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Book Review

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ANALOG OPTICAL LINKS – THEORY AND PRACTICE
by Charles H. Cox III, Cambridge University Press, 2004, xi+ 293 pp. with index, ISBN 0-521-62163-1, 219 ref. distributed chapter by chapter (Hbk, £70)

This book presents concepts and techniques to facilitate the design of Analogue Optical Links. The level of assumed knowledge is on a par with a good undergraduate degree containing substantial portions of electronics or physics. Throughout the book, the author develops a number of models and equations, and in many cases has chosen an intuitive approach. For those seeking a more rigorous background, the book contains extensive lists of references, and there are a number of appendices attached to some of the chapters for those who feel the immediate need to delve further. The book also contains a number of graphs which present both the theoretical results, and supporting external experimental results.

The approach taken by the author is to break the link into its constituent components – modulators, fibre, and demodulators detectors. He then analyses each component, and produces a series of models and equations. These are then combined to produce an overall analysis of the link under study.

The book is divided into seven chapters which are well laid out, and lead the reader through various aspects of link design, toward the final chapter where many of the elements are brought together in a discussion of the tradeoffs encountered by designers working in this field.

Chapter 1 is an introduction to the book and the field. It opens with a discussion of the components which go to make up a link (modulator, transmission medium, demodulator) and gives an overview of some of the issues which affect these elements. It also draws an early distinction between the RF elements (part of the modulation process), and the optical elements. There follows a brief discussion of the typical areas in which such links may be required. The chapter closes with an introduction to some of the available fibre types, and their characteristics. [17 references]

Chapter 2 begins the stage by stage analysis of a link. It looks at small signal models of the link elements. Direct and external modulation devices are described and analysed, and the 'Incremental Slope Efficiency' of each is deduced for use later in the book. There is also a description and analysis of Photodetectors, and the 'Incremental Detection Efficiency' is deduced. [72 references]

Chapter 3 begins to look at the intrinsic gain of a link from a low frequency perspective. Combinations of devices, from chapter 2, which go to make up links, are analysed, and the chapter begins to look at some of the parameters which affect the overall link gain. [13 references]

Chapter 4 expands on the discussion in chapter 3, and looks at the frequency response of links. Once again, the link is broken down into its constituent parts, and the impact of a number of the device controlling parameters is discussed. (e.g. electrode design in Mach-Zehnder modulators). Chapters 2 and 3 introduced impedance matching to build the device and link models. Chapter 4 contains an extensive discussion of passive impedance matching, where and what to introduce, and the impact of the matching impedances on the 'Incremental Modulation Efficiency'. [28 references]

Chapter 5 explores noise on an Analogue optical link. It begins with Thermal and Shot noise, and then explores Relative Intensity Noise (RIN) in Lasers. The chapter then looks at different link noise models, based on the dominant noise source, and deduces Noise Figure equation in terms of parameters of the devices constituent in the link. The chapter goes on to examine methods for reducing the Noise Figure of a link, and produce equations to calculate the minimum Noise Figure. [25 references]

Chapter 6 introduces distortion into the picture. The discussion begins with defining distortion, and then examining methods to produce distortion measurements. Once more, the constituent parts of the link (modulators, and photodetectors) are addressed individually, and distortion equations (up to 3rd order intermodulation) are presented. The chapter closes with a look at methods for reducing distortion, and separately addresses electronic and optical methods of optimisation. [51 references]

Chapter 7 ties the book together with a discussion of the various tradeoffs available to the link designer, in terms of the parameters which control the devices within the link. It also includes a discussion on the use of pre- and post-link amplification. [13 references]

This book represents an excellent coverage of this area from an unusual angle. It ties together the different elements of the link, how the different models interact and uses the models to point towards design choices for different link criteria.

I think that this is a very useful text for those involved in designing optical links, or those considering entering this area.

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