



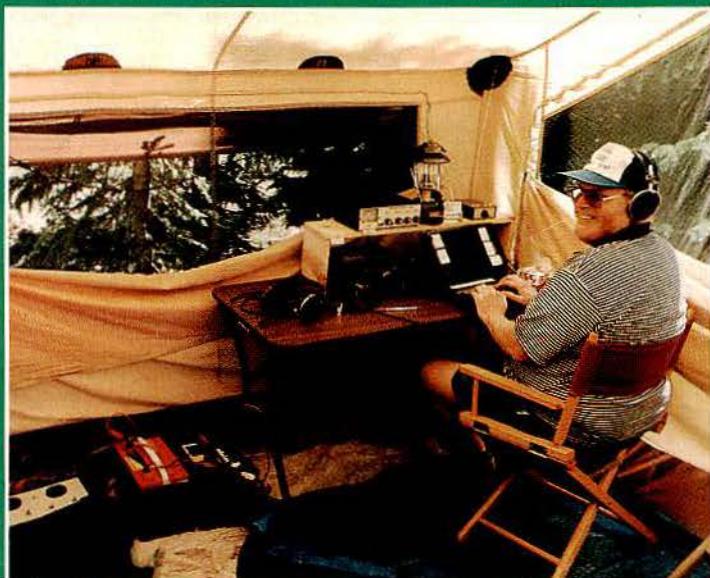
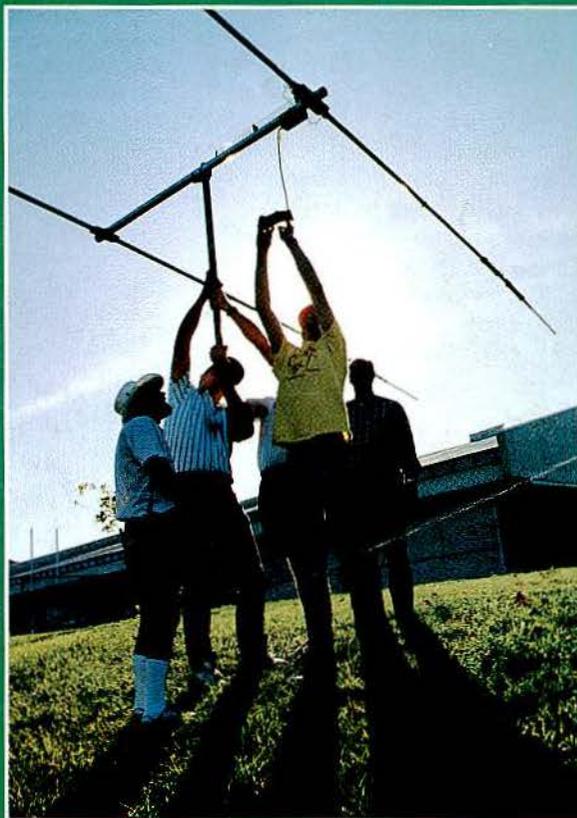
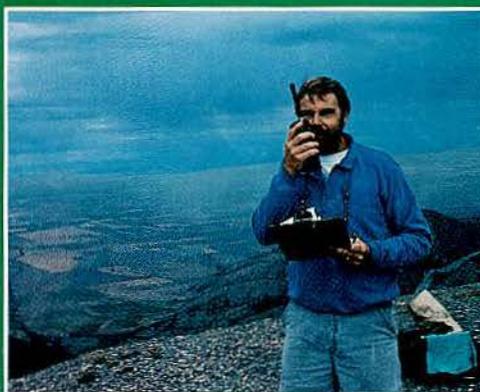
# NEW HAM COMPANION



Your Introduction to **QST**  
and The American Radio Relay League

## Inside...

- Learn the tricks of successful FM operating
- Discover the Russian EasySats
- Make new friends with packet radio mail
- Get on the HF bands for less than \$200



# hf

## Tuned To Amateur Radio

Cushcraft is pleased to welcome you to the family of amateur radio operators.

Whether you're a casual hobbyist or take ham radio to the limits of technical expertise and proficiency, you will always find the antenna to suit your needs and budget from Cushcraft.

We make ham radio more enjoyable with over 100 different antenna models for virtually every type of operation. They are all easy to use with the highest quality materials, user friendly manuals and state-of-the-art designs.

Cushcraft Corporation has been providing quality, high-performance antennas to the ham market for over 45 years. Our antennas are in stock with dealers throughout the world. See your local dealer for the model of your choice. Ask for your 18 page Cushcraft antenna catalog or call us for your free copy.



### R7000

10, 12, 15, 17, 20, 30, 40m

- 80m Add-On Kit Available
- No Ground Radials
- Automatic Band Changing
- Slim Silhouette
- Reliable
- Easy Installation

The R7000 is a 10 through 40 meter antenna that does not need ground radials and can be expanded to include 80 meters with our R80 kit. The R7000 incorporates the best features of its predecessor the R7 plus many more. Our new trap design allows us to hold inductance within close tolerance so there's less tuning and excellent in-weather performance. We've designed double wall tubing into the bottom 3 sections to insure top performance in winds up to 80 m.p.h. All materials are either stainless steel, aluminum, or high impact plastic.

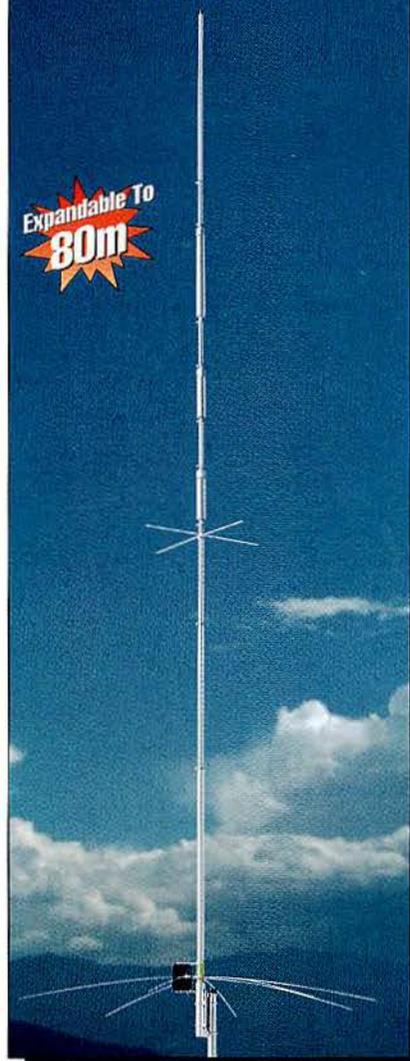
### A3S / A4S / A3WS

Multiband Beams  
(10, 12, 15, 17, 20, 30m)

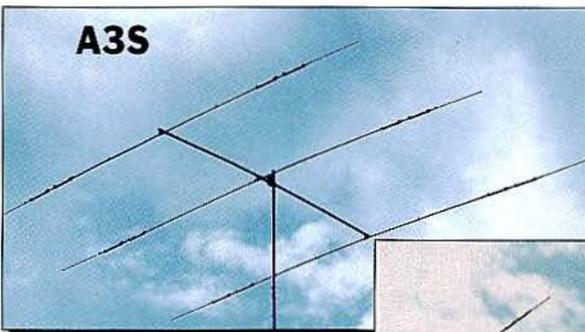
The most popular HF tri-banders among hams worldwide. These antennas are the choice of contest stations and DX-peditions worldwide. They're rugged, reliable and designed to perform. The compact A3S has a 14 foot boom with excellent gain and a good front to back ratio. It weighs just 28 pounds. For even more performance consider the A4S, our premium tribander.

### R7000

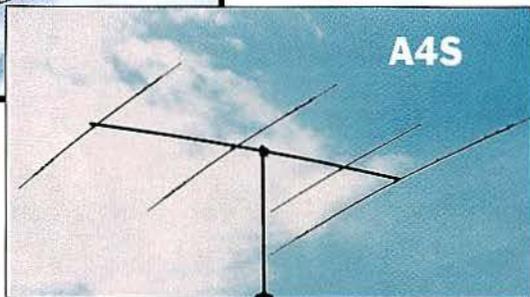
Expandable To  
80m



### A3S



### A4S



A 40 meter add-on kit is also available for both antennas. A3WS is a compact, high performance WARC band beam. Use it with your existing tri-bander.

# vhf/uhf

## DUAL BAND (2m / 70cm)

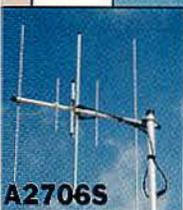
Cushcraft brings you the latest in dual-band technology with two new 2m/70cm products – the ARX6 high gain 6 meter vertical and the CG270M Gold mobile. These exciting products will complement our already proven AR270 dual band compact base antenna.



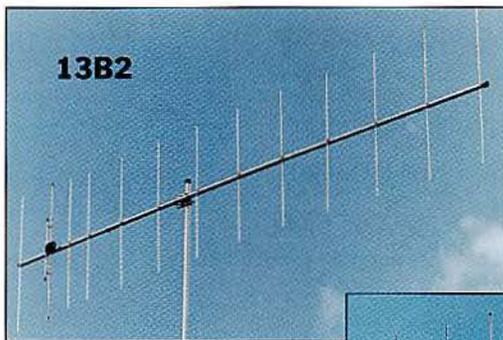
A27010S

### A27010S & A2706S Dual Band Yagis

Increase your range by selecting one of the new Cushcraft dual band Yagis on 2m and 70cm. Direct more output power when transmitting at the same time reducing interference and increasing signal strength when receiving. Assembly is a snap. A27010S has nearly twice the performance of the A2706S.



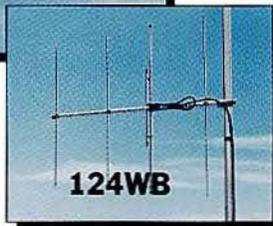
A2706S



13B2

### 124WB (2 meter) 4 Element Wideband

The right choice for packet systems and other applications requiring a dedicated directional antenna.



124WB

### 13B2 Wideband Boomer (2 meter)

Our most popular VHF Boomer, the 13B2 delivers wideband performance across the active 2 meter band. It has a boom length of 15 feet with a high gain and precise pattern. 13B2 has the UltraMatch balanced feed system for optimum performance in all conditions. It can be polarized vertically for FM and Packet or horizontally for SSB, CW or DX'ing.

### ARX6 Ringo Ranger (6 meter)

The ARX6 was developed to meet the needs of serious 6 meter FM hams. It has twice the gain of the standard AR6. If you're looking for wide area coverage from a repeater or home station, the ARX6 is made for you.



### ARX2B Ringo Ranger II (2 meter)

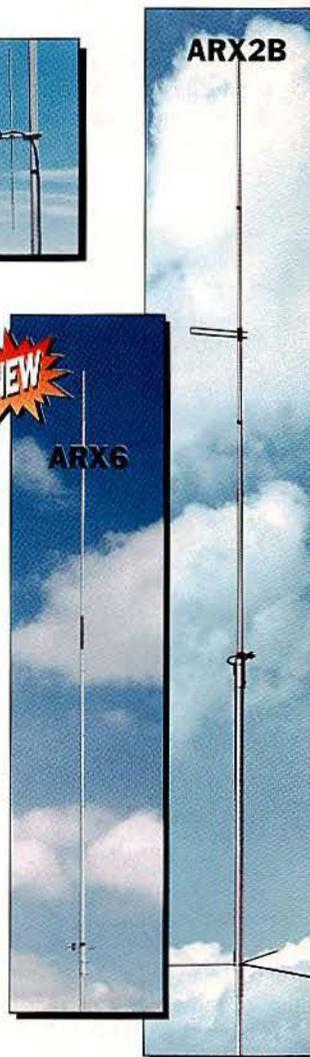
The Ringo Ranger II has become a legend in ham radio. This affordable performance vertical is a favorite of hams everywhere – in fact it's synonymous with 2 meter FM. The ARX2B is a snap to mount and puts you in the middle of the active 2 meter band – the most popular of all amateur frequencies. Over half a million Ringo Ranger II's have been sold to date.

### AR270B (2m / 70cm) Compact, High Performance Dual Band Base

For many hams this antenna offers the optimum combination of performance, size and price. The AR270B is a great performer in an eight foot high package.

### AR270 (2m / 70cm) Compact Dual Band Base

Experience the performance of the most popular dual-band base antenna. It is compact, easy to use and radiates an amazing signal.



ARX6

ARX2B



CG270M



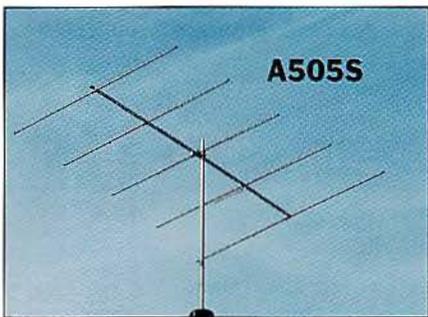
AR270



AR270B

### Cushcraft GOLD CG270M Dual Band Mobile (2m / 70cm)

For unequaled styling and performance, you need look no further than the all new CG270M. This premium mobile is the first in our new GOLD product line. We back this antenna with our 5 year warranty.



A505S

### A505S / A506S 6m Yagis

These broadband Yagis (5 & 6 element) will not detune in bad weather. They feature stainless steel hardware to ensure long life.



P.O. BOX 4680, 48 PERIMETER ROAD, MANCHESTER, NH 03108 • 603-627-7877 • FAX: 603-627-1764  
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# 2 Meters + 440 THIS IS HOW IT'S DONE.

## DR-610T DUAL BAND MOBILE/BASE VALUE LEADER

Full-featured, easy to operate, dependable performance.

- Expandable to 240 memory channels—5 memory banks!
- Detachable remote-mount face plate
- Versatile operation—VHF/UHF, UHF/VHF, VHF/VHF, UHF/UHF
- Internal duplexer at no extra cost. One easy antenna connection.
- Long Tone Zero (LITZ) Emergency Alert
  - Aircraft band receive
  - Includes CTCSS encode PLUS European tone bursts
  - 9600 bps packet ready!
  - 50/10/5 watts/2m 35/10/5 watts/440
- Alinco's Channel Scope<sup>SM</sup> graphic band activity display
- RX - VHF 108 to 173.995 MHz, UHF 420 to 470 MHz
- MARS/CAP Modifiable (permits required)
- Cross-band repeater function



## DJ-G5TH DUAL BAND HT PACKED WITH FEATURES!

The 2 Meter/440 HT that's ready to travel the world.

- 200 memory channels (100 VHF, 100 UHF)
- 5 watts output
- Large illuminated display and backlit keypad
- Versatile operation—VHF/UHF, VHF/VHF, UHF/UHF
- Alinco's Channel Scope<sup>SM</sup> graphic band activity display
- "Clones" over the air!
- Includes CTCSS encode/decode PLUS European tone bursts
- Aircraft band receive
- 2 PTT buttons, assign one for each band or high power/low power transmit
- MARS/CAP modifiable (permits required)

Plus many more advanced functions at no extra cost!

## DR-605T DUAL BAND MOBILE/BASE ECONOMY CHAMP

Full 2 meter/440 performance at an affordable price!

- 100 memory channels including cross-band memories
- CTCSS encode PLUS European tone bursts (1450, 1750 and 2100 Hz)
- 9600 bps packet ready with dedicated terminals
- Internal duplexer—one easy antenna connection
- Cross-band repeater function
- Large controls, easy to operate, easy to program
- RX - VHF 136 to 173.995 MHz, UHF 420 to 470 MHz
- TX - VHF 50 watts, UHF 35 watts
- MARS/CAP modifiable (permits required)
- Time-out timer
- With the optional EJ-24U CTCSS Tone Decoder Unit can operate in "tone squelch" receive AND search (tone scan) or a specific CTCSS tone in a received signal



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Specifications are subject to change without notice or obligation. Performance specifications only apply to amateur bands. Permits required for MARS/CAP use.

# Welcome to Amateur Radio!

Congratulations! You've taken your first step into a hobby—and a service—that knows no limits. Amateur Radio is a worldwide network of people from various cultures, united by a common love of wireless communication. Amateur Radio is as old as radio itself, and its



future is no less fantastic than its past.

For most people, Amateur Radio is a lifelong pursuit. We want to make sure you get a good start, which is why we've sent you this copy of *New Ham Companion*. But first, who are "we?"

## The American Radio Relay League

The seed for Amateur Radio was planted in the 1890s, when radio's pioneers began experimenting with wireless telegraphy. Soon, there were dozens, then hundreds, of experimenters 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 and mysterious communications medium. To coordinate all of this activity, the United States government began licensing Amateur Radio operators in 1912.

By 1914, there were thousands of Amateur Radio operators—hams, as they were called—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 of 1914 he founded the American Radio Relay League (ARRL) to meet that need.

Today, the League has more than 170,000 Members, and is the national organization of radio amateurs and a leading ham radio organization worldwide. By joining the ARRL, you'll receive many special benefits. Here are a few examples:

◆ **Help for New Hams:** Are you a beginning ham looking for help in getting started in your new hobby? The Educational Activities Department (EAD) at ARRL HQ in Newington, Connecticut, will be glad to assist you. Call EAD at 1-800-32-NEW HAM (1-800-326-3942). EAD maintains a computer data base of ham clubs and ham radio "helpers" from across the country who've told us they're interested in helping beginning hams. There are probably several clubs in your area! Contact EAD for more information.

◆ **Licensing Classes:** If you're looking to upgrade, you'll need to find a local license exam site sooner or later. ARRL Registered Instructors teach local licensing classes all around the country and ARRL-sponsored Volunteer Examiners are there to administer your exams. To find the locations and dates of Amateur Radio licensing classes and test sessions in your area, call the Educational Activities Department at 1-800-32-NEW HAM (1-800-326-3942).

◆ **Clubs:** As a beginning ham, one of the best moves you can make is to

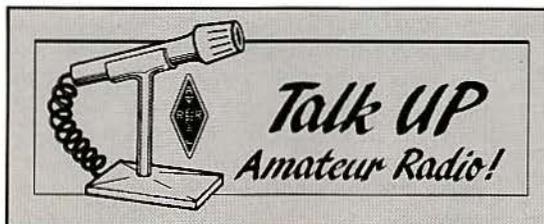
join a local ham club. Whether you join an all-around group or a special-interest club (repeaters, DXing, and so on), you'll make new friends, have a lot of fun, and you can tap into a ready reserve of ham radio knowledge and experience. To find the ham clubs in your area, call HQ's Educational Activities Department at 1-800-32-NEW HAM (1-800-326-3942).

◆ **Technical Information Service:** Do you have a question of a technical nature? (What new ham doesn't?) Contact the Technical Information Service (TIS) at HQ. Our resident technical experts will help you over the phone, send you specific information on your question (antennas, interference and so on) or refer you to your local ARRL Technical Coordinator or Technical Specialist. It's expert information—and it doesn't cost Members an extra cent!

◆ **Regulatory Information:** Need help with a thorny antenna zoning problem? Having trouble understanding an FCC regulation? Vacationing in a faraway place and want to know how to get permission to operate your ham radio there? HQ's Regulatory Information Branch (RIB) has the answers you need!

◆ **Operating Awards:** Like to collect "wallpaper?" The ARRL sponsors a variety of certificates and Amateur Radio achievement awards. For information on awards you can qualify for, contact the Membership Services Department at HQ.

◆ **Equipment Insurance:** When it comes to protecting their Amateur Radio equipment investments, ARRL Members travel First Class. A. H. Wohlers Company provides the League's "all-risk" equipment insurance plan. (It can protect your ham radio computer, too.) It's comprehensive and cost effective, and it's available only to ARRL Members. Why worry about losing your valuable radio equipment when you can protect it for only a few dollars a year?



◆ **Amateur Radio Emergency Service:** If you're interested in providing public service and emergency communications for your community, you can join more than 25,000 other hams who have registered their communications capabilities with local Emergency Coordinators. Your EC will call on you and other ARES members for vital assistance if disaster should strike your community. Contact the Field Services Department at HQ for information.

◆ **Audio-Visual Library:** Need a program for your next ham club meeting or informal get-together? ARRL affiliated clubs can borrow a tape from the League's video library at HQ! There are many to choose from, including popular titles on Amateur Radio's role in Operation Desert Storm and space shuttle activities. Contact the Educational Activities Department at HQ to check out your tape.

◆ **Blind, Disabled Ham Help:** For a list of available resources and information on the Courage HANDI-HAM System, contact the ARRL Program for the Disabled at HQ.

With your membership you also receive the monthly journal *QST*. Each 200-page issue is packed with valuable information you can use—including a special *New Ham Companion* section similar to what you are reading right now! And *QST* Product Reviews are the most respected source of information to help you get the most for your Amateur Radio equipment dollar. (For many hams, *QST* alone is worth far more than the cost of ARRL membership.)

The ARRL publishes newsletters and dozens of books covering all aspects of Amateur Radio. Our Headquarters station, WIAW, transmits bulletins of interest to radio amateurs and Morse code practice sessions.

When it comes to representing Amateur Radio's best interests in our nation's capital, the League's team in Washington, DC, is constantly working with the FCC, Congress and industry to protect and foster your privileges as a ham operator.

Regardless of your Amateur Radio interests, ARRL Membership is relevant and important. We will be happy to welcome you as a Member. Enjoy your copy of *New Ham Companion* and don't hesitate to contact us if you have any questions!

Get All Three  
on ONE CD!



The ARRL 1995 Periodicals CD-ROM has it all—every 1995 issue of *QST*, *QEX* and the *National Contest Journal* on a single CD.

Pop the ARRL 1995 Periodicals CD-ROM into your computer and browse through every word, drawing, and photograph published in the 1995 editions of these popular magazines. Many of the photographs are in color, even though they may have appeared originally in black and white! There's even a special section for the advertisements.

Let your computer do the searching! A flexible search feature turns your PC into an "information detective." Just type in a title, call sign, name or whatever and within seconds you'll have a list of possible matches on your screen. Click your mouse button and the articles appear. What could be easier?

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Stop stacking old magazines in your bookshelves! Magazine collections are impressive—until you have to find something! With the ARRL 1995 Periodicals CD-ROM, one standard CD-ROM disk replaces heavy piles of paper.

If you own a PC with a CD-ROM drive, what are you waiting for? If you're an ARRL member, it's only \$19.95, plus \$4 shipping and handling; for nonmembers, \$29.95 plus \$4 shipping and handling.

Call ARRL  
Headquarters at  
860-594-0250 and order  
your CD today!

"It Seems to Us..."

## Extending Your Horizons

We'd like to address some words of welcome to the thousands who are new to Amateur Radio. About the first thing a new ham does is to buy a 2-meter hand-held transceiver (H-T). No surprise here: Ever since 2-meter FM gained widespread popularity in the early '70s, it's been the "watering hole" for local Amateur Radio. In some areas, another band—222 or 440 MHz—may be a logical choice for a first rig, or a dual-band H-T may be indicated; but 2 meters is a safe bet.

Marconi would never have become rich and famous if he'd only built one station. He needed two, so he'd have someone to talk to. So it is with Amateur Radio. A transceiver all by itself isn't very useful. In hooking you up with other people, an H-T with one of those ubiquitous rubber ducky antennas doesn't give you much of a reach beyond your neighborhood. Put the H-T (and its antenna) inside a vehicle (a car body provides pretty good shielding, unless yours happens to be plastic) and you'll be lucky to talk any farther than you can see. Limit yourself to this kind of Amateur Radio operating without any outside assistance, and you'll quickly begin to wonder why you worked so hard to get a license (or why you should even need one).

The easiest and most popular way of extending your horizons is a repeater. Well-sited and linked repeaters can extend the reach of your anemic little H-T to thousands of square miles. Connect an outside antenna and a small amplifier to that hand-held, or add a higher-power base or mobile rig to your complement of equipment, and your choice of repeaters will multiply (as will your simplex coverage, that is, how far you can talk without a repeater). Not all repeaters are open to all comers. When you're using someone else's repeater you're in effect operating their station as a guest. So, of course, you need to behave accordingly and to respect their wishes, including joining the club that sponsors any repeater you use regularly.

Many amateurs derive great satisfaction from FM and repeaters, particularly if they get involved in public service communication and other organized local activities. We hope you will, too. But at the same time, we hope you'll try a few of the many other things that make Amateur Radio's horizons virtually limitless.

Hook your H-T to a computer through a packet radio TNC, and you'll instantly become a part of a worldwide digital communications network. Not satisfied with the world? Then try space communications! It's not as difficult as you may think; check out Steve Ford's article, "Try the Russian EasySats," elsewhere in this issue. If the thought of capturing pictures transmitted from space appeals to you, take a look at the column Steve wrote in October 1992 *QST*.

Want other ways to go farther than your local repeaters can take you, without leaving 2 meters? How about reflecting signals off meteor trails to bridge 1300-mile paths? The secret? Using SSB or CW instead of FM—and perseverance! Even without meteors or unusual conditions, SSB and CW operators at the low end of the band routinely work 200 miles with 10 watts, and a well-equipped station can triple that range. By reflecting his 2-meter signal off the moon, one dedicated amateur, Dave Blaschke, W5UN, was the first to contact more than 100 countries on that band! The other VHF, UHF and microwave bands pose opportunities and challenges of their own and plenty of chances to be "first."

Want to know more? Then an ARRL publication, *Your VHF Companion*, is right up your alley. Edited by the aforementioned Steve Ford, WB8IMY, it's an up-to-date, easy-to-digest look at the incredible array of experiences you can enjoy in Amateur Radio without ever taking a license exam past Novice or Technician. Want to experience even more? We hope you will, and we hope you'll enjoy the challenge of working your way up the licensing ladder. Even if you have no interest in the HF bands right now, the satisfaction of upgrading can be its own reward—not to mention the possibility of a new call sign!

Whatever route you decide to take and no matter how old you are now, you'll discover that Amateur Radio can truly be the hobby of a lifetime. There's a lot of talk that hams are getting older; statistically, it's true. But there's a good reason for it. Once Amateur Radio becomes an important part of someone's life, it stays that way—no matter how old, chronologically speaking, you may get.

Welcome. The thrill of discovery awaits! The ARRL is here to help you make the most of it.—David Sumner, K1ZZ

# We're At Your Service

ARRL Headquarters is open from 8 AM to 5 PM Eastern Time, Monday through Friday, except holidays. Our address is: 225 Main St. Newington, CT 06111-1494. You can call us at 860-594-0200, or fax us at 860-594-0259.

If you have a question, try one of these Headquarters departments . . .

	Contact	Telephone	Electronic Mail
<b>QST Delivery</b>	Circulation Desk	860-594-0338	circulation@arrl.org
<b>Publication Orders</b>	Sales Desk	860-594-0250	pubsales@arrl.org
<b>Regulatory Info</b>	Norm Bliss	860-594-0323	reginfo@arrl.org
<b>Exams</b>	VEC	860-594-0300	vec@arrl.org
<b>Educational Materials</b>	Educational Activities	860-594-0301	ead@arrl.org
<b>Contests</b>	Billy Lunt	860-594-0252	contest@arrl.org
<b>Technical questions</b>	ARRL Lab	860-594-0214	tis@arrl.org
<b>Awards</b>	Eileen Sapko	860-594-0288	awards@arrl.org
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<b>QSL Service</b>	Joe Garcia	860-594-0274	buro@arrl.org
<b>Scholarships</b>	Mary Garcia	860-594-0230	foundation@arrl.org
<b>Emergency Communication</b>	Rick Palm	860-594-0261	k1ce@arrl.org

You can send e-mail to any ARRL Headquarters employee if you know their name or call sign. The second half of every Headquarters e-mail address is @arrl.org. To create the first half, simply use the person's call sign. If you don't know their call sign, use the first letter of their first name, followed by their complete last name. For example, to send a message to John Hennessee, KJ4KB, Regulatory Information Specialist, you could address it to: [jhennessee@arrl.org](mailto:jhennessee@arrl.org) or [kj4kb@arrl.org](mailto:kj4kb@arrl.org).

If all else fails, send e-mail to [hq@arrl.org](mailto:hq@arrl.org) and it will be routed to the right people or departments.

**ARRL on the On-Line Services**  
We maintain accounts on these major

on-line services and check for mail several times daily.

Service	ARRL Address
CompuServe	70007,3373
America Online	HQARRL1
GENie	ARRL
Prodigy	PTY502A
MCI	215-5052

Downloadable files for the new ham, upgrader, instructor or disabled ham are featured in the various on-line ham radio file libraries.

### ARRL BBS

The ARRL Hiram Bulletin Board System is as close as your telephone. Hiram offers more than a thousand software files for your enjoyment. You can also use Hiram to send

messages to anyone at Headquarters—or to other hams who frequent the BBS. Hiram accepts up to four simultaneous connections at rates from 1200 to 28,800 baud. Fire up your modem and call 860-594-0306.

### Technical Information Server

If you have Internet e-mail capability, you can tap into the ARRL Technical Information Server, otherwise known as the *Info Server*. To have user instructions and a handy index sent to you automatically, simply address an e-mail message to: [info@arrl.org](mailto:info@arrl.org)  
Subject: **Info Request**  
In the body of your message enter:

HELP  
SEND INDEX  
QUIT

### ARRL on the World Wide Web

You'll also find the ARRL on the World Wide Web at:

<http://www.arrl.org/>

At the ARRL Web page you'll find the latest W1AW bulletins, a hamfest calendar, exam schedules, an on-line ARRL Publications Catalog and much more. We're always adding new features to our Web page, so check it often!

### Stopping by for a visit?

We offer tours of Headquarters and W1AW at 9, 10 and 11 AM, and at 1, 2 and 3 PM, Monday to Friday (except holidays). Special tour times may be arranged in advance. Bring your license and you can operate W1AW anytime between 1 and 4 PM!

ARRL Headquarters is within easy driving distance from Interstates 84 or 91. In addition, Hartford is served by Amtrak with several trains daily from

New York, Boston and beyond (call 1-800-USA-RAIL for more information). Bradley International Airport in Windsor Locks, Connecticut (about 20 miles north of Headquarters), is served by many major carriers.

### Would you like to write for QST?

We're always looking for new material of interest to hams. Send a self-addressed, stamped envelope (55¢ postage) and ask for a copy of the *Author's Guide*. (It's also available via the ARRL Info Server, and via the World Wide Web at <http://www.arrl.org/aguide/>.) The guide contains all the information you'll need to craft an article to meet our requirements. Send article ideas or manuscripts to the attention of the QST Editor (e-mail [qst@arrl.org](mailto:qst@arrl.org)).

### Press Releases and New Products/Books

Do you have an important news item, or a hot new book or other product? Let us know and we'll tell the world! Send your press releases and new book announcements to the attention of the QST Editor (e-mail: [qst@arrl.org](mailto:qst@arrl.org)). New product announcements should be sent to the Product Review Editor (e-mail [reviews@arrl.org](mailto:reviews@arrl.org)).

### Strays and Up Front

Send your Strays and Up Front materials to the QST Features Editor (e-mail [upfront@arrl.org](mailto:upfront@arrl.org)). Be sure to include your name, address and daytime telephone number.

### Photographs

We can accept black & white or color transparencies, slides or glossy prints. QST cannot be responsible for returning these materials, so do not send negatives or irreplaceable originals.

## ARRL Directors

### Atlantic Division

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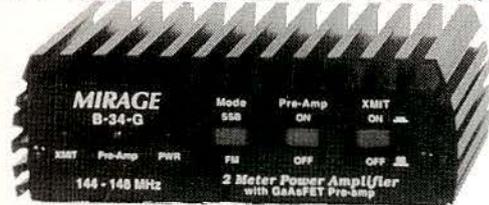
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B-34-G  
**\$99**

Suggested Retail

**MIRAGE RUGGED!**

Power Curve -- typical Mirage B-34-G output power

Watts Out	18	30	33	35+	35+	35+	35+	35+
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For an incredibly low \$99, you can boost your 2 Meter handheld to 35 watts -- the power of an expensive mobile!

Your handheld becomes a powerful mobile or base when you need it -- for a lot less money.

The Mirage B-34-G is perfect for both HTs and all mode SSB/CW/FM 2 Meter rigs.

A built-in low noise GaAsFET receive preamp gives you 18 dB gain for weak signals.

Works with HTs up to 8 watts. Power Curve gives typical output power. 5 1/4 x 1 3/4 x 4 3/4 inches.

## Here's why the Mirage B-34-G is MIRAGE RUGGED!

... First-class strip-line techniques and modular construction -- gives you superb RF performance and unsurpassed reliability.

... Custom wrap around heatsink -- runs cool for extra long life

... Reverse Polarity Protection -- this Mirage feature can save your amp -- and your pride -- if you connect power backwards.

... Low input SWR -- keeps your handheld safe from overheating

... Positive-action RF sense transmit/receive switch -- ensures precision transceiving.

... LED indicators -- On-Air, receive preamp and power -- gives you confidence

... Pushbuttons -- select FM/SSB, receive preamp on/off and power on/off

... Free mobile mounting bracket

... Full one year MIRAGE warranty

... Legendary MIRAGE ruggedness

**35 watts, FM only... \$79**

B-34, \$79. 35 watts out for 2 watts in. Like B-34-G, FM only, less preamp, mobile bracket. 3 1/4 x 1 3/4 x 4 1/4 inches.



## MIRAGE Dual Band 144/440 MHz Amp

**MIRAGE RUGGED!**

BD-35  
**\$199**  
Suggested Retail



Power Curve -- typical Mirage BD-35 output power

Watts Out (2Meters)	30	40	45	45+	45+	45+	45+
Watts Out (440 MHz)	16	26	32	35+	35+	35+	35+
Watts In	1	2	3	4	5	6	7

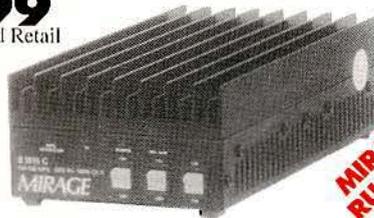
- 45 Watts on 2 Meter/35 W on 440 MHz
- Automatic Band Selection
- Single Connector for dual band radios and antennas
- Full Duplex Operation
- Reverse polarity protection
- Includes mobile bracket
- "On-Air" LEDs
- Works with all FM handhelds up to 7 watts
- One year Mirage Warranty

Add this Mirage dual band amp and boost your handheld to a powerful mobile or base -- 45 watts on 2 Meters or 35 watts on 440 MHz!

Mirage's exclusive FullDuplexAmp™ lets you talk on one band and listen on the other band at the same time -- just like a telephone conversation! (Requires compatible HT)

B-5016-G  
**\$299**  
Suggested Retail

# 160 Watts on 2 Meters!



**MIRAGE RUGGED!**

Power Curve -- typical Mirage B-5016-G output power

Watts Out	130	135	140	145	150	155	160	165	170
Watts In	20	25	30	35	40	45	50	55	60

MIRAGE's most popular amplifier gives you 160 watts of brute power for 50 watts input!

The B-5016-G is ideal for your 20 to 60 watt 2 Meter mobile or base station. Power Curve chart shows typical output power for your input.

## 6 Meter Amplifiers (50-54 MHz)



Bust through 6 Meters with 150 watts of brute power and work exotic DX! The A-1015-G, \$389, is the world's most popular all mode FM/SSB/CW 6 Meter amplifier. For 1 to 15 watt transceivers. 150 watts out for 10 in. A-1035-G, \$659, 350 watts out for 10 in. Both are a compact 12x3x5 1/2 inches.

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MIRAGE's most popular 70 cm amp -- the D-3010N, \$365 -- gives 100 watts out for 30 in. For 5 to 45 watt mobile/base. D-1010-N, \$395, 100 watts out for 10 in. Dual purpose -- for handhelds or mobile/base. D-26-N, \$269, 60 watts out for 2 in, for handhelds.

Prices and specifications subject to change. © 1996 Mirage Communications

You'll talk further, longer and clearer on all modes -- FM, SSB or CW -- and hear weak signals better than you've ever heard before!

Low noise GaAsFET preamp gives you excellent 0.6 dB noise figure for pulling out weak signals. Select 20 dB or 15 dB gain to minimize receiver overload and intermod.

The B-5016-G is legendary for its ruggedness. We know of one that has been in constant use since 1979!

Your B-5016-G is fully protected with features found only in pricey commercial amps.

The Mirage B-5016-G prevents damage from high SWR or excessive input power by bypassing the power amplifier. LED warns you.

Your expensive power transistors are protected from overheating by MIRAGE's Therm-O-Guard™.

The B-5016-G knows when you're transmitting and kicks in 160 watts of power. Adjustable

## Low noise GaAsFET Preamps



High gain ultra low noise GaAsFET preamps for receiving weak signals. Selectable gain prevents receiver intermod. 15 to 22 dB gain. Less than 0.8 dB noise figure. Automatic RF switching up to 160 watts.

Choose In-Shack model or Mast-Mount (includes remote control) model to reduce loss. Rugged die-cast enclosure.

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220-225	KP-1/220	KP-2/220
430-450	KP-1/440	KP-2/440

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Industry standard ATV amps -- D-1010-ATVN, \$414, 82 watts PEP out / 10 in. D-100-ATVN, \$414, 82 watts PEP out / 2 in. (without sync compression)

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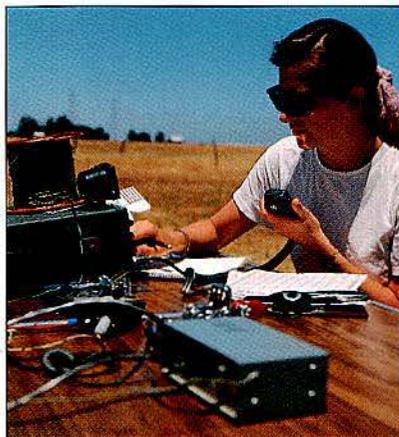
Here, Brad, KC1EX, operates ATV from W1INF.



Ham radio and hiking go well together! Zach Bergen, AA0FM, works VHF/UHF from Huron Peak in Colorado. (It's an inexpensive way to put up a 6000-foot-high antenna....) (photo by Bob Witte, KB0CY)



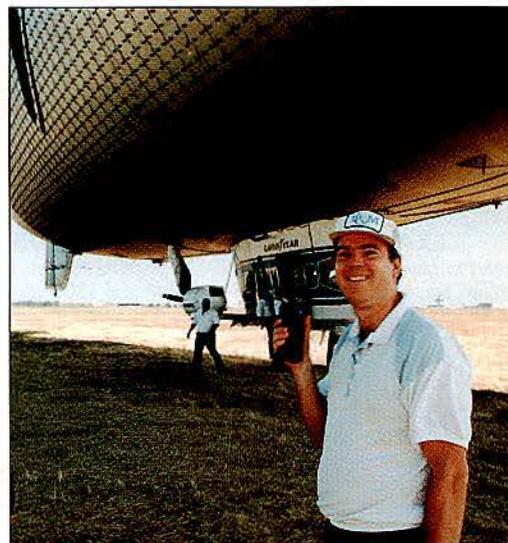
Here is Danish amateur B. V. Sorensen, OZ1UM, on one end of a 56-mile, 47-GHz conversation with Michael Kuhne, DB6NT, in Germany. You can build your own microwave gear and set up a "private" voice or computer link with friends across town! (photo by Steen Gruby, OZ9ZI)



Every June, ham clubs from around the country take to the hills to test their emergency operating skills. The two-day, fun-filled "competition" is the perfect place to meet new ham radio friends and improve your operating skills—and newcomers are always welcome. For a list of clubs in your area, call HQ at 800-32-NEWHAM. Shown here is Robin Wortley, KC6RUD, at a Field Day site in California.



Astronaut hams regularly operate from space shuttles in orbit, and with a simple 2-meter FM rig, you can join in the fun! Astronauts Dick, KB5SIW, and Ellen, KB5SIX, "ham" it up aboard *Columbia*.



Max Trescott, K3QM, prepares to take his hand-held transceiver aboard the Goodyear Blimp for some 2-meter airborne operating!

# Kit Building Is Fun...And Saves Money

A kit building tradition started with the dawn of ham radio in the 1920s, peaked in the 1960s and nearly vanished when HEATHKIT™ discontinued ham products in the 1980s. Many of you continue to encourage us to revive the tradition.

The T-Kit division of TEN-TEC is dedicated to putting the fun back into building. Our pledge is to design kits from the ground up to be built by average hams with simple test equipment. And best of all, kit building saves you money...20, 30 even 40% over comparable factory built gear. Have some fun and build your next project!

## 2 METER FM TRANSCEIVER

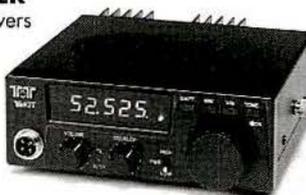
Building a sophisticated microprocessor controlled rig is easy with our step-by-step assembly manual. You build in sections and then make progress tests along the way. Added benefit is the knowledge to maintain it yourself for years to come. Only test equipment required is a VOM.

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  - Large LED readout
  - Build it now 5 or 30 watts, or upgrade to 30 watts later
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  - Complete enclosure, mike and mobile bracket included
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|------------|----------------------|--------|
| 1220 ..... | 5 watts out .....    | \$195* |
| 1222 ..... | 30 watt module ..... | \$64*  |



## 6 METER FM TRANSCEIVER

Same features as 2 meter model. Covers 50.095-54.1 MHz.  
1260.....5 watts out .....\$195\*  
(sorry, FCC rules forbid sales of add-on power amp)



## 220 MHz FM TRANSCEIVER--COMING SOON

## EXPLORE 6 METERS FOR ONLY \$95

No need to buy a complete transceiver to discover the fun of 6 meters. T-Kit offers two transverters to choose from. Model 1209 converts your 2 meter handheld or mobile rig to 6. All features and modes on your 2 meter rig immediately available on 6 (FM SSB CW). Tune 144-148 MHz to work 50-54 MHz. Model 1208 converts any modern HF rig with 20 meters to 6. Tune 14-16 MHz to work 50-52 MHz.

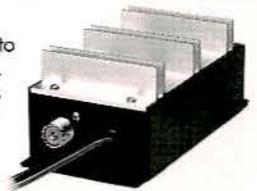
- 5 watts max input delivers 8 watts out
  - Only 1.3"H, 7.25"W, 6.125"D
  - Simple hookup, no mods needed to most rigs
  - Silent RF-sense PIN diode T/R switching
- |             |  |        |
|-------------|--|--------|
| 1208 .....  | 20 to 6 meter, kit .....               | \$95*  |
| 1208A ..... | 20 to 6 meter, factory assembled ..... | \$159* |
| 1209 .....  | 2 to 6 meter, kit .....                | \$95*  |
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## 2 METER AMP

Easy to build amp boosts your 1-5 watt HT to 20-35 watts for mobile or fixed operation. Includes painted case and heatsink. Covers 144-148 MHz plus MARS/CAP. Fast RF-sense T/R switch. Class C. BNC input, SO239 output.

- |             |                         |        |
|-------------|-------------------------|--------|
| 1200 .....  | kit .....               | \$74*  |
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## DUAL BAND SWR/Rf WATTMETER

Connectors for both HF and VHF let you leave meter in line with BOTH rigs. Front panel switch between HF and 2 meters. Measure power or SWR on 20 or 200 watt ranges. 1.8-30 MHz and 144-148 MHz.

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## 4-BAND RECEIVER ONLY \$24

This Regen beats the pants off those favorite 3-tube radios of the 1950s. Covers 49 and 31 meter SW bands, 40 and 20 meter ham bands plus 12-15 MHz. Includes front panel. Dress it up with your own case and knobs. Push button bandswitch, Main Tuning, Regen control, volume, on-off switch. You provide DC, stereo phones or speakers. Popular group project!

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| 1054 ..... | \$24* | Buy 5 for \$110* |
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- |            |       |
|------------|-------|
| 1056 ..... | \$29* |
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# FM and Repeaters

Get started the *right* way on the most popular mode among new American ham radio operators.

By Brian Battles, WS10



**E**veryone is new to something. As a licensed Amateur Radio operator, you're probably familiar with (and eager to use) local FM repeaters. Don't grab that mike and start talking just yet, though! Because many hams don't have proficient, seasoned "Elmers" to help them learn the ropes, we'll try to help you start off on the right foot with this article.

Most radio amateurs don't make a fuss over issues of "etiquette and protocol," but hams are protective and proud of the courteous operating procedures that have become standards. You may bump into an occasional ill-mannered character who appears inclined to criticize or ridicule a newcomer, but take it in stride. The most skillful radio amateurs are those who display tolerance and encourage the efforts of newcomers. As with any established pursuit, it's best to avoid the embarrassment of making gross *faux pas* in public by simply taking the time to learn the customs and practices accepted and expected by more experienced participants.

## Your License is an Opportunity

Once upon a time, it was traditional for most hams to start out in Amateur Radio as Novices. They were limited to operating with low-power CW on a few small slivers of the HF bands below 30 MHz. As the FCC rules have evolved, however, new hams have been granted authorization to operate on more frequencies, using a wide variety of modes. The most popular entry level license today is the Technician class, which includes full amateur privileges above 30 MHz. In addition to their HF privileges, Novices may operate FM simplex at 222-225 MHz and FM simplex, or through repeaters at 222.15-225.0 MHz and 1270-1295 MHz.

Your new amateur license is a great opportunity for getting involved with VHF and UHF FM repeaters. Unprecedented numbers of friends and family members now enjoy being able to get in on the excitement and rewards of Amateur Radio. Many have become involved in public service, emergency communication support, traffic handling or just keeping in touch with their ham friends. New hams are welcome to join repeater clubs and support their activities.

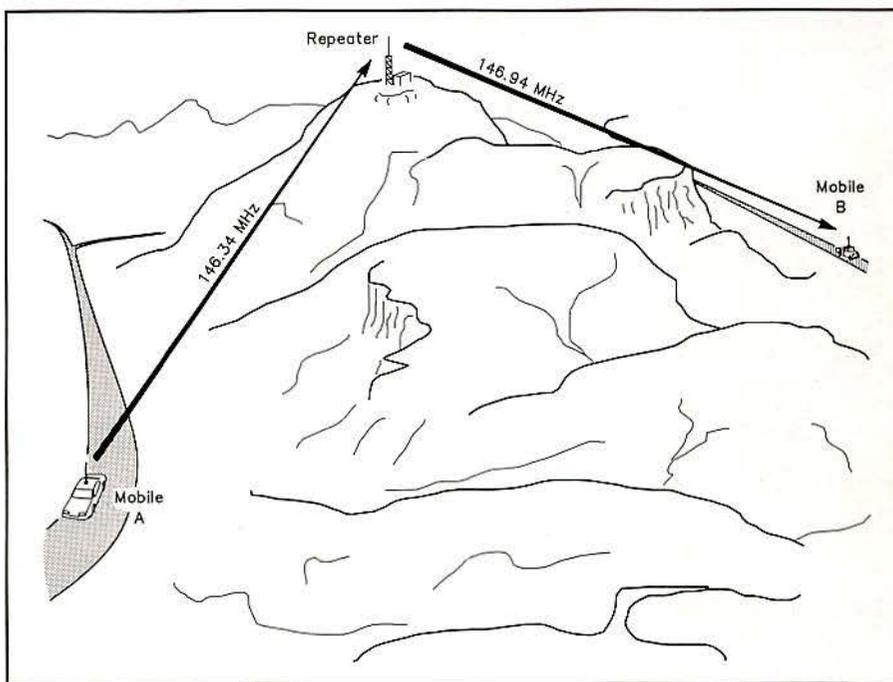


Fig 1—The mountain blocks direct (simplex) communication between mobile stations A and B. When mobile A transmits on 146.34 MHz, however, the repeater detects its signal and relays it to mobile B on 146.94 MHz. When it's mobile B's turn to talk, the same relay process takes place in reverse.

In Amateur Radio, the most popular communication activity across the US is using VHF/UHF FM repeaters. American hams are in good company; many other countries also offer codeless VHF/UHF-only licenses and have thousands of active FM operators.

## Getting Acquainted with the "Machines"

American hams often call a repeater a "machine." A repeater is an Amateur Radio station designed to receive signals on one frequency and simultaneously retransmit them on another. Because they receive and transmit on different frequencies, they can do so simultaneously. To use a repeater, you operate your transceiver in the "split" mode. You listen to the repeater's output frequency and transmit on its input (see Fig 1). Because its receiver is separate from its transmitter, a repeater is a duplex de-

vice. That means signals go into and out of it at the same time.

Another term you'll hear is simplex, which just means direct, two-way ham-to-ham communication. It's always better to operate simplex than to use a repeater, if possible. The ideal practice is for repeaters to be used only as a secondary means of communicating if your equipment isn't able to maintain direct contact with another station. The agreed-upon national simplex frequencies are 146.52, 223.50, 446.0, 906.5 and 1294.5 MHz.

A repeater is usually located in a high place where it can be easily heard by users over a wide area. The idea is to extend the reach of hand-held and mobile transceivers that normally have limited, line-of-sight range.

Nearly every active amateur has used an FM repeater. The US is liberally dotted with machines. The largest number by far is on the 2-meter band, but don't limit

## VHF/UHF FM Terminology

**access code:** one or more numbers and/or symbols that are keyed into the repeater with a telephone tone pad to activate a repeater function, such as an autopatch.

**autopatch:** a device that interfaces a repeater to the telephone system to permit repeater users to make telephone calls. Often just called a "patch."

**break:** the word used to interrupt a conversation on a repeater to indicate that there is an emergency.

**channel:** the pair of frequencies (input and output) used by a repeater.

**closed repeater:** a repeater whose access is limited to a select group.

**control operator:** the Amateur Radio operator who is designated to *control* the operation of the repeater, as required by FCC regulations.

**courtesy beep:** an audible indication that a repeater user may go ahead and transmit.

**coverage:** the geographic area within which the repeater provides communication.

**CTCSS:** continuous-tone coded squelch system. This is a system in which the repeater's receiver will only respond to signals that carry a subaudible tone in addition to the audible voice signal transmitted by a ham transceiver. The purpose is to reduce the amount of unwanted signals that may activate the repeater. Sometimes called "PL," although this is Motorola Corp's registered trademarked term for the CTCSS implementation it calls "Private Line."

**frequency coordinator:** an individual or group responsible for assigning channels to repeaters so that they won't interfere with other repeaters.

**full quieting:** a received signal that contains no noise. Sometimes you'll hear hams use the term "DFQ," which means "dead full quieting."

**hand-held:** a portable transceiver small enough to fit in the palm of your hand or clipped to your belt. Sometimes called an H-T or handie-talkie.

**key up:** to turn on a repeater by transmitting on its input frequency.

**link:** many repeater systems have the capability to interconnect receivers and transmitters on more than one band. A 2-meter repeater, for example, may have a repeater on the 440-MHz band. The repeaters can be tied together (ie, all signals received on 2 meters or 440 MHz are simultaneously retransmitted on 2 meters and 440 MHz, and vice versa). When the repeaters are in this state, they are said to be

"linked." In this operating mode, users on one band can't readily tell what band other users are actually coming in on because the repeater equipment automatically carries the incoming signals across both bands. Such repeaters may be linked or unlinked by remote control, by users or by a designated control operator, and may have coded courtesy tones (see above) that indicate the status of the links. Complex systems may provide links to operators on 29, 50, 144, 222, 440, 902 and 1270 MHz.

**machine:** a repeater system (slang).

**magnetic mount, mag-mount:** a mobile antenna with a magnetic base that permits quick installation and removal from a motor vehicle.

**NiCd:** a nickel-cadmium battery that may be recharged many times; often used to power portable transceivers. Pronounced "NYE-cad."

**open repeater:** a repeater whose access is not limited.

**output frequency:** the frequency of the repeater's transmitter (and your transceiver's receiver).

**picket fencing:** if a repeater user's signal isn't strong enough to maintain solid access to the machine's input (such as when operating from a vehicle passing beneath underpasses or through hilly terrain), the signal would be hard to copy because of a pronounced, rapid flutter or choppy characteristic. It sounds as if the transmitting station is passing behind a picket fence that alternately blocks and passes its signals. Picket fencing usually ceases when the transmitting station moves closer to the repeater or into a clearer location.

**simplex:** a mode of communication in which you transmit and receive on the same frequency.

**time-out:** to cause the repeater or a repeater function to turn off because you've kept it operating for too long in one continuous transmission.

**timer:** a device that measures the length of each transmission and causes the repeater or a repeater function to turn off after a transmission has exceeded a certain length. Timers are used to protect the machine from damage if a station accidentally activates it for too long (as may happen if someone sits on his radio, unknowingly depressing his transceiver's PTT button) or to prevent operators from hogging the machine with excessively lengthy transmissions.

**tone pad:** an array of 12 or 16 numbered keys that generate the standard telephone dual-tone multifrequency (DTMF) dialing signals.

yourself: Novices can operate on 222 and 1270 MHz, while Technicians can also use 50, 222, 440, 902, 1240 MHz and above. As a licensed ham you can join the fun on a variety of bands.

To use FM repeaters, you need to know the frequencies of the machines in your area. Local hams can provide information about repeater activity. Check with members of a local club. Ask the Volunteer Examiners who administered your license test. Once you find a repeater to use, resist the urge to transmit immediately. Listen to it for a while and familiarize yourself with its operating procedures and etiquette.

### Courtesy is the Key

The key to success on the air is described by one word: *Courtesy*. There's no other way to explain how hundreds of thousands of ladies and gentlemen can share the same radio frequencies worldwide with a minimum of interference and conflict. An attentive, courteous operator is welcome anywhere. If you keep courtesy at the front of your mind, you'll rarely have difficulty on the air. Before making your first transmission in the world of FM and repeater communication, however, you should also be aware of basic operating techniques. These vary slightly with local custom, but here

are some general suggested procedures:

There are no laws or national rules regarding the details of appropriate procedures for seeking a contact on an FM repeater. Depending on your location, different local customs dictate the preferred method to initiate a two-way radio contact via a local machine. In most areas, if the repeater is quiet, press the switch on your mike and transmit your call sign as, "WS10 standing by," "WS10 listening," "WS10 monitoring" or simply "WS10." After you stop transmitting, the repeater may send an unmodulated carrier for a couple of seconds to let you know it's working. If anyone is

## ARRL Autopatch Guidelines

Autopatch operation involves using a repeater as an interface to a local telephone exchange. Hams operating mobile or portable stations are able to use the autopatch to access the telephone system and place a call. Hams use autopatches to report traffic accidents, fires and other emergencies. There's no way to calculate the value of the lives and property saved by the intelligent use of autopatch facilities in emergencies. The public interest has been well served by amateurs with interconnect capabilities. As with any privilege, this one can be abused and the penalty for abuse could be the loss of the privilege for all amateurs. The suggested guidelines here are based on conventions that have been in use for years on a local or regional basis throughout the country. The ideas they represent have widespread support in the amateur community. Amateurs are urged to observe these standards carefully so our traditional freedom from government regulation may be preserved as much as possible.

1) Although it's not the intent of the FCC Rules to let Amateur Radio operation be used to conduct an individual's or an organization's commercial affairs, autopatching involving business affairs may be conducted on Amateur Radio. (The FCC has stated that it considers nonprofit and noncommercial organizations "businesses.") On the other hand, amateurs are strictly prohibited from accepting any form of payment for operating their ham transmitters, they may not use Amateur Radio to conduct any form of business in which they have a financial interest and they may not use Amateur Radio in a way that economically benefits their employers.

Amateurs should generally avoid using Amateur Radio for any purpose that may be perceived as abuse of the privilege. The point of allowing hams to involve themselves in "business" communication is to make it more convenient and to remove obstacles from ham operations in support of public service activities. Before this rule was revised in 1993, it was often technically illegal for amateurs to participate in many charitable and community service events because the FCC regarded any organization, commercial or noncommercial, as a business with respect to the rules, and prohibited hams from making any communications to in any way facilitate the business affairs of any party. That meant that operating a talk-in station for a local nonprofit radio club's hamfest constituted a violation!

So now it's legal to use ham frequencies, including autopatch facilities, to communicate in such a way as to facilitate a business transaction. The distinction is essentially whether the amateur operator or his employer has a financial stake in the communication. This means that a ham may use a patch to call someone about a club event or activity, to make a dentist appointment, to order a pizza or to see if a load of dry cleaning is ready to be picked up. In such situations, the ham isn't in it for the money. However, no one may use the ham bands to dispatch taxicabs or delivery vans, to send paid messages, to place a sales call to a customer, or to cover news stories for the local media (except in emergencies if no other means of communication is available). If the ham is paid for or will profit from the communication, it may not be conducted on an amateur frequency. That's why there are telephones and commercial business radio services available.

Use care in calling a business telephone via an amateur autopatch. Calls may be legally made to one's

office to receive or to leave personal messages, although using Amateur Radio to avoid the cost of public telephones, commercial cellular telephones or two-way business-band radio isn't considered appropriate to the purpose of the amateur service. Calls made in the interests of highway safety, such as for the removal of injured persons from the scene of an accident or for the removal of a disabled vehicle from a hazardous location, are clearly permitted.

A final word on business communications: Just because the FCC says that a ham can place a call involving business matters on a repeater or autopatch doesn't mean that a repeater licensee or control operator must allow you to do so! If he or she prefers to restrict all such contacts, he or she has the right to terminate your access to the system. A club, for instance, may decide that it would rather not have members order commercial goods over the repeater autopatch and may vote to forbid members from doing so. The radio station's licensee and control operator are responsible for what goes over the air and have the right to refuse anyone access to the station for any reason.

2) All interconnections must be made in accordance with telephone company rules and fee schedules (tariffs). If you have trouble obtaining information about them from telephone company representatives, the tariffs are available for public inspection at your telephone company office. Although some local telephone companies consider Amateur Radio organizations to be commercial entities and subject to business telephone rates, many repeater organizations, as noncommercial volunteer public service groups, have successfully arranged for telephone lines at repeater sites to be charged at the lower residential rate.

3) Autopatches should not be made solely to avoid telephone toll charges. Autopatches should never be made when normal telephone service could be just as easily used. The primary purpose of an autopatch is to provide vital, convenient access to authorities during emergencies. Operators should exercise care, judgment and restraint in placing routine calls.

4) Third parties (nonhams) should not be put on the air until the responsible control operator has explained to them the nature of Amateur Radio. Control of the station must never be relinquished to an unlicensed person. Permitting a person you don't know well to conduct a patch in a language you don't understand amounts to relinquishing control because you don't know whether what they are discussing is permitted by FCC rules.

5) Autopatches must be terminated immediately in the event of any illegality or impropriety.

6) Station identification must be strictly observed.

7) Phone patches should be kept as brief as possible, as a courtesy to other amateurs; the amateur bands are intended primarily for communication among radio amateurs, not to permit hams to communicate with nonhams who can only be reached by telephone.

8) If you have any doubt as to the legality or advisability of a patch, don't make it. Compliance with these guidelines will help ensure that amateur autopatch privileges will continue to be available in the future, which helps the Amateur Radio service contribute to the public interest.

interested in talking to you, they'll call you after your initial transmission. Some repeaters have specific rules for making yourself heard, but usually your call sign is all you need. In a few areas, users may call CQ to initiate a conversation on a repeater, but most hams use the term "CQ" only on HF or on VHF/UHF simplex frequencies, and don't call CQ on a local FM machine. Ask a ham neighbor (off the air) or listen to the repeater to hear how others do it.

If you want to join a conversation in progress, transmit your call sign between the other stations' transmissions. The station that transmits next should acknowledge you. As with calling CQ, local customs determine appropriate operating procedures. In most areas, don't use the word "break" to join a routine conversation. In most parts of the country, "break" usually suggests an emergency and "break, break" or "break, break, break" indicates a serious emergency. In any case, all stations should stand by for a station with emergency traffic.

If you want to call a station and the repeater is inactive, simply call the other station. (For example, "WB8IMY, this is WS10." If the repeater is active, but the conversation in progress sounds as though it's about to end, be patient and wait until it's over before calling another station. If the conversation sounds like it's going to continue for a while, transmit your call sign between transmissions. After one of the other hams acknowledges you, politely ask to make a quick call. Usually, the other stations will yield to you. Make your call short. If your friend responds to your call, ask him to move to a simplex frequency or another repeater, or to stand by until the present conversation is over. Thank the other users for letting you interrupt them to place your call.

Likewise, if you're in the midst of a conversation and another ham transmits his call sign between transmissions, the next station in the queue to transmit should acknowledge that station and permit the newcomer to make a call or join the conversation. It's discourteous not to acknowledge him and it's impolite to acknowledge him but not let him speak. You never know; the calling station may need to use the repeater immediately. The other operator may have an emergency on his hands, so let him make a transmission promptly.

Some hams can't keep their thumbs off the push-to-talk (PTT) switch. It's been suggested that this button be renamed Release To Listen (RTL)! A brief pause before you begin each transmission allows other stations to participate in the conversation. Don't key your microphone as soon as someone else releases his. If your exchanges are too quick, you'll block other stations from getting in.

The "courtesy beeps" on some repeaters compel users to leave spaces between transmissions. The beep sounds a second or two after each transmission to permit new stations to transmit their call signs in the intervening time period. The conversation may continue only after the beep sounds. If a station is too quick and begins a long transmission before the beep, the repeater may respond to the violation by temporarily shutting down!

Keep each transmission as short as possible. Short transmissions permit more people to use the repeater. All repeaters promote this practice by having timers that "time-out," temporarily shutting down the repeater whenever the length of a transmission exceeds the preset time limit. Learn the length of the repeater's timer and stay well within its limits. The length may vary with each repeater; some are as short as 15 seconds and others are as long as three minutes.



Tammy-Beth Zimmerman, KA1WWP, chats with friends on the local repeater. (photo by Kirk Kleinschmidt, NT0Z)

Some repeaters automatically vary their timer length depending on the amount of traffic on frequency; the heavier the traffic, the shorter the timer.

If two hams try to talk on a repeater at once, the resulting noise is known as a "double." If you're in a roundtable conversation, it's easy to lose track of which station is next in line to talk. There's one simple solution to eradicate this problem: Always pass off to another ham by name or call sign. Saying, "What do you think, Jennifer?" or "Go ahead, 'YUA" eliminates confusion and avoids doubling. Try to hand off to whoever is next in the queue, although picking out anyone in the roundtable is better than just tossing the repeater up for grabs and inviting chaos.

The key to skillful, courteous FM repeater operation is to be brisk and to the point, and to leave plenty of room for others. Keep it moving. Don't drone; dart in and out. Don't hem and haw or be reluctant to "yield the floor." Your turn will come again in a moment. Turn it over, pause for others, get things rolling. Snappy, clearheaded ex-

changes sound sharp and are more enjoyable for your QSO partners.

### Following the Rules

You must communicate your call sign at the end of each transmission or series of transmissions and at least every 10 minutes during the course of a contact. You don't have to transmit the call sign of any other station, including the one you're contacting. Sometimes it's a good idea to identify a bit more often during a long conversation or roundtable chat, so that others can figure out who you are without waiting 10 minutes. It's illegal to transmit without identification. Aside from breaking FCC rules, it's poor operating practice to key your microphone to turn on a repeater without identifying your station. This is called "kerchunking" the repeater. If you don't want to have a conversation, but simply want to check whether your radio works or if you're able to access a particular repeater, simply say, "WS10 testing." This way you accomplish what you want to do legally.

Simplex is a fancy-sounding word for a direct contact on a single frequency. After you've made a contact on a repeater, move the conversation to a simplex frequency, if possible. The function of a repeater is to provide communications between stations not able to communicate directly because of terrain or equipment limitations. If stations are able to communicate without a repeater, they shouldn't use a repeater. Always use simplex whenever possible so that the repeater will be available for stations that need its facilities. Simplex communication offers a degree of privacy impossible to achieve on a repeater. There's also no timer to worry about or courtesy beep to wait for. When selecting a frequency, make sure it's designated for FM simplex operation. There are frequencies specifically set aside for simplex. To help you choose an appropriate frequency, consult the complete list in *The ARRL Repeater Directory*, an indispensable book for VHF/UHF operators. If you select a simplex frequency indiscriminately, you may interfere with other repeaters or stations operating in other modes (and you may not be aware of it).

Repeater facilities must not be used for the broadcasting of information of interest to the general public. If a repeater can transmit information of interest to the general public, such as weather reports, those transmissions must occur only when requested by a licensed amateur and must not conform to a specific time schedule. The retransmission of radio signals from other services is not permitted in the amateur service except with special permission, as specified in Part 97.113(e). (For example, you can retransmit a NOAA weather broadcast under certain

## Calling 911

During an emergency, you may be the first or only person available to report it to the appropriate public safety agency (police, fire or rescue). When this happens, the most crucial information you must provide is the nature of the emergency and its precise location. The primary purpose of autopatching is the capability to place telephone calls to public service agencies if you need to report an emergency. That may not always be as simple as it sounds. There are also technical considerations that have the potential to create confusion.

More than 30 million Americans are served by Enhanced 911 Service. This service permits Public Service Answering Points (PSAPs) to automatically identify the number of the telephone from which a 911 call is placed and to pinpoint its location. Many repeaters are set up so hams can dial 911 via their radios. Enhanced 911 Service complicates matters. If you dial 911 via repeater autopatch, the PSAP attendant receives a computer display or printout of the location of the repeater's telephone equipment. Unless the emergency happens to be at the repeater site, this information is useless and misleading. Instead, you must inform the PSAP attendant that the emergency is located elsewhere.

The PSAP attendant has no interest in hearing that you're a ham radio operator, that you're using a repeater autopatch or what your call sign may be. The main concern is the emergency and exactly where the response personnel must be sent. Before you dial 911 on an autopatch, you must know precisely where assistance is needed. Don't say, "I'm not sure where I am, but I just passed an exit sign that said Central City," or "I'm somewhere on Route 2 heading south out of Springfield." When you place the call, immediately tell the operator what happened and where. It's a good idea to grab a pencil and paper, and note the details first. Be prepared to say, "I'm a ham radio operator calling from my car and I'd like to report a westbound tractor-trailer truck that just overturned on the center median at mile marker 32 on Interstate 20 just east of Glendale. I'm at the accident site and the driver is conscious, but he's stuck inside the cab and appears to be injured." This is no time to describe Amateur Radio, repeaters or autopatching. The PSAP attendant probably doesn't even care about your name, much less your call sign or other mumbo jumbo. If he needs to know more, he'll ask you. He may ask if there is a fire, if other vehicles are involved, if traffic is obstructed, whether there's any sign of a chemical spill or how recently the accident happened. Otherwise, complete the call and terminate the patch.

It's important to know what truly constitutes an emergency. Call 911 when there's immediate danger to human life or property. This includes auto accidents, fires, airplane crashes, floods, hurricanes, tornadoes, criminal assaults, downed electrical power lines, accidents while hiking, camping, skiing or boating, a person suddenly taken ill, and other such traumatic situations. It doesn't include disabled vehicles (flat

tires and the like), littering, animals struck by cars and other such incidents which *have* been reported to PSAP attendants by hams and other people.

Your local Amateur Radio club may be able to prepare its members for a valuable community service by arranging a training session to be given by public safety officials familiar with the operation of Enhanced 911 Services. They can explain how it works in your area and what are the right ways to use it. There are particular techniques and details that make PSAP attendants' jobs easier and improve your ability to effectively summon aid when it's needed.

One other thing to keep in mind: There are thousands of cars equipped with mobile cellular telephones today. Unlike a decade ago, you're not likely to always be the only person around who's equipped for immediate communication with public safety agencies. You should, however, be a trained, skillful professional communicator when it comes to using your equipment. Because most nonhams aren't trained to communicate under emergency conditions, public safety agencies continue to respect Amateur Radio operators as a reliable source of backup communication support in emergencies. To maintain that high standard, it's vital that you receive the proper training and keep your skills sharp through drills, practice and experience. Someday your ham radio may save someone's life.

**Table 1**

### Authorized Repeater Bands

The FCC permits US amateurs to operate repeaters in the following frequency ranges:

Frequency (MHz)	Wavelength
29.5-29.7	10 meters
51.0-54.0	6 meters
144.5-145.5	2 meters
146-148	
222.15-225.0	1.25 meters
420-431	70 cm
433-435	
438-450	
902-928	33 cm
1240-1300	23 cm

The ARRL has published bandplans to guide amateurs in the establishment and use of operating modes on all ham bands, based on organized general agreement among all Amateur Radio operators in the interest of cooperation and operating practice. Appropriate frequencies for each type of authorized amateur operation are specifically recommended for each amateur band. For example, there are explicit segments of the above subbands where the general amateur population accepts repeater operation and other segments where it is strongly discouraged.

circumstances.) The retransmission of taped material from other sources is permitted. You could play back a tape recording of a friend reading instructions for wiring a TNC, provided you follow accepted amateur practices and identify your station appropriately. The idea is that an amateur station is not a broadcasting facility and its intended audience is other licensed amateur stations, not the general public.

### Support Your Local Repeater

How often do you stop to think of what goes into the machine you conveniently use any time, 24 hours a day, 365 days a year?

It takes time, money, knowledge and energy to operate a reliable repeater system. Nobody should feel compelled to join any group, and you can use thousands of repeaters across the US without joining any clubs. If you frequent a system, however, or just want to contribute to the cost of its upkeep so it can be counted on in an emergency, support your local repeater.

Make it a habit to run your transceiver on a low-power setting. There's usually no need to pump out heavy watts on VHF or UHF FM if you're within a reasonable range of a repeater or other station operating simplex. High power can also interfere

with distant repeaters on the same frequency.

### Helpful Tips

Inspect your station regularly for loose connections, broken wires, antenna problems, intermittent grounds and other potential weak spots. Mobile installations are most prone to wear and damage. Using minimum power is not only a courtesy to the distant repeaters, but an FCC requirement.

The following guidelines are worth remembering to help promote efficient communication and harmony between operators.

## Additional Reading

*QST* is the monthly publication sent to all ARRL Members. It features news, technical and general-interest articles of interest to all amateurs, ARRL organizational information, projects, correspondence and regular features. The FM & Repeaters column is particularly valuable to VHF/UHF simplex and repeater operators.

### *The ARRL Operating Manual.*

This is the ultimate all-in-one book that covers every kind of on-air ham radio activity. Chapter 11 is devoted to FM and repeater operating.

### *The ARRL Repeater Directory.*

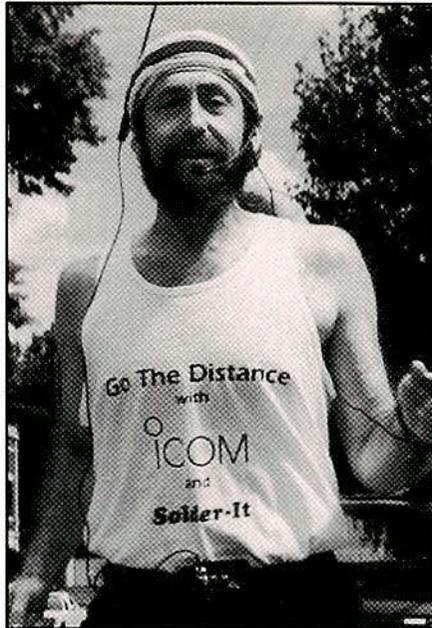
The annual pocket-sized book lists more than 19,000 repeaters in the US and Canada on 10, 6, 2, 1.25, 0.70, 0.33 and 0.23 meters and above. Listings include FM voice, packet radio and amateur television machines. Repeaters are listed geographically by band, state, served communities and modes. There are operating tips, band plan charts, club listings and more.

*The FCC Rule Book.* A comprehensive book that contains the complete text of 47 CFR Part 97 (the FCC regulations covering Amateur Radio) and a detailed practical discussion and interpretation of the rules. Every ham should own a copy and have it readily accessible for review.

*The ARRL Handbook.* Since the earliest days of Amateur Radio, this has been the world's most popular reference to the technical side of the radio hobby. There are detailed plans and construction projects on building, modifying and using all types of equipment for VHF and UHF operation. A new edition is published every year.

*Now You're Talking!* The complete license-preparation guide for the FCC Novice and Technician written examinations. This book introduces Amateur Radio to newcomers and explains the rules and theory covered by the tests given to beginning hams. Chapter 9 contains operating tips for FM and repeaters.

*Your VHF Companion.* A definitive 200-page guide to Amateur Radio operating on frequencies above 30 MHz, with practical information on a variety of modes, such as FM, single sideband, CW, packet, moonbounce, transmitter hunting, satellite communication, amateur TV and more. Chapter 2 is all about FM and repeaters.



Fred Doob, AA8FQ, trains for the New York Marathon while enjoying FM conversations using a hand-held transceiver and a headset. (photo courtesy ICOM America)

### DOs:

□ Speak clearly and don't key or unkey your microphone as you start or finish talking. Give your rig and the repeater a moment to come on. This ensures that listeners won't miss any part of your transmission. Repeated transmissions take up unnecessary air time.

□ If the repeater has a courtesy tone, wait until you hear it before transmitting. This allows time for other stations to break in if necessary, and allow the system to reset. If you don't hear a courtesy tone, wait 2-3 seconds after the previous user has finished before making a transmission.

□ If you hear a jammer, *ignore him*. Resist the temptation to "set the jammer straight." *Don't acknowledge his presence in any way.* Anything you might say about it probably doesn't belong on the band and may contribute to the problem. If the jammer has no audience, he won't have any fun and will soon be gone. If repeater jamming becomes a persistent problem, get in touch with your ARRL Section Official Observer Coordinator (OOC) to ask for advice. You can find out who your OOC is by reading the Section News column in *QST*, or by contacting your Section Manager (SM). You'll find your SM's address and telephone number in any recent *QST* or you can call ARRL Headquarters.

Repeater traffic priorities:

- 1) Emergency and priority.
- 2) System test or maintenance transmissions by control operators or system owners.
- 3) Public service.

4) Fixed (base) stations should ensure that mobile and portable stations have priority, especially at 6-8 AM and 4-6 PM. The weekday commute hours are the only time many hams can get on the air.

5) Fixed (base) station communications.

□ Follow the FCC's requirement to identify your station once every 10 minutes and at the end of a QSO. But don't "over identify" by sending your call sign after every transmission.

□ Ask somebody for a signal report if you're using a hand-held transceiver with a "rubber ducky" antenna. Little rigs can't always capture the repeater's receiver adequately. The excessive noise of partial quieting made by weak signals may make your transmissions uncopyable and is irritating to those who monitor for extended periods.

□ There are always other operators and people with scanners listening. Don't say anything that should be "private," and do your best to sound friendly, professional and courteous.

### DON'Ts:

□ Don't use radio jargon. Talk as you would over the telephone. Listen and learn from the examples of experienced users. Don't say things like "QSL," "Roger that," "10-4," "What's your QTH?" and "The handle here is...". Such terminology is often a misused habit carried over from HF, Citizens Band or public safety services, and on Amateur Radio repeaters it confuses more than it communicates. There are probably hundreds of other hams listening to the machine and nonhams monitoring with scanners. You may not hear them, but they hear you. Ensure that they get the best impression of your operating skill and of the Amateur Radio service.

□ Don't break an ongoing conversation unless you have emergency or priority traffic or something valuable to add.

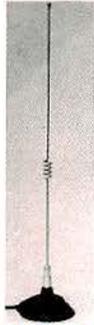
□ Don't use the repeater to shoot the breeze endlessly with a local station. Make your contact and move to a simplex frequency. The system is designed for mobile and long-distance QSOs, not for local ragchewing.

□ Don't drag out a conversation longer than necessary. Allow others to use and enjoy the system. Limit your ragchews to a reasonable length, especially during commuting hours.

□ Don't use excessive or insufficient microphone gain. Your transceiver's microphone input circuitry is technically advanced, but it isn't foolproof. Distorted voices and background noise make it difficult to carry on an enjoyable contact. Speak across, rather than directly into, the mike element and talk at a reasonable volume level. Nothing's more frustrating than operating a mobile station and trying to copy someone who mumbles. It's also irritating to have one person in a roundtable whose voice is extraordinarily loud. If in doubt, ask other users for an audio report.



# MFJ Dual Band Mobile Antenna



For an incredible \$14.95, you get a dual band 2 Meter/440 MHz mobile antenna with strong magnet mount, stainless steel radiator, 15 feet of coax and BNC adapter for your handheld -- It's the fastest selling mobile antenna in ham radio!

MFJ-1724B For an incredibly low \$14.95, you get an MFJ dual band 2 Meter /440 MHz mobile antenna!

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You get excellent gain for solid, noise-free QSOs. On 440 MHz, it's

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Dual band ground plane antenna for 2 Meters and 440 MHz gives you extra long range

on 440 MHz with a high gain halfwave over quarter wave radiator. On 2 Meters you get solid quarter wave performance. Mounts on 1 to 1 1/2 inch mast with single U-bolt. Easy-to-tune.

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You get easy tuning, low loss ceramic antenna insulator and strong lightweight aluminum construction.

Single U-bolt mounting for 1 to 1 1/2 inch mast. Cutting chart included for 220/440 MHz. Made in USA.

## MFJ Pocket Roll-Up™ 2 Meter halfwave J-pole antenna

MFJ-1730 **\$14.95**

Roll up this halfwave 2M J-pole antenna and stick it in your pocket! It's

the perfect gain antenna for traveling. Get home station performance on the go. Just hang your MFJ Pocket Roll-Up™ in the clear and plug the BNC connector into your handheld.

It's omni-directional and has significant gain over a 1/4 wave. It does not need a cumbersome ground plane so it's convenient for indoors and works great with handhelds. Made in USA

## Dual Band flexible Ducks 144/440 MHz flexible ducks for HTs

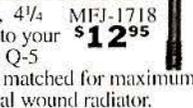
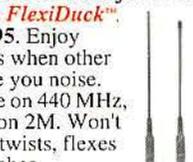
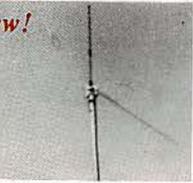
A. High Gain FlexiDuck™

MFJ-1717, \$19.95. Enjoy dependable QSOs when other rubber ducks give you noise. High gain 1/2 wave on 440 MHz, full size 1/4 wave on 2M. Won't jab you -- bends, twists, flexes with you. 15 3/4 inches.

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Add this short, 4 1/4 inch ShortyDuck™ to your 2M handheld for a Q-5 signal! Impedance matched for maximum gain. High-Q helical wound radiator.



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Competitive 5/8 wave mobile antennas can't work any better -- no matter how much more they cost.

You get low SWR so your rig can safely deliver maximum power into your antenna. It's rated at 300 watts PEP so you can use any mobile rig plus a mobile amplifier.

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# Get Out of the Shack and into the Action

Public service communications is a golden opportunity to demonstrate how ham radio operators can assist their friends and neighbors.

By Brian Battles, WS10

**T**he parade marches by as a lost child is reunited with her mother. Bike racers whiz past a just-fallen colleague as a first aid wagon quickly pulls up to administer assistance. A Boy Scout with a twisted ankle is carried to the Jamboree's medical tent after a mishap along the trail. The checkpoint is well-stocked with extra water and towels when the walk-a-thoners trudge up the long hill. Volunteer Amateur Radio operators, carefully patrolling with hand-held transceivers, alerted event officials in the above incidents.

## Fulfill a Need

Providing communications at public events is an Amateur Radio tradition, and with so many reliable VHF and UHF repeaters and portable transceivers, the coverage hams provide is remarkable. FCC rules concerning Amateur Radio involvement in so-called "business" communication have changed. See the sidebar "The FCC's Views: Business Communications."

## Accept the Challenge

Can you do it? All you need is a hand-held transceiver. Most public service communications are handled on VHF and UHF frequencies because few activities spread out far enough that line-of-sight repeater coverage is not adequate. Two meters is most popular, but 6 meters to 23 cm are used, and if you own a hand-held transceiver, you can "get in on the act" and enjoy a rewarding facet of Amateur Radio.

## Experts Helping Experts

If you're a member of an ARRL Special Service Club, the Amateur Radio Emergency Service (ARES) or other active Amateur Radio club, you'll probably be invited to go along on public service out-

ings. These events also offer excellent training for emergency communications. If you haven't gotten involved with a club yet, or if your club hasn't engaged in such activities, ask around on the air and check the local nets. Your ARRL Section Manager (SM), Section Emergency Coordinator (SEC), Affiliated Club Coordinator (ACC) or Section Traffic Manager (STM) may be able to give you advice (to find out who they are, see any issue of *QST*).

If no one in your area actively pursues these projects, find someone experienced in public service communications support and ask him or her to train your group. See if someone will visit your club and describe how other clubs have tackled similar

can't. Bring hand-held transceivers along to demonstrate FM repeaters, but only use them if necessary. Your task is not to educate people about technical stuff, but to show how your group's assistance can be of benefit to them.

## Advantages of Ham Radio

A sponsoring organization can rent or buy a system from a commercial two-way radio vendor to handle event logistics. To keep tabs on the event's progress, they just may do that. A corps of experienced—and volunteer—communications experts that can safeguard participants and spectators from accidents, confusion and injuries, however, is available in the form of Amateur Radio operators. In addition

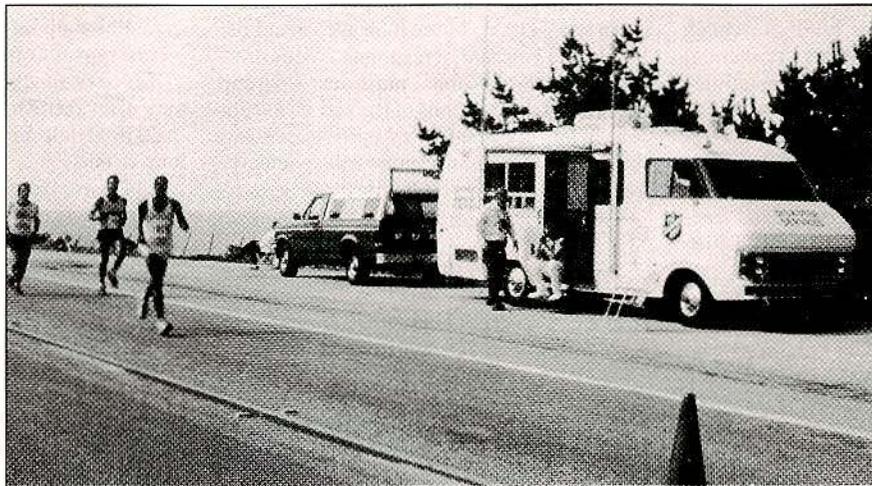
to experience, hams have unique equipment and repeater-coverage capabilities. Amateurs can also switch frequencies with more agility than public safety officials or commercial operators. This makes it possible to communicate on several specialized nets simultaneously, on clear frequencies, on multiple repeaters and on several bands—a plus for any event.

Today's amateurs can instantly set up portable repeaters or remote bases on the scene of an event without bureaucratic red tape or procedural tie-ups. They can also use whatever mode is suited to the traffic—VHF or HF, voice and packet, amateur television or Morse code. Ham radio gear can be operated from alternative power sources and is eminently portable.

They can also use whatever mode is suited to the traffic—VHF or HF, voice and packet, amateur television or Morse code. Ham radio gear can be operated from alternative power sources and is eminently portable.

## Your Game Plan

There are many elements to organize when you participate in public service communications, but it's mainly a matter of recruiting dependable volunteers. Keep a list



**Monterey Peninsula ARES members provide communications support during the Big Sur International Marathon. Ambulances and medical personnel standing by at this key checkpoint couldn't access their commercial repeater from the site, so the Amateur Radio net control station was set up here.**  
*(photo courtesy of the Salvation Army)*

events. Take a community service veteran and members of your group to approach the Chamber of Commerce, charitable organizations, Boy Scouts/Girl Scouts or other groups that put on suitable functions. Offer your free communications manpower and expertise. Explain what radio amateurs have to offer, observing the limits set forth in Part 97 of the FCC rules. Inform the agency you propose to serve that there are commercial options open to them, which may serve some of the needs amateurs



of everyone's name, call sign and telephone number. Give each volunteer a copy of the list—that way, they can learn who's who if they don't already know each other. Call and confirm participation with each person a week in advance and again the evening before an event. Enlist backup operators to fill in for people who don't show up or cancel at the last minute. Make sure everybody knows what to do in case the event is postponed because of foul weather or other reasons.

Before the event begins, the hams meet face to face to coordinate their plans. There may be more than one frequency to be used, depending on the type of traffic to be passed. Have a contingency plan in case of interference. Use simplex if you can. Check ahead of time to see if your chosen frequencies will interfere with regular nets or other activities. If you need a repeater, secure permission from the repeater group before you use their machine. Make arrangements for a backup repeater in case conditions make it necessary. Find out what frequencies the event organizers may be using for their commercial gear and bring a scanner (or wide-receive-coverage hand-held ham rig) to monitor their activity. You may even want to lend a scanner to an event director so he or she can monitor your ham traffic.

To avoid difficulties or embarrassment on the big day, go out to the site ahead of time with a couple of other members of your communications team and an event official. Walk the route with your radios to check signals and pinpoint dead spots or potential trouble zones (areas near utility substations, power-company transformers, urban "office canyons," behind hills and around noisy vehicles or equipment). Note likely spots where you'll need to take extra care, such as a point where a road race passes near a freeway or where runners must climb a hill. Draw up a map indicating landmarks, relevant checkpoints, where each operator will be stationed and the frequencies to be used. Distribute copies to all ham volunteers and event officials. You can invite others to help (and maybe get them interested in Amateur Radio, too). Potential hams, license-class students, friends and family members can join the fun as radio monitors, spotters, map readers, drivers and "gofers."

#### Follow the Leader

Large events sometimes require many nets on different bands. Each net will have one top-notch operator named to serve as net control station (NCS). Being asked to act as NCS at a public service function is an honor entrusted only to hams with a demonstrated ability to lead, to remain calm and to be scrupulously organized.

Once the operation begins, the NCS is coordinator, air traffic controller, commander-in-chief and traffic cop of the particular frequency the group is using. The NCS generally works from a fixed location. Others are deployed at strategic locations: fixed, on foot or mobile. If you have enough people, it may be more efficient to designate

pairs of hams to work together rather than spread more people about the site. The crew works directly with the event sponsor or municipal authorities. The hams' task is easy: They simply communicate. They don't make vital decisions, issue commands or furnish aid or advice.

#### Stick to Your Duties

Unless they also happen to be trained emergency volunteers or professionals—many police officers, firefighters, EMTs and others are hams—the amateurs' responsibility is to stay out of the way and act as a medium for communications. Don't let your enthusiasm interfere with your judgment; if you're not the best person to report on a matter, yield to someone with a better vantage point.

Unless you are fully briefed and authorized to do so, don't give answers or dispense advice about an event to spectators or participants. There should be authorized event workers stationed where needed, and questions should be referred to them. It's not up to you to tell runners that refreshments are available at the staging point, for example, even if you overhear race officials saying so. Don't try to second-guess procedures; a ham radio operator should not interpret rules or direct participants to go to a particular spot unless the event officials have requested that you do so for safety reasons.

You're not allowed to provide "news coverage," either. Make it clear to event officials that you cannot respond to requests to report race-position inquiries, parade progress or descriptions of the action, except as it benefits the safety of participants and the public. Make sure your role is clearly understood before you begin.

#### Be Prepared

Your goal is to fulfill a need by helping to safeguard participants and spectators at an event. You'll gain valuable experience in case you're ever needed in an emergency.

You also want to take advantage of a golden opportunity to showcase Amateur Radio at its best, serving your community and performing with dignity. Event organizers, participants, spectators, neighbors, the news media, public safety authorities and others are watching you. Remember the people listening on scanners. Common sense and planning will help ensure that you perform masterfully.

When you offer your services to a nonham group, here are some DOs and DON'Ts to keep in mind:

#### DO . . .

- Know your capabilities and limits (equipment and people).
- Present a professional image, in manner and physical appearance. Wear a name/call sign badge, identifying cap, shirt or jacket, carry QSL cards or business cards and bring a few brochures about your club or Amateur Radio to hand out to interested bystanders.
- Show up on time and ready to work.
- Transmit only when necessary.
- Carry snacks and water (the sponsors may offer refreshments, but don't mooch).
- Schedule breaks for operators during long events.
- Dress appropriately and carry an umbrella, hat, sunblock, jacket or other necessities to protect yourself and your rig from the elements. Wear comfortable shoes and socks (tight shoes can spoil a parade patrol).
- Make a checklist of items to bring along (batteries, connectors, tools, flash-

## The FCC's Views: Business Communications

When you studied for your license, you may have been told that all forms of business communications were prohibited. There have been recent changes that permit amateurs to decide for themselves what they want transmitted through their stations, with certain constraints.

On September 13, 1993, the FCC relaxed the business rules. Certain previously prohibited practices were specifically written into the rules. These new rules permit greater flexibility for amateur stations in their public service and personal communications without altering the basic purpose of the Amateur Radio service. The newly revised Section 97.113 is a response to the increasing communications needs of amateurs and to changes in technology that lessen the potential for abuse.

Several points to remember: Amateurs can't be paid to provide communications; Communications for the benefit of one's employer are prohibited; Communications in which the control operator or licensee has a pecuniary interest are prohibited; the Amateur Radio service can't be regularly substituted for other licensed radio services.—KJ4KB

light, wristwatch, pocket notepad and pen, gas in the car, compass, maps, address book, first-aid kit, insect repellent, etc). Prepare the night before. If the car's already loaded, you won't have to rush in the morning.

□ Take notes, if possible, and invite all the volunteer operators to join you afterward to analyze your performance and areas where improvement is needed.

□ Share the credit with your fellow hams.

□ Set an impeccable example for the Amateur Radio service.

□ Inform your SM or SEC about your activity. The ARRL Field Organization staff can help you get publicity and see that you get credit for your work.

□ Carry appropriate medical, property and liability insurance coverage for volunteers who may be injured or accidentally injure someone else, or have radios lost, stolen or damaged.

□ Have fun!

#### DON'T...

□ Appear pushy or come across with a know-it-all attitude.

□ Promise anything you can't deliver.

□ Answer questions unless you have explicit permission to do so.

□ Make frivolous or confusing remarks on the air.

□ Request or even hint that you expect any compensation for your work.

□ Leave your post unless you notify the NCS and receive acknowledgment.

□ Leave radio equipment lying around unattended.

□ Pester event organizers for refreshments, T-shirts or other special considerations. Arrangements for these things should be understood in advance and may not be accepted as "payment" or as a condition of offering them the services of amateurs.

For further details on special-event operation, the *Special Events Communications Manual*, the *Public Service Communications Manual* and *The FCC Rule Book* are available from the ARRL or your local dealer.

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## Radio Tips: Six Meters—The HF VHF Band

The 6-meter band extends from 50 to 54 MHz and is open to all amateur license classes except Novice. Six meters straddles the line between what hams consider to be HF and VHF. With its unusual position in the electromagnetic spectrum, 6 meters tends to have a split personality.

When the band is in its "VHF mode," it behaves much like 2 meters, offering excellent local and regional coverage. With modest CW or SSB equipment, small antennas and a decent location, you can expect to routinely work stations a few hundred miles distant. FM is also popular on 6 meters. Point-to-point simplex QSOs are common and repeaters are often available to provide coverage over wide areas.

Occasionally you'll have an opportunity to take advantage of meteor scatter propagation. As the name implies, this involves bouncing your signal off the ionized trails of meteors as they plunge through the atmosphere. This type of propagation is common on 6 meters and not as difficult as it sounds. You don't need to know the trajectory of the meteor and you don't need exotic equipment or antennas. Just listen for strong signals that seem to suddenly burst out of nowhere. You have to pounce quickly! Like the wispy trails themselves, the strong signals soon vanish.

Six-meter signals are also reflected off the polar auroras. This unusual mode of propagation can provide excellent VHF DX. Auroral signals have a distinct, distorted sound that you'll always recognize after you've heard it the first time. SSB can be used despite the distortion. CW is also very popular.

Six meters can enter its "HF mode" at virtually any time, but it's highly influenced by the seasons and sunspot cycles. Activity is highest in the summer and fall, but the band can explode with

continental or worldwide DX when you least expect it!

Tropospheric band openings (or simply *tropo*) are the products of weather—usually slow-moving high pressure systems. A large tropo opening can spread your signal over half the continent, but such opportunities are rare on 6 meters.

When *sporadic E* (often called "E<sub>s</sub>" for "E sporadic") comes into play, 6 meters really gets cooking! You can expect sporadic E on most days during June and July. December and January are active months, too. A typical E<sub>s</sub> band opening will allow you to reach most areas of North America with ease. If you live near the East or West Coasts, strong E<sub>s</sub> openings have the potential to bring signals from other continents!

Sporadic E propagation can last from several minutes to several hours. During this time the propagation can shift from one geographic area to another. Stay on your toes and monitor the band frequently. Automated 6-meter beacons operate 24 hours a day. Listen for them and you'll get a pretty good idea of 6-meter band conditions at any given time. (You'll find a listing of beacons for all VHF and UHF bands in the *ARRL Repeater Directory* and *The ARRL Operating Manual*.)

When ionospheric propagation is particularly strong, the Maximum Usable Frequency (MUF) will reach the 6-meter band. Under these conditions, 6 meters behaves much like 10 meters. You won't need high power or sophisticated antennas to work choice DX. If the propagation path is carrying your signal into Europe, 10 watts is almost as good as 1000 watts. Most 6-meter DX is worked on SSB, although CW and even FM repeaters get into the act!

How far can you go on 6 meters? The current distance record is over 12,000 miles. Not bad for a VHF band!—W8JIMY

# THE DOCTOR IS IN



**Q** Dan Levit, N9HBH, asks, "My nearest packet bulletin board is more than 20 miles away. There's nothing in between except a few other packeteers. I'm using a hand-held rig as my 2-meter packet transceiver and its 2-watt signal won't go the distance. I can't afford an amplifier and power supply. What are my alternatives? Should I put up a ground plane or J-pole antenna?"

**A** Considering your low output power, neither a ground plane nor a J-pole are likely to do the job at low heights unless you or the PBBS are in an exceptionally good location. Instead, consider a *directional* antenna, such as a 2-meter Yagi or quad. Small VHF directional antennas are not expensive. In fact, new 2-meter beams can be purchased for less than \$60. Shop at some local hamfests and you'll probably find used antennas for much less. Or, try building one—it's a good first-time construction project.

If you're only interested in working the bulletin board, you don't need a rotator. Just install the antenna and point it at the station. Use low-loss coaxial cable such as Belden 9913, 8214 or equivalent. You can't afford to waste your hand-held rig's signal in feed-line losses.

Another alternative is to use the other packet-active hams as *digipeaters*. Virtually every terminal node controller (TNC) has the capability to relay packets from other stations. This means that *any* ham can act as a relay for another. Monitor the bulletin board frequency and note the call signs of other stations that are using the system. If they can reach the PBBS with little trouble, they must be using better antennas, more output power or both. Perhaps you can share their superior hardware! Try to connect to the system using the following command:

**CONNECT <PBBS call sign> VIA <relay station call sign>**

With luck, the designated relay station will hear your packets and pass them along to the PBBS. If you establish a connection to the PBBS, the station will continue to act as the relay. Unless the operator is paying close attention to his equipment, he may not even notice that you're using his packet station as a digipeater!

The obvious problem with this approach is that your relay station may leave the air unexpectedly. If you plan on using the PBBS often, consider contacting some of the local packeteers and making arrangements to use them as relays on a regular basis.

**Q** I'm having a problem with my VGA computer monitor. The images on the screen jitter constantly. I took it in for service, but they told me there was nothing wrong with it! I thought that RF might be getting into the monitor, but the jumping

and jittering is present even when I'm not transmitting. What could cause this?

**A** If you've eliminated RF as the culprit, I'd suggest that you look for strong magnetic fields nearby. They may be interfering with the deflection of the electron beam in the CRT, causing it to "jitter" as you describe.

Turn everything on and wait for the image to start jumping. Now, switch off each piece of equipment and keep your eye on the monitor as you do so. Does the jittering stop when a particular device is switched off? If so, you may have found your villain. Try moving it farther away from your monitor and see if the jittering continues.

**Update:** The reader replies, "I found it! The culprit was my 15-amp dc power supply. I recently moved it closer to my computer monitor when I rearranged my station. It was sitting just six inches from the screen. When I switched it off, the jittering stopped instantly. I moved it to the opposite end of my desk and haven't had a problem since!"

**Q** A fellow on the local repeater told me that I'm operating illegally because the music from my car radio is audible in the background. Is he right?

**A** If you interpret FCC rules literally, he is correct. Part 97 rules forbid the transmission of music on Amateur Radio frequencies. However, the issue of *intent* is critical. In your case, you were unaware that your car radio could be heard in the background. This constitutes an *unintentional* transmission of music. Although the FCC won't penalize you, good Amateur Radio practice dictates that you should turn down your car radio when you're operating.

There are situations where you cannot squelch the music. For example, if you're operating a special-event station at the county fair, the music from a nearby band may be audible whenever you transmit. Once again, you're not transmitting this music intentionally. It just happens to be present in the background and is unavoidable. This is not the kind of situation the rules were meant to address.

As an interesting footnote, did you know that there was a time when hams *were* allowed to transmit music? In the beginning, there were no restrictions whatsoever on the material hams could transmit. Many early radiotelephone enthusiasts sent music to each other regularly. This practice soon got out of hand, however, and the government intervened. The use of music was restricted to short "test" transmissions, but even this didn't last long. By the mid-1930s, music was banned from the Amateur Radio airwaves entirely.

**Q** I was listening to a DX pileup on 20-meter CW last night. I couldn't believe how fast those stations were send-

ing! There's no way I can send and receive at those speeds. I guess I should confine my DX hunting to SSB, right?

**A** Not necessarily! Some of the stations you heard can indeed copy high-speed CW with little difficulty. Many of the others, however, are merely listening for the standard exchange—which is easy to decipher once you've heard it several times. Let's say your call sign is N1BKE. If the DX station (for example, 5U7M) hears you, the exchange might go something like this:

**N1BKE 5NN**

(The DX station replies with your call sign and a signal report "N" is short for "9" when a numeral is expected.)

**TU 5NN N1BKE**

(You reply with a TU, signal report and call sign.)

**TU DE 5U7M**

(He's now ready for other callers.)

If you listened to exchanges like this many times, you'd finally understand the format the DX station was using. It doesn't take long to figure out the DX station's call sign, either. After the DX station completes an exchange, start throwing out your call sign as fast as you can send it, on the frequency where he's listening. Don't worry about hearing your own call sign in the DX station's reply. You'd be surprised how well you can recognize your own call sign—even at high speeds. Be prepared to hammer out a quick response when he calls you. Don't bother with your name, location and so on. Just follow the format he has established.

If you're using an electronic keyer with *memory* features, you can preprogram the entire exchange! Use one memory slot for your call sign. Program another to send the expected response. Set the keying speed to match the DX station, and start sending your call sign. When the DX station answers, all you have to do is press the appropriate button to send the reply.

While many hams use their electronic keyers in this fashion, there's no substitute for being able to copy high-speed CW *au naturel*.

**DO YOU HAVE A PROBLEM? ASK THE DOCTOR! SEND YOUR QUESTIONS (NO TELEPHONE CALLS, PLEASE) TO: "THE DOCTOR," ARRL, 225 MAIN ST., NEWINGTON, CT 06111.**

# Build a Portable Groundplane Antenna



By Zack Lau, KH6CP/1  
ARRL Laboratory Engineer

**T**he rubber ducky antennas common on hand-held VHF and UHF transceivers work fine in many situations. That's no surprise, considering that repeaters generally reside high and in the clear so you and your hand-held don't have to! Sometimes, though, you need a more efficient antenna that's just as portable as a hand-held. Here's one: A simple groundplane antenna you can build—for 146, 223 or 440 MHz—in no time flat. It features wire-end loops for safety (sharp, straight wires are hazardous) and convenience (the top loop lets you hang it off high objects for best performance).

## What You Need to Build One

All you'll need are wire (single-conductor, no. 12 THHN), solder and a female coax jack for the connector series of your choice. Many hardware stores sell THHN wire—that is, thermal-insulation, solid-copper house wire—by the foot. Get 7 feet of wire for a 146-MHz antenna, 5 feet of wire for a 223-MHz antenna, or 3 feet of wire for a 440-MHz antenna.

The only tools you need are a 100-watt soldering iron or gun; a yardstick, long ruler or tape measure; a pair of wire cutters; a 1/2-inch-diameter form for bending the wire loops (a section of hardwood dowel or metal tubing works fine), and a file (for smoothing rough cut-wire edges and filing the coax jack for soldering). You may also find a sharp knife useful for removing the THHN's insulation.

## Building It

To build a 146-MHz antenna, cut three 24 3/8-inch pieces from the wire you bought. To build a 223-MHz antenna, cut three 17 3/8-inch pieces. To build a 440-MHz antenna, cut three 10 3/8-inch pieces.

The photos show how to build the antenna, but they may not communicate why the cut lengths I prescribe are somewhat longer than the finished antenna's wires. Here's why: The extra wire allows you to bend and shape the loops by hand. The half-inch-diameter loop form helps you form the loops easily.

### Make the End Loops First

Form an end loop on each wire as shown in Fig 1. Strip exactly 4 inches of insulation from the wire. Using your 1/2-inch-diameter form, bend

## What's a Groundplane?

This article emphasizes how to build and adjust a groundplane antenna for better communication at 146, 223 or 440 MHz. You can find out the technical details of how groundplane antennas work in Chapter 2 of *The ARRL Antenna Book*, available from your dealer and The ARRL Bookshelf.—WJ1Z

the loop and close it—right up against the wire insulation—with a two-turn twist as shown in the bottommost example in Fig 1. Cut off the excess wire (about 1/2 inch). Solder the two-turn twist. Do this for each of the antenna's three wires.

### Attach the Vertical Wire to the Coax-Jack Center Pin

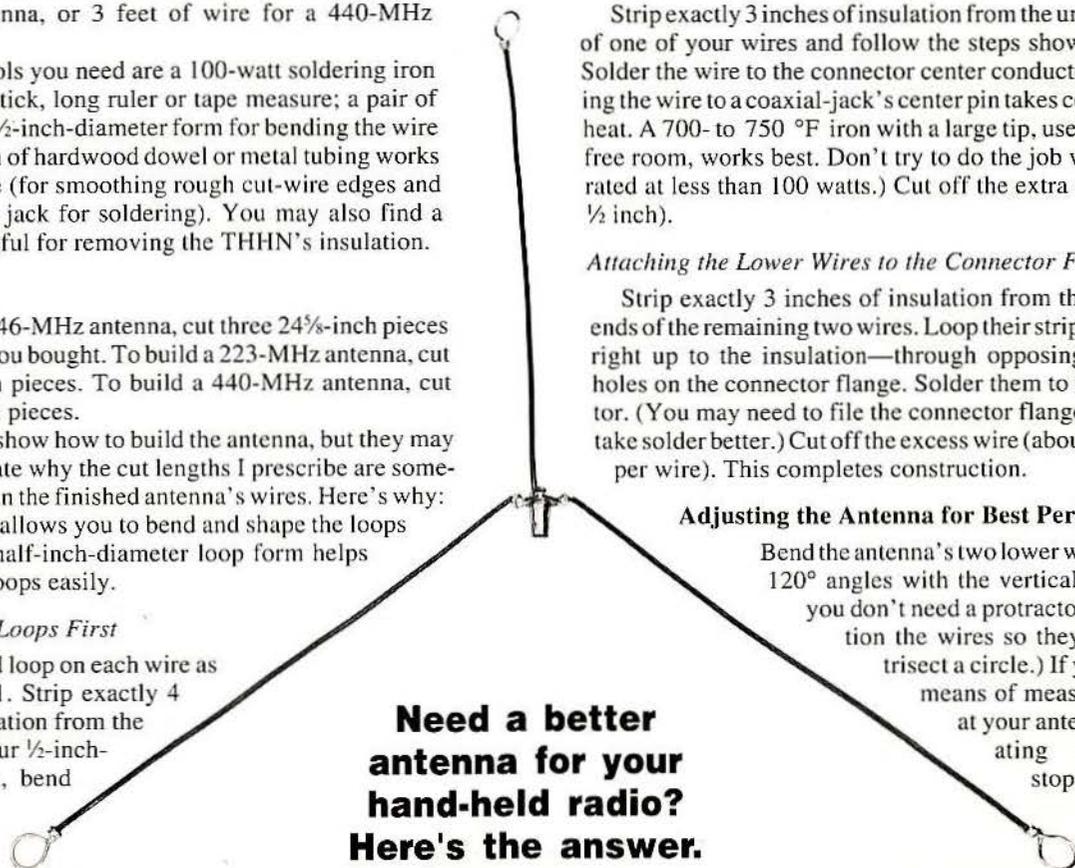
Strip exactly 3 inches of insulation from the unlooped end of one of your wires and follow the steps shown in Fig 2. Solder the wire to the connector center conductor. (Soldering the wire to a coaxial-jack's center pin takes considerable heat. A 700- to 750 °F iron with a large tip, used in a draft-free room, works best. Don't try to do the job with an iron rated at less than 100 watts.) Cut off the extra wire (about 1/2 inch).

### Attaching the Lower Wires to the Connector Flange

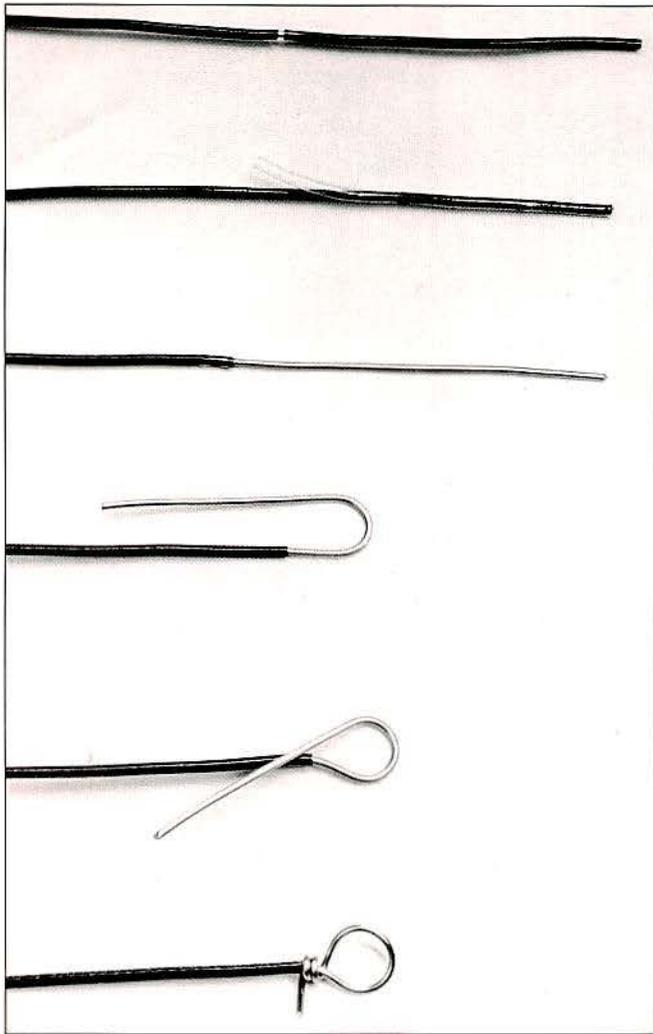
Strip exactly 3 inches of insulation from the unlooped ends of the remaining two wires. Loop their stripped ends—right up to the insulation—through opposing mounting holes on the connector flange. Solder them to the connector. (You may need to file the connector flange to get it to take solder better.) Cut off the excess wire (about 2 1/4 inches per wire). This completes construction.

### Adjusting the Antenna for Best Performance

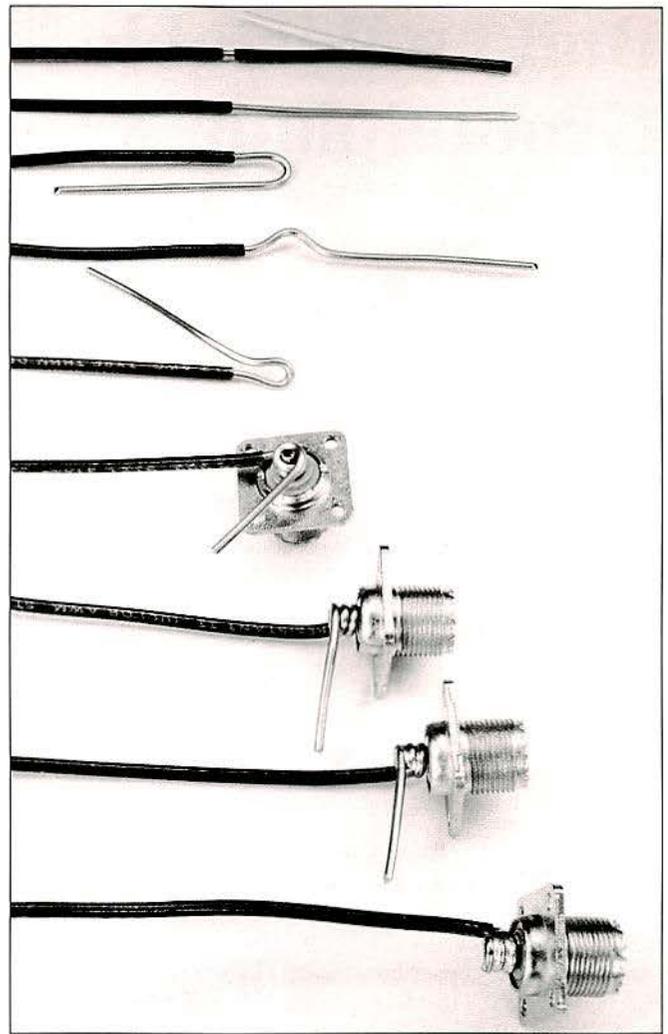
Bend the antenna's two lower wires to form 120° angles with the vertical wire. (No, you don't need a protractor: Just position the wires so they just about trisect a circle.) If you have no means of measuring SWR at your antenna's operating frequency, stop adjustment



**Need a better  
antenna for your  
hand-held radio?  
Here's the answer.**



**Fig 1**—Making loops on the antenna wires requires that you remove exactly 4 inches of insulation from each. Stripping THHN insulation is easier if you remove its clear plastic jacket first.



**Fig 2**—Remove exactly 3 inches of insulation to attach the vertical wire to the coax-connector center pin. This photo shows an SO-239 (UHF-series) jack; the title photo shows a BNC jack. Use whatever your application requires.

here and start enjoying your antenna! Every hand-held I know of should produce ample RF output into the impedance represented by the antenna and its feed line.

Adjusting the antenna for minimum SWR is worth doing if you have an SWR meter or reflected-power indicator that works at your frequency of interest. Connect the meter in line between your hand-held and the antenna. Between short, identified test transmissions—on a simplex frequency—to check the SWR, adjust the angle between the lower wires and the vertical wire for minimum SWR (or reflected power). (You can also adjust the antenna by changing the length of its wires, but you shouldn't have to do this to obtain an acceptable SWR.) Before considering the job done, test the antenna in the clear to be sure your adjustments still play. (Nearby objects can detune an antenna.)

#### Plug and Play

As you use the groundplane, keep in mind that its coax-connector's center pin wasn't made to bear weight and may break if stressed too much. Barring that, your groundplane should require no maintenance at all.

There you go: You may not have built a monument to radio science, but you've home-constructed a portable antenna that'll get much more mileage from your hand-held than its stock rubber ducky! Who said useful ham gear has to be hard or expensive to build?

#### **Radio Tips: Bending Dipoles**

The classic image of a dipole is a length of straight wire hanging horizontally between two supports. Does it always have to be this way? The short answer is *no*.

Dipoles for any HF band can be bent in a number of different ways according to the amount of space you have available. You may need to trim or lengthen your bent dipole to get it to resonate on the desired band. For multiband operation, put up a dipole for the lowest frequency possible and use an antenna tuner to "force feed" it on other bands. If you're using an open-wire feed line or good-quality coaxial cable (such as RG-213), SWR is of little importance. Adjust the antenna tuner for a 1:1 SWR indication and your transceiver will be happy.

Don't worry if your dipole doesn't match the drawings you see in the antenna books. Put up as much wire as possible—whether it's horizontal, vertical or zig-zag. Load it with an antenna tuner and get on the air! Don't be afraid to experiment. Try different designs until you find one that works best for you.

—WB8IMY

# VHF/UHF Contesting



By Rus Healy, NJ2L and Brian Battles, WS10

**A**mateur Radio contests test your ability to work the most stations in different geographical areas on the most bands during the contest period. Contests give you a chance to evaluate your equipment and antennas, and to compare your results with others. In most VHF/UHF contests, each contact is worth a certain number of points. You multiply your point total by the total number of different grid squares (multipliers) to calculate your final score. The only restrictions in these events are that contacts through repeaters and satellites don't count, and the national 2-meter FM calling frequency, 146.52 MHz, is off limits for ARRL contest QSOs. SSB and CW are the most popular contest modes, but you can have a lot of fun with FM, too! During the first hour or two of a VHF/UHF contest, contacts may come fast and furious. Then the pace slows as operators prowl the bands looking for new stations.

## Who Can Enter?

Most VHF/UHF contests are open to any licensed amateur who wants to participate. The ARRL sponsors the major VHF/UHF contests (see Table 1) and specific rules, descriptions of the different categories, and entry forms are available free from ARRL Headquarters. You don't have to be an ARRL Member to participate in these contests, nor are you required to submit your completed logs, although doing so helps the ARRL Contest Branch verify contacts that others claim. VHF/UHF contests feature a variety of categories among which you can choose. For single operators (those operating without assistance), entry classes in the ARRL contests include all-band, single-band, QRP portable and one for rovers (those who operate from more than one grid square during the contest). The ARRL *Operating Manual* is a good source of information on selecting an entry category and what it takes to go QRP portable or roving to different grid squares during a contest.

## When and Why?

ARRL VHF/UHF contests are held throughout the year, with

emphasis on the warmer months to encourage hilltop operation during favorable weather. Outside of that, the ARRL VHF/UHF contest program is designed to take advantage of propagation enhancements that usually occur at certain times of the year. For instance, the June VHF QSO Party almost always occurs during periods of excellent sporadic-E propagation, giving you an opportunity to enjoy long-distance contacts on 6 and 2 meters. In fact, the first documented sporadic-E contact on the 222-MHz band was made during a June VHF QSO Party. As shown in Table 1, the major VHF/UHF contests consist of the January Sweepstakes (SS), June and September VHF QSO Parties, the CQ Worldwide VHF contest, August UHF Contest and the VHF/UHF Spring Sprints. Except for the Sprints, these events each encompass many bands. The January SS and June and September QSO Parties are the most popular, and each permits activity on SSB, CW and FM on all amateur frequencies from 50 MHz on up. The UHF Contest is slightly different than the other events because only contacts on the 222-MHz and higher bands are allowed for contest credit. The Spring Sprints are single-band, four-hour contests held over a several-week-long period. These short contests provide super opportunities to try out new locations or pieces of equipment.

## Contest Operating

As in all Amateur Radio contests, there's a standard exchange of information between stations. In many cases, the exchange consists of your grid square location and a signal report. (see "Radio Tips: What's Your Grid?") You can hunt for stations to call or find a clear frequency and call "CQ" yourself.

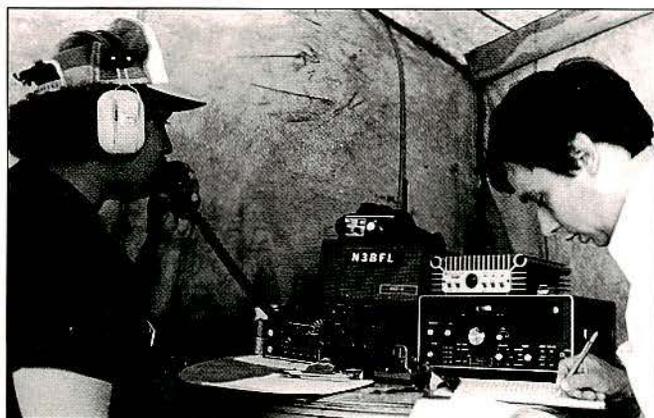
Check the contest rules ahead of time to make sure you know the exchange requirements. Some contests, for example, require that you give each person a contact number beginning with 001. Your first contact would be 001, your second 002, your fifteenth 015 and so on.

## Being There

You'll find lots of 6- and 2-meter activity during VHF contests. On SSB, most stations stay near the calling frequencies of 50.125, 50.20, 144.20, 222.10 and 432.10. On CW, look between 80 and 100 kHz above 50, 144, 222 and 432 MHz. (Six meters offers less CW activity than the other VHF/UHF bands.) On FM check the recognized simplex frequencies:

**Table 1**  
Major VHF Contests

Contest	Bands	When
Sweepstakes	50 MHz and up	Varies according to Super Bowl date
Spring Sprints	One per band	April/May
June VHF QSO Party	50 MHz and up	2nd full weekend
CQ Worldwide VHF Contest	50 MHz and up	July
August UHF Contest	222 MHz and up	1st full weekend
September VHF QSO Party	50 MHz and up	2nd full weekend



Jim Kelly, N3BFL, with Gene Marcus, W3PM, logging, operates 2-meter SSB during Field Day.

Where were you during the last VHF/UHF contest? Did you miss the ARRL Spring Sprints in April and May? The ARRL UHF Contest in August? The September VHF QSO Party? Will you be ready for the January VHF Sweepstakes?

The standard answers are, "I'm not a contester," "I don't have an all-mode rig for those bands," or "I don't have time to stay on the air all those hours." Fortunately, none of these standard answers are valid reasons to ignore the events. You may say, "The only ham radio activities I like are handling traffic and chatting with friends on the local repeater." It's funny how that's not much different from operating in a VHF contest.

#### **"I'm Not a Contester"**

Who is? Only a person who elects to participate in a contest. And even then, you aren't really known as a contester by anyone else unless you submit an entry log. If your main interest is ragchewing, helping with public service activities, organizing emergency communications or handling traffic on the local repeater, you can also have fun by trying your hand at a VHF/UHF contest. Making a contact is easy. You simply exchange your call sign and grid square. Unlike the big HF contests, a VHF/UHF contest QSO can be much more leisurely. There's rarely any QRM to fight, and because there are fewer stations in range, there isn't the frantic pace HF contesters must maintain. Some of the best contesters come from the ranks of traffic handlers, which makes sense because contest operation requires the ability to copy the other station accurately and efficiently.

#### **"I Don't Have an SSB or CW Rig"**

You don't need one. Every ARRL VHF/UHF contest lets participants use FM. You simply can't use repeaters. There aren't any special multipliers for working DX stations or having a 1000-W amplifier feeding a stacked array of Yagis. Each FM simplex contact with a neighbor is worth just as many points as a CW contact with a station 1000 miles away. That hand-held 2-meter FM transceiver can net you enough points to make a strong showing in your Section—if you go to the trouble of using it. How much trouble? Pick a simplex frequency and listen for—or call—"CQ contest." You can even make a multiband effort if you have access to one of the new dual-band transceivers that have become popular and affordable in the past few years.

#### **"I Don't Have Time"**

If you plan to be on the air at all over a contest weekend, you have time to join the fun. Simply exchange the necessary information and write it in a log. There's no minimum number of operating hours or contacts you have to make, no bonus points for staying awake all night, no special awards or certificates for climbing Pike's Peak or Mt McKinley, operating from a submarine or autogiro, or standing on your head. You can take a stab at the contest while sitting comfortably in your shack, living room or car for an hour or two. Grab a snack and a mug of coffee or hot chocolate, a couple of pencils and a log sheet. If you don't have a contest log, use a plain piece of paper. You can always copy the info onto a standard log afterwards, if you decide to "officially" enter. If you prefer, boot up a contest logging program on your computer and let the silicon do the thinking. You can get such software by mail order, by downloading it from local telephone BBSs or national online services, or ask for a copy from almost any contester you know.<sup>1</sup>

#### **"I Never Hear Anyone Using FM During Contests!"**

If no one else is calling "CQ Contest," you may as well do it. You'd be surprised at how many others might pop out of the woodwork to make a QSO. An almost foolproof strategy is to recruit your friends and members of your club in advance to join you to give each other contacts. This can lead to hundreds of "easy" points and give your contest log a shot in the arm. Other hams you convince to try it may also become regular contesters, too, and perhaps you can form the nucleus of your own team. (As an added incentive, if you can get 25 people you know to get on the air during the ARRL September VHF Sweepstakes, and each of you works everyone else, you'll all be eligible for participation pins!) If you want to make it easier to convince friends or club members to participate, ask them to call or listen on a particular frequency at the top of each hour from, say, 1 PM to 6 PM. That way, they'll be more likely to find someone and make a contact or two, rather than randomly turning on the rig, hearing nothing and giving up. There are well-known frequencies to go hunting on: Try the following frequencies: 144.9-145.0, 146.49, 146.55, 146.58, 147.42, 147.45, 147.48, 147.51, 147.54, 147.57; 223.50; and 446.0 MHz. Don't use the 2-meter national simplex frequency, 146.52 MHz, for calling or soliciting contacts.

#### **"What's in it for Me?"**

Contests put a lot of hams on the air. The FM simplex frequencies that may be normally quiet most of the time will usually be fairly busy. You'll get a better idea of how effectively your station functions, what kind of range your station is capable of spanning, how propagation and seasonal conditions affect your station, and what neighboring stations you can hear.<sup>2</sup> You might get your call sign or your club's name into the contest results write-up in *QST*. In some Sections with a smaller active ham population, your modest effort could even earn a certificate or plaque for yourself or a club gavel for your club! You can make new friends on the air who prob-

ably don't live too far away. You might discover a propagation "opening" and experience the thrill of working someone hundreds of miles away with your hand-held transceiver. You'll hand out QSOs for points to other contest operators. (As a newcomer, you'll quickly learn how welcome you are, because your call sign will be very noticeable to regular local VHF/UHF contesters who may be frustrated by always hearing the same bunch of stations during every contest.) Most important, it's almost certain that you'll have fun.

#### **Notes**

<sup>1</sup>Excellent computer contest-logging programs are readily available and inexpensive. If you have a modem, but don't know where to start looking for contesting software, try the ARRL HQ BBS (203-594-0306) or such commercial online services as CompuServe, NVN, America Online, GEnie, Prodigy, etc. Contesting software is also available from commercial vendors that advertise in *QST*, the *National Contest Journal* and other ham magazines.

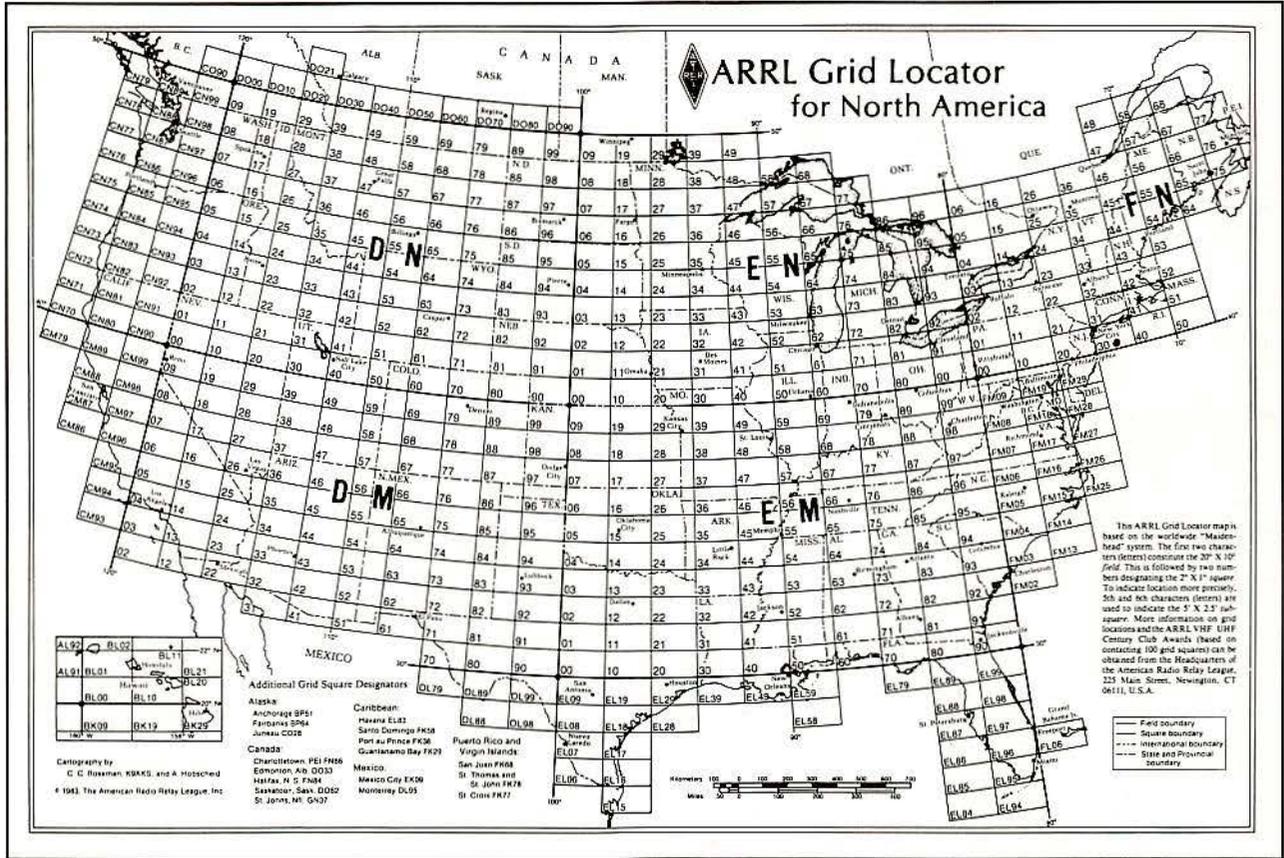
<sup>2</sup>I've been astonished by the possibilities of long-distance communications on 2-meter FM. For example, there was a band opening one evening not long ago when I made simplex contacts from my home in Connecticut with stations in Cape Hatteras and in Maine, and I was even called by a station in Panama City, Florida (!), although I couldn't complete a two-way QSO with that station. I wasn't using an exotic rig, antenna, power amplifier or preamp: my trusty hand-held transceiver (about 8 W output) was feeding a  $\frac{1}{8}$ -wavelength whip antenna on top of the chimney of a two-story house.—WSTO

*Dive into a sea  
of operating  
excitement.  
Once you have  
your license, it's  
not a spectator  
sport!*

# Radio Tips: What's Your Grid?

One of the first things you'll notice when you tune the low end of any VHF band is that most QSOs include an exchange of *grid squares*. Grid squares are a shorthand means of describing your general location anywhere on Earth. (For example, instead of trying to tell distant stations that, "I'm in Canton, New York," I tell them, "I'm in grid square FN24kp." It sounds strange, but FN24kp is a lot easier to locate on a map than a small town.)

Grid squares are coded with a 2-letter/2number/2-letter code (such as FN24kp). This handy designator uniquely identifies the grid square and your exact location in latitude and longitude; no two have the same identifying code. There are several ways to find out your own grid square identifier. The ARRL offers a grid-square map of North America, a World Grid Locator Atlas and a program for PC-compatible computers (*GRIDLOC*).—Mike Owen, W9IP

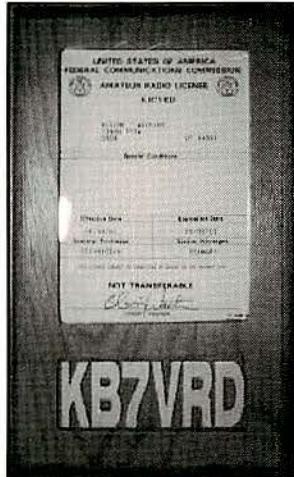


The ARRL Grid Locator Map. You can use a map like this to determine your present grid location and the grid locations of other stations. You can get your own copy of this map for the wall of your shack from ARRL HQ.

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# DXing with 2-Meter Packet Mail

By Presley Smith, N5VGC  
5727 Bent Creek Tr  
Dallas, TX 75252-2620

**S**uddenly, you find yourself with a new license that lets you explore the world above 30 MHz and you say to yourself, "Is there any way I can enjoy some international (DX) contacts up here?" On the VHF and UHF bands, satellites are your best bet for live, *real-time* DXing. But is there an alternative?

Certainly! If you don't mind waiting several days or weeks for a reply from another station, why not try DXing via packet mail? There are hams all over the world waiting to exchange mail with you. Imagine checking into your local packet bulletin board (PBBS) and finding a dozen messages from hams in the UK, Italy, Germany, Japan, Argentina or wherever! All it takes is a basic packet radio station and a little patience.

## Getting on the Air

Let's talk about packet radio equipment (see Fig 1). In many cases, you can get started with an old data terminal that you can find for sale at a larger hamfest flea market. Despite its appearance, a terminal is *not* a computer. It's simply a device that allows you to communicate with a computer—whether that computer is a big mainframe system or a tiny microprocessor.

Terminals are popular with some hams because they're inexpensive on the used market. On the other hand, owning a computer has many advantages. With a computer you can use sophisticated software that will make your packet operating more enjoyable. Even a used computer will do the job. If you shop carefully, you can find one for \$200 or less—sometimes much less!

The heart of your packet station is the Terminal Node Controller, or TNC. The TNC takes data from your computer or terminal and assembles it into packets for transmission over the airwaves. It also accepts signals from your radio and converts them back into information you can read on your screen. There are many types of TNCs available—too many to discuss here. *QST* reviewed several popular models in the December 1993 issue (*QST Compares: Packet TNCs*, page 80).

The radio is the easiest part of your station. Just about any 2-meter FM transceiver will work for 1200 bit/s packet. This includes popular hand-held transceivers. Your TNC connects to the microphone jack and the receive-audio output (external speaker) jack. Your TNC manual will offer advice on how to wire it to your radio and your computer. For additional information on setting up a packet station—and packet operating in general—pick up a copy of the ARRL's *Your Packet Companion*.

I started with a Kantronics KPC-3 TNC, an ICOM IC-2AT hand-held transceiver, and an old terminal that I got for \$25 at a sidewalk sale. I ran the radio on a power supply that I paid about \$25 for, and I splurged and got a 1/4-wavelength ground-plane antenna for \$17.50 and mounted it on the roof. I still use this system, but I've made a few upgrades since then.

## What's Your Address?

When you get your packet system assembled and ready to operate, you first must select a packet bulletin board system as your home PBBS. Ask other packeteers in your area for the call signs and

frequencies used by local PBBSs or go exploring with your TNC some evening. A PBBS is a kind of clearinghouse for the bulletins and mail that flows through the global packet network. They're easy to spot by watching for transmissions that contain lists of call signs and "subject" lines.

Choose a PBBS that you can reach without much difficulty. When you check in for the first time, you'll probably need to register as a new user. This usually involves answering a few questions, such as your name, station location and so on. When you're registered with a PBBS, it becomes your home system.

To understand how you go about sending packet mail, you need to know how a *hierarchical* address is created. When you combine your call sign with the call sign of your home PBBS, you produce an address that's unique in the world. If I sign on to the N5AUX PBBS here in Dallas and register with my call sign, N5VGC, N5AUX becomes my home PBBS. Now

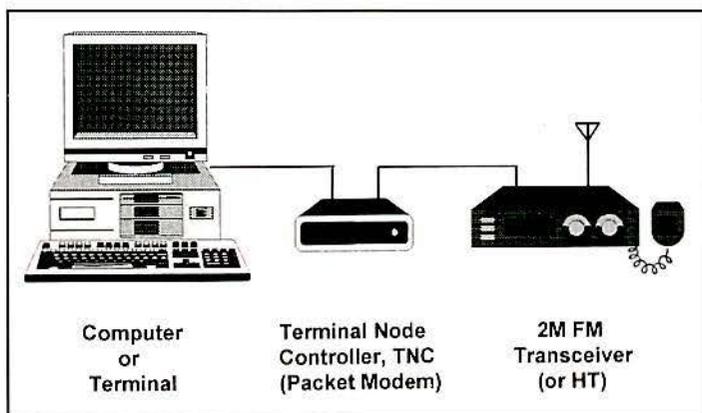


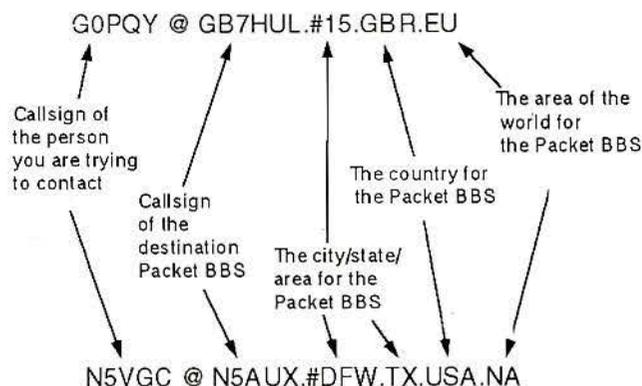
Fig 1—The components of a basic packet station.

my hierarchical address is:

N5VGC @ N5AUX.#DFW.TX.USA.NA

Start reading from left to right. You see my call sign followed by an @ (at) sign, followed by the call sign of my home PBBS. There's an optional city/area designator (preceded by a #), the state abbreviation and then the country and area of the world.

The packet addresses of DX stations use the same scheme. Here's an example for Andy, G0PQY, in England. In the UK, they use #nn, where nn is the area of the country where the PBBS is located.



Just as my address is unique, Andy has a unique address, too. I can address a packet message to Andy, send it, and if his address is correct, he should receive it.

## Searching for DX Addresses

Check into your PBBS and send the following command:

L> CQ

This tells the PBBS to send you a list of every message on the

system that has "CQ" in the "TO:" field. Packet mail DXers often address their messages to "CQ" in the hope of attracting the attention of others. Here's a typical PBBS response:

Message Choice - [\*]

Msg #	TSL	Size	To	@ BBS	From	Date/Time	Subject
29102	BS	429	CQ	@WW	VK3USB	0525/1334	CQ.CQ From Australia!
28973	BS	987	CQ	@WW	F6GPM	0523/2011	CQ FROM FRANCE !
28842	BS	895	CQ	@WW	4Z9CHB	0520/1925	* CQ CQ QSL, PSE *
28684	BS	751	CQ	@WW	GU0GWJ	0522/1408	***CQ EVERYONE

In addition to CQs, some hams use the ALL@WW address for messages, although "ALL" isn't a good idea for an address; anything more descriptive helps other PBBS users determine which messages to read. Many times you'll find the "CQ" in their message titles. To see a list of messages addressed to ALL, for example, send the following command:

L> ALL

Here's what you'll probably see:

Msg#	TSL	Size	To	@ BBS	From	Date/Time	Subject
54753	BS	2691	ALL	@WW	DJ8KI	0825/1522	>>CQ from GERMANY<<
54751	BS	1113	ALL	@WW	IK1QLD	0827/2128	FROM TURIN UNIVERSITY
54750	BS	1387	ALL	@WW	EB4AFG	0825/1840	CQ CALIFORNIA
54619	BS	792	ALL	@WW	KD6TKS	0827/2004	WANTED-PACKET FRIENDS
54581	BS	2744	ALL	@WW	ON1BRS	0829/2122	CQ-WW
54568	BS	1070	ALL	@WW	G1VWB	0831/1012	CQ CQ FROM THE UK
54016	BS	1113	ALL	@WW	2E0AAB	0819/2004	CQ DE DAVE

When you find a CQ, you can read it and respond to it.

### Answering a CQ

Let's assume that you've found a CQ bulletin. How do you respond? The first step is to read the message and write down the DX packeteer's address. For example:

```
From      : 4Z9CHB
To        : CQ @WW
Type/status : BS
Date/time  : 20-May 19:25
Bid       : 9695_4X4HF
Message #  : 28842
Title     : *** CQ CQ QSL, PSE ***
Path      : !W5IFP!4X4HF!
```

Hi !

My name is Ohad and my QTH is Haifa in the northern part of Israel. My QTH locator is KM72MT.

I collect QSL cards from all over the world.

I would like to have yours.

If you don't have one, a postcard with a view of your QTH will be great.

You can send it via the bureau or directly.

My address: Ohad Miller, 4Z9CHB  
12 Ha'ari St  
Haifa 33190  
Israel

73 and shalom de Ohad, 4Z9CHB @ 4X4HF.ISR.MDLE  
===== End of message #28842 =====

If you look carefully, you'll see Ohad's address in the second-to-last line:

4Z9CHB @ 4X4HF.ISR.MDLE

To reply, send the SP (send personal) command (or SR on some PBBSs). The PBBS will ask you for the subject and text. Enter a brief subject line and then proceed with your message (keep it short). End it with Ctrl-Z or /EX on a line by itself.

SP 4Z9CHB @ 4X4HF.ISR.MDLE

Response to your CQ



Hello, Ohad. This is Presley, N5VGC, from Dallas, Texas, responding to your CQ message. Dallas is a big city in Texas and there are lots of hams in Dallas on packet. I'd like to know more about your family in Israel and will tell you more about my family in Dallas. I'd also be interested in exchanging QSL cards with you. I will look forward to a message from you.

73, Presley, N5VGC @ N5VGC.#DFW.TX.USA.NA  
/EX

Always check and recheck the SP line. If the address is wrong, your chances of a successful delivery are greatly reduced (just as if your antenna didn't work!). Don't forget to include your return address in the body of the packet message. Sometimes addresses on the messages are changed for various reasons by PBBS systems as messages are forwarded to their destinations.

The time it will take for this message to arrive in Israel depends on a number of factors. Packet messages are routed in several ways. Some are relayed to forwarding stations via VHF/UHF packet radio until they eventually get to an HF station that forwards the message to another HF station in a distant place. These HF stations may be running packet or they may forward mail using other digital modes, such as AMTOR, PacTOR or CLOVER. Many international packet messages are also handled by Amateur Radio satellites.

### Calling CQ

A word of advice: When you send your CQ bulletin, you must be willing to answer all the responses you get. If you put out a CQ and don't answer all responses, you create a bad impression among your fellow hams. Word travels quickly on the network, so you don't want to cultivate a reputation as a person who sends bulletins and never responds to replies!

To send a CQ, you must send a bulletin targeted to a specific area or for worldwide (WW) distribution. Connect to your PBBS and use the SB (Send Bulletin) command. Here are some examples:

SB CQ @ WW

SB CQ @ TEXAS

SB CQ @ GB7ZAA.#34.GBR.EU

When the PBBS asks for a subject, use CQ as part of the title:  
CQ from Dallas, Texas

In the body of your message, tell the reader a bit about yourself and include your packet address at the end. Remember that English may not be the first language of many who will read your message, so keep your sentences short and simple.

Just as with live CQs, you may not get the responses you anticipate. And responses may be slower than you expect them to be. Be patient; a CQ may take several weeks to make it around the world.

### Happiness is a Full Mailbox!

There are at least 100 packet-active countries in the world. I've made contact with about 70 of them using the information contained in this article. It's likely that you'll find some frustrations similar to sending a CQ on HF. (In other words, sometimes you get an answer and sometimes you don't!) Even so, packet mail DXing works more often than it doesn't. It's a great way to strike up friendships through Amateur Radio. Enjoy!

*Presley Smith, N5VGC, earned a Technician-class license on August 6, 1991. He writes a monthly packet radio column for the Plano Amateur Radio Klub (PARK) newsletter. He owns and maintains the packet hub BBS for Dallas, Texas. He's manager of the Development Software Product department at CONVEX Computer Corp in Richardson, Texas.*

# Try RS-10 and Mir!

**P**sst! Would you like to know a secret? Operating through Amateur Radio satellites is a *lot* easier than you think. Sure, some satellites require specialized equipment, but there are several birds that are perfect for beginners.

## RS 10

RS-10 stands for *Radio Sputnik 10*. It was placed in orbit several years ago by the former Soviet Union. This powerful satellite is an orbiting SSB/CW repeater. From its orbital vantage point, RS-10 is able to cover a huge amount of real estate! When the satellite is passing over the central US, for example, hams on both coasts can talk to each other.

### Linear Transponders

Earthbound FM repeaters listen on one frequency and repeat what they hear on another, right? Imagine what would happen if your local repeater could retransmit everything it heard on an entire *group* of fre-

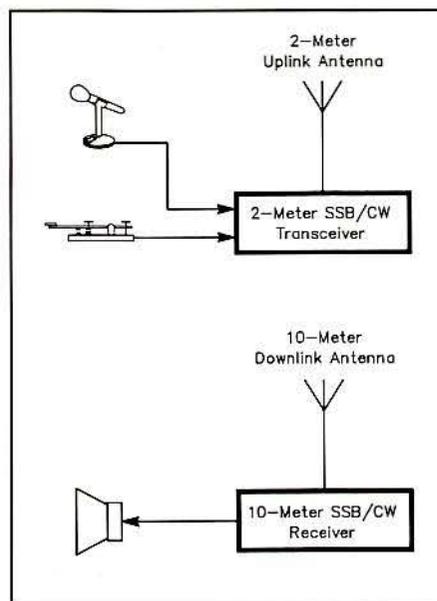


Fig 1—A diagram of a typical RS-10 station. SSB or CW transmissions are sent to the satellites on 2 meters. The satellite downlink signal can be easily monitored on a 10-meter receiver connected to a wire dipole.

**A cheap and  
painless way to  
explore the joys of  
space  
communications!**

**By Steve Ford, WB8IMY  
Managing Editor**

quencies? This is exactly the function of a *linear transponder*.

RS-10's transponder listens to a portion of the 2-meter band from 145.860 to 145.900 MHz (the *uplink*) and retransmits on the 10-meter band from 29.360 to 29.400 MHz (the *downlink*). In amateur satellite language, this uplink/downlink combination is known as *Mode A*. The range between the highest and lowest uplink (or downlink) frequencies is the transponder's *passband*.

### Assembling your RS-10 Station

To operate through the RS-10 satellite, all you need is a 2-meter SSB/CW transmitter and a 10-meter SSB/CW receiver (see Fig 1).

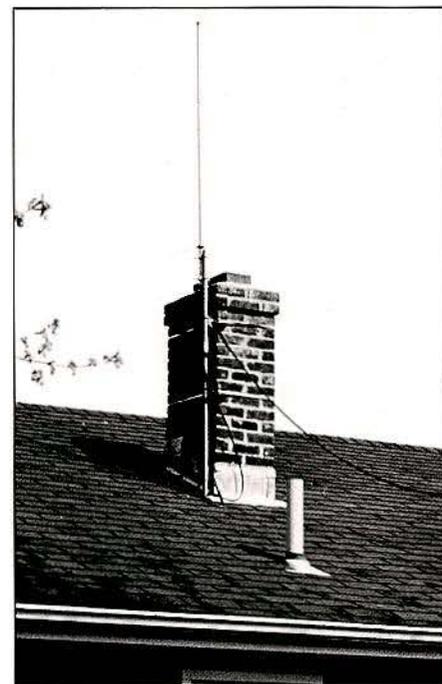
What's that? You say you can receive on 10 meters but don't own a 2-meter SSB/CW rig? No problem! You can use your 2-meter FM transceiver as a CW transmitter. All you have to do is wire a CW key to the push-to-talk (PTT) pins of your rig's microphone jack (consult your manual, or ask a friend to show you how to do it). Your signal may sound a little raw and "chirpy" on the downlink, but you'll be transmitting usable CW! This is a great way to try the satellite before you invest in an all-mode radio.

Elaborate antennas are definitely *not* required to work RS-10. A wire dipole—even indoors—is fine for receiving the 10-meter downlink signal. By the same token, a basic groundplane is adequate for

your 2-meter uplink. In terms of power, 20 to 30 watts seems to work well—although I've been able to work stations through RS-10 with only 2 watts!

With the wide separation between uplink and downlink frequencies, you work the RS-10 in *full duplex*. In other words, you hear your own signal on the satellite downlink *while you're transmitting!* One of the great thrills of operating RS-10 is hearing your own signal coming back to you *via satellite!*

When you communicate through RS-10 for the first time, you'll notice that the signals on the 10-meter downlink seem to drift. There's nothing wrong with your radio! It's all due to a pesky little problem known as *Doppler shift*.



The author's 2-meter "EasySat" antenna is nothing more than a  $\frac{1}{2}$ -wave groundplane attached to his chimney. The drooping cable above the roof connects to his HF dipole (not shown)—a perfectly adequate RS downlink antenna for 10 meters.

## The Mystery of the Shifting Signal

Doppler shift is caused by the difference in relative motion between you and the spacecraft. As it moves toward you, the signal frequencies in the downlink passband gradually *decrease*. It's the same effect you hear when a speeding railroad locomotive blares its horn. As it passes your position and moves away, the frequency decreases. (Keep this in mind the next time you're stopped at a crossing. Listen to how the locomotive horn sounds *before* and *after* it reaches the crossing.)

When I made my first RS-10 contact on CW, I noticed that I had to adjust my 2-meter transmitter as my downlink frequency began to shift. If the satellite is particularly busy, it's possible that one conversation in progress can actually collide with another! As you gain experience with the satellite, you'll discover how to select uplink and downlink frequencies that minimize the chances of a collision.

## RS-10 Operating Techniques

Since the satellite is available for only about 10 or 15 minutes during each pass, contacts tend to be brief. Listen around 29.357 MHz for the CW telemetry beacon. As the satellite rises above your horizon, this beacon will become louder.

Tune through the downlink passband and listen to the signals. CW operators generally congregate in the lower portion of the passband. They transmit between 145.860 and 145.875 MHz. The satellite repeats their signals between 29.360 to 29.375 MHz. SSB operators transmit from 145.875 to 145.900 MHz with their signals appearing between 29.375 and 29.400 MHz.

If you hear someone calling CQ on SSB, note the downlink frequency and *quickly* tune your 2-meter SSB transmitter accordingly. As you answer the call, adjust your uplink signal until you hear your own voice on the downlink. You can even do this *while the other station is still calling CQ*. I've heard some SSB operators adjusting their uplink frequency and saying, "Test, test, test..." By using this method they're assured of being on-frequency and ready to respond when the other station stops calling. Make sure to wear headphones when operating SSB to avoid audio feedback!

Answering a CW call is just as easy. As soon as you copy the call sign, tune your 2-meter transmitter to the proper frequency and start sending a series of *dots*. Listen on the downlink and adjust your transmitter until you hear the tone of your CW signal roughly matching the tone of the station sending CQ.

If you're using a 2-meter FM rig as your CW uplink transmitter, you're probably limited to tuning in 5-kHz steps. This makes it difficult for you to tune onto other stations when they're calling CQ. In this situ-

ation, it's often best to simply stay in one place and call CQ yourself. The hams who own the more agile radios will come to you!

RS-10 also carries a unique device known as a CW *ROBOT*. When it's active, you'll hear it calling CQ about once per minute on 29.403 MHz. To answer a *ROBOT*, your signal must be within its 2-kHz-wide *receive window* centered on 145.820 MHz. Don't forget to take Doppler shift into account when you select your uplink frequency! To contact the *ROBOT*, I'd send:

**RS10 DE WB8IMY AR**

With any luck I'll hear this response:

**WB8IMY DE RS10 QSO NR 589 OP  
ROBOT TU FR QSO 73 SK**

The three-digit QSO number (589 in our example) is incremented after each contact. If the *ROBOT* only gets part of your call, you may hear it send QRZ, QRM or RPT. If you're sending too fast or too slowly, it may respond with a QRQ (send faster) or QRS (send slower).

## The *MIR* Space Station

*Mir* has been occupied by Russian cosmonauts for several years as a laboratory for testing human responses to long-duration space flights. These studies are important for future manned missions to Mars and beyond. Cosmonauts who wish to operate the *Mir* Amateur Radio station are assigned special call signs (such as U6MIR). If they don't already hold Amateur Radio licenses, they are tested before lift-off.



Like the RS-10 satellite, *Mir*'s signal is powerful. You'll usually find it on 145.55 MHz and you won't need sophisticated equipment to hear it—or to be heard. Once again, an outside antenna—such as a groundplane—works fine. *Mir*'s orbit provides a couple of good passes each day for most areas. (Just last month I listened to *Mir* in my car while driving home from work!)

## Mir on Packet

The *Mir* Amateur Radio station uses AX.25 packet protocol at a data rate of 1200 bits per second—the same packet format most hams use here on Earth. This means you *do not* need a special packet TNC to contact the station (see Fig 2). The *Mir* packet station includes a mailbox where you can leave messages for the cosmonauts (or anyone else), and pick up their replies.

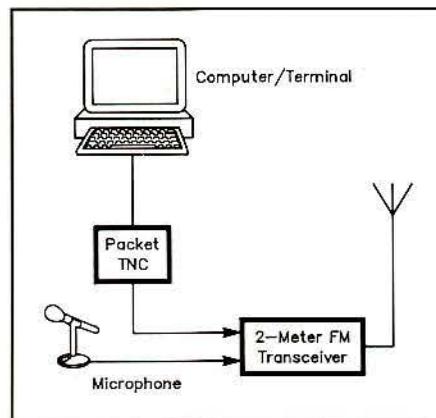
The biggest problem with working *Mir* on packet is interference—lots of interference! With the signal coverage the space station enjoys, you can imagine how many hams might be trying to contact *Mir* at the same time. This creates pure chaos as far as its receiver is concerned.

If you're able to connect to the mailbox, the constant bombardment of signals may make it difficult for you to post your message before the space station disappears below your horizon. Here are a couple of tips to improve your chances:

- ❑ Listen before you start sending connect requests. Monitor a few transmissions and make sure you have the correct mailbox call sign. The call sign changes whenever a new crew occupies the station.

- ❑ Use as much power as you have available. If there were only a couple of stations competing for *Mir*'s receiver, you'd only need a couple of watts to have a decent chance of connecting. During a normal pass, however, there are usually *dozens* of stations blasting out connect requests. The stations that pack the bigger punches seem to win consistently.

- ❑ Try connecting during "unpopular" hours. If you have the stamina to sit up and wait for a late-night pass, you may have a better opportunity to make a connection.



**Fig 2—You don't need elaborate equipment to work *Mir*. For packet operating, all that's required is a computer or data terminal, a packet TNC (terminal node controller) and a 2-meter FM transceiver. If you're interested only in voice contacts, all you need is a 2-meter FM transceiver and a microphone!**

## Finding the Satellites

All current Amateur Radio satellites are in non-geostationary orbits. This simply means that the satellites are not in fixed positions in the sky from our perspective here on Earth. They are like tiny moons, rising and setting rapidly over your local horizon. While the satellites zip around the Earth at tremendous speeds, the Earth is turning beneath them. The result is that you can't rely on satellites to appear in the same places at the same times each day.

### Orbital Elements

So how can you know when a satellite is about to make an appearance in your neighborhood? To answer that question you need to know the satellite's *orbital elements*.

As incomprehensible as it may seem, an orbital element set is merely a collection of numbers that describes the movement of an object in space. By feeding the numbers into a computer program, you can determine exactly where a satellite is (or will be) at any time. Don't worry about the definitions of *mean anomaly*, *argument of perigee* and so on. If you're curious, get a copy of the *Satellite Experimenter's Handbook*<sup>1</sup> and you'll learn all about those definitions—and more. For the moment, consider the words as labels for the numbers that appear beside them.

### Finding the Elements

There are several sources of orbital elements:

- Satellite newsletters<sup>2</sup>
- W1AW RTTY and AMTOR bulletins<sup>3</sup>
- Packet bulletin boards
- Telephone bulletin boards<sup>4</sup>
- AMSAT nets<sup>5</sup>
- World Wide Web<sup>6</sup>

If you have an HF radio, RTTY capability, a packet TNC, a telephone modem or the necessary cash for a subscription, you'll always be able to get the latest orbital elements for the satellites you want to track. If all else fails, there is probably someone in your area who has access to the elements. Ask around at your next club meeting.

### Using the Elements

Computers are common in most Amateur Radio stations today. If you have a computer in your shack, you're in luck! There are many programs on the market that will take your orbital elements and produce detailed satellite schedules.

Among other things, the programs tell you when satellites will appear above your local horizon and how high they will rise in the sky (their elevation). When working satellites, the higher the elevation the better. Higher elevation means less distance between you and the satellite with less signal loss from atmospheric absorption.

<sup>1</sup> *The Satellite Experimenter's Handbook* is available from your local dealer or direct from ARRL HQ.

<sup>2</sup> *The AMSAT Journal* is included with membership in AMSAT, PO Box 27, Washington, DC 20044. (\$30 per year US, \$36 Mexico and Canada)

*OSCAR Satellite Report* (\$29 per year US, \$32 Canada) and *Satellite Operator* (\$33 per year US, \$36 Canada) are available from R. Meyers Communications, PO Box 17108, Fountain Hill, AZ 85269-7108.

<sup>3</sup> W1AW transmits satellite orbital elements on Tuesdays and Saturdays at 2330 UTC using 45.45-baud Baudot RTTY, 110-baud ASCII and Mode B (FEC) AMTOR. Frequencies are 3.625, 7.095, 14.095, 18.1025, 21.095, 28.095 and 147.555 MHz.

<sup>4</sup> Satellite orbital elements may be downloaded from the following telephone bulletin boards:

ARRL BBS—tel 860-594-0306

Dallas Remote Imaging Group (DRIG)—tel 214-394-7438

<sup>5</sup> AMSAT Information Nets:

Sunday at 1800 UTC on 21.280 and 14.282 MHz

Tuesday at 2100 Eastern Time on 3.840 MHz

Tuesday at 2100 Central Time on 3.840 MHz

Tuesday at 2000 Pacific Time on 3.840 MHz

<sup>6</sup> <http://www.amsat.org/>

When you finally connect to the mailbox, make your message entry *short*. The station will be out of range before you know it and other hams will be waiting to try their luck. Packet software that permits users to create message files in advance comes in handy for *Mir*.

### Voice Contacts with *Mir*

The *Mir* cosmonauts obviously enjoy packet, but sometimes they crave the sounds of other human voices. You may be waiting for a chance to connect on packet, only to hear them calling CQ instead!

Talking to *Mir* on FM is much easier than connecting to *Mir* on packet—especially if you're using low power and omnidirectional antennas like I am. Working *Mir* is pure excitement. You sit with microphone in hand and wait until you hear the cosmonaut complete an exchange. At that moment you key the mike and say your call sign. Now listen. No response? Call again

quickly! Keep trying until you hear him calling you or someone else. I've heard of hams working *Mir* while mobile and some claim to have worked *Mir* with hand-helds. As you might imagine, *Mir* QSL cards are highly prized!

The *Mir* cosmonauts tend to operate on an erratic schedule. They have many daily assignments and are not always able to find the time to operate their amateur station. In addition, they're sometimes forced to turn off their equipment altogether to avoid interference to other systems during critical tests.

The space station travels at a relatively low altitude, so it's always subject to a significant amount of atmospheric drag. If it didn't occasionally "boost" to a higher orbit, the station would reenter the atmosphere and be destroyed. Every time *Mir* fires its rocket engines to adjust its orbit, a revised set of *orbital elements* must be distributed. If you want to try your luck with *Mir*, plan to update your elements for the space station as often as possible (see

the sidebar, "Finding the Satellites").

### Where do I Go from Here?

When this article was written there were over a dozen Amateur Radio satellites in orbit with many more on the way. If the idea of communicating with spacecraft excites you, there are lots of opportunities for fun and adventure!

Take the PACSATs, for example. They're packet satellites with tremendous capabilities. Some function like orbiting packet bulletin boards. Others carry video cameras and transmit images of the Earth and other objects in space! To communicate with the PACSATs you'll need to add 435-MHz receive capability along with a specialized TNC and software.

For the moment, enjoy yourself on the Russian EasySats. If you hear me on RS-10, give me a call. I'm working toward getting my VHF/UHF Century Club—Satellite award and I need all the contacts I can get!

# Earn an ARRL Friendship Award

It's fun, it's friendly,  
and you'll love  
the certificate!

By Chuck Hutchinson, K8CH  
ARRL Membership Services Manager

**P**erhaps your first Amateur Radio certificate was for membership in the Rag Chewer's Club (RCC). That wasn't hard to do, was it? Now you'd like to earn other operating awards. You say that's a problem: The awards you want to earn don't allow contacts through repeaters, and you only operate FM phone—mostly through repeaters.

No problem! The Friendship Award is for you. Rules for this new award were written to make it possible for any ARRL Member to qualify. Your license class is no hindrance, and you can use your favorite bands and modes. You can make all your contacts through repeaters or, if you prefer, elsewhere on VHF/UHF or HF bands.

The text on the certificate says, in part, "These contacts were made in the spirit of friendship. Let all who read this know that radio amateurs are friendly. They give friendly advice and counsel to beginners. Kindly assistance, cooperation and consideration for the interests of others are the hallmarks of the amateur spirit. Those words sum up the spirit of this award."

## Who is it Really For?

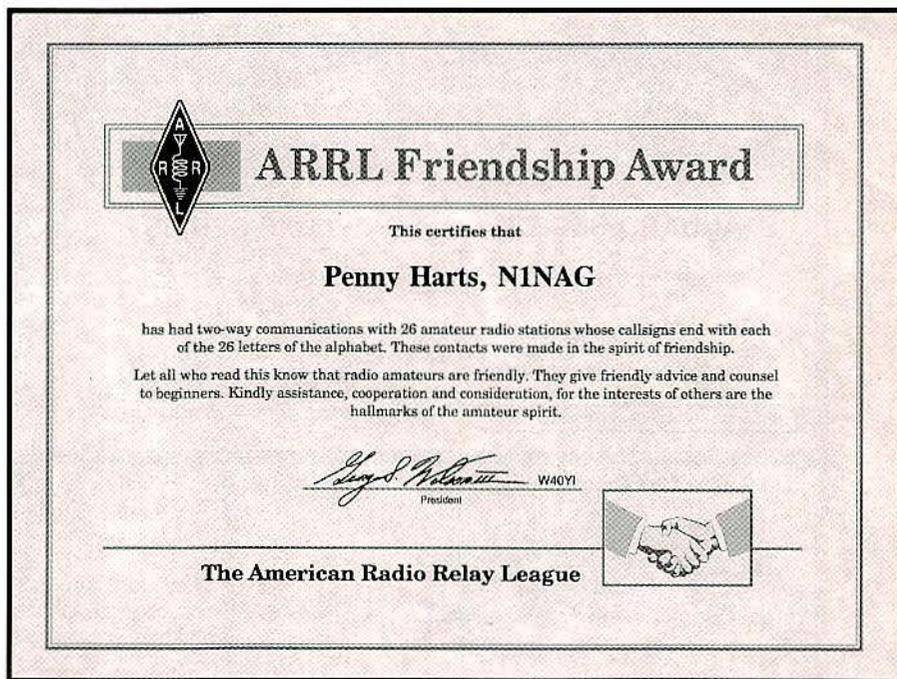
This award is for all League Members. For example, Sam is a DXer, and he loves contests. He's a little tired of cookie-cutter, fill-in-the-blanks QSOs. It'll be fun for him to take some time and get better acquainted with the ham on the other end.

Sarah earned a Technician license to share her husband's hobby interest. Since then, she's been particularly active in public service activities. She listens to the local repeater in case she can help. In going for the Friendship Award, Sarah will become acquainted with people she only occasionally hears on the air.

You may be into satellites, packet, TV, traffic handling or whatever. Here's an opportunity to make friends and collect some nice "wallpaper" shown here.

## Getting Started

You can begin making the contacts to earn this award right away. Keep a log or other record of the information required in rule 2. Contact your local ARRL-affiliated Amateur Radio club. Ask if the club is par-



The new ARRL Friendship Award. Be one of the first to earn one for *your* shack!

ticipating in this program. If so, it has, or will receive (upon request) a supply of application forms and certificates.

Affiliated clubs should request application forms (contains rules) and certificates.

Clubs may also issue Rag Chewer's Club (RCC) and Old-Timers Club (OTC) certificates. Details, forms and certificates are available from the Affiliated Club Branch at ARRL HQ.

## Rules for the ARRL Friendship Award

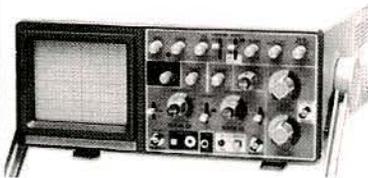
- 1) The ARRL Friendship Award is available to any ARRL Member who submits log extracts that show two-way communications with 26 stations whose call signs end with each of the 26 letters of the alphabet. (For example, N1MZA, K0ORB, W3ABC...K1ZZ.)
- 2) Log extracts should indicate the contact date, call sign, name, location and another fact about the person contacted. (Other facts could include names or call signs of mutual friends, other family members who are licensed, other hobbies, etc.)
- 3) Contacts may be made on any authorized Amateur Radio frequency using any authorized mode. Contacts made through repeaters or satellites are permitted and welcome.
- 4) Contacts may be made from (or to) any location or any number of locations.
- 5) Special endorsements (band, mode, etc) are not available for this award.
- 6) Contacts must be made November 1, 1993, or after.
- 7) Application Procedure:
  - a) An application form can be obtained from any participating ARRL-affiliated club or from ARRL HQ.
  - b) Completed applications should be submitted to any participating ARRL-affiliated club or to ARRL HQ.
  - c) Applications sent to ARRL HQ must include a 9- x 12-inch self-addressed stamped envelope (SASE) with two units of First-Class postage (sufficient for two ounces).

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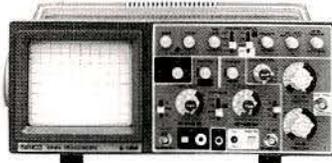
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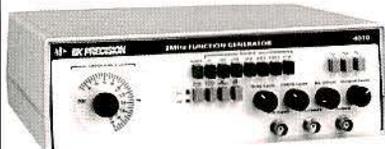
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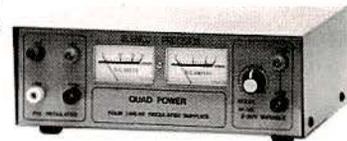
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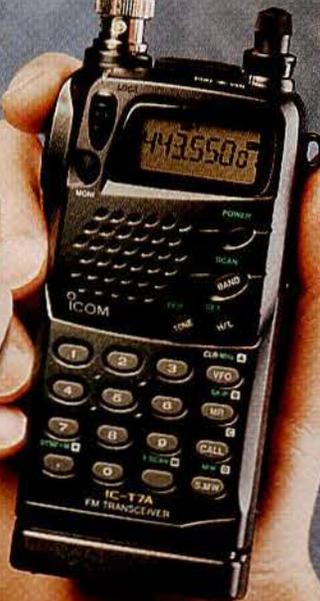
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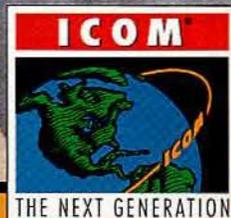


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# Getting the Most Out of Nickel-Cadmium Batteries

Most of us use NiCds; few of us agree on how to use them right. Here's help in separating NiCd fact from myth.

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**M**any radio amateurs own hand-held transceivers; for some hams, a hand-held is their *only* radio. Almost all hand-held users depend on battery power much of the time—battery power from nickel-cadmium (NiCd) batteries. We value NiCds as a power source because they stuff considerable energy storage into small packages and because their output voltage stays relatively constant until just before they run down. Most importantly, though, we value NiCds because they're *re-*

*chargeable*. Instead of throwing them away, we can reuse them many times.

Hamdom reverberates with fact, opinion, myth and legend about NiCd batteries and how to use them. We hear about memory effect, self-discharge, cell reversal, slow charge, fast charge, trickle charge, overcharge and undercharge. We're told to discharge NiCds fully before recharging them; we're told that we can top them off anytime without hurting their performance. What's fact and what isn't?

One thing seems sure: You want your NiCd batteries to last as long as possible. In this article, I'll discuss NiCd facts, myths and legends, and some of the things you can do to extend your NiCd pack's life, and I'll provide practical, how-to NiCd information in a question-and-answer session.

## What Drives NiCd Evolution and Know-How

Most of what we know about building better NiCds and using them effectively

## NiCd Questions and Answers

**Q: How long can I expect a NiCd pack to last before I need to replace it?**

A: The answer involves so many variables that it's very difficult to answer. One cell of a pack may give up after a year or two, another cell in the same pack may last as long as ten years. Statistically, you should be able to get at least two to three years of solid use from a NiCd pack in handheld service if the pack is properly maintained and not abused by high temperatures (such as inside a closed-up, un-air-conditioned car in summer), poor charging/discharging techniques and so on, but there's no guarantee. Buy quality packs for best life; bargain packs may give disappointing performance.

**Q: Should I discharge a NiCd pack all the way before recharging it?**

A: Never discharge a NiCd pack "all the way." Doing so can force individual cells to reverse polarity and can cause the cell to generate gas. This weakens the cell by drying out its electrolyte—an irreversible process.

**Q: Someone told me that there is a big difference between "full discharge" and no voltage present across a pack's terminals, but I thought that you use a pack until it's totally empty, like a can of soda. What's correct?**

A: Full discharge can be defined to mean that all cells in the battery pack are completely discharged. This is impossible to achieve with sealed NiCd packs. A condition of zero terminal voltage on a pack invariably indicates one or more positively charged cells, with the remainder of the cells having a reverse charge.

**Q: Although a NiCd's discharge curve is pretty flat, it exhibits some shape. With this in mind does, measuring a NiCd pack or cell's terminal voltage tell me anything**

**useful about its state of charge?**

A: Not reliably. The voltage is also affected by cell temperature and charge rate. The really meaningful indicator is the voltage rise that occurs when the cell reaches full charge. At that time, its voltage goes from about 1.35 to about 1.45-1.5. Conversely, when the cell voltage drops below about 1.1, it is almost completely discharged. Between these extremes, you can expect cell voltages to stay near 1.25 over most of their discharge curve and 1.35 over their charge curve.

**Q: Is it true that short-circuiting a NiCd cell or pack is dangerous?**

A: Very dangerous! Shorting any battery or cell, of any type causes very high current to flow through the cell(s). The cell's internal resistance converts some of this current to heat that may boil the electrolyte and generate high internal pressure. This can damage the cell, and may even crack or explode the cell case. A short-circuited cell may be destroyed even if it outwardly appears undamaged.

This is a good place to mention NiCd first aid. NiCd-cell electrolyte contains potassium hydroxide (KOH). Potassium hydroxide is very similar to lye (sodium hydroxide [NaOH]; oven- and drain-cleaner products often contain it). *Potassium hydroxide is caustic and very dangerous to skin and eyes—more dangerous than the sulfuric acid used in lead-acid batteries.*

Skin contact with KOH is a serious matter and calls for prompt action. If any splashes on the skin, immediately flush the affected area with running water to prevent chemical burns.

Eye contact with KOH is a medical emergency. **IMMEDIATELY** get running water flowing into the eyes and keep it flowing for at least 15 minutes. Once this process is

comes from satellite development. Of all battery applications, none demands more of battery life than satellites. In fact, battery life is the determining factor in predicting the useful life of a communications satellite, in which battery charge-discharge occurs daily for—hopefully—many years. With millions of dollars riding on the reliability of these electrochemical power plants, satellite designers choose only the best available batteries for their birds. Today, as at the dawn of the satellite era, the NiCd wins hands down.

Spacecraft power specialists thoroughly investigate anything that promises to lengthen satellite battery system life. What they discover either leads to improved space hardware or is discarded as useless. Because the results of such research—especially the negative results—trickle down to consumers slowly (if at all), false information about NiCd performance persists among consumers. Let's examine the biggest NiCd myth first: *memory*.

### Memory

How many of us haven't heard these variations on a theme? "Memory killed my battery pack, so I have to buy a new one." "You can have it for nothing—memory ruined that pack and it won't hold a charge." "Always fully discharge a NiCd battery before recharging, or memory will result."

According to popular belief, NiCd memory works something like this: Using a battery for the same amount of time each day eventually trains the battery to that time and/or discharge limit. Beyond that point, zero capacity—and the pack can't be retrained.

NiCd memory can occur, but only under very specific conditions, and I doubt that any ham has actually seen memory in a hand-held or power tool. The characteristics of true NiCd memory are not what many people consider them to be.

Memory is not a condition where a cell "drops dead" after a short period of discharge. What does happen is that the cell potential drops several tenths of a volt below normal and remains there for the rest of the discharge. *The cell's total ampere-hour capacity is not significantly affected.* Memory usually disappears if the cell is almost fully discharged and then recharged a time or two. Memory can occur during cyclic discharging to a definite fixed level, and subsequent recharging. Even then, memory rarely occurs—so rarely that battery manufacturers have considerable difficulty in forcing it to occur so they can study it!

Some satellite power systems, it's true, use NiCds in ways that require careful management to avoid memory. When a geosynchronous satellite passes within the earth's shadow—once a day—it operates solely on



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battery power. The batteries recharge when the satellite emerges from earth's shadow and its solar cells once again provide power. A continuous charge/recharge cycle this regular can promote memory occurrence. Memory rarely occurs in our hand-held-transceiver battery packs because we rarely discharge them to the same level each time we use our hand-helds.

Even in geosynchronous satellites, memory is uncommon enough that batteries are reconditioned only once every year or so by taking a given battery off line, almost fully discharging and recharging it a time or two, and putting it back in service. This simple preventive-maintenance process eliminates any memory condition that might have occurred and restores affected cells to full capability.

Note that I said that satellite battery reconditioning involves almost fully discharging batteries. NiCds in communications

underway call 911. **IMMEDIATE MEDICAL CARE IS NECESSARY!** Flush the eyes with water and continue flushing. Seconds count because vision is at stake!

### Q: Can I damage a NiCd pack by leaving it on a C/10 wall charger beyond its topped-off state?

A: NiCd battery manufacturers generally state that cells can be left on charge for extended periods beyond the time required for full charge. Most of them also mention that this is not a good idea because maintaining electrochemical action beyond the full-charge point can shorten cell life. Accidentally leaving a battery on a C/10 charge for a day or so should cause no lasting harm, but don't make a practice of leaving a battery on charge continuously to keep your hand-held ready for instant use. Charge the battery only when necessary or top it off for a few hours before a special activity.

### Q: Can I damage a NiCd pack by leaving the radio it powers turned on with its squelch open?

A: You better believe it! This will cause cell reversals and can shorten pack life.

### Q: Some NiCd applications involve fast charging—jamming a full charge into a pack in a short time. What's good about fast charging?

A: It's fast.

### Q: What's bad about fast charging?

A: Discharged NiCds can sop up high charge currents without difficulty—so much so that, in industrial flooded-cell NiCd systems based on cells with capacities in the hundreds of ampere-hours, charger safety, not battery safety, is the main concern. The real problem with high charge rates occurs when the cells approach full charge. If the charger fails to sense that full charge on even a single cell has been reached, cell out-gassing can occur. Loss of cell capacity always accompanies outgassing.

Apply high-rate charging only to cells that are internally designed to withstand overcharge conditions at the charger's output current. A properly designed fast charger should reduce charge current as the battery approaches full-charge terminal voltage.

### Q: NiCd cells sometimes short-circuit internally. Why and how does this happen?

A: The tubular NiCd cells many hams use contain a sandwich that consists of a thin positive plate, a thin layer of porous insulating material (separator), a thin negative plate, and another separator. These are tightly rolled together into a cylindrical shape and stuffed into the battery case (such as an AA or similar shell). To get the highest possible current capability from the cell, the separators are made as thin as possible.

Thermal flexing inside a cell can abrade these separators, causing the plates to touch and short. More commonly, however, sharp whiskers or spikes, called dendrites, grow from the plates and puncture the separator. The cell short circuits when a whisker touches the opposite-polarity plate.

### Q: Can I rejuvenate a shorted NiCd cell by "zapping" it—that is, by subjecting it to heavy overcharge for a few seconds?

A: Zapping seems to be fairly popular, and sometimes works—for a while. All it really does is postpone the affected cell's death, because once a NiCd cell shorts, it cannot be restored to its rated full capacity.

Zapping actually burns out dendrites, but it's not a 100% cure because some of the vaporized metal diffuses into the separator, causing an electrically leaky metallic path that slowly discharges the cell. This condition worsens with time. Eventually, cell replacement is necessary.

birds are *never* fully discharged! Doing so would shorten their life. Since such batteries are expected to last for seven or more years without failure, "running 'em down to zero" is definitely not one of the procedures!

### What Actually Kills NiCds?

To examine the mechanisms for NiCd cell failure, let's look first at the NiCd cell itself. The electrolyte is potassium hydroxide, the uncharged positive plate is nickel hydroxide, and the uncharged negative plate is cadmium hydroxide. As the cell charges, the positive plate changes to nickel hydroxide, and the negative plate becomes metallic cadmium. Once the charging process has taken this conversion as far as it can go, the battery is fully charged. Further charging energy looks for, and finds, other chemical work to do: It breaks down electrolyte water—into oxygen gas at the positive plate, and hydrogen at the negative.

NiCd-cell manufacturers deliberately make the positive plate smaller than the negative to allow the positive plate to reach full charge before the negative. Overcharging then generates oxygen first, which dif-

fuses through the insulating separator material between the plates and reacts with the negative plate's cadmium metal to convert the cadmium back to its uncharged (cadmium hydroxide) form. In practice, this means that keeping overcharge current to low levels allows the oxygen generated to combine with the negative plate and keep it from reaching full charge. Increasing overcharge current beyond the point at which the oxygen generated can combine with the negative plate causes cell outgassing—oxygen and hydrogen if both plates reach full charge. Whatever gas develops builds up pressure in the cell. The oxygen will slowly combine with the negative plate and reduce cell pressure if overcharging ceases at this point; any hydrogen produced, however, will remain. If overcharging continues, pressure builds until the gas escapes through the cell's pressure-relief vent—a good thing, since oxygen supports combustion, and hydrogen can burn with explosive force.

Gas venting indicates water loss, which means electrolyte loss. Electrolyte loss reduces cell capacity. If you overcharge a NiCd battery vigorously enough to cause

outgassing, you're losing electrolyte and throwing away battery capacity. How much you overcharge the battery—that is, how much overcharge current you push through the battery how fast, and for how long—makes the difference between a destructive overcharge and an overcharge your battery can handle.

### Chargers

Charging your NiCd batteries and cells right goes a long way toward maximizing their life. Generally, you'll be okay if you use the charger that matches your hand-held's battery pack—use it according to the manufacturer's instructions, that is. With homemade and aftermarket chargers, you need to be more careful. Here's an overview of the charger types and charging techniques you're likely to encounter.

*Wall chargers*, plug-in transformer/rectifier units, come with many hand-helds. Typically, they're designed to supply a constant current of about 10% of the cells' ampere-hour (Ah) rating. (In battery jargon, this is referred to as a "C-Over-10" rating—C standing for capacity, equal to 100%—and

**Q: My battery pack's terminal voltage is abnormally low. Is this a sure indication that at least one of the pack's cells is shorted?**

A: No. Abnormally low output voltage may also indicate that one or more of the pack's cells is reverse-charged.

**Q: I discharged my NiCd pack so far that one or more of its cells reversed polarity. What's the best thing to do with the pack now?**

A: Speak softly to the pack. Ask its forgiveness. Tenderly plug it into its charger and charge it for the time recommended by the equipment manufacturer. Try not to let it happen again.

Actually, reversing cells in a pack a time or two probably won't destroy the pack if it happens at a low discharge current, such as that drawn by a hand-held's receiver. NiCd cells are designed to accept some reverse charging, but this is nowhere near as effective as a cell's designed-in overcharge protection.

**Q: Can I successfully repolarize a reversed NiCd cell?**

A: Yes. Keep in mind that because the very low reversed polarity terminal voltage of a reverse-charged cell bucks the voltage produced by the pack's healthy cells, a reversed cell at first appears to be a shorted cell. A reversed cell must bleed off its reverse charge before it can accept a normal polarity charge. Start recharging the pack and monitor its terminal voltage. You'll see the pack's terminal voltage increase by about a volt each time a reversed cell suddenly "breaks loose."

**Q: How long can a fully charged NiCd battery sit unused before I need to top it off with a few hours at the C/10 rate? Does pack temperature affect self-discharge rate?**

A: Of the many factors affecting a NiCd battery's self-discharge rate, temperature is the one over which we have the most control. High-quality cells, when new, can be expected to self-discharge at about 5% to 10% of charge per month when kept at room temperature.

**Q: Should I store a charged pack in a particular environment**

**to best preserve its charge, or is occasional C/10 maintenance charging the best overall response to self-discharge?**

A: Storing cells in cooler areas reduces the self-discharge rate; strong battery packs in hotter areas, such as the trunk or glove compartment of a car in summer, greatly accelerates it. Many hams store NiCds and alkaline batteries in their refrigerator (not the freezer!) because of this. Giving a battery a couple of hours of low-rate charging once a month or every other month should be okay.

**Q: One of my pack's cells really did short, and I decided to replace just the shorted cell. Then I heard that a pack's cells must be matched. What's cell matching, and how is it done?**

A: Some companies that sell replacement hand-held battery packs and pack inserts mention that they use matched cells. Cell matching involves running a large number of cells through one or more discharge/recharge cycles and rating them by ampere-hour capacity. Constructing packs only of cells that closely match each other in capacity ensures that when a pack's weakest cell reaches a certain discharge level, the others in the pack are discharged to just about the same point. This provides some protection against cell reversal because it limits how long a discharge cell must withstand reverse charge before the entire pack fully discharges. So, although cell matching increases battery-pack cost, it's good insurance.

Cell matching is feasible for battery manufacturers because it can be automated, and because a manufacturer can grade and stock thousands of cells. For hams or experimenters who want to build their own battery packs, matching is prohibitive in terms of cell cost and time.

**Q: Some hand-held transceiver manufacturers sell empty battery packs designed to hold dry cells. Is there a most-economical dry-cell type (carbon-zinc, alkaline, mercury, and so on) to use in such a pack? What are the trade-offs?**

is written as C/10. A 5% charge rate would be C/20, or "C-Over-20," and so on.)

Wall charges are safe and effective, can be left plugged in and charging for extended periods of time without damaging a battery. The price you pay for this convenience and safety is time: A wall charger typically takes 15 to 16 hours to charge a fully discharged battery. A second battery pack is the simplest way around this limitation: Use one pack while the other charges.

**High-rate chargers**, sometimes available as extra-cost options for hand-held transceivers, can recharge a battery in much less time than a wall charger, with some manufacturers claiming recharge times as short as 1 to 2 hours. The charger and battery must be made for each other, because high-rate chargers can damage cells not rated to accept the charge currents they produce. Chargers capable of taper charging (reducing their charge current as the battery reaches full-charge terminal voltage) are generally safer for a battery. (Exception: If the battery contains one or more shorted cells, a taper charger will damage the pack's remaining good cells by attempting—and failing—to

charge them to the full-charge voltage appropriate for an undamaged pack.)

**Pulse charging** NiCds is somewhat controversial. Pulse charging, according to its adherents, charges NiCds efficiently with little heating by means of strong, very short current pulses. It seems that one commercial organization, experimenting with pulse charging for spacecraft batteries, has achieved greater charging efficiency—not cell life—with pulse charging under specific conditions. The benefits were apparently insignificant, however, because my contacts in the space field have confirmed that pulse charging remains unused.

The pulse charger in this aerospace application produced very-high-current, low-duty-cycle pulses. In contrast, the pulse charges described in several popular magazine articles I've seen consist of little more than a rectifier and step-down transformer operating at 60 Hz. Ordinary wall charges achieve essentially electrically identical "pulsing" because they contain almost no filtration. (A charging NiCd battery absorbs and smoothes ripple far better than the largest filter capacitor installable in a tiny wall

charger.) Overall, pulse charging has yet to prove its worth.

## Dischargers

Entrepreneurship has recently brought another product class to the NiCd-accessories field: Battery *dischargers*. Avoid these at all costs. The deeper you discharge a rechargeable battery, the more you stress it. Why deliberately wear out a battery by increasing its discharge? It's never done industrially, because industrial NiCd users know that memory is not an issue. Intentional battery discharge increases the likelihood of cell outgassing and polarity reversal—two effects that can kill a battery pack. Don't needlessly discharge your batteries—put their stored energy to work.

## Summary

I hope that the information I've presented here boosts your faith in NiCds. Although they certainly don't deserve the poor reputation they receive via the rumor mills, they can be abused. Applying proper NiCd-care know-how should net you better performance and longer life from these popular batteries.

## What about putting separate NiCds in such a pack?

**A:** Cell holders like this are worth having around, especially for ARES/RACES members. In the event of an emergency in which recharging power may not be available, or when there's not enough time to recharge depleted NiCd packs, a hand-held can be kept on the air with AA-size dry cells.

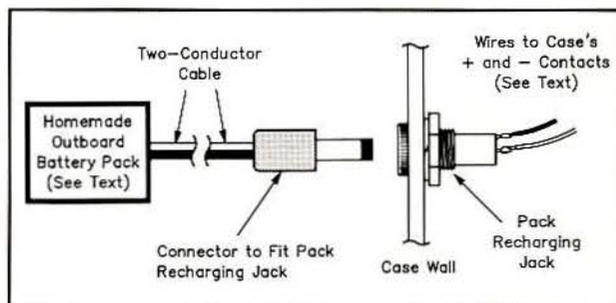
As to cell types, we can eliminate mercury and carbon-zinc (standard "flashlight") cells. Mercury cells are difficult to find and extremely expensive. (Mercury also represents a disposal problem because it's hazardous waste.) Carbon-zinc cells exhibit relatively high internal resistance, and may be unable to supply sufficient current during transmission. (You can use carbon-zincs when nothing else is available, of course. If possible, set your radio's transmitter to low power when doing so.)

The ultimate choice for a primary (non-rechargeable) cell is the alkaline. These combine a lower internal resistance than carbon-zinc cells with about twice carbon-zinc's ampere-hour capability (about four times the capacity of the best NiCds for a given cell size). Remember, though, that an alkaline cell's internal resistance is higher than a NiCd's. This means that alkaline cells may cause your radio's battery-warning light to come on during high-power transmission. This won't necessarily mean that your alkalines are dying, but may instead indicate that the cells can't deliver the current necessary for full-power transmission.

Of course, you can stuff individual NiCd cells into the holder and use it as an additional rechargeable battery pack. As another option, you can use a dry-cell pack (or the case from an exhausted NiCd pack) to connect a high-capacity outboard pack to the radio. (I made my own rechargeable pack by getting two four-C cell holders from Radio Shack, mounting them on a piece of fiberboard and connecting them to the pack contacts as shown in Fig 1.)

## Q: Are NiCds hazardous waste?

**A:** Yes! The US Navy won't let companies use NiCds in shipboard systems. Also, the Environmental Protection Agency



**Fig 1—**You can use the case from an exhausted NiCd pack to connect an outboard pack to your hand-held as shown here. Use as many NiCd cells (approximately 1.2 V each) in the outboard pack as necessary to supply your radio's operating voltage; for example, an 8.4-V radio requires seven cells. Equip the pack with a color-coded power cable (use the darker of the two colors for negative) terminated with a plug that fits the battery-pack case's recharging connector. (Radio Shack tells the plus and acks typically used for this application as DC Power Connectors, page 150 of the 1992 RS catalog.) Wire the charging connector directly to the pack shell's positive and negative contacts, removing whatever circuitry may exist between the charging connector and pack contacts. Check your cable, plug and connector wiring to ensure that your outboard pack's positive terminal connects to the pack shell's positive terminal; likewise for the negative wire. Your radio or its operating manual should show the polarity of its power connections.

lists cadmium and its compounds as #2 on its list of toxic waste materials, and nickel and its compounds as #12. So don't just throw NiCds away with your trash. Call your local waste-disposal authorities for information on how to discard them responsibly.—W3VFN (questions by ARRL technical staff)

# The Lure of the Ladder Line

By Steve Ford, WB8IMY  
Managing Editor

**L**ike many hams, I live in a home that's inhospitable to antennas. My house sits on a 100-foot square lot with trees along the back. I always hoped to be the proud owner of a tower and an HF beam antenna, but that was out of the question. What about a vertical? Well, I'd have to bury plenty of radial wires in the rocky Connecticut turf. That didn't sound like fun. I could buy a vertical that didn't require radials, but those antennas were a bit out of my price range—and their awkward, spiky appearance didn't blend well with the landscaping. A wire antenna seemed to be the ideal candidate.

Hanging a wire between two trees wasn't a problem, but there was still the *aesthetic* issue to consider. As much as I love ham radio, I didn't want to arouse the anger of my wife and neighbors by installing a copper monstrosity that looked as if it was spun by a mutant spider. All I wanted was a simple, low-profile dipole that I could operate on a number of HF bands.

Perhaps I could string up a single dipole and feed it with coaxial cable, using an antenna tuner to load it on several bands. The length of the antenna wouldn't be critical. I'd put up as much wire as possible and let the tuner worry about transferring power to the system. Even under high SWR conditions, where lots of energy is reflected back and forth between the tuner and the antenna, a substantial amount of RF would still be radiated. That sounded fine to me.

I put up a 66-foot dipole and fed it with low-loss coaxial cable. Sure enough, my antenna tuner was able to load it on all bands from 40 through 10 meters—more or less. The tuner balked a bit on 17 meters and it was very touchy on 10 meters. (Sometimes it arced with a startling snap!) Despite the problems, I used my system to work 75 new countries in just a couple of months, finally clinching my DXCC award. I also enjoyed many stateside contacts.

The SWR was quite high on most bands. At 100 watts output, however, the heavy-duty coax withstood the mismatch without noticeable heating. (I'd certainly notice it at higher power levels, though!) The antenna looked great and seemed to be performing well. Even so, I knew I was losing power in the cable and I wondered how it was affecting the overall performance.

While considering the alternatives, my thoughts drifted to *trap* dipoles. Yes, a trap dipole can be resonant on several HF bands, but the coil-and-capacitor traps tend to be bulky and prone to loss. How about a *fan* dipole? Simply attach several resonant

dipoles to the same center point and feed them all with one cable. Too big and ugly! (We're back to the spider-web problem again.)

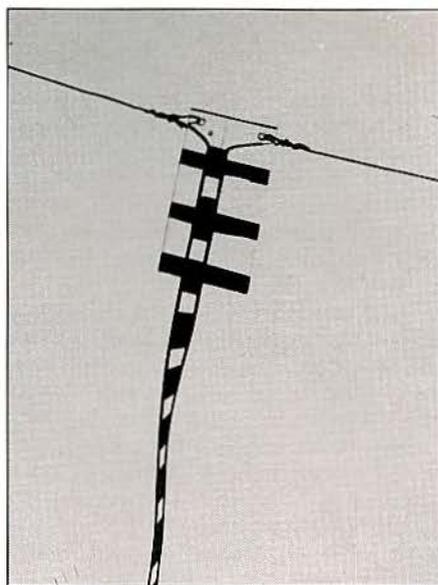
## How Bad Can it Be?

I allowed my thoughts to drift for more than a year—until I met Dean Straw, N6BV, our new Senior Assistant Technical Editor here at League Headquarters. Dean's field of expertise is antennas and propagation, so I peppered him with questions about my antenna situation.

Yes, he said, my original assumption was correct. A nonresonant antenna will work—even with sky-high SWR—if the feed-line loss is low enough. My cable provided a low loss. The *ARRL Handbook* chart indicated that its loss was less than 1.5 dB per 100 feet at 100 MHz. I was only using 50 feet and my highest operating frequency was 29.60 MHz. (Cable loss decreases as feed-line length and frequency decrease.) So how bad could my losses be?

Very bad!

I made the mistake of underestimating the loss *under high SWR conditions*. Dean used a computer program to calculate the loss on various HF bands when used with my 66-foot dipole. You can see the results



in the middle column of Table 1. I was shocked, to say the least! My 100-watt signal was reduced substantially on some frequencies. (The higher the dB figure, the more power is lost in the cable. A 3-dB loss represents a 50% reduction.)

Since I insisted on sticking with a single-dipole design, Dean suggested that I replace my coaxial cable with *ladder line*. Unlike coax, where one conductor completely surrounds another, ladder line places both conductors in parallel. Insulating material is used to maintain a consistent separation. As a result, the fields radiated by the conductors cancel each other and the line is *balanced*. In 450Ω line, sections of insulating

*I was feeding a short, limited-space antenna with coaxial cable. Everything seemed to be okay, but was it?*

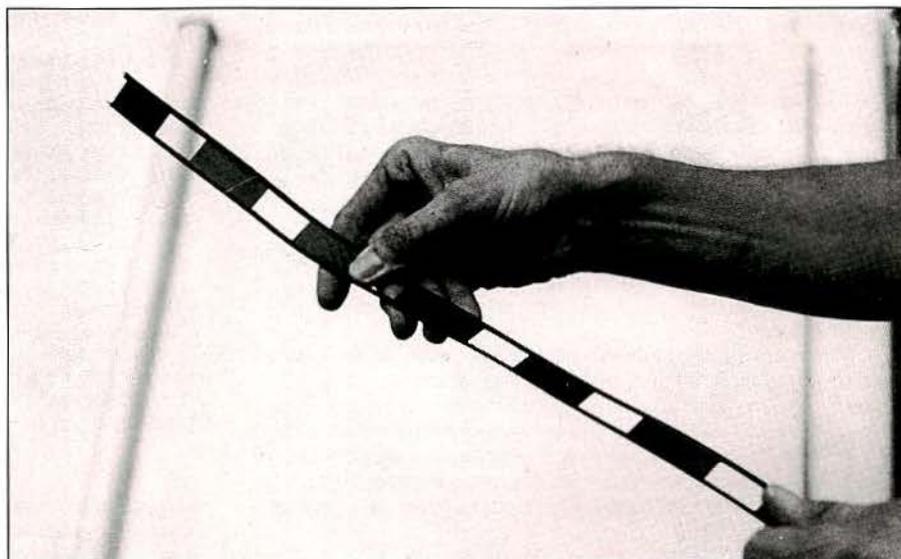
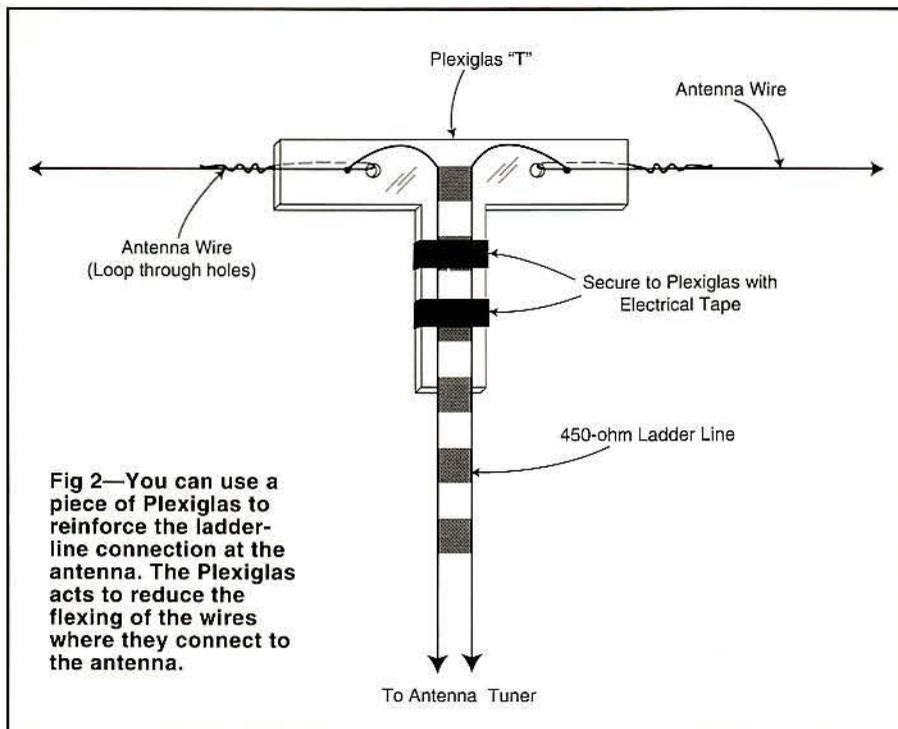


Fig 1—This type of 450Ω ladder line uses plastic insulating material to maintain a consistent separation between the two conductors. The air gaps between the insulation give it its ladder-like appearance. Other types of open-wire line are available, but 450Ω ladder line is the most common.



**Fig 2—You can use a piece of Plexiglas to reinforce the ladder-line connection at the antenna. The Plexiglas acts to reduce the flexing of the wires where they connect to the antenna.**

plastic give the cable a ladder-like appearance, hence the name (see Fig 1).

"Oh, no," I said. "I know all about ladder line. It radiates RF in your house and you have to keep it away from metal or it won't work."

Dean simply smiled. He ran the loss calculations again, but this time he substituted ladder line (see the right-hand column of Table 1). Wow! On 40 through 10 meters, the loss hardly exceeded 0.3 dB. Now he had my attention. But what about all those ladder-line problems?

"If the ladder line is balanced, it doesn't radiate RF," he replied. "As far as metal objects are concerned, you need to keep the line a few inches away from big sections of steel, aluminum and so on. The fields around the conductors can couple to metal and this creates an imbalance. Unless you intend to

tape the ladder line along your gutters, however, I wouldn't worry about it. Your tuner should be able to handle any imbalance that occurs."

### The Test

I was determined to put Dean's statements to the test. I purchased a 100-foot roll of 450Ω ladder line and attached it to the center of my dipole. Since this was a temporary installation, I routed the line across the roof and into the window of my radio room. Along the way I passed over a couple of gutters, across some chimney flashing and along some aluminum siding to my window—which was equipped with metal sashes!

After attaching the line to the balanced-antenna posts on my tuner, I fired up the radio. "This will never work," I mumbled.

The tuner loaded easily on 40 meters, but that proved nothing. The antenna was resonant on 40 meters anyway. I started moving up, band by band. Each time, the tuner reduced the SWR at the transmitter to a flat 1:1 match without difficulty. No arcing. No RF interference. I was stunned!

On 15 meters, I heard a pileup centered on a station in the Marshall Islands. I grabbed the microphone and announced my call sign when he said, "... standing by for calls." He answered me on the first attempt!

"I know what I'll do," I said with a fiendish laugh. "I'll load the antenna on 80 meters. It's way too short to load on 80!"

Wrong again. The tuner quickly brought the SWR down to 1:1. I then proceeded to make several contacts and received outstanding signal reports. This was the first time that I was ever able to use my dipole on 80 meters. I tried 160 meters, but that was

pushing it a bit too far for the tuner. A muffled frying sound indicated its displeasure.

The performance of the antenna fed with 450Ω ladder line has been excellent on all bands. As you might guess, the improvement is most dramatic on the bands where the SWR is highest. Thanks to ladder line, the vast majority of my output power is now radiated at the antenna—not lost in the feed line.

### Not a Cure-All

It's important to point out that my nonresonant dipole is a compromise solution designed for the restrictions at my home. The ladder line isn't magical. It simply allows a mediocre antenna to perform much better than it might otherwise. I must keep my output below 150 watts or risk dangerously high RF voltage levels on the feed line (now you know why the tuner arced on 160 meters!). Some antenna tuners may arc even at relatively low power levels. If you decide to attempt this type of antenna design, I recommend a heavy-duty antenna tuner rated at 1 kW or higher. The tuner must provide a *balanced* output (not all tuners do).

Of course, if I had a resonant antenna instead, I could go back to my low-loss coaxial cable and enjoy equally good performance. I probably wouldn't need an antenna tuner and I could run much more power.

Ladder line can be affected by weather. (Ice, water or debris between the conductors can upset the balance.) Unless you reinforce the connection at the antenna (see Fig 2), the line is likely to break rather quickly. And ladder line can be difficult to locate. (If your local dealer doesn't sell it, check the advertising pages of *QST* for wire and cable suppliers.) These disadvantages notwithstanding, ladder line is an excellent choice for almost any kind of HF antenna. Not only is it inexpensive, the loss figures at HF frequencies are very low.

### Apartment and Condo Dwellers

If you're an apartment/condo dweller, or anyone else suffering under antenna restrictions, ladder line may offer a way for you to get on the air. If you have an attic, for example, install the longest dipole you can and feed it with ladder line. Don't worry about the length of your antenna. Just make sure that both sides are equal. Use your antenna tuner and determine on which bands you can achieve a 1:1 SWR. You may be surprised to discover that you can become active on at least some HF bands after all!

**Table 1  
Loss Comparisons for Belden 8214 Coaxial Cable and 450Ω Ladder Line.**

Cable length: 50 feet.  
Antenna: 66-foot dipole at a height of 30 feet.  
Calculated by Dean Straw, N6BV,  
Senior Assistant Technical Editor

Frequency (MHz)	Loss (in dB)	
	8214	Ladder line
1.9	26.9	8.62
3.8	13.7	1.37
7.15	0.19	0.07
10.14	2.85	0.07
14.27	5.30	0.15
18.14	6.96	0.31
21.40	0.78	0.12
24.90	3.94	0.13
28.50	5.69	0.18

# Falling in Love With Ham Radio For Less Than \$200



## NEW HAM HORIZONS

By Jeff M. Gold, AC4HF  
1751 Dry Creek Rd  
Cookeville, TN 38501

**I'**ll never forget the thrill of talking to 18 DX stations in less than 45 minutes using a small battery, a piece of wire and a tiny transceiver. My low power (QRP) station fits very nicely in a small backpack and was assembled for less than \$200!

After a year of grinding away at work, it was finally time for a vacation. Not only was I going to get some time off, I had an extra \$200 to spend on a portable station. I saw an article about a new MFJ QRP transceiver that was small enough for backpacking. Because I didn't have enough time to build a rig before my vacation, I made some calls and finally found a dealer who had a preassembled model in stock at a discount price.

While waiting for the rig to arrive, I assembled a resonant dipole antenna. I used inexpensive #14 copper wire purchased from a local electrical wholesale store. At a cost of \$20 for 500 feet, it was a bargain! Some 1-inch PVC pipe scraps became the end and center insulators. I fed the antenna

with RG-58 coaxial cable (you can get 50 feet of RG-58 with PL-259 end connectors from Radio Shack for about \$14). I also visited my local hobby store and purchased a 7 amp-hour radio-controlled airplane battery (\$18).

Within three days my new transceiver arrived. I wired a power cord from the battery to the rig and put a connector on my straight key. I also grabbed some heavy

**You don't need huge antennas, hundreds of watts or an overstuffed bank account to enjoy Amateur Radio.**

fishing line and an old spark plug. They'd come in handy when it was time to install my antenna in the trees.

### Time for a Test!

I still had two weeks to go before my vacation, so I figured I had better test the rig and see how it would perform. I packed

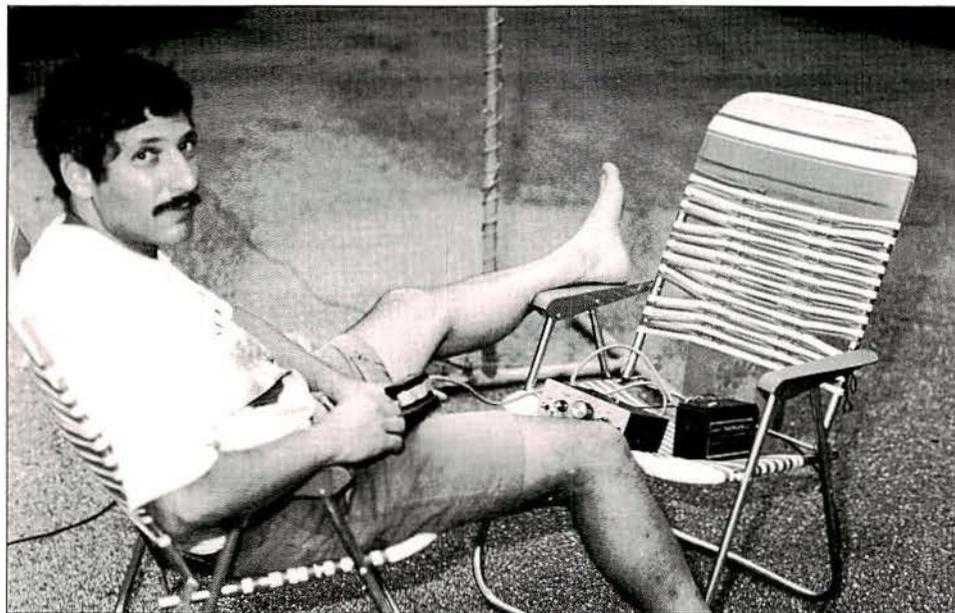
the whole setup, including the antenna, into a backpack and headed for a nearby riverside recreational area. Operating CW QRP brought to mind a picture of spending two hours banging away at a key just to barely reach someone down the block. If my gloomy scenario came true, at least I could console myself with a swim!

I found a place by the river with tall trees and a picnic bench. Using my trusty spark plug as a throwing weight, I managed to get the fishing line high into the branches. Tying the ends of the antenna to the fishing line, I raised it as far off the ground as possible. The entire setup took 25 minutes.

With shaky hands I pushed the power button on my new rig. I heard something! This was getting exciting! I twisted the tuning knob and seemed to hear signals, but there was nothing distinct. Soon I realized that I was turning the knob too fast, going right past dozens of stations! Curbing my nervous excitement, I took out my pen and paper and started to explore the band.

Within minutes I heard an EA3 station in Spain. His signal was surprisingly strong. I gave him a call, but another station beat me to it. I waited patiently and tried again. Bingo! He gave me a 559 RST and said he wanted a serial number. Huh? Looks like there was a contest going on! I gave him 001 and recorded the number he sent to me. I worked a few more EA stations, contacted several Italian and English stations, and then worked four Russian stations in rapid-fire order.

My head was spinning! I never imagined I would be able to work DX so successfully with such a small, inexpensive radio. The CW filtering made reception a snap and it seemed that my signal was getting out pretty well. After a while I grew tired of contesting and wanted to just relax and talk to someone. I was eager to tell other hams that I was only putting out 3 watts with battery power and a portable antenna! I continued tuning around the band and found some US ops who wanted to chat. They all said my rig sounded great. In fact, my RST was equal to some stations with beam antennas and 100 watts output!



Working the world with a couple of watts is a relaxing experience. The author takes it easy as he enjoys a CW conversation. (photos by Conard Murray, WS4S)

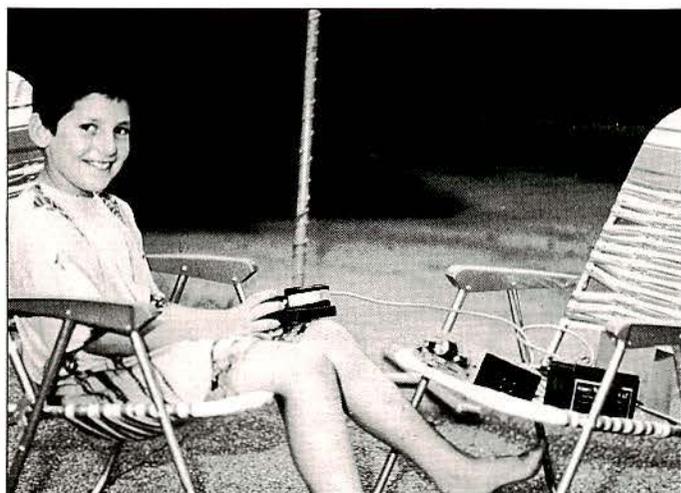


From left to right: the MFJ transceiver, the author's homemade CW paddle key and a rechargeable battery. The portable antenna is visible in the background.

At first I only attempted to answer people who were calling CQ with reasonably strong signals—579 RST or better. I assumed that if a station wasn't at least a 579, there was no way he or she was going to hear me. Further experience proved that this was *not* the case. I've since enjoyed short contacts with DX stations that had only 449 signals and carried on longer conversations with equally weak stations.

### On the Road

My portable station has traveled up Smoky Mountain trails, to lakes, to outdoor hamfests and even to a motel in Myrtle Beach where I strung my dipole between two buildings 60 feet apart! During my motel operation, I secured ropes to the fourth-floor railings and set up my station in plain sight. When people stopped by and asked what I was doing, I took off my head-



The author's son Danny, KD4HQV, gets into the act, too. He enjoys making CW contacts with his father's portable station.

phones and let them listen, explaining what they were hearing. I worked a good deal of DX and enjoyed some pleasant conversations.

On the last night, just as I was getting ready to tear down the station, a woman approached and began screaming questions. What was I doing? Was I a hit man, a spy perhaps? As it turned out, she was one of the motel owners!

I learned two important lessons from this jarring experience. One is to ask the owner of the motel for permission to set up a station (I haven't had any problems when I've asked). The other is to bring an alternative antenna if at all possible!

### The Alternative Antenna

An article in the April 1992 issue of *CQ* magazine (pp 38-41) describes how to build a portable vertical antenna from PVC pipe sections. The antenna uses helically wound wire and costs next to nothing to make. PVC sells locally for \$1.69 per 10-foot section. Since I already had the wire from the 500-foot roll I bought for my dipole, I tried the design. It worked so well that I decided to see if I could improve it.

My revised antenna is made from a heavier gauge PVC and uses  $\frac{1}{2}$ -wavelength wire instead of the  $\frac{1}{4}$ -wavelength specified in the original design. The result is a superb portable antenna that assembles in only five minutes and performs much better than the  $\frac{1}{4}$ -wave version. Now I can set up anywhere and be on the air in less than five minutes!

### Improving the Key

The only thing left to improve was the CW key. My nine-year-old son Danny, KD4HQV, has a General-class license and works CW exclusively. He never learned to use a straight key, but he's pretty good with a set of paddles. After some research, I found that none of the less expensive commercial paddles would be able to withstand the rigors of backpacking. The paddles that *did* meet the specifications were all priced at \$100 or more.

I had only been a ham for about a year and I was not accustomed to being an inventor. Time to seek outside help. I posted "help" messages on electronic bulletin

boards and took a good deal of ridicule! Sarcastic comments suggesting the use of ironwood or two teaspoons were common, but they stimulated my creative thinking. I finally realized that CW paddles just make and break electrical contacts. I don't have an extensive background in electronics, but it sure sounded like an electronic switch to me!

I went to Radio Shack and bought momentary-contact switches (look for part #275-618). Grabbing an old Plexiglas desk-top organizer, I sawed off one of the pen holder sections to use as a mounting platform. When I attached the switches they worked electrically, but were awkward to operate. Then I devised an elaborate system with nuts, bolts and tensioning devices attached to two pieces of plastic. After a couple of hours, I finally realized that it wasn't going to work!

Still, I refused to give up. I found some metal pieces that are used to hold slot positions in the back of IBM compatible computers. I drilled two holes in the Plexiglas pen holder and attached the thin metal strips. When I bent the metal into shape, I had working paddles which took only 10 minutes to finish. The entire paddle key was easily assembled in half an hour. After I mounted the switch assembly to a piece of pine, I tested the paddles and found that they worked fairly well—not too bad for about \$4 and half an hour of work!

I was so encouraged that I proceeded to cut some smoked Plexiglas for the paddle ends. A heavy brass grounding strip (I bought it for \$2 at a recent hamfest) was attached to the bottom for added weight. I included a strip of Velcro on the base to keep it from slipping.

Granted, it's not a high-quality paddle, but, boy, does it come close! My homemade paddles have survived many hours of operating as well as the bumps and jolts of backpacking. After the longest journeys, they need only a 30-second adjustment and I'm on the air!

### It's Easier Than You Think

Commercial QRP transceiver kits are available for \$100-\$150. See the advertising section of *QST* for sources. Plans for an excellent backpacking rig are available in the latest *ARRL Handbook*.

Running a low-power station *does not* mean inferior performance. All you need is a little more skill. Don't worry about finding someone to talk to. If you can hear them, chances are you can work them!

*Jeff Gold was licensed in May 1991 as a Technician. He upgraded two months later to Extra Class. Jeff is an ARRL Volunteer Examiner in Cookeville, Tennessee. His educational background includes a masters degree in Special Education from Manhattan College and a bachelor's degree in psychology from Adelphi University. Jeff's son Danny was licensed in July 1992 and holds a General license. He recently passed his 20-wpm CW test. Jeff is manager of computer support services for Tennessee Technological University.*

# Volunteer Examiner Coordinator:

## Your Gateway to Amateur Radio



By Brian Battles, WS10

**U**ntil late 1983, all Amateur Radio license testing was done at FCC field offices and a few remote sites across the country. The FCC exams were conducted mostly on weekdays and were usually held no more than once every month or every couple of weeks.

In the early 1980s, budget cutbacks greatly reduced the number of FCC examinations. By 1982, the FCC had nearly eliminated field office testing entirely.

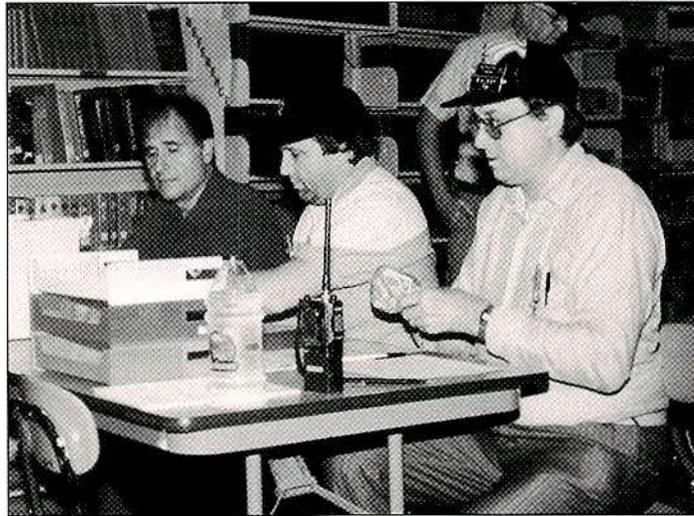
The ARRL, anticipating impending disaster, worked for legislation to permit voluntary, uncompensated assistance in the examination process. This allowed the FCC to use qualified volunteer Amateur Radio operators, rather than government staff members.

In early 1984, several umbrella organizations known as Volunteer Examiner Coordinators (VECs) began to coordinate the efforts of hundreds of license examining volunteers. These specially qualified radio amateurs are referred to as Volunteer Examiners, or VEs.

The VEC program coordinates the examinations for obtaining and upgrading a ham license. The VEC program is the interface between the studying candidates do to prepare for the test and the FCC's licensing facility in Gettysburg, Pennsylvania, which issues each new or upgraded Amateur Radio license.

### How to Upgrade a License

To upgrade to a higher license class, the candidate must pass the necessary exami-



Organization is the key to running a successful testing session. Tom, WA1RHP, and his team does everything it can to put everyone at ease.

**Table 1**

<i>Class</i>	<i>Elements(s)</i>
Novice	1(A) and 2
Technician	2 and 3(A)
Technician Plus (above 30 MHz)	1(A), 2 and 3(A)
General	1(B), 2, 3(A) and 3(B)
Advanced	1(B), 2, 3(A), 3(B) and 4(A)
Extra Class	1(C), 2, 3(A), 3(B), 4(A) and 4(B)
<i>Element</i>	<i>Requirements</i>
1(A)	5 WPM Morse code
1(B)	13 WPM Morse code
1(C)	20 WPM Morse code
2	30 questions concerning the privileges of Novice class operator license. To pass, 22 questions must be answered correctly.
3(A)	25 questions concerning the additional privileges of a Technician class operator license. To pass, 19 questions must be answered correctly.
3(B)	25 questions concerning the additional privileges of a General class operator license. To pass, 19 questions must be answered correctly.
4(A)	50 questions concerning the additional privileges of an Advanced class operator license. To pass, 37 questions must be answered correctly.
4(B)	40 questions concerning the additional privileges of an Extra Class operator license. To pass, 30 questions must be answered correctly.

nations(s) for the next higher license class. These examinations are held at a time (usually a weekend or evening) and at a location convenient to most people.

To help prospects locate test sessions, the ARRL/VEC maintains a computer data base of test sessions, most of them conducted by ARRL teams so candidates can get the most up-to-date information about tests being given in any area.

Each VEC (there are 18) coordinates the efforts of its VEs. The VEs determine the need for tests to be held in their areas. Sometimes this need is established by licensees and potential hams contacting the VE team. Other times, the team establishes an ongoing testing schedule to meet an area's needs. Many teams hold test sessions monthly.

### What You Need to Know to Upgrade Your License

As with the Novice or higher-class license you've already earned, you must pass certain Morse code and/or written examinations required for the class of license you seek. The required examination elements for each class of license are shown in Table 1.

For the Morse code examination, the test must be sufficient to prove that you have the ability to receive correctly by ear the code at the prescribed speed using all the characters of the English alphabet, numbers 0-9, period, comma, question mark, slant bar and procedural signals (prosigns)  $\overline{AR}$ ,  $\overline{BT}$  and  $\overline{SK}$ .

Each written examination is drawn from the appropriate

public domain Amateur Radio question pools and contains questions pertaining to FCC Rules, Station Operating Procedures, Propagation, Amateur Radio Practices, Electrical Principles as applied to amateur equipment, Station Equipment Circuit Components, Practical Circuits, Signals and Emissions, and Antennas and Feed lines.

#### A Decade of Success

The ARRL/VEC began operations on July 21, 1984. Since then, it's been busy meeting the needs of the amateur community. To show how the ARRL/VEC has helped the Amateur Radio community, here are some statistics:

In its first 11 years, the ARRL/VEC has accredited more than 35,000 VEs. These VEs have conducted more than 35,000 test sessions. At these sessions, more than 417,000 people have taken examinations to earn a license or to upgrade their license privileges. Of that number, 231,000 have had data from their successful applications submitted to the FCC for new and higher-class licenses.

#### The ARRL/VEC Can Help You

The ARRL/VEC's examiners conduct more than 400 test sessions per month at sites across the country. To find out where a nearby exam session is being conducted, call or write. The ARRL/VEC sends a free computer printout of the tests scheduled for a particular area, or a staff member can give all the information over the telephone. Next, the prospective examinee chooses a test site from the information provided and calls the contact person listed for that test session. If there are no examination sessions listed in a local area, tell the ARRL/VEC and it will contact its VEs to arrange a future exam session nearby.

Each local VE team's contact person has all the information regarding the test session. He or she will supply essential information about the test session, such as directions to the exam, what time to arrive and what to bring, and how long the test is expected to last. The contact person can answer any other questions regarding the test session.

#### Cost Recoupment:

##### A Small Fee, A Lifetime of Hamming

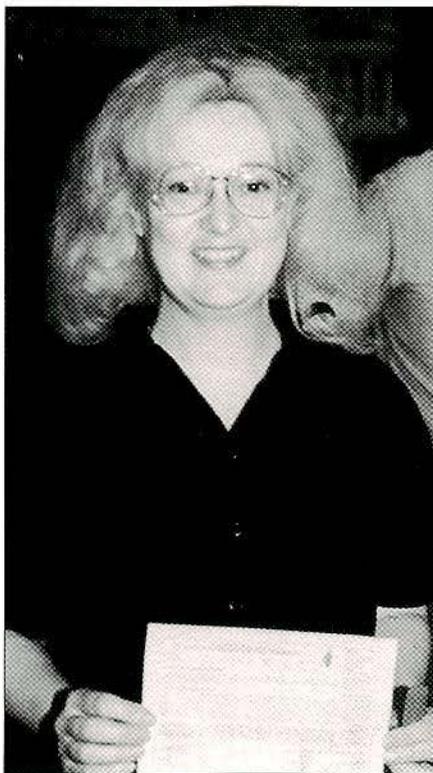
The FCC allows VECs (or VEs) to charge a test fee to reimburse volunteers for out-of-pocket expenses. The fee is based on postage, printing and duplicating costs. The ARRL/VEC test fee is \$5.90 and is charged once per sitting. Therefore, you could take one, or all, of the Morse code and/or written tests, and the cost is the same \$5.90 (no charge for Elements 1A or 2). (The amount of this fee is set by the FCC and has historically increased by a few cents each year based upon small annual increases in the government's Consumer Price Index [CPI]). There's no fee for a US Amateur Radio license, which is renewable

## The ARRL/VEC can help you obtain or upgrade your license and enhance your enjoyment of Amateur Radio.

every 10 years and is valid for life.

#### Using New Operating Privileges

If an exam candidate already has a license, he or she may use new upgrade privileges immediately. Upon successful completion of a Morse code and/or written exam, the VEs supply the examinee with a Certificate of Successful Completion of Examination (CSCE). If an amateur has earned an upgrade, the CSCE indicates what license class the ham has upgraded to. The new operator privileges are temporary until the actual upgraded license is received in the mail from the FCC, usually two to three weeks or less from the test date. And, with recent FCC Rules changes that went into effect on 12/20/94, you can go on the air as soon as the FCC receives and processes your



**The wait is worth it! Gwenneth Wallens, N1OJV/AG, just passed her 13-WPM exam to earn her General-class license. (She displays her General-class upgrade CSCE proudly.) Her husband and two children are also hams.**

new license application data and enters it into their Amateur Service data base. To find out if your new license has been granted by the FCC, at least seven business days after passing your exam, you can call the ARRL New Ham Hotline at 1-800-326-3942 (during ARRL business hours).

#### In Case of Failure...

If a candidate doesn't pass an examination, all is not lost. Not everyone passes their exams the first time. In fact, it takes some people two or three tries. There's no FCC limit on how long an applicant must wait to retake a failed exam. There can be some constraints, however, depending on the resources of the local ARRL VE team. A ham may be able to retake an examination immediately after failing it. Check with the VE team regarding the details. If it has another set of questions for that examination Element available, it may readminister the test on the spot.

#### The Board of Directors and Washington Representation

As part of the American Radio Relay League, the ARRL/VEC benefits from a Board of Directors that looks out for amateurs' best interests. Board members are volunteer radio amateurs, elected by League Members to represent hams in ARRL and government affairs. We have the benefit of a strong voice in Washington, DC. If a change in the FCC rules or in federal laws are needed to benefit Amateur Radio, the ARRL has the resources to make it happen.

#### Service After the Test Session

The ARRL/VEC provides its VE teams with all materials used at test sessions. When the session is over, completed exam materials are sent to the VEC offices at ARRL Headquarters in Newington, Connecticut. Trained staff members review the results, check the completeness of each application form and submit the applications directly to the FCC's Gettysburg licensing facility.

Because not every possible upgrading scenario can be anticipated, if there are any questions, call or write the ARRL/VEC with your inquiry.

#### Can You Become A VE?

Although you may just be starting out in Amateur Radio, perhaps someday you'll be ready to help others get started. The ARRL/VEC is always looking for qualified radio amateurs to join its VE program. Hams over the age of 18 who hold General, Advanced or Extra Class licenses may qualify to become certified VEs and help serve the community. Contact the ARRL/VEC for details.

To get in touch for any purpose, contact Bart Jahnke, KB9NM, Manager ARRL/VEC, 225 Main St, Newington, CT 06111; telephone 203-594-0200; fax 203-594-0259; Internet mail: VEC@arrl.org.

**CH-32**  
 Miracle Baby  
 146/446MHz  
 HT Antenna  
 Length: 1.75"  
 Conn: BNC



• Gold-Plated Connectors  
 • High-Quality  
 Craftsmanship  
 • Unique Fold-Over  
 Feature



**NEW Z750** • Dual-band 146/446MHz w/fold-over • Includes COMET exclusive theft-resistant lock!  
 Wave: 146MHz 1/2 wave • 446MHz 5/8 wave x 2 • Length: 39" • Conn: Gold-plated PL-259 • Max Pwr: 200W



**NEW Z780** • Dual-band 146/446MHz w/fold-over • Includes COMET exclusive theft-resistant lock!  
 Wave: 146MHz 6/8 wave • 446MHz 5/8 wave x 3 • Length: 62" • Conn: Gold-plated PL-259 • Max Pwr: 150W



**FJ-15S** • Tri-band 52/146/446MHz w/fold-over  
 Wave: 52MHz 1/4 wave • 146MHz 6/8 wave • 446MHz 5/8 wave x 3 • Length: 58" • Conn: PL-259 • Max Pwr: 120W



**SB-7/SB-7NMO** • Dual-band 146/446MHz w/fold-over  
 Wave: 146MHz 6/8 wave • 446MHz 5/8 wave x 3 • Length: 58" • Conn: SB-7 PL-259/SB-7NMO NMO • Max Pwr: 70W



**SB-5/SB-5NMO** • Dual-band 146/446MHz w/fold-over  
 Wave: 146MHz 1/2 wave • 446MHz 5/8 wave x 3 • Length: 39" • Conn: SB-5 PL-259/SB-5NMO NMO • Max Pwr: 70W



**CX-224/CX-224NMO** • Tri-band 146/220/446MHz w/fold-over  
 Wave: 146MHz 1/2 wave • 220MHz 5/8 wave • 446MHz 5/8 wave x 2 • Length: 36" • Conn: CX-224 PL-259, CX-224NMO NMO • Max Pwr: 100W



**B-20/B-20NMO** • Dual-band 146/446MHz w/fold-over  
 Wave: 146MHz 1/2 wave • 446MHz 5/8 wave x 2 • Length: 30" • Conn: B-20 PL-259/B-20NMO NMO • Max Pwr: 50W



**SH-55** • Super Flexible 146/446MHz HT Antenna  
 146MHz • 446MHz • Length: 15.5" • Conn: BNC • Max Pwr: 10W



**B-10/B-10NMO** • Dual-band 146/446MHz cellular look-a-like • Wave: 146MHz 1/4 wave • 446MHz 1/2 wave • Length: 12" • Conn: B-10 PL-259/B-10NMO NMO • Max Pwr: 50W

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# Better than a Rubber Duck

Extend the range of your H-T with a better antenna!

By Joel P. Kleinman, N1BKE  
Associate Technical Editor

**Y**ou've just bought a new handheld VHF radio (we'll call it an H-T, like many people do) and boy, are you anxious to get it on the air! If you're like most hams with a new radio, you'll not-so-carefully unpack it, put the manual aside for another time, attach the flexible rubber antenna (which we'll call a rubber duck, like most people do) and turn it on. You want that first contact, and you want it bad.

Nothing. Dead.

"Try attaching the battery pack," your friend suggests.

"Good idea," you admit.

You hit the push-to-talk switch, and... Dead again.

"You'll need to charge the pack first," Mr Helpful chimes in.

You resign yourself to making that first contact tomorrow. You plug in the wall charger, connect the other end to the radio and stare at the little red light.

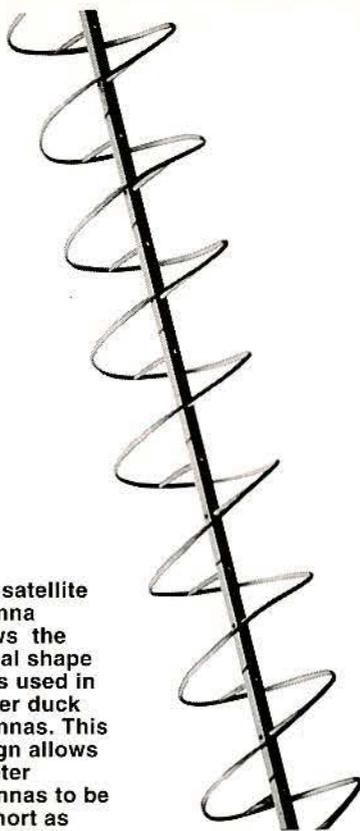
Tomorrow arrives. Now you're ready to get on the air.

The radio has many features, but all you want to do is announce your call sign over the W3HAM repeater and see if Mac or Gail is around. You bring up the repeater. Sort of.

Then you don't.

As you try the repeater from different spots, you seem to be out of range most of the time. But you can hear friends in surrounding towns hitting the repeater with no trouble at all—and you know they're using

This satellite antenna shows the helical shape that's used in rubber duck antennas. This design allows 2-meter antennas to be as short as 3 inches.



H-Ts, too. You've got all the switches in the right place (after following the directions in the manual you've finally gotten around to reading). What's going on?

Could be that your rubber duck isn't all it's cracked up to be.

## What's a Rubber Duck, Anyway?

The antenna that comes with most H-Ts is a cylindrical piece of rubber with a wire wound around inside it. This type of antenna is called a *helical* antenna, because the wire is in a helical (spiral) shape. It's designed this way to save space. Depending on the band they're designed for, rubber ducks may be described as  $\frac{1}{4}$ ,  $\frac{3}{8}$ ,  $\frac{1}{2}$  or  $\frac{3}{4}$  wave. This isn't usually the physical length. A full-size  $\frac{1}{4}$ -wave 2-meter antenna would be about 20 inches long. With the wire

H-T antennas come in several shapes and sizes. Those designed for 2 meters or 222 MHz are generally a bit longer than those for 440 MHz. Some are designed to work on both 2 meters and 440 MHz. (photo courtesy of Larsen Electronics)



## Two H-T Antenna Tips

- Keep a couple of rubber bands around your H-T. It's a handy way to attach your stock rubber duck to your radio when you're using your better-performing antenna.
- You can use your better-performing H-T antenna on your car without buying a special mobile antenna. Larsen Electronics sells a magnetic-mount base (with cable and connector) for any H-T antenna with a BNC connector.

## Where to Find Higher-Performance H-T Antennas

Check with your local dealer, read the advertising section of *QST* or contact the following (partial list):

Advanced Electronic Applications Inc  
PO Box C2160  
2006 196th St SW  
Lynnwood, WA 98036  
206-774-5554

### Hot Rod series

ANLI Antenna  
20277 Valley Blvd #J  
Walnut, CA 91789  
800-666-ANLI

### Gold Series

Larsen Electronics Inc  
PO Box 1799  
Vancouver, WA 98668  
360-944-7551 (fax: 360-944-7556)  
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# The Day the Repeater “Broke”

By Larry Wolfgang, WR1B  
Senior Assistant Technical Editor

**O**n my way home from work one night I heard several stations on the local repeater. They were having a round-table discussion about TCP/IP (a form of packet-radio networking). I was curious and wanted to ask a few questions.

During the brief pause between two stations' transmissions, I sent my call sign once, "WR1B." The next station acknowledged my call and turned it over to me after he finished his transmission. To avoid a possible time-out problem, I waited for the courtesy beep.

I asked a couple of questions, and turned it over to the next station. "WB8IMY to take it, this is WR1B." When I released the mike button, I discovered that Steve was already talking! He made a reference to my "not making it into the machine" and then called me to try it again. "WR1B, try it again Larry. We didn't get anything on that last transmission."

So I tried again. "Am I making it now Steve? WR1B."

"Sorry Larry, nothing heard. Try again if you get into a better location." And the conversation continued without me. I tried calling in once more that evening, but got no answer. I was puzzled, and worried that something had gone wrong with the repeater.

The next morning on my way to work, I heard Jim, KR1S, on the repeater. "KR1S listening." I decided to give Jim a call. "Good morning, Jim. This is WR1B." Jim answered immediately, and we had a nice conversation. I described the events of the previous night, but Jim had no idea what may have been wrong.

A few days later I joined another round-table discussion on the way home. Someone mentioned that the repeater had recently been switched to *subaudible tone access*. Ah-hah! Maybe that was the problem!

## The Mystery is Solved

At the next club meeting, the topic for discussion just happened to be *tone access*. How convenient! As I listened, I learned that our repeater had recently installed a continuous tone-coded squelch system (CTCSS). Despite the complicated-sounding name, CTCSS is easy to understand. It's based on a system that Motorola developed many years ago for business-band radios. In fact, some veteran amateurs still refer to CTCSS by the original Motorola trade name: *Private Line*—or just *PL*.

The original intent of the *Private Line* system was to allow several business users to share a single channel. For example, the Ace Trucking Company and Mel's Taxi Service might both use the same channel. All the Ace receivers respond to one PL tone and the receivers in Mel's taxis respond to another tone. When the Ace dispatcher calls a truck, their drivers all hear the call, but the taxi receivers remain squelched and no call is heard. As long as both dispatchers don't transmit at the same time, each company enjoys interference-free communications.

Amateurs have several reasons for using this type of system on their repeaters. Preventing *intermod* interference from keying up the repeater is one good application. Intermod can occur when two strong signals mix, producing a signal on the repeater input frequency. For example, a channel-8 TV signal on 181.25 MHz could mix with a business-band radio transmission on 36.4 MHz. The difference frequency is 144.85 MHz (181.25 MHz - 36.4 MHz), a popular 2-meter repeater frequency. The result is a repeater that's keyed time and time again, driving everyone crazy and rendering it nearly useless! By using a CTCSS, the repeater will respond *only* to signals carrying the proper tone, *not* the intermod signal.

Another common use occurs when a second repeater is on the same frequency in a neighboring area. Most of the time the repeaters cause little or no interference to each other. But during times of enhanced propagation, or when an amateur increases power considerably to access the repeater from a *fringe* area (beyond the repeater's reliable coverage area), users of one repeater may inadvertently key up the other repeater. In this case, the repeater owners may decide to add a CTCSS function to their machine to prevent hams from the neighboring group from keying it up.

A third application of CTCSS is to create a *closed repeater*. A closed repeater is one intended for use by a specific group of people, such as the members of a particular club, and no one else.

The first two cases are examples of *open repeaters* using CTCSS to solve a particular problem. The *ARRL Repeater Directory* lists the CTCSS tones for many open re-

peaters that use this system occasionally or all the time.

## How CTCSS Works

If your transmitter includes a CTCSS tone encoder, it sends a tone along with your transmitted signal. The tone frequency is below the lowest audio frequency that will go to the receiving station's speaker. Because it cannot be heard by other users, it's called a *subaudible tone*.

The repeater control circuit easily senses the subaudible tone and responds only to signals that include it. This effectively locks out signals that *don't* carry the correct CTCSS tone. Now I understood why I was having so much trouble with the repeater. Without the proper subaudible tone, I was locked out of the system. The problem wasn't the repeater, it was me! I wasn't transmitting the correct tone!

There are 42 standard CTCSS tone frequencies. They range from 67.0 to 254.1 Hz. Table 1 lists the Electronic Industries Association (EIA) standard frequency codes and with their Motorola alphanumeric designations.

Many VHF/UHF FM radios have a built-in CTCSS tone encoder. If one isn't built into your radio, you can probably add it as an accessory with little trouble. (Check with your radio's manufacturer, or look through the advertising in *QST*.)

To use the repeater, I simply had to program my radio to transmit the proper tone. The repeater trustee told us to use 88.5 Hz, and the information was printed in the next club newsletter. I had to check my radio's instruction manual to learn how to program a subaudible tone.

After pressing a few buttons, my rig was all set to go. My transceiver includes a **TONE** button, so I can turn the subaudible tone on or off once it is programmed. By programming the tone first, and then storing the repeater frequency in a memory, I can store a different tone with each memory. Some radios may only select one tone for use with all the memory channels, but that shouldn't be a serious drawback.

## The Last Piece of the Puzzle

I asked why the stations on the repeater

**One day I was in, the next day I was out!  
What was going on?**

**Table 1**  
**CTCSS Tone**  
**Frequencies**

Frequency (Hz)	Motorola Designator	Frequency (Hz)	Motorola Designator	Frequency (Hz)	Motorola Designator
67.0	XZ	107.2	1B	173.8	6A
69.3	WZ	110.9	2Z	179.9	6B
71.9	XA	114.8	2A	186.2	7Z
74.4	WA	118.8	2B	192.8	7A
77.0	XB	123.0	3Z	203.5	M1
79.7	WB	127.3	3A	206.5	8Z
82.5	YZ	131.8	3B	210.7	M2
85.4	YA	136.5	4Z	218.1	M3
88.5	YB	141.3	4A	225.7	M4
91.5	ZZ	146.2	4B	229.1	9Z
94.8	ZA	151.4	5Z	233.6	M5
97.4	ZB	156.7	5A	241.8	M6
100.0	1Z	162.2	5B	250.3	M7
103.5	1A	167.9	6Z	254.1	OZ



heard my call sign that first night, but couldn't hear any later transmissions. As it turns out, I made my initial call *before* the squelch tail dropped from the previous user. The repeater was already keyed, so it received and repeated my call sign. Because I was not transmitting the proper subaudible tone, however, I was unable to key the repeater on my own.

So the next time you think a repeater is "broken," find out if it's using a tone-access system. Program your rig for the proper tone and you'll be back in business!

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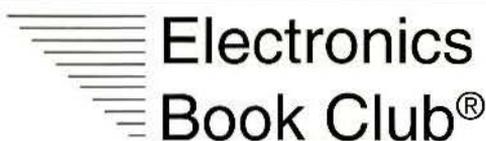


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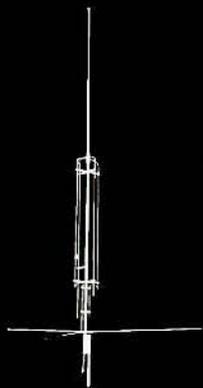
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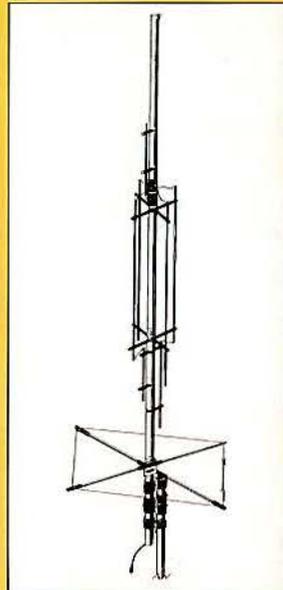
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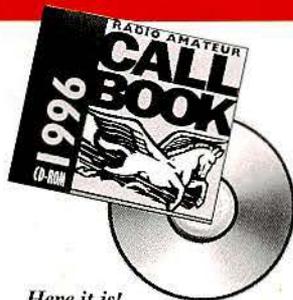


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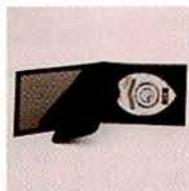
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I qualified for an ARRL 30 word-per-minute code proficiency certificate in 1954. In the nearly 40 years that have passed since then, it's been my pleasure to help more than a thousand people pass their code tests. After so many years of teaching, I've managed to accumulate a small collection of helpful tips. I've also observed a few things that, in my opinion, you should avoid.

Let's start abolishing the notion it's only necessary to practice 15- or 20- minutes at a time, a couple of times a week. I have one word for that idea: *nonsense!* By the time you get around to your next practice session, you may slip back to where you were before. At this pace, progress is slow—tantalizingly slow.

Code instructors should be honest with their students. They should tell them that it's going to require some effort and dedication. A coach doesn't tell his basketball hopefuls that the road to the NBA is lined with velvet. He tells them that there are tough times ahead. Why are we less truthful with aspiring hams?

## The Farnsworth Method

Should a code student begin at five words per minute and work upward from there? How about starting at 50 words per minute instead? (I can hear the gasps now.) No, I'm not suggesting that we bombard them with CW conversations at that speed—just characters!

This technique is put to good use in what has come to be known as the "Farnsworth Method." The letters are *formed* at anywhere from 15 to 18 words per minute, but are sent with 5 *word-per-minute spacing*. It may seem like an unusual method, but it works.

You begin by learning each character. As soon as you're confident that you know each letter, number and punctuation mark, start decreasing the spacing between them. The sounds of the characters *remain the same*, only the spacing changes. Within a short time, you'll reduce the spacing from the 5 WPM level to 18 WPM. During this process you don't need to relearn the characters—you already know them at 18 WPM! In other words, they're the same characters you learned the first time around. They're just coming at you faster.

Why don't we take this idea farther? Why not start by forming the letters at 20 words per minute? Moving from 5 to a solid 20 words per minute would be a snap. As an experiment, I taught my 9 year-old grandson the code in less than a day with the letters formed at twenty words per minute. Upon returning to his home in Wisconsin, he entered a class and qualified for his Novice license before the class was half-over. He is now KA9SNP. His mother had her Novice ticket at age nine and was, for a time, one of the youngest female hams in the country. This was in the late 50s, before the era of club-sponsored schools. Her elder sister qualified at age ten. All of

them profited by means of code-teaching techniques that are sound and easy to apply.

## Code Practice Tapes

Some of the worst tapes in existence are those which purport to send code as though you are listening to two stations having a conversation. Many use very poor procedures, and that's reason enough not to use them. As a new ham, the last things you need to learn are bad habits. In addition, these tapes are easily memorized, making them nearly worthless for instruction. On the other hand, tapes that use the Farnsworth Method are fine learning tools for new hams and I encourage you to use them. (ARRL practice tapes employ the Farnsworth Method.)

**Are you finding it difficult to increase your code speed? Use these techniques to go as high as 30 words per minute—or beyond!**

Tapes notwithstanding, if you already have a Novice or Technician ticket, I have four very important words for you: GET ON THE AIR. Seek out stations working just a bit faster than you can copy. Who cares if you have to ask the other station to repeat his or her name? The code practice available from WIAW is an excellent way in which to determine just how fast you're capable of copying. Use WIAW to measure your progress as you practice.

## Copying Behind

When you copy at slow speeds, there is a great deal of *lost time* available. The sending operator must observe the proper spacing between parts of characters, between the characters themselves, and between words. A space equal to a *dit* is required between character components. A space equal to a *dah* is required between each character and a space equal to three dahs is required between each word. Now that's a lot of time that you can use to your advantage.

At speeds above 15 words per minute, you can watch the receiving operator writing down the text in a very jerky fashion. Why? He's trying to follow the sending operator *exactly as he is sending*. This makes for erratic copy and a lot of stop-and-go writing.

Instead of trying to maintain such a frantic pace, slow down and relax a little. At 15 words per minute, let the first letter go by.

Don't write it down the instant you hear it. Jot the first letter as the operator starts to send the second. Don't rush it! You have all the time in the world.

At 20 words per minute, you can afford to let two letters slip by before putting pen to paper. Why did I say pen? You should copy with some variation of a ball-point or fiber pen. The best pencils have a habit of breaking, especially when you're a little nervous! Try to master long-hand writing rather than printing. It may seem strange at first, but you can copy code much faster in long-hand than you can by printing each letter.

At 30 words per minute, experienced operators can copy at least three or four letters behind; many copy a full-word behind. However, this requires some practice. If you want to reach the 30 word-per-minute goal, you must learn to copy behind. There's no way you can keep up with the operator, letter-for-letter, at that speed.

Many years ago I had the privilege of standing at the side of the legendary T. R. McElroy, as he was typing code at 55 words per minute. He was talking to me at the same time. I could hear snatches of words coming from the headphones. I soon realized that he was copying a *full sentence behind!* Ted, though he is no longer with us, claimed the world's record of 78.5-words per minute. A few years ago I met a young man at the Dayton HamVention who came there with the avowed intention of breaking Ted's record. He claimed to be able to copy code at 80-words per minute. I learned later that he didn't make it, but people are out there trying.

I strongly recommend headphones for any CW enthusiast. The degree of concentration you can achieve with headphones is perhaps 10 times that of copying from a speaker. In addition, when copying from a speaker, the reverberation from walls can make it difficult to hear the code accurately.

## Some Final Advice

Here are 10 valuable tips for learning to copy code at any speed you wish:

- 1) Relax
- 2) Learn to copy behind
- 3) Use long-hand (Don't print)
- 4) Use a ball-point or fiber pen
- 5) Write slowly
- 6) Get on the air (The world's best practice!)
- 7) Use headphones
- 8) Practice
- 9) Practice
- 10) Practice

*During World War II, Lee Aurick was an Army Signal Corps High-Speed Operator and Communications Chief. Interested in Amateur Radio since 1933, he was finally licensed in 1946. He attained one of the first Amateur Extra Class licenses in 1952. Lee served two hitches at ARRL Headquarters and retired in 1987 after more than a decade of service as QST Advertising Manager.*

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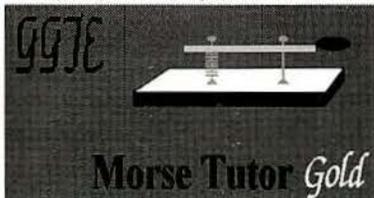
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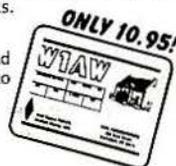
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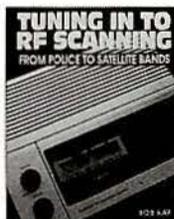
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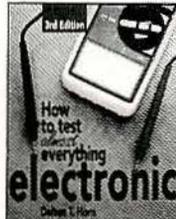
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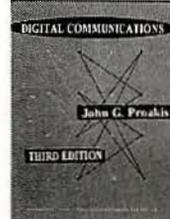
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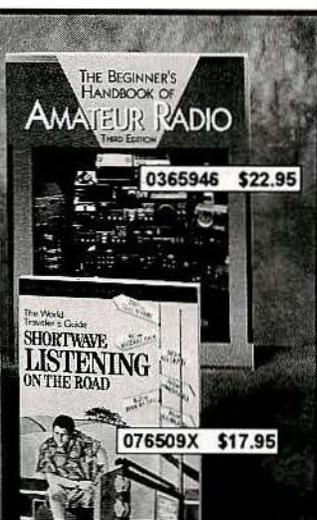
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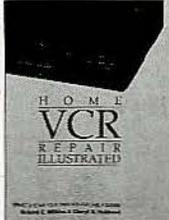
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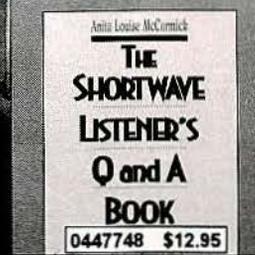
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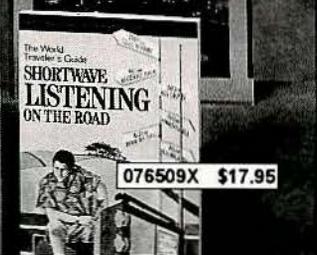
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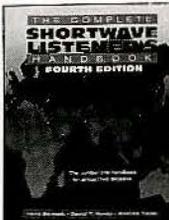
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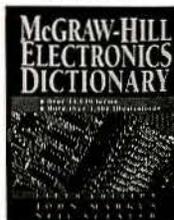
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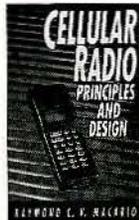
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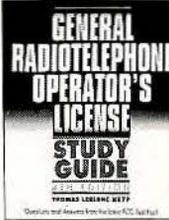
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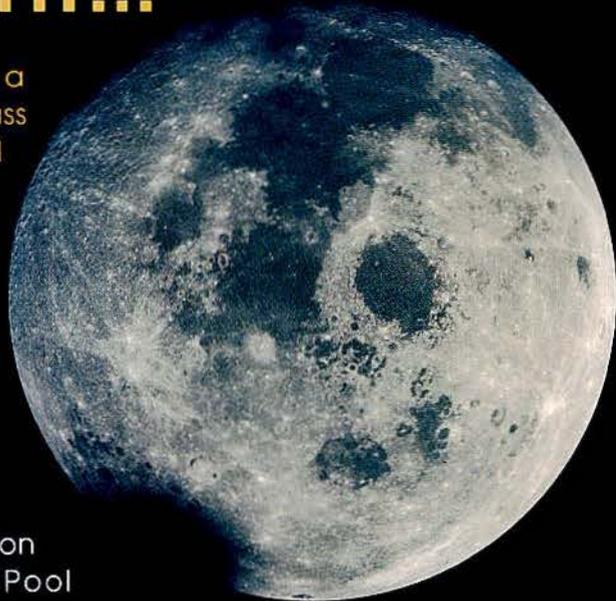
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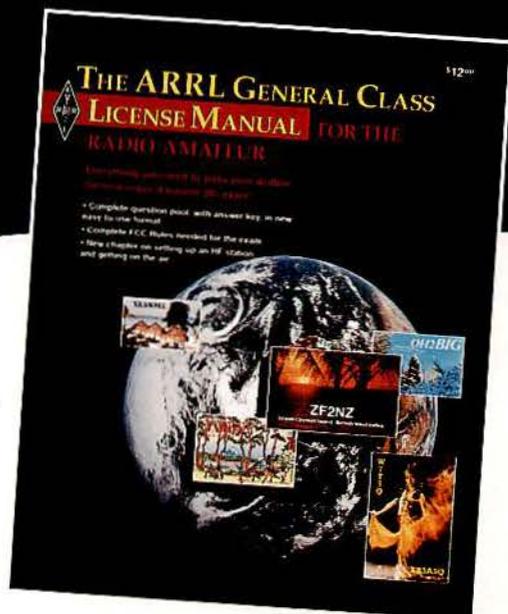
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### Help for Beginners

**Ham Radio Made Easy**, by Steve Ford, *WB8IMY*, may be the only beginner-level book with "attitude." With a sprinkling of wit and opinion, *Ham Radio Made Easy* will help you get on the air quickly and painlessly. This is a book you'll actually enjoy reading, whether you're fond of FM, packet, satellites, HF operating or whatever. No jargon. No mind-numbing mathematics. Just practical advice that you can use right away. 1st ed, ©1995, 208 pp ..... #5374 \$15.95

**W1FB's Help for New Hams**, by Doug DeMaw, offers sound advice on getting started in Amateur Radio after you get your license. Covers how to select equipment, station layout and accessories, building and using antennas, and operating. Whether you're into HF or VHF, this book will get you on the air.

2nd ed, ©1994, 304 pages ..... #4432 \$10

Written in an easy-to-understand style for electronics beginners, **Understanding Basic Electronics** is also for those who want to brush up on electronics principles. Loaded with illustrations, the book starts with math skills and progresses to dc and ac electronics principles. It concludes with clear, simple explanations of how components like diodes, transistors and integrated circuits work.

1st ed, ©1992, 448 pages ..... #3983 \$20

### Handy References

#### The 1996 ARRL Handbook

The brand new **1996 ARRL Handbook** is packed with new projects and updated information. And, for the first time in **Handbook** history, the 1996 edition includes SOFTWARE. See the following full description of disk for details! Whether you're an Amateur Radio beginner, an experienced operator, electronic technician, engineering student or engi-

neer, you'll find each chapter of the **1996 ARRL Handbook** a standalone "mini-book" that will cover your favorite topics and provide invaluable reference material, fascinating facts and some great new do-it-yourself projects.

This year's **ARRL Handbook** includes a 3.5-inch, 1.44-MB IBM compatible diskette with a variety of standalone applications and programs used with projects in the book.

**TISFIND**, a *Windows* application from the ARRL's Technical Information Service, provides you with the names and addresses of nearly 900 Amateur Radio vendors and organizations. Your frustrating hunts for suppliers are history!

**COILS**, from Brian Beezley, *K6STI*, calculates the important characteristics of solenoidal coils.

**ACTFIL** is for designing active audio filters described in the filters chapter.

The disk also features the software side of several projects in the book: an SSTV interface from Ben Vester, *K3BC*; a PC interface for sending CW from Ralph Taggart, *WB8DQT*; and a PC voltmeter from Paul Danzer, *N11I*.

Other software is useful for helping to find true North; for designing shortened, inductively-loaded dipoles; and for designing Pi and Pi-L matching networks.

If it's ham radio, it's in **The 1996 Handbook**. With 1168 pages and over 1000 charts and illustrations, **The ARRL Handbook** is an exceptional value. Softcover ©1995 ..... #1735 \$38

The fifth edition of **The ARRL Operating Manual** has been extensively revised and updated to reflect the many changes that have taken place in Amateur Radio during the last five years. **The Operating Manual** is your most valuable resource for whatever operating-oriented questions you may have. How do I use a repeater autopatch? Where is the CW subband on 20 meters? How do I use a QSL bureau? What is grayline propagation and how do I make it work for me? How do I get started on the ham satellites?

You'll find an impressive and colorful section that features dozens of US and overseas operating awards, and a handy reference section includes an ARRL DXCC Countries List, beam-heading information, a series of maps, US counties, sunrise/sunset tables, and much, much more.

©1995, 576 pages ..... #4939 \$22

**The 1996 ARRL Periodicals CD-ROM** is a compilation of all 1995 *QST*, *QEX* and *NCJ* issues on one CD-ROM. Here are some of the special features you'll find: the full text of every *QST*, *QEX* and *NCJ* article—including technical and general interest articles, columns, product reviews and New Ham Companion features; every drawing, table, illustration and photograph (many in color); more than 1000 advertisement images, indexed alphabetically by vendor and product; a powerful search engine that lets you find desired information quickly by entering article titles, call signs, names or just about any other word; *Windows* printing and Clipboard support, so you can print out articles or share them with other *Windows* applications; tools to create bookmarks at often-used articles and more.

You'll need these minimum system requirements: 386, 486 or Pentium™ IBM or 100% compatible (486 or better recommended); 4 Mbytes of RAM (8 Mbytes recommended); hard disk with at least 10 Mbytes of free space; Microsoft *Windows*™ 3.1 or higher; 640 x 480, 256-color graphics; CD-ROM drive (double speed or faster recommended); mouse or equivalent pointing device. .... #5579 \$19.95 plus \$4 shipping/handling for ARRL members, \$29.95 plus \$4 shipping/handling for nonmembers.

**The 1996 Amateur Radio Mail Order Catalog**

**and Resource Directory** is a one-stop sourcebook of dealers and vendors of electronic parts, components, software, books, tapes and equipment for the ham or electronics enthusiast. 220 categories, from Alternate Energy to Wire and Cable, arranged in an easy-to-use format. *The Resource Directory* includes such practical information as 100+ Free Catalogs and a Glossary of common ham radio terms. Edited by David L. Thompson, K4JRB. 5th ed, ©1995, 256 pages ..... #5242 \$15.95

**The ARRL Radio Buyer's Sourcebooks** are for anyone who buys, sells or owns Amateur Radio equipment. Two volumes are available: *The ARRL Radio Buyer's Sourcebook* covers selected QST Product Reviews from 1981 through 1991 and a few "golden oldies." *The ARRL Radio Buyer's Sourcebook Volume 2* contains all QST Product Reviews published in 1991 and 1992.

Both books explain what radios do, how well they do it, where to get them serviced and where to find articles about modifications. Handy comparative feature and performance charts cover equipment reviewed in the books. Each contains a history of Amateur Radio technology and a glossary of radio features and terms. Heading for a hamfest or ham dealer? Don't leave home without both *Radio Buyer's Sourcebooks*.

**The ARRL Radio Buyer's Sourcebook**  
1st ed, ©1991, 384 pages ..... #3452 \$15  
**The ARRL Radio Buyer's Sourcebook Volume 2**  
1st ed, ©1993, 240 pages ..... #4211 \$15

**The ARRL Electronics Data Book** is a valuable aid to the radio amateur, RF design engineer, technician and experimenter. All those commonly used tables, charts, and those hard-to-remember formulas and semiconductor pin-out diagrams are found in one handy source. You'll also find hundreds of popular circuits and "building blocks," including oscillators, mixers, amplifiers, other devices and their operating parameters. By Doug DeMaw, W1FB. 2nd ed, ©1988, 232 pages ..... #2197 \$15

The 13th edition of *Hints and Kinks for the Radio Amateur* has the best tips, suggestions and projects from the popular QST column (covering the years 1987-91). It's loaded with helpful techniques and easy projects that will enhance your operating enjoyment. ©1992, 176 pages ..... #3851 \$10

**The 1996-1997 ARRL Repeater Directory** includes more than 20,000 listings for voice and digital repeaters and propagation beacons located in North, Central and South America. This edition also lists more than 700 beacons from 7 MHz to 10 GHz. You'll also find band plans, a CTCSS tone chart, a list of frequency coordinators, ARRL Spectrum Committee, Digital Committee and Future Systems Committee, and a user-friendly list of ARRL Special Service Clubs. *The Repeater Directory* comes in a handy pocket size for your operating convenience. 25th ed, ©1996, 718 pages ..... #5609 \$8

**The ARRL Electronic Repeater Directory, 1995-96 Edition**, by Jerry Redington, KD6PPC, allows quick and easy access, via IBM-compatible computer, to all the information in the printed *Repeater Directory*. Powerful search utility makes it easy to find, and optionally print out, lists of voice, packet or ATV repeaters based on location, features and frequency—or any combination. Also includes list of beacons, band plans, frequency coordinators, repeater lingo and more. Computer requirements: MS-DOS, 286 or higher processor, 380 kB of system memory, 1.3 MB of hard disk space, VGA-compatible video graphics adapter and Microsoft-compatible mouse (optional). 3.5-inch disk, ©1995, ..... #5188 \$14.95

**The North American Repeater Atlas** is for the ham on the go who wants to keep in touch with

nearby repeaters. Whether you are heading out on a business trip, touring the country in your RV, or just find yourself on a trip to unfamiliar territory, this book will help keep you in touch. Inside you'll find: repeater maps for every US state, every Canadian province, Mexico, Central America, and the Caribbean; street maps showing repeater frequencies for most US metropolitan areas; repeater listings for 10 meters, 2 meters, 220 MHz, 440 MHz, 900 MHz, and 1.2 GHz; and more.

1995-1996 ed, ©1995, 168 pages ..... #5072 \$10

**Your Mobile Companion**, by Roger Burch, WF4N, is a practical, easy-to-digest introduction to the fun that awaits the mobile operator. You'll find answers to such questions as: Which bands should I use? Which transceivers and antennas are best, and why? How do I install the antenna without ruining my truck? And how can I deal with interference? It's all here, and more, in one handy book.

1st ed, ©1995, 192 pages ..... #5129 \$12

**The ARRL DXCC Countries List** is the ideal way to record the DXCC countries you've worked and QSLed. The latest printing includes DXCC Advisory Committee members, an expanded cross reference for prefixes and exotic countries and more. (Free shipping).

April 1996 ed, ©1996, 28 pages ..... #0291 \$2

**The ARRL Net Directory** lists hundreds of Amateur Radio nets of interest to North American hams—DX, ragchew, special-interest, fun and public service nets—they're all here. (Free shipping). 1995-1996 ed, ©1995, 48 pages ..... #4998 \$3

**Your QRP Operating Companion** shows that you don't need special rigs or expensive equipment to enjoy the excitement and challenge of low-power operating. Ragchewing, DXing, contesting—all are more enjoyable with QRP. Includes operating tips, lists of QRP clubs and organizations, net and calling frequencies, and much more.

1st ed, ©1992, 96 pages ..... #3762 \$6

**Passport to World Band Radio** is the "TV Guide" of shortwave listening. Updated annually, *Passport* contains comprehensive schedules for hundreds of international shortwave broadcast stations—when they're on, who they're targeting and what languages they're using—in an easy-to-understand format.

Also included are useful reviews of nearly every shortwave radio currently available, and excellent articles describing the best shows to be found on the international shortwave bands.

Increase your knowledge of today's changing world with *Passport to World Band Radio* and make the most of your listening.

1996 ed, ©1995, 528 pages ..... #5293 \$20

## VHF/UHF/Microwave Communications

**Your VHF Companion** lets you explore the fascinating activities on the VHF bands: FM and repeaters, packet, CW and SSB, satellites, amateur television, transmitter hunting, and more. A handy reference section helps you locate equipment, books, magazines and software. A must for all new hams—and all "veterans" as well!

1st ed, ©1992, 208 pages ..... #3878 \$8

**The ARRL UHF/Microwave Experimenter's Manual** is written for the growing number of radio amateurs who are discovering that there is life on our frequencies above 420 MHz. Technicians and engineers will find this book particularly useful. You'll find information on design and fabrication techniques, propagation, antennas and feed lines, transmission media and much more. Companion software is available for IBM PCs and compatibles. Book, 1st ed, ©1990, 448 pages ..... #3126 \$20  
Software (3.5-inch) ..... #4726 \$10

**The ARRL UHF/Microwave Projects Manual**

contains dozens of construction articles for transverters, preamplifiers, power amplifiers, antennas, and test and measurement equipment. Some articles are previously unpublished; others are reprinted from conference proceedings, QST, and QEX. If your interest lies in the bands above 432 MHz, you'll find this book to be invaluable.

1st ed, ©1994, 352 pages ..... #4491 \$20

If you're tired of hunting for bits and pieces of information on spread spectrum, the **ARRL Spread Spectrum Sourcebook** is for you. You'll find reprints of most spread spectrum articles from QST and QEX, as well as articles and news items from the **ARRL Newsletter** that show how SS developed from theory to a viable communications system. 1st ed, ©1991, 384 pages ..... #3177 \$20  
**Beyond Line of Sight: A History of VHF Propagation from the Pages of QST** explores the ways hams helped discover and exploit the propagation modes that allow VHF signals to travel hundreds and even thousands of miles. It's a subject all hams will find fascinating.

1st ed, ©1992, 234 pages ..... #4025 \$12

## Satellites/Space

**The Satellite Experimenter's Handbook** has the information you need to communicate through or receive signals from a growing "fleet" of orbiting satellites. Whether your interest is in Amateur Radio, weather, TV-broadcast or other spacecraft, you'll find an immense store of valuable data—everything from satellite design to ground station equipment and antennas. Written by Martin Davidoff, K2UBC. 2nd ed, ©1990, 352 pages ..... #3185 \$20

**Weather Satellite Handbook** by Ralph Taggart, WB8DQT, is a popular and easy-to-use reference for anyone interested in viewing our world from space. The revised and expanded 5th edition features an interface project that allows you to capture fascinating images from various weather satellites and HF WEFAX broadcasts (a kit is available). You'll learn how weather satellites function, how to build or modify your own receiving equipment and how to buy or build the right antennas. Companion software (revised for the 5th edition of the book) is available for IBM PCs and compatibles.

Book, 5th ed, ©1994, 224 pages ..... #4483 \$20  
Software (3.5-inch, requires high-density drive) #4653 \$10

**ARRL Satellite Anthology** contains the best recent QST satellite articles on all amateur spacecraft from OSCAR 10 through OSCAR 27, including: how to work DX via OSCARs 10 and 13, and how to get on the Pacsats and the Russian "Easysats." There's even a glimpse into the future with two articles about the advanced Phase 3D satellite. 3rd ed, ©1994, 128 pages ..... #4645 \$10

## Antennas and Transmission Lines

**The ARRL Antenna Book** is the definitive source for information on state-of-the-art antenna and transmission line theory and construction. The 17th edition presents the best and most highly regarded coverage of antenna fundamentals, propagation, transmission lines, Yagis and quads, as well as all popular wire antenna designs. You'll find a new chapter on HF Yagi Arrays based on the latest computer modeling software. The Radio Wave Propagation chapter has been revised to include comprehensive statistical data on the range of elevation angles needed for communication from all areas of the US to important DX locations. Included with this edition is a 1.44 MB 3.5-inch diskette for the IBM PC/XT/AT and compatible computers with software by K6STI, W1FM and N6BV for Yagi analysis, propagation prediction, transmission-line evaluation, and more.

©1994, 736 pages ..... #4734 \$30

Four volumes are available in *The ARRL Antenna*

**Compendium series**, and each is packed with previously unpublished articles on all the popular types of HF/VHF/UHF antennas and some you've never heard of! In **Volume 1** you'll find articles on a multiband portable, quads and loops, baluns and the Smith Chart. **Volume 2** features several verticals, an attic tri-band, antenna modeling and propagation. Among the 40 articles in **Volume 3** you'll discover a 12-meter quad, a discone, modeling with MININEC and VHF/UHF ray tracing. **Volume 4** includes articles on 80 and 160 meters, mobile work, portable or temporary antennas, and modeling. Bundled in Volume 4 is an IBM-format, 3.5-inch, 720-kB disk with source data used in modeling and executable programs relating to some of the antennas described in the book (modeling software not included).

All four volumes are a feast for the antenna enthusiast!

Companion software is available separately for Volumes 2 and 3.

**Volume 1**, 1st ed., ©1985, 176 pages .. #0194 \$10  
**Volume 2**, 1st ed., ©1989, 216 pages .. #2545 \$14  
 Companion software (5.25-inch) .... #2626 \$10  
**Volume 3**, 1st ed., ©1992, 240 pages .. #4017 \$14  
 Companion software (5.25-inch) .... #4033 \$10  
 Companion software (3.5-inch) ..... #4041 \$10  
**Volume 4**, 1st ed., ©1995, 224 pages .. #4912 \$20

**Your Ham Antenna Companion**, by Paul Danzer, N11I, provides all the antenna basics—and much more—in easy-to-understand, nontechnical language. Whether your interest is VHF or HF, feed lines or antenna tuners (or all of the above!), you'll find clear explanations and practical applications. Several inexpensive, easy-to-build projects are included, as is a handy *Antenna-Speak Glossary*. 1st ed., ©1995, 240 pages ... #5110 \$10

**Vertical Antenna Classics** is a compilation of previously published articles on the art and science of the vertical antenna. Chapters cover Theory and Modeling, VHF and UHF, HF, Directional Arrays, Reduced Size, and Radials and Ground Systems. A handy Antenna Products Suppliers list is included. 1st ed., ©1995, 128 pages ..... #5218 \$12

**Antennas and Techniques for Low Band DXing**, by noted DXer John Devoldere, ON4UN, is an in-depth treatment of the antennas and operating strategies you'll need to span the continents on 40, 80 and 160 meters. You'll find operating tips, antenna designs and software culled both from the author's many years of experience and those of other active DXers, contesters and antenna experimenters. Revised and expanded. 2nd ed., ©1994, 400 pages ..... #4661 \$20

**W1FB's Antenna Notebook** Not everyone has the room or the budget to put up a forest of aluminum. Doug DeMaw tells you how to get the best performance out of unobtrusive wire and vertical antennas, and how to build simple antenna tuners and SWR bridges. 1st ed., ©1987, 136 pages ..... #2618 \$10

**Antenna Impedance Matching** shows you how to use the Smith Chart to develop even the most complex matching network to maximize antenna effectiveness by minimizing feed line losses. With more than 200 pages, this book is a must for the antenna designer and serious amateur. Written by Willfred Caron. 1st ed., ©1989, 224 pages ..... #2200 \$20

**Low-Profile Amateur Radio** is for the ham who lives where antennas are frowned upon. You'll see that you don't need a house with acreage to enjoy your favorite hobby. One practical solution: hide your antennas. Another: operate with low power. This book tells you how to get on the air using these techniques—and others—without calling attention to yourself. 1st ed., ©1993, 128 pages ..... #4114 \$8

**ARRL MicroSmith V2.00**, by Wes Hayward, W7ZOI. **ARRL MicroSmith** is a Smith Chart simu-

lation program for the IBM PC and compatibles. You don't need detailed knowledge of the Smith Chart. Use **MicroSmith** to design matching networks with fixed or variable L-C components, stub-matching sections with transmission lines, and more. It's all done graphically on your computer screen. It's also useful for a variety of network analysis problems. Includes a 48-page user's guide with numerous illustrations. Requires Epson compatible 9-pin dot matrix printer. 3.50-inch diskette ..... #4084 \$39

## Interference/Direction Finding

**Radio Frequency Interference: How to Find It and Fix It** is a new approach to an old Amateur Radio problem. Written by RFI experts, it's filled with proven ways to solve common—and not-so-common—RFI or EMI problems, whatever their cause. In addition, you'll learn how to build a cooperative environment with neighbors and how to contact skilled volunteers who can assist with those tricky situations. 1st ed., ©1991, 256 pages ..... #3754 \$15

**Interference Handbook**, by William Nelson, WA6FQG, will help you locate and resolve interference problems of every type. Sources of interference are described along with the methods used to locate them. Suppression circuits for interfering devices are discussed in detail, as are protection techniques for home entertainment equipment. 2nd ed., ©1981, 256 pages ..... #6015 \$14

**Transmitter Hunting: Radio Direction Finding Simplified**, by Joseph Moell, K0OV, and Thomas Curlee, WB6UZZ, is all the information you need about equipment and techniques for HF and VHF radio direction finding. Transmitter hunting is both practical and fun. Using the information in this book, you can not only locate jammers and other sources of malicious interference, but you can also locate downed aircraft, engage in "sport hunting," even help search-and-rescue groups save lives! 1st ed., ©1987, 326 pages ..... #2701 \$19

## Practical Circuits

**ARRL Radio Designer 1.5** lets you create computerized models of audio, radio and electronic circuits so you can see how they work—and make them work better—without actually building them. Here's just some of what you can do with **ARRL Radio Designer**: model passive and small-signal linear circuits from audio to RF; predict and analyze performance of linear, small-signal active and passive dc, audio and RF circuitry (including amplifiers, filters, matching networks and power splitters and combiners); optimize circuit performance to meet goals you specify; display the signal level at any point in a simulated circuit; simulate component value variations due to temperature and tolerances with Monte Carlo statistical analysis; simulate circuit response to a steady-state time-domain signal using impulse, step, pulsed carrier or user-defined stimuli, and much more.

**ARRL Radio Designer** reports S, Y, Z, group delay and voltage probe parameters for n-port networks; chain (ABCD), hybrid (H), inverse hybrid (G), gain, voltage gain, and stability parameters for two-port networks, and more. Reports can be rectangular or polar graphs, or tables, displayed onscreen or printed on any Windows compatible printer in the colors, fonts and line weights you specify. Circuit entry is via a text-based circuit editor.

**ARRL Radio Designer** comes on two 3.5-inch floppy disks (example circuits and reports included), and includes an instruction manual containing how-to-use-it, tutorial and reference information. Requires *Microsoft Windows 3.1* or higher, 8 megabytes of RAM, and a hard disk with at least 5 megabytes of free space; a math coprocessor is strongly recommended. For more

information, contact ARRL. ©1995.

(\$5 UPS shipping) ..... #4882 \$150

**Introduction to Radio Frequency Design**, by Wes Hayward, W7ZOI, presents a treatment of the fundamental methods of radio frequency design using mathematics as needed to develop intuition for RF circuits and systems. He emphasizes application of simple circuit models whenever possible and prepares you to actually design HF, VHF and UHF equipment. This "timeless" reprint includes 3.50-inch software for IBM PCs and compatibles that goes with the text. ARRL 1st ed., ©1994, 400 pages ..... #4920 \$30

Whether you've just been bitten by the urge to operate flea power, or you've already discovered just how much fun it is to operate with 5 W or less, **QRP Power** is just what you've been looking for. It's crammed with projects you can build and resource information you can use. In addition to the best recent QRP-related articles from *QST*, *QEX* and *The ARRL Handbook*, there's a new, in-depth article on NN1G's popular 40-40 transceiver. 1st ed., ©1996, 208 pages..... #5617 \$12

**W1FB's QRP Notebook** by Doug DeMaw is packed with construction projects for QRP transmitters, receivers and accessories. This second edition is the completely rewritten successor to Doug's popular *QRP Notebook*, and features totally new circuits. Learn the inside secrets from this veteran builder, writer and former *QST* Technical Editor. Most of the projects feature printed circuit boards that are available from a commercial source. Gain understanding of circuits. Experience firsthand the thrill of making contacts using equipment that you built. 2nd ed., ©1991, 184 pages ..... #3657 \$10

**W1FB's Design Notebook: Practical Circuits for Experimenters** is just the book for the avid builder of Amateur Radio equipment. This plain-language book is filled with simple, practical projects that can be built using readily available components and common hand tools. There are explanations of how the various circuits work—without heavy mathematical analysis. 1st ed., ©1990, 200 pages ..... #3207 \$10

**Solid State Design for the Radio Amateur** is packed with information on Amateur Radio circuit design and applications, descriptions of receivers, transmitters, power supplies and test equipment. Much of the data cannot be found elsewhere. Essential for every technical library. ©1986, 256 pages ..... #0402 \$15

..... #0402 \$15

## Digital Communications

**Your Packet Companion**, by Steve Ford, WB8IMY, perfect for the packet newcomer, covers everything—from assembling a station to sending mail, from packet satellites to the latest networking systems. Its straightforward writing style and clear drawings will get you on the cutting edge of digital ham radio in no time. 1st ed., ©1992, 176 pages ..... #3959 \$10

The title says it all: **Practical Packet Radio**, by Stan Horzepa, WA1LOU, is going to make your life easier, whether you're setting up your first packet station or you're exploring TCP/IP or another more-advanced technique. The successor to WA1LOU's classic *Your Gateway to Packet Radio*, this book covers everything the packet-active ham needs to know; setting up a station, getting on the DX packet cluster, exploring bulletin boards and satellites and much more. A series of Appendices includes sources of packet-related hardware and software, a Glossary of Terms and the AX.25 protocol. 1st ed., ©1995, 224 pages ..... #5307 \$15.95

**Packet: Speed, More Speed and Applications** is for packet enthusiasts interested in medium- to



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In **Ham Radio Made Easy**, Steve Ford, WB8IMY, takes you on a breezy journey through Amateur Radio and arms you with the tools you need to get the most out of the hobby. Unlike many books of this type, Steve mixes serious instruction with a generous dose of humor and opinion. You'll read it to get started, then keep it handy as a valuable reference. This is the kind of how-to book that never goes out of style.

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#### Chapter 3: A Packet for You

Plug your computer into your radio and start swapping bytes with other hams!

#### Chapter 4: Barking at the Moon, and Other Concerns

Is there life beyond FM? Are "weak signals" really as weak as they seem?

**Ham Radio Made Easy** is the no pain-all gain reference tool you'll want by your side as you explore all the possibilities Amateur Radio has to offer. So, make it easy on yourself and order your copy today.

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#### Chapter 5: Outta Space!

Lots of hams enjoy satellite communication, even though this segment of our hobby lacks "atmosphere."

#### Chapter 6: The Camera Never Lies

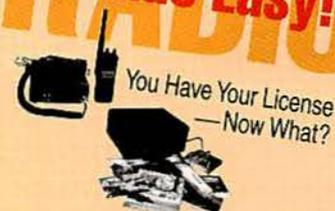
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#### Chapter 7: Working the World on a Wire

The public calls it "short-wave." Hams call it "HF." It's a world where a couple of watts of power and a piece of wire can take you anywhere.



**HAM RADIO**  
Made Easy!



You Have Your License  
— Now What?

by Steve Ford, WB8IMY

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FT-50-61....75	FT-140-43.....3.15
FT-50-77....75	FT-240-43.....8.00

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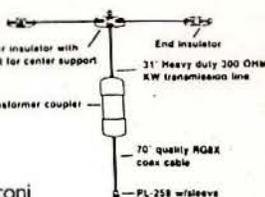
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## FAMOUS G5RV

- Completely assembled
- 102" long overall
- 2kw PEP
- All bands 3.5-30MHz
- Use as a marconi on 160 meters w/a tuner
- May be installed as a horizontal or inverted vee configuration



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## ANTENNA INSULATORS

Lightweight, durable molded tenite plastic.



2130CP.....\$1.50/pair

## VARIABLE CAPACITORS BROADCAST TYPE 1/4" SHAFT



1 GANG 14-365PF \$12.95  
2 GANG 10-400/10-400PF \$19.95

SIGNETICS NE602AN \$2.49  
MINI-CIRCUITS SBL-1 \$7.95

## CONNECTORS

PL-259 NICKEL PLATED.....	\$ .99
PL-259 SILVER TEFLON.....	\$ 1.49
UG-175 RG58 REDUCER.....	\$ .39
UG-176 RG59/RGBX REDUCER.....	\$ 1.39
SO-239 CHASSIS MOUNT.....	\$ .99

## COAX CABLE

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RG 8U.....	\$ .39/FT
RG 8X MINI .24" Dia.....	\$ .20/FT
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#14 COPPERWELD MADE-UP OF 7 STRANDS OF #22 WIRE  
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## DIPOLE CENTER INSULATOR



Constructing a dipole is easy with the HQ-1 center insulator. Attach each "arm" of your dipole to this device and then screw your PL-259 into the center. You get easy assembly, the best connection, the strongest support and the most waterproof fit.

HQ-1.....\$6.95

## MAGNET WIRE

Enamel coated solid copper. For winding coils, transformers, & toroids



### Prices for 1/4lb spools.

#14.....\$4.00	#28.....\$4.85
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#22.....4.25	#36.....6.85
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# One tough little dual bander!

## Features

- Frequency Coverage  
Wide Band Receive  
RX: 76-200 MHz, 300-540 MHz, 590-999 MHz\*  
TX: 144-148 MHz, 430-450 MHz
- AM Aircraft Receive
- MIL-STD 810 Rating
- Digital Coded Squelch (DCS)
- 112 Memory Channels
- 12V DC Direct Input
- High Speed Scanning
- Alphanumeric Display
- CTCSS Encode (Decode w/FTT-12)
- Auto Range Transpond System™ (ARTS™)
- Dual Watch
- Direct FM
- High Audio Output
- ADMS-1C Windows™ Programmable
- Four Battery Savers:  
Automatic Power-Off (APO)  
Receive Battery Saver (RBS)  
Selectable Power Output (SPO)  
Transmit Battery Saver (TBS)
- Time Out Timer (TOT)
- 2.5 and 5 Watt Versions Available
- Optional Digital Voice Recording System (DVRS)
- Full line of accessories



"You notice how loud this HT's audio is?"

"Yeah, it's Mil Spec tough like a commercial HT."



"Easy to operate, small, great price!"

"Yaesu did it again!"



**F**or the foremost in top-performing, durable, dual band handhelds there is one choice. The FT-50R. Manufactured to rigid commercial grade standards, the FT-50R is the only amateur dual band HT to achieve a MIL-STD 810 rating. Water-resistant construction uses weather-proof gaskets to seal major internal components against the corrosive action of dust and moisture. And, the rugged FT-50R withstands shock and vibration, so throw it in with your gear!

Dynamic and exclusive features set the FT-50R apart, too. Wide Band Receive includes 76-200 MHz (VHF), 300-540 (UHF), and 590-999 MHz\*. Dual Watch checks sub-band activity while receiving on another frequency, then when a signal is detected, shifts operation to that frequency. Digital

Battery Voltage displays current operating battery voltage. Digital Coded Squelch (DCS) silently monitors busy channels. Auto Range Transpond System™ (ARTS™) uses DCS to allow two radios to track one another. And, the FT-50R is ADMS-1C Windows™ PC programming compatible, too. To round out the FT-50R, it has four battery savers, and super loud audio—remarkable in an HT this size.

A reliable companion where ever you go, the FT-50R is one tough little dual bander with all the features you want!

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**FT-10/40R**  
Ultra Compact Handhelds  
VHF or UHF. Similar to FT-50R including MIL-STD 810, and other exclusive features.

# C156A

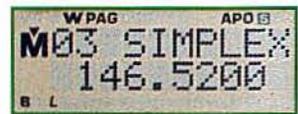
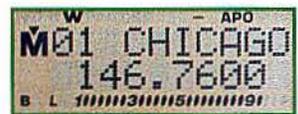
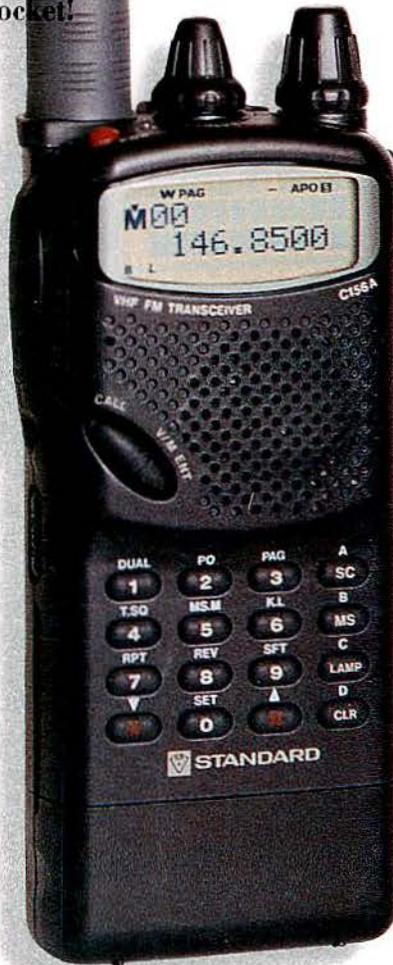
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STANDARD'S FEATURES!  
EVERYBODY'S PRICE!**

Standard's new C156A is indeed a hand-held that everyone can afford, yet it boasts all the user-friendly features that Standard users have come to expect. Take a look at the bright, clear Dot-Matrix display, with alpha-numeric ID as well as frequency, then look at these other features: • 100 Memory Channels plus CALL and VFO • CTCSS - 39 tones built-in • Battery Save 1, 2, 3, 4 or 5 Sec • Auto-Power-Off 30, 60, 90 or 120 min • Dual Watch mode • Scan - 1 MHz, All, Program, Memory, Block memory, Memory Scan Memory and CTCSS (with optional CTN115) and much, much more! Comes with "AA" penlight cell pack, so you need never run out of battery. All this in a Standard - for under \$200! See your Standard dealer today and you'll go home with a C156A in your pocket!

## SPECIFICATIONS

- Frequency Coverage  
VHF RX 135.000-174.000 MHz  
TX 144.000-147.995 MHz\*
- Frequency steps, 5, 10, 12.5, 15, 20, 25, 30 and 50 kHz
- Scan: Pause, Busy or Hold
- Store: Alpha-Numeric Titles, Repeater, Offset frequency,
- Paging, Code Squelch, Tone Encode; Tone Decode with optional CTN115
- Auto repeater offset
- Built-in 1750 Tone Burst
- PTT lock
- Keyboard lock
- Auto Squelch 8 settings
- TX Time-Out Timer
- Paging/Code Squelch
- Wake-up receive mode
- 9 DTMF memories
- 3 power levels: H, M, L
- Back-lighted display
- DTMF Paging and Coded Squelch
- Direct Frequency Input with Keypad
- Unsurpassed Intermod Rejection
- Size approx: 2.28" W, 4.92" H, 1.02" D;  
Weight approx: 10.6 oz
- C156A supplied with CBT156 dry battery case for 4 "AA" batteries. (batteries not included)

\*CAP/Mars Transmit with appropriate Permit



## OPTIONAL ACCESSORIES

- CAW151B Power Cable for Base Station
- CAW152B Mobile Cord with Noise Filter
- CHP111 Head Set with PTT
- CHP150 Head Set with VOX
- CLC155 Soft Case (CNB155/156)
- CLC156 Soft Case (CBT156)
- CLC157 Soft Case CNB157/CBT158
- CMB112 Mobile Bracket
- CMB600 Helmet Clip for CHP150
- CMC150 Mobile Charger (CNB155/156/158)
- CMP111 Speaker Microphone
- CMP113 Tie-pin Speaker Microphone
- CMP115 Small Speaker Microphone
- CNB155 4.8V 600 mAh Small Battery (1.8 Watt Output)
- CNB156 6.0V 600 mAh Standard Battery (2.8 Watt Output)
- CNB157 9.6V 600 mAh High Power Battery (5 Watt Output)
- CNB158 6.0V 1200 mAh Long-life Battery (2.8 Watt Output)
- CSA181AB Desk Top Charger
- CTN115 CTCSS Decode Module
- CWC156A Wall Charger (CNB155/156/158)
- CWC151A Wall Charger (CNB157)



For more information on this and other STANDARD products, please contact your nearest STANDARD dealer. Specifications, price and features are subject to change without obligation or notice. Standard Amateur Radio Products, Inc. P.O. Box 48480, Niles, Illinois 60714.  
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