



**INCLUDES**

**FREE  
NEWNES ONLINE  
MEMBERSHIP**

# CIRCUIT DESIGN

*know it all*

- **A 360 degree view from our best-selling authors**
- **Key facts, techniques, and applications fully detailed**
- **The ultimate hard-working desk reference; all the essential information, techniques, and tricks of the trade in one volume**

Ashby • Baker • Ball • Crowe • Hayes-Gill • Hickman • Kester  
Mancini • Grout • Pease • Tooley • Williams • Wilson • Zeidman

# *Circuit Design*

***The Newnes Know It All Series***

***PIC Microcontrollers: Know It All***

Lucio Di Jasio, Tim Wilmshurst, Dogan Ibrahim, John Morton, Martin Bates, Jack Smith, D.W. Smith, and Chuck Hellebuyck

ISBN: 978-0-7506-8615-0

***Embedded Software: Know It All***

Jean Labrosse, Jack Ganssle, Tammy Noergaard, Robert Oshana, Colin Walls, Keith Curtis, Jason Andrews, David J. Katz, Rick Gentile, Kamal Hyder, and Bob Perrin

ISBN: 978-0-7506-8583-2

***Embedded Hardware: Know It All***

Jack Ganssle, Tammy Noergaard, Fred Eady, Lewin Edwards, David J. Katz, Rick Gentile, Ken Arnold, Kamal Hyder, and Bob Perrin

ISBN: 978-0-7506-8584-9

***Wireless Networking: Know It All***

Praphul Chandra, Daniel M. Dobkin, Alan Bensky, Ron Olexa, David Lide, and Farid Dowla

ISBN: 978-0-7506-8582-5

***RF & Wireless Technologies: Know It All***

Bruce Fette, Roberto Aiello, Praphul Chandra, Daniel Dobkin, Alan Bensky, Douglas Miron, David Lide, Farid Dowla, and Ron Olexa

ISBN: 978-0-7506-8581-8

***Electrical Engineering: Know It All***

Clive Maxfield, Alan Bensky, John Bird, W. Bolton, Izzat Darwazeh, Walt Kester, M. A. Laughton, Andrew Leven, Luis Moura, Ron Schmitt, Keith Sueker, Mike Tooley, DF Warne, Tim Williams

ISBN: 978-1-85617-528-9

***Audio Engineering: Know It All***

Douglas Self, Richard Brice, Don Davis, Ben Duncan, John Linsley Hood, Morgan Jones, Eugene Patronis, Ian Sinclair, Andrew Singmin, John Watkinson

ISBN: 978-1-85617-526-5

***Circuit Design: Know It All***

Darren Ashby, Bonnie Baker, Stuart Ball, John Crowe, Barrie Hayes-Gill, Ian Grout, Ian Hickman, Walt Kester, Ron Mancini, Robert A. Pease, Mike Tooley, Tim Williams, Peter Wilson, Bob Zeidman

ISBN: 978-1-85617-527-2

***Test and Measurement: Know It All***

Jon Wilson, Stuart Ball, GMS de Silva, Tony Fischer-Cripps, Dogan Ibrahim, Kevin James, Walt Kester, M. A. Laughton, Chris Nadovich, Alex Porter, Edward Ramsden, Stephen Scheiber, Mike Tooley, D. F. Warne, Tim Williams

ISBN: 978-1-85617-530-2

***Mobile Wireless Security: Know It All***

Praphul Chandra, Alan Bensky, Tony Bradley, Chris Hurley, Steve Rackley, John Rittinghouse, James Ransome, Timothy Stapko, George Stefanek, Frank Thornton, Chris Lanthem, Jon Wilson

ISBN: 978-1-85617-529-6

For more information on these and other Newnes titles visit: [www.newnespress.com](http://www.newnespress.com)

# *Circuit Design*

Darren Ashby  
Bonnie Baker  
Stuart Ball  
J. Crowe  
Barrie Hayes-Gill  
Ian Hickman  
Walt Kester  
Ron Mancini  
Ian Grout  
Robert A. Pease  
Mike Tooley  
Tim Williams  
Peter Wilson  
Bob Zeidman



**ELSEVIER**

AMSTERDAM • BOSTON • HEIDELBERG • LONDON  
NEW YORK • OXFORD • PARIS • SAN DIEGO  
SAN FRANCISCO • SINGAPORE • SYDNEY • TOKYO

Newnes is an imprint of Elsevier



**Newnes**

Newnes is an imprint of Elsevier  
30 Corporate Drive, Suite 400, Burlington, MA 01803, USA  
Linacre House, Jordan Hill, Oxford OX2 8DP, UK

Copyright © 2008, Elsevier Inc. All rights reserved.

No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior written permission of the publisher.

Permissions may be sought directly from Elsevier's Science & Technology Rights Department in Oxford, UK: phone: (+44) 1865 843830, fax: (+44) 1865 853333, E-mail: [permissions@elsevier.com](mailto:permissions@elsevier.com). You may also complete your request online via the Elsevier homepage (<http://elsevier.com>), by selecting "Support & Contact" then "Copyright and Permission" and then "Obtaining Permissions."

#### **Library of Congress Cataloging-in-Publication Data**

Application submitted

#### **British Library Cataloguing-in-Publication Data**

A catalogue record for this book is available from the British Library.

ISBN: 978-1-85617-527-2

For information on all Newnes publications  
visit our Web site at [www.elsevierdirect.com](http://www.elsevierdirect.com)

Printed in the United States of America

08 09 10 10 9 8 7 6 5 4 3 2 1

<p>Working together to grow libraries in developing countries</p>		
<p><a href="http://www.elsevier.com">www.elsevier.com</a>   <a href="http://www.bookaid.org">www.bookaid.org</a>   <a href="http://www.sabre.org">www.sabre.org</a></p>		
<p>ELSEVIER</p>	<p>BOOK AID International</p>	<p>Sabre Foundation</p>

# Contents

<i>About the Authors</i> .....	xv
<b>Chapter 1: The Fundamentals</b> .....	<b>1</b>
1.1 Electrical Fundamentals.....	1
1.2 Passive Components.....	36
1.3 DC Circuits.....	87
1.4 Alternating Voltage and Current.....	124
1.5 Circuit Simulation.....	151
1.6 Intuitive Circuit Design.....	166
1.7 Troubleshooting Basic.....	177
References.....	208
<b>Chapter 2: The Semiconductor Diode</b> .....	<b>211</b>
References.....	215
<b>Chapter 3: Understanding Diodes and Their Problems</b> .....	<b>217</b>
3.1 Speed Demons.....	219
3.2 Turn 'em off—turn 'em on. . .	220
3.3 Other Strange Things that Diodes Can Do to You. . .	222
3.4 Zener, Zener, Zener.....	225
3.5 Diodes that Glow in the Dark, Efficiently.....	228
3.6 Optoisolators.....	228
3.7 Assault and Battery.....	231
References.....	232
<b>Chapter 4: Bipolar Transistors</b> .....	<b>235</b>
References.....	247
<b>Chapter 5: Field-Effect Transistors</b> .....	<b>249</b>
References.....	254
<b>Chapter 6: Identifying and Avoiding Transistor Problems</b> .....	<b>255</b>
6.1 More Beta—More Better?.....	257
6.2 Field-Effect Transistors.....	258

6.3	Power Transistors may Hog Current .....	261
6.4	Apply the 5-Second Rule .....	264
6.5	Fabrication Structures make a Difference.....	264
6.6	Power-Circuit Design Requires Expertise.....	267
6.7	MOSFETs Avoid Secondary Breakdown .....	269
	References .....	270
<b>Chapter 7: Digital Circuit Fundamentals .....</b>		<b>271</b>
7.1	Digital Technology.....	273
	References .....	278
<b>Chapter 8: Number Systems .....</b>		<b>279</b>
8.1	Introduction.....	279
8.2	Decimal–Unsigned Binary Conversion.....	280
8.3	Signed Binary Numbers.....	284
8.4	Gray Code .....	289
8.5	Binary Coded Decimal .....	290
8.6	Octal-Binary Conversion .....	291
8.7	Hexadecimal-Binary Conversion.....	294
<b>Chapter 9: Binary Data Manipulation .....</b>		<b>301</b>
9.1	Introduction.....	301
9.2	Logical Operations .....	302
9.3	Boolean Algebra .....	303
9.4	Combinational Logic Gates .....	306
9.5	Truth Tables.....	308
	References .....	317
<b>Chapter 10: Combinational Logic Design.....</b>		<b>319</b>
10.1	Introduction.....	319
10.2	NAND and NOR Logic .....	332
10.3	Karnaugh Maps .....	334
10.4	Don't Care Conditions.....	341
	References .....	341
<b>Chapter 11: Sequential Logic Design .....</b>		<b>343</b>
11.1	Introduction.....	343
11.2	Level Sensitive Latches and Edge-triggered Flip-flops .....	348
11.3	The D Latch and D-type Flip-Flop .....	348
11.4	Counter Design .....	354
11.5	State Machine Design.....	366
11.6	Moore Versus Mealy State Machines.....	377

11.7	Shift Registers.....	377
11.8	Digital Scan Path .....	379
	References .....	382
<b>Chapter 12: Memory.....</b>		<b>383</b>
12.1	Introduction.....	383
12.2	Random Access Memory .....	385
12.3	Read-only Memory.....	386
<b>Chapter 13: Selecting a Design Route.....</b>		<b>389</b>
13.1	Introduction.....	389
13.2	Discrete Implementation .....	391
13.3	Mask Programmable ASICs.....	400
13.4	Field-Programmable Logic.....	414
13.5	VHDL.....	434
13.6	Choosing a Design Route .....	436
<b>Chapter 14: Designing with Logic ICs.....</b>		<b>441</b>
14.1	Logic ICs .....	441
<b>Chapter 15: Interfacing.....</b>		<b>455</b>
15.1	Mixing Analog and Digital .....	455
15.2	Generating Digital Levels from Analog Inputs .....	458
15.3	Protection Against Externally Applied Overvoltages .....	461
15.4	Isolation .....	462
15.5	Classic Data Interface Standards .....	465
15.6	High-Performance Data Interface Standards .....	471
<b>Chapter 16: DSP and Digital Filters .....</b>		<b>477</b>
16.1	Origins of Real-World Signals and Their Units of Measurement .....	477
16.2	Reasons for Processing Real-World Signals .....	478
16.3	Generation of Real-World Signals.....	480
16.4	Methods and Technologies Available for Processing Real-World Signals .....	480
16.5	Analog Versus Digital Signal Processing .....	481
16.6	A Practical Example.....	482
16.7	Finite Impulse Response (FIR) Filters.....	489
16.8	FIR Filter Implementation In DSP Hardware Using Circular Buffering ...	494
16.9	Designing FIR Filters .....	497
16.10	Infinite Impulse Response (IIR) Filters .....	508
16.11	IIR Filter Design Techniques .....	511
16.12	Multirate Filters.....	514
16.13	Adaptive Filters.....	519
	References .....	523



---

<b>Chapter 17: Dealing with High-Speed Logic.....</b>	<b>525</b>
References on Dealing with High-Speed Logic .....	532
<b>Chapter 18: Bridging the Gap between Analog and Digital.....</b>	<b>533</b>
18.1 Try to Measure Temperature Digitally .....	536
18.2 Road Blocks Ahead.....	540
18.3 The Ultimate Key to Analog Success.....	548
18.4 How Analog and Digital Design Differ.....	549
18.5 Time and Its Inversion.....	556
18.6 Organizing Your Toolbox.....	556
18.7 Set Your Foundation and Move On, Out of The Box .....	557
References .....	558
<b>Chapter 19: Op-Amps.....</b>	<b>559</b>
19.1 The Magical Mysterious Op-Amp.....	559
19.2 Understanding Op-Amp Parameters .....	572
19.3 Modeling Op-Amps .....	599
19.4 Finding the Perfect Op-Amp.....	600
References .....	618
<b>Chapter 20: Analog-to-Digital Converters.....</b>	<b>619</b>
20.1 ADCs .....	621
20.2 Types of ADCs .....	624
20.3 ADC Comparison .....	633
20.4 Sample and Hold.....	634
20.5 Real Parts.....	636
20.6 Microprocessor Interfacing .....	637
20.7 Clocked Interfaces .....	643
20.8 Serial Interfaces.....	644
20.9 Multichannel ADCs .....	650
20.10 Internal Microcontroller ADCs.....	650
20.11 Codecs .....	652
20.12 Interrupt Rates.....	652
20.13 Dual-Function Pins On Microcontrollers .....	653
20.14 Design Checklist .....	655
<b>Chapter 21: Sensors.....</b>	<b>657</b>
21.1 Instrumentation and Control Systems .....	657
21.2 Transducers .....	659
21.3 Sensors.....	660
21.4 Switches.....	667
21.5 Semiconductor Temperature Sensors.....	672

21.6	Thermocouples .....	672
21.7	Threshold Detection.....	674
21.8	Outputs .....	676
21.9	LED Indicators.....	676
21.10	Driving High-Current Loads .....	678
21.11	Audible Outputs .....	678
21.12	Motors.....	681
21.13	Driving Mains Connected Loads .....	682
<b>Chapter 22: Active Filters .....</b>		<b>685</b>
22.1	Introduction.....	685
22.2	Fundamentals of Low-Pass Filters.....	686
22.3	Low-Pass Filter Design.....	697
22.4	High-Pass Filter Design .....	707
22.5	Band-Pass Filter Design.....	714
22.6	Band-Rejection Filter Design .....	724
22.7	All-Pass Filter Design.....	729
22.8	Practical Design Hints .....	734
22.9	Filter Coefficient Tables .....	744
References .....		752
<b>Chapter 23: Radio-Frequency (RF) Circuits .....</b>		<b>753</b>
23.1	Modulation of Radio Waves .....	753
23.2	Low-Power RF Amplifiers.....	759
23.3	Stability.....	762
23.4	Linearity.....	767
23.5	Noise and Dynamic Range .....	771
23.6	Impedances and Gain .....	773
23.7	Mixers.....	778
23.8	Demodulators .....	783
23.9	Oscillators .....	787
References .....		795
<b>Chapter 24: Signal Sources.....</b>		<b>797</b>
24.1	Voltage References.....	797
24.2	Nonsinusoidal Waveform Generators .....	800
24.3	Sine Wave Generators .....	808
24.4	Voltage-Controlled Oscillators And Phase Detectors .....	817
References .....		828
<b>Chapter 25: EDA Design Tools for Analog and RF .....</b>		<b>829</b>
25.1	The Old Pencil and Paper Design Process.....	835
25.2	Is Your Simulation Fundamentally Valid?.....	838

25.3	Macromodels: What Can They Do? .....	843
25.4	VHDL-AMS .....	849
	References .....	867
<b>Chapter 26: Useful Circuits .....</b>		<b>869</b>
26.1	Introduction .....	869
26.2	Boundary Conditions .....	873
26.3	Amplifiers .....	873
26.4	Computing Circuits .....	891
26.5	Oscillators .....	902
26.6	Some Favorite Circuits .....	910
	References .....	915
<b>Chapter 27: Programmable Logic to ASICs.....</b>		<b>917</b>
27.1	Programmable Read-Only Memory (PROM).....	918
27.2	Programmable Logic Arrays (PLAs) .....	922
27.3	Programmable Array Logic (PALs) .....	923
27.4	The Masked Gate Array ASIC.....	929
27.5	CPLDs and FPGAs.....	931
27.6	Summary.....	932
	References .....	932
<b>Chapter 28: Complex Programmable Logic Devices (CPLDs) .....</b>		<b>933</b>
28.1	CPLD Architectures .....	933
28.2	Function Blocks .....	934
28.3	I/O Blocks.....	936
28.4	Clock Drivers.....	937
28.5	Interconnect .....	938
28.6	CPLD Technology and Programmable Elements .....	940
28.7	Embedded Devices .....	940
28.8	Summary: CPLD Selection Criteria .....	944
	References .....	946
<b>Chapter 29: Field Programmable Gate Arrays (FPGAs) .....</b>		<b>947</b>
29.1	FPGA Architectures .....	947
29.2	Configurable Logic Blocks .....	948
29.3	Configurable I/O Blocks.....	951
29.4	Embedded Devices .....	954
29.5	Programmable Interconnect .....	955
29.6	Clock Circuitry.....	957
29.7	SRAM vs. Antifuse Programming.....	957
29.8	Emulating and Prototyping ASICs .....	961

29.9 Summary.....	964
References .....	965
<b>Chapter 30: Design Automation and Testing for FPGAs .....</b>	<b>967</b>
30.1 Simulation.....	967
30.2 Libraries.....	971
30.3 Synthesis.....	974
30.4 Physical Design Flow .....	977
30.5 Place and Route .....	977
30.6 Timing Analysis.....	978
30.7 Design Pitfalls.....	978
30.8 VHDL Issues for FPGA Design.....	979
30.9 Summary.....	979
References .....	980
<b>Chapter 31: Integrating Processors onto FPGAs.....</b>	<b>981</b>
31.1 Introduction.....	981
31.2 A Simple Embedded Processor .....	982
31.3 Soft Core Processors on an FPGA .....	1004
31.4 Summary.....	1004
<b>Chapter 32: Implementing Digital Filters in VHDL .....</b>	<b>1005</b>
32.1 Introduction.....	1005
32.2 Converting S-Domain to Z-Domain .....	1006
32.3 Implementing Z-Domain Functions in VHDL .....	1008
32.4 Basic Low-Pass Filter Model.....	1013
32.5 FIR Filters.....	1017
32.6 IIR Filters.....	1018
32.7 Summary.....	1018
<b>Chapter 33: Microprocessor and Microcontroller Overview .....</b>	<b>1019</b>
33.1 Microprocessor Systems .....	1019
33.2 Single-Chip Microcomputers.....	1020
33.3 Microcontrollers .....	1020
33.4 Microprocessor Systems .....	1020
33.5 Data Types.....	1024
33.6 Data Storage.....	1024
33.7 The Microprocessor .....	1025
33.8 Microprocessor Operation.....	1032
33.9 A Microcontroller System.....	1038
<b>Chapter 34: Microcontroller Toolbox .....</b>	<b>1043</b>
34.1 Microcontroller Supply and Reference .....	1043

34.2	Resistor Networks .....	1045
34.3	Multiple Input Control.....	1046
34.4	AC Control.....	1049
34.5	Voltage Monitors and Supervisory Circuits .....	1050
34.6	Driving Bipolar Transistors.....	1051
34.7	Driving MOSFETs .....	1054
34.8	Reading Negative Voltages.....	1057
34.9	Example Control System .....	1059
<b>Chapter 35: Power Supply Overview and Specifications .....</b>		<b>1071</b>
35.1	Power Supplies.....	1071
35.2	Specifications .....	1078
35.3	Off-the-Shelf or Roll Your Own .....	1078
<b>Chapter 36: Input and Output Parameters .....</b>		<b>1081</b>
36.1	Voltage .....	1081
36.2	Current.....	1082
36.3	Fuses.....	1082
36.4	Switch-On Surge, or Inrush Current.....	1084
36.5	Waveform Distortion and Interference .....	1087
36.6	Frequency.....	1090
36.7	Efficiency.....	1090
36.8	Deriving the Input Voltage from the Output.....	1092
36.9	Low-Load Condition.....	1094
36.10	Rectifier and Capacitor Selection.....	1095
36.11	Load and Line Regulation .....	1097
36.12	Ripple and Noise.....	1099
36.13	Transient Response.....	1101
<b>Chapter 37: Batteries.....</b>		<b>1103</b>
37.1	Initial Considerations.....	1103
37.2	Primary Cells .....	1108
37.3	Secondary Cells.....	1110
37.4	Charging .....	1114
<b>Chapter 38: Layout and Grounding for Analog and Digital Circuits.....</b>		<b>1117</b>
38.1	The Similarities of Analog and Digital Layout Practices .....	1117
38.2	Where the Domains Differ—Ground Planes Can Be a Problem.....	1121
38.3	Where the Board and Component Parasitics Can Do the Most Damage.....	1123
38.4	Layout Techniques that Improve ADC Accuracy and Resolution.....	1131
38.5	The Art of Laying Out Two-Layer Boards.....	1135
38.6	Current Return Paths With or Without a Ground Plane .....	1140
38.7	Layout Tricks for a 12-Bit Sensing System.....	1142
38.8	General Layout Guidelines—Device Placement.....	1144

38.9	General Layout Guidelines—Ground and Power Supply Strategy .....	1144
38.10	Signal Traces.....	1147
38.11	Did I Say Bypass and Use an Anti-Aliasing Filter?.....	1148
38.12	Bypass Capacitors .....	1148
38.13	Anti-Aliasing Filters .....	1149
38.14	PCB Design Checklist .....	1150
	References .....	1151
 <b>Chapter 39: Safety .....</b>		 <b>1153</b>
39.1	The Hazards of Electricity .....	1154
39.2	Safety Classes .....	1155
39.3	Insulation Types .....	1156
39.4	Design Considerations for Safety Protection.....	1156
39.5	Fire Hazard .....	1158
 <b>Chapter 40: Design for Production.....</b>		 <b>1161</b>
40.1	Checklist .....	1162
40.2	The Dangers of ESD .....	1164
 <b>Chapter 41: Testability.....</b>		 <b>1167</b>
41.1	In-Circuit Testing .....	1167
41.2	Functional Testing .....	1168
41.3	Boundary Scan and JTAG .....	1170
41.4	Design Techniques .....	1174
 <b>Chapter 42: Reliability .....</b>		 <b>1177</b>
42.1	Definitions.....	1177
42.2	The Cost of Reliability .....	1179
42.3	Design for Reliability .....	1180
42.4	The Value of MTBF Figures .....	1184
42.5	Design Faults .....	1186
 <b>Chapter 43: Thermal Management.....</b>		 <b>1187</b>
43.1	Using Thermal Resistance .....	1187
43.2	Heatsinks.....	1193
43.3	Power Semiconductor Mounting .....	1197
43.4	Placement and Layout .....	1201
 <b>Appendix A Standards.....</b>		 <b>1203</b>
A.1	British Standards .....	1203
A.2	IEC Standards .....	1206
 <b>Index.....</b>		 <b>1207</b>

This page intentionally left blank

## *About the Authors*

**Darren Ashby** (Chapters 1, 19, 26, and 35) author of *Electrical Engineering 101*, is a self-described “techno geek with pointy hair.” He considers himself a Jack of all trades, master of none. He figures his common sense came from his dad and his book sense from his mother. Raised on a farm and graduating from Utah State University seemingly ages ago, he has nearly 20 years of experience in the real world as a technician, engineer and a manager. He has worked in diverse areas of compliance, production, testing and his personal favorite, R&D.

He jumped at a chance some years back to teach a couple of semesters at his alma mater. For about two years, he wrote regularly for the online magazine “chipcenter.com.” He is currently the Director of electronics R&D at a billion dollar consumer product company. His passions are boats, snowmobiles, motorcycles and pretty much anything with a motor in it. When not at his day job, he spends most his time with his family and a promising R&D consulting/manufacturing firm he started a couple of years ago.

He lives with his beautiful wife, four strapping boys and cute little daughter next to the mountains in Richmond, Utah.

**Bonnie Baker** (Chapters 18, 19, 25 and 38) author of *A Baker's Dozen*, also writes the monthly “Baker's Best” for *EDN* magazine. She has been involved with analog and digital designs and systems for over 20 years. Bonnie started as a manufacturing product engineer supporting analog products at Burr-Brown. From there, Bonnie moved up to IC design, analog division strategic marketer, and then corporate applications engineering manager. In 1998, she joined Microchip Technology and served as their analog division analog/mixed-signal applications engineering manager and staff architect engineer for one of their PICmicro divisions. This expanded her background to



not only include analog applications, but microcontroller solutions as well. At present, she has returned to the Precision Analog fold at Texas Instruments in Tucson, Arizona.

Bonnie holds a Masters of Science in Electrical Engineering from the University of Arizona (Tucson, AZ) and a bachelor's degree in music education from Northern Arizona University (Flagstaff, AZ). In addition to her fascination with analog design, Bonnie has a drive to share her knowledge and experience and has written almost 300 articles, design notes, and application notes and she is a frequent presenter at technical conferences and shows.

**Stuart Ball, P.E.**, (Chapters 20, 34) author of *Analog Interfacing to Embedded Microprocessors*, is an electrical engineer with over 20 years of experience in electronic and embedded systems. He is currently employed with Seagate Technologies, a manufacturer of computer hard disc drives.

**Bruce Carter** (Chapter 19) a contributor to *Electrical Engineering 101*, is currently an Engineer for the Test and Measurement group of Texas Instruments. Carter earned a BS in Engineering Physics from Texas Tech University, and a BS in Electrical Engineering from the University of Texas. He authored several technical articles, including four chapters in *Op-Amps for Everyone*. New edition publishing soon.

**John Crowe** (Chapter 13) co-author of *Introduction to Digital Electronics*, is Reader in Biomedical Informatics in the School of Electrical & Electronic Engineering, University of Nottingham, UK. His contribution to this book is based upon material used in a Digital Electronics module delivered to 1st and 2nd year undergraduate students.

His research concerns the development of novel biomedical instrumentation such as fetal heart rate monitors and integrated optical and electronics ASICs for imaging skin blood flow.

**Ian Grout** (Chapters 7, 8, 9, 10, 11, and 12) the author of *Digital Systems Design* received his B.Eng in Electronic Engineering (1991) and PhD (1994) from Lancaster University (UK). He has worked in both industry and the academic field in microelectronic circuit and electronics design and test. He currently works in the areas of mixed-signal integrated circuit (IC) design for testability (DfT) and digital electronic circuit design using programmable logic. The author is currently a lecturer within the Department of Electronic and Computer Engineering at the University of Limerick (Ireland). He currently teaches programmable logic and integrated circuit design and

test principles within the university and has worked in Limerick since 1998. Prior to this he was a lecturer in the Engineering Department at Lancaster University (UK).

**Barrie Hayes-Gill** (Chapter 13) co-author of *Introduction to Digital Electronics*, is Associate Professor in Integrated Circuit Design and Electronic Instrumentation in the School of Electrical & Electronic Engineering, University of Nottingham, UK. He has lectured in integrated circuit design both within the University of Nottingham and at international locations around the World.

His research and industrial work concerns the development of compact and low noise instrumentation for medical devices and instrumentation where he deploys off-the-shelf electronic components and semi-custom and full custom integrated circuits for integrated optical sensors. He has published widely with over 150 publications and 10 patents on medical devices and VLSI systems. In addition to his University post he is also an Executive Director at Monica Healthcare Ltd.

**Ian Hickman, Eur. Ing. D. I. H. May B.Sc.Hons, C.Eng., MIEE, MIEEE** (Chapters 2, 4, 5, 23, 24) is the author of *Analog Electronics*. He has been interested in electronics since the late 1940s, and professionally involved in it since 1954. Starting with a crystal set, his interests over the years have covered every aspect of electronics, though mainly concentrating on analog. Now retired, Ian was a consultant to Electronics World for many years. He is a Member of the Institution of Engineering and Technology; and a Life Member of the Institute of Electrical & Electronics Engineers. He has also written several books including *Practical RF Handbook*, Hickman's *Analog and RF Circuits*, and *Analog Circuits Cookbook*, to name just a few.

**Walt Kester** (Chapters 16, 17) is the author of *Mixed Signal and DSP Design Techniques*. He is a corporate staff applications engineer at Analog Devices. For over 35 years at Analog Devices, he has designed, developed, and given applications support for high-speed ADCs, DACs, SHAs, op-amps, and analog multiplexers. Besides writing many papers and articles, he prepared and edited eleven major applications books, which form the basis for the Analog Devices world-wide technical seminar series including the topics of op-amps, data conversion, power management, sensor signal conditioning, mixed-signal, and practical analog design techniques. He also is the editor of *The Data Conversion Handbook*, a 900+ page comprehensive book on data conversion published in 2005 by Elsevier. Walt has a BSEE from NC State University and MSEE from Duke University.

**Thomas Kugelstadt** (Chapter 22) was a contributor to *Op Amps for Everyone*. He is a senior application engineer at Texas Instruments. He is writing many technical articles on various subjects, often system related.

He also provides freelance writing services if your company were ever interested in a technical subject but experienced difficulties finding a writer.

**Ron Mancini** (Chapter 26) the editor of *Op Amps for Everyone* has spent nearly fifty years in electronics. Recently retired, he was a Staff Scientist at Texas Instruments for many years. He was also a regular columnist for *EDN*.

**Richard Palmer** (Chapter 26) was a contributor to *Op Amps for Everyone*.

**Robert A. Pease** (Chapters 1, 3, 6) author of *Troubleshooting Analog Circuits*, attended Mt. Hermon School, and graduated from MIT in 1961 with a BSEE. He worked at Philbrick Researches up to 1975 and designed many Op-Amps and Analog Computing Modules.

Pease joined National Semiconductor in 1976. He has designed about 24 analog ICs including power regulators, voltage references, and temp sensors. He has written 65+ magazine articles and holds about 21 US patents. Pease is the self-declared Czar of Bandgaps since 1986. He enjoys hiking and trekking in Nepal, and ferroequinology. His position at NSC is Staff Scientist. He is a Senior Member of the IEEE.

Pease is a columnist in *Electronic Design* magazine, with over 240 columns published. The column, PEASE PORRIDGE, covers a wide range of technical topics. Pease also has posted many technical and semi-technical items on his main website: <http://www.national.com/rap> Many of Pease's recent columns are accessible there.

Pease was inducted into the E.E. Hall Of Fame in 2002. Refer to:  
<http://www.elecdesign.com/Articles/Index.cfm?ArticleID=17269&Extension=pdf>  
See Pease's other web site at <http://www.transtronix.com>

**Mike Tooley** (Chapters 1, 21, and 33) author of *Electronic Circuits*, is a technical author and consultant. He was formerly Vice Principal at Brooklands College in Surrey, England, where he was responsible for the delivery of learning to over 10,000 Further and Higher Education students increasingly by flexible, open and online distance learning. Mike is the well-known author of several popular engineering and related text books, including widely adopted course texts for BTEC, GCE A-level and GCSE

qualifications in Engineering. Mike's hobbies include astronomy, amateur radio, aviation, computing and electronic circuit design and construction.

**Tim Williams** (Chapters 14, 15, 19, 35, 36, 37, 39, 40,41, 42, 43, and Appendix A) is the author of *The Circuit Designer's Companion, 2<sup>nd</sup> Edition*. He works at Elmac Services, which provides consultancy and training on all aspects of EMC, including design, testing and the application of standards, to companies manufacturing electronic products and concerned about the implications of the EMC Directive.

Tim Williams gained a BSc in Electronic Engineering from Southampton University in 1976. He has worked in electronic product design in various industry sectors including process instrumentation and audio visual control. He was design group leader at Rosemount Ltd before leaving in 1990 to start Elmac Services.

He is also the author of "EMC for Product Designers" (now in its fourth edition, Elsevier 2006), and has presented numerous conference papers and seminars. He is also author of "EMC for Systems & Installations" with Keith Armstrong. He is an EMC technical assessor for UKAS and SWEDAC.

**Peter Wilson** (Chapters 25, 30, 31, 32) author of *Design Recipes for FPGAs*, is Senior Lecturer in Electronics at the University of Southampton. He holds degrees from Heriot-Watt University, an MBA from Edinburgh Business School and a PhD from the University of Southampton. He worked in the Avionics and Electronics Design Automation Industries for many years at Ferranti, GEC-Marconi and Analogy prior to rejoining academia . He has published widely in the areas of FPGA design, modeling and simulation, VHDL, VHDL-AMS, magnetics and power electronics. He is a Senior Member of the IEEE, member of the IET, and a Chartered Engineer.

**Bob Zeidman** (Chapters 27, 28, 29) author of *Designing with FPGAs and CPLDs*, is the president of Zeidman Consulting ([www.ZeidmanConsulting.com](http://www.ZeidmanConsulting.com)), a premiere contract research and development firm in Silicon Valley. He is also the president of Zeidman Technologies ([www.zeidman.biz](http://www.zeidman.biz)), a developer of tools for embedded systems hardware and software development, and president of Software Analysis and Forensic Engineering Corporation ([www.SAFE-corp.biz](http://www.SAFE-corp.biz)), the leading provider of software intellectual property analysis tools. Bob has designed ASICs, FPGAs, and PC boards for RISC-based parallel processor systems, laser printers, network switches and routers, and other systems for clients including Apple Computer, Cisco Systems, Mentor Graphics, and Ricoh. He is the inventor of SynthOSTM, a tool for synthesizing software