
SPICE Circuit Handbook

SPICE Circuit Handbook

Steven M. Sandler
Charles Hymowitz

McGraw-Hill

New York Chicago San Francisco Lisbon London Madrid
Mexico City Milan New Delhi San Juan Seoul
Singapore Sydney Toronto

The McGraw-Hill Companies

CIP Data is on file with the Library of Congress

Copyright © 2006 by The McGraw-Hill Companies, Inc. All rights reserved. Printed in the United States of America. Except as permitted under the United States Copyright Act of 1976, no part of this publication may be reproduced or distributed in any form or by any means, or stored in a data base or retrieval system, without the prior written permission of the publisher.

1 2 3 4 5 6 7 8 9 0 DOC/DOC 0 1 2 1 0 9 8 7 6

P/N 146858-7
PART OF
ISBN 0-07-146857-9

The sponsoring editor for this book was Stephen S. Chapman and the production supervisor was Richard C. Ruzycka. It was set in Century Schoolbook by TechBooks. The art director for the cover was Margaret Webster-Shapiro.

Printed and bound by RR Donnelley.



This book is printed on recycled, acid-free paper containing a minimum of 50% recycled, de-inked fiber.

McGraw-Hill books are available at special quantity discounts to use as premiums and sales promotions, or for use in corporate training programs. For more information, please write to the Director of Special Sales, McGraw-Hill Professional, Two Penn Plaza, New York, NY 10121-2298. Or contact your local bookstore.

Information contained in this work has been obtained by The McGraw-Hill Companies, Inc. ("McGraw-Hill") from sources believed to be reliable. However, neither McGraw-Hill nor its authors guarantee the accuracy or completeness of any information published herein, and neither McGraw-Hill nor its authors shall be responsible for any errors, omissions, or damages arising out of use of this information. This work is published with the understanding that McGraw-Hill and its authors are supplying information but are not attempting to render engineering or other professional services. If such services are required, the assistance of an appropriate professional should be sought.

This book is dedicated to my wife Susan and my daughters Shanna and Rachel. It is you who encourage me to be the best I can be.

Steven M. Sandler

This book is dedicated to my wife Teresa and my three wonderful blessings, Mitchell, Olivia, and Makenna. You make it all worthwhile.

Charles Hymowitz

Contents

Acknowledgments	xi
Chapter 1. Introduction	1
Chapter 2. Description of the PSpice, IsSpice, SIMetrix, and Micro-Cap Simulators	7
Basic Overview of SPICE	10
SPICE syntax and tutorial	10
DC analysis	11
Transient analysis	12
AC analysis	13
Simulation Types and Data Acquisition	14
Convergence Problems	14
Steps to avoid common mistakes	14
DC convergence solutions	15
Transient convergence solutions	16
AC convergence solutions	17
Chapter 3. Filter Circuits	19
Fourth-Order Butterworth Low Pass Filter	19
Fourth-Order Butterworth High Pass Filter	24
Fourth-Order Butterworth Band Pass Filter	25
Bessel–Thompson Delay Low Pass Filter	27
Bessel–Thompson Delay Low Pass Filter with Pulse Shaper	33
Inverted Bessel–Thompson Delay High Pass Filter	37
Chebyshev Band Pass Filter	39
Chebyshev Low Pass Filter	46
Chebyshev High Pass Filter	52
Electromagnetic Interference (EMI) Filter	52
Chapter 4. Power Conversion Circuits	61
LM117 Three-Terminal Linear Regulator	61
LM78S40 Simple Switcher DC-to-DC Converter	68

viii Contents

UA723 Hysteretic Buck Regulator	73
1524A Buck Regulator	82
Low Drop-Out Regulator	93
STR6600 Quasi-Resonant Discontinuous Flyback	106
Discontinuous Flyback Converter	112
Chapter 5. Electronic Load Circuits	119
Power Section of an Electronic Load	119
Positive DC to Negative DC Comparator Converter	129
Built-in Variable Electronic Load Adjustment	133
Electronic Load Using Power BJT Transistors	137
Chapter 6. Instrumentation Circuits	143
555 Timer	143
555 Missing-Pulse Detector	148
Class AB Amplifier	160
Window Detector	161
Voltage Clamp	176
Resistance to Voltage	176
Polarity Gain	186
Chapter 7. Logic Circuits	195
Binary Counter	195
Binary Decoder	199
Set-Reset Latch	205
Staircase Generator	208
Chapter 8. Resonator/Oscillator Circuits	215
555 Timer Oscillator	215
Fourth-Order Butterworth Low Pass Oscillator	216
Hex Inverter Oscillator	222
Fourth-Order Butterworth No-Offset Low Pass Oscillator	228
Harmonic Neutralized Sine-Wave Oscillator	236
Colpitts Oscillator	244
Schmitt Trigger Oscillator	250
LM111 Oscillator	256
Chapter 9. Gate Drive Circuits	261
UC1846 50% Duty Cycle Gate Drive Circuit	262
555 Pulse-Shaped MOSFET Driver	266
Zero-to-100% Duty Cycle Driver	269
Chapter 10. Voltage Multiplier Circuits	277
AC-to-DC Voltage Doubler	277
Cascade Doubler	281

Contents ix

Bridge AC-to-DC Doubler	285
AC-to-DC Quadrupler	287
AC-to-DC Octupler ($\times 8$)	292
High Voltage, High Current DC-to-DC Doubler	297

Index	305
--------------	------------

Acknowledgments

We would like to thank AEi Systems personnel, including Mark Kwamusi, Greg Boger, and Danny Chow, for performing all of the simulations for this book in an effort to obtain the best relative run times possible, capturing and running most if not all simulations on the same computer.

Thanks to Steve Chapman, the publisher at McGraw-Hill, for continuing to provide us these opportunities to write.

Thanks to John Wagner and his guys at Catena Software Ltd. for creating SIMetrix, Andy Thompson and the guys at Spectrum Software for creating Micro-Cap, Larry Meares and Intusoft for creating IsSpice, and OrCAD for creating PSpice.

Thanks to Priyanka Negi and the staff at TechBooks for the outstanding effort they put into creating this book.

Thanks to Ron Rohrer, Larry Nagel, and all the students at the University of California, Berkeley, who worked hard in 1969 and 1970 to develop the first computer simulation software, Cancer (Computer Analysis of Non-Linear Circuits Excluding Radiation). This effort would result in the release of SPICE into the public domain in 1971.

Steven M. Sandler
Charles Hymowitz

SPICE Circuit Handbook

