HIGH-SPEED DIGITAL SYSTEM DESIGN

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A HANDBOOK OF INTERCONNECT THEORY AND DESIGN PRACTICES

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PREFACE

This book covers the practical and theoretical aspects necessary to design modern high-speed digital systems at the platform level. The book walks the reader through every required concept, from basic transmission line theory to digital timing analysis, high-speed measurement techniques, as well as many other topics. In doing so, a unique balance between theory and practical applications is achieved that will allow the reader not only to understand the nature of the problem, but also provide practical guidance to the solution. The level of theoretical understanding is such that the reader will be equipped to see beyond the immediate practical application and solve problems not contained within these pages. Much of the information in this book has not been needed in past digital designs but is absolutely necessary today. Most of the information covered here is not covered in standard college curricula, at least not in its focus on digital design, which is arguably one of the most significant industries in electrical engineering.

The focus of this book is on the design of robust high-volume, high-speed digital products such as computer systems, with particular attention paid to computer busses. However, the theory presented is applicable to any high-speed digital system. All of the techniques covered in this book have been applied in industry to actual digital products that have been successfully produced and sold in high volume.

Practicing engineers and graduate and undergraduate students who have completed basic electromagnetic or microwave design classes are equipped to fully comprehend the theory presented in this book. At a practical level, however, basic circuit theory is all the background required to apply the formulas in this book.

Chapter 1 describes why it is important to comprehend the lessons taught in this book. (Authored by Garrett Hall)

Chapter 2 introduces basic transmission line theory and terminology with specific digital focus. This chapter forms the basis of much of the material that follow. (Authored by Stephen Hall)

Chapters 3 and 4 introduce crosstalk effects, explain their relevance to digital timings, and explore nonideal transmission line effects. (Authored by Stephen Hall)

Chapter 5 explains the impact of chip packages, vias, connectors, and many other aspects that affect the performance of a digital system. (Authored by Stephen Hall)

Chapter 6 explains elusive effects such as simultaneous switching noise and nonideal current return path distortions that can devastate a digital design if not properly accounted for. (Authored by Stephen Hall)

Chapter 7 discusses different methods that can be used to model the output buffers that are used to drive digital signals onto a bus. (Authored by Garrett Hall)

Chapter 8 explains in detail several methods of system level digital timing. It describes the theory behind different timing schemes and relates them to the high-speed digital effects described throughout the book. (Authored by Stephen Hall)

Chapter 9 addresses one of the most far-reaching challenges that is likely to be encountered: handling the very large number of variables affecting a system and reducing them to a manageable methodology. This chapter explains how to make an intractable problem tractable. It introduces a specific design methodology that has been used to produce very high performance digital products. (Authored by Stephen Hall)

Chapter 10 covers the subject of radiated emissions, which causes great fear in the hearts of system designers because radiated emission problems usually cannot be addressed until a prototype has been built, at which time changes can be very costly and time-constrained. (Authored by Garrett Hall)

Chapter 11 covers the practical aspects of making precision measurements in high-speed digital systems. (Authored by James McCall)

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