CAMBRIDGE

Cambridge University Press
978-0-521-33604-8 - Analog Electronics with Op Amps: A Source Book of Practical Circuits
A. J. Peyton and V. Walsh
Frontmatter
More information

This book presents a collection of analog electronic circuits based on the op amp, supported by a wealth of practical and technical detail which will enable the reader speedily to select, build and test a desired circuit.

The book is primarily intended to be a practical reference volume rather than a teaching text. Both students and professional engineers will discover in its pages an extensive and invaluable source of functional and established analog circuits, from integrators and differentiators to logarithmic amplifiers; from instrumentation amplifiers to filters. The circuits are conveniently grouped according to function, and the approach followed is to build up slowly from the basic textbook examples towards a series of practical, workable circuits.

Students who need to build and test particular types of analog circuitry as part of an assignment or project based activities will find this book invaluable. Professional engineers will also find the book useful for design and development work. The coverage is extensive and up-to-date, and provides a wealth of expert, technical advice on the selected circuits.

© Cambridge University Press www.cambridge.org

CAMBRIDGE

Cambridge University Press
978-0-521-33604-8 - Analog Electronics with Op Amps: A Source Book of Practical Circuits
A. J. Peyton and V. Walsh
Frontmatter
More information

Analog Electronics with Op Amps

© Cambridge University Press www.cambridge.org

CAMBRIDGE

Cambridge University Press
978-0-521-33604-8 - Analog Electronics with Op Amps: A Source Book of Practical Circuits
A. J. Peyton and V. Walsh
Frontmatter
More information

Analog Electronics with Op Amps

A Source Book of Practical Circuits

A. J. PEYTON
University of Manchester
Institute of Science and Technology

V. WALSH
British Aerospace Ltd

CAMBRIDGE
UNIVERSITY PRESS

© Cambridge University Press www.cambridge.org

CAMBRIDGE

Cambridge University Press
978-0-521-33604-8 - Analog Electronics with Op Amps: A Source Book of Practical Circuits
A. J. Peyton and V. Walsh
Frontmatter
More information

Published by the Press Syndicate of the University of Cambridge
The Pitt Building, Trumpington Street, Cambridge CB2 1RP
40 West 20th Street, New York, NY 10011–4211, USA
10 Stamford Road, Oakleigh, Melbourne 3166, Australia

© Cambridge University Press 1993

First published 1993
Reprinted 1996

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

Library of Congress cataloguing in publication data

Peyton, A. J.
Analog electronics with Op Amps: a source book of practical circuits / A. J. Peyton, V. Walsh.
p. cm.
Includes bibliographical references and index.
ISBN 0 521 33305 9. ISBN 0 521 33604 X (pbk.)
1. Linear integrated circuits. 2. Operational amplifiers.
I. Walsh, V. II. Title.
TK874.P459 1993 621.3815—dc20 92-22691 CIP

ISBN 0 521 33305 9 hardback
ISBN 0 521 33604 X paperback

Transferred to digital printing 2001

© Cambridge University Press www.cambridge.org

CAMBRIDGE

Cambridge University Press
978-0-521-33604-8 - Analog Electronics with Op Amps: A Source Book of Practical Circuits
A. J. Peyton and V. Walsh
Frontmatter
More information

Contents

	Preface	xi
1	**Instrumentation amplifiers**	1
1.1	Single op amp instrumentation amplifiers	2
1.2	Two op amp instrumentation amplifiers	6
1.3	Three op amp instrumentation amplifiers	8
1.4	Matched transistor instrumentation amplifiers	12
1.5	Using instrumentation amplifiers with transducers	18
1.6	Commercial single ic instrumentation amplifiers	18
2	**Isolation amplifiers**	25
2.1	Isolation amplifier using modulation and demodulation	26
2.2	Isolation amplifier using linearizing feedback	27
2.3	Commercial isolation amplifiers	30
3	**Charge amplifiers**	31
3.1	Current integrating charge amplifier	31
3.2	High input impedance charge amplifier	34
4	**Current-to-voltage and voltage-to-current converters**	37
4.1	A simple current-to-voltage converter	37
4.2	A current-to-voltage converter using a single op amp	38
4.3	Voltage-to-current conversion using a single op amp	43
4.4	A unipolar transconductance amplifier	48
4.5	A differential input voltage-to-current converter	52
4.6	Operational transconductance amplifiers	55
5	**Controlled amplifiers**	59
5.1	Some approaches to voltage controlled amplification	59
5.2	Commercial voltage controlled amplifiers	61
5.3	Automatic gain control (AGC)	62
5.4	Digitally controlled amplifiers	63
6	**Active filter design**	71
6.1	Filter transfer functions	72
6.2	Filter circuits	80
	Low pass filter circuits	80
	High pass filter circuits	88
	Bandpass filter circuits	94
	Band reject filters	99
	All pass filter circuits	104

© Cambridge University Press www.cambridge.org

CAMBRIDGE

Cambridge University Press
978-0-521-33604-8 - Analog Electronics with Op Amps: A Source Book of Practical Circuits
A. J. Peyton and V. Walsh
Frontmatter
More information

State variable filters 106
Summary 110
6.3 Controlled filters 111
6.4 Practical aspects of filter circuit design 119
Sensitivity 119
Tuning 120
Component selection 123
Stability of filters 125
6.5 Designing high order filters 125
Determining the required transfer function 127
Transformation and scaling 136
From transfer function to circuitry 140

7 Integrators and differentiators 143
7.1 Integration 143
7.2 Differentiators 152

8 Log and antilog converters 161
8.1 Log converters 161
8.2 Antilog converters 177
8.3 Commercial log and antilog converters 183

9 Arithmetical operations 185
9.1 Addition and subtraction 185
9.2 Multipliers 189
Multiplier operation and errors 190
Converting a multiplier to a divider 193
Summary of popular multiplier circuits 194
FET controlled resistor multiplier 196
Variable transconductance multiplier 196
Log–antilog multiplier 200
A pulse width/pulse height multiplier 203
Multipliers using D/A and A/D converters 207
9.3 Commercial analog multipliers 207

10 Function generating circuits 209
10.1 Function generating circuits using analog multipliers 209
10.2 Log–antilog function generators 214
Sine 217
Cosine 218
Tan^{-1} (arctan) 218
10.3 Breakpoint function generators 219
10.4 Function generating circuits using A/D and D/A converters 222

11 Limiters, peak detectors and rectifiers 223

© Cambridge University Press www.cambridge.org

CAMBRIDGE

Cambridge University Press
978-0-521-33604-8 - Analog Electronics with Op Amps: A Source Book of Practical Circuits
A. J. Peyton and V. Walsh
Frontmatter
More information

11.2 Peak detectors 231
Basic peak detectors 231
Two stage peak detectors 233
Overall feedback peak detector 234
Improving peak detector performance 236
Notes on component selection 242
Peak detectors using ic building blocks 245
11.3 Half wave precision rectifiers 246
11.4 Full wave rectifiers 248
Single op amp full wave rectifier 248
Current output full wave rectifier 249
Current input full wave rectifier 250
Two op amp full wave rectifier with minimum components 250
General purpose full wave rectifier 251
Current summing full wave rectifier 252
General notes on rectifier circuits 253

12 Peak, average and RMS circuits 257
12.1 Peak responding circuits 259
12.2 Mean absolute value circuits 262
12.3 Root mean square circuits 262
12.4 Thermal RMS converters 271

Bibliography 275

Index 279

© Cambridge University Press www.cambridge.org

CAMBRIDGE

Cambridge University Press
978-0-521-33604-8 - Analog Electronics with Op Amps: A Source Book of Practical Circuits
A. J. Peyton and V. Walsh
Frontmatter
More information

Preface

In recent years we have seen the emergence of a new subject in electronics, that of digital signal processing (DSP). In DSP, which is based on the computational power of the microprocessor, many new application areas have been pioneered and at the same time old ones have been given a fresh impetus. Results have been produced, through various software techniques, which would previously have been possible, if at all, only through the prohibitively extensive use of hardware. Over this same period, a new technology has also come to maturity centred around the creation of monolithic integrated circuits which combine both analog and digital operations on a single silicon substrate. These hybrid ics and powerful DSP systems have produced enormous benefits for the design engineer in terms of reduced costs, increased performance and greater flexibility. Analog electronics, however, tends to have been overshadowed, based as it is on the more mature technology of the op amp. Yet a sound grasp of analog electronics is probably more important now than ever since DSP has opened up so many new applications, all of which require an analog front-end for their operation. There will also continue to be a need for prototyping new designs in hardware in the early stages of development work, whether this prototyping is done in the industrial laboratory by the experienced design engineer or in the college or university laboratory by students who are just setting out on the engineering path. Useful as software simulations of analog circuits are to the engineer and student, there is still no substitute for the 'real-world' experience provided by a hands-on approach.

We are conscious, owing to limitations of space, of the absence of conversion electronics in these pages, especially in the use of digital to analog converters and analog to digital converters. Apart from this omission, readers will find that many practical circuits from analog electronics are usefully described and outlined. However, this book is not intended to be a textbook in analog electronics, nor is it an introduction to the fundamentals of the op amp. Many other works carry out this role perfectly well. Instead, it is offered as a source of practical circuits in analog electronics so that the reader can readily and speedily obtain information and advice on the particular task which needs to be carried out using that work-horse of analog electronics,

© Cambridge University Press www.cambridge.org

CAMBRIDGE

Cambridge University Press
978-0-521-33604-8 - Analog Electronics with Op Amps: A Source Book of Practical Circuits
A. J. Peyton and V. Walsh
Frontmatter
More information

the op amp. Using this superbly flexible building block, and a suitable addition of resistors, capacitors, diodes and discrete transistors, a remarkable range of operations can be carried out. If this volume is the first book which readers consult when they begin their task of designing, building and testing a particular analog circuit, then our work will have succeeded.

I wish to thank my wife, Denise, for her constant help and encouragement, and my daughters Lucy and Anna. With thanks also to my parents. [AP]

I wish to thank my wife Mary and my children, Katherine, Sean, Nicola and Daniel for their tolerance and support during the writing of this manuscript. [VW]

© Cambridge University Press www.cambridge.org