

analog - digital
CONVERSION HANDBOOK

by
The Engineering Staff of
Analog Devices, Inc.

Edited by
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PREFACE

This book, a milestone rather than a culmination, is the direct outgrowth of a series of conversations with Ray Stata and Jim Pastoriza, starting at the beginning of 1969. At that time (and increasingly since then), it was felt that the growing availability of data-processing facilities at low cost – especially minicomputers – would bring the analog-digital interface, in the form of modular A/D and D/A converters and accessories, out of the specialty houses and into the realm of the working design engineer.

Although there are books in print on digital, analog, and hybrid computing, on circuit design, and on digital communication theory and sampled-data systems, there were – and still are – virtually no books that could serve as a guide to the engineer on the practical aspects of understanding, specifying, and applying the commercially-available modular elements of conversion systems in these pursuits.

Lest any reader either expect or question our altruism in publishing this book, let us first of all say that this book will seek to tell you merely “Everything You Always Wanted to Know About Data-Conversion System Design Using Modules*” rather than “*Everything* About Data-Conversion Systems,” which would be an impossible (and at any rate, unrewarding) task.

Our viewpoint and credentials are those of a major producer of conversion-system integrated circuits and modules for the open market, and a growing supplier of high-performance monolithic-IC parts for in-house design and manufacture. We strive neither to hide nor to unduly emphasize our commercial motives, and the reader may find that the resulting honesty will impart a down-to-earth sense of practicality and realism.

On the other hand, we have restricted our temptations to crass commercialism to the extent of using model numbers and product specifications in the text for their flesh-and-blood illustrative effect. Our catalogs, data sheets, and other propaganda – and those of our competitors – are separately available in sufficient panoply, partisan quality, and timeliness, to make any effort to

*And Had Already Asked

outshine them in the present volume less than desirable (even if possible).

It is our hope that this volume will help the purely-digital or purely-analog hardware designer obtain appropriate practical knowledge of the complementary field, and that it will serve as a useful text and reference source for all designers of interface equipment. We will welcome the comments and suggestions of our readers for the benefit of future editions and readers.

June 1, 1972
Norwood, Mass.

D. H. Sheingold

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This book has been written by the engineering staff at Analog Devices. Individual contributors to Part I, *Converters at Work*, include Ivar Wold, Barry Hilton, Mike Lindheimer, and Stanley Froud; to Part II, *Converters*, Dick Ferrero, Rick Spofford, Bob Craven, Cy Brown, Frank McCormack, Wayne Marshall, and Lew Counts; to Part III, *Accessories*, Walter Borlase, C. Peter Zicko, Dr. Berry Phillips and Al Sanchez; to Part IV, *Guide for the Troubled*, Marty Gross, Dwight Wahr, Jim Maxwell, and other members of our Sales Engineering staff.

In addition, this volume could not have been possible without the dedicated work of our Publications group, under Mrs. Marie Etchells; the cooperation of members of our top management team; the stimulation and understanding of Lawrence T. Sullivan, our Vice President, Marketing; and, finally, the original impetus and continuing encouragement (as well as budget authorization) provided by our President, Ray Stata.

Last – but surely not least – we thank our customers, past, present, and (yes) future, for their many stimulating questions, which revealed the need for such a book, and for the invaluable opportunity to gain mutual application experience, through an open and continuing dialogue. Since it might be inappropriate to mention that their custom, in the final analysis, has paid for this volume, we shall refrain from doing so.

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INTRODUCTION: How to Use This Book

The users of this book, whether students or experienced design engineers, have a wide variety of backgrounds, interests, and needs. Although it is not expected to totally satisfy any reader, all who seek enlightenment, ideas, or guidance on matters having to do with modular and I.C. conversion devices should find something of value.

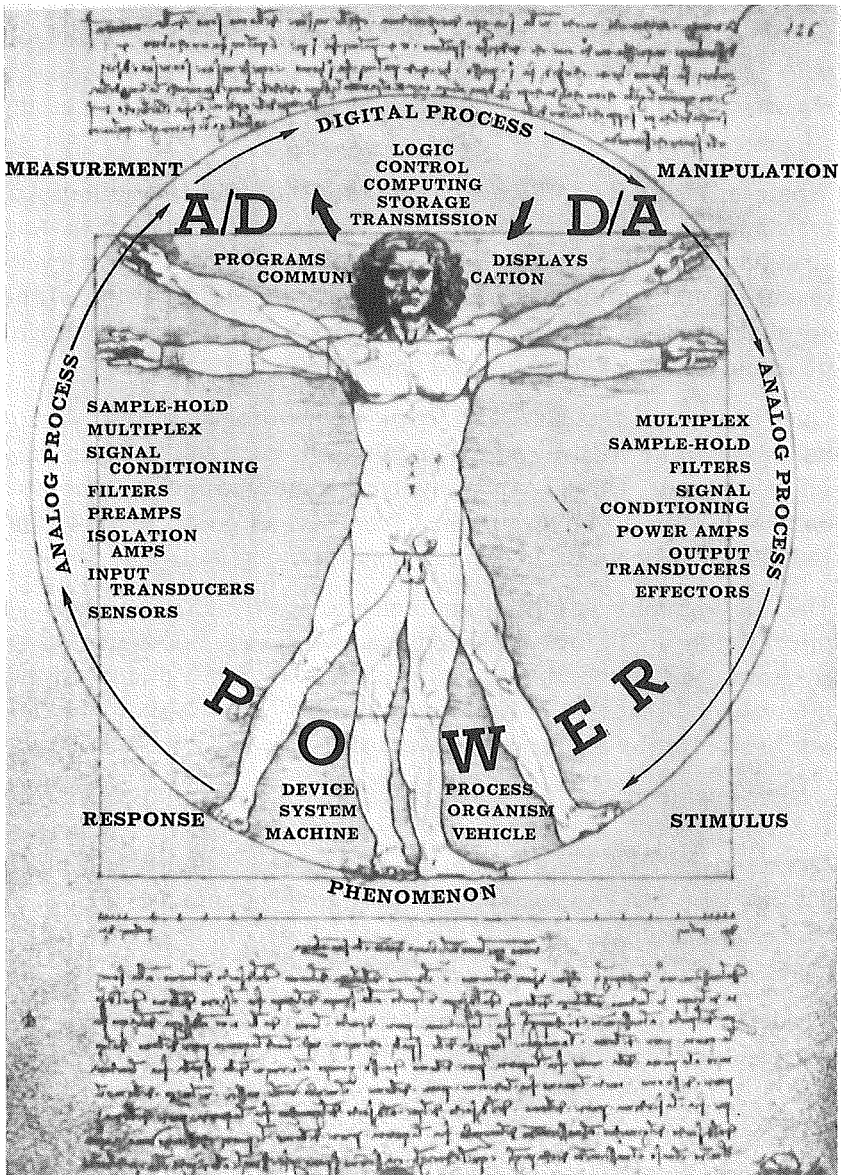
Whatever his interest, the reader will find this brief Introduction of assistance in making the best use of the book. Its self-explanatory structure is laid bare in the "Contents in Detail," which every reader should explore thoroughly before proceeding further. If he approaches with specific questions, the key to the answers might be found via "Frequently Asked Questions," in Part IV.

One can read through this book sequentially, but it is not necessary to do so; browsing is encouraged. Each unit is essentially self-contained. Though this involves some redundancy, it also enables a topic to be approached from several points of view. The Index should be useful in exploring any topic in depth.

The Bibliography is a brief and eclectic assortment of sources of information on various topics covered within the book. Each item is chosen, either because of its specific practical value or timely interest, or because it in turn has a reference section that will "fan out" and give the reader large coverage from a small base.

Design engineers should use this Handbook in conjunction with the most-recent edition of the comprehensive *Analog Devices Product Guide*. In addition to its up-to-date contents and much data (with prices) on specific products, it also contains a wealth of technical information, not all of which is duplicated in these pages.

Readers are invited to communicate to us their comments and suggestions for future editions of this Handbook, as to content, *errata*, omissions believed significant, and new applications ideas.



(D. H. Sheingold, with apologies to Leonardo da Vinci: Rule of Proportions, Academy of Fine Arts, Venice)

Figure 1. Functions in a Data System