” otherwise your entire text will appear in the table of contents!
* If Word has problems with the size of your document, break it into different documents, one for each chapter. Remember that when you are printing the entire document at the end that you can specify a start page number for each chapter and that you can create an automatic table of contents for each chapter and cut-and-paste it to the start of your document.

# Chapter 3 - Design of …

# Chapter 4- Implementation and Testing of …

# Chapter 5 - Results and Discussion

# Chapter 6 – Ethics

# Chapter 7 - Conclusions and Further Research

The conclusions chapter is very important in your report. It must conclude your work! It is not a summary of the work in the previous chapters; it must give insight into the value of your work, inform the readers of the impact of your work and should provide directions for future research on your report topic. This chapter allows you a chance to document your own opinions and insights while displaying ingenuity and imagination in choosing possible implementation applications or future directions of your own work.

The conclusions should include a clear statement of the success criteria and if they were met. It should describe your work and your contributions to research.

# References

[1] Nagel, H-H, “Extending the orientated smoothness constraint into the temporal domain”, *Proc 1st European Conference on Computer vision (Antibes, France),* April 1990.

[2] Horn, B.K.P and Schunck, B.G. “Determining Optical Flow”, *Artificial Intelligence*, pp185-203, 1987.

[3] Ullman, S. *The Interpretation of visual motion,* Cambridge, MA; MIT Press, 1979. pp99-107.

[4][[1]](#footnote-1) Sun Microsystems Inc., "Java 2 SDK Documentation – Version 1.4.1" <http://java.sun.com/j2se/1.4.1/docs/index.html>, 2002. (20 June 2003).

**IMPORTANT NOTE ON REFERENCES**

One area on which many students fall down is the area of references. The guideline here is quite simple: either you did the work and wrote the text, or *someone else did*. For any single sentence of your dissertation or report that falls into the latter category, you must provide as complete a reference as possible, so that another student or reader can easily access exactly the same source of information as you have. The desired form for the reference data is usually that used in IEEE journals. Please examine carefully the references used above in this document, which include an example of how to reference a document from the Internet.

Please delete this note when using this document as a template. More recent versions of MS Word will allow you to ‘Manage your Sources’ under the ‘References’ tab and Bibtex is great if you are using Latex to prepare your document.

# Appendix 1

You should put into an appendix, material which is required to be present with your dissertation, but which would interrupt the flow of the text if presented in the main body of the document.

# Glossary

If required.

1. Web references should include the URL, the author, the document/article title, when it was written and should also contain the date at which the reference was valid, i.e. when you used it last. [↑](#footnote-ref-1)