Preface

The evolution and pervasiveness of PCs as cost-effective computing platforms, recently joined by workstations with more powerful software tools, has resulted in a virtual explosion in data acquisition, signal processing and control systems from laboratory to industry including field applications. At least three separate approaches are currently widespread including complete GPIB-interfaced instruments, discrete signal conditioning and data conversion board products, and comprehensive VXI instrument-on-a-card systems. Since the integration of all of these implementations may be defined with respect to their computer interfaces it is remarkable that their designs continue to be based on circuit considerations. However, simultaneous economic and performance requirements have prompted the search for improved interface understanding and design methods that can achieve reduced parameter variabilities without the costs of overdesign.

The motivation for this book accordingly was to address these needs through the definition of quantitative methods capable of characterizing the design and analysis of computer I/O systems. Subsequently, this led to the derivation and proofing of comprehensive mathematical models for describing device and system elements and their combination in terms of a unified input-to-output error budget. This provides an efficient integration tool for defining the performance of computer interfacing systems, including their sensitivity to component and system choices. The use of these accountability measures imposes needed organization on the design of computer I/O systems to achieve precision signal acquisition and accurate data conversion. The translation of

these models into a software program in Chapter 7 further provides for the automation of the many detailed calculations to speed the analysis of existing instrumentation and computer interfacing products and the optimization of new designs. These methods therefore constitute a paradigm for quantitatively describing real-time I/O systems for digital computers, and the allocation of interface resources required to achieve the performance of interest including scale-up to many interconnected systems such as encountered in automated manufacturing.

This book presents a compendium of topics organized into ten chapters in a logical progression from input sensors to signal conditioning through digital conversion and output signal recovery elements, including extensions to advanced interfacing for sensor-based artificial intelligence applications and distributed I/O systems. A fundamental concern throughout is the accuracy of the data from the analog input circuits through the data conversion devices and output reconstruction components. The chapters are arranged according to the accompanying table into the three divisions of analog, conversion, and digital topics. The balance between theory and practice provides a usefulness for design applications that a more formal approach might lack. The book is intended as an extension to an electrical and computer engineering sequence, and to augment instrumentation, biomedical, manufacturing, or digital control courses at the senior and first-year graduate level.

ANALOG TOPICS	CONVERSION TOPICS	DIGITAL TOPICS
Chapter 1 Sensors	Chapter 5 Conversion Devices	Chapter 9 Processor I/O
Chapter 2 Amplifiers	Chapter 6 Sampled Data	Chapter 10 Distributed Systems
Chapter 3 Filters	Chapter 7 System Design	
Chapter 4 Signal Conditioning	Chapter 8 Advanced Interfacing	

Many of the developmens described in this book have not been presented either in other books or literature. Notable are the derivations of component errors, such as average filter error, and system errors including the signal conditioning improvement of signal quality and the intersample error representation of sampled-data signals. Development of the device and system models occurs with each chapter relevant to the subjects addressed and are combined

in complete system examples in the later chapters. The author accepts responsibility for the ideas presented and any shortcomings, and is especially indebted for the assistance and many helpful discussions with John P. Brockman and the software development efforts of Lawrence P. Ochs.

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