



Advanced Semiconductor Memories

Architectures, Designs,
and Applications

ASHOK K. SHARMA

ADVANCED
SEMICONDUCTOR
MEMORIES

IEEE Press
445 Hoes Lane, P.O. Box 1331
Piscataway, NJ 08855-1331

IEEE Press Editorial Board

Stamatios V. Kartalopoulos, *Editor in Chief*

M. Akay
J. B. Anderson
R. J. Baker
J. E. Brewer

M. E. El-Hawary
R. J. Herrick
D. Kirk
R. Leonardi
M. S. Newman

M. Padgett
W. D. Reeve
S. Tewksbury
G. Zobrist

Kenneth Moore, *Director of IEEE Press*
Catherine Faduska, *Senior Acquisitions Editor*
John Griffin, *Acquisitions Editor*
Tony VenGraitis, *Project Editor*

Technical Reviewer

Robert PENCHUK, *Analog Devices*

BOOKS OF RELATED INTEREST FROM IEEE PRESS

SEMICONDUCTOR MEMORIES: Technology, Testing, and Reliability

Ashok K. Sharma

1997 Hardcover 480 pp ISBN 0-7803-1000-4

NONVOLATILE SEMICONDUCTOR MEMORY TECHNOLOGY

William Brown and Joe E. Brewer

1998 Hardcover 616pp ISBN 0-7803-1173-6

ADVANCED THEORY OF SEMICONDUCTOR DEVICES

Karl Hess

2000 Hardcover 352pp ISBN 0-7803-3479-5

ADVANCED SEMICONDUCTOR MEMORIES

Architectures, Designs,
and Applications

ASHOK K. SHARMA



IEEE
PRESS



WILEY-
INTERSCIENCE

A JOHN WILEY & SONS, INC., PUBLICATION

This book is printed on acid-free paper. (∞)

Copyright © 2003 The Institute of Electrical and Electronics Engineers. All rights reserved.

Published simultaneously in Canada.

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, scanning or otherwise, except as permitted under Sections 107 or 108 of the 1976 United States Copyright Act, without either the prior written permission of the Publisher, or authorization through payment of the appropriate per-copy fee to the Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923, 978-750-8400 fax 978-750-4470 or on the web at www.copyright.com. Requests to the Publisher for permission should be addressed to the Permissions Department, John Wiley & Sons, Inc., 111 River Street, Hoboken, NJ 07030, (201) 748-6011, fax (201) 748-6008, e-mail: permreq@wiley.com

Limit of Liability/Disclaimer of Warranty: While the publisher and author have used their best efforts in preparing this book, they make no representations or warranties with respect to the accuracy or completeness of the contents of this book and specifically disclaim any implied warranties of merchantability or fitness for a particular purpose. No warranty may be created or extended by sales representatives or written sales materials. The advice and strategies contained herein may not be suitable for your situation. You should consult with a professional where appropriate. Neither the publisher nor author shall be liable for any loss of profit or any other commercial damages, including but not limited to special, incidental, consequential, or other damages.

For general information on our other products and services please contact our Customer Care Department within the U.S. at 877-762-2974, outside the U.S. at 317-572-3993 or fax 317-572-4002.

Wiley also publishes its books in a variety of electronic formats. Some content that appears in print, however, may not be available in electronic format.

Library of Congress Cataloging-in-Publication Data is available.

Sharma, Ashok K.,

Advanced semiconductor memories: Architectures, designs, and applications/

Ashok K Sharma

p. cm.

Includes bibliographical references and index.

ISBN 0-470-528-370 (cloth: alk. paper)

Reprinted in 2009. For sale in Taiwan only.

10 9 8 7 6 5 4 3 2

Explore Litigation Insights

Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

Real-Time Litigation Alerts



Keep your litigation team up-to-date with **real-time alerts** and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

Advanced Docket Research



With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

Analytics At Your Fingertips



Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

LAW FIRMS

Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

FINANCIAL INSTITUTIONS

Litigation and bankruptcy checks for companies and debtors.

E-DISCOVERY AND LEGAL VENDORS

Sync your system to PACER to automate legal marketing.