University of Cape Town

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This document is in draft format. It is known to be incomplet and incorrekt, and it has lots of bad formatting. Drafting styles are defined as follows:

Text that is old and must be re-worked or removed

Shorthand note that should be incorporated into the text later

Something that must be done

Something that must be rephrased

Internal link

Citation link

External link

```
// Comment
normal text
#pre-processor
class // Keyword
"String"
```

I know the meaning of plagiarism and declare that all of the work in the dissertation, save for that which is properly acknowledged, is my own.

.....

Author 1
Author 2
Author N

Abstract

The abstract should be a one or two paragraph summary of your paper. It is meant to sell your paper to interested buyers.

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Nomenclature

1 Acronyms

A ..... Amperes

AC ..... Alternating Current

ADC ..... Analogue to Digital Converter

API ..... Application Programmer's Interface

ARM ..... Advanced RISC Machine

ASIC ..... Application Specific Integrated Circuit

AXI ..... Advanced Extensible Interface

BAR ..... Base Address Register

BCD ..... Binary-Coded Decimal

Bd ..... Baud, in symbols per second

CFAR ..... Constant False Alarm Rate

CMOS ..... Complimentary Metal-Oxide Semiconductor

CPLD ..... Complex Programmable Logic Device

dBm ..... Deci-Bell, relative to 1 mW

DC ..... Direct Current

DDC ..... Digital Down Converter

DDS ..... Direct Digital Synthesis

DMA ..... Direct Memory Access

DSP ..... Digital Signal Processor (or processing)

EDA ..... Electronic Design Automation

FIFO ..... First-in, First-out (queue)

FIR ..... Finite Impulse Response

FMC ..... FPGA Mezzanine Card

FPGA ..... Field Programmable Gate Array

FSM ..... Finite State Machine

GUI ..... Graphical User Interface

HDL ..... Hardware Description Language

HPS ..... Hard Processor System

HSTL ..... High Speed Transfer Logic

I/O ..... Inputs/Outputs

I²C ..... Inter-IC

IC ..... Integrated Circuit

IDE ..... Integrated Development Environment

LE ..... Logic Element

LSb ..... Least Significant Bit

LSB ..... Least Significant Byte

LUT ..... Look-Up Table

LVCMOS .... Low Voltage Complementary Metal Oxide Semiconductor

LVDS ..... Low Voltage Differential Signalling

LVPECL .... Low Voltage Positive Emitter Coupled Logic

LVTTL ..... Low Voltage Transistor-Transistor Logic

MIMO ..... Multiple Input Multiple Output

MISO ..... Master Input / Slave Output

MOSI ..... Master Output / Slave Input

MSb ..... Most Significant Bit

MSB ..... Most Significant Byte

MSI ..... Message Signalled Interrupt

NCO ..... Numerically Controlled Oscillator

NTP ..... Network Time Protocol

PC ..... Personal Computer

PCB ..... Printed Circuit Board

PCI ..... Peripheral Component Interconnect

PCIe ..... PCI Express

PLL ..... Phase Locked Loop

PPDS ..... Point-to-Point Differential Signalling

PRF ..... Pulse Repetition Frequency

PRI ..... Pulse Repetition Interval

PSU ..... Power Supply Unit

RADAR ..... Radio-Assisted Direction and Ranging

REST ..... Representational State Transfer

RF ..... Radio Frequency

RISC ..... Reduced Instruction Set Computer

RMS ..... Root Mean Square

RPM ..... Revolutions per Minute

RSDS ..... Reduced Swing Differential Signalling

SI ..... Système International d'Unités

SoC ..... System On Chip

SPI ..... Serial Peripheral Interface

SSTL ..... Stub Series Terminated Logic

TCP ..... Transmission Control Protocol

TTL ..... Transistor-Transistor Logic

UART ..... Universal Asynchronous Receiver Transmitter

UDP ..... User Datagram Protocol

UFM ..... User Flash Memory

URL ..... Uniform Resource Locator

V ..... Voltage

VHDL ..... VLSI HDL

VLSI ..... Very Large-Scale Integration

XML ..... eXtensible Markup Language

2 Terminology

Developer	FPGA firmware developer, using any firmware development tool.
Device	The specific target FPGA.
Megafunction	A target-specific module, typically generated from within the vendor IDE, after the Altera nomenclature.
Module	Akin to a Verilog module; i.e. unit of digital circuit that has ports to the outside world and can exist at any level of the design hierarchy.
Object file	An intermediary file used in the ALCHA compilation process. It is the reult of compiling a single translation unit and describes a collection of objects.
Peripheral	Any device, external to the FPGA, that interfaces directly with the FPGA.
Platform	The platform that the ALCHA compiler runs on, including operating system and computer hardware.
Target	The platform ALCHA is compiling to, including FPGA, PCB, peripherals and vendor IDE.
Translation unit	Akin to a C language translation unit, i.e. a collection of source files and headers that translate to a single object file
User	The developer who is using ALCHA to develop FPGA firmware.
Vendor	The FPGA manufacturer.

Chapter 1

Introduction

If you are new to LaTeX, I would suggest reading [2]. If you want to use Microsoft Word (or one of its many clones), you can download the official IEEE conference template from [3]. The TA and tutors can provide LaTeX support. Use Word at your own risk.

The introduction is where you set the scene. Here you reference other, related work, as well as a summary relating to how you improve upon said work [4]. In the sense of the practical reports, the introduction will summarise the experiment the practical is all about.

As a general rule of thumb, keep the introduction to the first column and don't put any sub-sections into it.

Remember that, for bibliography citations to work, you have to include running BibTeX in the compile chain. My TeXstudio [5] compile chain for "Build & View" is

```
txs:///bibtex | txs:///pdflatex |
txs:///bibtex | txs:///pdflatex |
txs:///view-pdf-internal
```

1.1 Drafting Markup

When the template is in draft mode, you can use various helper macros, as illustrated below:

This is old text that should be removed. *This is a note about something to remember, or comments from the proof-reader.* **This is something that still needs doing.** When compiled with `\Draftfalse`, the content of these macros are removed from the output, *except something that needs to be rephrased.*

You can also use cards, as follows:

TODO

This is a todo card.

It is a minipage environment, so you can have all sorts of stuff in it. It can be many paragraphs long, but don't make it too long, because LaTeX will force the whole card onto a single page.

NOTE

This is a nested note card. You can nest cards of arbitrary types as deep as you like.

Chapter 2

Literature Review

Chapter 3

Methodology

In this section you should describe the method of the experiment.

3.1 Hardware

Include detail such as the hardware used. It's generally a good idea to include a block diagram at this point, such as the one presented in Fig. 3.1. This figure was drawn in InkScape [6]. When you want to import an InkScape figure (SVG format) into LaTeX, simply save it to PDF (use the drawing extents as the media box area) and include the figure.

3.2 Implementation

Also mention the implementation source code:

```
# You can include inline Matlab / Octave code
x = linspace(0, 2*pi, 1000);
y = sin(x);
plot(x, y); grid on;
```

Or you could turn it into a float: see listing 3.1. Floats are tables, figures and listings that

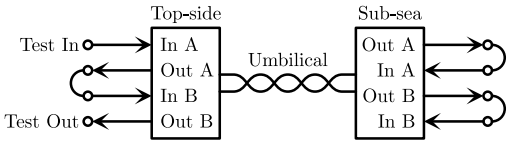

Fig. 3.1. Test setup used to test the implementation [1].

appear at a different place than in the source code. This template is set up to put floats at the top of the next column, as prescribed by the IEEE article specification.

Only list what is relevant. Don't give too much detail - just enough to show what you've done. This template supports the following languages:

- Matlab (Octave)
- GLSL
- OpenCL
- Verilog
- VHDL
- TCL
- Python
- C++ (use the name 'Cpp')

3.3 Experiment Procedure

Furthermore, include detail relating to the experiment itself: what did you do, in what order was this done, why was this done, etc. What are you trying to prove / disprove? You can include hypotheses, such as presented in Hypothesis H0 below.

Hypothesis H0: All scientific papers contain hypotheses. An hypothesis is generally not longer than a single paragraph, but the command does support multiple paragraphs if required.

```
__kernel void Multiply(
  __global float* A, // Global input buffer
  __global float* B, // Global input buffer
  __global float* Y, // Global output buffer
    const  int    N  // Global uniform
){
  const int i = get_global_id(0); // 1st dimension index
  const int j = get_global_id(1); // 2nd dimension index

  // Private variables
  int   k;
  float f = 0.0;

  // Kernel body
  for(k = 0; k < N; k++) f += A[i*N + k] * B[k*N + j];
  Y[i*N + j] = f;
}
```

Listing 3.1. OpenCL kernel to perform matrix multiplication

Chapter 4

Design

Chapter 5

Experimentation

Chapter 6

Results

The results section is for presenting and discussing your findings. You can split it into subsections if the experiment has multiple sections or stages.

6.1 Figures

Include good quality graphs (see Fig. 6.1). These were produced by the Octave code presented in listings 6.1 and 6.2. You can play around with the `PaperSize` and `PaperPosition` variables to change the aspect ratio. An easy way to obtain more space on a paper is to use wide, flat figures, such as Fig. 6.2.

Always remember to include axes text, units and a meaningful caption in your graphs. When typing units, a µ sign has a tail! The letter "u" is not a valid unit prefix. When typing resistor values, use the Ω symbol.

6.2 Tables

Tables are often a convenient means by which to specify lists of parameters. An example table is presented in table 6.1. You can use Tablesgenerator to make your LaTeX tables.

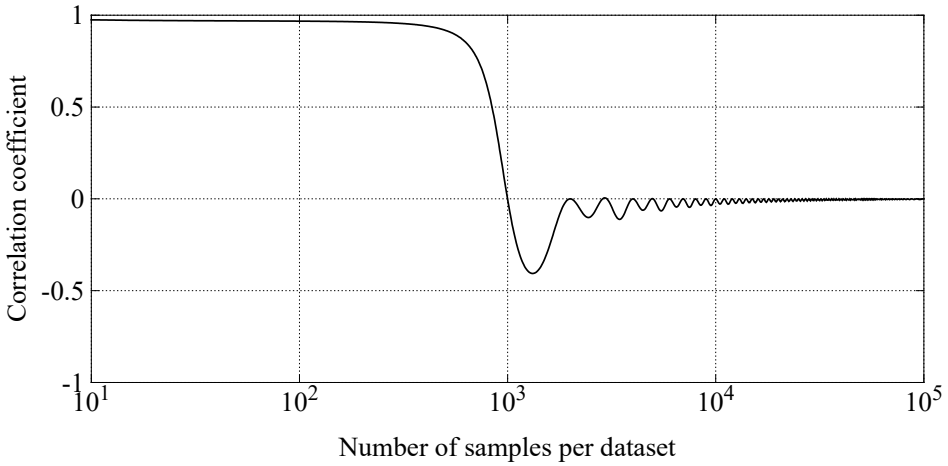

Fig. 6.1. The correlation coefficient as a function of sample count.

```
function FormatFig(X, Y, File);
  set(gcf, 'PaperUnits'      , 'inches');
  set(gcf, 'PaperOrientation', 'landscape');
  set(gcf, 'PaperSize'       ,       [8, 4]);
  set(gcf, 'PaperPosition'   , [0, 0, 8, 4]);

  set(gca, 'FontName', 'Times New Roman');
  set(gca, 'Position', [0.1 0.2 0.85 0.75]);

  xlabel(["\n" X]);
  ylabel([Y "\n\n"]);

  setenv("GSC", "GSC"); # Eliminates stupid warning
  print(...
    [File '.pdf'],...
    '-dpdf'...
  );
end
```

Listing 6.1. Octave function to format a figure and save it to a high quality PDF graph

```
figure;                                 # Create a new figure
# Some code to calculate the various variables to plot...
plot(N, r, 'k', 'linewidth', 4); grid on; # Plot the data
xlim([0 360]);                          # Limit the x range
ylim([-1 1]);                           # Limit the y range
set(gca, 'xtick', [0 90 180 270 360]);  # Set the x labels

FormatFig(...                           # Call the function with:
  'Phase shift [\circ]',...                    # The x title
  'Correlation coefficient',...                # The y title
  ['r_vs_N;_f=' num2str(f) ';_P=' num2str(P)]... # Format the file name
);
close all;                              # Close all open figures
```

Listing 6.2. Example of how to use the FormatFig function

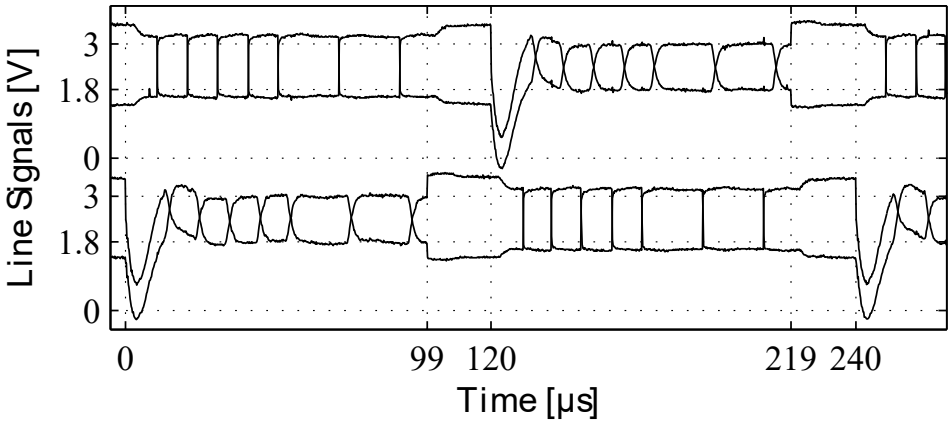

Fig. 6.2. Oscilloscope measurement showing physical line signals on both ends of a transmission line during master switch-over [1].

TABLE 6.1
MY INFORMATIVE TABLE

Heading 1	Heading 2	Heading 3
Data	123	321
Data	456	654
Data	789	987

6.3 Pictures and Screen-shots

When you include screen-shots, pdfLaTeX supports JPG and PNG file formats. PNG is preferred for screen-shots, as it is a loss-less format. JPG is preferred for photos, as it results in a smaller file size. It's generally a good idea to resize photos (not screen-shots) to be no more that 300 dpi, in order to reduce file size. For 2-column article format papers, this translates to a maximum width of 1024. **Never change the aspect ratio of screen-shots and pictures!**

It is highly recommended to make use of the `\Figure` macro for figures. It puts all the formatting tweaks in one place, so that you don't need to update all the individual figure inclusion points when you want to do a styling update. The file name is used for the LaTeX label, such as "Fig. 6.3".

Fig. 6.3. An example image with custom scaling

Make sure to always use the best quality image possible. Use JPEG for photos, PNG for screen-shots and PDF (scalable vector graphics) for everything else. JPEG is lossy, but good for photos, whereas PNG is lossless and good for images with large areas of solid colour, as can be seen in Fig. 6.4.

6.4 Maths

LaTeX has a very sophisticated maths rendering engine, as illustrated by equation 6.1. When talking about approximate answers, never use ±54 V, as this implies "positive or negative 54 V". Use ≈ 54 V or ∼ 54 V instead.

$$y = \int_0^\infty e^{x^2} \mathrm{dx} \tag{6.1}$$

(a) JPEG (b) PNG (c) SVG

Fig. 6.4. Comparison of various image format qualities

Chapter 7

Conclusion

The conclusion should provide a summary of your findings. Many people only read the introduction and conclusion of a paper. They sometimes scan the tables and figures. If the conclusion hints at interesting findings, only then will they bother to read the whole paper.

You can also include work that you intend to do in future, such as ideas for further improvements, or to make the solution more accessible to the general user-base, etc.

Publishers often charge "overlength article charges" [7], so keep within the page limit. In EEE4084F we will simulate overlength fees by means of a mark reduction at 10% per page. Late submissions will be charged at 10% per day, or part thereof.

Bibliography

[1] J. Taylor and J. G. Hoole, "Robust Protocol for Sending Synchronisation Pulse and RS-232 Communication over Single Low Quality Twisted Pair Cable," in *Proceeding of ICIT*. Taiwan: IEEE, Mar. 2016.

[2] T. Oetiker, H. Partl, I. Hyna, and E. Schlegl, "The Not So Short Introduction to LaTeX 2_ε," https://tobi.oetiker.ch/lshort/lshort.pdf, Jul. 2015, version 5.05.

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Appendix A

Item 1

Appendix B

Item 2