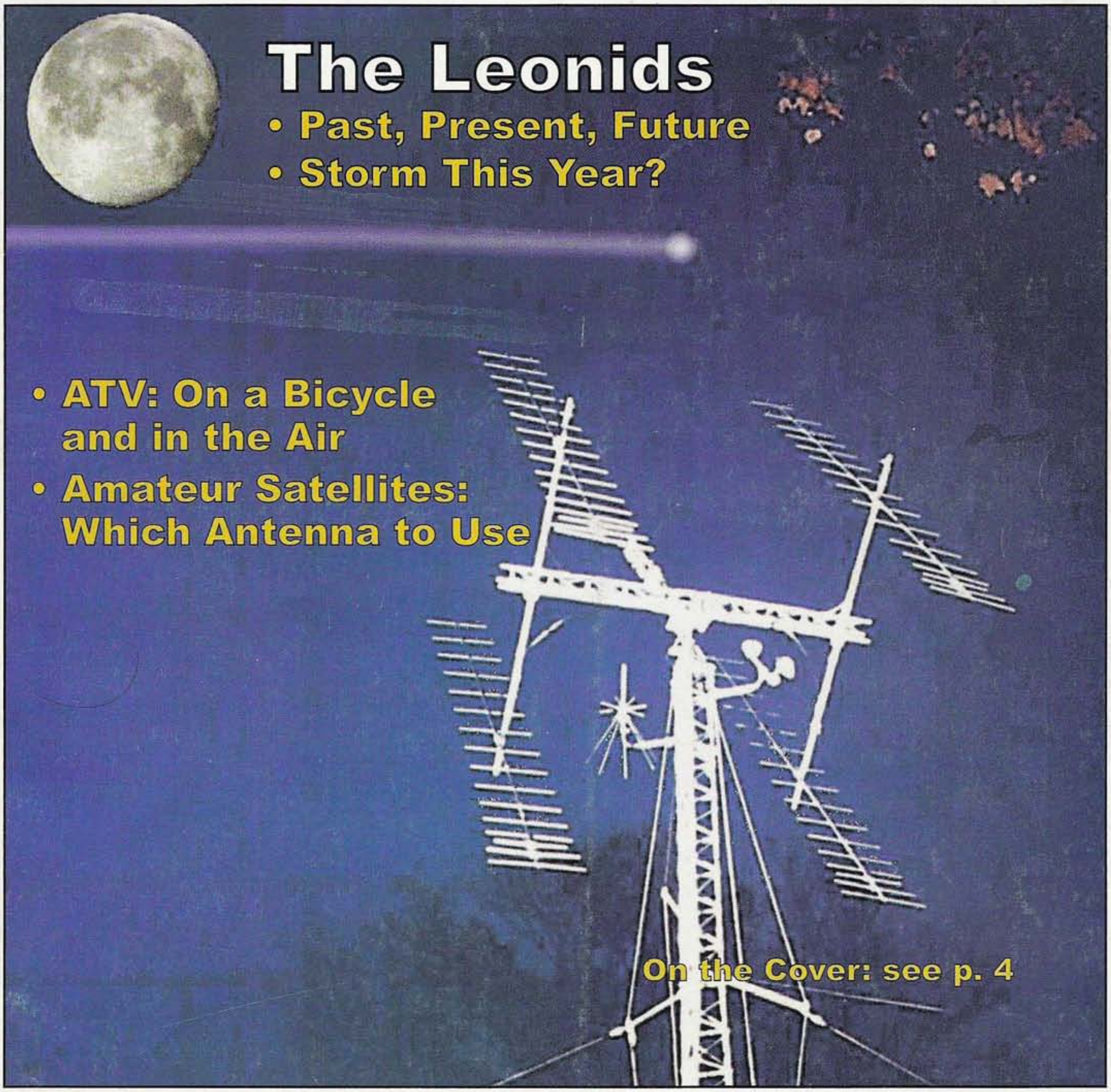
ISSN 1085-0708

CQ VHF

Ham Radio Above 50 MHz

www.cq-vhf.com
Fall 2002
$6.50



The Leonids

- Past, Present, Future
- Storm This Year?

- ATV: On a Bicycle and in the Air
- Amateur Satellites: Which Antenna to Use

On the Cover: see p. 4

■ VHF/UHF Weak Signal ■ Microwaves ■ Amateur Satellites
■ Repeaters ■ Packet Radio ■ Projects ■ Interviews
■ Plus...Reviews, Product News, and much more!

The Perfect Portable Rig

IC-706MKIIG *HF/VHF/UHF ALL MODE TRANSCEIVER*

HF+6M+2M+70CM

When looking for the perfect portable rig, look no further than ICOM's IC-706MKIIG. It's small size (6.5" wide x 2.25" high x 8" deep) and light weight (5.5 lbs) make it easy to pack along on any trip, whether on foot or by vehicle. For the person wanting to conserve battery power, the 'MKIIG offers adjustable power output, from 5~100 Watts. Plus, it's loaded with big-rig features like: built-in DSP, to reduce or eliminate QRM; CTCSS Encode/Decode with Tone Scan; 100 alphanumeric memories with up to 9 character naming; backlit keys with adjustable intensity; and much, much more. An optional remote mounting kit (RMK-706) is also available, giving you unlimited mounting configurations. To find out more about the 'MKIIG and its many uses, visit your authorized Icom dealer today.

Faceplate shown in optional Remote Control configuration. Requires OPC-581 11 ft. (3.5 m) or OPC-587 16 ft. (5 m) separation cable

ANTENNA TUNERS

AT-180

Great for base as well as mobile installations! Tune your vertical beam or coax fed antenna from 160 Meters to 6 Meters. A compact matching package for the IC-706MKIIG.

AH-4

This tuner loves the great outdoors! Whether under your vehicle, or in a tree connected to a long wire, it's the perfect match for your IC-706MKIIG. Compact, watertight construction.

IC-706MKIIG. Proven Performance.

HF/6M/2M/70CM • HF & 6M @ 100W, 2M @ 50W, 70CM @ 20W • 100 Alphanumeric Memory Channels • CTCSS Encode/Decode with Tone Scan • Auto Repeater • All Mode with DSP • Plug-n-Play Filters - Optional 500/250Hz CW, 1.9 kHz SSB Filters • Backlit Function Keys • Built-In Keyer • IF-Shift • Tone Squelch • Remote Head Operation (optional equipment required)

Why not? You deserve it!

www.icomamerica.com

ICOM®

A publication of
CQ Communications, Inc.
25 Newbridge Road
Hicksville, NY 11801 USA.

Offices: 25 Newbridge Road, Hicksville, New York 11801. Telephone: (516) 681-2922. FAX: (516) 681-2926. E-mail: cq-vhf@cq-vhf.com. Website: http://www.cq-vhf.com. CQ VHF (ISSN 1085-0708) is published quarterly (4 times a year) by CQ Communications, Inc. Periodical postage pending at Hicksville, NY and additional offices. Subscription prices (all in U.S. dollars): Domestic—one year $25.00, two years $45.00; Canada/Mexico—one year $35.00, two years $65.00; Foreign—one year $38.00, two years $71.00. Government Agencies: Subscriptions to CQ VHF are available to agencies of the United States government, including military services, only on a cash with order basis. Requests for quotations, bids, contracts, etc., will be refused and will not be returned or processed. CQ VHF does not assume responsibility for unsolicited manuscripts. Allow six weeks for change of address.

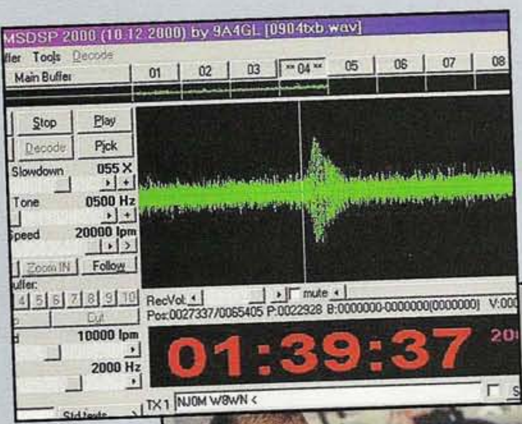
Printed in the United States of America.
Postmaster: Please send change of address to CQ VHF Magazine, 25 Newbridge Road, Hicksville, NY 11801.

contents

Fall 2002
Vol. 5 No. 3

page 9

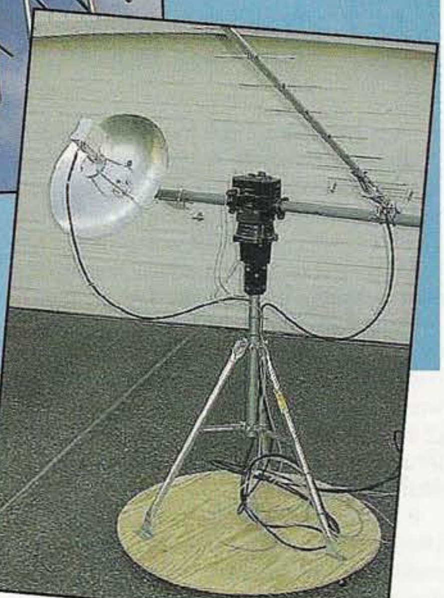
FEATURES



page 15

page 64

page 76



page 69

COLUMNS

DEPARTMENTS

CQ VHF Ham Radio Above 50 MHz

LINE OF SIGHT

A Message from the Editor

Once-in-a-Lifetime Operating Conditions

It was November 1966, more than a generation ago, when the *Leonids* last produced a major meteor storm over North America, and then mostly over the Midwest and West. This November a storm is again predicted, not only for most of North America, but also for western Europe earlier in the day.

Historically, the *Leonids* is rich in its ability to produce storms. As recently as last year, storms were evident in various parts of the world. However, this year represents the end of the trail, as such, of *Leonids* meteor storms for a very long time—to be more precise, at least 97 years!

It was the predictability of the *Leonids* in the 19th century that opened the door to the understanding of how meteor showers and the sometimes accompanying storms work. Ironically, it is this vast improvement in predicting the future of the *Leonids* that makes it clear that we are on the verge of experiencing the end of these oh-so-predictable celestial events.

This year is not only extraordinary because of the predicted termination of the events, but also because of the advanced technology now available. We amateur radio operators interested in operating on the VHF+ ham bands stand to benefit the most among our fellow hams from the propagation generated by the storm-caused conditions. Aiding us in our taking advantage of this special propagation are better-made receivers, and much better amateur-radio-designed software.

Moreover, because of the full Moon providing too much light interference for *viewers* of the storm, amateur astronomers will not fare as well as they have in the past in observing the *Leonids*. This situation will make our radio observations all the more important in documenting the activities of the storms.

In order to enlighten us concerning the predicted *Leonids* meteor storm, this issue contains two articles on the *Leonids* meteor shower, along with other articles making reference to it as well. In "The Leonids Meteor Shower Past, Present, and Future" your editor covers a brief history of and discusses future prospects for the *Leonids* meteor shower. In "A Beginner's Guide to Meteor-Scatter Operation, Part II" author Shelby Ennis, W8WN, discusses the evolution of the software available for meteor-scatter propagation. In his accompanying sidebar "*Leonids* 2002—The Last Big One?" Ennis covers the current predictions and what modes to use during this year's *Leonids*. In "Log Periodic Dipole Arrays: A Single-Antenna Solution for the VHF/UHF operator!" author Peter Bertini, K1ZJH, discusses the use of the log-periodic antenna for meteor-scatter work. Another meteor-scatter relevant article is Tom Webb, WA9AFM's "Satellite" column, in which he discusses various satellite antennas that also can be used terrestrially.

Speaking of antennas, in his "Antennas" column, Kent Britain, WA5VJB, also discusses the log-periodic antenna design and gives directions on how to build another one of his easy-to-build antennas, this one being for the 222 MHz band. Speaking of easy to build, simple construction articles include a 2-meter antenna tuner by Van Field, W2OQI, and a battery helper by Dr. Charles Pearce, K3YWY.

Features Editor Ken Neubeck, WB2AMU, discusses last fall's *F2* propagation on 6 meters. Our other Features Editor, Gordon West, WB6NOA, discusses the dos and don'ts of aeronautical mobile ATV. Speaking of mobile, Jason Baack, N1RWY, documents his entry into bicycle-mobile VHF work on a recumbent-style bicycle. What is a recumbent bicycle? You will learn all you wanted to know and then some from Baack in this issue.

Also in this issue, FM columnist Gary Pearce, KN4AQ, discusses his survey of repeaters located on commercial towers. SETI columnist, Dr. Paul Shuch, N6TX, covers the important role that amateur radio astronomers play in the search for extraterrestrial intelligence. As you look through this issue, you will find that there are even more VHF-related articles that will be of interest to you.

Thanks for Your Support

Over the summer my wife, Carol, W6CL, and I traveled to several locations, including the Central States VHF Society Conference in Milwaukee, Wisconsin; the ARRL Southwestern Division Convention in Escondido, California; and the Mena, Arkansas Hamfest. We really appreciate the warm support that you have given to the resurrected *CQ VHF* magazine and your suggestions for future VHF+ coverage. We met many of you for the first time and renewed old acquaintances, and have seen a great deal of enthusiasm for *CQ VHF*.

As our schedule and the weather permits, we will continue to travel to regional hamfests surrounding the northeastern Oklahoma area. We look forward to meeting you at one or more of these hamfests, for it is your encouragement that keeps us going in pursuit of still more excellent articles for future issues of this, your magazine.

On the Cover

This issue's cover represents some magical wishful thinking on the part of the photographer. It's that ideal night for you, the weak-signal operator, when everything is going just right. The EME antennas are aimed at a full Moon when a meteor passes overhead, exploding right in front of your antennas, thereby lighting up the night sky and firing up the meteor-scatter propagation at your QTH.

Photographer Shelby Ennis, W8WN, author of the two-part series "A Beginner's Guide to Meteor-Scatter Operation," writes of his photo:

The original photo was taken about ten years ago using an old Miranda 35-mm single-lens-reflex camera with a 55-mm lens. The photo is a time exposure, using several hand-held electronic flash shots from different angles while the shutter was open for illumination. The aperture setting is unknown, probably about F8. The film is Fujichrome, later transferred to a negative, and the print scanned into the computer.

Later, the "meteor" was "airbrushed" using Paint Shop Pro. Later still, the Moon was moved in from another picture using Paint Shop Pro.

The 144-MHz antennas are four KLM 16LBXs on an azimuth-elevation mounting at 15 meters. A small 432-MHz X-Yagi is just visible in the center. A Supercone VHF antenna and weather sensors are also on the top of the tower. Since the picture was taken, a four-element 50-MHz Yagi was added to the system.

The tower is aluminum—capable of being free-standing with this wind loading, but with guys and torque bars to cut down on twist and sway. The rotator is a Hy-Gain 300. Elevation is a pair of hinged plates with an old Airstream jackscrew. Both elevation and azimuth readout is by 400-Hz surplus selsyns. Just below the top, but on the opposite side of the tower, is the box for preamps and relays.

Here's hoping we all have such a magical night of propagation on November 19.

Until the next issue…

73 de Joe, N6CL

QUARTERLY CALENDAR OF EVENTS

Conventions and Conferences

The **20th Space Symposium and AMSAT-NA Annual Meeting** will be held November 7–11, 2002 at the Lockheed Martin Recreation Area in Fort Worth, Texas, which is located in the North Texas Metroplex. Hotel information: The AmeriSuites Fort Worth/Cityview has been designated the official hotel. Make reservations as soon as possible by calling the hotel directly (don't use the web-page form), and asking for the AMSAT group rate ($75/day plus taxes). AmeriSuites Fort Worth Cityview, 5900 Cityview Boulevard, Fort Worth, TX 76132 (telephone 817-361-9797, fax 817-361-9444). For more information visit the AMSAT-NA website at <http://www.edtexas.com/amsat/>.

Contests

November: The second weekend of the **ARRL International EME Competition** is November 23–24. See the September issue of *QST* for details, or go to the ARRL's website.

December: The following is from the Six Club. The first annual Winter (6-meter) Contest begins at 2300 UTC December 6 and goes to 0300 UTC December 9. Rules: Each QSO is worth one point in his/her own country and two points for every contact made outside of his/her country; Hawaii and Alaska each are considered a separate country. Scoring: Multiply total QSO points by the total number of grids worked. All entries must be received by January 15, 2003, either by e-mail or snail mail. Webpage address: <http://6mt.com/contest.htm>. The mailing address is: Six Club, P.O. Box 307, Hatfield, Arkansas 71945. Awards: Awards will be given to the first-, second-, and third-place winners in each country.

January: The ARRL VHF Sweepstakes is scheduled for the weekend of January 18–20, 2003. Complete rules for ARRL contests can be found in the *QST* issue the month prior to the contest or the month prior to the first weekend of contests extending over two months.

February: The second annual Winter (6-meter) Contest, sponsored by the Six Club, begins at 2300 UTC February 7 and goes to 0300 UTC February 10. For more information, see the December contest announcement above.

Meteor Showers

November: A rare double-peak meteor storm is predicted for this year's *Leonids* meteor shower. First, at 0356 UTC on November 19, western Africa, western Europe, northern Canada, and northeastern South America should experience storm levels. Next, at 1036 UTC most of North America will experience storm levels of meteor-scatter propagation. For more information on this storm, see the related articles elsewhere in this issue of *CQ VHF*.

December: Two showers occur this month. The first, the *Geminids,* is predicted to peak at around 1000 UTC on December 14. It has a broad peak and is a good north-south shower, producing an average of 100–110 meteors per hour at its peak.

The second, the *Ursids,* is predicted to peak on December 22; the exact time is unknown as of this writing. It is an east-west shower, producing an average of more than 12 meteors per hour, with the possibility of upwards of 90 at its peak.

January: The *Quandrantids,* or *Quads,* is a brief, but very active meteor shower. The expected peak is at around 0000 UTC on January 4. The actual peak can occur ±3 hours of the predicted peak. The best paths are north-south. Long-duration meteors can be expected about 1± hours after the predicted peak.

Quarterly Calendar

The following is a list of important dates for EME enthusiasts:

November 3	Moon perigee. Good EME conditions.
November 4	New Moon.
November 8	Lowest Moon declination.
November 10	Poor EME conditions.
November 11	First quarter Moon.
November 17	Poor EME conditions.
November 18	Moon apogee.
November 20	Full Moon.
November 23	Highest Moon declination.
November 23–24	ARRL International EME Competition second weekend.
November 24	Moderate EME conditions.
November 27	Last quarter Moon.
December 1	Moon perigee. Good EME conditions.
December 4	New Moon.
December 6	Lowest Moon declination.
December 8	Poor EME conditions.
December 11	First quarter Moon.
December 14	Moon apogee.
December 15	Poor EME conditions.
December 19	Full Moon.
December 20	Highest Moon declination.
December 22	Moderate EME conditions.
December 27	Last quarter Moon.
December 29	Moon perigee. Good EME conditions.
January 2	New Moon. Lowest Moon declination.
January 5	Poor EME conditions.
January 10	First quarter Moon.
January 11	Moon apogee.
January 12	Poor EME conditions.
January 17	Highest Moon declination.
January 18	Full Moon.
January 19	Moderate EME conditions.
January 23	Moon perigee.
January 25	Last quarter Moon.
January 26	Good EME conditions.
January 29	Lowest Moon declination.
February 1	New Moon.
February 2	Poor EME conditions.
February 7	Moon apogee.
February 9	First quarter Moon. Poor EME conditions.
February 13	Highest Moon declination.
February 16	Full Moon. Moderate EME conditions.
February 19	Moon perigee.
February 23	Last quarter Moon. Good EME conditions.
February 26	Lowest Moon declination.

—EME conditions courtesy W5LUU.

Your Hand-held or Mobile is Now Your Bridge to the World, and Your "Local" Repeater Will Never Be the Same!

WIRES™–II uses DTMF signaling to connect your hand-held or car transceiver, via the HRI-100 Interface Box, to the Internet, and from there the sky really is the limit!

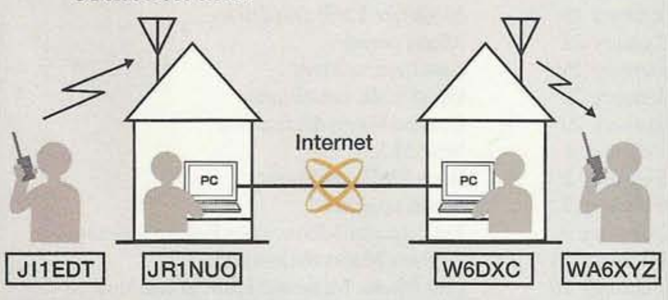
Give Your Repeater Worldwide Coverage with WIRES™–II

WIRES-II

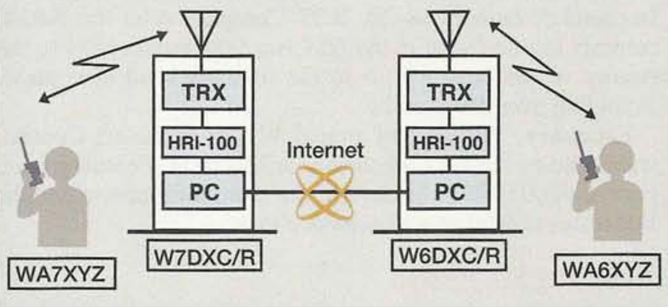
Wide-Coverage Internet Repeater Enhancement System

The Newest, Most Flexible Amateur Radio Internet Linking System!

Internet "bridge" using home stations to establish link.



Repeater with WIRES™–II



WIRES™–II Amateur Radio Internet Linking Kit

HRI-100 Interface Box (Requires 12 V DC Input)

Components

- AP01 CD-ROM (Including Manual)
- Power Cable
- Data Cable (RS-232C DB-9 Plug)
- Data Cable (8-pin Mini-DIN Plug)
- Audio Cable (3.5 mm Plug) (2)
- WIRES™–II User/Server Agreement
- • Optional Accessory: NC-72B AC Adapter

YAESU

Vertex Standard
US Headquarters
10900 Walker Street
Cypress, CA 90630 (714)827-7600

For the latest Yaesu news, visit us on the Internet:
http://www.vxstdusa.com
WIRES™ E-Mail Inquiries: wires@vxstdusa.com

From Solar to Satellite
(Who says exercising has to be hard?)

This bike is long! *At 13 feet long when pulling the trailer, this bike is hard to miss, and is almost as long as most compact cars. (All photos by the author unless otherwise noted.)*

Do you dream of spending hours in your shack chasing DX, sending SSTV images, or just rag chewing on the local repeater while feeling guilty about not spending the time exercising? Take a look at what N1RWY did, as a new bicycle purchase moved his shack to the road!

By Jason Baack,* N1RWY

Summers in Maine are great. Warm temperatures and bright sun provide wonderful opportunities to exercise. However, the summer also brings about terrific conditions on VHF, whether it's sporadic-*E* or ducting up the Atlantic Ocean coastline.

Like most hams, I tend to spend too much time in the shack waiting for an opening rather than exercising in the great outdoors. Last year, however, all that changed for me as I discovered a way to combine both exercise and ham radio. Oh, what fun it is!

"It's like riding a lawn chair."

Last year I was looking for a new exercise plan to add spice to my usual daily walking regimen. The same distance, the same route five times a week for months on end, had become quite tedious, so I was looking for a change. Because I enjoy the Maine seasons too much to be inside, I did not want to join a gym or a health club. Outdoor activity provides a constantly changing scene and a healthy dose of sunlight. I did not want to give that up. To change my regimen, I had thought about riding a bicycle. However, sitting on a standard bike seat for more than 20 minutes caused me a great deal of discomfort, and the thought of spending a lot of money on something I could only ride for 20 minutes at a time was out of the question.

One afternoon I happened to see one of my friends, Martin Orloski, N1WST, out riding a very strange-looking bicycle. He was almost lying down, pushing pedals that were out in front of his feet. When I stopped and asked him what he was riding, he replied that it was a "recumbent" type of bicycle.

"A what?" I exclaimed.

"A recumbent. It comes from the French, meaning a reclining position," Martin explained.

**5 Lily Lane, Frankfort, ME 04438*
e-mail: <n1rwy@n1rwy.com>

Jason posing with his new ham exercise-equipment package.

Seeing Martin in his reclined position, I asked the question to which I knew the obvious answer: "Is it comfortable?"

His face broke into a large smile as he answered, "Oh yeah! It's like riding a lawn chair."

That was all I needed to hear. For two weeks I searched the phone books and scoured the web, looking for everything relating to recumbents. As it turned out, coincidentally one of the largest dealers in Maine was in the next town over from my workplace QTH. Countless hours talking with the owner helped me with my decision. A month and several different test rides later, I had my own recumbent bicycle.

The bike I purchased is a RANS Velocity Squared (see <http://www.rans.com>). It's a long-wheelbase recumbent, which stretches out to about 8 feet in total length. When I travel on the bike, I also pull a modified child trailer, which when added to the bike, gives about 13 feet total length. This is about the same length as most small cars, and I'm very hard to miss when pedaling down the road.

Now that I had the bike, I found that I was able to ride for almost an hour without any discomfort, and adjusting my position was unnecessary. A new exercise plan had begun! Within a few weeks I had racked up a few hundred miles, and I began dreaming of doing some touring, such as a two- to ten-day trip, supported only by what I could carry in pannier bags and a trailer. The bags and trailer would mean extra space, and extra space meant more ham gear—ah, yes, ham gear.

Recumbent cycles and ham radio go together like peanut butter and jelly. The reclining position of the rider on the cycle makes an almost natural position for radio gear at the handlebars. From the moment I bought the bike, I started dreaming about a rolling ham shack; it was just a matter of making everything fit.

Adding Hardware

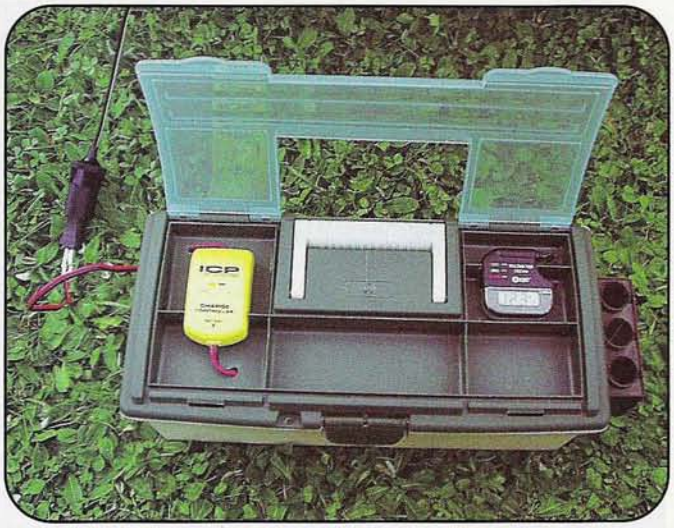
This spring I went on my first unassisted tour. I traveled 214 miles from the southernmost point of Maine, up the coast, and ended in Orono, the home of the University of Maine, my place of employment. I figured it would be a fitting place to end the trip, because I had spent countless hours before and after work riding around the campus, getting used to riding a recumbent bicycle and testing all of my gear.

Planning for the tour was exciting: poring over maps for the right route, planning out food and rest stops, as well as where I would be staying each night. However, planning all the ham gear was the icing on the cake. A solo trip meant that I had to provide my food, my shelter, and as far as the radios were concerned, my power.

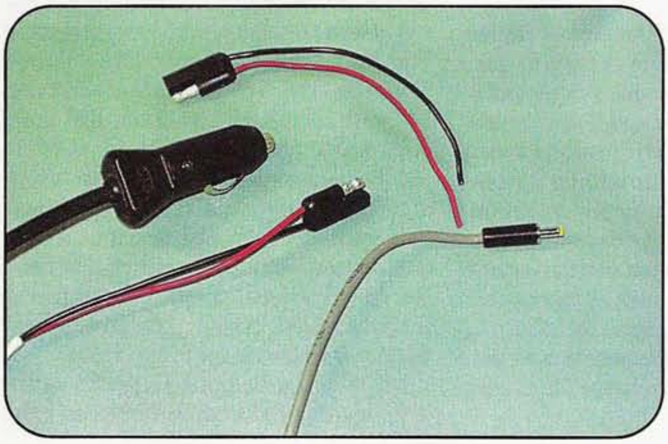
My trailer, fully loaded with cycling gear, along with a day's worth of food and water, weighed about 70 pounds. Along with the standard fare of bicycle touring equipment—including a small assortment of general bicycle-mainte-

Have solar will travel! These two Solarex MSX-10L panels produce about 1.2 amps at 17 volts in full sunlight. Note the Tripmate GPS receiver used with the APRS and ATV systems in the lower left of the image.

The battery that powers it all. A view inside with the Panasonic 7.5 SLA battery charged via solar power. Notice the three cigarette receptacles for power distribution.



A shot of the battery box exposing the ICP charge controller and the automotive LCD voltage meter connected to the solar panels via a cigarette plug. The top cover does a great job of keeping water as well as debris out of the system, yet still allowing easy viewing of the components inside.



A view of the connectors used on the bicycle, standard cigarette plugs, and trailer connectors.

nance tools, a spare tire, a headlamp for late-afternoon /bad-weather riding, a rain poncho, a hand air pump, an air horn, and five inner tubes (Between the trailer and the bike, I had four wheels to take care of.)—also needed was the heart and soul of my rolling station, the ham-radio-equipment power source.

Free Energy

As we know, radios need power to work. This power can come from batteries or from 110-volt power sources. However, storage batteries are heavy, and 110-volt outlets would not be accessible as I pedaled down the road. A heavy battery was not something that I wanted to add to the 70 pounds that I would already be pulling in my trailer. In addition, charging the batteries at night meant that I would need to camp where power was available. Also, it meant that I would need to carry (and possibly lose) more equipment, which was not an option. This dilemma forced me to think of other creative ways to provide power to the station. I decided on another route, taking advantage of the Sun and its ability to provide free energy, that being solar power.

My solution to the power problem was solar panels. Two 10-watt Solarex MSX-10L solar panels generated all the electricity used on my cycle. These panels provide about 0.58 amps at 17 volts per panel. Wiring them together allowed for roughly 17 volts at 1.6 amps per hour. Assuming roughly five hours a day of full sunlight with a few hours of degraded efficiency, I was looking at about 9 amps at 12 volts per day of free solar power to be used by all the equipment on board. Not a bad deal! The panels charged a sealed, lead-acid (SLA) 7.5-amp hour battery, which in turn provided power to all the electronics on the bike.

To regulate the 17 volts from the panels and to charge the battery, I used a small solar charger from ICP (see <http://www.icp.ca/>). I mounted this charger as well as a voltage meter from the local automotive store in the top of a fishing box, with the battery inside. This would protect the electrical connections on the battery and provide a secure environment from the other gear that could shift in the trailer. A small switch on the side of the box allowed me to turn the voltage meter on and off to see the battery's charge condition. The LEDs on the charger let me know if the battery status was charging or "full." Power was routed from the battery box via a three-gang female cigarette receptacle mounted on the outside of the box.

Regarding the availability of the Solarex MSX-10L solar panels, subsequent to BP Solar purchasing Solarex, the panels were discontinued from the product line. However, they still remain available for purchase from several websites for about $120 and up. More information on BP Solar's product line can be found at <http://www.bpsolar.com>.

Cigarette Plugs?

Yes, I realize that cigarette plugs are not the most efficient power connector. However, they are widely available at just about any store. Furthermore, they are inexpensive, and they

Watching weather station data from the N1RWY weather station on the bicycle.

are very easy to replace if needed. Also, just about every piece of ham gear made today comes with an "automotive adapter." Using cigarette plugs allowed me to use standard off-the-shelf equipment without modifications.

Common automotive trailer connectors found at any big-box, RV, or automotive store (RadioShack part #270-026) were used for all the rigs to feed into the main power bus. Utilizing only two different styles of power connectors would make repairs and equipment changes very easy to manage, allowing for a variety of power "sources" available on the cycle when testing or moving gear around to and from the shack or my automobile. Monitoring the entire system was accomplished via two front-mounted LCD display panels providing system status for the solar/battery power station. A battery voltage meter on the front handlebar fork read the open-circuit voltage of the solar panels as well as the battery voltage level, depending on the charging status. This told me if the panels were getting enough sunlight to charge the battery stored in the trailer.

Another display built into one of the radios gave me a quick glance at the status of the battery voltage. The power was routed from the trailer to a small bag mounted mid-shaft on the bicycle. This arrangement allowed me to disconnect all or some of the electronics without digging into the trailer.

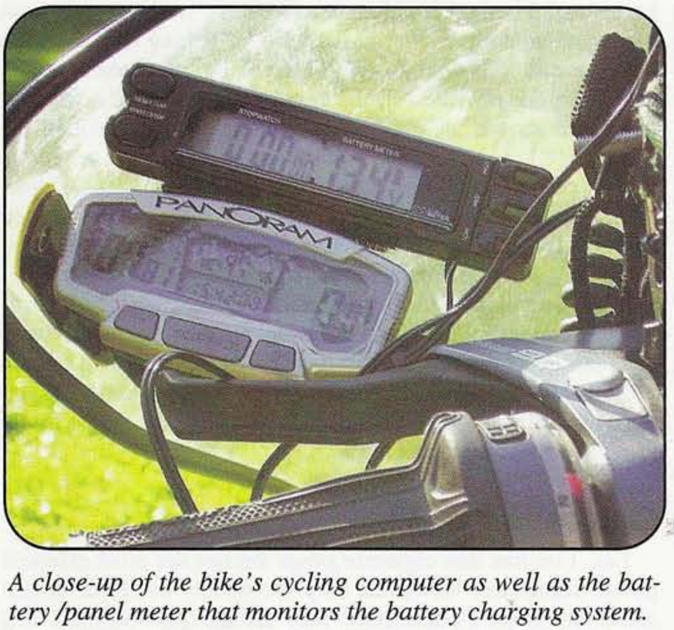
APRS

My bicycle is equipped with a system called APRS, Automatic Position Reporting System. APRS was developed by Bob Bruninga, W4APR, for tracking and for digital communications with mobile GPS (global positioning system) equipped stations via two-way radio. I figured it would be a natural addition to the bicycle, as I run a weather APRS station at my home and enjoy watching the various tracked stations as well as weather reports from all over the country.

The station was built around a Kenwood THD7 handheld FM transceiver, a Larsen half-wave antenna, and a Delorme Tripmate GPS. The THD7 is a dual-band HT with a built-in TNC (terminal node controller). This feature, along with the ability to transmit and receive on two separate bands at once, makes a very attractive package. One can transmit APRS data on one band, and use the other band for scanning local simplex and repeater frequencies, all utilizing the same antenna. A very nice design!

My GPS is a Delorme Tripmate, which is no longer produced. Refurbished units

(Continued on page 80)



A close-up of the bike's cycling computer as well as the battery /panel meter that monitors the battery charging system.

N1RWY's Recumbent Bicycle Equipment

Radios
- Yaesu FT-817 (HF/VHF/UHF)
- Kenwood THD7 (VHF/UHF)
- ATV 1.5-watt, 429 MHz transmitter board (UHF)

Antennas
- 17/20-meter Hamsticks (HF)
- Larsen dual-band half-wave (144/440 MHz)
- MFJ half-wave (144 MHz)
- Arrow Antennas 146/437-10 (144/440 MHz)
- Homebrew quarter-wave vertical (440 MHz)

Miscellaneous
- Palm M105 PDA (logging and satellite prediction)
- Kenwood VC-H1 communicator (SSTV)
- Lipstick B&W camera/GPS overlay board (ATV)
- Panasonic 7.5 SLA battery
- (2) 10-watt Solarex solar panels
- ICP 7.5-amp solar charger

The *Leonids* Meteor Shower Past, Present, and Future

This November the *Leonids* meteor shower is predicted to produce a storm. Such has been the stormy past of the *Leonids*. This article briefly documents the history of the *Leonids* and tells what can be expected for its future.

By Joe Lynch,* N6CL

The *Leonids* periodic meteor shower has displayed some major shows during its more than 14 centuries of recorded tenure. It is because of these displays and current investigations that we have come to be aware that a storm is predicted for this year's shower.

The *Leonids* Trail

In 1833, it was the forecast of a potential *Leonids* meteor storm that caused many to worry that the end of the world was near. Fortunately, the end-time prognosticators were wrong. What did result, however, out of the focus on the *Leonids* meteor showers was a better understanding of the predictability of the reoccurrence of this shower, and meteor showers in general.

As history shows, the *Leonids* seems to have been the *Rosetta Stone*, or the key to understanding how meteor showers occur. Because of its relatively predictable reoccurrence (every 33 or so years), astronomers have been able to study the *Leonids* and thereby make the tie-in with a particular comet and that comet's periodicity.

Leonids Early Recorded History

The first recorded evidence of the Earth passing through the debris of a comet was late in the ninth century. In 868 A.D., the Earth passed through the path of the then unknown comet Tempel-Tuttle. It took approximately another 34 years before the Earth again passed through the comet's orbit. Debris from this comet caused a meteor storm, which the Chinese recorded in 902 A.D.

It would be more than 850 years before anyone in the Western Hemisphere observed and recorded any other major meteor storms. Germans Humboldt and Bompland, then living in Cumana, Venezuela, observed the meteor storm of 1799 and wrote about it. From their investigation, they heard of observations of this storm as far south as Brazil and as far north as Greenland. Reports of the storm also came from Labrador, a fledgling country called the U.S.A. (in particular from Andrew Ellicott, who was on board a ship off the Florida Keys), Great Britain, and from their home country of Germany. They also heard from South American natives that a similar "rain of stars" had been seen 33 years earlier.

During the ensuing 34 years, along with Humboldt and Bompland's documentation, enough additional international investigation was done so that there was an anticipation of some sort of storm. Those anticipating such a storm were not disappointed, when in 1833 a major storm occurred that was observed in widespread locations throughout North America. A well-known quote by astrophysicist Agnes Clerke aptly describes what happened the night of November 12–13, 1833:

"[A] tempest of falling stars broke over the Earth. . . . The sky was scored on every direction with shining tracks and illuminated with majestic fireballs. At Boston, the frequency of meteors was estimated to be about half that of flakes of snow in an average snowstorm. *(Agnes Clerke, Victorian Astronomy Writer)*

The 1833 Leonids *meteor storm as seen from Niagara Falls, New York (from Smith's Illustrated Astronomy, a school book by Asa Smith, 1864).*

Clerke estimated that in excess of 240,000 meteors fell during the nine-hour storm. Indeed, others reported that the lights from the fireballs of the storm were so intense that they were awakened from their sleep. The meteor storm was visible across the North American continent. Contemporary Native American writings of that time refer to the event as "the night the stars fell."

It is not surprising that so many panicked at what they saw. During this period in religious history in the U.S. there was a fledgling but growing movement that interpreted *The Bible* as indicating Judgment Day was very near. The meteor storm of that November night lent itself

**Editor,* CQ VHF *magazine, and "VHF Plus" column editor,* CQ *magazine*
1621 N. Sheridan Rd., Tulsa, OK 74115
e-mail: <n6cl@utulsa.edu>

as a most probable and predictable event, which was part of that doomsday fever.

However, Denison Olmsted analyzed what happened that night in light of what had happened a year earlier on November 12, 1832, when a large number of meteors were observed in Europe, the Urals, Arabia, and Mauritius, and by sailors in the North Atlantic. Thanks to his work, it was concluded that what had occurred on November 13, 1833 was a meteor storm, and that the storm was caused by some sort of cloud of debris the Earth had encountered and could encounter again the following year.

Just what the cloud of debris was or what caused it Olmsted did not know. Even so, commenting on the fury and the fervency associated with the storm, Olmsted wrote, "Probably no celestial phenomenon has ever occurred in this country, since its first settlement, which was viewed with so much admiration and delight by one class of spectators, or with so much astonishment and fear by another class. . . ." (Denison Olmstead, "Observations of the Meteors of November 13th, 1833," *The American Journal of Science and the Arts*, 25 (1834), p. 363).

One of the data that Olmsted discovered was the storm's approximate position in the night sky. At about the same time, A. C. Twining (West Point, New York) and W. E. Aiken (Emmittsburg, Maryland) independently determined a more precise location of the shower's radiant, that being in proximity of the constellation *Leo*. This gave rise to the naming of the storm (by 1866) after its associated constellation. Hence, the name *Leonid* or *Leonids* became associated with it.

The following year there again was a storm. However, it was nowhere near the intensity of the one in 1833.

In the ensuing years data continued to be published related to the storm of 1833. Finally, in 1837 Heinrich Olbers analyzed the data and concluded that the *Leonids* had a periodicity of approximately 33 to 34 years. From his conclusions, he predicted a return of the storm in 1867.

It was the work of Hubert Newton, however, that really solidified the periodicity of the *Leonids* meteor shower. In the years 1863–1864, Newton examined meteor shower and storm reports of the previous 2000 years from around the world. From his examinations, he concluded that those meteor showers or storms that were observed in the years 585, 902, 931, 934, 1002, 1202, 1366, 1582, 1602, and 1698 A.D. had periodicity relationships with the storms that occurred in 1799 and 1833. From his studies, he concluded that the *Leonids* had a period of approximately 33.25 years. Furthermore, he predicted that the next return would actually occur on November 13–14, 1866, a year earlier than Olbers predicted.

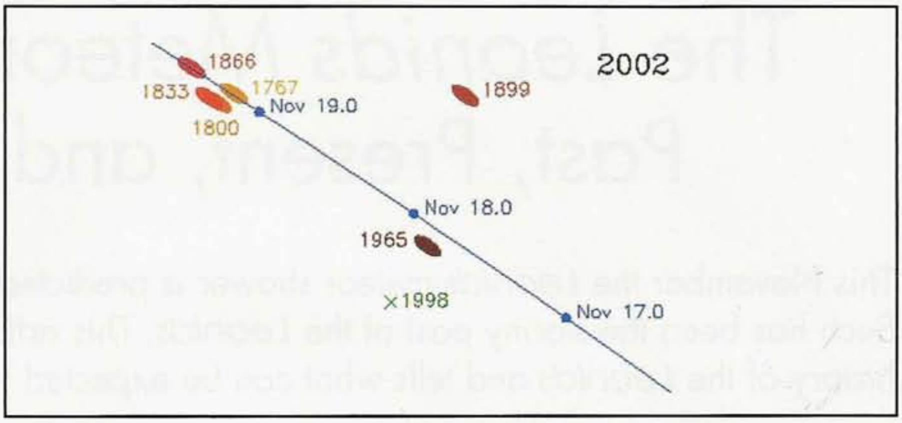


Figure 1. Leonids *dust trails for 2002. (Used with permission of David Asher)*

Discovery of the Tempel-Tuttle Comet

In 1866 two important events occurred. First, Ernst Tempel in Marseilles, France and Horace Tuttle at Harvard College Observatory, Massachusetts independently discovered a comet. Tempel first observed it on December 19, 1865. Tuttle spotted it on January 6, 1866. Named after these two observers, the calculated orbit of the Tempel-Tuttle comet was slightly greater than 33 years. As mentioned above, it also was in that year, based on the previous 33-year interval, that Newton predicted another *Leonids* storm would occur.

It is interest to note that Tuttle's spotting of the comet was just six days before its perihelion. Around February 9 it disappeared, leaving the astronomers little but the faith that they were on the right track in associating it with the *Leonids* meteor shower. Not until 1965 would the comet be seen again. It was recovered by Bester (South Africa) on June 30 that year thanks to the hard work of tracing its orbit by Joachim Schubart of the Astronomisches Rechen-Institut. Ironically, the position indicated that Schubart's prediction was only five days too early.

Eventually, the coincidental relationship of the orbit of the Tempel-Tuttle comet and the reoccurrence of the *Leonids* meteor storm was studied by Dr. C. F. W. Peters, Italian astronomer Giovanni V. Schiaparelli, and Theodor von Oppolzer independent of one another, with their conclusions indicating that the two were related. These conclusions led to the establishment of the connection between meteor showers and comets.

In 1867, in particular, Schiaparelli speculated that the comet was probably related to the 1833 and 1866 meteor showers. Upon further examination of the data, it became clear to the investigators that the Tempel-Tuttle comet was somehow emitting some sort of debris in its wake, and that this debris continued to orbit the Sun in the comet's path, with the ensuing meteor shower being caused by the intersecting of the Earth's orbit each year in November.

It is important to note here that two other comet sightings presumably have ties to the Tempel-Tuttle comet. The first of these occurred in 1366. Both Chinese and Japanese observers made this observation. On October 26, 1699, G. Kirch in Germany observed a comet. However, there seem to be no other observations of that comet sighting remaining in historical records. Even so, some of the predictors believe that these two sightings (1366 and 1699) were prior observations of the Tempel-Tuttle comet.

The second event was the reoccurrence of the *Leonids* meteor storm as predicted by Newton. While light from the Moon interfered with good observation of the storm, enough data were acquired to indicate that the prediction was a success. From this event and analyzing the data, in 1867 von Oppolzer more precisely cal-

(Continued on page 56)

A Beginner's Guide To Meteor-Scatter Operation Part II

Part I of this article, which described the basics of meteor-scatter communications, appeared in the spring issue of *CQ VHF*. Part II describes the evolution of the software used for this communications mode.

By Shelby Ennis,* W8WN

A brief history of meteor scatter and how amateur radio operators used the "big three" annual meteor showers to make "slow CW" and SSB DX contacts on 144 MHz was presented in Part I of this two-part article. However, operating meteor scatter (MS) only three brief periods each year was not enough for the Europeans, who began making contacts every day of the year using high-speed techniques to take advantage of the huge number of daily sporadics that continually bombard the Earth. This time we outline the development of high-speed CW meteor-shower activities and the development of associated software programs.

North American HSCW

North American high-speed CW meteor scatter (HSCW MS) began in May 1997, when Steve Harrison, KO0U (now K0XP) and I ran several standard "slow speed" CW skeds. Both of us enjoyed CW MS, so we increased our speeds to the absolute limits of our ability to copy—approximately 50 WPM for me and 80 WPM for him. I used a programmable electronic keyer, while Steve used the keying program in OH5IY's *MS-Soft* program.

At about this same time, DL3JIM released his *SBMS* (Sound Blaster Meteor Scatter) program. Immediately upon learning about this program, I downloaded it and began using it to assist with receiving, while Steve continued to copy by ear.

That August (1997), Tihomir Heidelburg, 9A4GL, a college student in Croatia, released the first DOS version of his HSCW receiving program, *MSDSP* (Meteor Scatter using DSP). The *MSDSP* program, although not highly developed, showed great potential. We began corresponding with Tihomir by e-mail with suggestions and requests. He responded with version after version. Before the *Perseids* that year, a beta version with transmit capability was available and speeds immediately jumped to 2000 LPM (letters per minute, or 400 WPM). As other operators learned about *MSDSP* and joined the group, speeds continued to increase, eventually reaching the current record of 16,000 LPM (3320 WPM)![1]

In 1999, Tihomir released his first Windows® version of the program, *WinMSDSP 2000*.[2] This version was quickly downloaded by operators in Europe and North America, and it is now

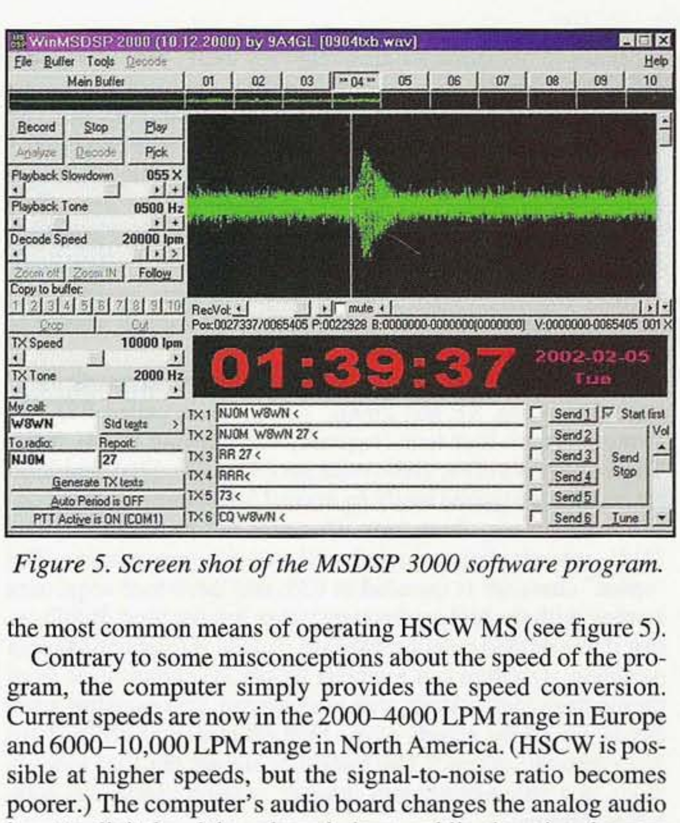


Figure 5. Screen shot of the MSDSP 3000 software program.

the most common means of operating HSCW MS (see figure 5).

Contrary to some misconceptions about the speed of the program, the computer simply provides the speed conversion. Current speeds are now in the 2000–4000 LPM range in Europe and 6000–10,000 LPM range in North America. (HSCW is possible at higher speeds, but the signal-to-noise ratio becomes poorer.) The computer's audio board changes the analog audio input to digital and then slows it down, while changing the now very low pitch to a usable audio frequency. After this conversion, the operator can then play back and copy the ping at a usable speed. Using HSCW, pings as short as one-tenth of a second may contain some usable information!

For those operators who were using *MSDSP*, this program revolutionized meteor-scatter operation, producing contacts every morning of the year. The only problem was that most North Americans did not seem to like the "CW" aspect of HSCW operating. As a consequence, it was not long before every North American HSCW MS operator had worked everyone within range, and usually many times over.

WSJT with FSK441

In 2001, Joe Taylor, K1JT,[3] and I had an argument. I contended that the computers in use by most of us could not beat the

**465 Springfield Road, Elizabethtown, KY 42701*
e-mail: <w8wn@arrl.net>

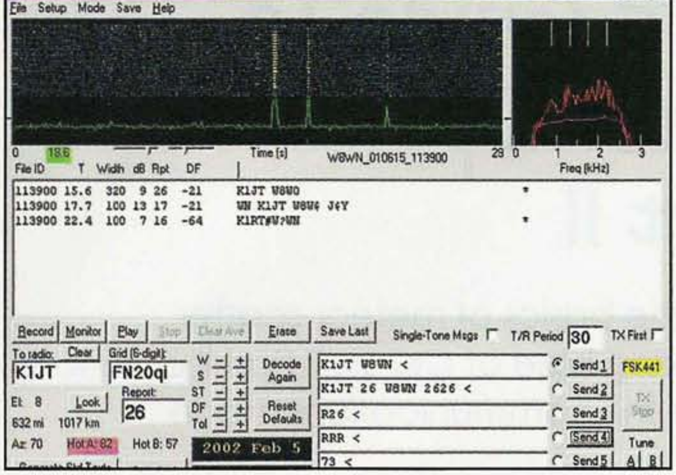


Figure 6. Screen shot of the WSJT software program.

ear-brain combination for decoding very weak, very short high-speed MS signals. Joe disagreed, and he set out to prove me wrong. The result was WSJT, "Weak-Signal communication by K1JT," transmitting FSK441 for high-speed meteor scatter.[4] FSK441 is a digital mode, somewhat like many of the other new digital modes. However, *FSK441 is optimized for tiny, short underdense pings, and only for tiny, short underdense pings.*[5] It does not work well with weak, more-or-less steady signals, or even with long, strong overdense bursts! In other words, it is a mode that can be used every day of the year for MS work (see figure 6).

WSJT is designed for computers running Windows® 95 or later (including XP and 2000). The mode is called FSK441 because it uses four-tone frequency-shift keying at 441 baud. The frequencies of the audio tones are 882, 1323, 1764, and 2205 Hz, so they are passed easily by normal SSB filters. Each encoded character uses three tone intervals, and therefore requires 3/441 seconds (approximately 2.3 ms) for transmission. The "space" character is encoded as 033, and three-tone sequences starting with the highest frequency tone are not used. It follows that if transmitted messages always include at least one space, a decoding algorithm can establish proper synchronization from the message content itself, with no overhead. This encoding strategy is one of the secrets of the high efficiency of FSK441 for MS communications.[6] The transition among the four tones is made in a phase-continuous manner, making extraneous sidebands minimal.

Unlike packet and many other digital modes, there is no error correction, so the operator must be heavily involved in FSK441 operation. It operates at a speed of 8820 LPM (1764 WPM), meaning that at this speed, even a 20-ms ping can contain some usable information. To get all the information possible from the many pings, it is necessary to use the "mouse-pick feature" to manually extract everything from them. In fact, this feature is necessary to decode overdense bursts or extra good pings properly, because the program is not optimized for them (See the *WSJT* manual for details.).

How well does FSK441 work? It works about the same as or slightly better than HSCW in the 8000–10,000 LPM range. Both modes can use extremely short and weak underdense pings. Both modes (at the higher HSCW speeds) transmit information at approximately the same rate. Both need a signal-to-noise ratio of a few dB for reasonable decoding accuracy. HSCW at 9000 LPM occupies a bandwidth of about 1500 Hz, while the FSK441 tones are detected and analyzed with software filters matched to the width and spacing of the tones, namely 441 Hz, thereby giving FSK441 a signal-to-noise (S/N) advantage of about 5 dB over higher-speed HSCW. Several operators have found that their HSMS contacts, averaged over a period of time, have been completed more quickly with FSK441, probably because of its better inherent S/N ratio.

Once you are familiar with both modes, you will find that FSK441 is slightly easier to use. Even so, both require a lot of operator involvement; again, this is not packet! Also, both require some experience for optimum usage. With HSCW, you need to be able to copy the Morse code—at least somewhat. *WSJT* appears to be slightly more efficient, even compared with the highest HSCW speeds that currently can be used. While many people consider it more fun to use CW for a contact, for many others the thrill of just getting that elusive ping is sufficient. Another difference is the fact that there are now many more people using *WSJT*-FSK441 than HSCW. Nearly everyone in North America has switched to *WSJT*'s FSK441 mode.[7]

The very large number of skilled and experienced VHF operators in Europe were strongly entrenched in HSCW. However, the 20 February 2002 Bavarian Contest Club's release on the 2001 Meteor Scatter Contest during the *Geminids* observed, "As you can read in many comments, *WSJT* seems to get more and more interesting for meteor-scatter friends. Not only SSB operators, but also well-known HSCW 'freaks' are found on the WSJT frequencies."

Equipment Needed for MS

The equipment needed for MS operation is basically the same as for any VHF DX work. On 50 MHz, 50 to 100 watts, a three- or four-element Yagi, and a multi-mode rig can be used. Less has been used, but more is better, of course.

On 144 MHz, a multi-mode rig with the standard 150-watt, solid-state amplifier and a 12-element Yagi in the clear will work. Again, less has been used, but more is better. All of this needs to be qualified somewhat, however.

Routine HSMS contacts have been made using much lower power and smaller antennas. For example, Joe Goggin, K9KNW/MM, has used only a halo successfully (but did much better with a small Yagi). Several stations have made contacts using less than 20 watts. Even though it is possible to operate with very low power and tiny antennas, such operation is not recommended. The most successful HSMS operators generally run higher power with larger and higher antennas, just like the most successful stations that are heard regularly via aurora, tropo, etc.

On the 222 and 432 MHz bands, there has not been a lot of regular MS operation. As one would expect, more power and larger antennas are much more important here because of the signal strength loss and the burst length on the higher frequencies. HSMS contacts have been made on both bands using well under 100 watts. If you are serious about MS work on these bands, the recommendation is high power and a pair of long Yagis.

How important is your radiated power? Theory says that the *number* of underdense pings can be expected to increase as the square root of power increases. That is, the number will double if the power is increased by four.[8] However, in actual practice, the number of underdense pings may increase more rapidly than theory indicates. The reason is probably because of the

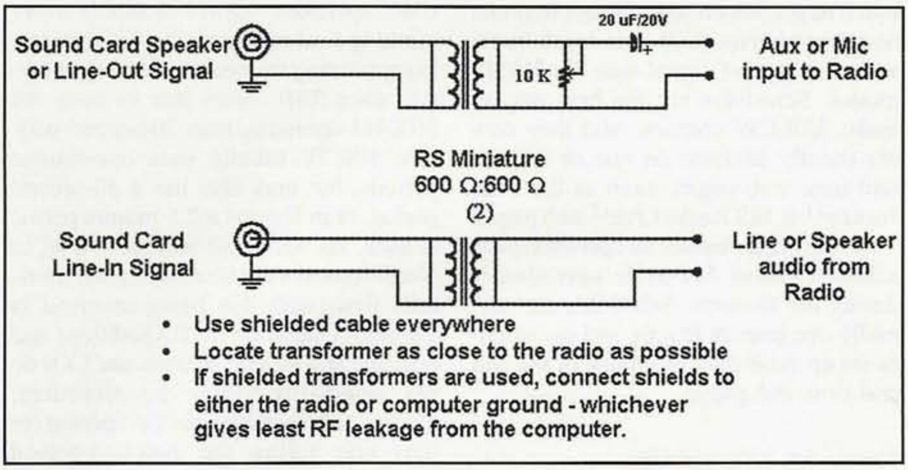


Figure 7. Generic interface using isolation transformers.

large number of pings that are just below the level of usefulness. Increasing the transmitter power level can bring a significant number of these "almost usable" pings into the range of usefulness. On the other hand, for overdense bursts the variation is far less, and little improvement in number is likely with reasonable power increases.

How big should your antenna be? The answer today is the bigger the better. EME-capable arrays have been extremely successful in HSMS work. This answer differs from the one which usually was given in the past. Years ago, an antenna with a broad front lobe was considered more important than high gain. The reason for this antenna configuration is because in those days, the general thinking was that only overdense bursts were usable for communications. Although rare even during showers, overdense bursts require less power. A broader front lobe would cover more of the sky and would thus potentially intercept more overdense bursts. Today, most MS operation uses high-speed techniques and requires only the very weak, short underdense pings. A higher ERP, rom a high-gain antenna, generally produces better results for HSMS than a lower gain antenna with a broad pattern. Because of the lower ERP, the smaller array does not produce as many pings.

Additional equipment needed includes an accurate clock that can be synchronized easily to WWV or WWVB. For HSMS operation, a computer running Windows® 95 or higher is needed. Obviously, the proper program (*WSJT* or *WinMSDSP*) is needed. Several other accessory programs can be a big help. Examples include a program for synchronizing your computer's clock to an atomic standard, one for quickly changing the computer's audio settings, one giving a shower's efficiency for various directions, etc. A number of these programs are available on the Accessory page on the W8WN HSCW website;[9] others are available on the WB5APD website.[10]

For HSMS operation, audio and control cables (and probably an interface box) are needed. Keying is accomplished by injecting an audio signal into the microphone or data port, with the transmitter set for USB. Several commercial interfaces are available, or the interface can easily be built. The audio cable from the receiver to the computer is simply a shielded cable with a small audio transformer or series capacitor in the line. The audio cable from the computer to the transmitter again can be just a shielded cable, an audio transformer, and a 10-K pot for level control (see figure 7). The control cable from the computer's RS-232 port to the transmit line can use either an inexpensive transistor (and little else) or a sensitive reed relay for switching, with a series switch to disable it when it is not needed (see figure 8). All of this, with a few added controls, can be built into a small box. The cables and interfaces are the same as those needed by most of the other digital programs. For FSK441 operation, a small muffin fan for the amplifier is a *very* good idea, as the rig is running in essentially a key-down condition during transmit.

How to Maximize Slow CW/SSB Operation

For SSB schedules, 15-second periods have become standard. For CW, both 30- and 60-second periods are used (and occasionally 15 seconds). *In North America, the western station always transmits first.* (Note that in Europe this sequence is reversed.) The exceptions to this are DXpedition stations, portable or mobile stations, and CQs, which normally use the first period regardless of location or antenna heading. SSB CQs may use either 15-second periods, or more often are a simple 1-by-1 call with a break.

The exchange for an MS contact is the same as for any other contact—an exchange of calls, an exchange of some form of information, and "Rogers." The information exchanged is usually a special MS signal report for schedules, and either the signal report or the grid square for CQs (For most contests, the grid square is the required exchange.). After Rogers have been received, sending "73" is customary. Note that the 73 is *not* necessary for a complete QSO, but it is a courtesy to let the other station know that everything is complete. For a flow chart showing what to send when, see WB5APD's HSMS website.

On 50 MHz, you might try CQs on the calling frequencies during weekend mornings. In the past, if you had a few hundred watts of power it usually was possible to make several contacts. There has been much less activity in recent years, which may be your biggest limitation. The standard 15-second period has been used for SSB, as well as for simple "CQ scatter W5XXX break" calls, with

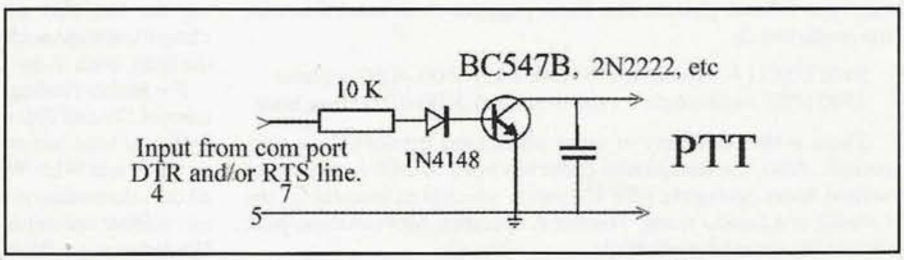


Figure 8. Interface for serial port to transmit line.

the latter being the most common. A way of being sure that you have someone on the other end is to make a schedule. These schedules are normally made on one of the 50-MHz or MS reflectors.

On 144 MHz, MS SSB CQs are useless except during shower peaks. At times during these peak periods they can be fairly successful (or they can be very unsuccessful). If you do not have a schedule, and if it is near the peak of the *Perseids* or *Geminids* meteor showers, tuning around 144.200 ready to pounce on that sudden call could be time well spent. Apart from shower times, CW CQs likewise are useless. CW and SSB schedules are likely to be unproductive except during showers. During major showers, SSB is usually the *preferred* mode of operation because of the possibility of a much larger percentage of long pings and overdense bursts. SSB does much better with this type of signal than the HSMS modes. Schedules are the best way to make SSB/CW contacts, and they now are usually initiated on one of the MS real-time web pages, such as the Ping Jockey[11] or MS Rocks Live[12] web pages.

On the higher bands, all operation is by schedule. Most 432-MHz operation is during the showers. Schedules are normally one hour in length, and are usually set up via e-mail or on one of the MS real-time web pages.

How to Maximize HSMS Operation

High-speed meteor-scatter operation is very different from either SSB or "slow CW" operation. HSMS is usable every morning (and most evenings) of the year, except during the peaks of the big showers, when SSB comes into its own. All FSK441 operation uses 30-second periods. HSCW usually uses one-minute periods, but may also use a 30-second period, or in Europe a 2.5-minute period is used. As with SSB and slow CW, in North America the *western* station transmits first (with this being reversed in Europe). Operation by DXpeditions and portable and mobile stations and CQs do not necessarily follow this procedure, tending to transmit on the first period (or they may follow the direction-period convention). The exchange is about the same as any other mode (calls, information, RS). The MS "two-number" report is used for HSMS operation unless the

Leonids 2002—The Last Big One? In a Nutshell

By Shelby Ennis, W8WN

The *Leonids* are predicted to produce one or more storms between the hours of 0300 and 1200 UTC on November 19. This meteor storm may be the last in our lifetime.

Within that time frame, the Earth is expected to cross two or more dust trails left by previous passages of Comet Tempel-Tuttle. Every 33 years the comet sweeps through the inner solar system, shedding debris. The Earth crosses the comet's path every November 17–19. If we happen to cross a particularly dense portion of one of these dust trails, we can expect a much larger shower that year. The last perihelion passage of the comet was in 1998, and once again, we have been reaping the benefits.

As has been noted, the predictions for the other annual showers simply are based on the time of the Earth's crossing of the path of the orbit of that particular comet. While this gives us a ballpark estimation, it seldom will be any closer than about ±2 hours, and usually not that close. The predictions tell us nothing about the expected intensity beyond what a "typical" year may bring.

The *Leonids* are different now. Astronomers have recently learned to calculate the locations in space of individual dust trails—those long, narrow filaments of debris that were ejected into space during each of the comet's last few returns. Several of the recent *Leonid* peaks have been predicted successfully to within an hour, and even to within only a few minutes. While the intensity of the shower can't yet be predicted as accurately, it is getting better and better each year.

This year the predictions of the various researchers differ from each other slightly, as one would expect. However, the overall picture is as follows (see the Hot News page for more exact times for the predictions):

0400 UTC: (7-revolution 1766 dust trail) 3000–4000 per hour
1030 UTC: (4-revolution 1866 dust trail) 2600–10,000 per hour

There is the possibility of other submaxima between these time periods. Also, the background count has been 50–100 or higher for several hours during the past few years, which is as unusual for the *Leonids* as a *Leonid* storm. Therefore, operation between these peak times also could be worthwhile.

In the mid-Northern Hemisphere, the *Leonid* radiant rises around local midnight. In North America, the radiant still will be below the horizon for the 0400 UTC peak. For the 1030 peak, however, its position will be just about right. (Europe should have an opportunity at both peak times.) Moonlight will cause major interference with visual observations this year—hence, all the more interest in the radio activity of the meteor showers/storms.

How good will this shower be for communications? This is impossible to tell. It usually is assumed that any shower having a Zenith Hourly Rate (ZHR) peak above 100/hour or so will be very good during the peak times; therefore, with the likelihood of a storm, the *Leonids* should be very good. However, this also is dependent upon the size of the particles. Interestingly, many felt that the "fireball storm" of 1998, even though it had a lower rate, produced better MS conditions than did the much higher rates (but with smaller particles) of the next two years.

Which mode of communication should be better, SSB or HSMS? The answer to this question depends as much on the size of the particles as the ZHR of the shower/storm. If the particles are large, SSB definitely will be better. If they are small (more likely), HSMS probably will do better except near the actual peak. (It is not unusual for some sorting of sizes, with the larger particles occurring at a slightly different time than the smaller ones.) Any suggestion would be only a guess.

Is extreme DX possible during the *Leonids*? Nobody knows for sure. Even so, this is expected to be the last major display for many, many years, so now is the time to find out! For more on this aspect, see the last part of the *Leonids* section on the Hot News at <http://www.qsl.net/w8wn/hscw/papers/hot_news.html> and follow the links, both in the *Leonids* section and at the bottom of the page.

For further reading, I suggest you pick up a copy of the November issue of *Sky and Telescope,* as it is anticipated that this magazine will feature at least one article on the *Leonids*. For the latest information on the World Wide Web, use Google to search on the web. However, all the information you really need is available in the main article that this sidebar accompanies, as well as in this sidebar itself and on the Hot News page. With all of this proliferation of information, there is no excuse for you not to get on the air and join the excitement!

grid square has to be exchanged. For an explanation of the "two-number" reports, download the HSMS "Procedures" paper from the W8WN and other HSMS websites. (This short paper is *strongly* advised reading for everyone who has not operated MS recently.)

Additional information is available in the various manuals, on the W8WN HSMS website (many pages), on a number of very good VHF websites,[13] and even on the main *WSJT* screen. This article is intended to give only a little background information on these programs, modes of operation, and MS propagation itself.

On 50 MHz, the North American HSCW CQ (gathering) frequency is 50.300 MHz, and the FSK441 frequency is 50.270 MHz. Most schedules for both HSCW and FSK441 are in the 50.275–50.295 MHz segment. CQs are often posted on the Ping Jockey website, and schedules are commonly set up there. At the time of this writing, stations are on the web every morning and nearly every evening looking for 50 MHz HSMS contacts.

Most worldwide MS operation has always been on 144 MHz, and now either HSCW or FSK441 is the usual modulation type. In Europe, operation seems to be about equally divided between HSCW and FSK441, but with more operators moving to FSK441 because of its greater efficiency. In North America, nearly all operation is FSK441. There are a couple of stations on FSK441 in South America, probably a few in South Africa, a small but growing group in Australia/New Zealand, but no others on HSMS in the rest of the world, as far as is known. There are stations with HSMS capabilities in several other countries. Generally, they have no one within range whom they could work.

The North American HSCW CQ (gathering) frequency is 144.100 MHz, and the FSK441 CQ frequency is 144.140 MHz. Both HSCW and FSK441 schedules are normally run between 144.105 and 144.135 MHz. (*Note:* HSCW can be used below 144.100 but FSK441 cannot, because FSK441 is a digital mode.) On HSCW, a "CQ-letter" is often used to move answering stations off frequency (see the "Procedures" paper for details). On FSK441, "CQ U5" for "I'm listening and will reply up 5 kHz" is used instead.

CQs are usually announced on the Ping Jockey real-time website, and schedules are made there on a regular basis. There are stations on every morning and every evening of the year looking for contacts. DXpeditions using FSK441 are now common, and Clint Walker, W1LP/MM (see figure 9), has given *many* all-water grids to a number of fellows. Schedules are normally 30 minutes in length. Most stations are running about 150 watts to a medium or long Yagi. A few are running less than 150 watts, and of course, others are using bigger rigs. With HSMS, contacts every morning of the year (and most evenings) are possible, and even easy by stations equipped for normal VHF DX operation.

On 222 and 432 MHz, all HSMS operation is by schedule; most 432 operation is during showers. There are no CQ frequencies. Schedules are usually made by e-mail or on the Ping Jockey website.

Hitting the "Hot Spot"

Since the release of the latest versions of *WSJT*, there have been questions about the "hot spot" and its use in MS work. A full discussion is beyond the scope of this article. You can read more in several of the references listed, or you can simply read the proper offset in azimuth from the *WSJT* screen.

Briefly, because of the orientation of usable meteor trains, there is a dead spot on the direct heading between two stations. Because we are in the habit of aiming directly along the great-circle route, this means that we are pointing toward a part of the sky that has fewer meteors. If we were to aim slightly to one side or the other of the direct heading, we should pick up more pings. If you are using an antenna with a broad front lobe, this is of little importance. With many of the long Yagis now commonly in use, it can make a difference. Thus, it is now standard procedure to point toward the proper hot spot.

The heading to the hot spot for sporadics is automatically computed for you by *WSJT*. Enter the other station's call and tell the program to look up that station in the "callsign.txt" list, or manually enter the other station's grid square, then simply read the heading off *WSJT*'s main screen. Note that this procedure is only for *sporadic* meteors.

For meteor *showers,* depending upon the time of day (and thus the location of the shower's radiant) and the direction, the hot spot may be considerably different from the sporadic hot spot. While *WSJT* does not compute this, you can still read it off the screen, for OH5IY's *MS-Soft* program can show the offset.

Figure 9. Clint Walker, W1LP's maritime mobile QTH. Clint has given out many water-only grids on the VHF+ ham bands.

Along with knowing the location of the hot spot, it is good to elevate your antenna for the shorter distances. In fact, for distances under 600 miles, elevation may be more important than the azimuth offset for the hot spot. Several years of regular schedules with W4ZD showed that there was a definite peak for me over this path at an elevation of 7–8 degrees, with a drop in number below 5 degrees and above 12 degrees. The shorter the distance, the more important the elevation becomes.

For distances of 500 miles and shorter, side-scatter (with both stations aiming at a common point about 400 miles distant from both) is also often used. See some of the references for more information.

How Never to Make a Contact!

Some operators seem to be afraid of not only meteor-scatter, but also some computer programs. When they set up for HSMS, those operators appear to be afraid to try anything. I have had a number of fellows contact me, saying that they were going to listen for some CQs. I tell them that unless they happen to be in exactly the right place at the right time, on the right frequency, and pointed in the right direction, they normally will hear nothing. The only way to hear something is to make a schedule. The only way you can learn to use these programs is by actually using them. After some reluctance, some of these fellows have then run a few schedules and have become active on MS. Of those who did not make a schedule soon but only monitored, almost none were ever heard from again.

There are a lot of "tricks and techniques" to getting the most out of both *MSDSP* and *WSJT*. While you can learn to use the programs without ever getting on the air, you cannot get any experience until you actually do get on the air. You also are not likely to find many (if any at all) signals to monitor unless you live right down the road from an active MS operator.

Therefore, when you download the program and have it running, be sure to have read some of the program's manual *(Remember: When all else fails, read the instructions!)*, have the cables hooked up, and then get on the real-time website to request a schedule. Simply tell the other operator that you are new. He will be glad to walk you through everything. After about three good schedules, *you* will be in a position to help a newcomer get on the air.

If you only try to monitor, you are very unlikely ever to get on the air. As noted early in this article, meteor scatter is different from other means of propagation, and high-speed meteor scatter is different from slow CW and SSB MS operation. Get on and give it a try.

The New JT44 Weak-Signal Mode

The latest versions of *WSJT* also have a second modulation mode, JT44.[14] JT44 is *not* for meteor scatter. Instead, it is for *very* weak-signal operation when you have a more or less steady signal, such as tropo scatter, ionospheric scatter, or EME (moonbounce). It has proven to be very effective, and a number of operators on all continents (except possibly South America) are now using it. It gives an approximately 10-dB advantage over CW for EME. Stations that could have worked only a few of the EME "big guns" on CW (and then only with difficulty) have already completed several JT44 EME contacts.

Many who have downloaded *WSJT* for meteor scatter have found the JT44 operation to be just as worthwhile. JT44 is being used not only by small stations, but also by big stations, such as Dave Blaschke, W5UN (of "Mighty Big Antenna" fame), who is heard calling CQ regularly on 144.165 MHz (especially when EME conditions are poor).

Monitoring Other Services

Some people have done quite well monitoring other services, such as the FM broadcast band, low-VHF TV carriers, etc., for meteors. These operators usually fall into three groups: those who monitor all the time, providing a record to the meteor researchers; those who monitor during showers, trying to catch the start of a big burst to know when to call a quick CQ; and those who simply monitor during showers for the fun of it. A good communications receiver (with BFO) works best, although some operators have used sensitive FM broadcast receivers. Even NASA does this with a live website where one can listen for pings.[15] (Don't expect to hear much.) See the OH5IY website, etc., for more information on this subject.

In Conclusion

If you are serious about VHF DX, you almost certainly have a multimode rig with an amplifier, a decent antenna, and a computer. If you have thought about VHF DX and if you have some of the above-mentioned equipment, and even if you have experienced little or no DX VHF operation, think about trying it. In much of the country, all you will hear is white noise most of the time. Extended tropo is not common, auroras are less common (All this depends upon where you live, of course.), and sporadic-*Es* on 144 MHz usually occurs only a few times each summer. Meteors, however, are always there just waiting for you to use them. ■

Notes

1. <http://www.qsl.net/w8wn/wd8kvd/ wd8kvd2.html>
2. <http://www.qsl.net/w8wn/hscw/hscw. html>
3. <http://www.nobel.se/physics/laureates/ 1993/taylor-autobio.html>
4. Download from <http://pulsar.princeton.edu/~joe/K1JT>. (Be sure to read the notes on his opening page.)
5. Taylor, Joe, K1JT, "WSJT: New Software for VHF Meteor-Scatter Communication," *QST*, December 2001, pp. 36–41.
6. *WSJT* manual, p. 35.
7. Pocock, Emil, W3EP, "The World above 50 MHz," *QST*, November 2001, pp. 82–83.
8. See note 2.
9. <http://www.qsl.net/w8wn/hscw/hscw. html>
10. <http://www.qsl.net/wb5apd/wsjt-fsk441.html>
11. <http://www.pingjockey.net/cgi-bin/ pingtalk>
12. <http://dxworld.com/hsms.html>
13. Especially see the "Make More Miles on VHF" website at <http://www.meteorscatter.net/> and the papers on the OH5IY website at <http://www.sci.fi/~oh5iy/> and follow the URLs to still other sites. For a general update on conditions in space, see <http://www.spaceweather.com>.
14. Taylor, Joe, K1JT, "JT44—Revolutionary EME Software," *CQ VHF*, Spring 2002, pp. 12–13, 16.
15. <http://science.nasa.gov/headlines/ y2001/ast21feb_1.htm?list133415>

CQ VHF *Reviews*

The ICOM V8000 VHF FM Transceiver

By Peter Bertini,* K1ZJH

The V8000 2-meter VHF FM transceiver from ICOM America is aimed squarely at the ardent 2-meter FM enthusiast. I'll be the first to admit that I have neither explored nor needed every bell and whistle it offers. On the other hand, it is far better to have them available should the need arise. Mastering everything this radio can do requires reading and understanding the well-written, 76-page instruction manual. Thankfully, ICOM avoided using endless layered menu levels in this radio!

The V8000 styling is strongly reminiscent of some of the high-end commercial radios on the market. It uses a rugged single-piece chassis construction, and it is a handsome-looking radio. Nothing chintzy here! Finding a comfortable fit should not be difficult in most automobiles, as the radio is a scant 2 inches high and about 6 inches deep by 6 inches wide, and its weight is approximately 2.5 pounds. The rear-mounted cooling fan, which is surprisingly quiet, runs on demand; just be sure to avoid restricting the airflow when mounting the radio in the vehicle.

It took me a few minutes to figure out where the speaker was hidden. It is front-panel fired, and the audio is loud and crisp! Unfortunately, the air-conditioning in my vintage 1989 Jeep has long ceased functioning, and when I'm driving at 60 mph with all the windows open, I sometimes wish I had the optional ICOM SP-10 external speaker to provide a tad more volume. The radio is capable of 2 watts audio output into an 8-ohm speaker, which is plenty enough.

* *20 Patsun Road, Somers, CT 06071*
e-mail: <commquart@cox.net>

Photo 1. ICOM's 2-meter powerhouse, the V8000 VHF FM transceiver.

The V8000, with plenty of muscle, is rated for 75 watts output power, or the power can be stepped through four options, which are 75, 25, 10, or 5 watts. Accordingly, the operator has the choice of using only the minimum power needed to hold a QSO. Transmitting at 75 watts, the radio draws 15 amps, so the supplied heavy-duty power cable is best run directly to the vehicle battery in order to reduce voltage drop. If base-station operation is contemplated, you will also need a hefty AC power supply. I would suggest one rated at 20 amps continuous duty.

HM-133V Hand Mic

The HM-133V hand microphone is supplied with the V8000, and nearly all of the front-panel functions can be duplicated via entries on the microphone's 25 buttons. The microphone, despite its complexity, is comfortable in the hand, and the buttons, which are also backlit, can be "locked out" to prevent accidental entries while driving. The radio and microphone use Telco-style RJ-45 jacks. This allows swapping the stock microphone cord with either of the optional 16.4-foot or 8.2-foot microphone extension cables so the radio can be mounted out of sight and operated remotely by the mic. The microphone uses a serial data line to control the radio.

Weather Alert

An especially noteworthy feature of the radio (which can receive between 136 and 174 MHz) is the inclusion of an NOAA weather-alert function. When enabled, the radio checks the local NOAA weather transmitter frequency (selected by the user) every five seconds. If the NOAA 1050-Hz alert tone is present, the radio emits a series of attention-grabbing

Photo 2. The HM-133V microphone is capable of remotely operating the transceiver from the palm of your hand.

beeps and locks on the weather channel so the emergency information can be heard. All seven U.S. and the three Canadian WX frequencies are preprogrammed into the radio; they also may be monitored at will to hear routine weather forecasts.

Features

The LCD display is large and easy to read. The backlighting can be selected for either green or amber in four incremental intensity levels. The 207 memory channels are stored in ten different memory banks. For the long-haul traveler, this permits configuring the radio for up to ten different cities or routes; some 20 frequencies of interest for each locale can be stored in one of ten unique memory banks. Each memory channel retains information such transmitter offset, subaudible tones, and power level. The display shows the frequency and memory-channel number, or the user can opt to display in alphanumeric fashion up to six characters in length—a "name" for each channel stored in memory.

The six-digit assigned "name" can be a repeater callsign, or perhaps a clue to the geographical location. For example, Channel 1 in my review V8000 was programmed for a repeater on 146.715 MHz, and was assigned the nametag "SPFLD1." This serves as a reminder that Channel 1 is for accessing a repeater in the Springfield, Massachusetts area. Holding the MON/ANM button toggles the numeric or alphanumeric display. Another unique feature is being able to set the transceiver for either standard "wide" ±5 kHz or "narrow" ±2.5 kHz deviation. The narrow or wide mode is also unique to each memory channel.

A VFO frequency can be set as a "Priority Watch" while operating on a memory channel. The radio will scan the Priority channel every five seconds, looking for activity. Three Scan modes are supported: Full Scan, which repeatedly scans over the entire band; Memory Scan, which repeatedly scans the memory channels that haven't been set to skip; and Programmed Scan, which scans between two user-defined frequency limits. Scan resume can be set for 5-, 10-, or 15-second pauses on an active channel, or to resume scanning when the signal disappears.

Transmitter Lockout

Have you ever reached for the microphone and given a call on the local repeater, only to discover the volume control turned down and the frequency already in use? While embarrassing, it happens to the best of us! ICOM solves the problem by including a clever "Repeater Lockout" mode; when that is on, the transmitter is disabled if there is activity on the channel! This is also a nice feature to use on repeaters with relatively short tails, as it permits time for others to chime in and join an existing conversation.

Group Paging

While the V8000 has sub-audible and three-digit DTCS ability, adding the optional UT-108 DTMF decoder allows paging via three-digit DTMF sequences. The pager and code squelch functions require ID codes and a group code (the three-digit DTMF sequences) to be written into the code channels. Pocket Beep is another paging mode, and uses sub-audible tone signaling. This indicates that someone called in while you were away from the transceiver, and the identity of the person is displayed so you know who it was. All these tools are useful for emergency-preparedness groups or for club activities.

The V8000 has ten DTMF memory channels that will hold DTMF sequences up to 24 digits each. These memory channels can be quite handy for entering autopatch access codes or autodialing, or for commanding repeater controllers to execute macros, control, or linking functions.

Programming and Cloning

Programming is via the rear-apron external speaker jack, which also serves as a data port for these applications. The optional OPC-474 cable is used for radio-to-radio cloning, while the optional CS-V8000 Cloning Software and OPC-478 Cloning Cable are needed if you wish to program the radio to or from a PC using the Windows® 95/98/ME operating system.

The V8000 is a workhorse that would be a fine daily companion on the road or at home.

Final Comments

It is kind of difficult to get excited over a single-band, single-mode VHF FM transceiver, because this type of transceiver is the sort of thing you rely on every day, without giving it a second thought. Even so, I rather enjoyed using the V8000. It is a workhorse that would be a fine daily companion on the road or at home.

When I first started experimenting with FM communications in the early '60s, trunk-mounted dynamotor-powered commercial radios were the current state-of-the art. The ICOM V8000 shows how far we've advanced. It hardly occupies the same physical area that one of those vintage control heads would have required, and has features that were as yet undreamed of.

The V8000 is manufactured by ICOM America, 2380 116th Avenue NE, Bellevue, WA 98004 (425-454-8155). Price class: V8000, $307; UT-108 DTMF decoder, $35; OPC-440 16.4-foot microphone extension cable, $85; CS-8000 software CD, $35; OPC-478 computer cable, $45; OPC-474 transceiver-to-transceiver cloning cable, $18. ■

"DXing" With a Heathkit Twoer

What was your first DX contact? You will never forget working your first DX QSO—especially if it was a QRP contact! Bob Witmer, W3RW, challenges us to never underestimate what can be accomplished in amateur radio, no matter how Spartan the equipment you own may be.

By Bob Witmer,* W3RW

Would you believe that a Heathkit Twoer and a hand-held beam produced an AM QSO of nearly 100 miles—without the aid of any mountaintops?

First, of course, you have to know what a Heathkit Twoer *was*. It was a 2-meter AM transceiver with a crystal-controlled transmitter and a tunable receiver *(which generally tuned about one quarter of the band at any given time!—ed.)*.

Back in 1967, I operated 6 meters AM exclusively. However, I wanted to try something new. A good friend, Allen McQuate, K3HQC, was a member of the Radio Amateur Civil Emergency Service. (RACES). Allen was using a Civil Defense (CD) Gonset Communicator IV transceiver on 2 meters, and he was having a great time. I decided to try the band.

Like most hams at the time, I was very familiar with the Heathkit catalog and the Heath HW-30 Twoer (see table 1). The price of the Twoer was reasonable, so I decided to buy one. At that time, I was attending Drexel University in Philadelphia, which presented another factor in my decision to purchase the rig. Since Dennis Shaak, K3WFW, and I had many classes together, we decided that it would be fun to have a voice channel to use when we were doing homework. Two meters seemed like a good band to try *(In 1967, 2 meters was as sparsely populated as 222 MHz is today—ed.)*.

Educating myself while the Twoer was on order, I decided to see what had been written about it. I checked the Drexel library, and I was delighted to find a good collection of amateur radio magazines, including *CQ* and *QST*. I found an interesting article in the March 1965 issue of *CQ* entitled "Souping Up The Twoer," by Frederick W. Brown.

The Heathkit Twoer, a 2-meter AM transceiver with a crystal-controlled transmitter and a tunable receiver.

After reading the article, I decided that the section on improving the output power (to raise the original 1/2 watt to approximately 1 watt) would be worth trying. Because I had not yet built the kit, I decided to install the "mods" from the beginning of the assembly.

The Twoer was my first VHF point-to-point wiring kit—no circuit boards and no preassembled wiring harnesses. After the kit arrived, I set up a table, collected a couple of empty egg cartons to hold parts, and started building it. I enjoyed every step, which included unpacking the individual bags of parts and even counting the hardware! It didn't take long before I was at my favorite part of the kit-building process—installing the tubes!

The radio's alignment also was easy. The superregenerative (or superregen, for short) receiver had only two alignment adjustments, which were peaked easily with the help of an on-air signal provided by K3HQC, who lived just a few miles away. The transmitter alignment was almost as simple. A rear-panel "stereo" headphone jack provided two metering connections: one for final stage current monitoring, and one indicating relative RF power.

Of course, in traditional Heath style, the kit came with everything needed to construct a dummy load (which, in this case, consisted of a No. 47 pilot bulb and an RCA male "phono" plug). It was quite

* *146 Forest Trail Dr., Lansdale, PA 19446*

Heathkit HW-30 2-meter Twoer Transceiver
Description and Specifications

Receiver type: Superregenerative detector with RF amplifier stage
Tuning Range: 143.0 mc to 149 mc
Sensitivity: Usable with signals as low as 1 microvolt at antenna terminals
Speaker size: 3.5" (round)
Audio power output: Approximately 1 watt (undistorted)
Transmitter power input to Final RF amplifier: Approx. 5 watts
Frequency control: Quartz crystal: 8 mc fundamental—FT-241 or FT-243 holder
Power requirements: With built-in supply: 105–125 volts 50/60 cycle AC 45 watts; with external supply: 6V @ 2.35 amps or 12V @ 1.2 amps, 260 volts DC at 90 ma
Cabinet dimensions: 8" H × 6" D × 9" W

Table 1. HW-30 description and specifications taken from the Heath manual.

a thrill when I reached the point in the transmitter alignment when I could see the bulb start to glow!

With the Twoer completed, I could hardly wait until Monday night so I could check into the 2-meter CD/RACES net. When the net began, I was disappointed with what I could hear using my indoor horizontal dipole antenna. Even with the "wide" superregen receiver, I had to tune around to hear most of the other stations.

Those were the days before repeaters, and almost no one ever operated on exactly the same frequency—at least not for long. Most equipment didn't even have crystal frequency trimming adjustments! The real problem was that I couldn't hear many of the stations, and the net control station couldn't hear me.

I knew that Allen had a pair of 11-element beams which worked well, so it was time to improve my antenna system. Being a "poor" college student at the time, I couldn't afford to buy a beam. Consequently, I decided to build one.

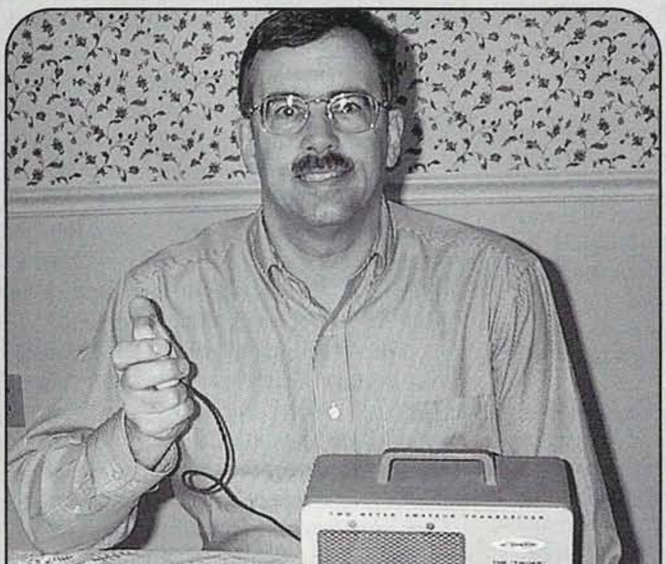
I chose to build a 5-element beam design from an ARRL publication. I think it was the first edition of *The Radio Amateur's V.H.F. Manual.* I collected the materials I would need, including a 6-foot 1" × 1" for the boom, along with aluminum ground wire for the directors and reflector and copper wire for the driven element.

I made the driven-element connections by using the recommended "Y," or "Delta" match, configuration, along with a 1/2-wave coaxial 4:1 balun with crocodile clips. I constructed the 4:1 balun from the information in the manual. While I didn't have any real way to check my construction, after some crude adjustments of the crocodile clips, without benefit of an SWR bridge, I was ready to try it on the air.

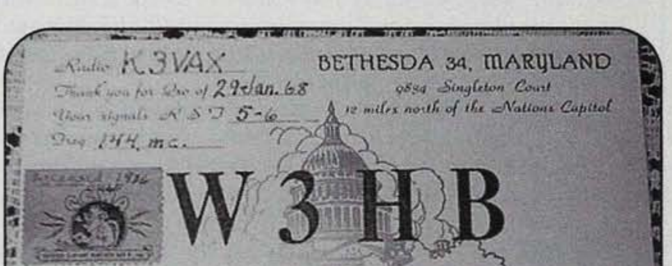
The next net night the beam made a great improvement over the dipole. I could hear many of the stations, and the net control operator, who was located 13 miles away, could even hear me!

One note about my station setup: When I was operating, I held the beam over my head, allowing for quick rotation adjustments of its direction. Also, it was my first introduction to the "armstrong" rotator concept, which is commonly used today by some hams who use HTs with beams to work AO-27 and similar satellites.

To get the full understanding of my operating situation, you have to understand that the Twoer did not have a push-to-talk microphone. Located on the front panel was a three-position T/R switch. One position was momentary transmit, while another was continuous transmit, with the receive position located between the two transmit positions. At the end of each transmission, while still holding the beam in the other hand, I would have to put down the microphone and turn the T/R switch manually to receive. Of course, performing this operation always had some impact on the beam's direction. Therefore, I would have to try to return the beam to its optimal direction by listening to the other station. Even though



The author and his original Heathkit Twoer, also known as the "Benton Harbor Lunchbox" because of the handle on top.



W3HB QSL card confirming the author's first 2-meter "DX" contact between Pennsylvania and Maryland back in 1968.

Operating via UO14 and Similar Satellites with the Yaesu FT-817 Using Two Separate Antennas and No Duplexer

By Arnie Coro, CO2KK

The Yaesu FT-817 transceiver has an additional feature (not described in the user's manual) that makes it easier to operate on the UO14, AO27, and future FM repeater satellites with two separate antennas. This feature allows the user to program the front antenna connector—the BNC—for the 145-MHz uplink so that a 2-meter antenna is attached to this output of the transceiver. The rear connector is then assigned via the menu for the 70-cm band receiving downlink simply by switching to that band, going to the menu, and selecting the rear connector for the UHF 70-cm band.

As explained in the manual, you must program the FT-817's memories for split operation, assigning five memory channels to be able to take care of the Doppler shift as the satellite moves quickly in the sky.

Although the FT-817 is not a *full-duplex* transceiver, it works very well with the UO14 and AO27 satellites using a 70-cm Yagi with between four and six elements for receive, attached to the rear SO239 connector, and a three- to four-element Yagi attached to the front BNC connector, so there is no need to use a duplexer.

By making use of this feature, which effectively assigns the front or rear connector to each band, one can use, as I did during my first tests on these satellites, whatever antennas are available without the need to have a 2-meter to 70-cm duplexer.

One interesting finding during those tests was that the CO2KK 2-meter, 6-dB gain omni-directional vertical was an excellent choice for satellite passes close to the horizon, making it easy to work stations at the far end of the spacecraft coverage area.

Maybe one day we will have an FM multi-channel repeater orbiting the Earth at more than 1000 km to make possible longer QSOs, too!

the Twoer didn't have an S-meter, I was able make a rather quick adjustment because fortunately the beam's pattern wasn't too sharp!

My First Big "DX" Contact!

I was now enjoying 2-meter operation, but it was all strictly local communications. On the evening of January 29, 1968 all that changed. As I was tuning around the band, I was surprised to hear several unfamiliar callsigns. In particular, I heard Brownie, W3HB.

I "swung" the beam to peak his signal and gave him a call. To my amazement, he answered me right away. As we exchanged the usual information, I was astonished to learn that he was located in Bethesda, Maryland—nearly 100 miles away! (My QTH at that time was the town of New Holland, located in eastern central Pennsylvania.) Brownie was running a Viking 6N2 with 30 watts input power to an 8 over 8-element beam array. In commemoration of this special QSO we exchanged QSL cards.

Looking back, I'm still amazed by that QSO. Even in today's terms it is amazing! The Twoer's superregen receiver was rated at 1-microvolt sensitivity, and the transmitter output was measured later at slightly over 1 watt! Who knows what the gain of my beam was (but somehow it worked) and all this was accomplished on AM! It was an exciting introduction to the DX that was possible on 2 meters!

I still have that Twoer today. I had sold it to a friend, but I was fortunate enough to be able to buy it back several years later. Just for fun, I fired it up the other day. Without any adjustments, the Twoer was still putting out a little over 1 watt, and the original crystal microphone's AM audio still sounded great! Then I transmitted using my IC-706 for the first time on 2 meters AM, with the power turned all the way down. It sounded great on the Twoer's superregen receiver.

I did not connect the Twoer to an antenna because I didn't want to wipe out any nearby 2-meter receivers. Even though it has an RF stage for isolation, enough RF from the superregen's oscillating detector feeds through to the antenna connector to potentially cause interference.

All in all, that first DX QSO was one I'll never forget. The "moral" of the story is never to underestimate what can be done on the ham bands with the equipment at hand! ■

Six-Meter Propagation Tools of the Trade

Secrets of Internet Spotting and The Tree Beam Revealed!

In the Spring 2002 issue of *CQ VHF*, WB2AMU's article on 2001's great 6-meter *F2* propagation covered the propagation patterns that occurred and the stations he was able to work. This month he focuses on some of the tools and tactics used by him and others in working this *F2* propagation.

By Ken Neubeck,* WB2AMU

The experienced 6-meter operator surely knows how fleeting 6-meter propagation is! The nuances of some modes, such as sporadic-*E* propagation, with regard to duration and timing are well known to anyone who has operated on 6 meters for any significant period of time. In contrast, the recent *F2* season observed over the fall/winter months of 2001–2002 presented a bit of relief to most operators, because the openings were easier to spot and their longer duration provided the operator with the luxury of time.

There were certain tools and techniques, however, which helped make it easier to work the *F2* season. These included the use of internet spotting and the availability of a portable 6-meter setup that could be operated from one's vehicle. Let's look at some of these tools and techniques.

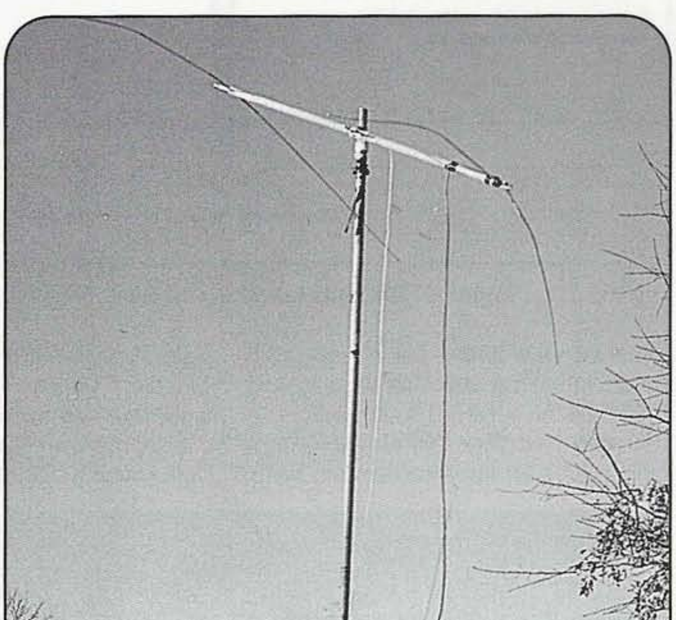
The Value of Internet Spotting

Since the peak of the last sunspot cycle, the internet has been a great tool used worldwide. A number of chat pages and DX spotting pages have been developed (similar to the original packet clusters of a decade ago), and these pages are great for spotting DX on the ham bands. Some of these sites are tailored specifically to the 6-meter operator.

We certainly know how difficult it can be to spot openings on the band, even when we are sitting in front of a rig for an entire day. These spotting sites are a big help. The four sites which track 6-meter propagation specifically on a daily basis are as follows:

- http://6m.dxers.info/chat/
- http://www.eham.net/DX/
- http://oh2aq.kolumbus.com/dxs/50.html
- http://dxworld.com/50prop.html

My favorite choice is the first one listed, which is run by Tim Havens, NA1CW (ex-N1RZ). Tim is relatively new to 6 meters



As described in the article, this is the portable, two-element Yagi beam built by the author and mounted on 15 feet of mast. This setup was used for his single-operator portable effort in the ARRL's January 2002 VHF Contest. Of course, the only day it snowed all winter on Long Island was during the contest! Despite the weather conditions, the band had an F2 *opening to the West Coast on Sunday, January 20, during the contest, and the author was able to work several stations using 10 watts output. (Photos by WB2AMU)*

*CQ VHF *Contributing Editor, 1 Valley Road, Patchogue, NY 11772*
e-mail: <wb2amu@cq-vhf.com>

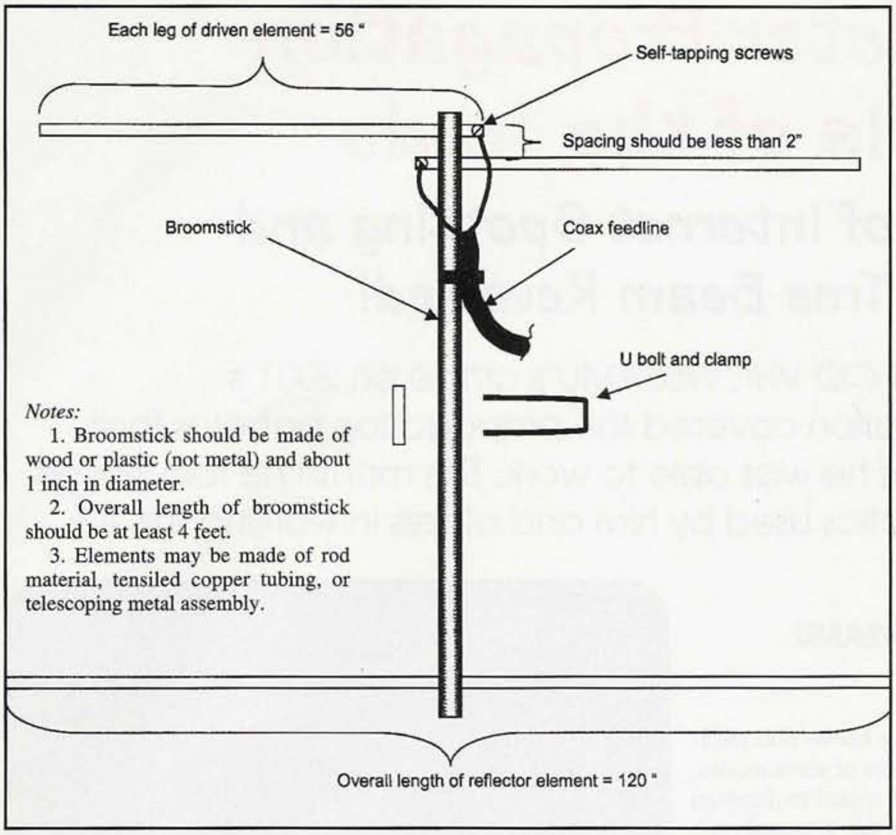


Figure 1. The broomstick two-element, 6-meter Yagi.

(since October 2000), but he took to 6 meters in such a way that he achieved DXCC on the band in 13 months!

A prior chat page that closed in September 2001 set the precedent for Tim's page. A software programmer by trade, Tim did a yeoman's job of developing a brand new website from scratch, with both a mapping program and a chat page. Unfortunately, Tim did not have the benefit of the code that was developed from the previous chat page. In spite of this drawback, and beginning his effort in September, by October Tim had a working chat page, one which was used extensively for spots on 6 meters during the great *F2* season. Because a significant amount of money has been expended to obtain the hardware and software needed to support the site, many hams who use this site have sent contributions to Tim.

A close-up view of the two-element Yagi in the tree at the author's work QTH. The stealth-style setup was ideal. Oh, the things veteran 6-meter operators go through to try to work DX!

Tim's page gets my personal endorsement. On several occasions when I had a free moment at work I monitored the site. I saw hams in areas near my location who were reporting 6-meter propagation, as well as DX stations that were being heard. Then I ran to my portable setup in the car, which will be described in the next section. Often I heard the DX station and worked him within a matter of minutes.

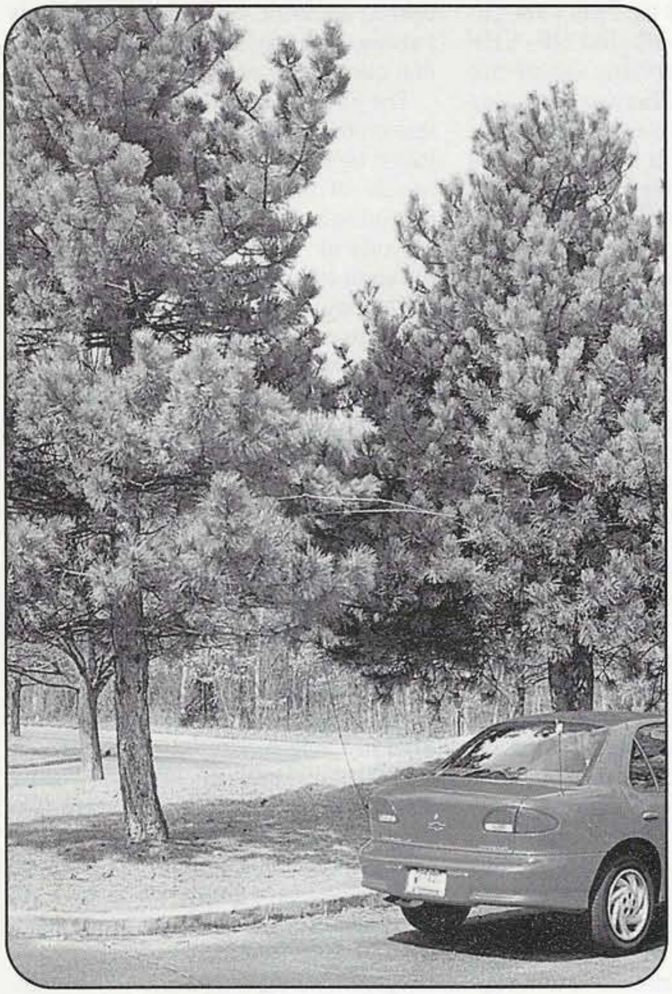
Because of this invaluable spotting, some of the calls I worked on 6 meters were FR5DN from Reunion Island (yes, on 6 meters!), MUØFAL in Guernsey, ZB2EO in Gibraltar, NL7Z in Alaska, OY9JD in the Faroe Islands, and TI9M on Cocos Island. Would I have worked any of these stations without this spotting site? No! I might have caught one or two of them via a long-duration opening, but in the case of FR5DN, NL7Z, OY9JD, and TI9M, the openings lasted only five to ten minutes at best! I would have to say that internet spotting has been as useful to me as the 28.885 MHz 6-meter liaison frequency has been to many operators.

When using these URLs one needs to be responsible and exercise courtesy and fair play. For example, after hearing or working a station coming in on 6 meters via skip, the individual should report it on the URL as soon as possible.

Some hams have made the unfortunate choice of reporting an opening 30 minutes to an hour later. This late reporting does no one else any good, and it looks somewhat like "DX bragging." Another problem is that not all hams like one another, and sometimes individuals take issue with those they dislike on these pages, causing major distractions. This type of situation was the reason why one site closed.

The lesson here is that it is best to respect the purpose of the spotting site. The same rules that govern acceptable behavior on a repeater generally apply to these ham radio chat pages.

For the most part, using URLs on the computer restricts one to the home QTH (an exception being my personal mobile



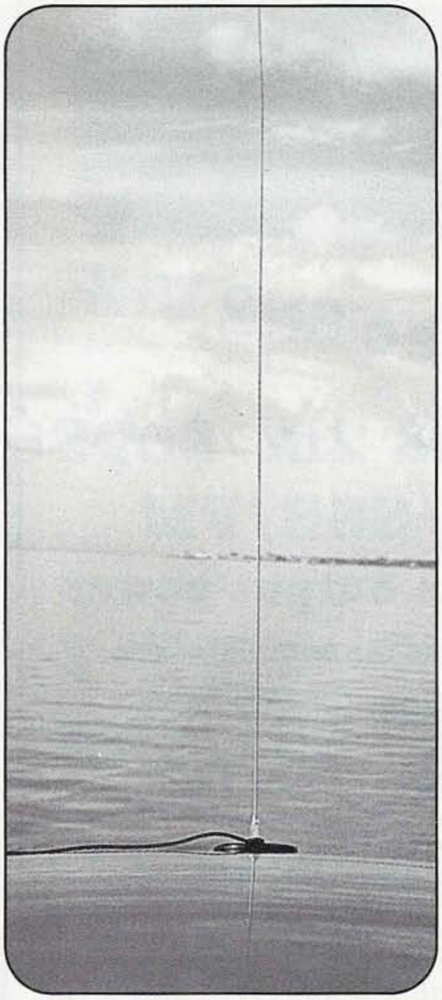
Can you find the same two-element Yagi in this photo? It is in the pine tree to the left of the author's car, about 10 feet off the ground and suspended from one of the branches. The beam gave a little more boost in both receiving and transmitting during marginal openings on the band. This was particularly true on the day the photo was taken (March 1, 2002), as the antenna was pointed south and was instrumental in the author's working TI9M, the Cocos Island expedition, on 6 meters.

experience above). For those of us who predominantly work away from home, let's look at other tactics we can employ.

Portable 6-Meter Setup Saves the Day!

The majority of the *F2* openings I observed at my location on Long Island, New York took place between 8:00 AM and 4:30 PM local time, the time when many people must be at work. Going home at lunchtime for the purpose of operating on 6 meters is not always practical. In my case, I am 20 minutes away from the home QTH and I get one hour for lunch, so there is no chance of my going home for lunch. Therefore, developing some sort of mobile or portable capabilities made more sense.

On another note, during the period November 2001 through January 2002 the "*F2* Flu" attacked many serious 6-meter DXers. The reason for their "sickness" was to be able to take the day off to work 6-meter *F2* DX propagation. However, what if



It was not always possible to set up the two-element Yagi, particularly when mobile or in certain locations. The fallback was to use the old, reliable mag-mount 1/4-wave vertical. This setup performed just fine during many of the days of F2 *propagation on 6 meters, allowing the author to talk to European and West Coast stations while mobile! On the day in late November when this photo was taken, with his vertical antenna the author was able to work Jon, HC8/NØJK, during his 6-meter DXpedition.*

there are only a limited number of days allowed off from work? How can the 6-meter operator take advantage of openings that occur during work hours?

In my opinion, many VHF operators do not appreciate the tremendous flexibility of working 6 meters. Because of the relatively small wavelength, it is not difficult to construct small directional antennas with decent gain. This small wavelength lends itself to both mobile and portable work.

My answer came in the form of outfitting my car with an FT-100 HF+VHF transceiver. I had previous experience running 10-meter DX from my car using an HF radio to a mag-mount 1/4-wave, 10-meter vertical. This setup was great for working new countries on my lunch hour. I knew a similar approach could be used for 6 meters.

Initially I used a 1/4-wave vertical on 6 meters from the car at my work QTH. This setup was suitable for working sporadic-*E* from my car during the summer. Often during my lunch hour I set up and took down a two- or three-element Yagi beam on mast sections. However, this was very time consuming. In addition, during the fall of 2000 I discovered that the vertical was not always very good for the marginal *F2* openings, and working weak signals was very difficult, let alone breaking pile-ups.

In response to these dilemmas I built a lightweight, two-element Yagi beam antenna using a broomstick as the mast and telescoping car antennas as the elements (see figure 1). I do not use a matching section, but the purist could add a tuning stub.

By the end of 2000 I started to arrive at work early, and I decided to hang this lightweight, two-element Yagi pointed east from a pine tree in the corner of the parking lot. To hang the antenna in the tree, I threw a small Crescent wrench that was attached to the Teflon line holding the antenna over the branch of the pine tree. From late October 2001 through early March 2002 I performed this ritual every morning at 6:30 in the parking lot. Fortunately, the winter was very mild in the northeast, and I was able to put up the antenna during the entire time.

The portable antenna arrangement first paid off on December 29, when I worked GMØEWX in Scotland. A few days prior to that I could not work this station using a vertical. The beam also was ready to go during my lunch hour or during the day if I got a quick ten-minute break (the break usually was dictated by spots on internet sites, such as NA1CW's site). In the morning I contacted stations in Europe with the beam pointed east. By noontime I generally changed the direction of the beam from east to west, following the path of the sun and subsequently the *F2* propagation.

Typically, the antenna was only up 10 feet at best, and usually I was running 60 watts or so off the battery. Even so, because conditions were fantastic every day, I knew that in general I was going to contact someone with this setup. I knew I always had a fighting chance at any DX that came along on 6 meters.

The east-west *F2* skip was so consistent on 6 meters during this time period that it now has become historical in the annals of amateur radio. Six meters proved to be a legitimate DX band, and all sorts of "firsts" were made between different countries.

The payoff for me was tremendous. I added to my country total, and my grid-square total, on 6 meters. Somehow, though, getting the several new grids seemed secondary to the new countries I worked. By the time the *F2* season finally faded in March, I had worked over 150 stations and 10 new countries from my work QTH over the course of the season.

I did not have to miss out on the action while I was mobile either. During the *F2* season I was able to work 83 stations via *F2* skip and three new countries. While I was mobile or while I was parked in a parking lot other than the one at work, I used my mag-mount 1/4-wave vertical; my power was typically 60 watts. The *F2* was quite strong at times during November, January, and February, so much so that the amount of power or the type of antenna I used hardly mattered. I ran QRP at times (10 watts or less), and I worked some stations in Washington, Oregon, and British Columbia. These stations were running less than 5 watts.

I also went on a short trip to Nevada at the end of November. I brought along a portable setup for use with the rental car—my FT-690 radio at 10 watts output along with a mag-mount telescoping vertical. I managed to work a few DX stations, including VP5/K5CM and K2KK/6Y5, while mobile in the Las Vegas area.

During one excursion into Death Valley I heard the beacon from Maine. I promptly worked VE1YX while I was traveling between two different grids (DN16 and DN17). Ten watts and a vertical is not a particularly optimal setup, but it worked because the *F2* conditions were so good.

TI9M

I mentioned some of the highlights of the season in the first section of this article. However, the contact with TI9M on March 1 is interesting to examine in detail.

After February 6 the *F2* activity, particularly the east-west skip, died down significantly for 6 meters in the mid-lat-

Thoughts about 6-Meter *F2* Propagation Possibilities for Fall 2002

By the time you read this, hopefully we will have gone through another productive summer sporadic-*E* season in the Northern Hemisphere. The many operators who experienced the past *F2* season have become more accustomed to listening for DX via double-hop and triple-hop sporadic-*E* during the summer months. Now we direct our thoughts to what may happen on 6 meters this fall with regard to propagation.

Certainly we can expect an aurora opening or two during September and October to keep things interesting. The daily solar-flux values most likely are going to be lower than they were a year ago when we had that fantastic *F2* season. There is no expectation of *F2* openings occurring on a daily basis during November or December as we did in 2001, except if there is a triple-peak configuration for this cycle!

I suspect that most of the *F2* will be in the southern areas of the Northern Hemisphere. South Florida, southern Spain, and so forth, will have *F2* propagation into areas south of them during the early part of the fall.

It will be interesting to monitor how high the solar flux values become during September and October. This information may provide the best clues as to what can be expected with regard to *F2* propagation for the following months.

itude regions of the U.S. I then debated the value of putting up the antenna every morning if there was nothing to work.

The TI9M expedition left for Cocos Islands at the end of February, with Matt de La Hunt, KAØKKO, a full-time 6-meter operator. He monitored the band as well as the 6-meter liaison frequency on 10 meters (28.885 MHz). Every day during the last week of February there were scattered reports on the chat pages that the expedition was working into some parts of the U.S. and Canada, but the signal strength was very weak.

Finally, on March 1, I saw a report that TI9M worked W1AW, the ARRL station in Connecticut, which is located about 100 miles north of me. At this point I ran out to my car, and I was happy to hear TI9M coming in with a decent signal strength on 50.110 MHz. He was heard for about 15 minutes into my area. After two tries I was able to contact him on SSB.

Here both the tools of the internet and having a portable beam setup made the difference. To think that I almost did not set up the beam that day! The lesson to be learned here is that it is worth a little time and inconvenience to work a new country on 6 meters, even if the band is only open for very short periods of time.

Totals and Observations

The combined portable and mobile effort accounted for 230 contacts, which represents 60 percent of the 330 contacts I made on 6 meters via *F2* propagation over the season. I was able to get my DXCC total on 6 meters up to 63 countries because of the extra effort in setting up a portable antenna every day. In my opinion, a mobile/portable presence was definitely very helpful for anyone on 6 meters. I will be using this same setup for the summertime sporadic-*E* season, which runs from May through August here in the Northern Hemisphere. Also, I will again monitor the internet.

Mobile and portable operation can be very helpful in achieving goals such as DXCC on 6 meters. The process of going to work (commuting and being at the job) can consume 10 hours of prime time during the day and the peak hours of *F2* propagation throughout the season. The methods I have described here worked for me, and they could work for other serious 6 meter operators.

It is amusing to see some propagation columns in other magazines trying to predict 6-meter *F2* or sporadic-E openings based purely on information collected from packet cluster reports! As most veteran 6-meter operators will tell you, 6 meters is unique when compared with the other amateur radio frequencies.

The conventional HF-bands prediction methods for tracking the MUF do not apply to 6 meters, and for now, methods using actual observations will provide the foundation of our new knowledge of how to work the band. The value of making first-hand observations on 6 meters cannot be emphasized enough, as proven by the data that was collected during the past fall and winter seasons.

Band Etiquette

During this record-breaking season I noticed that many 6-meter stations spread out over the entire band during the *F2* openings. Some of the big U.K. signals, such as GMØEWX, were above 50.200 MHz when the band was crowded.

The proposal of five years ago to expand the DX window or to move the 50.125 MHz domestic calling frequency really seemed to be a moot point, because the DX was everywhere on the band. Hams spread out like they do on 10 meters when that band is filled with activity. Based on what many of us observed, it is my opinion that the need to implement a new band plan is unnecessary if hams continue to spread out.

There were major pile-ups, but I observed no inadvertent interference from domestic operators talking to other domestic operators near the DX station's frequency. Also, there were so many DX operators calling CQ that it did not make much sense for U.S. stations to call CQ DX very often. Everyone who looked for DX was able to find it somewhere on the Magic Band! ■

A Simple-to-Build 2-Meter Antenna Tuner

Here is a simple project that you yourself can build, or you can make into an evening-long club project. W2OQI describes a straightforward antenna tuner for 2 meters† constructed from easily obtainable parts.

By Van R. Field,* W2OQI

Why build a VHF antenna tuner? After all, you buy a rig, an antenna, some coax, put it all together, and people talk to you! However, would more QSOs result from more power to the antenna?

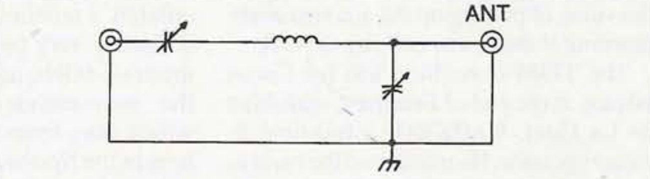
The serious VHF-UHF operator, whether on FM or SSB, needs to take a look at the SWR at the rig. If you use a beam cut for the SSB end of the band, what happens on 147 MHz? Get a reasonable SWR bridge and look. Some of the newer rigs have them built in.

I decided to tackle the problem when I put up a beam for SSB. I forgot that when I built it, I was thinking FM and 147 MHz. On the low end, the SWR was high enough to fold back the power on my rig. Rig manufacturers protect your equipment by building the equipment so that the power automatically cuts back when the SWR rises. If your antenna doesn't take the power, then the transistors in your rig heat up, and with no fold-back circuit they will overheat and burn out!

**17 Inwood Rd., Center Moriches NY 11934-3335*
e-mail: <wreck_and_rescue@juno.com>

†To take a look at the 6-meter antenna tuner I built, see the "Project Corner" column (p. 63) in the September 1997 issue of CQ VHF.

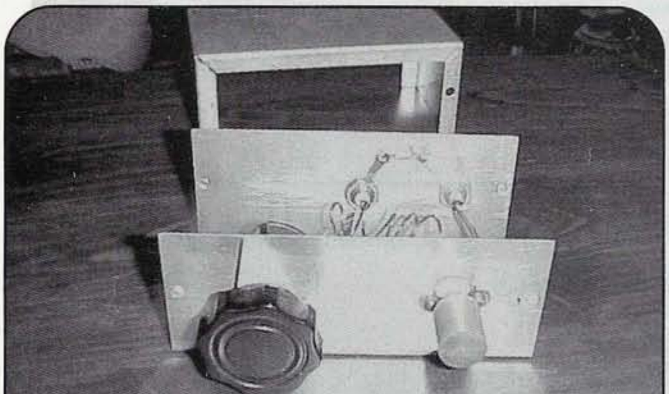
To solve my problem I found two old tuning capacitors about 25 pF each and some #16 wire for the coil. The ground wire from a piece of Romex electrical cable will do. I wound 5 turns on the shank of a 3/8-inch drill bit, and then the hunt was on for



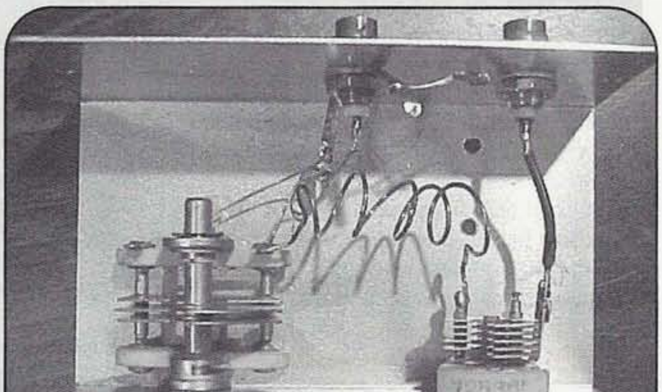
Parts List

2 ea. UHF chassis connector
2 ea. 25 pF tuning capacitors
2 plastic knobs
Short lengths of #16 or #14 solid wire, and #12 wire if you use a plastic box
Box: RadioShack part No. 21-533, or equivalent

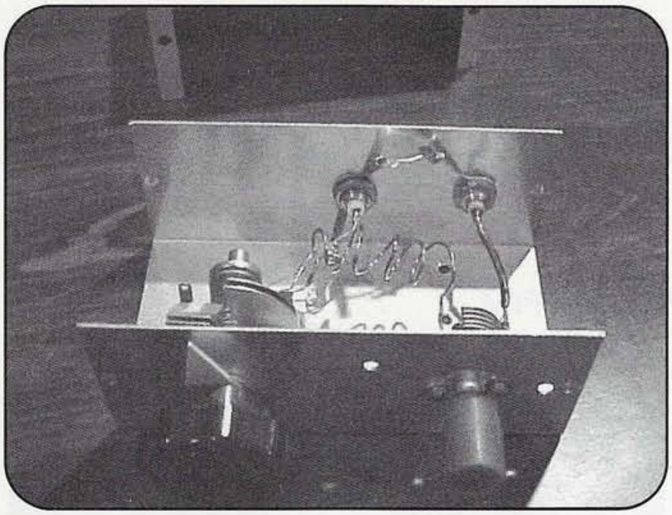
Figure 1. Schematic diagram of the 2-meter antenna tuner. Both capacitors are 25 pF, and the coil is five turns of #16 wire. Coax connectors and knobs are the choice of the builder.



View of the front of the 2-meter antenna tuner showing the junk-box selection of knobs. Note: The shaft of one of the capacitors must be insulated if you use a metal box.



The inside of the antenna tuner showing the simplicity of construction.



Inside view from the back, and the wiring of the input and output connectors.

a box. RadioShack came to the rescue with a $5\frac{1}{4}" \times 3" \times 2\frac{1}{8}"$ aluminum box.

A look at figure 1 reveals that one tuning capacitor is in series and needs to be insulated from ground. A plastic knob will be necessary here. A plastic box might be a better choice to make it easy to insulate the shaft. I used a metal box because I had it. If a plastic box is used, be sure to run a heavy ground bus from the ground side of both connectors. A #12 wire would be appropriate, if you have a soldering iron to handle it.

I used BNC connectors because years ago I standardized my shack to use them. Most hams use UHF connectors. Be careful of cheap ones. The silver-plated variety found advertised in ham magazines is much easier to solder and generally much better built.

It would be handy to include an SWR bridge in the box. However, as simple as the circuits are, they are not that easy to get working. After trying out several circuits, I concluded that an inexpensive RadioShack unit (part No. 21-533) will do fine. It's marked 3–30 MHz, but it seems to work all right through 2 meters. A dummy load can check it for you. A 50-ohm dummy load is a handy piece of shack equipment. If one is available, the tuner may be checked.

Simply adjust each capacitor for the lowest SWR. If the capacitor is all the way open or closed, the coil can be pulled apart or squeezed together to adjust the final inductance. The tuner should adjust to 1:1. It should adjust the same way on your antenna.

Now you can use the same antenna on your all-mode rig. Just don't expect to be able to work much FM with a horizontal beam or much SSB with a vertical antenna. On VHF and above, antenna polarization is all-important. Operator convention dictates that vertical polarization is used on FM and horizontal polarization is used on SSB. When on HF, your signals are bouncing off the ionosphere, and they come back with less clearly defined polarizations. However, rarely does your signal bounce off the ionosphere on 2 meters and above. Therefore, it is necessary to maintain polarization compatibility.

There you have it, a simple 2-meter antenna tuner made from scratch. I trust that building this project will be as fun for you as it was for me. ■

CQ VHF Reviews

The K1EL K10+ CW Keyer Kit

By Simon Lewis,* GM4PLM

As a devoted fan of the CW mode, one of the most useful items in my DX armory is my memory keyer. This very useful tool makes general CW operating effortless and contests a joy, and without a doubt it has increased my QSO rates over the years.

Recently, I was looking to replace my aging TTL-logic-driven keyer with a modern microprocessor-driven unit. After searching the internet looking for a suitable replacement, I was quite horrified to see the prices that some kit suppliers were asking for such items. Surely a simple printed circuit board (PCB) and programmed processor should not cost more than $50?

I was pleasantly surprised when I came across an interesting site run by Steven Elliot, K1EL (http://www.k1el.com). Steven runs a small business that produces a range of kits based on photonic integrated circuit (PIC) technology.

For those of you unfamiliar with the PIC processors, they are a range of quite powerful tiny microcomputers and are contained on small integrated circuits (ICs). Very few additional components are required for most projects, and the devices use very little power, making them perfect for battery operation. They are interesting devices, and there have been plenty of books and articles written on their use.

A search of the internet for amateur radio applications for the PIC will lead you to some exciting ideas. One kit marketed by K1EL, the K10+ electronic keyer unit, caught my eye. The specifications listed show that the kit is packed with features, plus it is only $15. I arranged for one to be sent across from the US.

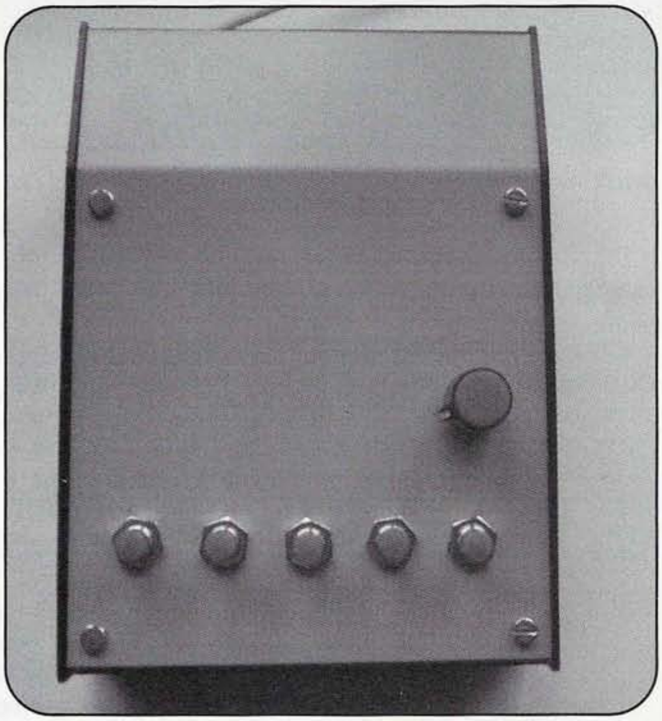
What Do You Get For Your Money?

The answer to the question is not a lot of components—that's for sure! However, don't let that fool you for a minute. That little 1.5-inch-square PCB is a powerhouse packed with technology that really flies!

You can buy a programmed chip and PCB, or you can buy a complete kit containing PCB, programmed chip, and all board-mounted components (this includes the onboard speaker and 5-volt regulator). You supply a case, pushbutton switches, and hardware for mounting the board.

There are four or five pushbutton switches required, depending on whether you choose to use a panel-mounted potentiometer to set and load the keyer speed or simply use key entry to set it. The other buttons are used for entering the command mode and to replay the programmable memories. A small PC-board-mounted piezo speaker is supplied with the full kit, or audio can be fed to an additional audio frequency (AF) amplifier or the rig audio input line.

*Keydata UK Limited, Cambridge House, 8 Cambridge Street, Glasgow G2 3DZ Scotland
e-mail: <Simon.Lewis@keydata.co.uk>



The completed unit.

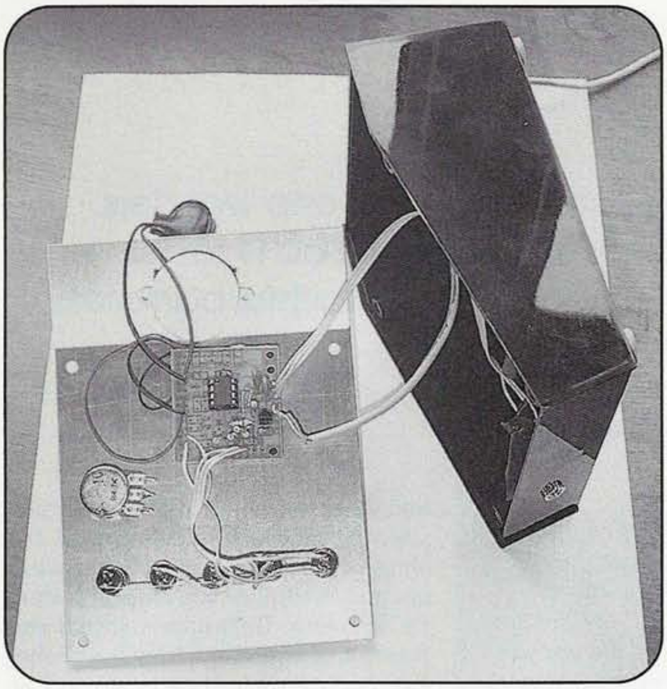
I won't describe building the unit. It should not take more than an hour to build it and can be built by anyone who can competently handle a soldering iron. Comprehensive instructions are supplied with the kit, or they can be downloaded from the K1EL website.

There are a number of construction and powering options for the unit; these are detailed in the instructions supplied. No power switch is required, as the unit will go to "sleep" when not being used and will consume less than 1 µA, so no On/Off switch is needed. That's a good thing, especially if you have ever tried to find a spare set of batteries for the flat ones in the keyer after stumbling out of bed at 4 AM for that early morning sked!

Features Galore!

Now let's take a look at some of the features the K10+ offers.

Okay, so it's a CW keyer and you are expecting that it will do the normal functions of a CW keyer, right? The K10+ will do speeds of 5–59 wpm using Iambic A and B modes. The dot/dash ratio is adjustable; you can swap the sides of the paddles, reduce letter spacings, and select an automatic letter-space mode. The keyer also supports Farnsworth modes. The sidetone frequency can be altered, as can the speed, either from the key or from an external potentiometer. The keyer has all the basic



The K1EL printed circuit board.

K1EL K10+ Keyer Command Set
A - Sidetone on/off
B - Start CW Beacon
C - Set command speed in CW
D - Set fast/slow AFK tail delay
F - Set Farnsworth letterspace
G - Select AF/normal keying
H - HSCW mode enabled
I - Select Iambic mode A/B
J - Select 3:1 or 4:1 Dah:Dit ratio
K - Select straight/iambic mode
L - Load message memory slot online
M - Load message memory slot offline
O - Select Tone or keyed HSCW oscillator
P - Start receive practice session
Q - Query current WPM speeds
R - Review message without transmitting
S - Set CW transmit speed in WPM
T - Key transmitter for tuning
U - Select autospace on/off
V - Start transmit practice session
W - Set keying compensation in milliseconds
X - Exchange paddles
Y - Analog input diagnostic
Z - Select sidetone frequency

Table 1. Keyer commands.

functions you would expect of a good electronic keyer, and believe me, it does them well. However, the K10+ offers a lot more than that.

The keyer also has four memory slots which can hold a maximum of 96 characters in total, and this is where the fun begins. The K10+ has a range of predefined embedded commands that can be inserted into these memory strings. These commands cover standard texts such as NAME IS, QTH IS, and UR RST IS. Embedded commands look like the slash character (DN) followed by a letter. The keyer interprets this as an embedded command and sends the preloaded command's text. Clever!

The keyer is also very useful for DXpeditions and microwave work, as it has a built-in beacon mode which can be programmed for 1–59 seconds delay. Memory slots 1 and 2 can be sent alternately by using more embedded commands, and the transmitter can be keyed to give a key-down tone. I have already used this function for beaconing on 10 GHz, and it's a very useful one.

Entering commands into the unit is very simple. One of the pushbuttons is marked as a command entry, and this button is pressed and held for two seconds. After this time lapse the transmitter keying is disabled, and the unit responds with "R" in the built-in sidetone. The K10+ can then be instructed by entering the command letter in Morse Code. An extended entry is required with some functions, and the K10+ will prompt you by adding an "E" to tell you so! There are 24 commands in total; these are detailed in table 1.

The K10+ firmware also includes a CW send-and-receive practice mode. Entering "P" in the command mode puts the keyer into the practice mode. The keyer then requests a difficulty level. A letter from A to D is entered, "A" being the easiest level and "D" the hardest. Random letters are then sent in groups of five, with a space between them.

In the transmit practice mode the keyer will send a letter and you are required to respond by entering the corresponding letter. The keyer then sends two letters and the same is required from the operator. This continues to three letters and then reverts back to one letter. The mode is designed to increase head copy (as opposed to transcribing what is being heard) and build letter-recognition skills.

A noteworthy feature is the high-speed CW mode (HSCW) used for meteor-scatter (MS) operations. The K10+ can be loaded to run MS routines and will send character strings at speeds of 1000 and 6000 letters per minute (LPM). I won't go into the details of MS operations, but the unit will supply an audio line to a microphone connector for audio keying of a transceiver for MS use. You can program the K10+ to loop your MS message, and it will play it for 1 or $2^1/2$ minutes, depending on whether you are in US or European mode.

In Operation

I built and boxed the keyer in an evening and then spent a few nights practicing how to drive the unit before connecting it to my transceiver. Connecting it to my Yaesu FT-847 was easy. I simply disabled the internal keyer and then connected the K10+ to the key line.

I made myself a small command table, which I affixed to the top panel of the keyer case. This reminds me of all the commands available. Loading memories is easy, and I tend to leave them loaded with strings such as CQ DX CQ DX de GM4PLM GM4PLM GM4PLM K …

I have found the unit to be a joy to use and simple to drive and program. Adding a memory is easy and can be done live very quickly. The price is excellent, with its nearest rival almost four times the cost. Dislikes? None really, except I'd like to see a contest mode that increases the serial numbers incrementally. However, there is very little I could say I don't have.

Overall it's a great little kit and has the place of distinction on my desk. Even more important, it is in use almost daily. It sort of speaks for itself!

The K10+ kit is available for $15 from Steven Elliott, K1EL, 43 Meadowcrest Drive, Bedford, NH 03110 USA. Steve regularly updates the firmware, so keep an eye on the K1EL website at <http:// www.k1el.com>. He also can be reached by e-mail at <k1el@aol.com>. ■

Are Your Batteries Charged?

With all of the different types of batteries on the market, one wonders which battery is best to use for a particular application. Bob Shrader, W6BNB, gives us some idea of what to expect from our faithful batteries, and tells us just how faithful they can be.

By Bob Shrader,* W6BNB

When you recharge a run-down battery—one in a Handie-Talkie, for instance—how do you know when the battery is fully charged? In too many cases, there is no way of knowing whether the battery has been over charged, fully charged, or under charged.

Sometimes, if a charger was made for the equipment in which a battery is being used, the charger either may stop charging when the battery comes up to full charge, or it may drop to a very low trickle charging rate. In too many situations, however, chargers will over charge a battery and shorten its life if the charger is left on for too long.

The Resistance to Charge

To determine the state of charge of some of my HT batteries I devised the following method of stopping the charging at the correct time.

First, when dealing with a battery, consider it as always having some value of internal resistance. The more discharged a battery is, the greater its internal resistance becomes.

The symbol for a battery is normally a series of short and long lines (figure 1A). To be truly accurate, it should be diagramed with a variable resistor inside, because this is the way it actually works (figure 1B).

A "voltage drop" (by Ohm's Law, $E = IR$, where E = volts, I = current in amperes, R = resistance in ohms) will always develop across the internal resistance of a battery whenever current is flowing through it, as when the HT is connected across it. The amount of internal voltage drop will determine the actual terminal voltage that is being provided by the battery to the load connected to it.

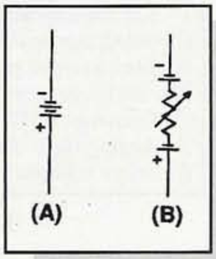


Figure 1. (A) Symbol for a battery. (B) Symbol indicating internal resistance.

When no current is being delivered to a load, the voltage across the terminals of a battery will be at a maximum. For example, when measured with a DC voltmeter, six fully charged nickel-cadmium (NiCd, or NiCad) dry cells in series form a battery that should read 7.2 volts across it (1.2 volts per cell). Unfortunately, it is rare to have two voltmeters read exactly the same. Therefore, always use the same voltmeter when making battery voltage measurements.

The Choice of Voltmeters

Analog DC voltmeters used to measure the voltage of a battery consist of a small moving coil that rotates in the field of a strong fixed magnet. The indicator needle is attached to the coil. In series with this coil is a "multiplier" resistor, which normally is mounted somewhere inside the meter's case. The multiplier resistor value will be whatever is required to produce the desired full-scale DC voltage reading.

A reasonably high-sensitivity DC voltmeter might have a rating of 50,000 ohms-per-volt. Such a 10-volt full-scale-reading meter would have a series multiplier resistance of $R = E/I$, or 500,000 ohms. (The coil resistance in series with the multiplier would be negligible.) A less-sensitive, and usually less-expensive, 10-volt meter might have a 1,000 ohms-per-volt rating and would have an internal multiplier resistance of about 10,000 ohms. Both meters should read the same when testing a fully charged battery, because such a battery has very little internal resistance. Therefore, it has very little voltage drop inside when it is being measured.

The low-sensitivity meter, however, would be drawing 50 times as much current to produce its reading as the high-sensitivity meter. For this reason, the sensitivity of a voltmeter is an important factor. When measuring voltages in high-resistance circuits, the higher the sensitivity, the more accurate the voltage readings will be across resistors.

Sensitivity only refers to the amount of current required to produce full-scale deflection of a meter; it does not refer to the accuracy. A low-sensitivity meter might be more accurate than a high-sensitivity meter in low-resistance circuits.

Because of the greater current required for the low-sensitivity meter, it would produce 50 times the voltage drop across any internal resistance in a battery that is being measured for its terminal voltage. This voltage loss will show up more when measuring the voltage of a less than fully charged battery.

If a battery were discharged to the point where it had a significant internal resistance, a low-sensitivity meter would indicate considerably less terminal voltage than a high-sensitivity meter. In this case, the low-sensitivity meter would be a better indicator of the battery being discharged, although the 50,000-ohm voltmeter should give a more nearly accurate terminal no-load voltage indication. A 100,000-ohm voltmeter would give a more accurate value. An electrostatic

*11911 Barnett Valley Road, Sebastopol, CA 95472
e-mail: <w6bnb@aol.com>

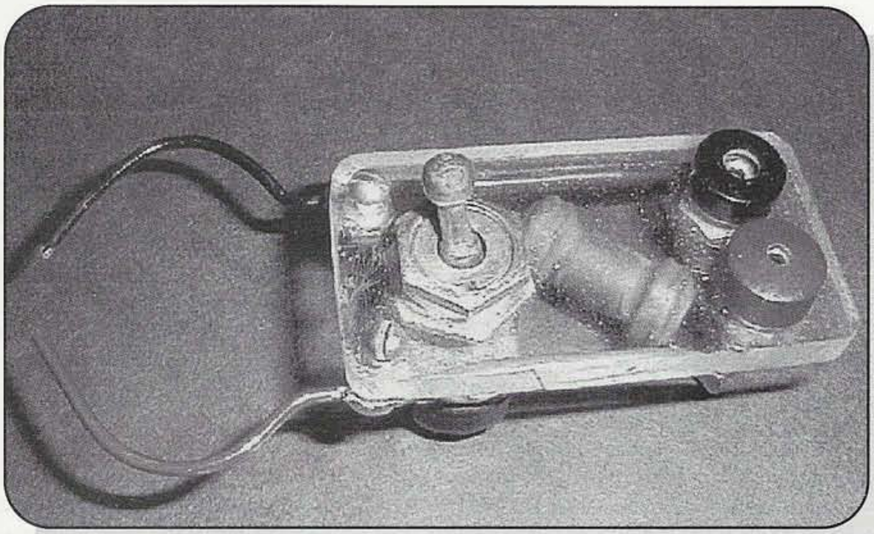


Figure 2. Battery-charge tester.

voltmeter, which requires no constant current flow at all, would give an exact voltage reading, regardless of the state of charge of a high-voltage battery.

Measuring Voltage Drop

Suppose a 5-watt RF power output HT is being used across a battery that has a 7.2-volt fully charged value. When transmitting with the key down, the HT might be drawing 14 watts from the battery. There is a basic power formula, $P = EI$, where P is in watts, E is in volts, and I is in amperes. (This formula is sometimes given as $P = VA$.) By transposing the formula, the current drain from the battery under transmit conditions can be determined. Using $P = EI$, but transposing it to read the current value, or $I = P/E$, the current flow should be 14/7.2. Therefore, the drain on the battery by the 14-watt load, when the battery is fully charged, would be 1.94 amps.

Under transmitting conditions, even with a fully charged battery, if the HT terminal voltage of the battery above is measured with a DC voltmeter, the indication should be a little less than 7.2 volts, because all batteries, even when fully charged, have some internal resistance.

If the battery above was discharged to the point that it developed 1-ohm internal resistance, and if it was still drawing 1.94 amperes (which it would not, because the battery-terminal voltage would no longer be the full 7.2 volts), the internal voltage drop would be something like $E = IR$, or 1.94(1), or 1.94 volts. Subtracting 1.94 volts from the unloaded 7.2 volts results in a battery-terminal voltage of 7.2 volts less about 1.94 volts, or about 5.26 volts! This voltage level might not operate the HT's transmitter at all, although the receiver section may still work almost normally, because the receiver section draws so much less current. With less current being drawn, there would be less voltage drop inside the battery, thus providing a more nearly full-battery-terminal voltage for the receiver section.

The fact that an HT's receiver is working does not mean that its battery is charged! If its transmitter does not work, assuming there is nothing else wrong with the transmitter, the battery simply should be recharged.

The resistive load produced by the HT while operating with the battery fully charged (according to Ohm's Law, where $R = E/I$, or $R = 7.2/1.94$) would be 3.71 ohms. If a 3.71-ohm wire-wound resistor instead of the transmitter was connected across the discharged battery, and if the voltage across the resistor was measured, it would read the working voltage. If the working voltage is considerably below the no-load voltage, the battery should be put on charge.

Recharging the Battery

Once a battery is on charge, the charger should be disconnected, perhaps every 15 minutes, and the battery's voltage should be read using the voltmeter and resistor load. The battery should read closer to its fully charged voltage after each 15-minute charging interval. By checking every 15 minutes, two different test readings eventually will indicate the same voltage. This voltage should be very close to the no-load battery voltage, which indicates that the battery is essentially fully charged. One more charging interval could be used just to make sure the battery is fully charged.

Because chargers and batteries differ considerably, a charging test interval of 30 minutes might work out better than a 15-minute interval; perhaps a 45-minute interval or a one-hour interval might be best. The test interval used might be the one that requires about five test intervals to produce a full charge.

The battery also could be tested for its state of charge by using some value of resistance other than the fully charged resistance load value. In the case above, perhaps a 5-ohm resistor with a voltmeter in parallel across it might be used. If there is a noticeable voltage drop, the battery should be recharged.

Rather than connecting a resistor across the voltmeter for tests, I made up a two-wire battery-contacting device on an insulating board (figure 2). The illustrated model uses clear plastic to allow both top-side and bottom-side parts to be visible. A 5-ohm wire-wound resistor is visible on the underside of the plastic oblong. A small sheet of any type of insulating material would work just as well as the plastic.

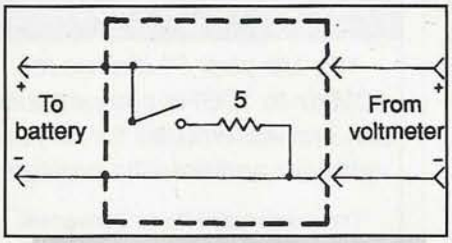


Figure 3. Diagram of a battery tester.

On the insulating board mount an ON/OFF push switch (the round object in the center of the illustration) and (at the right) two single-pin jacks (sockets) into which the voltmeter test leads can be plugged. Note that the black-painted, negative-wire test lead is connected to the negative, black voltmeter jack, and the lighter colored (red) lead is connected between the normally red positive meter jack and the lighter colored (red) battery test contact. The parts are connected as shown in figure 3.

The two bare #14 copper-wire contacts at the left are to be held against the two terminals of the battery. The spacing can be varied as desired merely by bending them to make proper contact with the cell or battery terminals. The wires might be made longer than shown, depending on the battery or cell on which they are to be used.

Testing for the Charge State

To test for the state of charge of a battery, first hold the two wire contacts against the two battery terminals to read the unloaded voltage of the battery. When the switch is pushed, the battery will be loaded by the resistor, providing a well-loaded voltage value. If these two voltages are essentially the same, the battery must be in a reasonably charged condition. Whenever the test resistor loaded battery or cell voltage reads noticeably below the unloaded voltage, recharging is probably required.

Always be sure that the negative lead of the charger goes to the negative battery terminal, and the positive lead goes to the positive terminal. The charger voltage must always be greater than the fully charged battery voltage in order to force current backward through the battery during charging. This reverses the battery's normal discharge chemical action with rechargeable-type batteries.

When first taken off charge, all good batteries will read a higher than fully charged voltage for perhaps up to an hour or so. For example, the voltage of a normal fully charged NiCad cell is 1.2 volts, although right after charging, it might read 1.25 or even 1.3 volts. A NiCad cell that has been sitting unused for any great length of time should be recharged if its terminal voltage has dropped to 1.1 volts.

The 7.2-volt NiCad battery mentioned above should be recharged if its unloaded voltage ever drops to 6.6 volts. For HTs to be used in emergency situations, the battery should be kept nearly at its fully charged voltage at all times.

If a battery ever fails to hold its rated full-charge voltage after a few hours of non-use, it is probably worn out and should be replaced. If the battery is tested with the meter and load above, it probably will show a material drop in voltage. Before discarding the battery, make several attempts to charge it.

The same theory of voltmeter/resistor testing described above can also be used with a 12-volt automobile battery. A 1-ohm resistor might be used to develop a reasonably heavy test load of 12 amps. For a 12-volt battery, the power rating for the resistor should be about $P = E^2/R$, or 144/1, or 144 watts. Actually, a 100-watt, or even 50-watt, wire-wound resistor probably would be satisfactory if the voltage testing takes only a second.

The switch must be able to carry a current of at least 12 amperes when it is held closed for the one second required to get the loaded voltage reading. Care should be taken not to touch the resistor when testing for loaded voltage readings, because it will become quite hot!

Measuring Battery Charge State By RF Power

It is also possible to measure the state of charge of a battery-operated transmitter or transceiver by its RF power output as indicated by a simple field-strength meter mounted at a fixed position and distance from the transmitter's antenna. First check the field-strength meter indication when the battery is fully charged. Then note the field-strength indications as the battery becomes more and more discharged, down to the point where the equipment stops working.

The field strength will indicate when to recharge the battery. Disconnect the charger, and check the field-strength readings at intervals by turning on the transmitter for a 10-second transmission to provide a reading on the field-strength meter. Continue charging until the fully charged RF power-output value is shown on the meter.

Usually, if the field-strength indication drops at all during any 10-second transmission, the battery is not near full charge. Such a simple, fixed-in-place field-strength meter will only work if the transmitting equipment is operating with a fixed-in-place antenna. Because an HT is usually hand-held and thus not held steady, it can be difficult to make such measurements accurately unless the HT is returned to the exact same position, in a fixed holder perhaps, whenever measurements are taken.

A simple field-strength meter might consist of a 12- to 24-inch wire whip antenna attached to a grounded high-sensitivity DC voltmeter preferably with a germanium diode (although a silicon diode will work) across the meter, as shown in figure 4. Also, the diode could be connected in series with the meter. A 50k-ohm potentiometer will provide a control on the sensitivity of the meter indications. Always use the same transmitting frequency when making such tests.

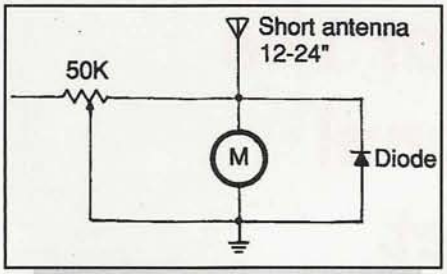


Figure 4. Simple field-strength meter.

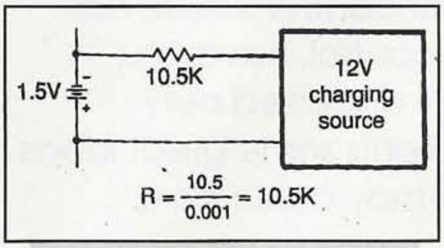


Figure 5. Simple 1-milliampere charging circuit for a 1.5-volt cell.

Anomalies of Charging Different Battery Types

While there is some discussion on the subject, apparently NiCad batteries should always be almost completely discharged before recharging. These batteries are said to have a voltage "memory." If they are not almost completely discharged before recharging and are not fully recharged, the next time they are put on charge they may only come up to the last highest charged voltage value. The newer rechargeable nickel metal hydride (NiMH) high-capacity batteries can be charged at any time without having been fully drained, as can lead-acid batteries.

While discussing battery charging, it should be stated that the common carbon-zinc 1.5-volt dry cell is not supposed to be rechargeable. Normally, when it runs down it should be replaced. If one desires to try to recharge any such cells or batteries, try a very low charging rate, perhaps 5 milliamperes for the smaller size cells and 15–20 mA for the larger sizes.

At intervals check the state of charge by the cell's terminal voltage. The fully charged voltage of a new dry cell is 1.51 volts, but when recharged it may read 1.51 volts or higher. Even so, the cell rarely will hold that voltage after an hour or so, nor will such a cell operate for very long, although some manufacturers' cells seem to hold a charge better than others.

A simple charging circuit is shown in figure 5. To determine the value of the resistor value, use Ohm's Law, $R = E/I$, where E is the difference between the charging-source voltage and the fully charged cell voltage, and I is the desired charging current.

Some discharged wristwatch cells may be given a 1 mA charge for four to eight hours and as a result provide useful operation for days, or weeks, or at least until a new cell can be obtained. However, some of these cells will not recharge at all.

If any so-called "dry" cell or battery ever shows any signs of leakage, it should be discarded at once before the internal liquid chemicals eat through the cell's casing any further and damage the equipment in which the cell or battery is being used. Along the same line, if battery-operated equipment is not to be used for any extended length of time, all cells or batteries should be removed, because they eventually will discharge themselves and most likely leak. The minimum "shelf life" of dry cells or batteries usually is indicated on the packaging, although they probably can be expected to operate fairly well for some time after that date, provided they have been kept reasonably cool and show no leakage. ■

Improved Results for the Directed Directional Weak-Signal Net

Have you ever tried to check into a weak-signal net only to have to work through an HF-type pile-up, then find out that the net control station has his antenna pointed away from you? Or, as the net control, have you ever had trouble managing a geographically widely dispersed net? *CQ VHF* Features Editor Gordon West, WB6NOA, presents some great ideas on how to hold down the confusion that sometimes may occur on a weak-signal net.

By Gordon West,* WB6NOA

West Coast 2-meter SSB weak-signal net controllers typically may pull in over a hundred stations. With a directed directional net, this can be accomplished in less than an hour!

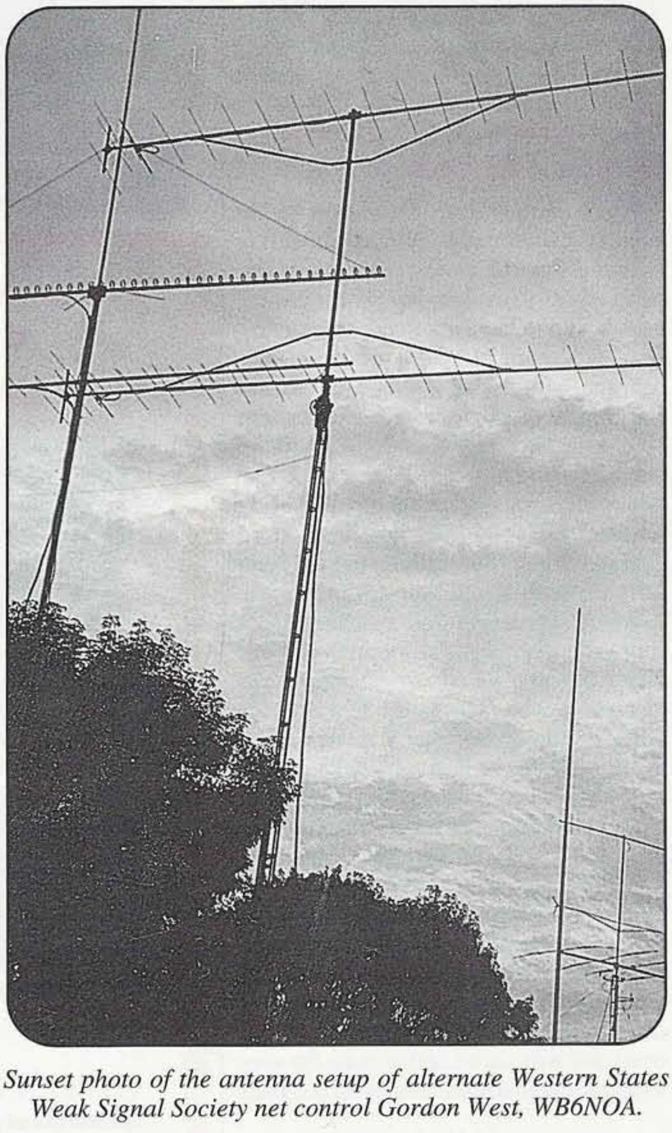
The weak-signal nets normally begin with news and announcements. Net control will start with the news that he or she knows. The net control then will ask for any net station with additional news to tell the story briefly. The net control may paraphrase that announcement so that everyone can hear.

When it comes time for roll call, everyone tuned into the net most certainly wants to check in and be acknowledged. If roll call is carried out alphabetically, everyone has an approximate idea of when he or she may be called. However, the problem that the operator of a big-antenna net control station has is continually rotating the beam to pick up the first station down south, the second one maybe due north, and the third station to the east. By the time the net is finished, the rotator is probably as hot as a firecracker.

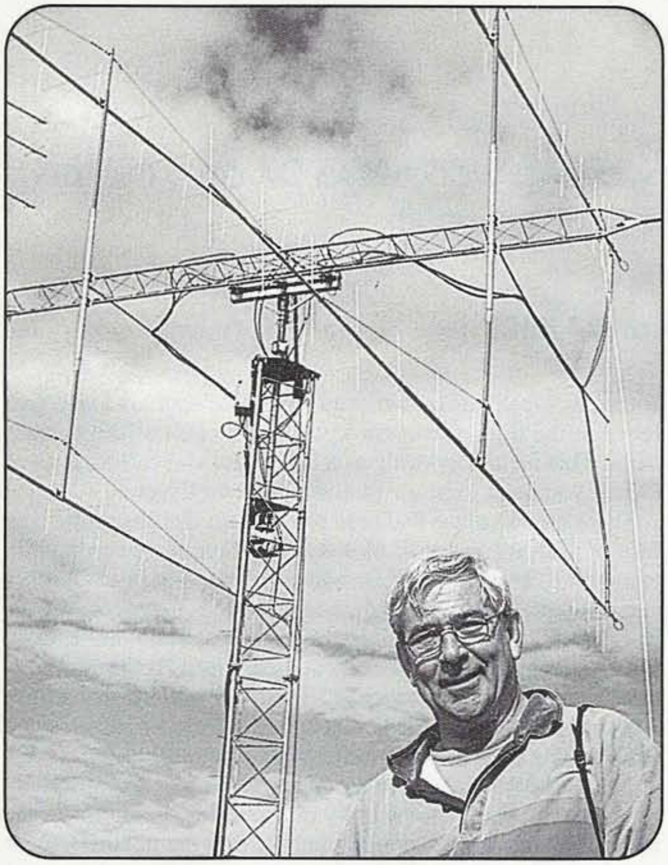
One technique adopted by Sidewinders on 2 and Western States Weak Signal Society Northern California Net Manager Larry Hogue, W6OMF, is to call roll by geographic sectors. He begins by calling those stations he knows he can hear and who can hear him, regardless of his beam direction. Once Larry checks in the "locals," he then runs a directed net roll call to the north, then to the east, then to the west, and about 55 minutes later, to the south. This method allows the more distant stations to anticipate when the net control operator is going to turn the big beams in their direction. It might also allow time for those distant stations to conduct their own roll call, and then stand by for the more distant net control station to come up on the frequency.

Here in southern California, David Peters, KI6FF, became so popular with his every-Sunday-evening Western States Weak Signal Society 2-meter SSB net that when he called for anyone

*CQ VHF *Features Editor, 2414 College Dr., Costa Mesa, CA 92626*
e-mail: <wb6noa@cq-vhf.com>



Sunset photo of the antenna setup of alternate Western States Weak Signal Society net control Gordon West, WB6NOA.



Western States Weak Signal Society Northern California Net Manager Larry Hogue, W6OMF, pictured with his antenna farm in the background.

wishing to check in, the pile-up was several minutes long. Signals were coming in all at once from any and all directions. As a result, David adopted the directed net by calling stations alphabetically, and by calling them in sectors, as he aimed his beam in their direction. This minimized the pile-up effect and maximized the capabilities for stations hundreds of miles away to squeak in a signal on 2 meters SSB, knowing they would have a good chance of getting through because his powerful beam antenna would be headed in their direction.

This net control plan has worked out so well that David has almost doubled the amount of net check-ins, regularly picking up new visitors. Many times he will get signals coming in from the desert, one or two states away!

If you're running a weak-signal 2-meter, 222-MHz, 432-MHz, or 1296-MHz SSB net, do consider alphabetical call-ups by sector, pausing after each sector's known check-ins with a call for visitors. You might be surprised by how many more new stations you will pick up that will regularly join in on your weak-signal net. It surely beats saying, "Okay, that's the news, and now who would like to check in?" only to be hit with two or three minutes of a major pile-up with not a single call getting through. Direct the net, make it directional, and stand by for some surprising long-range signals.

Western States Weak Signal Society website: <http://www.wswss.org>; callsign W6WSS. ■

The 6-Meter CQ WAZ Award

One way of achieving recognition for working worldwide DX on 6 meters is by attaining CQ's 6-Meter Worked All Zones award.

By Paul Blumhardt,* K5RT

In early 2001, after quite a bit of discussion with the VHF DX community, CQ created a 6-meter version of the popular Worked All Zones award. Interest in the award has been high. As can be seen below, we have issued over fifty 6-Meter WAZ award certificates as of September 1, 2002!

The challenge of working the required 25 zones on 6 meters is formidable. If we compare 6-Meter WAZ to 160-Meter WAZ (also very difficult to attain), we quickly realize that 6-Meter WAZ represents a level of dedication that is an order of magnitude higher.

The 160-meter band has DX openings many times each year. High QRN levels as well as the requirement for specialized receiving antennas and large transmitting antennas make the 160-Meter WAZ award difficult to achieve. Even with those obstacles, working all 40 zones on 160 meters is possible with a few years of work. As of this writing, 60 operators have confirmed all 40 zones on 160 meters.

On the other hand, 6 meters is basically dead for about six years out of the sunspot cycle. That's where the dedication comes in. Openings on 6 meters tend to be short and selective (even at the high end of the cycle); you can't afford to miss them. This means listening to a lot of hiss and calling a lot of CQs if you want to be a successful 6-meter DXer.

There are two areas that hold promise for the times when the face of Old Sol is not so blotchy. The first is we continue to learn more about propagation with every passing year. Obscure and unnoticed openings are being revealed. For example, we have witnessed an incredible path between KH6 and Europe via the South Pole which occurs at the equinox. Is this path present at the low end of the cycle? Time will tell. Meteor scatter is also a propagation mode that some can use to garner some 6-Meter WAZ QSOs when the band otherwise would be closed.

The second area that holds promise is the increasing activity on 6 meters. With more activity on the band, coupled with the means of getting the word out quickly (via the internet), more people are listening to the band and announcing openings.

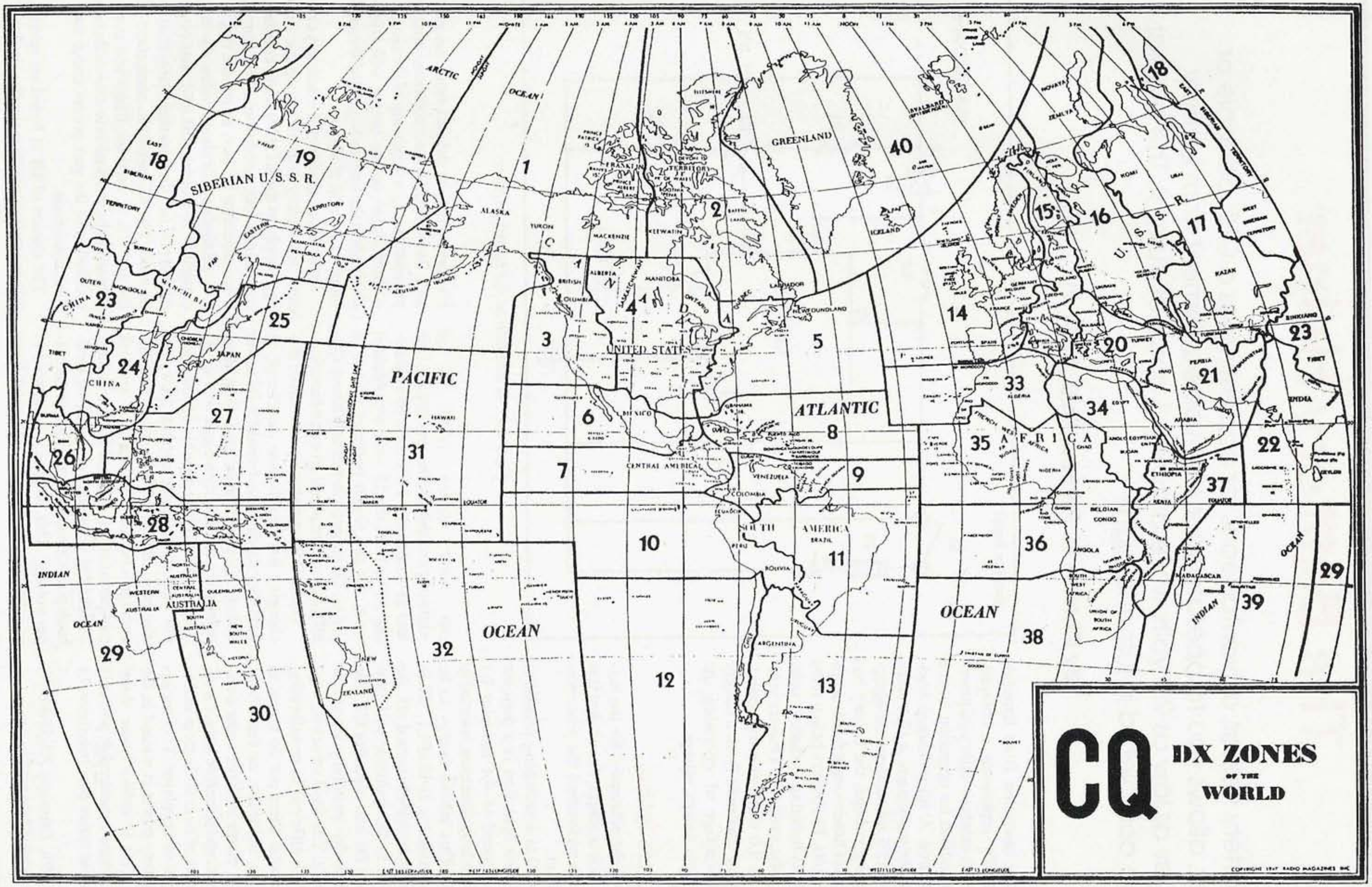
The list below shows those stations that have reached the minimum requirement of 25 zones confirmed. It also shows which zones they need in order to confirm all 40.

Who will be the first to confirm all 40 zones on 6 meters?

*CQ WAZ Award Manager, 2805 Toler Road, Rowlett, TX 75089
e-mail: <k5rt@cq-amateur-radio.com>

6-Meter WAZ Awards Issued Through September 1, 2002

No.	Callsign	Needed Zones
1	N4CH	16,17,18,19,20,21,22,23,24,25,26,28,29,34,39
2	N4MM	16,17,18,19,20,21,22,23,24,26.28.29,34,39
3	JI1CQA	2,18,34,40
4	K5UR	2,16,17,18,19,21,22,23,24,26,27,28,29,34,39
5	EH7KW	1,2,6,18,19,23
6	K6EID	16,17,18,19,20,21,22,23,24,26,28,29,34,39
7	KØFF	16,17,18,19,20,21,22,23,24,26,27,28,29,34
8	JF1IRW	2,40
9	K2ZD	2,16,17,18,19,21,22,23,24,26, 28,29,34
10	W4VHF	2,16,17,18,19,21,22,23,24,25,26,28,29,34,39
11	GØLCS	1,2,3,6,7,12,18,19,22,23,25,28,30,31,32
12	JR2AUE	2,18,34,40
13	K2MUB	16,17,18,19,21,22,23,24,26,28,29,34
14	AE4RO	16,17,18,19,21,22,23,24,26,28,29,34,37
15	DL3DXX	1,10,18,19,23,31,32
16	W5OZI	2,16,17,18,19,20,21,22,23,24,26,28,34,39,40
17	WA6PEV	3,4,16,17,18,19,20,21,22,23,24,26,29,34,39
18	9A8A	1,2,3,6,7,10,12,18,19,23,31
19	9A3JI	1,2,3,4,6,7,10,12,18,19,23,26,29,31,32
20	SP5EWY	1,2,3,4,6,9,10,12,18,19,23,26,31,32
21	W8PAT	16,17,18,19,20,21,22,23,24,26,28,29,30,34,39
22	K4CKS	16,17,18,19,21,22,23,24,26,28,29,34,36,39
23	HB9RUZ	1,2,3,6,7,9,10,18,19,23,31,32
24	JA3IW	2,5,18,34,40
25	IK1GPG	1,2,3,6,7,10,12,18,19,23,24,26,29,31,32
26	W1AIM	16,17,18,19,20,21,22,23,24,26,28,29,30,34
27	K1LPS	16,17,18,19,21,22,23,24,26,27,28,29,30,34,37
28	W3NZL	17,18,19,21,22,23,24,26,27,28,29,34
29	K1AE	2,16,17,18,19,21,22,23,24,25,26,28,29,30,34,36
30	IW9CER	1,2,6,18,19,23,26,29,32
31	IT9IPQ	1,2,3,6,18,19,23,26,29,32
32	G4BWP	1,2,3,6,12,18,19,22,23,24,30,31,32
33	LZ2CC	1
34	K6MIO/KH6	16,17,18,19,23,26,34,35,37,40
35	K3KYR	17,18,19,21,22,23,24,25,26,28,29,30,34
36	YV1DIG	1,2,17,18,19,21,23,24,26,27,29,34,40
37	KØAZ	16,17,18,19,21,22,23,24,26,28,29,34,39
38	WB8XX	17,18,19,21,22,23,24,26,28,29,34,37,39
39	K1MS	2,17,18,19,21,22,23,24,25,26,28,29,30,34
40	ES2RJ	1,2,3,10,12,13,19,23,32,39
41	NW5E	17,18,19,21,22,23,24,26,27,28,29,30,34,37,39
42	ON4AOI	1,18,19,23,32
43	N3DB	17,18,19,21,22,23,24,25,26,27,28,29,30,34,36
44	K4ZOO	2,16,17,18,19,21,22,23,24,25,26,27,28,29,34
45	G3VOF	1,3,12,18,19,23,28,29,31,32
46	ES2WX	1,2,3,10,12,13,19,31,32,39
47	IW2CAM	1,2,3,6,9,10,12,18,19,22,23,27,28,29,32
48	OE4WHG	1,2,3,6,7,10,12,13,18,19,23,28,32,40
49	TI5KD	2,17,18,19,21,22,23,26,27,34,35,37,38,39
50	W9RPM	2,17,18,19,21,22,23,24,26,29,34,37
51	N8KOL	17,18,19,21,22,23,24,26,28,29,30,34,35,39
52	K2YOF	17,18,19,21,22,23,24,25,26,28,29,30,32,34
53	WA1ECF	17,18,19,21,23,24,25,26,27,28,29,30,34,36
54	W4TJ	17,18,19,21,22,23,24,25,26,27,28,29,34,39



ADDENDUM TO WAZ MAP

All Sakhalin Island and the Russian Kurile Islands are now in Zone 19. Zone 19: Eastern Siberian Zone—UAØ (C, D, F, I, J, K, L, Q, X, Z). Zone 25: Japanese Zone—HL, P5, and JA.—*April 1995*

The Battery Helper

This battery helper, advantageous for contesting as a QRP portable or a rover, allows you to operate your 13.8-volt equipment from battery voltages as low as 9.0 volts while drawing 3 amps of current. The project can be completed in just one night.

By Charles W. Pearce, Ph.D.,* K3YWY

Portable operation from batteries generally represents a compromise, as amateur radio equipment is usually specified for operation from a 13.8-volt source. A fully charged lead-acid battery generally starts at 12.6 volts. Given even a 15% tolerance on the equipment operating voltage, the battery has only 0.9 volts of headroom before it drops below 11.7 volts. The battery helper fixes this problem by boosting the battery voltage to 13.8 volts, even with a battery voltage as low as 9.0 volts, thereby extending the time of operation from a battery with the advantage of operating the equipment at its design voltage.

Circuit Description

Figure 1 is the schematic for the battery helper. It is a simple circuit, but it is worthwhile to understand the principles of its operation.

The LT1070 is a switching regulator. The basis of its operation is a periodic shorting to ground of the inductor L1 through a switching transistor, internal to the LT1070. This allows energy to be stored in the magnetic field of L1. When the switching transistor is turned off, the energy stored in the inductor will flow through diode D1 into capacitor C1. The rate at which the switching occurs is around 40 kHz. The ideal switching regulator is 100% efficient in transforming voltages, because there are no losses in ideal switches, inductors, or capacitors. Actual circuit elements have some parasitic resistance, and therefore induce loss, but efficiencies of over 90% are possible with this style of regulator. This means very little battery power is wasted in the conversion. This is unlike linear shunt regulators,[1] where considerable power is dissipated in the series pass transistor. In our rover station (visit us at <http://www.thegridrangers.org>), we had generated the 13.8 volts by regulating down from the 18 volts we obtained from 12- and 6-volt batteries placed in series. This approach was only about 75% efficient and required an extra battery.

*410 South 12th, Emmaus, PA 18049
e-mail: <cpearce@fast.net>

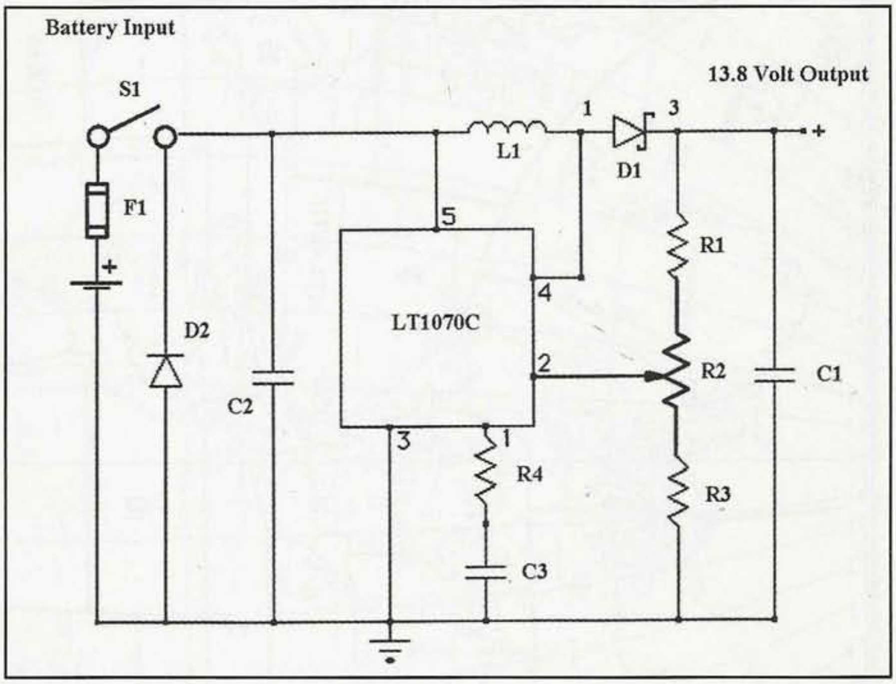


Figure 1 . Schematic of the battery helper.

Diode D1 keeps the capacitor from discharging backwards into the circuit. A Schottky diode is preferred for its lower voltage drop and faster switching characteristics, but a silicon diode will work. This diode must be capable of handling not only the average current draw, but also peak currents of up to three times the average current. The resistor network composed of R1, R2, and R3 is a voltage divider that provides a signal to the feedback pin to maintain regulation of the output voltage. This voltage is compared to an internal reference of 1.244 volts. Fuse F1 should not be deleted from the project. Even if you have a polarized plug to prevent the reverse biasing of the circuit, a short circuit on the output will effectively short the battery to ground through inductor L1 and diode D1.

Input filter capacitor C2 is not very critical, and mainly is used to keep the voltage supply to the LT1070 fairly constant under transient conditions. The output filter capacitor C1 acts to reduce ripple. The minimum calculated value for this capacitor is around 250 μFd, but good design practice dictates that a larger value be used. The RC network, comprised of R4 and C3, is used for frequency compensation. Its purpose is to ensure that no oscillation of the part occurs under transient conditions.

The choice of L1 is based on several factors, among which is the physical vol-

Part	Value	Source	Part No. or Comment
C1	1000 µFd, 25 V	DigiKey	P5156-ND
C2	470 µFd, 16 V	DigiKey	P5141-ND
C3	1 µFd, 100 V	DigiKey	EF1105-ND
R1	10 kΩ, 1/4 W	RadioShack	5% tolerance
R2	200 Ω, 15T, trim pot	DigiKey	3006P-201-ND
R3	990 Ω, 1/4 W	RadioShack	5% tolerance
R4	1 kΩ, 1/4 W	RadioShack	5% tolerance
D1	10 A, 20 V, Schottky	DigiKey	MBR1045-ND
D2	1 A, 50 V	DigiKey	1N4001GICT-ND
L1	150 µH, 5 A	DigiKey	M9825-ND
IC1	LT1070CT	DigiKey	LT1070-ND
			TO-220 case
F1	3AG, 6 A, 125 V	DigiKey	F124-ND
S1	5 A, 125 V	RadioShack	275-634
H1, H2	TO-220 heat sink	DigiKey	345-1024-ND
Project board	IC PC board	RadioShack	276-150

Table I. Parts list for the battery helper.

ume of the core, which will determine how much power can be delivered. It must be large enough to support the magnetic field that will store the energy without saturating. If you choose to wind your own inductor, you can use the information on toroids in *The ARRL Handbook*[2] to select a core and the number of turns to get the proper inductance. The actual value of inductance can vary by 10% or so, but be sure to use a large core. I tried a T106, mix 1 (blue) core with 50 turns of #20 enameled wire as an alternative to the part in Table I, and it worked fine.

Construction

Table I is the parts list. The parts are readily available from DigiKey (<http://www.digikey.com>) and your local RadioShack. The part numbers are listed for convenience.

Figure 2 shows the battery helper constructed on a project board along with the fuse holder and switch, but with heat sink H2 removed for clarity. You can mount it in a box as a stand-alone unit or inside an existing piece of equipment, which is what I typically have done. If you choose to mount the unit in a metal box, the tab of the LT1070 is at ground, so it can be mounted to the box for heat sinking purposes. Otherwise, use H1 for the heat sink. With the tab of the LT1070C face down and the pins facing you, pin 1 is on the left. The diode specified for D2 comes in a TO-220 package and has the same pinout convention with pin 1 being on the left. Its tab should be kept isolated. Use heat sink H2 for the diode heat sink. Be sure to place trim pot R2 such that it can easily be accessed. Once all the parts have been obtained, this project can be completed in a few hours.

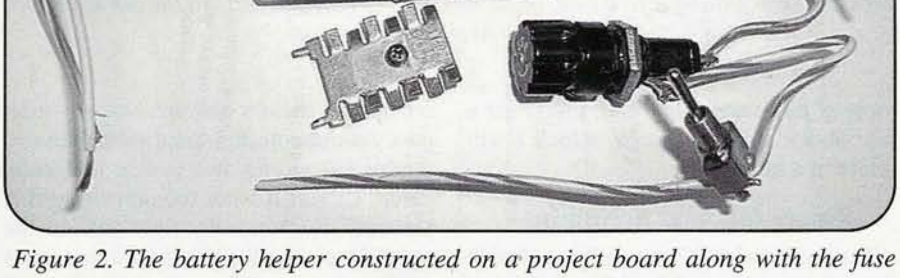


Figure 2. The battery helper constructed on a project board along with the fuse holder and switch, but with heat sink H2 removed for clarity.

It is best to ensure that the current return is through the tab rather than lead 3 of the regulator. This is easily accomplished when using a metal mounting box.

Most commercial DC-to-DC converters are placed in shielded boxes with the leads bypassed to eliminate any RFI. I did not experience this problem, but if you do or choose to use a metal box, you can bypass the leads with 0.1 µFd capacitors rated at 50 volts or better.

Operation and Performance

Without a load, connect the battery helper to a battery and turn on S1. Measure the voltage at the output and adjust trim pot R2 to 13.8 volts. There should be enough range in R2 to adjust for tolerance variations in both resistors R1 and R3. Check pin 2 of IC1. It should be 1.24 volts. Apply a load of not less than 4.6 watts and see if it maintains the 13.8-volt output voltage. If you connect the battery helper to a variable power supply for testing, you will notice that it will maintain the output voltage down to about 3 volts on the input, albeit at reduced output current. This illustrates the versatility of the switching regulator.

I checked the efficiency using a 50-watt resistor as a load, and measured the efficiency at 93%. Thus, at full power the battery helper is only dissipating on the order of 3 watts.

To test the battery helper's performance under load, I used a 5.1-watt resistor with a nine-year-old automotive battery as the source. Fully charged, the no-load battery reading was 12.77 volts, and 12.41 volts with the load applied. The battery helper provided 13.8 volts at 2.7 amps for about 9 1/2 hours. At the end of this time, the battery voltage was down to 9 volts. This design should provide 3 amps down to a source voltage of 9 volts, but at a source voltage of 10.5 volts, it delivers 3.5 amps. Depending on your specific needs, more current is available if you don't take the battery voltage as low.

Complete specifications for the LT1070 are available from Linear Technologies' website <http://www.linear-tech.com>, along with application notes and a comprehensive design manual.

Notes

1. Pearce, C. W., "Build a 25 Amp, 12 Volt MOSFET Power Supply," *CQ VHF*, August 1997, p. 18.

2. See, for example, *The ARRL Handbook*, 1996 ed., Chapter 24. ■

By Gary Pearce,* KN4AQ

FM

FM/Repeaters—Inside Amateur Radio's "Utility" Mode

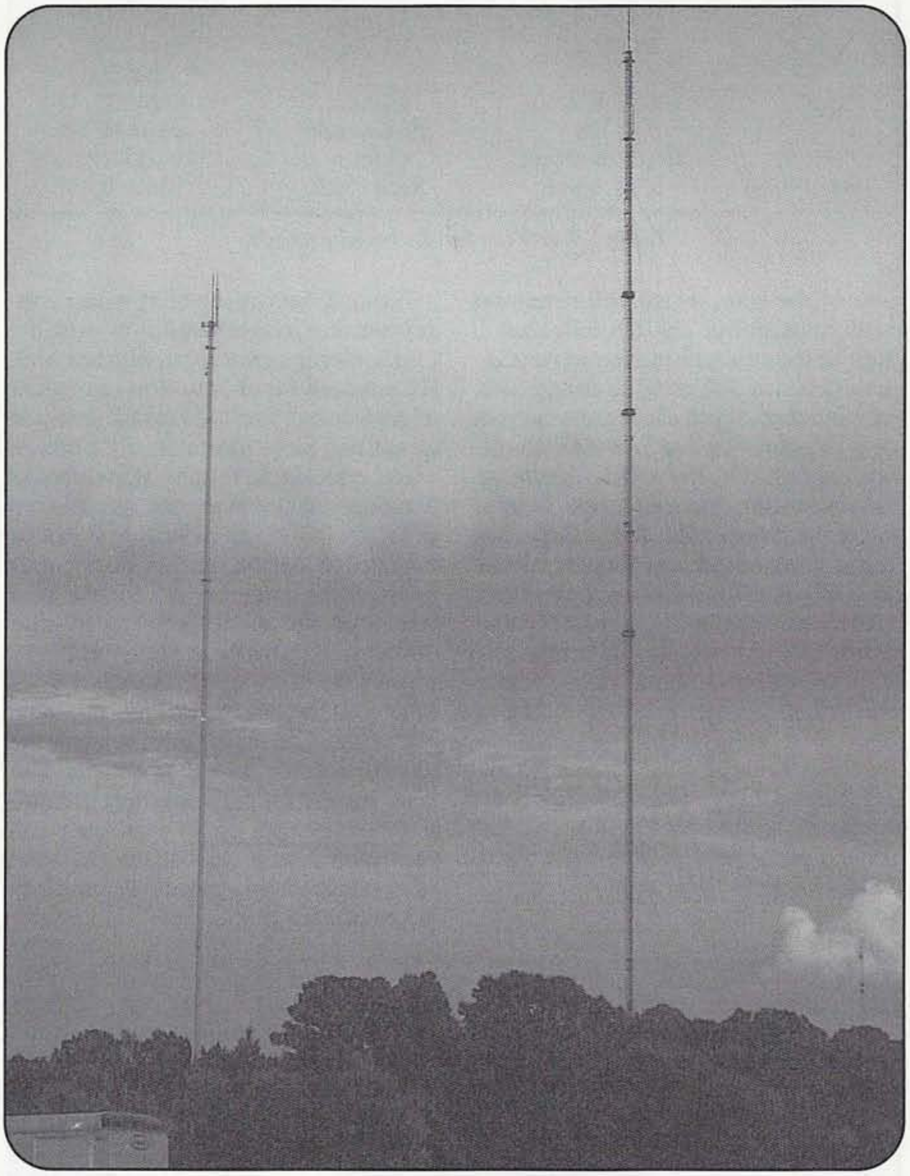
Look! Up in the Sky! It's . . .

It's your repeater antenna, proudly waving hundreds of feet above average terrain. A few lucky repeater sticks are 1000 feet or more above your rubber duckies and 5/8-wave mobile whips, which is pretty awesome, especially if you stop to consider that the biggest of the big-gun ham antennas rarely scrape the 200-foot mark. When it comes to height above average terrain, repeaters are in a class by themselves.

Oops. No they're not. The class is shared by broadcast radio and TV stations, commercial two-way companies, paging systems, cellular providers—outfits with the need and the finances to get their antennas up high and have them stay there. Amateur radio repeaters have the need, too. The finances? One casual rule of thumb for calculating the value of extreme vertical real estate is one dollar per foot per month, which is obviously going to vary, depending upon just what that air is hovering over. New York City is more expensive than Lizard Lick, North Carolina. What ham group can afford any variation of a formula that would have them shelling out hundreds of dollars per month for an antenna mount, just so you can complain about traffic on the commute to work?

No, most ham repeaters are getting a free ride to the top, or at least a very reduced rate. Eric Meth, VE3EI, says that the company he worked for put amateur radio repeaters in the class of "technical charity." Indeed. Most amateur repeater owners pay less than $100 per year for space that is just as good and just as high as that of their commercial neighbors who are paying full freight. Nice work if you can get it, but getting it is becoming more difficult.

Actually, responses to my request for repeater-site success and failure stories in this past summer's column were more positive overall than I had expected. There are thousands of amateur repeaters operating across the U.S. and Canada, and most of them are doing fine. I did hear a few horror stories, though, which I will relate in a minute.



A pair of 2000-foot commercial towers near Raleigh, North Carolina. Many ham radio repeaters are getting a free ride, or at least a very reduced rate, to the top of towers such as this one.

Space for Next to Nothing

Just how do hams wangle this valuable space for next to nothing? If you think it is amateur radio's commitment to emergency communications and public service, you're not wrong, but you're in second place. I guess it's not too surprising that personal contacts—the right ham in the right place—top the list. You'll find hams working for most every company that can

*116 Waterfall Court, Cary, NC 27513
e-mail: <kn4aq@arrl.net>

grant access to antenna sites. They are technicians, chief engineers, and even owners. Although no one confessed to it, I'm sure that there is more than one repeater out there operating on the sly with a midnight connection to an orphan antenna. Mostly, the hams are able to convince their bosses that an amateur radio repeater is a good thing to have. Then public service comes into play to seal the deal. Public-service claims by themselves don't seem to get repeaters a foot off the ground.

Cheer up, however. There are always exceptions. Hospitals are more public spirited than your average tall building, and many repeaters have found a haven at a hospital when they were unwanted elsewhere. Government-owned towers, buildings, and mountaintop sites support many ham repeaters. Here in North Carolina, the state university TV system has a bunch of nice, tall towers with carefully selected ham repeaters on them—rent free! There are hams who are working for those state agencies, and their influence helps, but the state is persuaded by the energy that hams show at the Emergency Operations Centers (EOCs). In South Carolina, Lloyd Mitchell, KD4HTW, reported that hams in Florence successfully pitched their county board for access to an emergency services tower. In return, they cut the grass and do some maintenance around the shack. The tower/lawn-mower connection is a popular one.

Don Williams, W4VT, President of the SouthEastern Repeater Association, relates one particularly good-luck story. The Dismal Peak Amateur Radio Society has a mountaintop site in Virginia on U.S. Forest Service land with multiple repeaters and packet systems. Rent is affordable. Even better, a local TV station donated their microwave-relay building on top of the mountain when the TV networks went to satellite delivery in the mid-1980s. On the flip side, a repeater group in eastern Oregon reports a bit more trouble with the Forest Service. They were facing a rent increase from $75/year to thousands/year. They lobbied successfully with local politicians to beat back the increase. Less lucky was a repeater in rural Illinois that got booted off its tower when some of the commercial tenants complained about interference. Ironically, the club got another interference complaint call two weeks after they had taken down their repeater.

Headaches for Repeater Owners

Two significant factors are working to cause headaches for repeater owners trying to find or keep antenna space.

The first is digital television. Every TV station in the country has to add a digital transmitter (and a new antenna for it) to its system. Some of the stations are evicting tower tenants in order to make room for the extra antennas. On the other hand, some new towers are being built, making more room for commercial and ham antennas.

The second factor is the appearance of several companies in the nationwide tower ownership and management business. Broadcast, two-way, and cellular companies have been selling their towers by the thousands and leasing back space on them. The conglomerates don't necessarily see the benefit of giving hams a break on the price of space, if they let hams put antennas on the towers at all.

Peter Policani, K7PP, who has a network of repeaters in western Washington State, is a good example. Peter worked for Motorola, and he had contacts who helped him put repeaters on eight sites around Seattle-Tacoma. Then Motorola sold the sites to Pinnacle Towers, a professional tower company with more than 5000 towers and sites nationwide. Peter's previously nominal rent skyrocketed, and he says that the company would not negotiate an "amateur rate." Unable to afford thousands of dollars in annual rent, Peter was forced to look elsewhere. He found a home at several sites owned by the State of Washington. Even though Peter's installations were always professional, he still had to spend more money for specific duplexers and circulators that were required by the state.

Peter remains philosophical about his experience. He says that site owners and managers have some legitimate beefs and concerns about amateur radio repeaters and the people who run them. Many ham radio repeater owners are wincing right now at the thought of things they've seen—things they've done—at repeater sites, such as messy, haywire racks; non-commercial equipment; extra equipment that the site manager doesn't know about; and uninsured tower climbers. Write your own list. If you are up against a tower manager whose experience is with that kind of ham, good luck! Check out Peter's website, <http://www.k7pp.com>, and click on the "articles by K7PP" link. He has written several articles on obtaining and maintaining a good repeater site. He has gone way out of his way to prove his integrity and value to site owners by rebuilding a roof, rewiring AC, installing conduit, and so on.

Be Professional

Being professional is a universal recommendation, if not a universal experience. It isn't easy, and it can be very expensive. Not too many years ago, I often climbed the 400-foot tower that held my club's antenna in order to do maintenance or just to look around. If we were going to do something "heavy," we hired a professional crew. No longer. Antenna maintenance today costs hundreds of dollars for the labor alone for bonded, insured professional climbers. If you know that a crew is going up to work on a commercial antenna, you might get a favor from them for a small gratuity while they are up there.

Rich Ball, WA2ZPX, agrees that one needs contacts to get on a tower in the first place. He passed along these "housekeeping" recommendations for being able to stay there:

1. Your installation and appearance must look more professional than anything else at the site.
2. Clean up after yourself.
3. Do not leave on any speakers.
4. At the first complaint of any interference, be the first one there trying to assist.
5. Offer to perform general site maintenance and inspection.
6. Notify the site owner of any irregularities.

Yes, I know that not all commercial installations are neat as a pin. There are some commercial horror stories, too. However, they do not provide us with any bargaining room, do they?

Tower Companies

Now what about those tower companies, the ones that are buying up and locking up towers as well as sites across the country? Do they really have the draconian "no ham discount" policies we have heard reported? I called Pinnacle Towers and American Tower, two companies that are often cited for making life prohibitively expensive for hams once the company took over a tower. Neither returned my call.

I've heard only negative comments about Pinnacle, but I have different personal experience with American. My club's repeater is on one of American's towers in Raleigh, North Carolina. We had been on a tower for over 15 years, through a succession of owners. Our tech chairman received a phone call once which began, "Who are you guys, and what are you doing on our tower?" With the transition to American, such wasn't the case. The old owner (and now tenant), Alltel, sold to American and recommended that we be allowed to stay. It took a lot of paperwork, but in the end we got a lease with all the "T"s crossed for token rent. Furthermore, we got good cooperation when we went back to them to get tied into the tower ground system. Your mileage with American may vary, but it can happen.

Long-Term Solutions

Finally, some novel suggestions for long-term solutions:

Joe Szczech, K1IKE, in eastern Connecticut, says that his group got some area towns to write "Public Safety" into their zoning requirements for commercial towers. In order to get a tower zoned, a company has to agree to provide low-cost space for public-safety tenants, including amateur radio. Dennis Belles, WA7DRO, Portland, Oregon, suggests an idea to improve coverage without resorting to the big-stick sites—use multiple, voted receivers, and multiple transmitters connected via the internet. Sites could be shared by several repeater groups. He says the IRLP already has some provisions for this arrangement. This idea would add a lot of complexity to a repeater system, but if you can't go up, maybe you can spread out.

As I said, there are thousands of repeaters on the air, and most of them are doing fine for now. However, unless you own your own string of towers, the way Brian Short, KCØBS, does across the Midwest, sooner or later you could be in jeopardy of losing your good thing. Maybe it's time to spruce up the old cabinet.

New NFCC Officers

Frequency coordinators around the country have elected a new slate of officers to the NFCC, the National Frequency Coordinators' Council. They are:

President: Nels Harvey, WA9JOB
Vice President: Ken Chilton, KA1TIH
Secretary: Alex Harvilchuck, N3NMN
Treasurer: Vince Bardsley, KB3OM

Nels Harvey, WA9JOB, is the only returning officer.

The NFCC is the national organization representing frequency coordinators to the ARRL and the FCC. It was created in October 1995 at an ad-hoc meeting of coordinators in St. Louis. Those were dark days for the coordination community. The FCC was lying low in amateur radio enforcement, limiting the importance and effectiveness of coordination. There was infighting among coordinators in some states. In addition, relations between many coordinators and the ARRL were strained.

One of the goals of the NFCC was to create a "Single Point of Contact" between coordinators and the FCC in hopes that the Commission would spend a little more time and energy on amateur radio repeater issues if it only had to talk to one contact. That never happened. Instead, Riley Hollingsworth, K4ZDH, was appointed to head amateur radio enforcement, and he has actively pursued contacts with all coordination groups. For the time being, a single point of contact isn't needed.

The NFCC did help improve the relationship with the ARRL. One result is that coordination groups receive substantial payments for the repeater data that is published in the *ARRL Repeater Directory*. Also, the ARRL provides space and support for some NFCC activities.

Letter to the "FM" Editor

Hello, Gary,

Thanks for the nice article in the Summer 2002 issue of *CQ VHF*. This type of column has been way overdue. I too am partial to FM and repeaters. I do some SSB, but FM is where I spend most of my time.

I would like to suggest some ideas for future columns. As 2 meters and 70 cm become overloaded, we are going to have to start to look up towards the 902 and 1.2 GHz bands for FM and repeaters. I would like to see more articles on how groups are building 902 and 1.2 repeaters, as there are no repeaters available from the manufacturers. Also it would be good to discuss the characteristics of these bands as far as propagation, etc., is concerned. Maybe this will also spur some activity on these bands, and that might lead to manufacturers making more radios for these bands as well.

Also, you might cover some of the linked repeater systems throughout the country. I know there are some very nice and complex systems out there that take a lot of thought and engineering to make them work, and that will stand up to any ridicule from the SSB crowd.

Thanks and keep up the good work.

Dale Urban, NØKQX

Congratulations to the new NFCC officers, and thanks for taking on a generally thankless task. We'll look deeper into the activities of the NFCC in a future column. Meanwhile, you can check their website at: <http://www.arrl.org/nfcc>.

IRLP and Echolink:

Are They Legal? Are They Ham Radio?

I fired up Echolink for the first time last night, and stayed up a lot later then I had planned—not because it was hard to get working, but because I was having fun. Echolink is an internet-based system that lets hams talk to other hams through the nternet. It's similar to IRLP, which uses the internet to link repeaters together. However, it goes a few steps beyond, allowing hams to use their computers to connect to and talk through repeaters and simplex stations that have "nodes" attached, and talk to other hams on their computers with no radios involved at all. Its free, Windows®-based software makes it more accessible to the average ham than the IRLP's Linux-based program, and each ham who installs Echolink can connect it to their own radio using available interfaces designed for Echolink, or general ones such as RigBlaster.

While I chatted with Duane Reese, KC6ZSR, through his simplex station outside San Francisco, and then with Dave Rodriguez, KC4AEV, in Brooklyn, on his computer (while the KE4TTE repeater in Orlando listened in—and I realize this is getting confusing), I tried to figure out where this fit in the scheme of the rules. Should I use my callsign? I was pushing the spacebar on my computer keyboard, and it didn't quite feel like push-to-talk. Was I third party? Control operator? Is this ham radio?

I'm not the only one asking these questions. The FCC has received lots of comments and complaints, and there has been plenty of debate. Riley Hollingsworth, K4ZDH, the FCC's head ham radio enforcer, says it "raises interesting issues." So far, for the FCC the big question is control. The FCC doesn't much care how it's done as long as a ham is in control of the RF emitted from the antenna. While this technology seems to be outstripping the rules, maybe it's not. Riley said he and Bill Cross, W3TN, who works in the section of the Wireless Bureau responsible for writing new amateur radio rules, are "not inclined to limit new technology." Their goal is to keep fewer rules and

not strangle amateur radio in regulations. They are "not in a restrictive mode."

Riley said that he and Bill would discuss the complaints raised about IRLP and Echolink and reach some conclusions around the end of September, well before this issue goes to press, but well after this column was written. Maybe some of the big questions are already settled, such as "Are IRLP and Echolink transmitters on 2 meters really 'auxiliary' stations?" If so, they are not currently legal, but don't expect any pink slips from the FCC without a clear declaration on the issue.

The question "Is this amateur radio?" isn't really a legal one, and I suppose it will be debated for a lot longer. To me, the IRLP doesn't raise that question at all. It is ham radio in, ham radio out. It's just linked repeaters, using a newer form of linking that goes beyond even the huge linked systems such as Cactus and Zia. You can argue whether or not this is a good thing. Does it stifle a code-free Tech's incentive to upgrade so he can get on 20 meters and battle for a 4-second contact with a DX station? (You can tell I'm not totally neutral in this debate.)

Echolink is not as clear-cut. It's designed for hams. You register with your callsign, which is "verified" somehow. Then you run software on your computer that looks and feels a little like AOL Instant Messenger with a ham repeater component prominently added. You talk and listen through your sound card, and you can connect to repeaters, simplex stations (they call them "link" stations), and other computers. That last part you can do with AOL, Yahoo, and a few other voice-chat software clients. On my DSL connection, it worked and sounded pretty good, although today something is bollixed and I can't connect to any other stations. I'm sure I'll clear it up quickly.

As I said, on the first night it was fascinating. I was talking to hams, like a ham. The guys on the air sounded very much like ham radio. Dave, on his computer, sounded more like Dave on his computer. I've never warmed up to AOL IM's voice chat. That may be because sitting next to my computer talking through it feels like a waste of time. I could be on the radio doing that. Furthermore, I don't seem to have enough time to do that on the radio, so why do it on the computer?

Okay, time to declare. Take a courageous stand. Echolink is ham radio. It's a different kind of ham radio, but it is ham radio. I'm not afraid of new technology (Could someone slow it down a tad though?). I think I can go back in my CD collection of old *QST*s and find some quotes from hams who said that phone isn't ham radio. RTTY isn't ham radio. SSB isn't ham radio. I know I can find quotes from hams who said FM isn't ham radio (Some of those guys are still around.).

Maybe I'll see you on Echolink—if I get it fixed. 73, Gary, KN4AQ

Attention: Arkansas Repeaters

The Arkansas Repeater Council had a glitch in their on-line registration system, and they need to have some repeater owners in the state re-submit their data. You are okay if you submitted a paper coordination form during or after the April 27th Little Rock Hamfest meeting, or online after August 17th. If your info went in before those dates, drop by their website <http://arkansasrepeatercouncil. org/> and send it again. This info will be used for next year's *ARRL Repeater Directory*. The Arkansas council is also beginning a process of updating coordination information for every state repeater every two years. Repeater owners will have to keep their info up to date to retain coordination. No web access? Write to: P.O. Box 324, Conway, AR 72033. Coordination services are free.

Predicting VHF/UHF Conditions

If you live along the coastline of the U.S., here is a simple way to predict how far you can talk on VHF/UHF.

By Van R. Field,* W2OQI

Undoubtedly, there are some exotic computer programs which when fed with the proper information can predict, at least short term, how far one can talk on VHF/UHF.

I offer a simple system, particularly for those who live along the coastlines of the U.S. The equipment consists of a VHF scanner. If Marine Channel 16 (156.8 MHz) is programmed, then with a simple outside antenna the Coast Guard stations up and down the coast can be monitored. The Coast Guard uses its location for a callsign and repeats it frequently, so you know right away where the station you are hearing is located. Channel 22 (157.10 MHz) is used for weather broadcasts and to talk to pleasure boaters.

You should be alert for *not* hearing a distant station as well as hearing it. Sometimes conditions change rapidly, and a full-quieting signal one moment may be gone the next.

The Coast Guard operates from "groups" of stations. Large groups are called *Activities*—i.e., Activities New York. Group Long Island Sound is at New Haven, Connecticut. Stations usually use 25-watt radios with antennas no higher than 90 feet. Groups use 100-watt stations in several locations, which are keyed by the same operator, sometimes simultaneously. The Group/Activities location may have a local 25-watt radio as well. This makes a difference when listening for changes in local conditions, but when I hear Group Cape Hatteras at my QTH on Long Island, I get the idea that the band is open at that moment to North Carolina. On the other hand, tuning 2-meter sideband may produce only a few over-the-horizon stations. After a while, you catch on to the condition of the band, even if you don't hear anyone.

Sometimes you may hear the vessels with which the Coast Guard is communicating, indicating a good opening, because antennas on small vessels aren't more than 20 feet off the surface of the water and all vessel stations are 25 watts.

I've never heard anyone south of North Carolina from my QTH. Of course, weak-signal work on CW or SSB will yield better DX.

This approach is definitely "low-tech," but it should be a learning experience for the continuously changing conditions. Even in the 25-mile range, signals may be loud and clear and then completely disappear! You know they are still there, because you can hear the vessel talking to the station.

Here on the East Coast, a good band opening south usually means that we are in for a big weather change. This brings up the subject of the mechanics of the changes, and I have tried to avoid putting labels on these enhanced conditions. There is a lot of literature on the subject, so if all of this piques your interest, look into the subject further. That's what ham radio is about: It gives you a chance to expand your knowledge.

*17 Inwood Rd., Center Moriches NY 11934-3335
e-mail: <wreck_and_rescue@juno.com>

The *Leonids* Meteor Shower
Past, Present, and Future

(Continued from page 14)

culated the period to be 33.17 years. In addition, Urbain Le Verrier calculated another, less accurate period for the *Leonids*.

Perturbation Plays with the Prediction

In 1899 another storm was anticipated, and an increase in *Leonids* activity did occur. However, the activity was disappointingly low. Charles Olivier called the lack of activity "the worst blow ever suffered by astronomy in the eyes of the public." It was later determined that the stream came under the gravitational influence of both Jupiter and Saturn in 1868 and 1870, respectively, thereby diverting its debris away from the predicted intersection by Earth in 1899 to more than double what it was in 1866. Such gravitational influence is called a *perturbation*.

Despite the less than predicted 1899 *Leonids* shower rate, the rates for the subsequent annual showers continued to increase, reaching a near storm level in 1901. The activity was most visible in the Midwest and western U.S. that year. Observers at Carlton College in Minnesota put the count at about six to seven meteors per minute, and E. L. Larkin, perched on Echo Mountain, California, counted around five per minute at the shower's peak. *Leonids* showers also occurred the following two years.

In 1902, moonlight obscured visibility of the shower. Yet in 1903, European observers John Henry in Ireland and Alphonso King in England noted levels approaching an estimated 200 meteors per hour.

Due to what seemed to be the increase in reliability of the predictions of the *Leonids,* yet another storm was anticipated in 1932. However, this time in North America weather obscured the viewing of the storm. It was thought by some that because limited observations were made here, a storm did not occur.

Nevertheless, observations were made in other parts of the world. Data from these observations indicated that there possibly were two peaks. P. A. Curry at the Helwan Observatory in Egypt noted a rate approximating over 100 at his observed peak at around 4:00 AM local time. Several hours later (now in daylight) in Egypt, J. P. M. Prentice observed rates approaching over 200 per hour. Nevertheless, while a storm was not observed in 1932, predictors looked forward to the years of 1965–66 as yet another possibility for a storm.

This woodcut depicts the impression people had of the 1799 Leonids. *It appears to show everything the artist saw during the entire shower, rather than the view at any given instant. (Artwork courtesy NASA)*

Radar First Used to Detect the *Leonids*

In 1946 radar was first employed to detect the *Leonids* meteor shower. That year the ZHR was approximately 24. Unfortunately, the ensuing years produced results that were not above the sporadic rate, thereby causing these radio astronomers to all but abandon the tracking of this shower via radar.

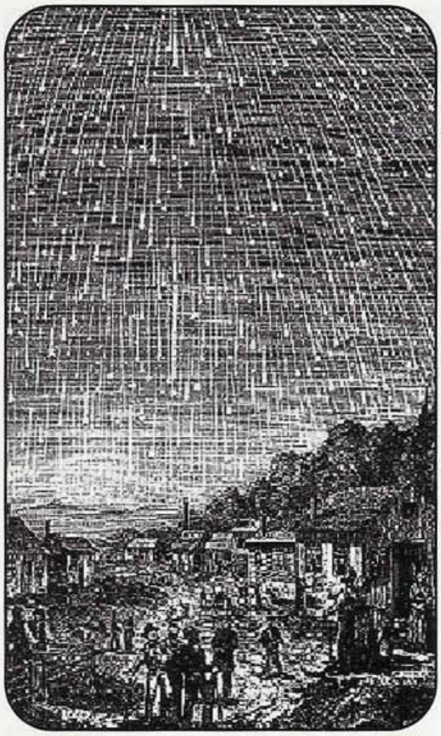
Even so, alert visual observers picked up increasing *Leonids* activity. This activity continued its upward climb, and in 1965 the *Leonids* count increased dramatically. As a result of this increasing activity and advance publicity, a number of amateur radio operators obtained excellent results from the *Leonids* shower of 1965. It was from these observations that predictors were fairly confident of a decent shower level the following year. However, because of the previous perturbation of the stream by Jupiter and Saturn, no one was willing to go out on a limb and predict a storm.

Continued good press prompted more interest. Encouraged by predictions in the November 1966 issues of *Sky and Telescope, Natural History,* and *QST* magazines, hams stood by for what they thought might be a better-than-average night for the 1966 *Leonids* shower.

Hams who were on the air at that time, and visual observers in the western parts of the U.S., were not disappointed. Visual observations compared the count to that of the 1833 storm. However, there really was no way to tie together the levels of the two because of the lack of comparable data.

Nevertheless, it was far more than "better than average!" The headline for Sam Harris, W1FZJ's "World Above 50 Mc." column in the January 1967 *QST* was "November Leonids—Shower of a Lifetime." Sam recounted, "Hundreds of contacts were made by calling CQ, or by breaking stations when their skeds were completed, as most were in the first minute or two of prearranged calls." It is important to remember that these skeds took place on CW and AM by hams who were using equipment that woefully lacked today's sophistication of software-defined radios and supportive software programs.

Reports of visual observations were sent to *Sky and Telescope* from all over the country. One report came from Shelby Ennis, W4WNH (now W8WN). Shelby wrote, "For us in Kentucky, the 1966 *Leonids* will be rated much better as a 'radio' shower than as a 'visual' shower due at least in part to the very sharp peak coming after dawn." Even so, in areas where dawn hadn't come, particularly in the west, the display was awesome. Reports of 2000 meteors per minute were not uncommon. It was a night (or early morning) to remember for amateur radio operators and amateur astronomers alike. *(For this writer, my vantage point was standing in military formation outside my barracks in Ft. Bliss, Texas. It was during my basic training in the U.S. Army, and, as a draftee training for the Vietnam War, the absolutely last place I wanted to be was in*



The 1833 Leonids *as they appeared off the coast of Florida as witnessed by a government civil servant on his way to New Orleans. (Artwork courtesy NASA)*

the Army, thereby missing the real action on the VHF-plus ham bands!)

This Cycle

Now, 35 years later, we are well into the next cycle of the *Leonids* storm. Reports of the 1994 *Leonids* meteor shower indicated a dramatic increase over the previous year. Some reports compared the rates to the *Perseids* shower earlier that year. Reports of 1995 and 1996 showers indicated continued increased activity. The Dutch Meteor Society also reported that a team of its observers recorded a period of an increase in faint meteors riding on top of the shower during the overall peak for a period of between one and two hours. These observations put the EZHR (estimated zenith hourly rate) at about twice that of the rest of the shower overall.

The year 1997 proved to be noteworthy for *Leonids* observers because comet Tempel-Tuttle, which had not been seen since 1966, was recovered on March 4, 1997 by Karen Meech, Olivier Hainaut, and James Bauer at the University of Hawaii. At the time Tempel-Tuttle was very faint (22.5 mag), but the recovery proved that it was returning on schedule and that its orbit was very well established. Based on the 1995 and 1996 observations, and the recovery of the Tempel-Tuttle comet, predictors indicated that a storm was possible both in 1997 and 1998.

While the recovery of the comet foretold the probability of future *Leonids* storm activity, it was not to be during 1997. The peak of the 1997 shower occurred around 1215 UTC. However, at the shower's peak, the ZHR did not reach 100. This statistic coupled with the light interference caused by the full Moon and the lack of worldwide visual reports prompted some of the observers to say that the observed peak could have been attributed to normal sporadic rates of meteor debris.

The 1997 shower notwithstanding, the reports for 1998 were quite the opposite. These reports indicated two good peaks, one at around 0200 UTC (with a ZHR of approximately 250) and the other, a very sharp peak, at around 2030 UTC (with a ZHR of approximately 180), both on 17 November. Questions arose as to why two peaks. Could it have been a separation of the peak riding on top of the other peak that the Dutch had observed? As a result of the double peak of 1998, many diverse predictions were made for 1999.

What rolled out in 1999 was a storm. The International Meteor Organization (IMO) commented:

> A storm of *Leonid* activity was observed from western Asian, European, and African locations at a solar longitude of lambda = 235.285° ±0.001°, corresponding to November 18, 1999, 2h02m ±2m UT [0202 UTC] with a peak equivalent ZHR [the number of meteors reported to have fallen in an hour] of 3700 ±100 based on 2.8-minute intervals.
>
> *(See <http://www.imo.net/articles/shower/leo99.html>)*

By contrast, the 2000 *Leonids* did not reach storm capacity. Even so, this time three peaks were observed. Again, the IMO reported,

> Three major activity outbursts were found:
> lambda = 235.28 (November 17, 8h07m UT) with ZHR = 130 ± 20
> lambda = 236.09 (November 18, 3h24m UT) with ZHR = 290 ±20, and
> lambda = 236.25 (November 18, 7h12m UT) with ZHR = 480 ±20
>
> *(See <http://www.imo.net/articles/shower/leo00.html>)*

For 2001, again reports of predictions of two peaks surfaced. According to Space.com (<http://www.space.com/scienceastronomy/astronomy/leonids_2001.html>):

> The two most widely watched *Leonid* predictions are made by Rob McNaught of the Australian National University and David Asher of the Armagh Observatory. Even these two researchers, however, admit that prior to 1999, meteor forecast had a checkered past.
>
> 'But a new theory is able to explain the historical events and should thus be able to make sound predictions for the near future,' McNaught says. 'Prospects appear good for a moderate storm visible in dark skies from Australia and eastern Asia in 2001, and in moonlit skies over Europe, west Africa and North America in 2002.'
>
> America will not be left out this year, either. 'It seems certain that the Americas and the Far East will be treated to a grand display without interfering moonlight in 2001,' said Robert Lunsford of the American Meteor Society, shortly after reviewing 2000's event and noting that predictions were on target.
>
> McNaught and Asher study these dust trails to make their predictions. They expect a peak that year of up to 15,000 meteors per hour over Australia and East Asia and as many as 2,500 per hour over North and Central America.

The Space Operations Support Office at The Aerospace Corporation (http://www.leonidstorm.com) made the following observations at their URL, "Observing the 2001 *Leonids*":

> The 2001 *Leonids* are anticipated to be the best showing for meteor showers since the 1999 *Leonids* over Saudi Arabia. They will peak in the early morning hours of the 18th of November with rates that could exceed the 1999 event (~2500 meteors per hour).
>
> Several models are predicting two significant peaks: one over the United States (especially towards the west) beginning about 3–4 a.m. EST (0800–0900 UTC) and lasting until 6–7 a.m. EST (1100–1200 UTC). The maximum, according to these models, will occur around 5 a.m. EST (1000 UTC). The level of activity for this peak could be as much as 2000 meteors per hour.
>
> The second significant peak will begin around 12 noon EST (1700 UTC) and last until 2 p.m. EST (1900 UTC) on the 18th of November. The best viewing for this peak will be over Australia and the Far East. The level of activity for this event could be anywhere from 7000 to 15000 meteors per hour!
>
> Another model does not anticipate distinct peaks such as those just described. Instead, the prediction here is a general increase in activity for the entire night of the 18th of November beginning about 3 a.m. EST (0800 UTC) on the 18th and lasting until 3 p.m. EST (2000 UTC). The highest level of activity will be around 1500 meteors per hour over

Predictor	Best Seen From	Peak Time (UTC)	ZHR	Duration (hours)	Dusted Ejected in Year
Asher/McNaught	Western Europe	03:53	3000/hr.	1.5	1767
Lyytinin	Western Europe	04:03	3500/hr.	1.76	1767
Jenniskens	Western Europe	03:48	5900/hr.	0.64	1767
Jenniskens	Western Europe & Americas	04:50	51/hr.	4.1	1799
Jenniskens	Americas	05:59	28/hr.	4.8	1833
Lyytinin	Americas	06:36	160/hr.	—	1866
Asher/McNaught	Americas	10:29	10,000/hr.	1.2	1866
Lyytinin	Americas	10:40	2600/hr.	2.03	1866
Jenniskens	Americas	10:23	5400/hr.	0.6	1866

Table I– Summary of Leonids *forecasts for November 19, 2002 UTC (from <http://leonid.arc.nasa.gov/1998.html>). Note: On November 17, at 20:10 UTC (Asher) or 19:30 UTC (Jenniskens), Earth will pass by the 1965 dust trail at a considerable distance. Predicted peak rates are less than ZHR = 1, but east Asian observers should be on the alert for a possible minor outburst that night.*

Hawaii, with both the US and Australia/Far East observing anywhere from 500–1000 meteors per hour.

2001 *Leonids* Delight Amateurs Worldwide

What proved to be not as big as predicted in some places but bigger than predicted in others, the 2001 *Leonids* meteor shower delighted amateur radio operators and amateur astronomers alike —and in some unpredicted places. Early reports indicated that while Europe was predicted to be pretty much out of the shower, they did experience quite a show. For example, Szigy Iulius, YO2IS, reported on the Moon-net listserv that he heard propagation for several hours.

Complementing the European observation, Shelby Ennis, W8WN, commented in his "Hot News" column, "Reports of 100 or more contacts have been received, even though Europe was not expected to get much of a shower."

From Australia, Doug McArthur, VK3UM, reported that the peak occurred between 1700–1800 UTC. He indicated that some bursts lasted as long as six minutes. He added,

> We in VK rarely experience anything like the effects of a meteor shower as is seen in the Northern Hemisphere. Generally, at best, we are lucky to realize 25 percent of what is experienced in the Northern Hemisphere. Many if not most showers have little effect down under!
>
> For the 2001 *Leonids* it was much different! It predicted to peak between 1700–1800 UTC (0400–0500 local); the experts seemingly got it right. Visually speaking, we were blessed with a clear crisp sky, and from this QTH with its 360° views, the display was brilliant.

Doug also commented that there is an unconfirmed report of a VK2-ZL QSO.

From his URL (http://www.minecost.com/hamstuff/), Mike Farrell, VK2FLR, added, "The VK calling frequency on 144.100 ran hot with pileups during long burns, when DX stations were louder than the locals. . . . Amid the 144.100 QRM, it was often difficult to decide who was working whom."

As for North America, from this writer's vantage point in the near central U.S., I observed hams across North America participating in the shower. While the Asher and McNaught prediction indicated a short, intense spike centered on 0955 UTC for North America, those who were on the air much earlier were not disappointed. I started listening about four hours before the predicted peak and eventually logged K4ZOO as my first SSB contact at 0631 UTC. While I had to QRT at around 1200 UTC, others reported contacts as late as 1900 UTC.

During the peak, the propagation appeared to come in waves. For example, Tim Marek, K7XC, operating rover from an excellent visual vantage point in DM09, observed the following: "Many large rocks exploding near the end of their descent, leaving a visible gas cloud for over a minute. I watched as one to the northwest exploded visually, immediately followed by 2 meters going nuts for over a minute in the same direction, with plenty of stations heard on backscatter as well." Dozens more reports from various locations around the world were accumulated and published in my "VHF Plus" column in February 2002 *CQ* magazine.

Choosing to remain on 2 meters and working strictly randoms, I was pleasantly surprised to notice how many operators spread out. I worked randoms as low as 144.180 MHz and as high 144.225 MHz.

Several operators opted for a particular frequency and hammered away on that frequency. For example, Gene Zimmerman, W3ZZ, was heard quite a bit at approximately 144.220 MHz.

This parking on one frequency made it easier for less well-equipped operators who chose to search and pounce, because as each successive wave of propagation hit, one could return to that frequency to work the operator on that frequency.

Indeed, the waves did hit—wave after wave after wave. When a wave did hit, you could spin the dial and hear dozens of stations across a particular area coming into the receiver. Because many of the waves lasted long enough (upwards of over a minute at a time), you could make a choice as to whom to work, and those on a fixed frequency could complete sometimes upwards of five QSOs during one wave.

Predictions Are Out For This Year

Ever since the results of last year's *Leonids* meteor storms began to surface, the withering question among ham radio ping jockeys has been, "Will there be another storm in 2002?"

All predictors say yes! In fact, the three most well-known predictors—the team of David Asher of the Armagh Observatory in Northern Ireland and Robert McNaught of the Australian National University (<http://www.arm.ac.uk/leonid/>); Finnish astronomer Esko Lyytinen (<http://www.ursa.fi/ursa/jaostot/meteorit/leoeng02.html>); and Peter Jenniskens of the SETI Institute (<http://leonid.arc.nasa.gov/ACM2002.pdf>)—all indicate two storms will occur, one over western Europe and the other over the Americas. Table I summarizes their respective predictions.

What makes these forecasters so sure of themselves? Last year's successful predictions, in particular those of Lyytinen, were the most accurate prediction of *Leonids'* meteor activity ever. Riding on that success, these four have examined their models and predict that this year will be lots of fun.

That's the good news. The not so good news is that except for a higher than normal activity level in 2006, this will be the last we see of the *Leonids* until 2099–2100, when the Earth again will pass through debris left in the orbit of the Tempel-Tuttle comet, the parent comet of the *Leonids* meteor showers. The question of why there is a giant gap of nearly a century in *Leonid* activity is answered later in this article.

Speaking of the debris clouds, these are what make for the possibility of storms. It is when the Earth either passes through or near the debris clouds that are left behind in the aftermath of the comet's perihelion and associated gravitational influence from the Sun that there is the possibility of an increase in meteor activity. When the comet approaches the Sun, ices evaporate and the dust particles are ejected into orbit in geyser-like fountains. These fountains appear as clouds of dust that (as near as the researchers can tell) remain in an elliptical orbit which the Earth sometimes encounters during its circular orbit around the Sun.

In the case of this year's predicted storms, as with last year's, the Earth will pass through debris left behind after the 1767 and 1866 perihelia. For the western European event, the Earth will pass through the debris cloud left behind from the 1767 perihelion, and for the Americas event the Earth will pass through debris left behind from the 1866 perihelion.

By way of illustrating how Earth will pass through these debris clouds, David Asher drew a series of plots showing a timeline of where the Earth will be in relationship to the various debris clouds of previous *Leonids* perihelia. As part of the ongoing research program of the Leonids MAC (Multi-instrument Aircraft Campaign) project, NASA illustrators have taken Asher's plots and combined them with graphs that illustrate the intensity (in zenith hourly rates) of the meteor shower or storm for the years 1998–2002. In the case of 2002, the graph represents a prediction of how the spike in meteor activity will appear. Figure 1 illustrates this year's prediction of Earth's encounter with the comet Tempel-Tuttle's debris. For those of you who have access to computers, illustrations for other years can be seen at <http://leonid.arc.nasa.gov/why.html>.

The Near and Distant Future

After this year, the next three years do not hold out much promise beyond sporadic meteor activity. However, as mentioned above, 2006 holds out promise for increased *Leonids* activity. In that year Asher and McNaught indicate that the Earth will pass through the tail end of the Tempel-Tuttle Comet trail of two orbits before. They indicate a sharp peak of *Leonids* activities centered on 0445 UTC, 17 November, with a ZHR of approximately 100. Africa and Europe seem to be the prime beneficiaries of this peak. After this peak, Gary L. Kronk (<http://comets.amsmeteors.org/meteors/showers/leonidprediction.html>) indicates that Jupiter and Saturn will once again cause perturbations of the comet's orbit, thereby disrupting the possibility of the Earth intersecting with the meteor stream not only in 2033, but in 2066 as well. It seems that we will have to wait until 2099 for the potential for storm-like conditions to once again be a part of the *Leonids* meteor shows—should we live that long! ■

Additional Resources

Leonids URLS

In addition to the URLs cited in the main article, there are a few others worth checking out. The most extensive URL that I have found is the following from NASA: <http://leonid. arc.nasa.gov/>. You may find others by going to <http://www.atnf.csiro.au/asa_www/ info_sheets/leonids.html>. Also check out Sky Publishing's home page, <http://www.skypub. com/news> for their latest information. Another URL is the International Meteor Organization's site, <http://www.imo.net>, particularly noteworthy for their documentation of annual visual observations of the *Leonids* and many other meteor showers. From New South Wales, there is <http://www.asnsw.com/articles/leonids-gb.htm>. Finally, a rather exhaustive URL on this and other meteors can be found at <http://comets.amsmeteors.org/index.html>.

Books on Meteors

The Heavens on Fire: The Great Leonid Meteor Storms, by Mark Littmann (1999, Cambridge University Press), plainly tells the history of meteors, especially the *Leonids* showers. Publication of this book coincided with the peak activity of the November 1999 shower, when swarms of a thousand meteors an hour were expected to be seen. The founding scientists, the history of meteors, and the dangers posed to Earth also are discussed in this book.

Observing Meteors, Comets, Supernovae and Other Transient Phenomena, by Neil Bone (Practical Astronomy, 1998, Springer Verlag), is somewhat of an update of his 1994 work, *Meteors*, released by Sky Publishing Corporation as part of their *Sky and Telescope Observer's Guides* series. For the radio amateur, these books provide a great deal of insight into what a meteor is, and how the meteor and Earth collide to create the visual (and, in our case, the electronic) observations we experience. The former book devotes nearly a full chapter to the *Leonids* meteor shower. The latter book gives a brief history of meteor studies, and contains a season-by-season calendar of annual meteor showers and their characteristics. A few paragraphs are devoted to the amateur radio operator's interest in meteor-scatter propagation.

The International Meteor Organization's *Handbook for Visual Meteor Observations*, edited by Paul Roggemans, and also published by Sky Publishing Corporation, covers meteor showers extensively. While somewhat dated (its second edition was published in 1989), included in it are historical anecdotes of both major and minor showers. The *Handbook* is out of print. However, you might try one of the online out-of-print book services.

For a copy of *The Heavens on Fire*, *Observing Meteors*, or *Meteors*, you might try online at <http://www.amazon.com> or other online book services.

Log-Periodic Dipole Arrays

A Single-Antenna Solution For the VHF/UHF Operator!

One thing about the VHF+ ham bands: There are lots of them, which can be a problem if you don't have enough antennas. Enter the log periodic. K1ZJH gives an over view of this antenna and briefly reviews some of the more popular models.

By Peter Bertini,* K1ZJH

Here's something for a budding VHF/UHF enthusiast to consider before spending lots of money on single-band Yagis. Amateur VHF/UHF band assignments span from 50 through 1300 MHz. Within this spectrum, there are no less than six amateur bands to use and explore, or seven bands if you include the British 4-meter 70-MHz band!

Things have changed a lot in the past several years. Many HF rigs now sport 6- and 2-meter and 70-cm band multimode coverage out-of-the-box. Perhaps you are one of those HF rig owners with a hankering to explore those additional bands—at minimal cost, of course—to see if VHF+ operating is your cup of tea. For many of us on limited ham budgets, being able to afford six single-band antennas, along with the requisite individual coax runs, connectors, and related tower-mounting expenses, is just not feasible . . . sigh. Hence, those elusive frequency allocations remain just out of reach!

For years, my modest VHF/UHF antenna farm consisted of individual long-boom Yagi antennas for the 6-meter, 2-meter, and 70-cm bands. After 15 or 20 years most of these antennas needed serious attention: Failing coax-connector seals, overweight birds, Father Time, and some close encounters with wind-driven tree branches had taken their toll.

I enjoy VHF operating, but lately my VHF operating is growing more casual, with some infrequent contesting throw in. My need was for a single antenna that would cover all of the VHF/UHF bands, with gain and directivity. I also wanted something that could be handled on a modest fold-over tower, requiring minimal maintenance.

* *20 Patsun Road, Somers, CT 06071*
e-mail: <commquart@cox.net>

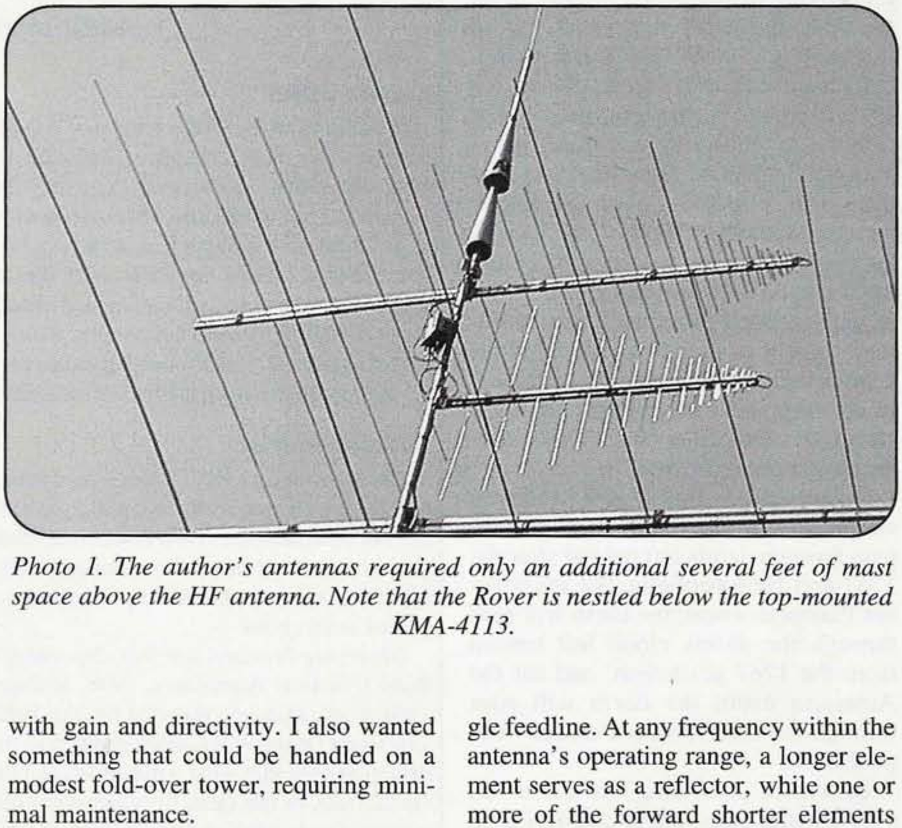


Photo 1. The author's antennas required only an additional several feet of mast space above the HF antenna. Note that the Rover is nestled below the top-mounted KMA-4113.

Enter The LPDA!

First things first: What is a log-periodic antenna? Well, this antenna has been around for years. Many 12-channel VHF TV antennas are log-periodic designs, and some early KLM VHF/UHF antennas used log-periodic drivers to achieve full-band coverage. You can view them as being a series of dipole antennas, each cut for a slightly different frequency, all being fed, transposed fashion, from a single feedline. At any frequency within the antenna's operating range, a longer element serves as a reflector, while one or more of the forward shorter elements work as directors. Some limitations are placed on the minimum number of elements needed to do the job—too few—and the SWR will vary widely across the design range! There are several different log-periodic antenna variations, with the Log Periodic Dipole Array (LPDA) being most popular among amateurs. Figure 1 shows a schematic of how the LPDA looks electrically.

All things being equal, log-periodic antennas are sort of a compromise solution. Remember that gain is limited by an

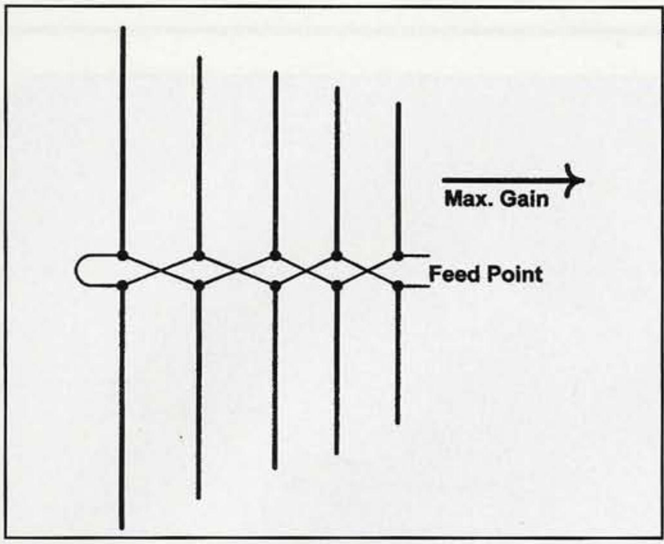


Figure 1. Schematic representation of a Log Periodic Dipole Array (LPDA), the most commonly used design for amateur applications.

antenna's boom length, and there is only so much gain that can be eked out of any design. Yagi antenna designers face several tradeoffs. The important qualities of a Yagi are forward gain, SWR bandwidth, front-to-back ratio, and for many users, the lack of unwanted lobes in the vertical and horizontal antenna plots. Everything is a compromise! A Yagi optimized for the most gain trades bandwidth, F/B ratio, for that extra dB or two, or for other parameters.

What is Lost, What is Gained

The above remains true for the LPDA. A typical 20-meter monobander on a 20-foot boom might have a forward gain in

Cushcraft ASL670

Frequency Coverage:	50 MHz to 500 MHz
Number of Elements:	14
Longest Element:	126 inches
Boom Length:	6' 8"
Turning Radius:	6' 3"
Weight:	11.25 lbs.
Wind Area:	3 sq. ft.
Antenna Gain:	6.5 dBi/4.4 dBd
F:B Ratio:	20 dB
SWR:	1.5:1.0 average
Materials:	stainless-steel hardware
Connection:	50 ohms direct
Options:	vertical/horizontal mounts supplied
Price Class:	$333.62 list, distributor "street pricing" is usually discounted

KMA 4113

Frequency Coverage:	40.6 MHz to 1300 MHz
Number of Elements:	30
Longest Element:	12 feet
Boom Length:	12 feet
Turning Radius:	8.5 feet
Weight:	12 pounds
Wind Area:	3 sq. ft.
Antenna Gain:	8 dBi (free space)
F:B Ratio:	26 dB
SWR:	1.8:1.0 max.
Materials:	T6061 aluminum, stainless-steel hardware
Connection:	50 ohms direct
Options:	1:1 ferrite bead balun, vertical mount
Price Class:	$325.00, factory direct

Tennadyne T28

Frequency Coverage:	50 MHz to 1300 MHz
Number of Elements:	28
Longest Element:	10.05 ft.
Boom Length:	12 ft.
Turning Radius:	7.5 ft.
Weight:	17 lbs.
Wind Area:	3 sq. ft.
Antenna Gain:	8.44 dBi/6.30 dBd
F:B Ratio:	to 45 dB
SWR:	1.7:1.0 max.
Connection:	50 ohms direct
Options:	no balun needed
Price Class:	$395.00, free shipping U.S., except Hawaii and Alaska, factory direct

KMA Rover

Frequency Coverage:	88 MHz to 1300 MHz
Number of Elements:	24
Boom Length:	64 in.
Antenna Gain:	8 dBi
Materials:	T6061 aluminum, stainless-steel hardware
Connection:	50 ohms direct
Options:	ferrite-bead balun, vertical mount
Price Class:	$265.00, factory direct

(Full specifications available by request, e-mail factory)

KMA 50500

Frequency Coverage:	50 MHz to 500 MHz
Number of Elements:	20
Longest Element:	12 ft.
Boom Length:	12 ft.
Turning Radius:	8.5 ft.
Weight:	12 lbs.
Wind Area:	3 sq. ft.
Antenna Gain:	8 dBi
F:B Ratio:	28 dB
SWR: 1	1.8:1.0 max.
Materials:	T6061 aluminum, stainless-steel hardware
Connection:	50 ohms direct
Options:	ferrite-bead balun, vertical mount
Price Class:	$315.00, factory direct

KMA 50500S

Frequency Coverage:	50 MHz to 500 MHz
Number of Elements:	14
Longest element:	12 ft.
Boom Length:	6.5 ft.
Turning Radius:	6.7 ft.
Weight:	12 lbs.
Wind Area:	2.5 sq. ft.
Antenna Gain:	7 dBi
F:B Ratio:	24 dB
SWR:	1.8 : 1.0 max.
Materials:	T6061 aluminum, stainless-steel hardware
Connection:	50 ohms direct
Options:	ferrite-bead balun, vertical mount
Price Class:	$275.00, factory direct

Table I. Specifications of some log-periodic antennas.

the area of 7 dBd, while an LPDA with a 2:1 frequency coverage of, say, 14 to 30 MHz might only achieve 4.8 dBd forward gain midband for the same boom length. Amateur VHF/UHF logs are available that span from 41 through 1300 MHz on a 12-foot boom! Obviously, the gain will be far less than a monoband design for the same 12-foot boom length. However, an LPDA will deliver rated gain, a decent F/B ratio, and SWR bandwidth over the intended operating range. The F/B ratio increases with frequency, typically figures of 15 to 25 dB. In general, an LPDA will exhibit lowest gain at the upper and lower frequency limits.

What's Available?

Several respected manufacturers currently offer LPDA antennas for the amateur market. Table I lists the manufacturers and the specifications for their products. All of the models can be used for base or portable work, while the smaller boom designs are more easily broken down and handled for transport. Most of the manufacturers have optional kits to permit mounting the antennas for vertical polarization. Note that vertical polarization often requires end mounting the boom to the mast, which in turn creates a slight lateral imbalance on the mast. Cushcraft's offering, the model ASL6701 log periodic (which will be reviewed in an upcoming issue of *CQ VHF*), comes out of the box supplied with the needed hardware for either polarization. The smallest LPDAs' boom lengths run around 6 feet, and the larger LPDA arrays' boom lengths are about 12 feet. A larger TV antenna rotator should handle these antennas easily.

Toward The Microwaves!

CQ VHF "Antennas" columnist Kent Britain, WA5VJB, produces a line of UHF and microwave log-periodic antennas made from etched PC-board material! Kent was kind enough to send me a few samples. The largest version covers from 400 to 1000 MHz, and it has a "boom" length of 9 inches. Two other smaller models cover from 900 to 2500 MHz, and 2.1 to 6.1 GHz. While they can be used as stand-alone antennas, they are also ideal feed systems for parabolic dishes. If the antennas are to be mounted outside and exposed to the elements, you will need to enclose them in a suitable radome. The 400- to 1000-MHz antenna accepts a PCB-mount SMB connector, and the smaller antennas require soldering directly to the miniature hardline cable used for a launcher. Kent's antennas can be seen in photo 2; contact Kent directly for information (see the references section at the end of this article).

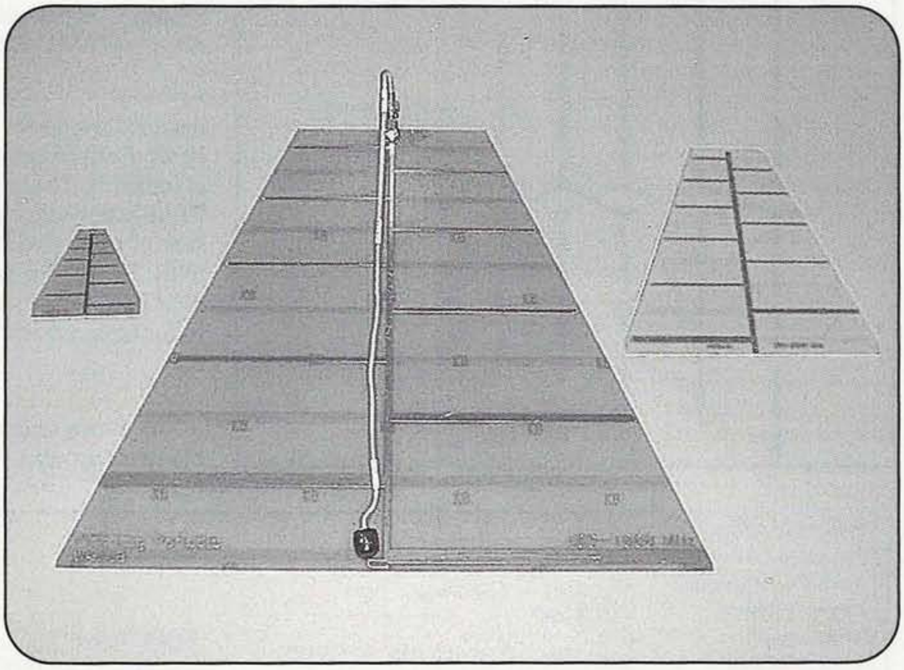


Photo 2. Kent Britain's line of PCB Log Antennas. The largest covers 400 to 1 GHz. The smaller models cover 900 MHz to 2.5 GHz, and from 2.1 to 6 GHz.

How Well Do They Work?

As I mentioned before, these are compromise antennas, suited for those casual operators with limited real estate or ham budgets, or for those who want to sample VHF/UHF operating before committing to a large financial investment. I've had the antennas long enough to get a feel for how well they work, and I'd place them as being on a par with a small two- to four-element single-band beam. I've done a lot of listening during normal band conditions as well as during major contests, and I've heard some decent DX. You will be able to make some DX contacts with these antennas, given a good location, but you probably will not break any records. They do the job and fit my operating style to a proverbial "T."

My Antenna Farm

I'm using the KMA Rover and the KMA 4113 antennas on my tower (see photo 1). Why two antennas? Well, the Rover was designed for the contesting crowd—intended to be used as a quickly set up and easily transported antenna for "roving" mobile stations traveling to rare grid squares during contests. It covers from 88 to 1300 MHz. Likewise, the Cushcraft ASL670, with its short boom and 6-meter coverage, is an ideal candidate for rover or base stations. I end-mounted and vertically polarized the Rover (a factory option) so it would serve for my vertically polarized FM-repeater and FM-simplex needs. Also, the KMA 4113 can be mounted vertically as an option, but I elected to use it horizontally for conventional "DX" SSB/CW work. Tennadyne's T-28, with its 12-foot boom and similar band coverage, is another good candidate to consider for your home station.

I like the slim, sleek look of these antennas! They are also kind of stealth. If you want to keep your ham activities quiet, you easily could convince most neighbors that the antennas are TV antennas, and that's the truth; they will work as such if you so desire.

One Feedline, Two Antennas

Here's a novel solution for saving on coax costs! My feedline length, between the antennas and the operating positions, exceeds 240 feet. The tower is located in the rear-treed lot, about 110 feet in back of my home. My feedlines are buried 7/8-

Photo 3. This Transco relay is similar to the mast-mounted relay on the author's tower. It selects which antenna is connected to the feedline. The relays use a soleniod-driven indexing DC stepper motor and are extremely reliable.

inch Heliax™, carried in underground 4-inch PVC electrical conduits, with intermediate 1/2-inch Heliax™ runs up the tower and into the shack. Rather than duplicate expensive coax runs for each antenna, I located a few surplus military coaxial switches, which use index motors to permit selecting antennas remotely from the shack. I've found 2-, 3-, and 4-pole models at flea markets and on eBay, usually at bargain prices. An example is shown in photo 3. Transco seems to be the most common manufacturer, and I believe they were a high-reliability aircraft-related product. If you look closely at photo 1, you can see the small, protective PVC outdoor enclosure that houses the antenna relay, which is mounted to the mast near the Rover. The box is available from electrical supply houses, such as Graybar.

Other Uses

These antennas cover the high-band VHF public-service band, military and commercial aviation frequencies, as well as all the UHF commercial (GMRS), government, and public-service radio frequencies. An additional bonus is available if you enjoy scanning or FM/TV DXing as a second hobby. They are great for distant FM radio, or for TV stations.

Here's another advantage: Many DXers listen for unusual propagation by monitoring distant commercial public-service, pager, TV, or FM stations, which often gives them the edge in finding good band openings. Many excellent band openings are missed because there is no activity for others to hear! For example, the visual carrier for TV channel 2 is nominally 48.25 MHz in Europe, 49.750 MHz in Africa, and at 45.250 MHz in New Zealand. Another possibility is listening for British activity on their 4-meter 70-MHz band, which is not available for amateur use in the U.S.

Resources

Cushcraft Corporation, 48 Perimeter Rd., Manchester, NH 03103 (phone 603-627-1764). Further information and antenna manuals are available online at <www.cushcraft.com> or e-mail: <sales @cushcraft.com>.

Kent Britain, W5VJB, 1626 Vineyard, Grand Prairie, TX 75052 (e-mail: wa5vjb@cq-vhf.com).

KMA Antennas, P.O. Box 451, New London, NC 28127 (phone 704-463-5820; <www.qsl.net/w4kma/>, or e-mail: <w4kma@qsl.net>).

Tennadyne, P.O. Box 34202, San Antonio, TX 78265-4202 (phone/fax 210-599-9064; <www.tennadyne.com>; or e-mail: <tennadyn@satx.net>). ■

By Kent Britain,* WA5VJB

ANTENNAS

Connecting the Radio to the Sky

Log Periodics

The log periodic is part of a family of antennas designed to work over a broad range of frequencies. The elements are mounted along the transmission line with increasing length. The radio wave travels along the boom and picks out the element it likes best. That element resonates, becoming the driven element. The shorter element in front acts like a Yagi director, and the longer element in the rear of the antenna acts like a Yagi reflector. I like to think of a log periodic as a three-element close-spaced Yagi. It's just a three-element Yagi on whatever frequency you choose.

The log periodic in photo 1 operates from 140 to 1400 MHz. Can we operate a log periodic over an even wider band of frequencies? Yes. It's just a matter of physical size on the low end as well as precision for the smaller and smaller high-frequency elements.

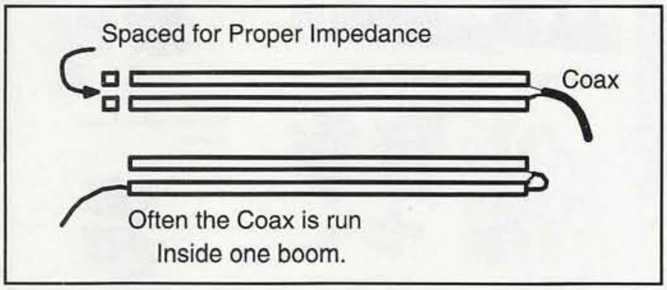


Figure 1. Booms and coax.

As I mentioned earlier, the booms are transmission lines. You should space the booms far enough apart to make them look like a section of twinlead transmission line, approximately 100 to 125 ohms impedance (figure 1). If you try to make the booms down around 50 ohms (one of my first mistakes), the booms may radiate. Also, the elements have a loading effect on the impedance of the booms. While the impedance of the booms may be 100 or 125 ohms, it is possible to use the loading effects of the elements to pull the impedance of the antenna down to 50 ohms.

As you can see in figure 2, the booms look a lot like a cross between a J-pole antenna and a folded dipole. If you are not careful, the booms will radiate mainly off the sides of the antenna, which really messes up the antenna radiation pattern. Later, the loading effects of the elements can be used to load the booms from 125 ohms down to 50 ohms. (My thanks to Roger Cox, WBØDGF, for straightening me out on that one.)

For a Yagi to work, the current in the reflector must be out of phase with the current in the driven element. Carefully choosing the length and spacing between the driven element and the reflector takes care of this (figure 3).

Unlike Yagis, log periodics have some complex phase problems to keep under control. The phase of each set of elements is reversed, which is why the log periodic is usually drawn as shown in figure 4. Each element has the current going the opposite of the two elements closest to it. There are two ways to get this phase reversal. One is by crossing the phasing line, and the second is as shown in the log periodic in photo 1. As an alternative, the elements may be attached to the top or the bottom boom.

*1626 Vineyard, Grand Prairie, TX 75052
e-mail: <wa5vjb@cq-vhf.com>

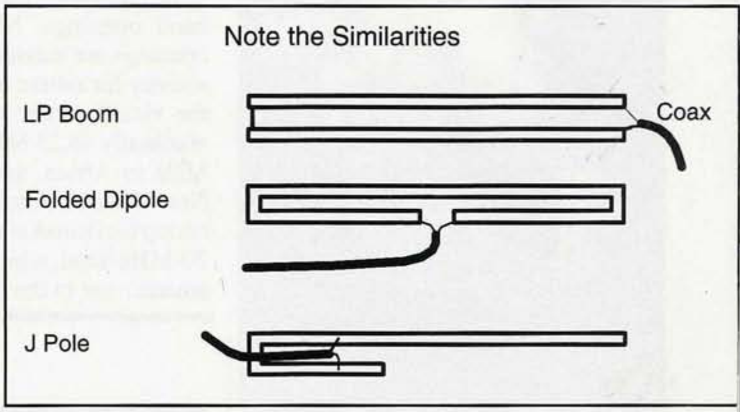


Figure 2. J-pole and folded-dipole antennas.

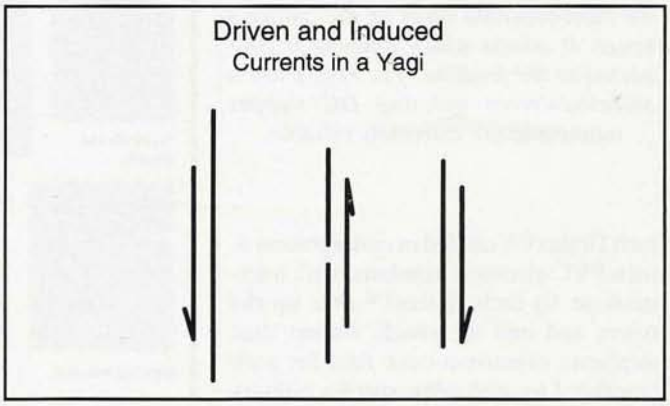


Figure 3. Elements, Yagi and log periodic.

Log-Periodic Computer Programs

There have been some simple formulas distributed around the amateur radio community for designing the log periodic. While these formulas design nice, mathematically perfect log periodics, they usually are not good antennas when built using aluminum.

The diameter of the boom affects the length of the elements. Most of the log-periodic software programs do not factor in the effects of the boom. When the usual element correction factors are being used, you must be very careful, because the element is only sticking out one side! I gave up on calculating this with my first big log periodic. The prototype elements were thread-

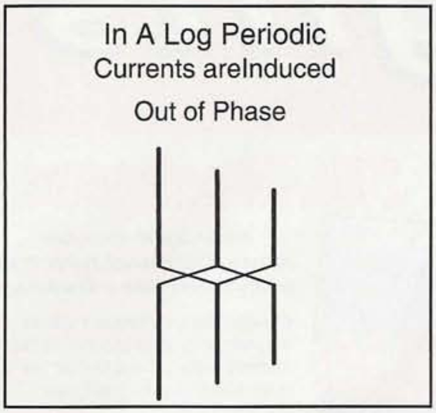


Figure 4. Log-periodic crossed phasing lines.

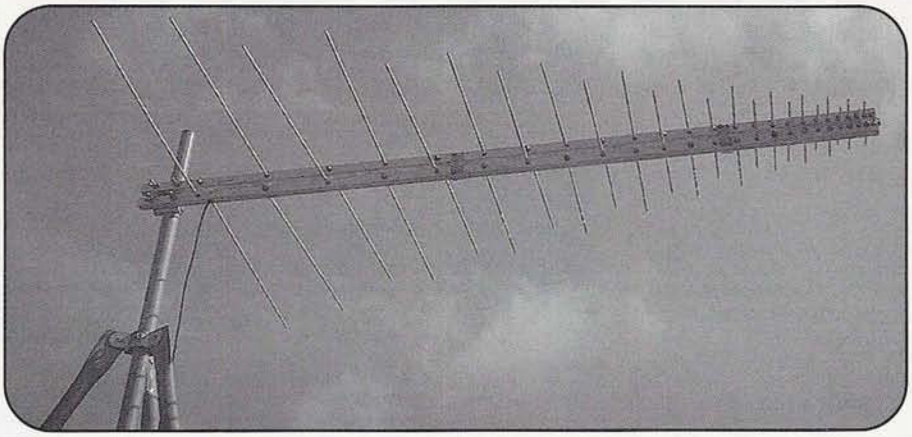


Photo 1. A 140–1400-MHz log periodic.

ed so I could run them in and out of the boom. After a few hours on a network analyzer the design was fixed, and the next ones were not adjustable.

Therefore, most of these programs do not allow for the booms, the size of the booms, the spacing of the two booms, how the elements are connected to the booms, or even the impedance of the coax you plan to use. A a consequence, these simple computer programs are a good starting point for developing a new log-periodic design, but don't expect good performance from the first prototype.

I used to think of the current as moving down the boom and picking out the element it liked. I recently saw a demonstration that showed the current more evenly distributed between the elements. On the "in-between" frequencies, the current will divide evenly between the two elements. Therefore, the transition between elements and frequencies is quite smooth.

	No. of Elements	Reflector	Driven Element	D1	D2	D3	D4
	3						
Length		26.0	*	23.75			
Spacing		0	5.5	13.5			
	4						
Length		26.25	*	24.1	22.0		
Spacing		0	5.0	11.75	23.5		
	6						
Length		26.25	*	24.1	23.5	23.5	21.0
Spacing		0	5.0	10.75	22.0	33.75	45.5

Note: All dimensions are in inches.
**All versions use the same driven element as in figure 6.*

Table I. 222-MHz "Cheap Yagi" dimensions.

Years ago, I saw an amazing demonstration of a logarithmic antenna using a sheet of liquid crystals. You know—that sheet-plastic stuff they make which changes colors when it's heated, often used in "mood rings," and those sheet-plastic thermometers. The demonstration utilized a sheet of this temperature-sensitive plastic lying over a logarithmic antenna. A 10-watt signal generator was connected to the antenna. The RF heated the plastic enough to make it change

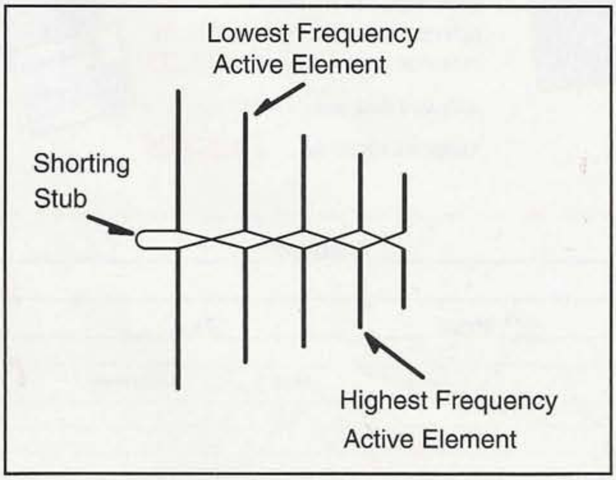
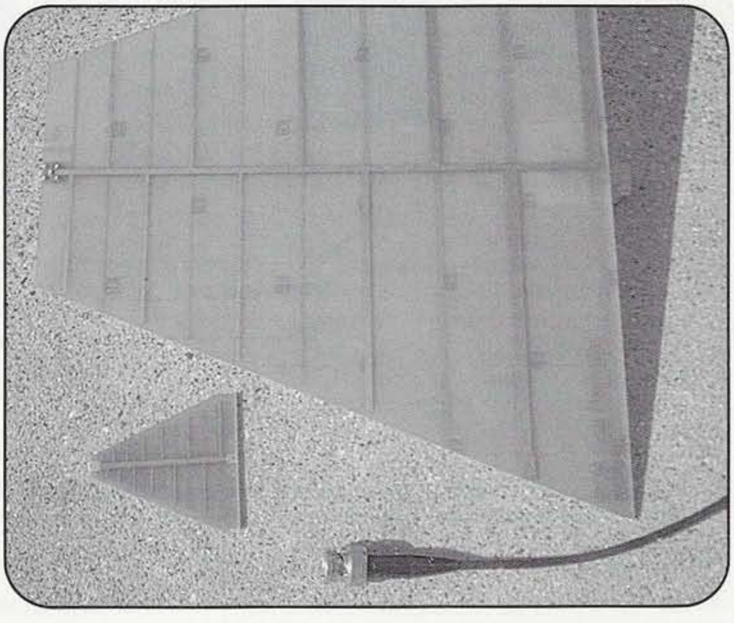


Figure 5. Active elements.

Photo 2. Log periodic antennas using PC-board artwork. →



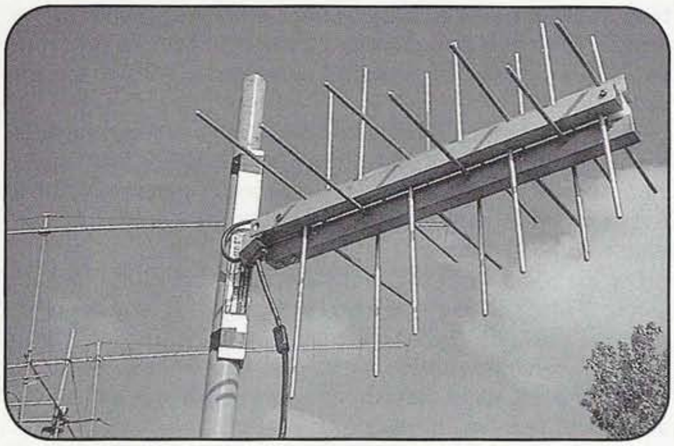


Photo 3. A 435-MHz circular-polarized log periodic.

color. It actually allowed us to "see" where the RF was on the antenna. As the frequency changed, the active area of the antenna changed, running up and down the log periodic as we changed the frequency. The RF didn't really jump from element to element, but it progressed smoothly along the antenna, often with the hot spot halfway between a set of elements.

Shorted Booms

Most of the 20 or so log periodics I have designed, including all five commercial log periodics I have on the market, have the backs of the booms shorted together. At first one would think that this shorts out the RF and kills the antenna. As I mentioned previously, the RF comes along the boom and hits the elements it likes, and the power goes into the elements. The power does not continue along the boom, so it has little effect on the SWR of the antenna. There are big advantages to having the entire antenna as one common ground. If just half the antenna is open, it tends to act a bit like a a quarter-wave antenna on some frequency, and picks up a lot of static electrically when mounted in the open.

If you are trying to reverse engineer a log periodic, these are the last active elements (figure 5). While the first and last elements will resonate, the pattern will be more like that of a dipole than a Yagi, and the SWR will be poor.

We usually make log periodics with all the elements the same diameter, which is certainly the easiest way to build the antenna. For more advanced designs, log periodics really like the diameter of the elements to taper. Even so, we usually can just make them all the same diameter on a limited frequency range without any problems. When making a log periodic using PC board artwork, it is very easy to taper the element diameters, as shown in photo 2. The big one is 400–1000 MHz and the little one is 2–10 GHz.

Yes, circular polarization is possible with a log periodic (photo 3). It's not simple and it's not cheap, however.

A 222 MHz "Cheap Yagi"

This month we have a 222 MHz "Cheap Yagi" (photo 4 and table I). The 222 MHz ham band is pretty narrow, so we don't have to worry about SSB and FM versions because one size fits all on this band.

The driven element is made from 1/8-inch diameter material (figure 6). Silicon bronze welding rod works great. Brass tubing from a hobby shop also works well. Bare #12 copper wire is a

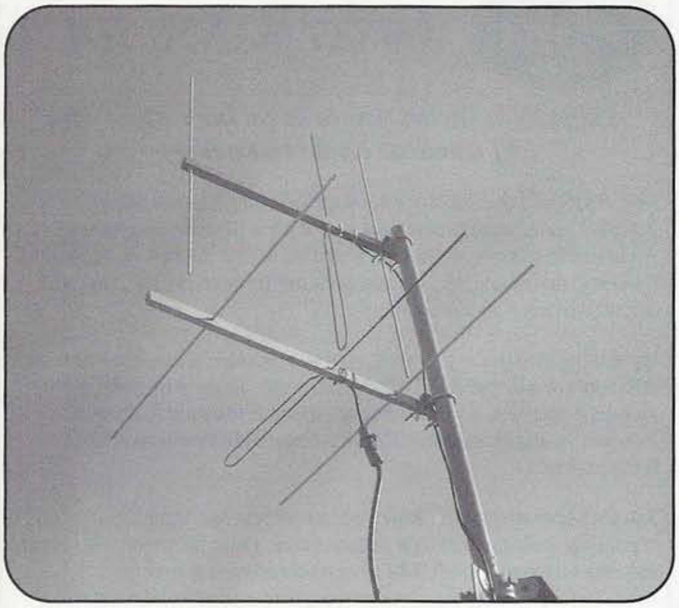


Photo 4. The 222-MHz "Cheap Yagi" construction project.

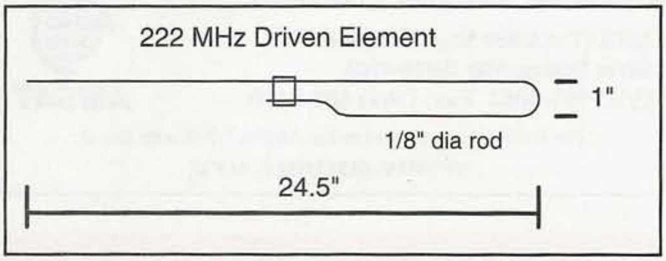


Figure 6. Driven element.

bit soft, but it works on 222 MHz. In the drawing I show the use of RG-58, but you are welcome to use a better grade of coax (figure 7). It's kind of stiff but once I did solder RG-214 to the driven element.

The reflector and directors are made from 3/16-inch diameter rod. For this antenna, however, you can use 1/8-inch diameter rod with little change in performance. Aluminum ground-rod wire, copper wire, welding rod, and hobby tubing have been used with good results.

For the boom I like to use my favorite, 1/2-inch by 3/4-inch wood; 3/4-inch square wood also works well. A drop of epoxy or super glue will hold the elements in place. If you plan to mount the antenna outside for long periods of time, a coating of house paint, clear varnish, or spar varnish will extend the antenna's life by many years.

At the moment, I have six different versions of a Cheap Yagi mounted inside my attic, each looking at different beacons and repeaters. Some have been up there for almost ten years, and they still work fine. I have another dozen or so that I use when I am roving, or when I am out on the antenna range. ■

Feedback
2.45 GHz and "War Driving"

The computer hackers have discovered that those 2.45-GHz wireless networks cover a lot of ground, and many sysops don't encrypt. CNN and several computer magazines have published a gain antenna made from a Pringles® potato-chip container. At the Central States VHF Society Antenna Contest this past July, Lloyd Ellsworth, NE8I, had some 2.45-GHz antennas made from those potato-chip cans. Gain was about 15 dB below a dipole, and what little signal was leaking into the coax was because of the difficulty involved in making a good RF connection to cardboard and aluminum foil. The diameter of those cans is just too small for 2.45 GHz.

In the winter edition of *CQ VHF,* I'll show you how to make a proper 2.45-GHz antenna from a one-pound coffee can. In addition, we'll go over 900-MHz "Cheap Yagis."

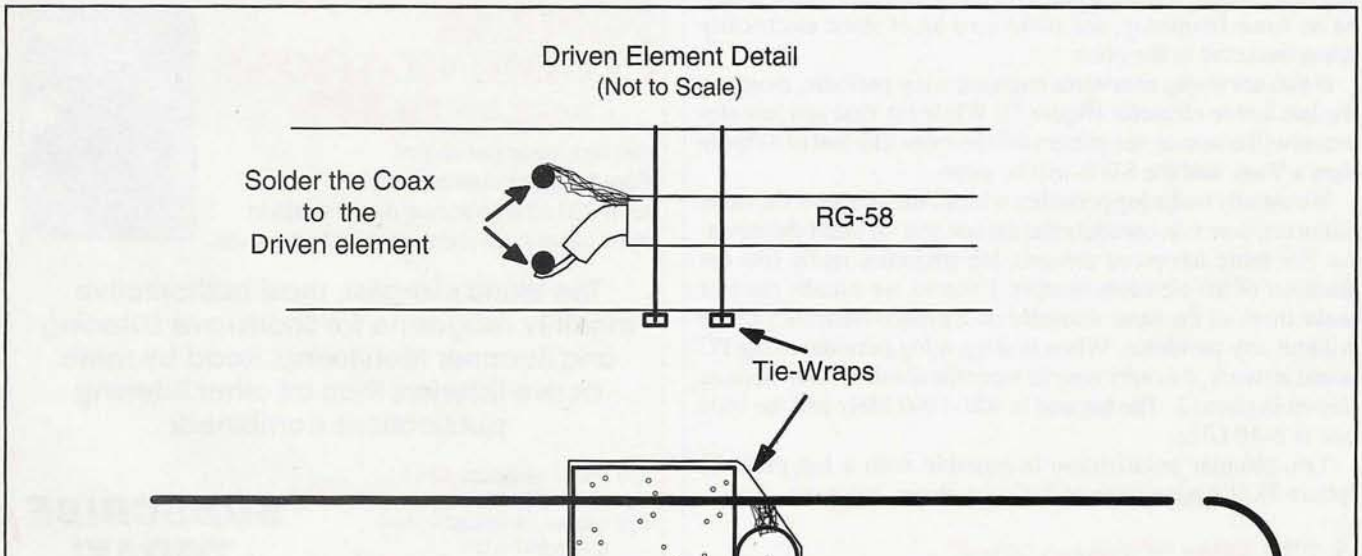


Figure 7. Attaching the coax.

By Tom Webb,* WA9AFM

SATELLITES

Artificially Propagating Signals Through Space

Antennas for Satellite Work

Before we begin this month's topic, I must correct some erroneous information in my summer issue column. I made mention of an HF board for the Yaesu FT-736. *This was incorrect!* The HF board was an accessory for the FT-726! Regrets to all the 736 owner/ operators who thought they had discovered a little-known accessory, and especially to Chip Margelli, K7JA, of Yaesu, who fielded all the calls from operators wanting to know where to get hold of "one of those HF boards."

The Antenna

Now to the business at hand: You have selected a tracking software program and a satellite rig; our next consideration will be antennas.

When I first took up the hobby of amateur radio as a junior high school student, my Elmer imparted several important axioms to me, one of which was "If you have an extra buck to spend, put it into your antenna." This is certainly true in selecting antennas for amateur radio satellite operations.

Several factors can impact your selection—which birds you will work (LEO, AO-40, digisats), location (i.e., covenants and restrictions pertaining to antennas, or room to spare); unattended operations; your budget . . . the list goes on.

Where Do You Put Them?

One thing that isn't critical to mounting satellite antennas is height. Yes, it's best to be clear of trees and buildings, and high enough to be out of the reach of young fingers or folks strolling by, but going to 70 feet will offer no real advantage. Remember, you are communicating through a satellite several hundred or thousand miles away, so an extra 50 feet isn't going to help.

Ground or roof mounting near the shack is the ideal situation. If you are planning on ground-mounting steerable antennas—i.e., azimuth and elevation control (AZ/EL)—such arrays should have enough height to allow an adult to walk under them without bumping the antenna (or putting out an eye). Some folks have elected to mount their satellite arrays on a tripod with minimal ground clearance. This does offer the advantage of easy access, which can be a real plus when antenna work is needed. In the case of a small, stationary array, give the attic (if you have one) some consideration.

The array at this author's station (see photo 1) is 20 feet above the ground and clear of the house eaves. It requires only an 85-foot run of cable (all but the last 12 feet is in the attic). It is just below the roof ridge line, and hidden from the neighborhood association. (We really don't have any antenna restrictions, but why press the point?) Even at 20 feet, access is not really a problem. The tower itself is the ladder to the roof, and the antennas can easily be worked on when oriented vertically, and at the appropriate azimuth.

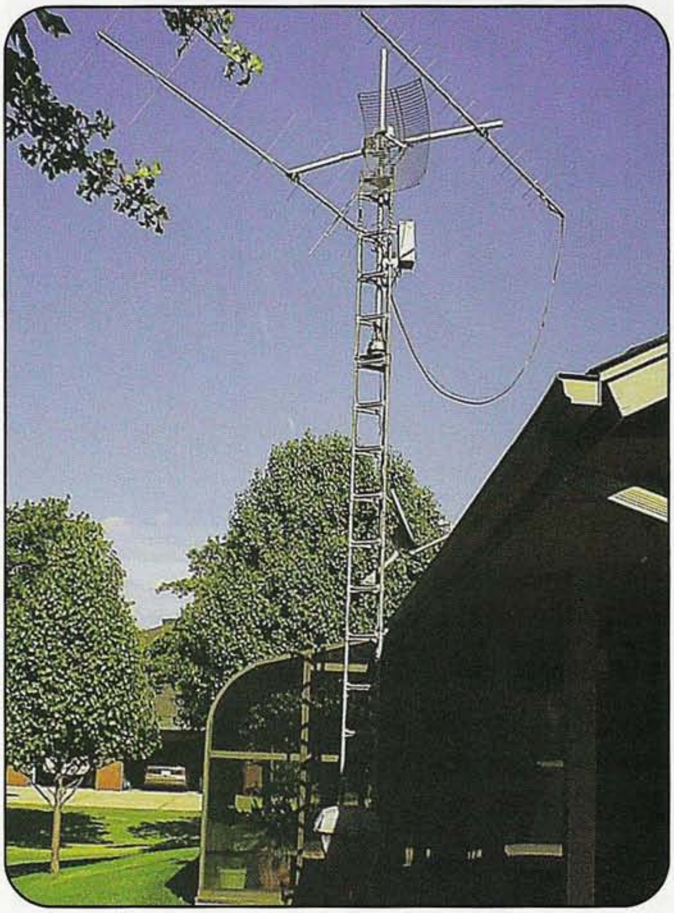


Photo 1. The author's satellite array. Just 20 feet high, it provides plenty of ground clearance, is easily accessed for maintenance, and is hidden from the public street. (Photo courtesy WA9AFM)

If your neighborhood association is deadly serious about its restrictions on antennas, you'll have to get creative. Isn't that what amateur radio is all about, though? Consider the solution devised by Tracy Floren, K7KCS (see photo 2). His entire AO-40 S-mode array is on a rolling platform! When stored, the antennas are put at a predetermined azimuth/zero elevation and rolled into the garage. When Tracy gets on the air, the "mobile satellite array" is rolled out into the driveway, the platform is aligned by "calibrated eyeball," and the fun begins. The aggregate driveway at Tracy's QTH has a rough surface, which prevents the platform from rolling; on a smooth sur-

*10421 SE 55th, Oklahoma City, OK 73150
e-mail: <tmwebb@ionet.net>

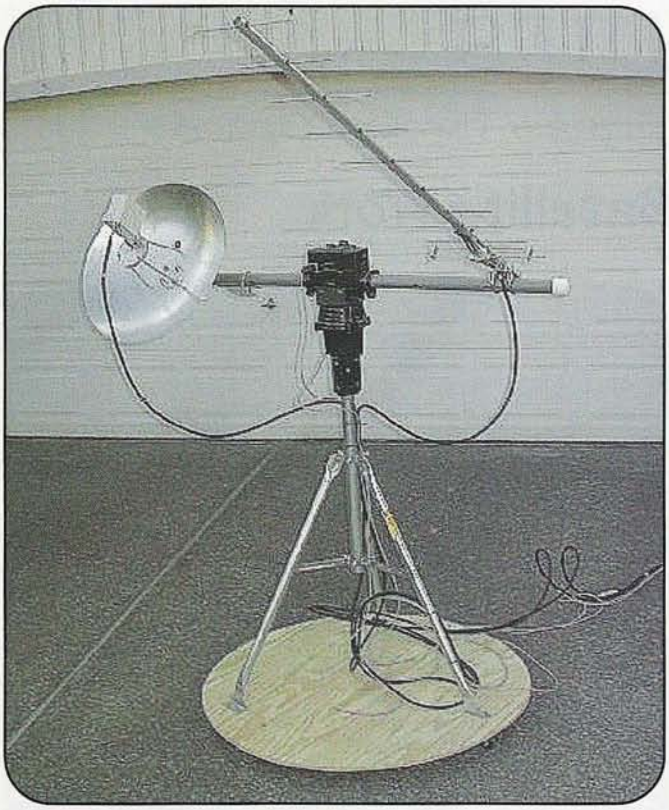


Photo 2. Tracy Floren, K7KCS, won't be deterred by antenna restrictions. The "mobile satellite array" is on a rolling platform and sports a 70-cm beam, 60-cm dish with S-mode converter and AZ/EL rotors. (Photo courtesy K7KCS)

face, rollers with brakes, wedges, or small sandbags should keep things in place.

Which Birds Do You Plan To Work?

The satellite activity you plan to pursue certainly will dictate which antennas you need. For general, multi-purpose activity an AZ/EL array with a 2-meter and 70-cm circular-polarized (more on polarization later) antennas should work nicely. This provides not only for satellite activity, but also for terrestrial operations.

If you plan to work only "low earth orbit" (LEO) satellites, 2-meter/70-cm linear beams should be suitable. Stationary antennas are also an option for the LEOs. Commercial and homebrew stationary antennas can be quite effective. Stationary antennas can also be an acceptable solution to covenants and lease restrictions. AMSAT appears to be returning to the Microsat (see the summer issue of *CQ VHF,* p. 13), specifically OSCAR-E, as the next generation of amateur satellites. These will be LEO birds and easily worked with stationary, nondirectional antennas.

An interesting note about the article in the summer issue: No less than twelve times, the author, Rick Hambly, W2GPS, mentions the technology to be used in the OSCAR-E series has "been flown successfully on several LEO/Microsat missions." I'm confident that this is to reassure the satellite community that the OSCAR-E series will employ tried-and-true technology. You can build a LEO station with the confidence that it will get plenty of use.

If you plan to work AO-40, be ready to look at 23-cm (1.2-GHz) and 13-cm (2.4 GHz) antennas, and if you are really serious, even high as 5-, 3-, and 1.25-cm (5.7-, 10.5-, and 24-GHz) antennas. The employment of SHF and microwave in future satellites is quite likely. Helix, loop, Yagi, and dish antennas would be the order of the day in this case.

The Simplest of All

You may already have the simplest of all satellite antennas, which is a dual-band mobile or base antenna. Although it's not as effective as a directional array, during a low-elevation pass—i.e., the satellite is near the horizon—you can work the LEO birds (for example, AO-14 and AO-27 on FM and FO-29 on SSB). Ironically, an overhead pass usually is not accessible because of the null above a vertical. Tilting your dual-band vertical may help, but this is not always convenient nor even mechanically possible, and if you are moving, as in the case of a mobile station, you might end up pointing the null at the satellite anyway. The bottom line on using your standard-issue mobile/base antennas for LEO satellite work: Leave it vertical and take the contacts you can get; it's part of the challenge. Despite the negatives, mobile stations *in motion* frequently check in on LEO passes.

Directional AZ/EL Antennas

For general-purpose amateur satellite and terrestrial communications, a 2-meter and 70-cm cross-polarized combination beam will serve well. The cross-polarized antennas normally consist of two rows of elements perpendicular to one another on a common boom to present a "circular polarization" (CP). Linear antennas can be configured to give CP by mounting them at opposing 90-degree angles on a common boom (see the spring issue of *CQ VHF*, p. 62, or Chapter 9 of the *Amateur Satellite Handbook*).

In dealing with CP, the receiving antenna must have the same "sense" (signal polarity) as the transmit antenna. To put it in very basic terms, when a downlink signal gets to your station, the sense is either "right hand" (RHCP) or "left hand" (LHCP), as determined by the transmit antenna. If the receive antenna is configured for RHCP and the signal is the opposite sense (LHCP), reception is seriously degraded. To solve this dilemma, a phase (or polarity) switch can be added to change the antenna between R and LHCP. CP and R/LHCP can get very involved; if you really want to delve deeper into it, again look at Chapter 9 of the *Amateur Satellite Handbook.*

Also, ideally, the cross-polarized antennas should be mounted on a nonconductive crossboom so as not to disfigure the circularity. These crossbooms are usually fiberglass, PVC pipe, or even wood. Can a metal crossboom be used? Yes. However, certain criteria in mounting should be followed so as not to disfigure the circularity. For an excellent discussion of this matter by Howard Long, G6LVB, go to <http://www.g6lvb.com/fibermetalboom.htm>. Also, Kent Britain, WA5VJB, provides a short essay on this subject in the spring issue of *CQ VHF* (see p. 58). The metal boom does offer the advantages of strength, it won't sag, and it's much cheaper than a fiberglass unit. Before making your final decision, study the subject in the *Amateur Satellite Handbook* and G6LVB article.

Antenna Sources

In the early years of amateur satellite communications, the primary companies marketing directional, cross-polarized antennas were KLM, Cushcraft, and Hy-Gain. The KLM array

Photo 3. Cross-polarized (CP) antennas provide good, general-purpose service for satellite and terrestrial communications. Note the tips of the 2-meter antenna (left) elements are perpendicular to the elements of the 70-cm antenna. This improves isolation and minimizes desensing. (Photo courtesy WA9AFM)

seemed to be in favor, based on its history and its reputation in the VHF/UHF antenna field. For satellite work, the most popular of the KLM offerings was the model 2M-14C, a 14-element 2-meter antenna, and the 435-18C, an 18-element 70-cm antenna.

KLM did some odd marketing. The 2-meter antenna came with a R/LHCP switch. It wasn't much; a relay was mounted on an exposed circuit board, which required some type of shelter or sealing. In contrast, the 70-cm switch had to be purchased separately and was built like a tank in a cast-aluminum box. The 18C offered the advantage of "end mounting"—i.e., nothing sticking out beyond the back of the boom. However, the 2-meter antenna had to be balanced at the center of the antenna boom, which made the crossboom front heavy. Many folks added a counterweight off the back of the crossboom to minimize strain on the elevation rotor (dead Alliance U-100 rotors were the favorite solution). KLM also offered an extended-boom version of the satellite series.

The "KLM pair" was my first satellite antenna array. They functioned well until a classic Oklahoma hailstorm all but destroyed the 2-meter antenna, and severely damaged the 70-cm antenna.

When KLM closed its doors, M^2 picked up most of their line, improved it, and offered the 2M-CP14, a 14-element 2-meter CP antenna, and the 436-CP30, a 70-cm CP antenna. There are also available a 22-element version of the 2-meter antenna and a 42-element version of the 70-cm antenna. Go to <http://www.m2inc.com> to get full details and specs on these fine antennas.

Hy-Gain also quietly produced its own satellite-antenna offering by combining the 70-30 SAT, a 30-element 70-cm antenna, and 216 SAT, a 16-element 2-meter antenna (see photo 3) into the DB-218SAT OSCAR Satellite Antenna package. Hy-Gain did some smart design and marketing with this package. First, both antennas came with feed points and polarity switches sealed in PVC enclosures. Second, the package also included a 5-foot fiberglass crossboom; most other manufacturers sold the crossboom separately. The Hy-Gain pair have excellent specs and are easy to assemble and rugged in design. The Hy-Gains at my station have operated for over 12 years without problems. The Hy-Gain package was unavailable for a time after MFJ purchased the company. However, they are back in production and merit consideration. Go to <http://www.mfj.com> for further information.

Until about five years ago, Cushcraft offered the AOP-1 satellite antenna package. The AOP consisted of a 10-element (5 vertical, 5 horizontal) 2-meter cross-polarized beam and a 70-cm cross-polarized beam, which was also 10 elements. In addition, a 20-element version of both antennas was offered. They were straightforward, lightweight antennas at a reasonable price. One big advantage of the 10-element 2-meter version was the "end mount" configuration, which was a plus in space-restricted areas (the attic, or above an HF beam) or when low visibility was needed. The polarization was determined by how you connected the phasing harness. If you wanted a remote polarization switch, one was sold separately for each antenna, although you could homebrew one with a coax switch and 90-ohm coax (See page 10-10 of the current edition of the *Satellite Handbook*. You do have a copy, don't you?) According to Cushcraft representatives, the company does not plan to return any dedicated amateur satellite antennas to its product line. Keep an eye out at hamfests and flea markets, however. AOP-1 packages still can be found.

If you are interested in "rolling your own," satellite antennas are the perfect way to satisfy those creative juices. In the spring issue of *CQ VHF,* Kent Britain, WA5VJB, gives step-by-step instructions for a simple, but quite effective 70-cm antenna, and in the summer edition, a 2-meter version (See p. 62 of the spring issue for the 70-cm antenna, and p. 58 of the summer edition for the 2-meter antenna.). Kent's 70-cm design provides about 11 to 13 dB gain, depending on the number of elements. The 2-meter version gives around 8 dB gain on the 3-element version, 9 dB with 4 elements, and 11 dB with 6 elements. The 70 cm version can be configured for circular polarization (Yes, detailed instructions are provided.). The materials for both antennas can easily be obtained: 1/8-inch diameter aluminum wire, aluminum rod, #10 or #12 copper wire, some 72-ohm coax (for the phasing lines), and 1" × 1" × 2–5' wood boom. That's right—wood! As Kent asserts, "Wood is cheap!"

Stationary Arrays

(Or Did Julia Child Design This?)

If you suffer under zoning or rental restrictions (think attic mounting), intend to work LEO satellites only, or if you just want a simple, straightforward satellite array with minimal maintenance, you should consider stationary arrays. A stationary array is essentially "set and forget." Mount the selected antennas (usually 2 meters and 70 cm) up and in the

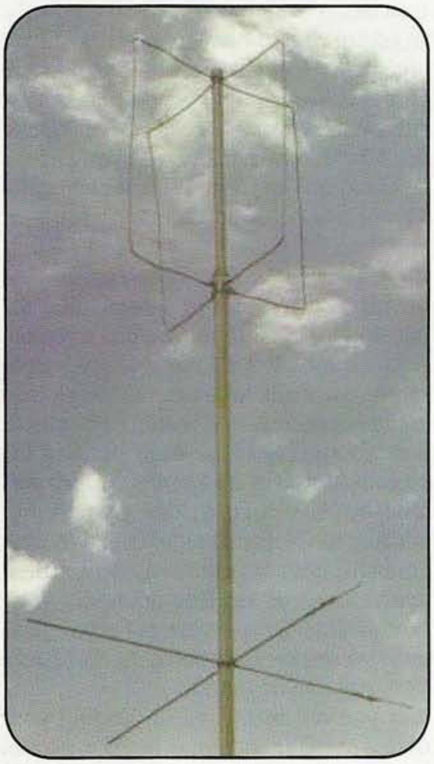


Photo 4. A 2-meter homebrew Eggbeater antenna designed by Jerry Brown, K5OE. Jerry has also built a 70-cm version. Jerry's website (http://hometown.aol.com/k5oe) is a treasure trove of information on satellite antennas. (Photo courtesy K5OE)

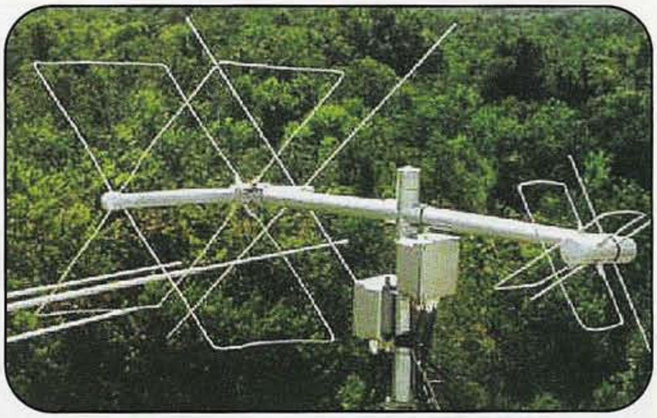


Photo 5. A Texas Potatomasher II, also by K5OE. The 2-meter element is to the left; the 70 cm to the right. The array is rotated for azimuth only. This design represents a great compromise between a stationary and directional array. (Photo courtesy K5OE)

clear, and you're ready to go. The stationary array gives you "bubble"-shaped coverage over your location; no rotors, and no tower needed. Properly installed, the stationary array can be a very effective antenna.

The "Eggbeater" is one of the more popular stationary satellite antennas, although it is rather odd in appearance. The commercially made Eggbeater antenna from M^2 has been around for a while, and it is quite popular among the digisat crowd. The 2-meter (EB-144) and 70-cm (EB-432) versions are available. An accessory radial kit is also provided to enhance coverage for an overhead pass. One satellite operator in Oklahoma City worked AO-13 (when it was still in orbit) using the Eggbeater pair—while operating mobile!

The halo (a.k.a. loop) antenna, which was very popular in the early 1960s, is making a comeback for base and mobile work. Also, it makes a pretty decent LEO satellite antenna. The "big wheel" antennas are in the same category. The KB6KQ Loop Antennas (http://www.kb6kq.com), the Olde Antenna Lab of Denver, M^2, and the PAR Electronics "OmniAngle" series (http://www.parelectronics.com) all deserve serious consideration.

Again, if you want to "roll your own," check out the website of Jerry Brown, K5OE (http://hometown.aol.com/k5oe). Jerry has not only constructed a homebrew eggbeater (photo 4), he also has taken it one step further with The Texas Potatomasher (photo 5). Jerry's entire site is a treasure trove of information on satellite antennas. Some browsing on his site would be time well spent.

"A" Mode Receive

The "A" mode (2-meter uplink/10-meter downlink) was the first mode used. OSCAR-6, launched in October 1972, lasted $4^1/2$ years. The logic for creating the "A" mode (29.4–29.5MHz downlink) was simple. For uplink, there was not a lot of commercial or even affordable homebrew 70-cm gear in the early 1970s. In some countries, UHF frequencies were not available and equipment could not be obtained. Receiving the downlink on "A" mode was a fairly simple project. Because most operators could get their hands on some sort of 2-meter CW rig and virtually everyone had some kind of 10-meter receiver, it opened up satellite communications to the entire amateur community.

If you have an HF beam in the air, you're in business—at least for low- to mid-elevation passes. For higher elevation passes, a 10-meter dipole works nicely. The dipole's main disadvantage is its deep null off the ends. To solve this, mount two separate dipoles perpendicular to each other, with the feed lines coming into the shack (or use a remote coax switch) and select the antenna giving the best reception. To get the full benefit of a high-elevation pass, consider a "loop" antenna on its side. The old "Squalo" 10-meter mobile should also do the trick. For a wire antenna, the formula for loops can be found in *The ARRL Amateur Radio Handbook.* There is also an excellent discussion of "A"-mode receive antennas in Chapter 10 of the *Amateur Satellite Handbook.*

Why consider a mode that was last employed on RS-16 launched in 1996? The answer is simple. One currently operating amateur satellite still uses "A" mode, RS-15, and at random times the recently resurrected AO-7 shifts into "A" mode. This mode still might make a comeback. As mentioned, in countries where UHF or microwave gear is unavailable or not authorized, "A" mode is the perfect satellite communications channel. Also, the International Space Station (ISS) eventually will be equipped with HF gear. We wouldn't want to miss out on that, would we?

Portable

Most operators envision portable satellite operation as "doing a satcom demo at the hamfest." However, there is a tremendous amount of portable, roamer, or rover work done on satellite. For a portable antenna, the Arrow Antenna (model 146/437-10) is favored for activating those rare grid squares. As the name implies, the "Arrow" uses aluminum arrow shafts for its elements and a $^3/4" \times$ 36" aluminum box beam for the boom. (A new version of the Arrow allows the boom to be broken down to shorter lengths). The Arrow has a 3-element 2-meter antenna mounted perpendicular to a 7-element 70-cm antenna (see photos 6 & 7). It comes with a foam grip for easy handling. The two antennas have their own feed points (BNC connectors). If you plan to use a rig without separate 2-meter/70-cm connectors, such as an HT or a mobile rig, you will need a duplexer. The manufacturer offers a 2-meter/70-

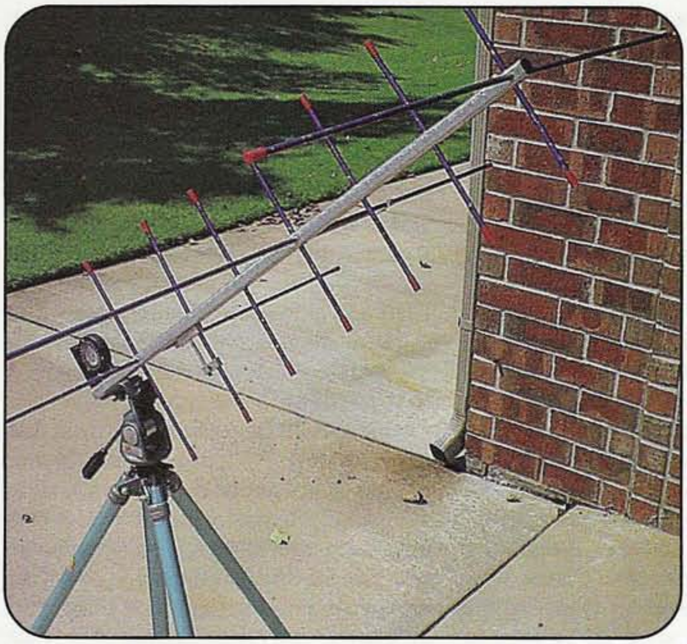


Photo 6. The Arrow Antenna is the odds-on favorite for portable operation for either satellite or mountaintopping. It can be completely disassembled for easy transport. For satellite work, a protractor has been added to the end of the boom to align elevation. An extra hole drilled into the boom permits mounting on a standard camera tripod. (Photo courtesy WA9AFM)

cm duplexer that fits inside the boom, but any standard-issue 2-meter/70-cm duplexer will work fine.

Some bird chasers use the Arrow as their primary antenna. Some Arrow antennas offer mast clamps for mounting the antenna to standard mast. Because the entire antenna can be completely disassembled, it's great for mountaintopping, and a "roll up" case recently has been introduced to store the Arrow

Photo 7. Pete Mann, KF5RD, using the Arrow Antennas 146/437-10 to make a few satellite QSOs during the recent N5V special event station operation.

during transit. More detailed information can be found on the Arrow Antenna website at <http://www.arrowantenna.com>.

S- and L-Mode and Above

If you plan on working L-mode (1.2 GHz uplink) or S-mode (2.4 GHz downlink), you are looking at some rather specialized antennas. Without a doubt, the helix antenna is the most elegant, "scientific"-looking antenna for this job. Its "corkscrew" shape with the supports and reflecting plane has such a professional look that even the neighbors will be impressed. However (there's always a *however* that seems to spoil things), it cannot be configured to switch polarity. It is either RHCP or LHCP. Therefore, if you want the flexibility of switchable polarity, you have to mount two antennas—one RHCP and one LHCP. On the up side, the gain on a helix, which is determined by the number of turns, can be quite good. On a theoretical 70-cm helix, the gain can range from 10 dBi for three turns to 16 dBi for twelve turns.

Because of the Helix coil's size, 2-meter and 70-cm helix antennas can be rather difficult to construct, but they are available commercially. SSB USA <http://www.ssbusa.com> carries the WiMo line of helix antennas for 70 cm up to 2.4 GHz. Downeast Microwave <http://wwwdowneastmicrowave.com> has several brands of helix antennas, including the Directive Systems Helix, which has a protective cover (for more information on the Directive Systems Helix, see Downeast's website, <http:// www.directivesystems.com>).

For 13 and 23 cm, things are not quite so difficult if you want to "roll your own." Because the coil of a 13- or 23-cm helix is fairly small, heavy copper wire will do quite nicely without any support. Jim Miller, G4RUH, has written numerous articles (see <http://www.amsat.org/ amsat/articles/articles/html>) on constructing helix antennas from rather simple materials, which include the reflector from a dish-shaped hanging lamp, along with "other bits and pieces." Jerry Brown, K5OE, has done some extensive helix experimentation, and the results were presented in a paper to the 2001 AMSAT-UK Colloquium (see <http:// hometown.aol.com/k5oe>). Also, Kent Britain, WA5VJB, provides a short essay on this subject in the spring 2002 issue of *CQ VHF* (see p. 58).

Another antenna to consider for L- and for S-mode is the loop Yagi. A long-time favorite of the ATV community, the loop Yagi is simple in construction, has gain in excess of 18 dBi, is light weight, and in some cases can be end mounted (a real space saver). Although the loop Yagi is relatively easy to build (see *The ARRL Antenna Handbook* for construction details) the loop Yagi is available commercially. One downside of the loop Yagi is its susceptibility to damage, specifically the delicate metal loops. Once when I was considering the use of a loop Yagi, I was advised to mount the antenna with the loops hanging down. This prevented, or at least minimized, possible hail damage. Also, birds were prevented from landing on the loops and flattening them. Downeast Microwave has several brands of loop Yagis, including the Directive Systems loops (for more information on the Directive Systems loop, see their website <http://www.directivesystems.com>).

The standard Yagi is also an option. M^2 <http://www. m2inc.com> offers the model 23CM22EZ, a 22-element 1.2 GHz Yagi, and a 35-element version, the 23CM35EZ. With the appropriate phasing harness, the 22 and 35EZ can be configured for RHCP or LHCP.

The "bar-b-que grill" antenna is quite popular for S-mode

Photo 8. The "bar-b-que grill" antenna for S-mode downlink derives its name from the cast-magnesium/aluminum reflector. This model has better than 24-dB gain. Its original function was for Multipoint Microwave Distribution System (MMDS)—i.e., wireless cable television. (Photo by the author)

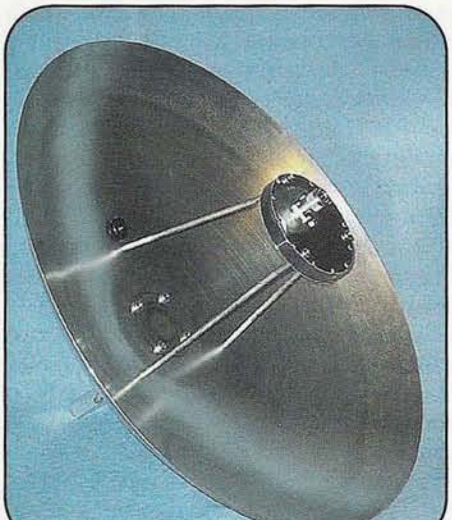


Photo 9. A 60-cm (2-foot) spun dish with patch antenna for 2.4 GHz. The unit is available from Jim Miller, G4RUH <www.jrmiller.demon.co.uk/products/sant.html>. The dish with patch antenna has a gain of about 21 dBi. It is configured to permit the mounting of an S-mode converter directly to the back of the patch antenna. (photo courtesy James Miller, G4RUH)

receiving (see photo 8). The name is derived from the reflector plane, which is fabricated from either cast magnesium/aluminum alloy or a heavy wire grid. These antennas began life as receive antennas for Multipoint Microwave Distribution System (MMDS), *a.k.a.* Wireless Cable. With the advent of Direct Satellite Service (DSS), MMDS quickly became obsolete. MMDS shares the 13-cm spectrum with the Amateur Radio Service, so "the grill" was an ideal and economical 2.4-GHz downlink antenna. They are relatively small, just 2' × 3.5', and take up little space, nor do they add much weight to a crossboom. They are available from several commercial sources, including SSB USA <http://www.ssbusa.com> and P.C. Electronics <http://www.hamtv.com>. Check with your local cable company (Most of the MMDS operations were an adjunct to cable operations.) and see if they have any sitting in the corner taking up space. You might get a "freebie."

Covering the reflector plane with fine wire mesh can enhance the characteristics of the "grill." Some experimenters have renovated the grill into a quasi-disk antenna, mounting the S-mode converter at the focal point. Jerry, K5EO, made a presentation on these modifications at the 2001 AMSAT NA Symposium <http://hometown.aol.com/k5oe>. The magnesium-alloy version of the grill is pretty rugged; the wire grid version is susceptible to damage, but can be repaired. Yes, you can transmit with the grill. It will handle between 10 and 50 watts.

The dish antenna (see photo 9) provides just about the ultimate package when operating in the SHF/microwave spectrum. George Murphy, VE3ERP, presented a detailed article on the dish, more specifically the "parabolic dish reflector," in the spring 2002 issue of *CQ VHF* (see p. 42). The solid, spun-aluminum dish, with either an L- or S-mode converter mounted at the focal point, can provide up to 21 dBi of gain with a rather modest structure. The dish has the advantage of virtually no sidelobes, and very light weight (about four pounds). Its rather small size allows mounting in restricted space, and it has a low noise factor. This latter point is very important when using a low-noise converter/preamp. The basic dish, usually made of spun aluminum, requires a set of supports, extending to the focal point to mount the antenna/converter assembly.

Jim Miller, G4RUH <http://www.jrmiller.demon.co.uk/products/sant.html>), markets a 60-cm (about 2-foot) dish kit with "patch" antenna. A small helix antenna will work quiet well also, but the patch antenna offers better mechanical stability. As mentioned, to achieve maximum efficiency, the converter, and preamp if required, should be mounted directly at the focal point. Other sources for the 60-cm dish include SSB USA and Downeast Microwave.

There are, however, a couple of disadvantages to a dish. One is wind resistance, so if you live in a windy area, a very solid mounting will be required. Also, a dish not only reflects radio signals, it also reflects heat, and heat is not a friend of delicate electronic equipment. A recent thread on the AMSAT bulletin board addressed the subject of painting the dish. The general consensus was that flat-gray or white would minimize heat reflection; witness the DSS (digital satellite service) antennas. Although some operators first thought that painting would attenuate signals, experimentation revealed no measurable degradation.

What about DSS dishes? Certainly they will work, but remember that you are working with an "offset" focal point, which can involve some rather thrilling math. However, the approximate focal point is already identified for you by the LNA (low-noise amplifier) on the support arm. With a bit of experimenting, the true focal point for your patch or helix antenna can be discovered. DSS (*a.k.a.* PrimeStar, DishNet, DirecTV) dishes are usually fiberglass, very weather resistant, and (Here's the good part.), fairly cheap!

Now For Something Completely Different

As you can imagine, antennas at VHF/UHF, especially those used in satellite communications, can take on some rather strange shapes and configurations. The Lindenblad and Quadrifilar Helix are two fine examples.

During visits to your local airport, you may have noticed some rather strange antenna configurations on the control tower. One antenna in particular looks like a badly damaged turnstile antenna; this is a Lindenblad antenna, *a.k.a.* Lindy (see photo 10). Long used for aircraft communications, it provides an omnidirectional pattern, favoring low elevation angles with circular polarization—an ideal configuration for working aircraft in various altitudes of flight and, by

Photo 10. The Lindenblad antenna for 2 meters. Originally design for aircraft communications, this rather strange-looking design offers an omnidirectional pattern and circular polarization, which is ideal for horizon/low-elevation passes. Like the helix, it is either RHCP or LHCP; switching is not an option. (Photo courtesy Howard Sodja, W6SHP)

Photo 11. The Quadrifilar Helix antenna (QHA) gives excellent reception for overhead passes. Favored by WXSAT enthusiasts for reception of 137-MHz weather satellite photos, it has also been embraced by digisat operators for unattended operation. Although construction is a bit complex, it can produce outstanding results. (Photo courtesy Steve Blackmoore, Pilot Consultancy Limited) →

happy circumstance, satellites low on the horizon. With an increase in transmitter output power, you might even be able to work a bird at, or even just below, the horizon. Essentially, the Lindy is four dipoles mounted in a circle about 0.3 wavelength in diameter. The dipoles are tilted at a 30-degree angle and fed in phase with a coax power divider. The Lindy, like the helix, is either RHCP or LHCP—no switching. It is a rather easy antenna to build for either 2 meters or 70 cm. An excellent essay by Howard Sodja, W6SHP, on the theory and construction of the Lindy can be found on the AMSAT website <http://www.amsat.org/amsat/articles/w6shp/lindy.html>.

The Quadrifilar Helix, *a.k.a.* QHA (see photo 11) is a rather odd-, but at the same time elegant-, looking antenna. It almost has the look of a piece of artwork—a handy story if the neighbors begin to get inquisitive. The QHA is an omnidirectional antenna, which favors the main axis of the antenna, with a beamwidth around 110 to 115 degrees. When mounted vertically, its pattern is an omnidirectional bubble directly above the station. It is ideal for unattended operation, which is the reason the weather satellite (WXSAT) community favors it. Thus, it has found favor among digisat operators. It also makes an excellent antenna for a spacecraft. The recently resurrected AO-7 uses a QHA on the 2.4-GHz beacon. The QHA is actually four 2-turn helices mounted around a common axis. The phasing and feeding of the QHA is quite critical, making it somewhat difficult to build. Again, if you like "rolling your own," check out Steve Blackmoore's website <http://www.pilotltd.net/qha.htm> for construction details and other links to information and construction of a QHA.

A Tip of the Hat

I would like to take this opportunity to thank Ed Hammond, WN1I, of Cushcraft Antennas; Jerry Brown, K5OE; Jim Miller, G4RUH; Tracy Floren, K7KCS; Al Lowe, NØIMW, of Arrow Antenna; Steve Blackmoore, of Pilot Consultancy Ltd.; and Howard Sodja, W6SHP, for their assistance preparing this article.

73, Tom, WA9AFM

Flying Amateur Television Some Dos and Don'ts

Last issue N6CL highlighted the use of ATV while airborne, describing the fun and benefits of aeronautical mobile ATV. In this article Features Editor Gordon West comments on these issues and gives advise on what can and cannot be done with your air-mobile ATV station.

By Gordon West,* WB6NOA

The summer issue of *CQ VHF* presented an exciting photo review of the Tulsa, Oklahoma Amateur Radio Club's ATV operation during Field Day *(see the sidebar by N6CL on p. 76 in the feature "What is ATV?"—ed.)*. Air-mobile amateur television is not only fun and educational when it comes to propagation, it is also potentially life saving during a widespread emergency. Every emergency team should try to include airborne ATV in its disaster-preparation plan. No other mode can truly show the disaster area as well as television aloft, and sometimes the news choppers might be hours out before they can hover over an affected area.

In this article we will look at aeronautical ATV from both a technical and a legal perspective. Not only are ATV ham-band transmissions regulated by FCC rules, the equipment inside the aircraft is governed by FAA rules, as well.

The author prepares the ATV equipment for a disaster preparedness flight.

First, The Rules

"The FAA says that anything that is fastened to the aircraft must be approved and signed off," explains Tom O'Hara, W6ORG, with P.C. Electronics.

"The ATV equipment all can be put into a plastic milk crate or into an open suitcase and strapped into one of the seats. A gel-cell can be used to power the equipment," advises O'Hara, who is an expert in flying with ATV in his own helicopter, and who also set up airplane ATV during recent Rose Parade events.

Here in southern California, our local city helicopter mechanic (KF6EGL) works closely with an air-frame inspector, giving us the capability of "semi-portable" ATV installations. Everything you do from within the helicopter must be approved by the pilot, and the pilot needs to know when you are transmitting ATV to ensure that there is no interference to onboard radio equipment.

There are also FCC rules that must be met before ATV is installed on an aircraft. FCC Rule 97.113(b) prohibits one-way transmissions done simply by turning on the ATV equipment and flying with it always on. You should transmit only when a ham on the ground directs the ham in the aircraft to start transmitting, and then you should stop transmitting. This can be done on a 2-meter simplex ATV liaison frequency.

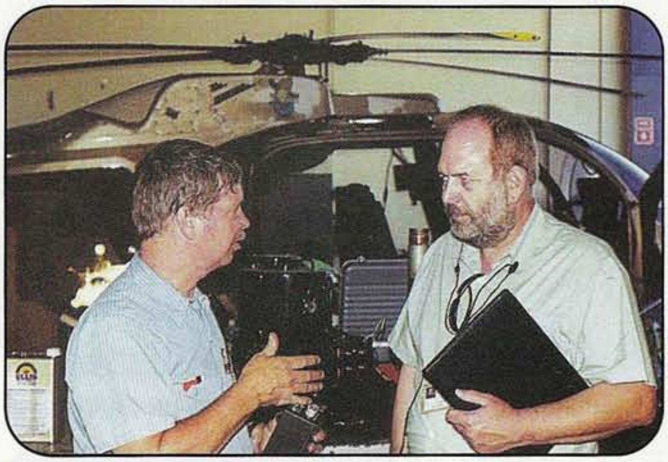
Another rule, 97.101(d), requires that the ATV control operator in the aircraft monitor the channel before transmitting to ensure that the frequency is clear. This is accomplished easily with the ICOM R-3, a very handy device for keeping a check on your ATV transmit audio and video levels.

City volunteer hams instruct the ham licensed pilots when to turn on their ATV transmitter. (Photos by the author)

FCC Rule 97.119(b) requires identification. This might be done on the ATV camera, or by panning to a white card with callsigns, or putting the call letters on the skid of the helicopter, or saying

*CQ VHF *Features Editor, 2414 College Dr., Costa Mesa, CA 92626 e-mail: <wb6noa@cq-vhf.com>*

This is the P.C. Electronics 10-watt ATV transmitter inside the helicopter.



Helicopter mechanic Chris Freeman, KG6EGL (left), discusses where he will install the antenna.

Checking ATV reception from the nearby craft with the ICOM R3 TV/scanner.

your callsign over the audio link. Most hams do video ID constantly, because audio added to the video is not much more than the constant engine noise of the aircraft.

FCC Rule 97.113(a)(3) must also be heeded: Never allow the operator of the aircraft to send ATV pictures on behalf of his or her employer. This means a cropduster ham cannot send ATV pictures back to his buddy who owns the crop-duster business while spraying a nearby field. It also means that ham operators who are also pilots flying the city police helicopter cannot do ATV surveillance, nor police chases, nor crime-scene investigations and send pictures down to the watch commander, even though the watch commander may have a ham ticket. The exception to FCC Rule 97.113(a)(3) is if the pilot of the crop duster is sending back pictures of a lovely lake and boats on the lake to his pal on the ground, or if the licensed ham police pilot is sending down disaster training video scenarios to the all-volunteer ham radio emergency response group. Regarding the latter, as long as the ham licensed pilot is not paid, and his city does not receive any pecuniary kickback on this training, FCC Rule 97.1(a) "particularly with respect to providing emergency communications" would best describe this type of disaster ATV training.

For more information on this subject, log on to <http://www.hamtv.com> and review the W6ORG discussions of ATV in aircraft—both the legal and technical considerations.

The Technical Side

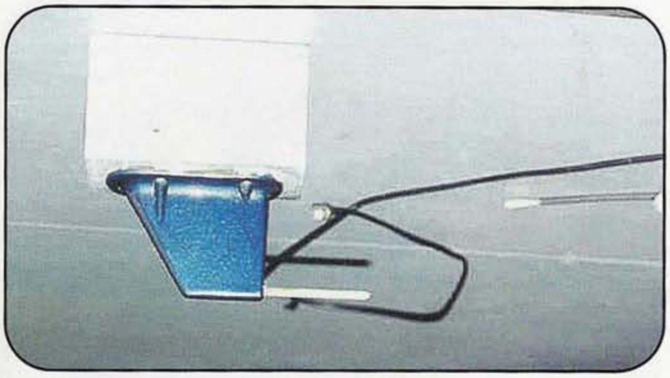
Regardless of how portable your aircraft ATV system is, the transmitting antenna *must* be out in the breeze for best reception. If your aircraft is equipped with an extra UHF spike on the belly, you are all set. Even though the spike is probably tuned to public safety at 460 MHz, we have found that it will work dandy down at 428 MHz, and for short ATV transmissions, the elevated SWR will not overheat your small transmitter. Normally, we choose the 70 cm band for ATV simplex activities, because this is where most of the low-cost ATV transmitters are found. 900 MHz and 1.2 GHz are also available for ATV, but the 70-cm band seems to work best in both range and equipment availability.

Warning: Do not substitute a longer spike for the aeronautical-approved, slightly shorter quarter-wave whip. Vehicle whips are not suited to aeronautical installation, and they will fracture quickly with the vibration. The FAA will not be pleased to see spikes falling out of the air! Stay with only approved aeronautical antenna installations.

Aeronautical coax cable is usually Teflon®, double-shielded, with a tight braid or an aluminum-foil weave. Tom, W6ORG, suggests RG-400 or RG-162. Your aircraft mechanic will have plenty of this cable on hand for his communications installation. **Caution:** Always let the mechanic do the wiring unless it's your own personal aircraft.

Your transmitter can be 10 or 20 watts output, with no amplifier needed. Any more than 20 watts and you will zap your portable battery fast. You will also create interference to other communications equipment onboard. The difference between 10 watts out and 20 watts out is negligible when seen by a ground station up to 20 miles away.

For airplanes, your little handy camera will be fine. Take the focus out of the automatic mode, or the camera will try to focus on the clear windshield. Also, I suggest manual aperture so your light level does not fluctuate constantly. Run a videotape at the same time as you are running ATV, and this way you can compare the pictures from the air with the pictures on the ground.



Aircraft ATV UHF antenna being wired into position.

Excellent ATV reception from a mobile ground station using horizontal loops. →

Having a videotape running will also keep your camera from shutting off automatically.

For helicopter installations where there may be a forward-looking infrared (FLIR) unit in place feeding an onboard VCR, check with the aircraft mechanic to see if you can tap off the VCR for your ATV camera input. This can give you some exciting video, including infrared, zoom, wide-angle color, camera graphics, altitude, and anything else that may be displayed on the cockpit computer screen.

If your helicopter is part of a public-safety agency fleet, I suggest that you *do not* tie into their audio system. You can inadvertently repeat-out headset audio, which is not permitted in the amateur service. Our local city flies with no audio, and all of our intercommunication from ground to air and back again is carried over our local ham repeater frequency or on the local ATV simplex coordination frequency.

Before taking off, test the ATV system on the ground. If you use a down-converter or the little ICOM R-3 handheld, you *must* be separated by at least 1000 feet, or you will swamp the receiver and could mistakenly assume that there is something wrong with the transmit video. The overload will cause the picture to look scrambled. To compensate for this, remove the little antenna, and the picture will come in fine.

As a good test to see how an ATV picture will look, use the little ICOM handheld with no antenna, separated from the aircraft by about 100 feet. If you still hold on to a P5 picture, you are all set.

Double check that the aircraft is going to transmit on a simplex ATV frequency, such as 426.250 MHz. Many areas of the

The American Red Cross tunes in ATV as part of disaster preparedness.

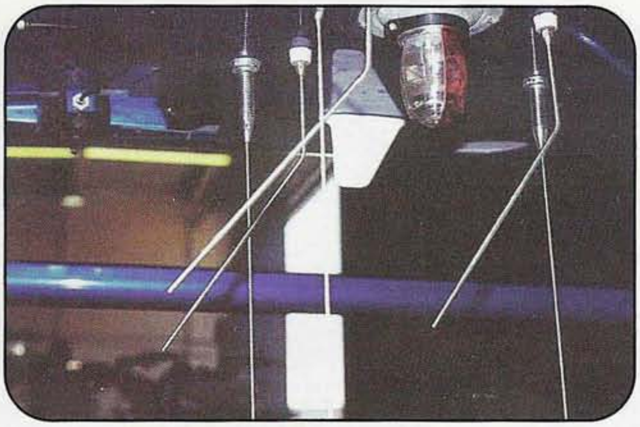
country have ATV inputs on other 70-cm frequencies, and you could inadvertently trigger up a building-top or mountaintop repeater on another band. You would never operate ATV over an ATV repeater until *after* the repeater control operator has given you the go-ahead. Here in southern California, our amateur television network (ATN) is always excited to see what we are going to show from the air over their 5000-foot mountaintop repeater.

Here is something that should be obvious, but is often overlooked: If the repeater is on a mountaintop higher than the altitude at which the aircraft is flying, the belly-mounted antenna would have a hard time getting the signal to that repeater; and while direct ground reception looks P5, the repeater reception looks terrible around P1. Shielding, as well as a helicopter rotor-blade disruption of the UHF signal, causes this problem. We could not believe it: On the ground, the repeater picked up the helicopter P5, but as soon as the blades started revolving, it would begin to chop up and quickly became P2. Lesson learned: Your best reception from helicopters and most likely airplanes is almost always direct from aircraft to ground.

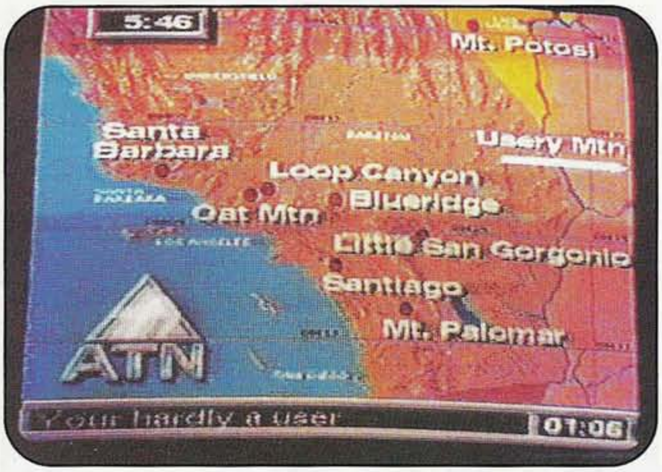
Your ground antenna should *not* be a high-gain collinear, white fiberglass, major-gain antenna. This type of antenna creates a major null off the tip, and you already have a major null off the tip of the aircraft antenna. Two major nulls lead to terrible reception, even though you can see the aircraft or helicopter circling overhead. Switch over to a simplex quarter-wave whip, or better yet, a weak signal loop antenna, and you will be surprised how much the nearby aircraft signal will improve.

When the aircraft flies directly overhead, you will notice that the received signal gets progressively worse. This is not caused by signal reduction from the vertical antenna tip null, but rather because of multipath signal cancellation when the aircraft is so close. There are out-of-phase signals coming in from cars, trees, and buildings around you. If you want your best demonstration from the aircraft, tell them specifically *not* to fly overhead, but rather to do a lazy circle a half-mile away!

If you have the capabilities of a beam and rotator, it will extend the range at which you can pick up the distant aircraft. Typical 20-watt, 70-cm range from quarter-wave vertical to quarter-wave vertical is about five miles. As soon as the aircraft dips behind a hill, your ATV signal will disappear. If you switch from your base vertical to a vertical beam, you will hold



The ATV antenna, in the white radome, mounted on the belly of the helicopter.



ATV picture of the ATN test pattern on the 1200 MHz band.

on to the aircraft signal to about 15 miles away. As soon as the aircraft dips below a line-of-sight shot to your beam, however, you will instantly lose signal.

This reduced range is because of the 6-MHz bandwidth of the transmitted ATV signal, and although you might think you can talk to the aircraft over the same distance at which you can easily see it on ATV, not so. You will be talking 2-meter simplex to the aircraft 25 miles away, but you won't begin to see any indication of its ATV transmit signal until it is 10 miles away or less. Much of this range reduction is because of the aircraft simply being below line of sight.

I personally have seen ATV signals from a balloon coming in at nearly 100,000 feet altitude. While 100,000 feet up sounds impressive, keep in mind that this is 20 miles straight up on a perfect ascent. Your ATV aircraft is probably well below the local buildings and tree line more than three miles out.

Minimum ATV range is actually good; it could allow several different ham organizations to run emergency exercises on ATV simplex without a city interfering with another city 10 miles away.

When you say city and ATV together, as mentioned above, *always* keep in mind that any city using ATV for its routine aero activities is absolutely in violation of the rules. As volunteers working with the city to give them a new tool in disaster preparation, nothing beats the capability of ATV. This is especially true when the city may have a pilot who already has a ham license and knows the difference between disaster preparation and the illegal broadcasting of a car chase to his or her watch commander. Of course, no ham would ever allow this to happen on the ham bands, so I barely gave this proposition a second thought. It just won't happen.

Finally, test your ATV capabilities every week on a regular basis. Even a five-minute test is plenty to let you know that all systems are up and running. If the local pilots are not hams, your club needs to outfit an ATVer with a completely portable system that might use a telescopic whip stuck right next to the inside of the windshield, running no more than 10 watts output for brief periods to minimize RF radiation to everyone within the cabin.

I hope to see you in the skies soon! ■

Look who's on TV! Jason's helmet mounted ATV cam lets others see his perspective on the bicycle.

The mobile shack. Battery/solar-panel voltage as well as cycle computer on the left, FT-817 in the middle with the Kenwood VCH1 SSTV converter under it, and the THD7 APRS-enabled HT on the left.

All bands, all modes that fit in a small bag! Notice the headset on top of the bag and the PTT handlebar switch in the lower right of the picture.

Jason posing with an unidentified Delorme staff member in the Delorme headquarters in Freeport Maine. Eartha, the largest spinning globe in the world, is behind them.

can be found for sale on the Delorme website <http://www.delorme.com> as well as on eBay. It does not have a screen or any type of input device. It looks like an overgrown yellow hockey puck and has a single pigtail ending in a DB9 connector. Originally, it was designed to be connected to a computer serial port to run with Delorme mapping software. However, following the simple modifications from a website written by Gary Bargholz, N9UUR (see <http://home.wi.rr.com/ n9uur/delorme.html>), I was able to utilize this GPS for APRS duty on the bicycle. The GPS mounted on the back of the bicycle fed the NMEA GPS strings (including current speed, average speed, height above sea level, and current latitude/ longitude) to my THD7, which then broadcast this information on the VHF APRS RF network on 144.390 MHz.

With the advancement of APRS to use the internet in the past few years, RF stations can now be fed to the internet! A fellow club member, Andrew Brown, N1WTQ, set up a TCP/IP APRS gateway for me, so I was able to have my position gated to the internet as I was traveling on my bike tour, which provided my family and non-APRS ham friends with the ability to see exactly where I was during most of my trip.

Because I use the Delorme products, I thought it would be neat to stop at the Delorme map headquarters in Freeport, Maine. I thought it would be fitting to get a photo of myself with one of the Delorme employees, because I was using and promoting their GPS on the bicycle. Because everyone wanted to come outside and examine my bike, I ended up with several great photos.

SSTV

My shack on wheels contains a small SSTV (slow scan television) station for VHF and UHF. Utilizing the Kenwood VC-

Is Your Interest Piqued?

Are you interested in portable operations, alternative power, creative antenna solutions, or building your own bicycle, tricycle, golf cart, airplane, canoe, or pedestrian mobile station? If so, you can find hours of reading from the following ham groups:

HFPACK, the HF portable group <http://www.groups.yahoo.com/hfpack> is an amateur community based on the ideals of working stations outside of the typical shack, via the promotion of portable operations. The primary focus is HF activity. However, with almost 3000 members there are plenty of folks willing to share information on a wide variety of topics.

BMHA, the Bike Mobile Hams of America <http://www.lafetra.com/bmha/> is an amateur group dedicated to the promotion and growth of the bicycle mobile operator. Tricycle, mountain, road, hybrid, and recumbent cycles make up this group. A large amount of VHF-related information is available, from battery and GPS technology to antennas and radio placement. The BMHA membership is $10, and members receive quarterly newsletters pertaining to ham cycling news all over the world.

H1 communicator with the THD7 HT, I was able to snap photos as I pedaled and send them via simplex or over the local repeater to hams all over the state and northern New England. The VC-H1 is a neat unit, which has a whole host of SSTV functions as well as the ability to double as a speaker microphone. The VC-H1 allowed me to send and receive SSTV images. It has a built-in LCD screen for image viewing, a ten-image memory for saving "good" photos, and a camera built right into it! Power is provided via AA batteries or a 6-volt regulator. For those who are interested in portable SSTV, you can't go wrong with the VC-H1. It is a very nice unit. More information about the VC-H1, including a great review of this product, was in the April 1999 issue of *CQ VHF*. I highly recommend your reading it.

ATV

The ATV (amateur television) system on the cycle has brought a great deal of enjoyment, especially to non-hams when I demonstrate the system at local hamfests. Who can resist seeing oneself on TV? The bicycle is equipped with a 1.5-watt PEP 437-MHz ATV transmitter and a weatherproof black-and-white camera, which is mounted on my cycling helmet. This placement of the camera is designed to capture what I see as I pedal down the road. A GPS overlay board rounds out the station, allowing me to pull the same GPS data that I use for the APRS system to be "overlaid" on the image I transmit on ATV. Therefore, hams are not only able to see what I see, but also to get the added information of my current speed and direction. While limited in range with the low power, this system performs remarkably well on the road, generating viewable images out to about a half-mile from my location with simple vertical antennas.

"N1RWY bicycle mobile listening"

The primary radio on the bicycle is the Yaesu FT-817. This 5-watt, 1.8–440-MHz radio has swept the nation by storm, and for me it is a very exciting rig. When the radio is not on the bicycle, it is either in my backpack or in the shack. The rig is in use constantly, and it is one of my favorites. Internal 9.6-volt batteries as well as external power make this all-mode, all-band radio quite a package. This rig provides all the primary voice communications for the cycle, from talking to locals on FM repeaters and simplex, to working some fellow HFPACK members on HF (see sidebar for more information on HFPACK), to chasing DX on the satellites. One of my best memories to date was a five-way mobile QSO that I had on one of the local repeaters. Stations were kayak mobile, pedestrian mobile, bicycle mobile, and, of all things, island-ferry mobile. Everyone was out and about enjoying the sunny afternoon.

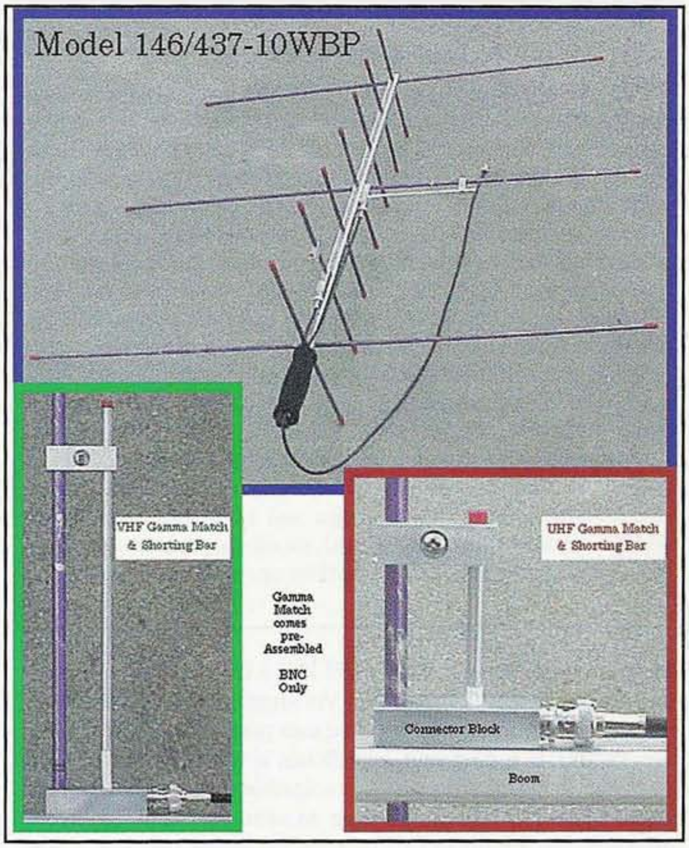
HF Mobile?

I would not be doing the bike justice if I did not mention the HF station that is on board. HF communication is accomplished via the Yaesu FT-817 to a combination of Lakeview Hamsticks, which are monoband HF antennas. With 2.5 to 5 watts of RF on HF, I have worked all over the world on 17 and 20 meters. The trailer and bicycle are electrically grounded together, which is needed because dragging radials is out of the question! Photos, links, and more information about other portable and bicycle HF operations, including mine, are available on my website, <http://www.n1rwy.com>.

"Can you talk to the moon with that thing?"

This question was asked during my last bicycle tour, and while I did take the time to explain that it was not possible to work EME (earth-moon-earth) with the station, I could talk to a few satellites. Having the trailer allowed me to carry some stuff that would not have been possible otherwise. One such item was my satellite radio system, the FT-817 mounted on the handlebars of the bike, my Palm PDA for pass prediction data and logging, and an Arrow Antenna 146/437-10 (<http://www. arrowantennas.com/146-437.html>). This antenna uses three elements on 2

PTT and single-ear boom microphone combination from the KR8L design.



Arrow Antennas model 146/437-10WBP antenna. (Photo courtesy Arrow Antennas) ⟶

meters and 10 elements on 70 cm. It is a portable beam, designed to be hand operated, and is standard for working UO-14 and AO-27 FM satellites out in the field. With this antenna I have worked all over the U.S. and Canada with as little as 2 watts. With roughly four "good" passes a day, it gives me plenty of opportunities to talk to someone in a new grid square and to make some new friends. If you attempt to work satellites from your bicycle, I should mention that I did get a lot of strange looks from passing cars as I sat on my bike waving around what appeared to be a long stick, and from their perspective, talking to myself.

Hands-Free Operation

Depending on the road surface, steering a recumbent cycle can be tricky. Trying to steer with one hand while holding a microphone with the other can be dangerous. Having experienced an unscheduled off-road adventure through a ditch first-hand, which ended up with me on my side and the bike on top of me, I decided that I needed a hands-free way of using the radios. A search through some of the past messages on the HFPACK e-mail group provided my solution. Following the modifications established by Bill Parmley, KR8L (AT&T headset interface for the FT-817; see <http://www.srv.net/~kr8l/>), I was able to utilize a $5.00 cell-phone headset to mate with the FT-817 for all my communication needs.

With no microphones to grab or drop while pedaling and good audio reports on FM as well as SSB, it was a welcome addition to the system. A small PTT thumb switch mounted on the right handlebar allows me to activate the headset without even moving my hands from the handgrips. The only drawback I found with this headset was the excessive wind noise generated when I was traveling over 18 MPH on the bike. A small bit of microphone foam from RadioShack quickly solved the problem.

Fun with Fitness

Riding a recumbent bicycle is a very pleasant and relaxing experience. Even without ham gear, riding a recumbent bike takes about a day to get used to, but once people do, most swear never to ride an upright bike again. For me, the ability to ride 20–30 miles at a stretch without any pain or discomfort is pure heaven. The added ability to take in the world around you from sitting in a seated or reclining position is a bonus. You almost forget that pedaling the bike is exercise, because it feels so natural.

One of the questions I am asked most often is "How much does it all weigh?" Between the trailer and the extra weight of the radio gear on the bicycle, the whole package weighs about 135 pounds. It does make for some very slow hill climbing and some very fast descents, but it's worth it. I have pedaled several 60+-mile days with this station and averaged about 13 miles per hour fully loaded. Last year I ended up with just under 1000 miles on the bike in five months. This year it looks as though I will have just over 2000 miles in the same time period.

Because of the amateur radio recumbent bike riding, I have lost weight, decreased my cholesterol levels dramatically, and gained a lot of muscle as well as cardiovascular strength. In addition, I have met many new ham friends on the air while chasing DX, playing with SSTV, talking to friends on the local repeaters, and adding traffic to the APRS networks—all on my recumbent bicycle. Who says exercise and ham radio don't mix?

Special thanks goes to Dave Atwood of Stillwater Recumbents <http://www. stillwaterrecumbents.com> for taking the time to educate me and get me on one of these fantastic bicycles. ■

Advertisers' Index

Reach this dynamic audience with your advertising message, contact Arnie Sposato at 516-681-2922, FAX 516-681-2926, or e-mail: arnie@cq-amateur-radio.com.

By Dr. H. Paul Shuch,* N6TX

DR. SETI'S STARSHIP

Searching For The Ultimate DX

A Fork in the Road

Small amateur radio telescopes such as this one are springing up in backyard gardens all around the world as part of the Project Argus all-sky survey for signals of intelligent extra-terrestrial origin. (SETI League photo)

Before its funding was terminated by Congress in 1993, NASA's two-tined SETI (Search for Extra-Terrestrial Intelligence) program relied on a pair of distinct but complementary research elements: a targeted search of nearby Sun-like stars, and an all-sky survey for interesting signals of unknown origin.

The former, which involves aiming at likely candidate stars for long periods of time, is well suited to large, steerable dishes with their narrow beamwidths and high sensitivities. Frank Drake's *Project Ozma* effort of 1960, which we discussed in the summer issue of *CQ VHF,* was a targeted search, concentrating on two nearby sun-like stars for evidence of technological life.

It was a sensible way to launch modern SETI. After all, if we guess right as to which stars constitute likely candidates, the targeted search will provide us with the greatest likelihood of immediate success. However, we know of only a limited number of relatively nearby candidate stars. Thus, concentrating our search in their direction may cause us to miss an equally good star of which we happen to be unaware.

An all-sky survey, on the other hand, makes no *a priori* assumptions as to the most likely direction to explore. The sky survey seeks to sweep out the entire sky as seen from a given location. No antenna tracking is required because it is the entire sky, rather than individual stars, which we scan. While target-search antennas must constantly be moved, sky-survey radio telescopes are operated in what is called *drift-scan,* or *meridian transit* mode. It is the Earth's rotation which turns them.

The best known of all the all-sky surveys was conducted for a quarter of a century from the Big Ear radio telescope, built by the late Dr. John Kraus, W8JK, at the Ohio State University radio observatory. That telescope sadly is gone now, an historical loss which will be the subject of a future column.

NASA's late targeted search was resurrected by the non-profit California-based SETI Institute (a group of professional radio astronomers, not to be confused with the 1300 radio amateurs in 60 countries who make up the grass-roots SETI League). Their *Project Phoenix* search hires time on some of the world's finest radio telescopes, such as the 305-meter diameter Arecibo dish in Puerto Rico, and the 76-meter wide Sir Bernard Lovell telescope at Jodrell Bank, Cheshire, UK. With them, our colleagues survey the 1000 nearest Sun-like stars, all within about 200 light years of Earth. If we have nearby neighbors, *Project Phoenix* is likely to detect their radio pollution. However, because large antennas have quite narrow beamwidth, they see only a small portion of the sky (perhaps one part in a million) at a given time. Despite their super sensitivity, their narrow beamwidth could cause them to miss the mark.

That's where amateur radio astronomers, with their modest systems in the back garden, can make all the difference. The sky-survey component is best performed with antennas of moderate size. Smaller antennas can see more sky within their beam patterns, but have less gain. We achieve reasonable sensitivities through digital signal processing, but the antennas need to scan for extremely long periods of time. The sky-survey approach thus seems ideally suited to the community of radio amateurs and microwave experimenters. This is the area in which The SETI League is concentrating its efforts, through our own *Project Argus* all-sky survey.

The two strategies, targeted search and all-sky survey, are entirely complementary. The former stands the best chance of detecting incidental radiation from other radio-using civilizations inhabiting nearby worlds. The latter is ideal for detecting powerful beacons being transmitted by advanced civilizations in distant corners of the galaxy. Between them, the two tines stand the greatest chance of catching that elusive fish in the cosmic pond. While the professionals continue to train their great telescopes on specific targets, hundreds of amateur astronomers around the world together are seeing in all directions at once, so that no direction on the sky shall evade our gaze.

It doesn't take a rocket scientist. You too can make a difference by becoming a part of *Project Argus,* the reincarnation of NASA's all-sky survey component. For more information on how you can become involved, please contact me at my e-mail or postal address listed with this column.

To paraphrase the American poet Robert Frost . . .

Two paths to the stars diverged, and I—
I chose the one that NASA let die,
And that may make all the difference.

73, Paul, N6TX

**Executive Director, The SETI League, Inc., <www.setileague.org>*
e-mail: <n6tx@setileague.org>

Alinco Unleashes the Power in Hand-held Communications!

Try the DJ-596 dual bander that can communicate in analog or optional digital modes! Check out the powerful DJ-196/296/496 monoband units. Pick up the "Gen2" DJ-S40 pocket HT. No matter which you choose, you'll get a transceiver that's rugged, easy to program and built for years of dependable operation. You expect more value from Alinco and we deliver!

DJ-596T VHF/UHF Dual-band HT with Digital Voice Option*

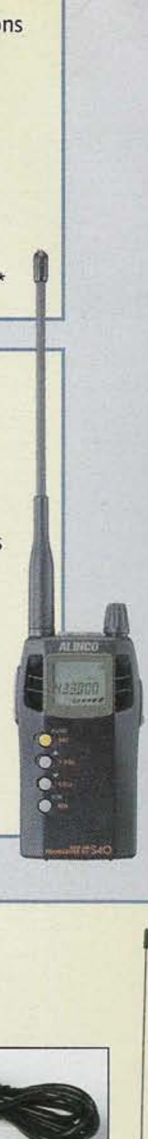
Loaded with features! The breakthrough design supports optional digital voice communications and you can easily switch the unit between analog and digital modes!

- Full 4.5 watts output VHF/4w UHF
- Powerful NiMH battery
- 100 memories in any combination of VHF or UHF channels
- Direct frequency input from keypad
- Each memory capable of "odd split" operation.
- Alphanumeric channel labels
- CTCSS and DCS encode+decode plus tone bursts
- Full 2m and 440 band coverage
- Accepts 6 ~ 16 VDC direct input
- Three scan modes
- Illuminated keys and display
- Wide and narrow FM modes
- 10 autodial memories
- Theft alarm feature
- Optional EJ-43U Digital Voice Board!*

DJ-196T (2m), DJ-296T (222 MHz), DJ-496T (440 MHz)

These sturdy, full-featured monobanders are priced low and ready to go!

- 5 watts DJ-196 / 4 watts DJ-296 and DJ-496
- Long-lasting NiMH battery
- 40 memory channels
- Keypad frequency input
- CTCSS and DCS encode+decode
- Alphanumeric display
- 13.8 VDC direct input
- Wide and narrow FM modes
- Illuminated keys and display
- Autodial memories
- S-meter



DJ-S40T 440 MHz Pocket HT

Our Gen2 pocket transceiver packs a powerful punch!

- 100 Memories
- Up to 1 watt output, 500 mw on AA batteries
- Uses AA batteries, optional battery pack or external DC
- Covers 420 ~ 450 MHz
- CTCSS encode + decode
- SMA antenna and connector
- VFO and Memory scan modes
- Hidden speaker produces loud, clear audio
- Wide choice of accessories
- Low Alinco price!

IronHorse.

Great Accessories for Alinco and other radios!

Iron Horse antennas and accessories extend the use of your transceivers and scanners. BNC connections make it easy to take your HT mobile for BIG signals in and out!

IHC 19 car window mount

BNC connectors, window mount, sets up in just seconds!

IHC 20 glass suction-cup mount

Extension BNC suction mount keeps your antenna inside but against the glass for a true "window on the world." For mobile or base use, includes 6 feet of RG-58U cable.

IHMM270 Compact VHF/UHF Magnetic Mount Antenna

BNC connector, 9 feet of RG-174 cable and a powerful magnet. Less than 20 inches high, SWR less than 1.5:1 throughout either band. Max power: 50w/VHF; 25w UHF.

IHMM3 Magnetic Scanner Antenna

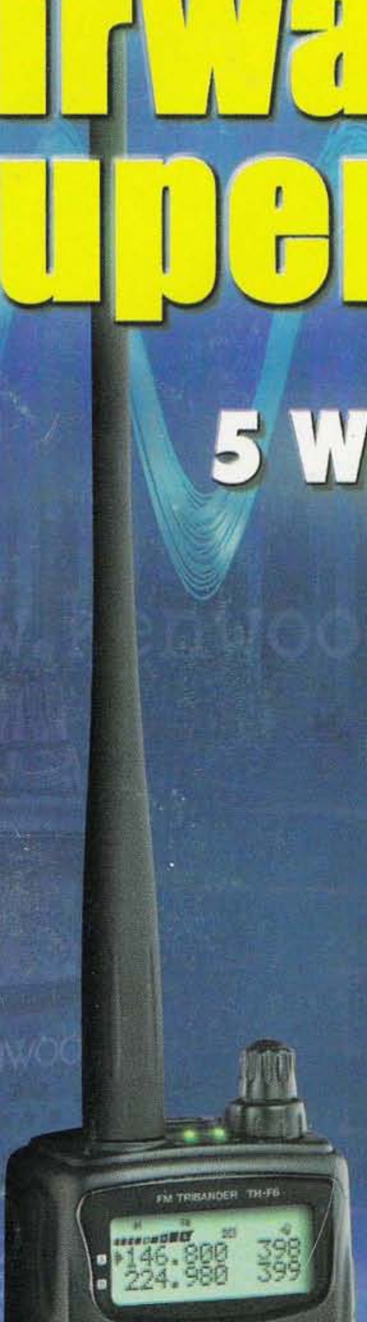
BNC connector, just 13.5 inches high. Powerful rare-earth magnet, 9 feet of RG-174 cable. Receives 100 ~ 1200 MHz, can transmit on 2m, 440~ 450 MHz and 824~ 896 cellular frequencies. Also available with Motorola-style antenna connector.

www.ALINCO.com

Distributed in North America by ATOC Amateur Distributing LLC • 23 S. High St., Covington, OH 45318 • (937) 473-2840
Specifications subject to change without notice or obligation. *Digital communications require at least two similarly equipped transceivers. Digital mode is compatible with Alinco DR-135/435T mobile transceivers equipped with EJ-40U digital communications board. Digital mode may not be legal in some countries. See FAQ on digital at www.alinco.com. Products intended for use by properly licensed operators. Permit required for MARS use.

Airwave Superiority

5 Watts / All Bands



- Triband (144/220/440 MHz)
- Receives 2 frequencies simultaneously even on the same band
- 0.1~1300MHz high-frequency range RX (B band)
- FM/FM-W/FM-N/AM plus SSB/CW receive
- Bar antenna for receiving AM broadcasts
- Special weather channel RX mode
- 435 memory channels, multiple scan functions
- 7.4V 1550mAh lithium-ion battery (std.) for high output[2] and extended operation
- 16-key pad plus multi-scroll key for easy operation
- Built-in charging circuitry for battery recharge while the unit operates from a DC supply
- Tough construction: meets MIL-STD 810 C/D/E standards for resistance to vibration, shock, humidity and light rain
- Large frequency display for single-band use
- Automatic simplex checker
- Wireless remote control function
- Battery indicator
- Internal VOX
- MCP software

"Specifications subject to change without notice."

TH-F6A

[1] Note that certain frequencies are unavailable. [2] 5W output

KENWOOD
COMMUNICATIONS CORPORATION

AMATEUR RADIO PRODUCTS GROUP
3975 Johns Creek Court, Suwanee, GA 30024
P.O. Box 22745, Long Beach, CA 90801-5745, U.S.A.
Customer Support: (310) 639-4200 Fax: (310) 537-8235

02ARD-2180 #040802

INTERNET
Kenwood Website
http://www.kenwood.net
Kenwood Information
ftp//ftp.kenwood.net

ISO 9001
JQA-1205
Communications Equipment Division
Kenwood Corporation
ISO9001 certification