

The ARRL

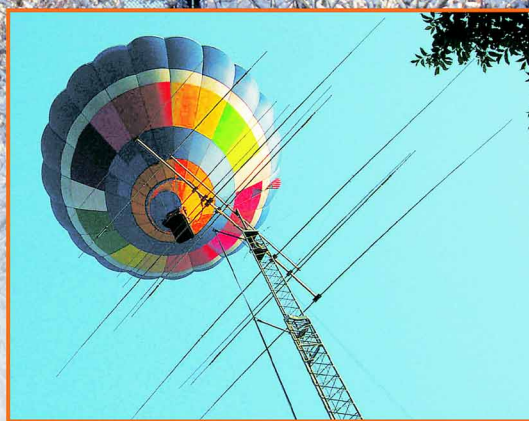
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# ANTENNA BOOK



20th Edition

The **ultimate** reference  
for Amateur Radio antennas,  
transmission lines and  
propagation



Includes the fully searchable book on CD-ROM

Published by:

**ARRL** The national association for  
**AMATEUR RADIO**



Radio amateurs and professionals rely on **The ARRL Antenna Book** for current antenna theory and a wealth of practical, how-to construction projects. This 20<sup>th</sup> edition is extensively revised and includes contributions from leading antenna experts. Many designs are the result of the latest advances in computer modeling.

Use this book and CD-ROM to find antennas from the most simple wire varieties, to specialized or highly optimized arrays.

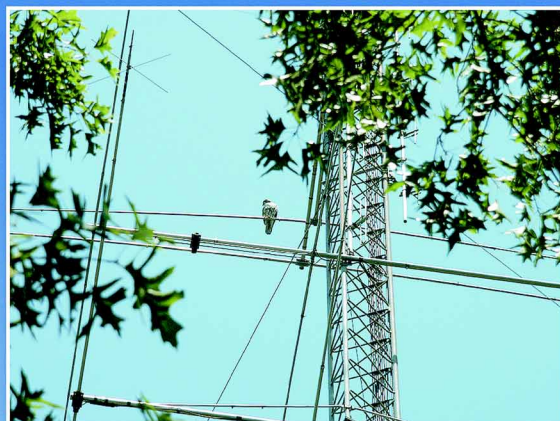
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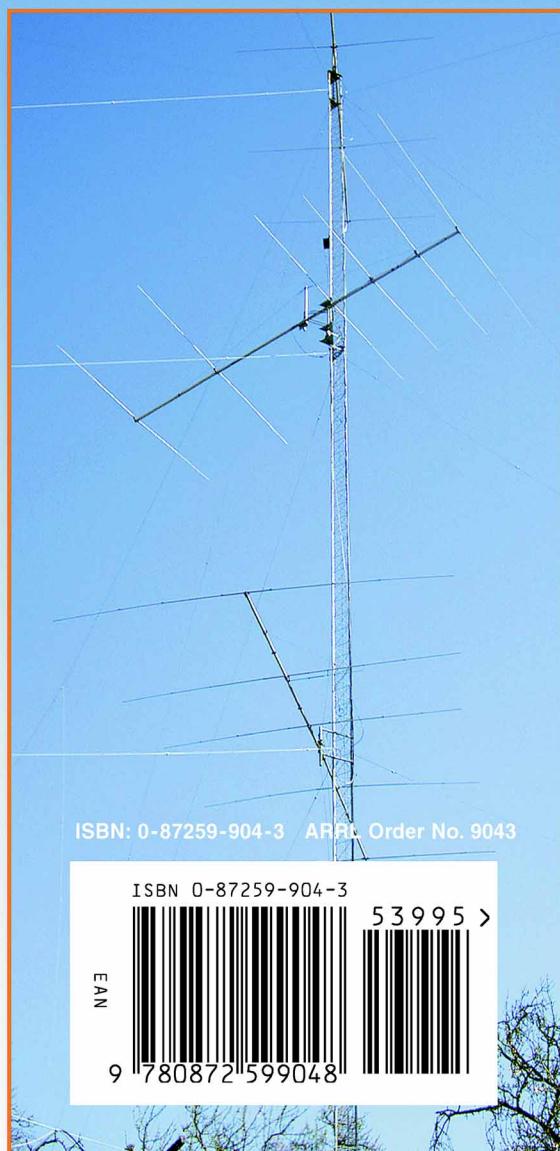
**PLUS** band-by-band propagation tables for over 150 worldwide locations!



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Antenna Fundamentals	VHF and UHF Antenna Systems
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Multielement Arrays	Transmission Lines
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Log Periodic Arrays	Coupling the Line to the Antenna
HF Yagi Arrays	Transmission-Line and Antenna Measurements
Quad Arrays	Smith Chart Calculations
Long Wire and Traveling Wave Antennas	
Direction Finding Antennas	
Portable Antennas	
Mobile and Maritime Antennas	

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# The ARRL ANTENNA BOOK

**20th Edition**

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# Foreword

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We are pleased to offer the 20th edition of *The ARRL Antenna Book*. Since the first edition in September 1939, each new *Antenna Book* has provided more and better information about the fascinating subject of radio antennas. We've sold more than a million *Antenna Books* over the years to amateurs and professionals alike, making it one of the most successful books in our extensive lineup of publications.

Fundamentals about antennas rarely change from edition to edition, but modern application of these fundamentals can result in more highly optimized or specialized antennas. For example, many of the antennas in this new edition benefit directly from advances in sophisticated computer modeling.

We usually update at least 30% of the material in a new edition, and this book is no exception. There have been major revisions in the following chapters:

- Chapter 3: Updated information about ground systems for verticals.
- Chapter 4: A completely new section on computer modeling.
- Chapter 6: New insights into the importance of low elevation angles for the lower frequencies, plus a whole new section on low-frequency “slopers.”
- Chapter 11: Greatly expanded section on stacking HF Yagis.
- Chapter 17: New section on computing the coverage of repeater antennas.
- Chapter 18: Expanded section on stacking VHF/UHF Yagis.
- Chapter 19: Completely new coverage of Satellite and EME arrays.
- Chapter 23: Expanded coverage of ionospheric sounding and detailed propagation predictions.

We are fortunate to have the expertise of some well-known and highly talented authorities, who either wrote or reviewed a number of new or revised chapters for technical accuracy:

- Rudy Severns, N6LF, and Roy Lewallen, W7EL—low-frequency antennas.
- LB Cebik, W4RNL—Modeling antennas.
- Dick Jansson, WD4FAB—satellite antennas.
- Dave Hallidy, K2DH—EME arrays.
- Bob Hunsucker, AB7VP, and Carl Luetzelschwab, K9LA—HF propagation.

In addition, some exceptional software writers have contributed programs and data for the *Antenna Book*.

- Roy Lewallen, the author of *EZNEC*, has created a special *EZNEC ARRL* program, just for the *Antenna Book*. *EZNEC ARRL* uses the multitude of specialized modeling files also included on the CD-ROM. These models were used in almost every chapter in the book.
- Dr Peter Guth and the US Naval Academy have graciously allowed ARRL to include the versatile *MicroDEM* mapping program on the CD-ROM. *MicroDEM* can easily and quickly generate customized terrain files for the *HFTA* terrain-assessment program, as well as map terrain all around the country using free US topographic data files from the Internet.
- Joe Ahlgren's *GeoClock* program is a versatile shareware program that tracks gray-line and daytime/nighttime conditions around the world.
- Jim Tabor, NU5S, wrote *Active Beacon Wizard*, a wonderful shareware program to track the NCDXF Beacons and to keep tabs on the latest Internet propagation bulletins.
- Dean Straw, N6BV, editor of *The ARRL Antenna Book*, has updated and upgraded his *YW* (Yagi for Windows) and *TLW* (Transmission Line for Windows) programs from the 19th Edition. He has also brought the DOS-based *YT* terrain-analyzing program into the Windows world, creating the *HFTA* (HF Terrain Assessment) program. Detailed statistical elevation-angle files for QTHs all around the world are included as well.
- Also included on the CD-ROM are DOS-based utility programs by several authors that analyze antenna tuners, design mobile antennas and LPDAs, and that scale Yagis for *YW*.
- Are you planning on going on a DXpedition to somewhere you've never been before? The CD-ROM now includes both Simplified and Detailed propagation prediction tables for more than 150 QTHs all around the world. Even if you don't journey to distant lands, these tables will give you plenty of insight on planning contesting or DXing strategies—They can also help you set up that Saturday afternoon schedule with your uncle Harry in Cleveland!

You now have in one place the information you need to design your own complete antenna system scientifically—the elevation angles to aim for from your part of the world and the effects of your own local terrain.

As usual, in a publishing effort of this magnitude, errors creep into the process, despite our best efforts. We appreciate hearing from you, our readers, about errors or about suggestions on how future editions might be made even more useful to you. A form for mailing your comments is included at the back of the book, or you can e-mail us at: [pubsfdbk@arrl.org](mailto:pubsfdbk@arrl.org).

David Sumner, K1ZZ  
Executive Vice President  
Newington, Connecticut  
August 2003

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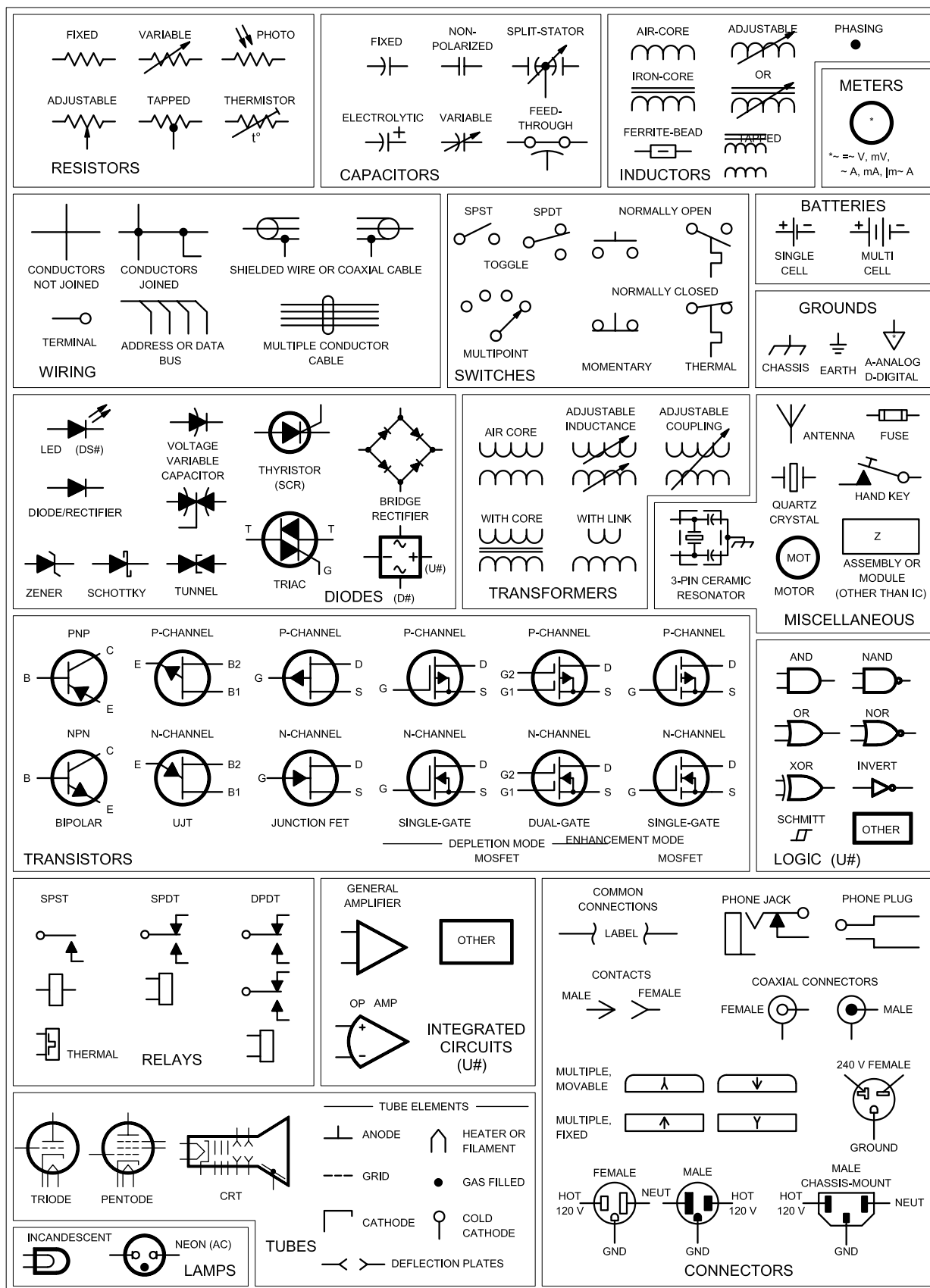
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# About the ARRL

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The seed for Amateur Radio was planted in the 1890s, when Guglielmo Marconi began his experiments in wireless telegraphy. Soon he was joined by dozens, then hundreds, of others who were enthusiastic about sending and receiving messages through the air—some with a commercial interest, but others solely out of a love for this new communications medium. The United States government began licensing Amateur Radio operators in 1912.

By 1914, there were thousands of Amateur Radio operators—hams—in the United States. Hiram Percy Maxim, a leading Hartford, Connecticut, inventor and industrialist saw the need for an organization to band together this fledgling group of radio experimenters. In May 1914 he founded the American Radio Relay League (ARRL) to meet that need.

Today ARRL, with approximately 170,000 members, is the largest organization of radio amateurs in the United States. The League is a not-for-profit organization that:

- promotes interest in Amateur Radio communications and experimentation
- represents US radio amateurs in legislative matters, and
- maintains fraternalism and a high standard of conduct among Amateur Radio operators.

At League headquarters in the Hartford suburb of Newington, the staff helps serve the needs of members. ARRL is also International Secretariat for the International Amateur Radio Union, which is made up of similar societies in 150 countries around the world.

ARRL publishes the monthly journal *QST*, as well as newsletters and many publications covering all aspects of Amateur Radio. Its headquarters station, W1AW, transmits bulletins of interest to radio amateurs and Morse code practice sessions. The League also coordinates an extensive field organization, which includes volunteers who provide technical information for radio amateurs and public-service activities. ARRL also represents US amateurs with the Federal Communications Commission and other government agencies in the US and abroad.

Membership in ARRL means much more than receiving *QST* each month. In addition to the services already described, ARRL offers membership services on a personal level, such as the ARRL Volunteer Examiner Coordinator Program and a QSL bureau.

Full ARRL membership (available only to licensed radio amateurs) gives you a voice in how the affairs of the organization are governed. League policy is set by a Board of Directors (one from each of 15 Divisions). Each year, one-third of the ARRL Board of Directors stands for election by the full members they represent. The day-to-day operation of ARRL HQ is managed by an Executive Vice President and a Chief Financial Officer.

No matter what aspect of Amateur Radio attracts you, ARRL membership is relevant and important. There would be no Amateur Radio as we know it today were it not for the ARRL. We would be happy to welcome you as a member! (An Amateur Radio license is not required for Associate Membership.) For more information about ARRL and answers to any questions you may have about Amateur Radio, write or call:

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Prospective new amateurs call (toll free):

**800-32-NEW HAM** (800-326-3942)

You can contact us also via e-mail at [newham@arrl.org](mailto:newham@arrl.org)

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