Broadband Monolithic Constrained Lens Design

by

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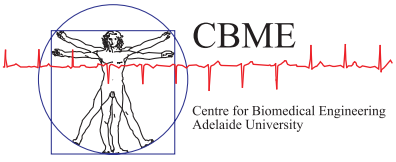

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To the friends I call family
and the family I call friends

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Abstract

Constrained lens geometries have attracted attention as a replacement for bulky mechanical beam-steering systems or complex and expensive electronically beam scanned systems. Despite the great potential of constrained lenses, poor matching techniques and port implementation have limited the performance of Rotman lenses.

This thesis provides a thorough engineering methodology for designing and analysing Rotman lenses. This has been achieved by reworking the Rotman equations for the intended application of a linear antenna array feed network. Further, a number of statistical methods are presented to evaluate the performance of the Rotman lens, providing a set of tools to optimise the lens for any linear array specification.

While mathematical analysis of the Rotman lens using geometrical optics has occupied much of the work in the literature, the real challenges of constrained lens design have been only briefly reported. These challenges include the design of port geometries, feed networks, and impedance matching, which are particularly significant due to the desire to exploit the broadband potential of constrained lenses.

The electromagnetic limitations of the Rotman lens architecture are presented with the analysis and fabrication of a 5 to 20 GHz Rotman lens design. In doing so, the mechanisms that limit lens performance are highlighted. This thesis presents a clear path through the minefield of design tradeoffs to a Rotman lens that transforms its broadband potential to reality.

Statement of Originality

This work contains no material that has been accepted for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text.

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1st August 2009

Signed

Date

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– Leonard Hall

August 2009

"The only laws of matter are those that our minds must fabricate and the only laws of mind are fabricated for it by matter"

– James Clerk Maxwell

Thesis Conventions

Typesetting. This Thesis is typeset using the LATEX2e software. Processed plots and images were generated using Matlab R2007b (Mathworks Inc.). Adobe Illustrator CS2 (Adobe) was used to produce schematic diagrams and other drawings.

Spelling. Australian English spelling has been adopted throughout, as defined by the Macquarie English Dictionary (A. Delbridge, Ed., Macquarie Library, North Ryde, NSW, Australia, 2001). Where more than one spelling variant is permitted such as 'biassing' or 'biasing' and 'infra-red' or 'infrared' the option with the fewest characters has been chosen.

Referencing. The Harvard style is used for referencing and citation in this Thesis.

Electromagnetic Simulation. Ansoft Designer 3.5 (Ansoft Corporation) and Ansoft Ensemble 6.1 (Ansoft Corporation) have been used to simulate the Rotman lens. HFSS 11 (Ansoft Corporation) has been used for all other electromagnetic simulations.

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