

AUTOMOTIVE ELECTRONICS HANDBOOK

Ronald K. Jurgen Editor in Chief

WAREHAM FREE LIBRARY 59 MARION ROAD WAREHAM, MA 02571

McGraw-Hill, Inc.

New York San Francisco Washington, D.C. Auckland Bogotá Caracas Lisbon London Madrid Mexico City Milan Montreal New Delhi San Juan Singapore Sydney Tokyo Toronto



Related McGraw-Hill Books of Interest

Handbooks

Avallone and Baumeister • MARK'S STANDARD HANDBOOK FOR MECHANICAL ENGINEERS

Benson • AUDIO ENGINEERING HANDBOOK

Brady • MATERIALS HANDBOOK

Chen • COMPUTER ENGINEERING HANDBOOK

Considine • PROCESS/INDUSTRIAL INSTRUMENTS AND CONTROL HANDBOOK

Coombs • PRINTED CIRCUITS HANDBOOK

Coombs • ELECTRONIC INSTRUMENT HANDBOOK

Di Giacomo • DIGITAL BUS HANDBOOK

Fink and Beaty • STANDARD HANDBOOK FOR ELECTRICAL ENGINEERS

Fink and Christiansen • ELECTRONICS ENGINEERS' HANDBOOK

Ganic • McGraw-Hill Handbook of Essential Engineering Information

Harper • ELECTRONIC PACKAGING AND INTERCONNECTION HANDBOOK

Harper and Sampson • ELECTRONIC MATERIALS AND PROCESSES HANDBOOK

Hicks • STANDARD HANDBOOK OF ENGINEERING CALCULATIONS

Hodson • MAYNARD'S INDUSTRIAL ENGINEERING HANDBOOK

Johnson • ANTENNA ENGINEERING HANDBOOK

Juran and Gryna • Juran's Quality Control Handbook

Kaufman and Seidman • HANDBOOK OF ELECTRONICS CALCULATIONS

Lenk • McGraw-Hill electronic testing handbook

Lenk • LENK'S DIGITAL HANDBOOK

Mason • SWITCH ENGINEERING HANDBOOK

Schwartz • COMPOSITE MATERIALS HANDBOOK

Townsend • DUDLEY'S GEAR HANDBOOK

Tuma • ENGINEERING MATHEMATICS HANDBOOK

Waynant • ELECTRO-OPTICS HANDBOOK

Woodson • HUMAN FACTORS DESIGN HANDBOOK

Other

Boswell • SUBCONTRACTING ELECTRONICS

Gieck • ENGINEERING FORMULAS

Ginsberg • PRINTED CIRCUTTE BOARD DESIGN

Johnson • ISO 9000

Lenk • McGraw-Hill Circuit encyclopedia and troubleshooting guide, vols. 1 and 2

Lubben • JUST-IN-TIME MANUFACTURING

Markus and Sclater • McGraw-Hill Electronics dictionary

Saylor • TQM FIELD MANUAL

Soin • TOTAL QUALITY CONTROL ESSENTIALS

Whitaker • ELECTRONIC DISPLAYS

Young • ROARK'S FORMULAS FOR STRESS AND STRAIN

To order or to receive additional information on these or any other McGraw-Hill titles, please call 1-800-822-8158 in the United States. In other countries, please contact your local McGraw-Hill office.

BC14BCZ



Library of Congress Cataloging-in-Publication Data

Automotive electronics handbook / Ronald Jurgen, editor in chief.

p. cm.
Includes index.
ISBN 0-07-033189-8
1. Automobiles—Electronic equipment. I. Jurgen, Ronald K.
TL272.5.A982 1994
629.25'49—dc 94-39724
CIP

Copyright © 1995 by McGraw-Hill, 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.

234567890 AGM/AGM 9098765

ISBN 0-07-033189-8

The sponsoring editor for this book was Stephen S. Chapman, the editing supervisor was Virginia Carroll, and the production supervisor was Suzanne W. B. Rapcavage. It was set in Times Roman by North Market Street Graphics.

Printed and bound by Arcata Graphics/Martinsburg.

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, Inc., 11 West 19th Street, New York, NY 10011. Or contact your local bookstore.

Information contained in this work has been obtained by McGraw-Hill, Inc. 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 printed on acid-free paper.



This book is dedicated to Robert H. Lewis and to the memories of Douglas R. Jurgen and Marion Schappel.



DOCKET

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.

