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August 1997

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On the Cover: Rod Greene, W7ZRC, of Boise, Idaho, relaxes with his favorite magazine! Details on page 46.

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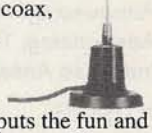

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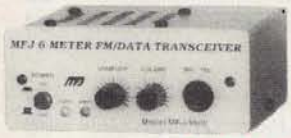

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CQ VHF Ham Radio Above 50 MHz

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FEATURES

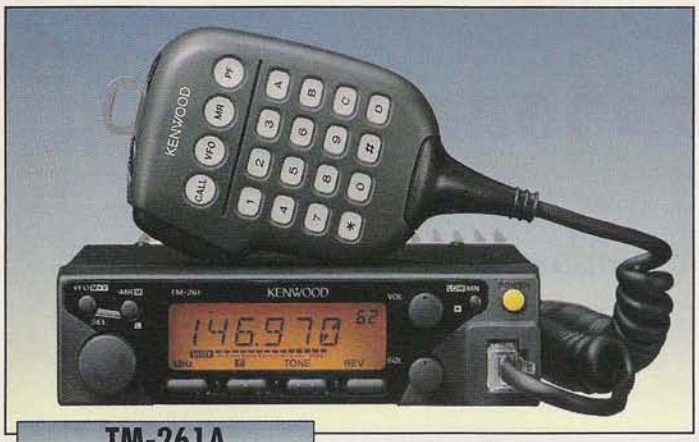
COLUMNS

BASICS

DEPARTMENTS

Next Month: "A Mini-Satellite over Germany," by Oliver Welp, DL9QJ/N3NSF

The Ultimate Choice in Amateur Radio



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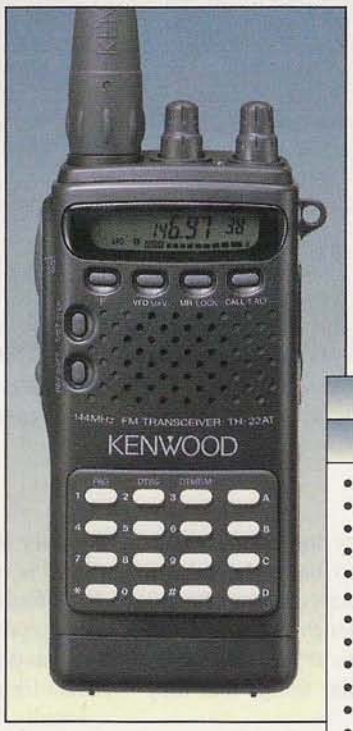

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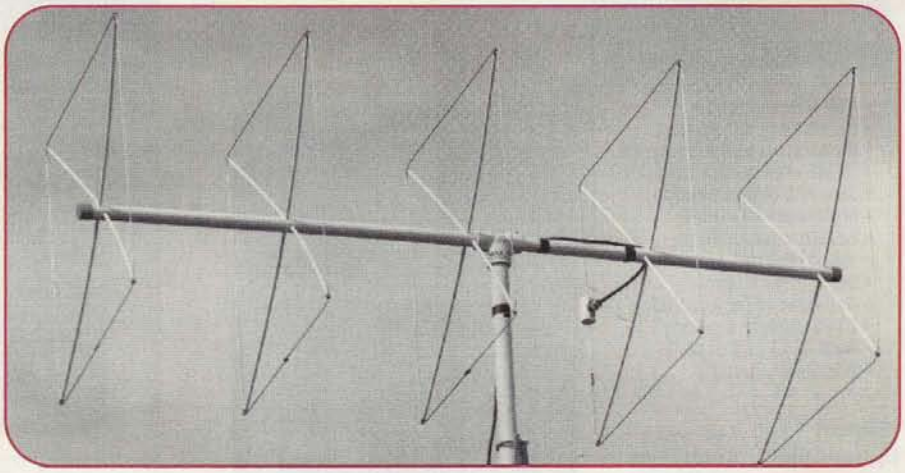
Radio Ambassadors

If you've got a ham license, you're an ambassador for amateur radio. But so are your family members. Do they have the basic facts they need to do the job?

Attention: If you're the ham in your family, don't read this editorial. It's for your non-ham family members. Oh, all right, you can read it, too, but it's really written for them. Please share it.

—W2VU



About those antennas...aren't they dangerous? And won't they attract lightning? Here are some basic answers to these and other common questions.

One of the teachers at my kids' school who happens to know I'm a ham recently started asking my wife (who's not a ham) questions about possible RF radiation hazards. Fortunately, my wife has been hanging around me long enough that she was able to answer his basic questions.

This isn't the first time something like this has happened, and it made us realize that even non-ham members of ham radio families sometimes need to be knowledgeable about the hobby. And it's important—not only for your personal image (so you don't look like a complete idiot) but also for ham radio's image (so we *all* don't look like complete idiots)—that even though you're not a ham, you have at least the basic knowledge necessary to answer basic questions before responding, "Well, that's too technical for me. You'll have to ask Joe." So we thought we'd help...

The Public's Major Worries

Radio is a mysterious thing to most people. And people have an inborn tendency to fear what they don't understand. (Fortunately, we also have the inborn ability to learn and overcome our fears.) They also have a tendency to oversimplify and to lump together things they don't understand with similar things that they *do* understand.

"It's important...that even though you're not a ham, you have at least the basic knowledge necessary to answer basic questions before responding, 'Well, that's too technical for me. You'll have to ask Joe'."

Take *radiation*, for example. All of us who grew up during or after World War II know about radiation: atom bombs cause radiation and radiation is bad for you. Radios emit radiation, too, so they must also be bad. It doesn't matter that RF radiation bears no resemblance to nuclear radiation. In the public's eye, radiation is radiation, and it's something to be feared. The possibility that certain levels of RF radiation may indeed be harmful—but nobody's sure—makes matters worse...the unknown again.

Next on our "public worries" hit parade is *interference*. Again, they don't understand what causes it. All they know is that it's only there when that blasted transmitter is on. So how can it be anyone else's fault? And about those *antennas*—why do you need them, anyway? Why do they have to be so high? And won't they attract lightening?

Finally, there's the worry they don't always think about when these other concerns come up: How will I get in touch with friends and relatives if there's a natural (or unnatural) disaster and I can't get through by phone? This is one worry we need to remind them about. Now, let's run down each of these major items and arm you with some basic, non-technical information to answer their questions.

Radiation

Yes, radio signals are a form of radiation. So is light. In fact, the most prevalent type of radiation we encounter is *solar* radiation: light, heat, and, yes, ultraviolet radiation, from the sun. Too much

By Rich Moseson, W2VU, Editor

"Yes, radio signals are a form of radiation. So is light. In fact, the most prevalent type of radiation we encounter is solar radiation: light, heat, and, yes, ultraviolet radiation, from the sun."

is bad for you. Just ask anyone who's gotten skin cancer as a result of too many sunburns. But if you cut back solar radiation too much, you've got other problems. Just ask the dinosaurs. We need solar radiation for life.

Radio signals are a type of radiation known as RF (for Radio Frequency). RF energy is part of a larger type of radiation known as *electromagnetic* radiation. Other types of electromagnetic radiation include *infrared* (what your wireless remote control uses), *x-rays* (again, too much is bad for you, but the right amount is invaluable), and *visible light*. Several years ago, one town in New Jersey proposed an ordinance prohibiting any electromagnetic radiation beyond one's property line—until it was pointed out that the law would also ban porch lights.

Is RF radiation dangerous? That's the key question. And the answer is "probably not, but we're not 100% sure, so it's best to take reasonable precautions." What are reasonable precautions? The FCC (Federal Communications Commission) has RF exposure standards that all licensees must follow. These represent maximum exposure levels of $^1/_{10}$ to $^1/_{100}$ of the levels thought to *possibly* be able to cause any harm. So, if tests showed that exposure to 10,000 watts of RF at a specific distance *might* be dangerous, the maximum exposure levels were set between 100 and 1,000 watts.

Starting next year, hams whose transmitters put out more than 50 watts will need to conduct "routine evaluations" to make sure they're in compliance with the FCC standards. A very simple-to-use computer program to make the calculations appeared in the January, 1997, issue of *CQ VHF* and may also be downloaded from our World Wide Web site <http://members.aol.com/cqvhf/>. So you can assure friends and neighbors that there are very strict standards which must be met and that, if the evaluation shows possible exposure above the standards, then changes must be made to reduce exposure (most ham stations don't even come near the limit to begin with).

The basic principle hams follow is "prudent avoidance," which means limiting unnecessary RF exposure. This includes making sure equipment is well-shielded and properly grounded, and that antennas are as *high* as possible (the higher the antenna, the greater the distance between the bulk of the RF energy and people on the ground).

But the most important thing to tell your neighbors is that ham radio transmitters are only one source of electromagnetic radiation—and that they might have other many sources right inside their own homes. Examples include cordless and cellular telephones (they're actually two-way radios and holding a cellphone antenna right next to your head poses a greater possibility of a hazard than living next door to a ham), TV receivers (they contain tiny transmitters called *oscillators* that generate RF signals needed to receive the TV signal, and most TV sets are poorly shielded), radio receivers, personal computers, fax machines, garage door openers, wireless security devices, and even cordless baby monitors (don't put the transmitter in bed with the baby).

Magnetic Fields

This is another concern about radio transmissions (remember, it's electro*magnetic* radiation). Much concern has to do with the effects of magnetic fields generated by electric lines and electric motors, although there is no proven link to any specific hazard. In talking with neighbors about magnetic fields, once again, *if* there's a hazard, there's more of it from stuff in their homes than from a ham rig next door.

The *ARRL Handbook* lists magnetic field levels of common household appliances in comparison to ham gear. An electric blanket will expose you to about the same magnetic field as sitting on top of a typical HF ham transceiver, except that the blanket will expose your *whole* body to the field. Electric drills and hair dryers are among the worst, producing magnetic fields at their handles up to 20 times as strong as you'd find on top of the ham rig. So, if they're not concerned about using their hair dryer, electric drill, or electric blanket, they have no reason to fear a ham station.

One final note on this topic: The "Newsline" ham radio news service recently reported that the U.S. Department of Energy is pulling the plug on its long-running research on the possible health risks of electromagnetic fields. Quoting an article in the journal, *Science,* the report says the agency's decision was based on a report last fall from the National Academy of Sciences which said it could find no conclusive evidence of adverse health effects from electromagnetic fields.

Interference

This is a toughie, because there's little question about the effects of interference: the person with the problem has trouble watching TV, listening to the stereo, talking on the phone, or keeping the garage door closed. The hardest thing to do is to make them understand that the fault most likely lies in *their* equipment, not in the

"...the U.S. Department of Energy is pulling the plug on its long-running research on the possible health risks of electromagnetic fields, [saying] it could find no conclusive evidence of adverse health effects...."

ham transmitter (assuming that the transmitter is properly shielded, properly filtered, and properly grounded, which we'll assume that it is).

Remember the little oscillator inside the TV that we mentioned a few paragraphs back? Well, another circuit in the TV takes the signal from that oscillator and mixes it with the TV signal coming in off the air, producing a signal at a third frequency, which is the one that's actually sent to the rest of the TV's circuits. A well-shielded and well-filtered TV set hears only the desired signals and blocks out everything else. Unfortunately, most TVs are *not* well shielded and well filtered, so any strong nearby signal will mix with the other signals inside the TV and...voilá, the ham signal shows up as well as the TV signal—interference.

"But how can it be my set?" the neighbor asks. "There's only a problem when that radio is on." One good comparison, believe it or not, is to the sun. If you go outside in the summer without "shielding," that is, clothing, sunscreen, etc., you're likely to get a sunburn. It's not the sun's fault, even though it only happens when the sun is shining! If you're not properly shielded, you're leaving yourself open to problems.

There are many other sources of interference; we even ran an article last year about a kid's radio-controlled car transmitter wiping out TV reception on one channel! ("A TVI Detective Story," September, 1996, *CQ VHF*)

What makes interference such a thorny problem to solve is that there are countless possibilities of signals mixing or wires acting as antennas, so there's no "easy fix." The good news is that almost every interference problem can be solved—with cooperation on both sides. The neighbors must be willing to help with making tests and be prepared to add filters or other interference-blockers to their equipment. But cooperation is essential to success.

Antennas

Finally, the omnipresent antenna questions (you may be asking them yourself!). Why do they need to be...so big, so high, so numerous? First, let's separate in your own mind what most non-hams lump together: antennas and towers. In general, a tower is simply something that *holds* antennas. By itself, it does not transmit or receive radio signals. It sits on the ground or on the roof and holds up antennas. This is why zoning officials usually refer to towers as *antenna support structures*. Their job is to support the antenna(s). Antennas are what actually transmit and receive radio signals. They may be attached to a tower, to a pole in the ground, to your car, or to the top of a handheld radio.

You can't talk on the radio without an antenna. It's that simple. The antenna is what transfers radio signals from the radio to the "airwaves" and vice versa. The size of the antenna is determined in part by the frequency on which the radio is transmitting.

And what about height? Generally speaking, the higher the antenna, the farther you can talk. Plus, as we already mentioned, a high antenna will significantly reduce the RF levels to which people down on the ground are exposed, along with the likelihood of certain types of interference

The Lightning Question

"Won't that antenna way up there attract lightning?" As long as the support structure (e.g., tower) is properly gounded, antennas should pose no greater threat of attracting a lightning strike than your roof in general does. During a thunderstorm, the air gets *ionized*. This means that some air molecules lose electrons and others pick up extra ones. Lightning is nature's effort to restore balance. Lightning, like any other electric current, flows better through metal or another *conductor* than it does through air, which is generally an *insulator*.

What makes a tower or antenna attractive to lightning is that those ions, or charged air molecules, tend to collect on things sticking up in the air. But if you've properly grounded the tower and use devices called *static discharge eliminators* (commonly known as lightning arrestors) in your feedlines, those charged particles will find their way to ground (which is where they want to go) before building up to the point where a lightning discharge is likely. So, a properly installed antenna system may be even less of a lightning target than a nearby tree. And if it *does* get struck, the ground cable should carry most of the current directly to ground, further reducing the risk of fire to your house or your neighbor's home.

Of course, with lightning, there are no absolutes, so it's always best to shut off all radios and disconnect (and ground, if possible) all feedlines when you hear a thunderstorm approaching.

Public Service

Finally, in your conversations with your neighbors, be sure to remind them of ham radio's value in emergencies and disasters, and the fact that the presence of a ham station in their neighborhood provides them with an additional means of contacting friends and family members if telephone communications fail. When nothing else can get through, ham radio often can.

Those Are the Basics...

There, in a nutshell, are the basic answers to the most commonly asked questions and concerns about ham radio. I hope you were able to understand it all, and that you'll now be better able to answer your neighbors' questions before hitting the point where you have to say, "Well, that's too technical for me. You'll have to ask Joe."

Now, please give the magazine back to Joe so he can read the rest of it (of course, you're welcome to keep reading as well).

73 (best wishes) de (from) Rich, W2VU (me)

Help Wanted

If you're involved with a project or activity that you think would be of interest to your fellow *CQ VHF* readers, we'd like to hear from you. Article submissions are welcome, as are "Op-Ed" opinion pieces if you have a point of view you'd like to share about a VHF-related topic. You can contact us by mail at 76 N. Broadway, Hicksville, NY 11801 (send an SASE for writers' guidelines), by e-mail to <CQVHF@aol.com>, or via our World Wide Web page, <http://members.aol.com/cqvhf/>. We look forward to hearing from you.

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VHF News

NEWS FLASH! Phase 3-D Launch Delayed Again

A defect in a rocket engine has caused yet another delay in the launch of the AMSAT Phase 3-D (P3D) satellite—until September 30 at the earliest—according to a report in the *Orbital Report On-Line* newsletter, and confirmed by AMSAT-NA President Bill Tynan, W3XO. The launch had been set for September 16, and the Ariane 502 booster rocket has already been shipped to the European Space Agency's (ESA) South American launch site in Kourou, French Guiana.

According to the June 15 issue of the space newsletter, a faulty component was discovered in the liquid oxygen turbopump of the main engine of the Ariane 504 rocket, due for later launch. But, according to the newsletter, "since the origin of the flaw was identified as a possible production defect and a similar element is known to be in the pump of the engine already mounted on Ariane 502 (recently arrived in Kourou), ESA and CNES have decided to remove the engine and replace it with the one originally scheduled for Ariane 503, which features a component from an older production batch. This replacement will take about a fortnight (two weeks)."

In a follow-up report June 16 from the Paris Air Show, *Orbital Report On-Line* said the launch of Flight 502 has been postponed "to September 30 at the earliest" in order to make the engine swap.

AMSAT President Tynan expressed mild disappointment at the delay. Speaking to *CQ VHF* from the P3D lab in Orlando, Florida, he said "We'd like to get it up there, but we don't want [ESA] to go before they're ready, either." Tynan noted that the P3D team won't be just sitting around and waiting. "We're not wasting any time that ESA gives us," he added. "We're using that time productively." Tynan says the delay should not add appreciably to the overall cost of launching the satellite, noting that "two weeks is kind of noise-level."

According to previous reports in *Orbital Report On-Line*, the Ariane 5 booster rocket scheduled to fly the P3D satellite into space was shipped to South America from France by freighter on June 2. In addition to the AMSAT satellite, this second qualification flight of the Ariane 5 rocket (Flight 502) is scheduled to carry a small science piggyback satellite and two dummy payloads.

The launch was earlier delayed by several months after the first qualification flight, Ariane 501, failed just after launch and exploded over the Atlantic. Ariane space officials conducted an extensive inquiry and are confident that the electrical and software problems that led to the loss of Flight 501 have been resolved. AMSAT gets a significant reduction in launch fees by taking the risk of launching its satellite aboard a qualification flight of an unproven rocket.

"Little LEO" Threat Eased...for Now

The U.S. government isn't giving the "Little LEO" industry what it wants—but that doesn't mean the threat to our bands is dead. "Little Leos" are small, low-Earth-orbiting satellites patterned after amateur radio microsats, intended for commercial use. A year ago, the "Little LEO" industry asked the government/industry advisory group preparing the U.S. position for this fall's World Radiocommunication Conference (WRC-97) to recommend "sharing studies" be performed on the possible use of a variety of frequencies below 1 GHz—including the 2-meter and 70-centimeter amateur bands.

There was massive opposition from the amateur community, and the advisory committee's final report recommended only a 1-MHz allocation for Little LEOs at 405 to 406 MHz, plus identifying an additional 1-MHz piece of spectrum for possible future use (this, in addition to a variety of worldwide Little Leo allocations recommended for frequencies above 1 GHz). There is no mention of sharing with amateurs.

However, an ARRL official familiar with the proceedings warned that the threat is not dead, noting that the Little LEO people can try to get other governments to present their proposals, and that

Compiled by the CQ VHF Staff

they can try again for WRC-99. "They will be back," said the official, who pointed out that the industry has just gotten an experimental grant from the FCC to operate at 455 to 456 and 458 to 460 MHz.

The next step is for the FCC and National Telecommunications and Information Administration (NTIA) to draft final proposals based on the advisory groups' recommendations. Then the State Department will develop the final U.S. positions based on the FCC/NTIA recommendations. WRC-97 will be held in Geneva this October and November.

Congress Passes Volunteer Protection Bill

Hams and others volunteering their time in public service activities will gain additional protection from lawsuits arising from their volunteer activities, under provisions of a bill passed by Congress in May. The Volunteer Protection Act of 1997 (S-543) was sponsored by Georgia Senator Paul Coverdell. It gives protection from liability claims to "volunteers of a non-profit organization or government entity" for harm caused by actions "within the scope of the volunteer's responsibilities." It does not apply to harm that results from gross negligence, willful misconduct, or "conscious, flagrant indifference" to individuals' rights or safety.

The bill is not quite clear on exactly what is meant by a non-profit organization (there's a variety of definitions), or whether you're covered for volunteer work that's not under the umbrella of such an organization.

At press time, while the bill had been passed by both houses of Congress, it had not yet been sent to President Clinton for his signature.

Mir, Back on Air, QSYs

The ham station aboard the Russian Mir space station is back on the air after being shut down for about two months amid difficulties with the station's power and oxygen systems. U.S. Astronaut Mike Foale, KB5UAC, has been active but prefers simplex operating. After discussions with the various officials involved, it was decided in mid-June to change Mir's 2-meter frequency from a 145.200/145.800-MHz split operation to 145.985-MHz simplex. This applies to both voice and packet. It's the third frequency change for Mir in less than a year. *(For more on Mir, see this month's "Orbital Elements" column elsewhere in this issue.—ed.)*

Other Satellite News

The venerable RS-10 satellite was temporarily taken off the air in early June for non-amateur tests. The satellite was expected to be back on in time for its 10th anniversary celebration in late June. *(Again, see "Orbital Elements" for more details.—ed.)*

AMRAD-OSCAR-27 (AO-27) has a new FM downlink frequency as of April 1, according to AMSAT and the "SpaceNews" newsletter. The new downlink is 436.792 MHz (changed from 436.800). Uplink remains at 145.850 MHz. AO-27's current operating schedule can be found on the Web at <http://www.umbra.com>.

And there seems to be yet another delay in the already long-delayed launch of South Africa's SUNSAT amateur satellite. The AMSAT News Service reports that launch officials told a news conference that the launch "certainly would not be this year." The Delta 243/Thor II rocket is also scheduled to carry a U.S. Air Force satellite (the primary payload) and a Danish satellite.

FCC Chairman Quits

Reed Hundt has resigned as Chairman of the Federal Communications Commission. According to a report in "Newsline," Hundt told President Clinton in a letter that he'll stay on until a successor is named. Leading candidates for the post include FCC General Counsel William Kennard, whom Clinton named to the Commission in May (along with Republican Harold Furchtgott-Roth); Commissioner Susan Ness, and Kathy Wallman, who is Clinton's Deputy Assistant for Economic Policy.

Among other accomplishments while chairman, Hundt promoted the concept of frequency auctions, turning the FCC into a giant government moneymaker.

Natural Disasters Keep Hams Busy

Ham radio operators rose to the occasion when a series of devastating tornadoes ripped through central Texas on May 27. According to the ARRL, "Hams from Waco to Austin were involved as the killer storms tore through the heart of the Lone Star State," killing more than two dozen people. Amateurs helped pro-

vide communication for the Red Cross and emergency medical services personnel when other means of contact failed. In Jarrell, Texas, which was hit by another tornado eight years ago, a 2-meter repeater installed after that storm "worked flawlessly" and provided the town's primary link to the outside world for about two hours, until cellular phone service could be restored.

By the end of May, most of the hams helping provide communications in the wake of severe spring flooding in North Dakota and Minnesota were able to return home, according to the *ARRL Letter*. However, some Salvation Army units were still using amateur communication. For more on the amateur response to these devastating floods, see this month's "In the Public Interest" column elsewhere in this issue.

Across the Sierra Nevada on 1296 Tropo

Robert Brown, N7STU, reports that he and Shawn Tayler, N7LQ, completed a two-way CW contact on 1296 MHz through (over?) the 10,000-plus-foot Sierra Nevada mountains on May 20, using tropospheric enhancement. Brown says the two-way exchange took about 10 minutes to complete and followed a week of evening skeds (schedules) in which N7LQ was consistently heard, but equipment problems at his station kept Shawn from hearing him. Robert wonders whether any other non-mountaintop stations have made successful tropo contacts across the Sierra Nevada on 1296. He can be reached via e-mail at <n7stu@psnw.com>.

ATV & Packet on Long-Duration Balloon Flight

Amateur television (ATV) and APRS (Automatic Position Reporting System) transmitters were both aboard a long-duration, high-altitude NASA balloon launched May 20 from Ft. Sumner, New Mexico. According to Bill Brown, WB8ELK, the balloon was scheduled to drift slowly to the west, eventually landing in California. But it actually came down approximately 60 miles south of Prescott, Arizona, after about 20 hours in the air. The main purpose of the launch was to study cosmic rays with an experiment using light flashes in plastic optical fibers. Telemetry data was transmitted via APRS, and the ATV camera/transmitter just sent back pretty pictures! More information is available on the Web at <http://wwwssl.msfc.nasa.gov/new-home/headlines/balloon/sofcal.htm>.

New FCC Form 610

The FCC has issued a new, Internet-friendly 610 form. The new amateur license application form, dated March, 1997, includes a space for an e-mail address and changed the environmental impact question (which asked if granting the application would result in a major impact on the environment and which many people blindly checked off as "Yes," resulting in a bounced application) into a statement in the certification section that granting their license will *not* cause a major environmental impact. "Newsline" reports that the FCC has stated that it will continue accepting forms dated November, 1993, and March, 1995, along with the new form, until further notice is given. ■

Letters

Your Spot to Speak Out

CQ VHF *welcomes comments and suggestions from readers. We'll print a representative sampling each month, and we reserve the right to edit letters for length or style. All letters must be signed and show a return mailing address or valid e-mail address. Writers' names will be withheld from publication upon request. Address letters to: Letters,* CQ VHF, *76 N. Broadway, Hicksville, NY 11801; or via e-mail to <CQVHF@aol.com>;<cqcomm.delphi.com> or <72127.745@compuserve.com>. Please specify that it is a letter for* CQ VHF.

More Code Thoughts

Dear *CQ VHF*:

Just my thoughts on the code debate. I was first licensed in 1994 as a No-Code Tech. I thought, this is great! For 20 years I have been into SWLing and scanning but always found an excuse for not taking an exam. Then, in 1994, I had some serious health problems and decided that there are some things in life I want to do and now is the time or maybe I never will. I learned that there was now a no-CW test for VHF operation and went for it. Success! This is all I'll ever need. *Wrong.*

There is more out there than 2-meter repeaters. The code? Me? Never! But 13 months later, I got my General. Great! No more tests! *Wrong!* Eleven months after that, I got my Advanced ticket. One more to go for Extra class. It's hard to describe the pride one feels when upgrading. To me, it's been more of an accomplishment than getting a promotion at work. What I really want to say is, upgrading is something you should do for yourself, not for the FCC, not for the old buzzards, not for tradition. Do it for yourself. You'll feel like a million bucks!

George Fuller, N1TDW
Windsor, Connecticut
(via e-mail)

Dear *CQ VHF*:

First, I would like to say that I really enjoy your magazine. It is certainly a wealth of information concerning 50 MHz and above.

I really enjoy the Letters column of your magazine. I have a suggestion for it. At the end of the letters you publish, would you please list the writer's name, call, and street, or e-mail address? I would like to correspond with my fellow readers of *CQ VHF*. Several times, I have tried to look up callsigns in the online call directories, only to be disappointed to find out that they were not listed.

I would also like to address the code issue. I would not like to see CW eliminated from the amateur radio bands. As we all know, code has played a very important part in the history of amateur radio. However, I do not think that it should be a requirement for entry onto the HF bands. Here's why I say that:

If CW is so vital and efficient, why are there no longer CW MARS nets? And why does the Coast Guard no longer use it? I think that we are afraid that HF may become very, very crowded, or that it may turn into the mess that is 11 meters (CB).

Amateur radio has other modes of communication that are much more efficient and effective than CW. For example, I know of several disasters in which packet nets were used to handle a lot of traffic effectively, and in a timely manner. I do not think that VHF and UHF has become a big mess, since the No-Code class has been established.

Dan Rhodes N9WFT
116 Harris Rd. #2
East Peoria, Illinois 61611

Dan—Very few magazines include full mailing addresses or e-mail addresses in their letters columns. This is done to protect the readers' privacy. Most people who write to a magazine do so to express an opinion, rather than to start a dialog with fellow readers. In our case, we have the ability to use the FCC database to find people's mailing addresses. Most of the online databases are updated pretty regularly. So if a person is too newly-licensed to be listed when you first look, a re-check a few weeks later may turn up the info you need.

Ideas from Down Under...

Dear *CQ VHF*:

As a repeater owner/trustee, I read with great interest the comments in December's issue ("Op-Ed") regarding the way repeaters are set up in the U.S. Here in New Zealand, we luckily don't have the problems that you have regarding co-repeater interference, lack of frequency space, etc. (I have been up to the U.S. on a few occasions and know of your problems). However, in saying that, I have wondered why, as a people with all this interest in radio communications, we are slowly getting behind the rest of the communication world.

I have often looked at the way that repeater systems are designed and wondered why we could not improve on the way we designed them. In a repeater system with a number of linked sites, for instance, why do we link them by the analogue way when digital linking could provide a great improvement.

For example, let me use a five-repeater system, with one of the repeaters being a main hub branching out to the other repeaters. You could then have all the repeater receivers listening to the same frequency. If the links are all digital, you could then have the main hub repeater poll the branches for the strongest signal (like voting). The audio from the strongest receiver would then be passed digitally to all the repeater transmitters (all on different frequencies).

The only problem with this setup is that all the transceivers would have to be able to scan the five transmit frequencies and lock onto the strongest frequency. This, I feel, would be right after the TX from the radio is released and when the signal got to a level set in the radio. If this idea were to be developed, it would mean the big radio manufacturers would have to add this feature to their radios, not a problem in this day and age.

The other plus for this system is that, if another repeater group wanted to connect, it would need only to have its own hub, and then connect the hubs together. There are many possible ideas that could be developed.

The only problem that I can see here is that there are many repeater systems in service at this time, and repeater owners don't want to spend big money to make improvements such as those I mentioned. What can be done to be added to present equipment? This, I am afraid, is beyond my expertise. Maybe someone reading this knows how to do it.

Doing things better requires people with ideas and people to design and develop those ideas. I, for one, have a lot of ideas that I am willing to share, but I can only spread my thoughts and let someone else hopefully figure out how to put them into practice.

Kevin Mitchell, ZL1UDD
Clarks Beach, South Auckland
New Zealand

ICOM'S NEW IC-2000H LEADS THE WAY TO CLEAR, CRISP RECEPTION! – Mobile radios (of all manufacturers) have recently experienced increasing problems from cross modulation interference. This has been caused by the increasing quantity of RF devices (i.e.– mobile radios, paging systems, cell phones, cordless phones, etc...) Commonly known as "intermod", this interference can make a mobile radio unuseable at certain frequencies, depending on local area conditions.

SUPERIOR WIDE BAND RECEIVER CHARACTERISTICS – ICOM's IC-2000H has been specifically designed to deal with this growing problem. A tracking tuning system and high quality RF band pass filters are employed to improve image rejection and intermodulation characteristics. Now you can pursue your hobby in areas previously not possible due to interference. Plus, you're less likely than ever to miss an important call!

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50 WATT OUTPUT – Work distant repeaters with the IC-2000H. The full 50 watts of output power gives you enough muscle to work most applications. And when you don't need as much power, such as when working a close station, you may choose a 5 or 10 watt output power setting.

"ONE-PIECE" CONSTRUCTION – ICOM gave the IC-2000H a rugged "one-piece" die cast aluminum frame and our largest heat sink ever. Now you'll get dependable, stable transmissions in extreme environments. Plus, any heavy duty cycle operation is no problem.

PRICE PERFORMANCE – Even with its high quality construction, great features and exceptional performance, the IC-2000H is one of the most economical 2 meter FM mobiles around. You'll get real value for your money. Come check it out today. For more information about the intermod-fighting IC-2000H, visit your local ICOM dealer, contact ICOM Technical Support in the HamNet forum on CompuServe® @ 75540,525 (Internet: 75540.525 @ compuserve.com) or **CALL ICOM'S BROCHURE HOTLINE: (206) 450-6088**

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- Code squelch/pager (UT-101 required)
- Tone squelch/pocket beep (UT-85 required)

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Product Update

SVETLANA 3CX6000A7 Triode

Svetlana Electron Devices announces the new 3CX6000A7/YU148 power triode. Svetlana has developed a drop-in replacement for the 3CX6000A7/YU148 used in popular FM transmitters. This tube is designed with a modern mesh filament which assures a no-compromise, long-life performance. In addition, the Svetlana 3CX6000A7/YU148 is manufactured with high alumina ceramic doped with chromium and molybdenum. This combination results in a true metal/ ceramic chemical bond, providing a stronger bond and allowing a higher processing temperature than that used by manufacturers in the West. High temperature bake-out drives gasses from internal electrodes during vacuum processing. Clean processing means long operating life. The chromium- and molybdenum-doped alumina give the Svetlana tubes their distinctive appearance. Further, each Svetlana 3CX6000A7 triode is full-power RF tested at the factory in Russia.

Improved design, thorough processing, testing, and innovative manufacturing produces a cost-effective long-life power tube backed by the strongest warranty in the industry—12,000 hours/three years—and the time warranty does not begin until the tube is put into operation.

For additional information, contact Svetlana Electron Devices, Inc., Headquarters at 8200 S. Memorial Parkway, Huntsville, AL 35802 USA; Phone: (205) 882-1344; Fax: (205) 880-8077; e-mail: <sales@svetlana.com>.

Circle 100 on reader service card

Speaker Mics for Yaesu FT-50R

Premier Communications has expanded its line of speaker microphones to include models compatible with the FT-50R and other radios using the new style Yaesu microphone plug.

Four models are currently available: The SPM-102 is a full-sized hand mic with speaker and high-quality transmit audio. The SPM-202 and SPM-202E are lapel mics which feature rugged metal clips for securing the mics and have built-in PTT switches on the side of the mic housing. Receive audio on the SPM-202 is sent to a "bud"-style earphone, while the SPM-202E uses an earphone secured using an adjustable rubber "hook." The SPM-302 features a conveniently located receive volume control and a lighted PTT indicator in an ergonomic hand mic.

Suggested retail prices are: $33.95 (SPM-102); $20.95 (SPM-202); $24.95 (SPM-202E); and $40.95 (SPM-302).

For more information, contact Premier Communications, 20277 Valley Blvd., #J, Walnut, CA 91789; Phone: (909) 869-5711; Fax: (909) 869-5710; e-mail: <premier@adi-radio.com>; WWW: <http: // www.adi-radio.com>.

Circle 101 on reader service card

Viking VHF Satellite Receiver

OFS WeatherFAX has released its new Viking satellite receiver, a high-performance computer-controlled synthesized VHF unit for satellite imagery and data telemetry. The technology uses many of the RF components used in Global Positioning System (GPS) receivers. The Viking design allows for use in harsh mobile, portable, and base station environments. The receiver works with the companion PC Card (PCMCIA) satellite decoder, which allows satellite technology to be used with both laptop computers and regular desktop computers (using the low cost ISA Bus Converter).

Innovative features of the Viking receiver include ease of use (there are no dials, switches, or buttons to be adjusted—all options are set using Viking software); miniature size (4.3" x 2.3" x 1"); automatic satellite tracking; built-in GaAsFET RF preamplifier; twice the number of RF filter stages of standard VHF satellite receivers; wide IF filters optimized for satellite and EMWIN (Emergency Management Weather Information Network) reception; software display of signal strength; spectrum analyzer scanning function, and self test mode, which verifies that the Viking receiver and system are operating correctly.

The system has numerous applications. For instance, it can be used by pilots and emergency management personnel to locate thunderstorms and severe atmospheric conditions; by amateur and hobbyist weather observers; by professional meteorologists; by military and other field and portable users to access the latest weather information; by fisherman to measure sea surface temperatures and to locate ocean currents; and by teachers in agriculture and science education.

Cost with standard DOS software for Windows and Win 95 is $445. Multitasking Win 95 software also available.

For additional information, call or fax (919) 847-4545 or e-mail to <jdahl@worldnet.att.net>.

Circle 102 on reader service card

Alinco DJ-S11T 2-Meter "Pocket Size" HT

Alinco ha s introduced a 2-meter model of its under-$150 handheld. The DJ-S11T, only slightly larger than most pagers, runs on three AA batteries. The unit features 21 non-volatile memories, CTCSS tone encoder, offset capability up to 15.995 MHz and output power of 340 milliwatts ($^1/_3$ of a watt).

Alinco expects the radio to be particularly popular with multi-ham families and hams looking for an economical way to acquire a 2-meter radio.

The DJ-S11T is a near-twin to the company's DJ-S41T, introduced in late 1996. A unique feature of these radios is their pivoting "swing up" telescoping antenna. This flexible design allows the radio to remain compact in a pocket or purse without detaching the antenna. It also does away with the risk of misplacing a detached "rubber duck" antenna.

For information, contact Doug Wynn, Sales Manager, or Taka Nakayama, Branch Manager, at (310) 618-8616 or write to Alinco, 438 Amapola Ave., Suite 130, Torrance, CA 90501; Fax: (310) 618-8758.

Circle 103 on reader service card

Alinco's NEW HTs keep you in touch while you're on the go!

Alinco believes every Ham should own a dependable HT. From newest licensee to seasoned Amateur Radio veteran, you'll be impressed with the features, prices and performance. And no matter how many radios you own, no matter what brand, every Ham should have the new DJ-S11T. There's never been anything like it at the price! Check out these terrific new radios, then check the super-low prices at your favorite Alinco dealer.

DJ-S41T 70 cm Pocket Radio

Already a "best seller," the DJ-S41T covers 425 ~ 450 MHz, has 21 memories, CTCSS encode, self-storing pivot antenna, accepts a wide range of accessories. Perfect for use with repeaters, simplex or cross-band links. At under $150, every ham in the family can own one!

NEW DJ-S11T 2 Meter Pocket Radio UNDER $150!

It's the one you asked for! Full 2 Meter coverage (144 ~ 148 MHz), 21 memories, CTCSS encode, pivot telescoping antenna, accepts standard Alinco speaker/mic and outside power, puts out 340 mw on 3 AA batteries, MARS/CAP and packet capabilities, fits in pocket or purse. You'll be amazed at its many features, performance and coverage. Get all this and more at a price under $150!!

DJ-191T and DJ-190T 2 Meter HT Prices start at under $170!

If you desire a full-size HT capable of 5 watts output, look to the DJ-191T or the DJ-190T.

Available in a number of battery/power output combinations including the DJ-191TD and the DJ-190TD dry-cell pack option. Both radios have 40 memories, accept speaker/mic units, external antenna and outside power (up to 13.8 VDC direct input), have MARS/CAP capability, extended receive and many "extra" features.

Economical DJ-190 is identical to DJ-191 in most functions but comes without keypad. It's perfect for basic communications, packet or for use in APRS "tracker" units.

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Ham Testing In Mexico...for a U.S. License

How to get a U.S. ham license (or upgrade) if you're in Mexico—and don't worry—it's completely legal.

By Gordon West, WB6NOA, Bob Wood, KC6UGF, and Sally Wood, KC6PBT*

Editor's Note: During a recent sailboat race to Puerto Vallarta, Mexico, WB6NOA wanted to get firsthand information about some of the glowing reports he'd received of FCC ham radio testing opportunities in Mexico for mariners and RVers. Bob (KC6UGF) and Sally (KC6PBT) Wood knew exactly who the examiners were and their schedules of upcoming exams. Here, together with Gordon, they offer some tips on how to take a U.S. amateur radio examination while cruising or motoring in Mexico.

How many amateur license exam "rooms" look like this? Inside or outside, this FCC license exam in Mexico is conducted under the watchful eyes of a team of accredited volunteer examiners. (WB6NOA photos)

FCC amateur radio testing must be conducted by a team of at least three accredited volunteer examiners (VEs). And, while the VEs must be FCC-licensed hams, there is no requirement that exams be given in the U.S. Despite the occasional difficulty in rounding up at least three VEs of the appropriate license classes, there are regular testing opportunities for U.S. ham licenses in many part of the world where Americans tend to congregate.

One of the places where you'll find regular testing opportunities is Mexico, where a group of mariners has put together a VE team with regular sessions to offer exams for prospective hams and to give beginning operators the opportunity to upgrade to General. Why the push for General? Well, it's the General class "ticket" that allows the ham mariners to shove off from Mexico and use their shortwave equipment on worldwide ham bands anywhere in international waters. Closer to shore, of course, VHF FM or SSB is possible as well. And satellites are accessible from just about anywhere. But when you're at sea, flexibility is the key, and the General class license gives you the most options.

**Gordon West, WB6NOA, is Senior Contributing Editor of CQ VHF. Bob (KC6UGF) and Sally (KC6PBT) Wood are accredited Volunteer Examiners who are among those giving U.S. amateur radio license exams in Mexico. All three are avid boaters.*

A Long-Running Opportunity

Testing for U.S. ham licenses in Mexico has been going on since the earliest days of the volunteer examining program, according to Sally, KC6PBT, who says that "Karen (WB6B) and Lee (W6NPQ) aboard *Mar Y Vent* offered some of the first tests for U.S. amateur operator licenses and upgrades in Puerto Escondido, Baja," Even in those start-up years when the FCC first turned ham exams over to the ham radio operators themselves, Karen and Lee were testing up to 50 candidates a year through the W5YI VEC (Volunteer Examiner Coordinator) system.

"To further accommodate mariners in Baja, Mel (KI7BK), Don (AA7YY), and Bill (AB6SQ) started up their own team in La Paz, Baja, California," adds Sally. This team started in 1994.

But there were many mariners on the mainland side of Mexico who needed FCC license exams, as well. "Evie (AA7PN), Russ (WA6AVS), and Pat

"...when you're at sea, flexibility is the key, and the General class license gives you the most options."

(AA6XR) flew in from the U.S., and in one day it was reported that 72 examinations were given in just a couple of hours," says Sally.

Monthly Sessions

Every examination team requires a contact VE, and Ron, AB5WE, became the contact VE for Puerto Vallarta. He arranged for monthly exams during the "high season" between December and April, with seating for 25 candidates at each session.

"On an average, these sessions produce seven new Technicians, two General upgrades, and usually one or two Advanced and Extra class upgrades," comments Bob Wood, KC6UGF.

And where do sailors find room for 25 candidates at a Mexican marina? "One time I arranged a tropical courtyard of a local Mexican complex for the examination," comments Tony, KC7RLL. But the examiners pointed out that each test site is chosen carefully for a minimum of noise, good dampening acoustics for the code tests, and a single room where the three examiners can see all of the candidates while they take their tests, as required by FCC rules.

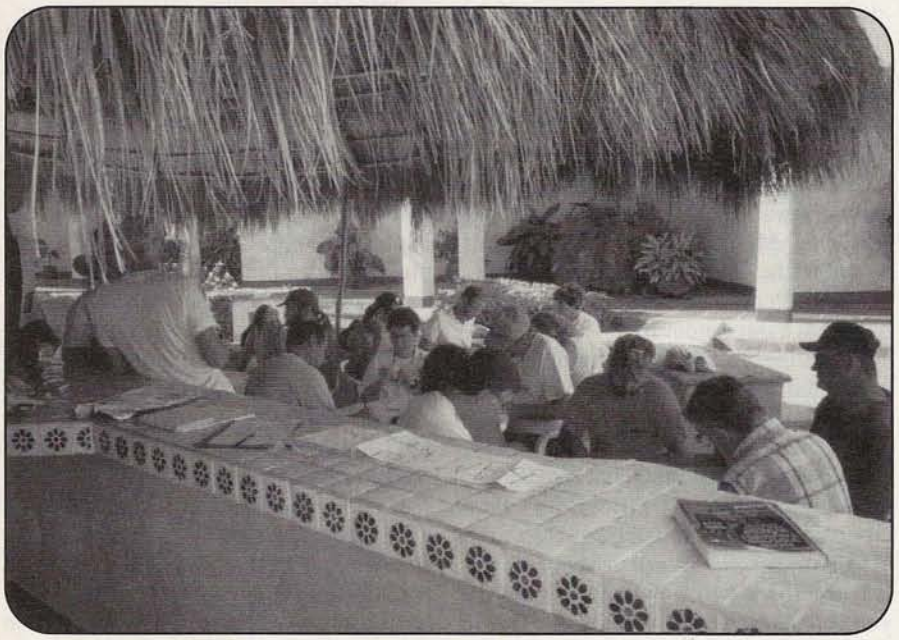
Testing in Tijuana?

The following hams are among the many accredited Volunteer Examiners in Mexico:

Pat Bobzin, AA6XR
Dick Dumas, AB6UD
Ninka Fortuin, WJ6W
Jane Kenny, N6EEC
Geves Keney, KG6CB
Ron May, AB5WE
Susan Middleton, AC6OF
Carol Noble, KE6HYE
Steve Odehnal, KO6UH
Mollie Odehnal, KE6AYV
Dean Pope, N7ZVW
Bob Sukiennicki, AA6YH
Jim Wilkins, WL7AAW
Bob Wood, KC6UGF
Sally Wood, KC6PBT

Air Mail

"Once the testing is over, our next biggest job is how to get the results back to the W5YI or ARRL VEC," says Sally Wood. "We depend on people flying from Mexico back to the United States to drop our mail in the nearest mailbox when they get off the plane." Ron, AB5WE,



Mexico is one of many countries around the world where U.S.-certified examiners give FCC amateur license exams. Except for representatives of foreign governments, anyone may take an exam and qualify for a U.S. ham license.

"All examinations conducted for U.S. amateur licenses are conducted in strict compliance with FCC rules and VEC guidelines."

aboard *Encounter*, has established a good working relationship with the American Radio Relay League VEC, thanks to voice and digital relays from a ham friend in Texas.

"And for new hams waiting to find out their new callsign, electronic filing now shortens down the amount of time they must wait before they can go on the air," adds Sally. In addition, the contact volunteer examiner might be able to see newly-issued FCC callsigns on a high-frequency BBS operated by Fernando, XE2EJ, in La Paz.

Fernando has specific permission from the SCT (the Mexican version of our FCC) to operate an amateur gateway on 7099 kHz. Mariners with high-frequency or VHF data capabilities with a terminal node controller may try to connect with Fernando at <xeej@lapaz.cromwell.com.mx>. The first line of the text should be your callsign, a slant bar, and your vessel name. (Cruisers are asked to contribute $13 a month to defray his expenses in keeping this e-mail gateway open for unlimited Internet access.)

One More Step

Before a U.S.-licensed ham may operate in Mexico, he or she must obtain an operating permit from the nearest SCT office. This is not an actual reciprocal license, but rather a permit that specifically allows you to use all of the radio bands in Mexico, apparently without regard to the class of U.S. license held.

"From Puerto Vallarta, obtaining this license is a three-hour trip to Tepic, Nayarit, or almost a five-hour trip to Guadalajara, Jalisco," says Sally. "There you must make an application, go to the bank and pay your fee for the permit that is usually good for six months, but renewable, then return to the SCT office where they take a copy of your receipt, and then send off all of your paperwork to Mexico City. It takes about two to four weeks before you actually get your permit."

Some hams along the Baja, California, peninsula may also obtain their permits in La Paz, and those who get licensed just before coming into Mexico may obtain their permits in Tijuana or Ensenada.

Playing By the Rules

All examinations conducted for U.S. amateur licenses are conducted in *strict* compliance with FCC rules and VEC guidelines. The teams in Mexico are coordinated by either the W5YI VEC or the ARRL VEC (or sometimes both). Like all other VE teams, they are trained for strict adherence to all of the many details that go into announcing, operating, and closing a day of testing. It takes about 40 pounds of test materials to keep the examinations running smoothly! And there are always those applicants who require special attention because of lost licenses, licenses with an old address on them, grandfathered licenses, and the occasional handicap waiver.

The groups in Mexico get high grades from the VECs. "Very professional, punctual, and accurate," comments the ARRL about their VE teams conducting tests "south of the border." Arlene at the W5YI Group/VEC adds, "Our volunteer examiners who accurately document all paperwork make it relatively easy for us to electronically file applications and receive new call letters within hours of our electronic filing."

Finding Mexican Exam Sessions

If you're a mariner, tune into local cruising nets to inquire when and where upcoming examinations may be scheduled. Get in contact with one of the volunteer examiners and find out specifically what you'll need for your upgrade. If you're calling for a non-ham to take a ham test, double check exactly what they must bring to the examination site. The list typically includes identification, copies and the original of a license for upgrades, and the examination fee (currently $6.25 U.S.). Some items, such as a tape recorder or earphones for a code test, that could be loaned to the VE team might also be appreciated.

If you're interested in becoming a such a "foreign exchange" candidate, make sure you arrive on time, work closely with the volunteer examiners, and enjoy Mexico, or whatever part of the world you're in. And remember: You don't have to be in the U.S. to take a U.S. ham test. Only in America... ■

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(800) 854-6046
Eric, KA6IHT, Mgr.
Victory Blvd. at Buena Vista
1 mi. west I-5

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Build a 25-Amp, 12-Volt MOSFET Power Supply

Power nearly anything that runs on 12 volts with this high-current, low-voltage supply featuring power MOSFETs and self-tracking overvoltage protection.

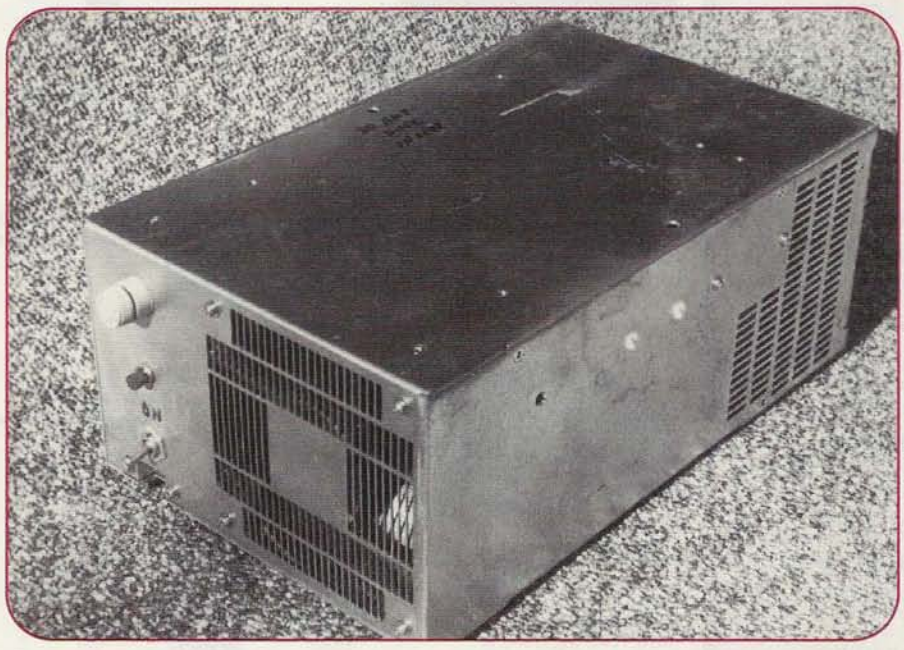
By Charles W. Pearce, Ph.D., K3YWY*

Just about everything in a modern ham shack runs on 12 volts DC. And when you're running several pieces of gear at once, the power demands can get pretty high. For example, a VHF "brick" amplifier putting out 180 watts needs about 15 amps all by itself.

So the next time you need more power, why not build your own supply? Building your own lets you finish with three things you probably didn't start out with: a new power supply, additional knowledge of how the circuitry works, and the satisfaction of knowing you did it yourself.

This project is a 25-amp, 13.6-volt power supply that uses a MOSFET as the pass device. MOSFETs have the advantage of improved high power dissipation and peak current capability when compared to the more conventionally used bipolar devices. (If some of the terminology is new to you, see the glossary elsewhere in this article.)

The design features self-tracking overvoltage protection, short circuit protection, and current limiting capability. This makes the basic regulator circuitry attractive for other power supply projects. This article is intended as a tutorial, so I'll describe how various parts of the design were determined. I'll also describe ways to adapt it to less than optimal transformers and Insulated Gate Bipolar Transistors (IGBTs) or standard bipolars as the pass devices.



Exterior view of the K3YWY power supply. It provides a reliable source of 12-volt power at current levels of up to 25 amps. (Photos by the author)

*Chuck Pearce, K3YWY, is a Fellow at Lucent Technologies (formerly Bell Labs) in Allentown, Pennsylvania. He lives in Emmaus, PA. Chuck has published over 40 professional papers in the area of silicon device processing, along with several book chapters.

Circuit Description

Regulator and Associated Circuitry

Figure 1 shows the overall schematic for the supply. The venerable LM723 serves as the regulator. The output voltage is determined by the resistor chain comprised of R4, R5, and R6. The specific values allow the voltage to be varied from about 10 to 17 volts. In general, the ratio of the total resistance in the chain to the combination of R6 and the resistance in R5 below the tap, times the 7-volt internal reference of the LM723, determines the output voltage.[1]

In operation, the analog closed loop control of the LM723 (based on the operational amplifier shown internal to the device in Figure 1) functions to keep the voltage at pin 4 equal to the 7-volt reference. This provides the basis for the overvoltage and short circuit protection. The R8, R9 voltage divider provides a volt-

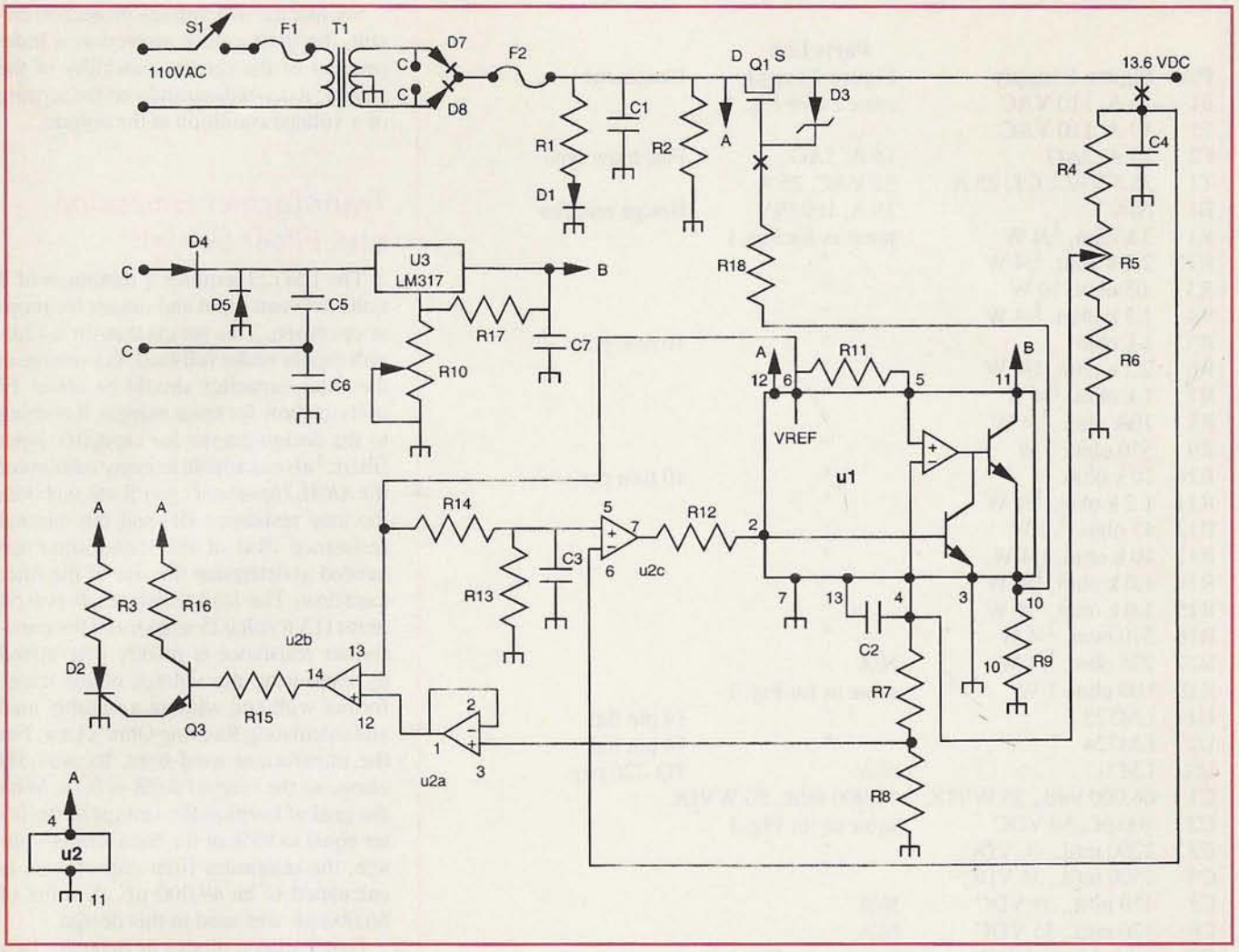


Figure 1. Schematic of the 25-amp, 12-volt power supply using a single MOSFET as the "pass device." See text for details of the parts required and construction.

age to a unity gain buffer (U2a) which is 90% of the pin 4 voltage. This voltage is compared in U2b to the 7-volt reference. Should the output voltage rise above the setpoint by 10%, U2b will turn on Q3 and then the SCR, D2. This will pull the fuse, F2, protecting any connected load.

The selection of the SCR and the design of the associated circuitry deserve serious consideration to ensure overvoltage protection. Let's start with the fuse, F2. It should be rated at the capacity of the supply and not higher, as a slight overcurrent won't blow the fuse. For example, the common 3AG fast blow type of fuse used here takes at least four hours to open at 110% of current rating and up to one hour at 135% of rating. However, at 200% of rating, it will open in less than five seconds. This forms the basis for the SCR selection and, as you can see, the SCR would need to pass 200% of the rated supply current, or, in this case, about 50 amps.

The obvious choice is a 50-amp SCR, but a smaller device can be used if some current limiting is included. Resistor R3 performs this function in this supply. Its value plus the internal resistance of the transformer should not limit the current to less than the required 200%. In this case, the internal resistance of the transformer is .09 ohm and R3 is .05 ohm. The resultant .14 ohm of resistance would only limit the current to about 125 amps, ignoring any other circuit limitations. Alternately, R3 can be sized along with the transformer resistance so the surge current capability of the SCR isn't exceeded. This will protect the device from damage during testing and was the original reason it was included in the design.

The value for R16 is based on the worst-case conditions of current drive needed to turn on the SCR, in this case, up to 30 milliamps. So the voltage at the filter capacitor under full load conditions, divided by the current needed by the SCR, basically determines its size. Any NPN transistor of high gain and suitable BVceo should suffice for Q3.

The short-circuit protection also uses voltage sensing. The output voltage is compared to 90% of the 7-volt reference at U2c. If the output voltage drops below that value, as in a short circuit condition, U2c will turn on the bipolar transistor internal to the LM723 to shut down the supply (again, refer to Figure 1). This circuit acts like a circuit breaker. Even when the short circuit is removed, the output stays at 0 until the supply is turned off and on again.

Parts List

Part	Figure 1 supply	Figure 2 supply	Comment
S1	10 A, 110 VAC	same as for Fig. 1	
F1	10 A, 110 VAC	"	
F2	25 A, 3AG	15 A, 3AG	Fast blow type
T1	35.5 VAC, CT, 25 A	22 VAC, 25 A	
B1	N/A	35 A, 100 PIV	Bridge rectifier
R1	3 k ohm, 1/4 W	same as for Fig. 1	
R2	2.2 k ohm, 1/4 W	"	
R3	.05 ohm, 10 W	"	
R4	1.5 k ohm, 1/4 W	"	
R5	1 k ohm	"	10 turn pot.
R6	2.2 k ohm, 1/4 W	"	
R7	1 k ohm, 1/4 W	"	
R8	10 k ohm, 1/4 W	"	
R9	570 ohm, 3 W	"	
R10	10 k ohm	"	10 turn pot.
R11	1.2 k ohm, 1/4 W	"	
R12	47 ohm, 1/4 W	"	
R13	10 k ohm, 1/4 W	"	
R14	1.0 k ohm, 1/4 W	"	
R15	1.0 k ohm, 1/4 W	"	
R16	570 ohm. 1/4 W	"	
R17	275 ohm, 1/4 W	N/A	
R18	100 ohm, 1 W	same as for Fig. 1	
U1	LM723	"	14 pin dip
U2	LM324	"	14 pin dip
U3	LM317	N/A	TO-220 pkg.
C1	66,000 mfd., 35 WVDC	10,000 mfd., 50 WVDC	
C2	100 pf., 50 VDC	same as for Fig. 1	
C3	2200 mfd., 16 VDC	"	
C4	1500 mfd., 35 VDC	"	
C5	470 mfd., 35 VDC	N/A	
C6	470 mfd., 35 VDC	N/A	
C7	0.1 mfd., 50 VDC	same as for Fig. 1	
D1	LED	"	
D2	25 A, SCR	"	DigiKey S4025L-ND
D3	16 V, 1 W	"	1N4745 Zener
D4	1 A, 100 PIV	N/A	DigiKey DL4002CT-ND
D5	1 A, 100 PIV	N/A	DigiKey DL4002CT-ND
D7	35 A, 50 PIV	same as for Fig. 1	1N1183A or 61MQ40
D8	35 A, 50 PIV	"	1N1183A or 61MQ40
D9	N/A	16 V, 1 W	1N4745 Zener
Q1	IRFP064	IRF140	available from DigiKey
Q2	N/A	IRF140	available from DigiKey
Q3	TIP 31	same as for Fig. 1	Radio Shack 276-2017

Substitution Guide

Current Level	MOSFET	IGBT
15 A	IRF150	IRGBC30S
25 A	IRFP064	IRGBC40S

The purpose of C3 is to provide a time constant in combination with R13 so that, when the supply is turned on, the voltage appearing at pin 6 of U2c rises faster than the reference voltage applied to pin 5. Otherwise, the supply will initialize in the shutdown mode. This is very safe, but not too useful! Similarly, C4 assures that, under transient loading conditions, the voltage at pin 6 remains above that of pin 5.

So, like the overvoltage protection circuit, the short-circuit protection is independent of the current capability of the supply; it depends entirely on the sensing of a voltage condition at the output.

Transformer Selection and Filter Design

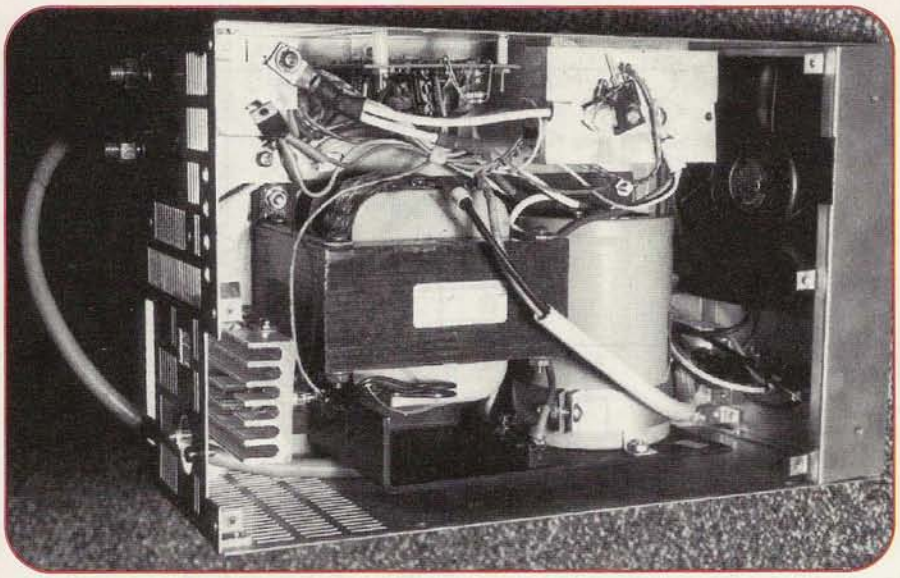
The LM723 requires a minimum of 3 volts between input and output for proper operation. This means that for a 13.6-volt supply under full load, the voltage at the filter capacitor should be about 17 volts to allow for some margin. Referring to the design graphs for capacitor input filters,[2] also available in many editions of the *ARRL Handbook*, you'll see that both the load resistance (R) and the internal resistance (Rs) of the transformer are needed to determine the size of the filter capacitor. The load resistance R is 0.54 ohms (13.6 volts/25 amps), and the transformer resistance is readily determined by measuring the voltage of the transformer with and without a suitable load and calculating Rs using Ohm's Law. For the transformer used here, Rs was .09 ohms, so the ratio of Rs/R is 0.17. With the goal of keeping the voltage at the filter equal to 95% of the transformer voltage, the minimum filter capacitance is calculated to be 49,000 µF. A value of 66,000 µF was used in this design.

Either silicon diodes or Schottky barrier diodes can be used as rectifiers to convert the AC supply voltage to DC. The Schottky diodes have a lower voltage drop (0.2 volt versus 0.6 volt) and therefore less heat dissipation.

Pass Transistor Selection and Thermal Considerations

The IRFP064 MOSFET chosen for this application is rated at 70 amps and 60 volts, BVdss for operation at 100° C, conservative for this application. (See the sidebar "Pass Transistors" for a more in-depth discussion of the relative merits of various pass devices.)

A major problem in the design of a supply such as this is power dissipation in the pass transistors. The dissipation in the pass devices is the current draw times the difference in the output voltage and the voltage appearing at filter capacitor C1. The minimum for this voltage difference is set by the LM723, which requires at



Interior view of K3YWY's heavy-duty power supply. As with most power supplies, the bulk of the space is taken up by the power transformer and filter capacitor. The bulk of the circuitry is on the pc board, mounted to the side of the case.

least 3 volts for proper operation. The particular transformer and filter combination used here has about 17 volts at C1 with a 25 amp load. If the output voltage is set to 13.6 volts, the power dissipation is 88 watts.

A series of heat flow calculations is needed to see if this exceeds the power dissipation rating of the device. These calculations involve the thermal impedance of the junction to case (Rjc), the case to heat sink (Rcs), and the heat sink (Rhs) to ambient air. Assuming a maximum ambient temperature of 100° F or 37° C, a heat sink with a thermal impedance of 0.5° C/watt would require a temperature of 81° C (37° C + 88 x 0.5 = 81° C) to pass the heat to the ambient. Given the typical Rcs of 0.24° C/watt for the device, the case temperature would be 102° C

Pass Transistors

Bipolar transistors have been the classic choice for pass devices in analog power supplies for quite some time. They're relatively rugged and inexpensive, but they do have certain limitations. For example, the common 2N3055 is limited to 15 amps of collector current, and the power dissipation available at a case temperature of 100° C is only 60 watts. The device also suffers from low current gain at high collector current. Thus, with a h_{fe} as low as 20, a 30-amp supply would need a minimum of four devices. Three devices in parallel with equalizing resistors in the emitter would carry the load, and the fourth—connected as a Darlington—would supply the base current.

Power MOSFETs and IGBTs offer both higher current carrying capability and power dissipation than bipolar devices. For example, the International Rectifier IRFP064 is rated at 70 amps continuous and will dissipate 150 watts at a case temperature of 100° C. A comparable IGBT is the IRGBC40S, also by International Rectifier, which is rated at 31 amps and 65 watts at the same case temperature. These devices have the advantage of being controlled by a gate voltage rather than a base current. Therefore, no Darlington arrangement is needed to develop sufficient base current. The drawbacks of the devices are the higher cost and the need for a bias circuit in some cases.

The differences between MOSFETs and IGBTs are slight in this type of application. IGBTs offer higher transconductance, but this is of little concern since the devices operate at sufficient drain-to-source or collector-to-emitter voltage drop. The choice can be made on the basis of price and availability.

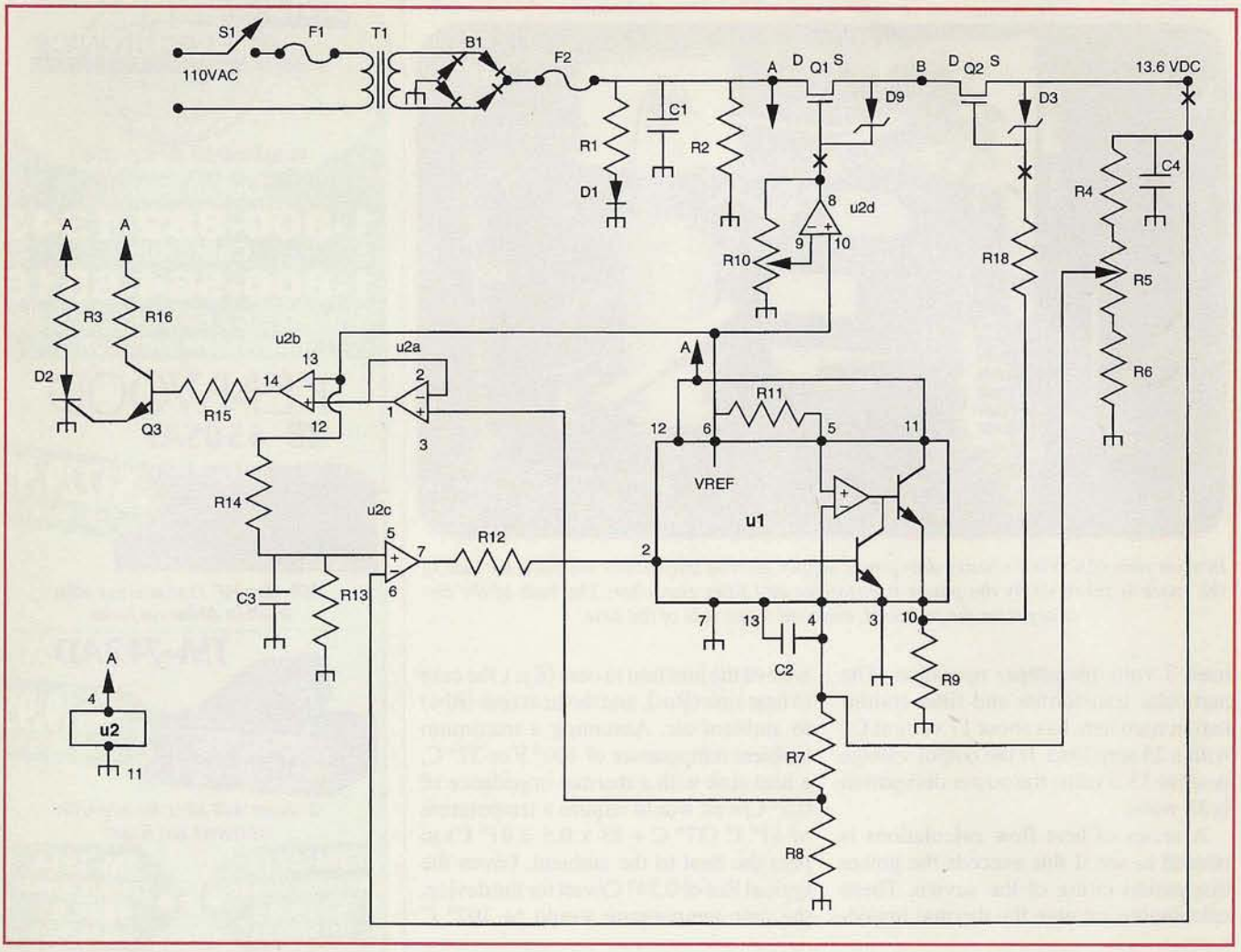


Figure 2. Alternate design of the power supply, using an "active load device" (Q2) to increase the available power dissipation, in case all of the parts for the circuit in Figure 1 are not readily available.

(81 + 88 x 0.24 = 102° C). The power dissipation of the device is 300 watts at 25° C and is derated at 2.0 watts/degree C. So, at a case temperature of 102° C, the available power dissipation is 146 watts (300 - (102 - 25) x 2.0).

Finally, the junction temperature must be calculated. The Rjc is 0.5° C/watt for this device. Starting at a case temperature of 102° C, the resultant junction is 146° C (102 + 88 x 0.5 = 146° C). This is below the maximum of 175° C for the device. In this instance, then, only a single pass device is needed. A heat sink to pass this amount of power with a thermal impedance of 0.5° C/watt would represent a volume of about 100 cubic inches. Although, it's best to be conservative when considering the heat dissipation aspects of a power supply design, this design would be capable of 32 amps without violating the heat dissipation or junction temperature specifications of the device. So, in low duty cycle uses, such as CW and SSB, somewhat higher currents could be safely drawn from the supply.

"...this design would be capable of 32 amps without violating the heat dissipation or junction temperature specifications of the device. So, in low duty cycle uses, such as CW and SSB, somewhat higher currents could be safely drawn from the supply."

The MOSFET used in this circuit will typically need a Vgs of about 6 volts to deliver 25 amps. This means that at an output voltage of 13.6 volts, the gate voltage would be 19.6 volts. A bias supply develops this voltage for the gate and consists of the voltage doubler formed by D4, D5, C5, C6, and the regulator U3. This supply also acts as the current limiter since R10 can be adjusted to limit the output current, as I'll describe later. The beauty of this approach is that most other MOSFETs and IGBTs can be substituted without changing the design.

Diode D3 is a 16-volt zener and acts to protect the gate in the event of a short circuit. The maximum gate Vgs for these devices is 20 volts, and, in the event of a short circuit, the bias supply will appear from gate to source.

Active Load Design Example

In many cases, a power supply project will begin with a transformer obtained at a hamfest or from a friend's junk box. It may not be the optimal choice for a given design, but, if the limitations are understood, it can sometimes be adapted. Fig-

ure 2 shows a power supply that's a variation on the design in Figure 1. It's for use with a transformer that has a 22.9-volt secondary and is capable of 25 amps, and it features an *active load device* to increase the available power dissipation. The Q2 device acts in the conventional manner, being controlled by the LM723, whereas the Q1 device operates under fixed bias and doubles the available power dissipation.

The IRF-140 MOSFET chosen for this design is rated at 27 amps and 100 volts, BVdss. The 27-amp rating is for operation at 25° C case temperature, at which the available power dissipation is 125 watts. At 100° C, the current capacity is derated to 17 amps and the power dissipation to 50 watts.

A series of heat flow calculations (as was done for the first design) is needed to determine the current capability. However, in this case, the filter-to-output voltage drop will be about 9.2 volts. Starting at an ambient temperature of 37° C as before, and using values for Rjc, Rcs, and Rhs of 1.0, 0.5, and 0.5° C/watt, respectively, the maximum continuous current capability is calculated as 12 amps. To obtain a higher continuous current from the supply, an IRFP064 could be substituted for the IRF-140. This device is rated at 70 amps (at both 25° C and 100° C) and a 25° C power dissipation of 300 watts derated at 2.0 watt/degree C. The maximum usable junction temperature is 175° C. Using values for Rjc, Rcs, and Rhs of 0.5, 0.24, and 0.5 appropriate for the IRFP064, calculations show two of these devices would be capable of handling 25 amps.

Notice that there is no bias supply in this design. This is because the voltage available at the filter capacitor is sufficient for both Q1 and Q2. Under full load conditions, the MOSFETs need about 5 volts gate-to-source to deliver the full current. This would be 18.6 volts for Q2 and, given an equal division on the voltage drop between the devices, 22.8 volts for the active load device, Q1. If the voltage at the filter capacitor was any lower, a bias supply would have been needed.

Construction

The parts list contains everything you'll need for both a single and dual MOSFET supply. Suggestions for IGBTs at various current levels are also included. All of the parts are commonly available, except possibly for the pass devices,

"In many cases, a power supply project will begin with a transformer obtained at a hamfest or from a friend's junk box. It may not be the optimal choice for a given design, but, if the limitations are understood, it can sometimes be adapted."

which are available from Digikey.[3] There are no special construction techniques that are required to build this design, and only the usual precautions for handling MOSFETs and IGBTs should be observed with the pass transistors. These devices are expensive and should be handled carefully. Despite the expense, it's a good idea to have a spare or two on hand just in case.

The pass transistors, as well as the rectifiers, should be properly heat-sinked. Vertical fin placement is the preferred orientation for convective cooling with the heat-sink.

The over-voltage SCR doesn't need heat sinking because it only operates briefly, if at all. Use a minimum of 16-gauge wire for the anode and cathode connections to the SCR.

All of the regulator and protection circuitry can be built on a small pc board, and a multi-conductor cable can be used to attach it to the rest of the supply and pass devices, indicated in Figure 1 at the places marked **X**, **A**, and **ground**. The same is true for the supply shown in Figure 2.

"Smoke Tests"

Once you're sure that everything is wired correctly, break the line from the bias supply at the point labeled **B** in Figure 1, then turn on the supply and adjust R10 to 20 volts. Next, turn off the supply, reconnect the break at **B**, and turn on the supply. Adjust R5 to the desired output voltage.

The overvoltage protection circuit can

Glossary

Some of the terms used in this article may be unfamiliar to readers. Here's what they mean:

Bipolar transistor—A transistor with two junctions, between the base and collector and between the base and emitter. Common examples include PNP and NPN "sandwich" transistors. Bipolar transistors are current-operated, unlike field effect transistors (FETs), which are voltage-operated.

BVceo—This is the breakdown voltage of a bipolar transistor between the collector and emitter terminals with the base unconnected.

BVdss—This is the breakdown voltage of a MOSFET between the drain and source terminals with the gate connected to the source.

Darlington arrangement—The placement of two transistors in a circuit so that the amplified output of the first is amplified further by the second. The transistors in a Darlington pair are connected directly to each other.

FET (Field Effect Transistor)—A semiconductor amplifier in which the current flow through a thin silicon bar, called a *channel*, is controlled by a high-impedance *gate*. Connections at the ends of the channel are known as the *source* and *drain* electrodes.

h_{fe}—This is the static common emitter current gain of a bipolar transistor, also known as beta. A transistor with a beta of 50 would exhibit collector current of 1 amp with a base current of 20 milliamps. (20 mA x 50 = 1000 mA = 1 amp).

MOSFET (Metal Oxide Silicon Field Effect Transistor)—An FET in which the *gate* electrode consists of a thin metal film insulated from the *channel* (semiconductor) by a thin oxide film. Other FETs commonly use a PN junction as the gate which controls current flow.

Pass transistor—In an analog power supply (i.e., not a switching supply), the pass devices are used to drop the voltage from the unregulated part of the power supply to the regulated output. Thus, all the current *passes* through these devices to the connected load. The pass devices are controlled by the regulator circuit to keep the voltage constant under varying load conditions.

Schottky barrier diodes—A solid-state diode in which the PN junction is formed by a metal and a semi-conductor.

SCR (Silicon Controlled Rectifier)—A semiconductor commonly used for control and switching functions.

Thermal impedance—Like electrical resistance, this quantity is a measure of the resistance a material offers to heat flow. Its dimensions are of degrees Celsius per watt (C/watt, or C/W). Generally, high values are bad as they represents a limitation on the ability of a transistor to dissipate heat.

Vgs—This is the voltage applied to the gate of a MOSFET as referenced to the source. Basically, it's the bias voltage.

be tested by connecting the output of the supply to pin 12 of the LM324; the short-circuit protection can be tested by simply shorting the supply. Remember that the supply must be turned off and on to be reset. Typically, it should be left off long enough for C3 to discharge through R13, or a pushbutton switch could be placed across the capacitor for a more rapid, albeit manual, discharge.

Finally, measure the voltage at the output under full load and adjust R10 to maintain the output voltage. Under full load, measure the voltage drop from **A** to output and make sure that the power dissipation is within the design limits. The load device can be either high-power passive resistors or an active load device.[4]

The procedure for the supply with the active load is to turn on the supply without a load and adjust R5 to the desired voltage. Then measure the voltages from **A** to **B** and **B** to **C**. Adjust R10 to equalize the two. Next apply a load equal to the full load and repeat the procedure to ensure equal dissipation in the devices. The short-circuit and overvoltage protection circuits are tested in the same way as the other supply.

Extensions of the Design

The usefulness of a regulator's design is seen mostly in the nature of the protection circuitry that is independent of the power supply attached to it. The voltage limitation with the current design is about 37 volts, derived from the 40-volt maximum rating of the LM723 and the 3-volt difference it requires between input and output for proper operation. The lower voltage is set by the 3.5-volt setpoint used to sense a short-circuit condition.

The MOSFETs and IGBTs need about 6 to 8 volts gate-to-source (emitter) to deliver the rated currents. Generally, this will require a bias supply if the design is one that minimizes the voltage drop between the output and the filter to the desired 4 volts, so as to minimize power dissipation in the pass devices. However, a wide range of these types of devices can be substituted since the bias requirements are very similar. The design can be readily adapted to bipolar pass devices by eliminating R9, which is used to develop the gate bias voltage. The pass transistor internal to the LM723 can be used to supply base current up to its limit of 150 milliamps. If more current is needed, a Darlington arrangement must be used.

Now Connect Something and Use It!

One of the greatest things about building your own gear is the knowledge and understanding you gain in the process. But the greatest benefit is a new piece of equipment to use and enjoy. And if that piece of equipment is a high-current power supply, it's something you can put to use immediately, no matter what your operating interests may be. Once you've tested it and everything is working OK, it's time to connect something and use it! Enjoy your new power supply! ■

Notes

1. National Semiconductor Corp., *Linear Data Book* 1982, pg. 1–143.
2. Otto H. Schade, "Analysis of Rectifier Operation," *Proceedings of the I.R.E.*, July 1943. The pertinent design curves from this reference appear in many issues of the *ARRL Handbook*.
3. DigiKey Corp., 701 Brooks Ave. South, P.O. Box 677, Thief River Falls, MN 56701-0677; Phone: (800) 344-4539.
4. Ben Spencer, *QST*, November 1993, pg. 29, Figure 3.

Reader FEEDBACK...

Shocking Advice!

Dear *CQ VHF*:

After reading KC7PJA & KC7PJB' s question regarding help for curing white noise in the "Q & A" column of the June issue of *CQ VHF* (p. 78), I couldn't wait for the stern warning forthcoming in your reply. The last two sentences prompted absolute SHOCK (no pun intended, honest) when you didn't caution them about the real risk of serious injury or death when you advised that raising their antenna above the level of the nearby power lines not only would "help," but "couldn't hurt"!

He clearly states that the antenna is *already* 24 feet off the ground, and the power lines are only 100 feet away. Even if the installation went without problems, a strong Oregon gust next autumn could effect a premature encounter with his celestial Creator. Your advice was a recipe for *disaster*! I hope your Law department offers better counsel. You're gonna need it! What were you thinking?

Pete Varounis, NL7XM

Pete—Obviously, we weren't *thinking about the antenna falling over! While it's desirable to get an antenna above the level of potentially noisy power lines—vertically—you must* always *be sure that there's* no way *the antenna or any part of the support system can accidentally come in contact with power lines.*

Thanks for pointing out our omission. By the way, on a similar topic, we're working on an article for a future issue on protecting mobile antennas from accidental contact with overhead lines.

—W2VU

Are You Reading Your Own Articles?

Dear *CQ VHF*:

At the end of the "Nature of Video—Part 3" article on page 76, third paragraph of the fine June 1997 issue of *CQ VHF*, you put the following editors note: "*(Remember that a TV signal is 6 MHz wide, so be sure to check local band plans in your area to be sure none of the frequencies below 442.250 MHz has been coordinated for repeater use. If they have, operating ATV on 439.25 creates an interference potential.—ed.).*"

I wonder if the frequency 442.250, is a typo? Don't you mean 440.250 MHz? As the article clearly points out, 90% of the energy is +/- 1 MHz from the video carrier. With the exception of the color and sound subcarriers at 442.83 (>-22 dBc) and 443.75 (-15 dBc) the sideband energy is typically down more than 50 dB +/- 1 MHz from the video carrier. My experience over many years is that actual interference to other modes has been minimal if more than 1 MHz away from the video carrier or 200 kHz from the two subcarriers; we also conducted experiments with FM link, CW and SSB DXers and satellite users who had fears that ATV would cause unacceptable interference to them.

On the other hand, any energy from other modes above 1 microvolt in the in the 438.0- to 440.0-MHz ATV receiver passband has interfence potential. Interference can be seen in the video down to -50 dB with respect to the video p.e.p., and tears it up at -15 dBc.

Here in Southern California SCRRBA does coordinate links within the ATV passband, but greater than +/- 1 MHz from the video carrier and, if the energy will be no more than 1 microvolt, into the ATV repeater's input. In the less populated areas of the country, there are 40 FM repeater channels that can be coordinated above 444.0 before the interference potential to either mode might occur. I suggest that all mode users in any given communications area should get together and work out an equitable and technically competent band plan before any interference occurs.

The current 70-centimeter ARRL band plan from 1979 is not a technical band plan and has a few flaws on the face of it. There is room for most everyone, even in the high density areas, if those affected are willing to have one or two of their most technically qualified representatives sit down at one time and work it out.

We did that here in Southern California, probably the highest communications density area in the country, in the 70s. Our efforts have worked out quite well, with two ATV channels, almost 200 FM voice repeater channels, links, digital, satellite, CW, SSB, and weak signal modes operating with minimal interference in the 420 to 450–MHz band. SCRRBA, Southern California Repeater and Remote Base Assn., one of the area frequency coordinators, hosts the local band plan meetings for 6 meters and the 70-centimeter-and-up bands, and has a core of representatives from every mode that forms a Technical Committee to call upon when revision is necessary.

Tom O'Hara, W6ORG
ARRL Technical Advisor for Spectrum Management and ATV
SCRRBA Technical Committee member

Tom—Thank you for the enlightening and educational letter. No, it wasn't a typo ..it was a "thinko." I was thinking more about problems that an ATV group here in metro New York had with getting a 70-centimeter coordination—based on a claim by the coordinator that it might interfere with repeaters between 440 and 442 MHz—than about whether the coordinator had a sound technical basis for its decision. Plus, obviously, I didn't read the article closely enough.

Close cooperation and coordination can go a long way toward preventing or resolving many conflicts within the amateur community, especially when it can be accomplished with a minimum of politics getting in the way.

—W2VU

The Debate over Spread Spectrum

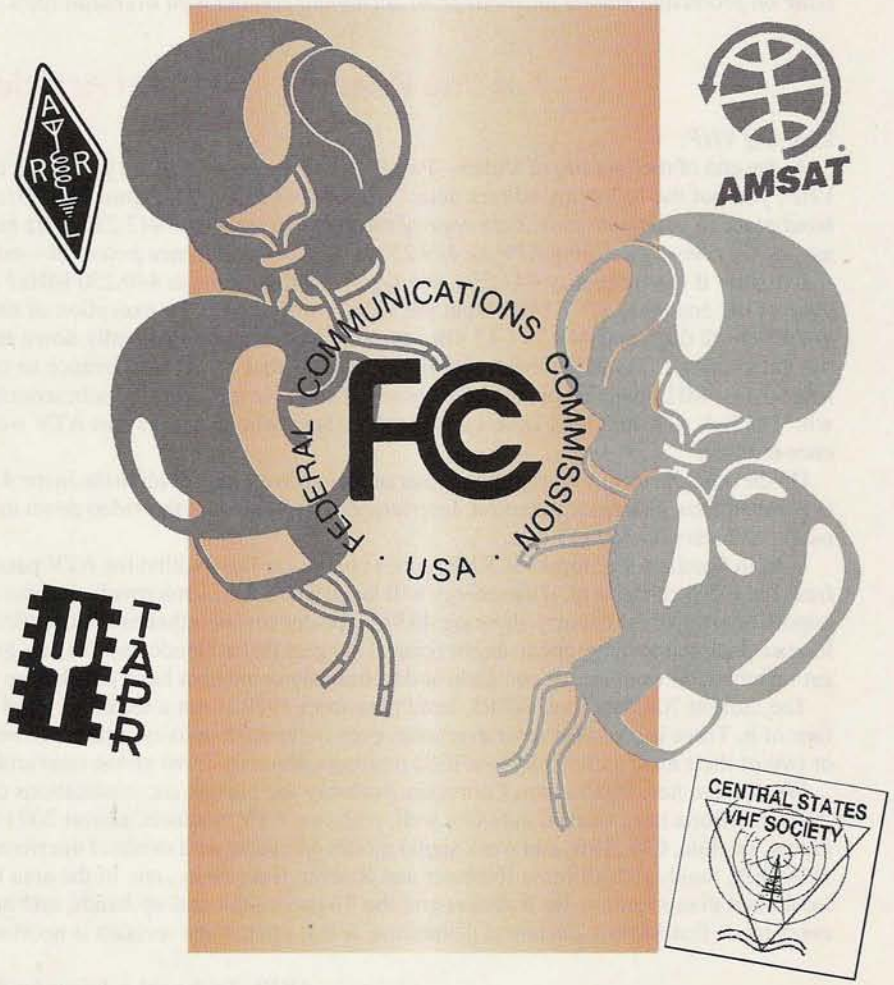
Some "big guns" in ham radio are facing off over an FCC proposal to loosen restrictions on spread spectrum communications. Is it a threat to current activities? Or the future of ham radio?

By Rich Moseson, W2VU*

The FCC's proposal to relax the rules governing amateur spread spectrum (S/S) communications hasn't gotten too much attention, except from those hams who want to do more S/S experimentation, and from those hams and others who feel greater amateur S/S use will threaten their own activities. But it has caught the attention of some of the leading ham radio organizations, and it really ought to be of interest to all VHF/UHF users, for a variety of reasons.

First of all, S/S has the potential to greatly improve the way we use our frequencies and the way in which we transmit data, voice, video, and even Morse code. Second, the folks who are worried about its impact on current activities include repeater owners, satellite users, and weak-signal operators—in other words, just about all current users of our VHF, UHF, and microwave bands. (Did I mention packet? Packet users should be the *most* interested, since the most immediate use of S/S is in faster, more reliable digital communication.)

In this article, we'll summarize the major issues, points of disagreement, and alternate proposals. But before we go any farther, let's take a look at what S/S *is*, what the current rules allow, and what the FCC is proposing.



What Is Spread Spectrum?

Here's how the FCC defines S/S in its Notice of Proposed Rule Making (NPRM) that's the subject of all this current debate:

Spread spectrum is a technique whereby the energy of the transmitted signal is distributed over a wide segment of spectrum. The signal power density can be very low and the duration of a transmission on any frequency in the segment of the spectrum can be but a fraction of a second. SS systems, therefore, can evenly share all of the spectrum in the available frequency segment, despite a number of stations transmitting simultaneously. They can often share the same spectrum unobtrusively with non-SS systems because the transmissions may not be noticeable to a casual listener.

Commercial uses of S/S are wide and varied. They include 900-MHz digital cordless phones, wireless computer networks, automatic meter readers, etc. I just

*Rich Moseson, W2VU, is Editor of CQ VHF.

"The comments basically fell into three groups: those who supported the proposal as is or who wanted even fewer restrictions; those who supported it in concept but wanted additional restrictions to protect users of other modes; and commercial interests who saw the NPRM as a threat...."

got an ad for a "Wireless Printer Sharing" device that says it uses a "high-performance 2.4 GHz Spread Spectrum Radio."

For a more detailed introduction to amateur S/S communications, see "Digital Data Link" in the May, 1997, issue of *CQ VHF*, plus "Spread Spectrum—Yesterday and Today" elsewhere in this issue.

The Current Rules

The FCC first authorized hams to use S/S in 1985, and the current rules can be found in Part 97, primarily under Section 97.311. These rules are very specific and very narrow. They...

- limit S/S communications to stations in FCC-regulated areas and to frequencies above 420 MHz;
- make S/S a secondary mode to all other emissions, barring S/S stations from causing harmful interference to hams using other modes and requiring them to accept all interference from other modes (this is the only amateur mode with such a restriction);
- limit S/S transmissions to one of two techniques, *frequency-hopping* and *direct sequence*, and specifically prohibit the use of hybrid techniques (these techniques are explained in some detail in the May '97 "Digital Data Link" column referenced above);
- set very strict, narrow, and limited technical standards for S/S transmissions;
- require extremely detailed log-keeping;
- require stations to identify in standard (narrowband) Morse code; and
- limit power output to a maximum of 100 watts (once again, the only mode that's so restricted).

Not surprisingly, in the face of the strict operating limitations and heavy record-keeping requirements, very few amateurs have gotten involved with S/S on the ham bands. In fact, most amateur S/S operation has been under one of two STAs (Special Temporary Authority) in which the FCC has waived some of the rules for participating stations. The current NPRM is an outgrowth of the latest STA, which was granted to Tucson Amateur Packet Radio (TAPR). The NPRM is based on a Petition for Rule Making filed in December, 1995, by the American Radio Relay League (ARRL).

The FCC's Proposal

The ARRL asked for five specific changes in the S/S rules:

1) to permit brief test transmissions in S/S, as is now allowed for other modes on those frequencies on which S/S operation is allowed;

2) to allow S/S contacts with stations in other countries that permit amateur S/S transmissions;

3) to remove a statement in the rules that unintentional triggering of carrier-operated repeaters does not constitute harmful interference (the ARRL felt it was redundant);

4) to remove the limitations on spreading codes and techniques in order to allow more experimentation; and

5) to require automatic power control (APC) by S/S transmitters using more than 1 watt of output, in order to minimize the likelihood of interference with other modes.

The FCC basically accepted all of the ARRL's proposals and incorporated them into WT Docket 97-12, which was released on March 3 of this year. Comments, which were due two months later, were filed by several amateur organizations, a few individual hams, and some non-amateur groups as well. Most of the comments were posted on TAPR's World Wide Web page (<http://www.tapr.org/ss>), along with the ARRL's original proposal and the FCC's NPRM (for which we thank the folks at TAPR).

You Need a Scorecard...

The comments basically fell into three groups: those who supported the proposal as is or who wanted even fewer restrictions; those who supported it in concept but wanted additional restrictions to protect users of other modes; and commercial interests who saw the NPRM as a threat to their unlicensed (Part 15) operations on bands shared with amateurs. Virtually all of the amateur comments—except the ARRL's—proposed eliminating the CW ID requirement, opposed mandatory automatic power control, and asked for elimination of the record-keeping rules. In addition, there seems to be no objection at all to allowing test transmissions and international contacts.

To help you keep track, here's a scorecard of who was in which group:

- *Approve as is or loosen up more:*
  - The ARRL
  - TAPR
  - Philip Karn, KA9Q (a member of the ARRL committee that drafted the original proposal and author of the APC requirement)
  - Robert Buaas, K6KGS (a participant in amateur S/S experiments since they were first permitted)
  - Lyle Johnson, WA7GXD (a co-founder of TAPR), and
  - the National Communications System (NCS), a federal agency made up of representatives from most other federal departments and managed by the Secretary of Defense.
- *Approve in concept, but more protections needed for other modes:*
  - Radio Amateur Satellite Corporation (AMSAT)
  - Central States VHF Society (CSVHFS)
  - the 220 MHz Spectrum Management Association of Southern California (220SMA)
  - Raphael (Ray) Soifer, W2RS (a former Executive Vice President of AMSAT), and
  - William (Bill) Tynan, W3XO (President of AMSAT and past president of CSVHFS)
- *Commercial interests who don't want interference from hams even though we're licensed and they're not:*
  - Metricom, Inc.
  - The Part 15 Coalition.

APC and the CW ID

As noted above, the current requirement for narrowband CW ID and the proposal for mandatory Automatic Power Control (APC) drew objections from virtually everyone.

Most commenters pointed out that a CW ID is not only impractical and inconvenient for an S/S transmitter, but could also end up *causing* interference. As WA7GXD noted, "Many commenters to the original proposal expressed concerns

about potential interference to narrowband users....But, we have in place a rule that requires the SS station to operate in a way that guarantees the emission will be heard by narrowband receivers!" And, as KA9Q put it, "it is vital to avoid an ID requirement that would itself cause interference even when the associated SS emission does not." Most commenters felt that standard direction-finding techniques could be used effectively to find the source of an interfering signal that cannot be otherwise identified.

APC is commonly used in cellular telephones and other commercial technology. The radios "talk" to each other and reduce output power until received signal strength at both ends of a circuit reaches a preset threshold. The NPRM mandates a specific means of APC, based on a mathematical formula[1], for amateur S/S stations running more than 1 watt of transmitter power. It is included in the NPRM as a means of minimizing potential interference between S/S stations and other users.

All of the amateur commenters except for the ARRL oppose this requirement, generally arguing that the rules already require amateurs to use the minimum power necessary for communication, and that the specific means for doing so should not be mandated in the rules, especially if they apply only to one transmission mode. In addition, several commenters pointed out that APC is impractical in many typical amateur settings, such as situations in which there is more than one intended receiver (a DX cluster, for example, or a "roundtable" setting in which each station in a group transmits to all other stations), and that it might be impossible to reach the most distant station without having your power knocked down substantially by the closest station.

The Interference Question

Here's the $64,000 question: If amateur S/S use becomes as popular as, say, packet is today, will it raise the noise level on the bands to the point where it causes significant interference to weak-signal operators and even to repeaters?

The ARRL says it's "unaware of any instances of interference to amateur narrowband communications from amateur SS communications using the same or adjacent frequencies," and K6KGS—attaching a series of graphs on frequency occupancy—agrees, noting that, "to date, no one has come forward with any evidence that amateur SS emissions have interfered with anyone."

But the weak-signal users respond that there hasn't been enough experience with large numbers of S/S signals on the air simultaneously to draw any valid conclusions. CSVHFS says that,

> ...if spread spectrum does become a popular mode, these short bursts of interference (from each SS station on a given frequency) will be repeated by each spread spectrum station on the air at the time. Thus, spread spectrum interference, instead of being an occasional 'pip,' will take the form of continuous 'hash.'...This will have the effect of eliminating all possibility of weak signal long-haul work.

And AMSAT says its calculations show that

> ...a single terrestrial SS station transmitting in the 435 MHz amateur satellite band, even with a power of only one watt spread over 10 MHz, could increase the 'noise' level up to 20 dB at a distance of 20 km, resulting in interference to reception of relatively weak amateur satellite signals. The situation worsens as the number of SS stations increases...."

Just one minute, though, responds TAPR. Why should an S/S operator be a "second-class citizen" on the ham bands? "After being authorized as a legal emission mode in the (amateur) service for over fifteen years now," says TAPR, "it now seems inappropriate to continue to single out SS to be considered secondary to all other allowable emission modes authorized in the service."

KA9Q is more to the point, noting that many sources of potential interference are restrained by "gentlemen's agreements," not by FCC rules. Karn also points out that some level of interference is, and always has been, an unavoidable part of operating on the amateur bands.

> It is impossible to say that under absolutely no circumstances could spread spectrum operations interfere with traditional narrow band operations. But it is wholly inappropriate to demand such guarantees in the first place....The amateur service has *always* been primarily an experimental, technically-oriented service. It is not a critical operational safety-of-life service like public safety or aviation, nor is it a common carrier utility like cellular telephones. Some level of unintentional interference is therefore to be expected and tolerated.

The fact of the matter is that there have been no large-scale, coordinated, tests of S/S operation conducted, even under the more liberal provisions of the STA, so all of the arguments on both sides of this question are, at this point, nothing more than conjecture. And they're likely to remain that way unless and until all sides agree to an unbiased and objective series of large-scale tests.

"Thomas Jefferson said 'That government which governs least, governs best.' And many of the commenters in this case agree."

Calls for Minimum Regulation

Thomas Jefferson said "That government which governs least, governs best." And many of the commenters in this case agree. K6KGS, for example, urged an almost complete deregulation of S/S within the general framework of amateur rules, calling for S/S authorization on all frequencies above 50 MHz at full amateur power, and with "any coding and/or modulation technology imaginable." He says freedom to experiment and work with different designs will do more to reduce potential interference than will restricting S/S frequencies.

"What will happen," he asks, "when the day comes that a novel weak-signal application wishes to use the very S/S technology now proven for deep space, yet the Rules prevent its use in spectrum reserved for weak signals?"

KA9Q's proposal goes even further: "The FCC's rules should...go no further than to set a maximum transmitter power level and to set limits on spurious emissions outside the amateur bands...therefore, the Commission should permit spread spectrum operations on *all* amateur bands, including HF, not just those above 50 MHz or 219 MHz." He also proposes an exception to the 100-watt power limit for "emissions directed to space," such as EME or contacts with interplanetary spacecraft (don't laugh; Phil says "discussions are already under way within AMSAT for an amateur-built spacecraft to be flown to Mars").

TAPR also feels the 100-watt power limitation is too restrictive and would like to see it eliminated, along with all of the record-keeping requirements currently on the books that the FCC plans to keep in place. Like K6KGS, TAPR also feels

S/S should be allowed on all amateur frequencies above 50 MHz and, like KA9Q, believes minimum regulation and maximum flexibility will allow technology to develop to meet whatever needs arise (including new schemes to reduce interference...if there is any).

Another "player" favoring minimum regulation is 220SMA, the 220-MHz frequency coordinator for Southern California—but with different reasoning. The 220SMA says it feels that coordination rather than regulation will be the best way to deal with potential interference problems, that regional differences dictate different approaches in different areas and that a "one-size-fits-all" approach is rarely the best fit for anyone. On the other hand, 220SMA says not enough is known about how heavy S/S use will coexist with heavy repeater use, so it suggests keeping the lower frequency limit on S/S transmissions at 420 MHz, at least for the time being.

Novel Approaches

AMSAT and CSVHFS, representing satellite and weak-signal operators, say they certainly don't want to discourage greater flexibility and more use of S/S, but "not in our back yard." Both propose limiting S/S frequencies to protect their current operations, but both also recognize the potential of S/S to be of use in their traditional activities. AMSAT proposes a rule allowing S/S in internationally-allocated satellite subbands *only* for communicating via satellites.[2] So, in the 435- to 438-MHz segment, for example, no terrestrial S/S would be allowed, but S/S transmissions directed to a satellite would be permitted.

CSVHFS came up with an even more novel approach, recommending that the FCC define two *types* of S/S transmissions. One, the traditional wideband variety currently in use, might be called *Broad Band* S/S, suggests CSVHFS, while another (in which the spreading is limited to a small bandwidth of, say, 10 kHz) would be called *Narrowband* S/S. The basis for this "narrowband" S/S transmission is a presentation made at last year's CSVHFS Conference by Phil Karn, KA9Q, and Tom Clark, W3IWI, in which they showed how S/S techniques, within a narrow bandwidth, might be used for EME and terrestrial weak-signal contacts. Since this "narrowband" S/S would take up no more total spectrum space than an AM voice signal, CSVHFS suggests permitting "narrowband" S/S on all amateur bands above 50 MHz, but limiting traditional "broad band" S/S to frequencies outside those most commonly used for weak-signal operation.[3]

The Commercial Interests

Most commercial S/S devices in use today, including some cordless phones, automatic meter readers, wireless computer networks, etc., operate as unlicensed devices under Part 15 of the FCC rules. Part of the "deal" under which they may operate without a license is that they limit their power to 1 watt, they may not interfere with licensed users of the same frequencies (including amateurs), and they must accept any interference from licensed users. Many of these S/S devices are using hybrid coding schemes, which are specifically prohibited from amateur use today but which the FCC is proposing to allow in this NPRM. As a result, hams could buy off-the-shelf commercial

S/S gear designed for Part 15 use, crank up the power to 100 watts, and build their own wireless LANs (local area networks) on some of the same frequencies used by the Part 15 services (specifically 902, 2400, and 5700 MHz). This has the Part 15 folks nervous.

Lining up on the side of those who fear significant interference problems from expanded amateur S/S use, Metricom (with its worries echoed by the Part 15 Coalition) says, "Part 15 spread spectrum operations in the 902–928 MHz band would...experience significant interference if widespread, more flexible amateur spread spectrum operations were allowed in this band."

However, rather than criticizing the proposed relaxation in spreading codes, Metricom says it "must strongly oppose amateur operations with 100 watts output and unlimited antenna gain in (bands that) are shared with Part 15." Curiously, though, the current rules already permit hams to use 100 watts and unlimited antenna gain on these bands. What Metricom and other Part 15 folks worry about, though, is that we hams might actually start using these shared frequencies in serious numbers.

Ironically, Metricom admits in its opening statement that it owes its business to advances made by hams. "Metricom's frequency hopping spread spectrum systems—at the leading edge of technology—had their origins in amateur radio, and many of Metricom's engineers are active amateur operators," says the company's comments. "The experimentation done with spread spectrum amateur radio enabled Metricom to develop...the fastest wide area (regional) wireless data network available today."

That said, the company says hams should now move on to other bands where they haven't yet built proven systems, and leave 902, 2400, and 5700 for the commercial interests to use without amateur interference. With friends like this, who needs enemies? Nonetheless, it will be important to see how the FCC deals with this aspect of the question, as it is one of the first times that amateur and commercial interests have clashed on shared frequencies.

What's Next?

The ball is now back in the FCC's court. The comment period closed on May 5, and reply comments had to be in by June 5. While one can never predict exactly when the FCC will act on something (it was over a year between the time the ARRL filed its petition for rule making and the time the FCC issued its NPRM), a good rule of thumb seems to be about a year from NPRM to Report and Order (the FCC's final decision). So it's possible that we'll see action by the Commission on this proposal sometime in the first half of 1998. In the meantime, if any of this caught your interest, why not use the time to learn more about S/S communication and how to join the hams at the leading edge of digital technology?

Resources

Introductions to amateur S/S can be found in the "Digital Data Link" column in the May, 1997, issue of *CQ VHF* and on TAPR's World Wide Web site, <http://www.tapr.org/ss>, where you can also find the full texts of all the documents quoted in this article.

For more in-depth information, we recommend the ARRL's *Spread Spectrum Sourcebook*, available from the CQ Bookshop at (516) 681-2922, or directly from the ARRL, 225 Main St., Newington, CT 06111; Phone: (860) 594-0200.

Notes:

1. The automatic power control formula set forth in the NPRM is as follows: The minimum output power required for communication "shall be determined by the use of the ratio, measured at the receiver, of the received energy per user data bit (Eb) to the sum of the received power spectral densities of noise (No) and co-channel interference (Io). Average transmitter power over 1 W shall be automatically adjusted to maintain an Eb/(No+Io) ratio of no more than 23 dB at the intended receiver."
2. AMSAT proposes allowing S/S emissions on 420–450 MHz, 902–928 MHz, 1240–1300 MHz and all amateur frequencies above 2300 MHz, with the following exceptions: "In the segments 435–438 MHz, 1260–1270 MHz and 2400–2410 MHz, SS emissions shall be used only for transmissions to or from amateur space stations, except for short tests to confirm proper operation of equipment in preparation for such work."
3. CSVHFS proposes restricting "broad band" S/S (see main text) from the following band segments traditionally used for weak-signal contacts: 50.0–50.5 MHz, 144.0–144.5 MHz, 222.0–222.15 MHz (if the FCC decides to allow S/S at all below 420 MHz); 431.5–432.5 MHz, 902.0–903.5 MHz, 1295.5–1296.5 MHz, 2303.5–2304.5 MHz, 3455–3457 MHz, 5759–5761 MHz, and 10367–10369 MHz.

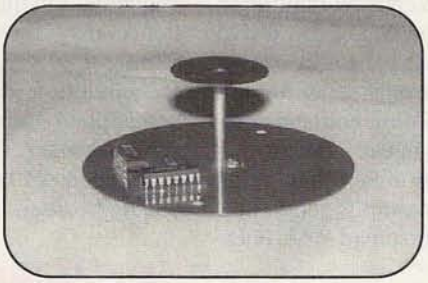
Picture This!

Readers' "Phun Photos"

So you've got a cool snapshot to share with us but, until now, we haven't had a place to put it if there wasn't an article attached to it. Well, we finally caved in and carved out some space for "phun photos." So keep those snapshots coming and we'll do our best to squeeze them in (no pay, just glory). Send your color prints to CQ VHF, *"Picture This!", 76 North Broadway, Hicksville, NY 11801. If you'd like your photo(s) returned to you, please tell us so and include an SASE (self-addressed, stamped envelope) along with sufficient postage.*

Hey, that's us! But no, it's not your editor's license plate. It belongs to VHF contester Doug Sharp, K2AD (ex-WB2KMY), who said he wanted to let the world know he's a VHFer (and that it couldn't hurt to give us a little free advertising)!

Did you work any of them in the contest? These are three long-time operators of the W2SZ/1 contest superstation at last summer's Eastern VHF/UHF Conference in Connecticut. From left, Brian Justin, WA1ZMS; Chief Honcho Dick Frey, WA2AAU; and Doug Sharp, K2AD (owner of the license plate in the top photo).



What'll it be this year? Banquet attendees at last year's Central States VHF Society Conference were each given one of these...things, with the challenge to figure out just what they were. The larger disc at the bottom is a piece of pc board, with a few ICs and other components on it, and the smaller disc is a piece of copper. Want to know what it is? Well, we're not telling! You'll have to go check out the CSVHFS Web page at <http://www.csvhfs.org>.

Spread Spectrum—Yesterday and Today

To add some background to the debate over an FCC proposal to expand spread spectrum operations on VHF ham bands, we thought that a bit of history and an overview of what's going on right now might be of interest.

By Steve Bible, N7HPR*

"Whuh? Oh," said the missile expert. "I guess I was off base about the jamming. Suddenly it seems to me that's so obvious, it must have been tried and it doesn't work."

"Right, it doesn't. That's because the frequency and amplitude of the control pulses make like purest noise—they're genuinely random. So trying to jam them is like trying to jam FM with an AM signal. You hit it so seldom, you might as well not try."

"What do you mean, random? You can't control anything with random noise."

The captain thumbed over his shoulder at the Luanae Galaxy. "They can. There's a synchronous generator in the missiles that reproduces the same random noise, peak by peak. Once you do that, modulation's no problem. I don't know how they do it. They just do. The Luanae can't explain it; the planetoid developed it."

England put his head down almost to the table. "The same random," he whispered from the very edge of sanity.

—from "The Pod in the Barrier" by Theodore Sturgeon, in *Galaxy*, Sept. 1957; reprinted in *A Touch of Strange* (Doubleday, 1958).

Science fiction or science fact? It's uncanny how science fiction writers can glimpse the future. However, spread spectrum (S/S) wasn't science fiction in 1957, although very few people knew anything about it. Cloaked in secrecy and shrouded in mystery, S/S has become one of the most misunderstood modulation techniques today.

Perhaps because of its lineage from intensive research during and after World War II, many people think of S/S as an obscure modulation technique that's beyond comprehension and is used predominantly for secrecy. Perhaps no other technology developed out of the post-war era carries such a stigma, except the Manhattan Project, which developed the first atomic bomb. But just as the Manhattan Project had many beneficial spin-offs that we take advantage of today, S/S is finding civilian uses as well.

Radar and Spread Spectrum

The beginnings of S/S communication date back to the 1920s with the advent of RADAR (*which, in case you didn't know it, is an acronym for "**RA**dio **D**etection **A**nd **R**anging.—ed.*). Spectrum spreading for jamming avoidance and resolution, whether for location accuracy or signal discrimination, was a concept familiar to radar engineers by the end of the World War II. S/S was a natural result of that war's battle for electronic supremacy, a war waged with jamming and anti-jamming tactics.[1] In trying to combat this threat, scientists determined that "...the best anti-jamming is simply good engineering design and the spread of the operating frequencies."

In the military, S/S techniques were primarily used to combat enemy jamming since they tolerate much more interference than conventional means. Jamming of communication and navigation systems was attempted by both sides, and the need for reliable communication and accurate navigation in the face of this threat was real. One major AJ (anti-jamming) tactic of the war was to change carrier frequency often to force the jammer to keep looking for the right narrowband to jam.

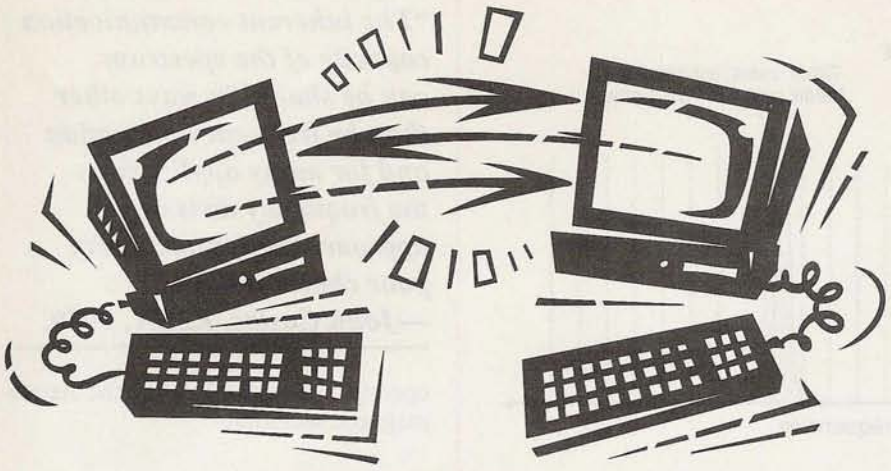
"Perhaps no other technology developed out of the post-war era carries such a stigma, except the Manhattan Project, which developed the first atomic bomb."

S/S dropped its cloak of secrecy in the late 1970s, when the Federal Communications Commission (FCC) began exploring the concept of using wideband S/S techniques for commercial purposes. But exploiting this concept required a new way of thinking about communications techniques. Communications engineers were used to thinking in terms of frequency and time. Now, a third dimension, coding, forced them to rethink how information was transmitted over wire and wireless. It was Claude Shannon who first applied statistical concepts to information transfer. Thus was born a new area of research we know today as *information technology*.

Non-Military Uses of Spread Spectrum

Given that S/S techniques have evolved largely in response to military require-

*Steve Bible, N7HPR, is a member of the Board of Directors of TAPR (Tucson Amateur Packet Radio) and is one of the group's leading experimenters with amateur S/S communication.



ments, and in view of the fact that they require large bandwidths (relative to the information bandwidth), it's reasonable to ask why anyone would consider S/S techniques for non-Government applications. But, in reality, only the anti-jamming property of S/S seems to be unique to military environments. The other uses, including resistance to unintentional interference, resistance to interception, discrete addressing, multipath resistance, multiple access, and pulse compression, all have potential civilian applications, both amateur and commerical.

In general terms, it's possible to identify four potential motivations for introducing a new communications or radiolocation technology.[2]

• *Reduced Cost*—Because of the performance improvements that are possible with S/S, it's conceivable that, under certain conditions, a particular S/S system could be less costly—due to reduced transmitter power or the elimination of ancillary circuits—than a narrowband system offering the same level of communication or ranging performance.

• *Improved Communication or Radiolocation Performance*—S/S systems can provide significant resistance to unintentional interference and multipath fading. To the extent that error correction coding is used, S/S systems provide improved performance against additive white Gaussian noise.

• *Expanded Capabilities*—S/S systems can provide user privacy, discrete addressing, and multiple access on a transmit-at-will basis.

• *Improved Spectrum Utilization*—The notion that S/S techniques could provide improved utilization may be at first surprising. While John Costas was the first to raise this possibility (see "Spread Spectrum and the Radio Amateur" below, more recently, Cooper and Nettleton[3] have predicted improved spectrum efficiency for high-capacity S/S mobile radio systems.

Unlicensed Spread Spectrum

One of the most rapidly developing and hotly contested areas of wireless data involves the use of spectrum that does not require the user to be licensed. In 1985, the FCC opened up three bands for unlicensed uses (data and other types of communications) based on a set of regulations designed to minimize interference and encourage the development of new services. Since then, 130 companies have developed more than 200 systems and products for use in these bands—the 900-MHz band being the most popular—and more than 3 *million* devices are now in use by consumers and businesses.[4]

Unlicensed systems and devices are widely known as *Part 15 devices* because they operate under Part 15 of the FCC's rules. Some of the services that operate under Part 15 include automated utility readers, wireless LANs, cordless phones, wireless audio speakers, home security systems, and medical monitoring devices.

The FCC Part 15 rule has been a catalyst for innovative wireless applications and has stimulated the development of many new forms of low-cost S/S radios. Perhaps the best protection for S/S radios is their inherent robustness against interference and large multipath delays.

Part 15 type rules have been adopted in part or whole by many other countries. Most countries worldwide now allow some form of unlicensed S/S radios for commercial applications,[5] and most in North, Central, and South America have adopted the same rules for their operation.

"Spectrum spreading for jamming avoidance and resolution, whether for location accuracy or signal discrimination, was a concept familiar to radar engineers by the end of the World War II."

"S/S systems can provide significant resistance to unintentional interference and multipath fading."

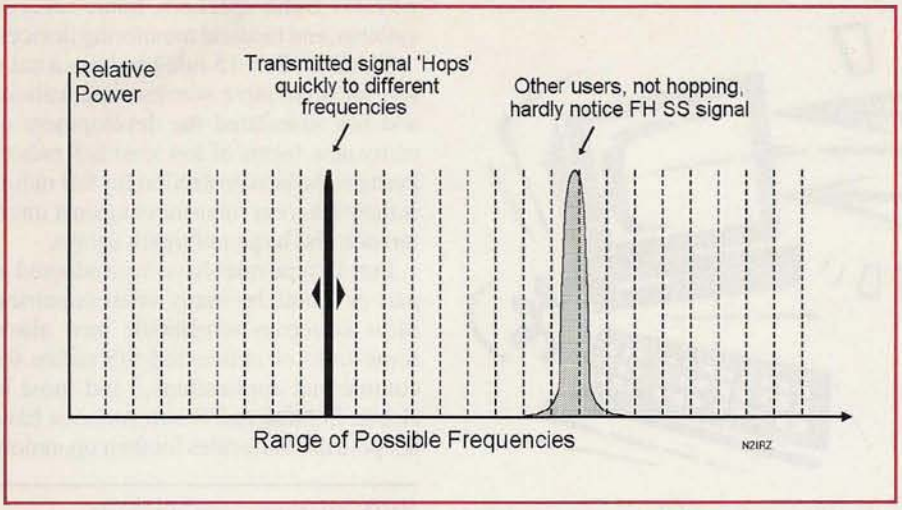
Wireless LANs

Wireless LANs closely approximate amateur packet radio (*LAN stands for Local Area Network, a relatively small linkup of computers.—ed.).* It's perhaps this technique in which amateurs will have the most interest. Wireless LANs operate in the 900-MHz, 2.4-GHz, and 5.7-GHz bands. They use either direct sequence or frequency-hopping S/S transmission techniques and offer speeds up to 5.3 Mbps (megabytes per second), although actual throughput is usually 1 to 2 Mbps.

A number of wireless LAN products operate in the unlicensed bands, and the IEEE (Institute of Electrical and Electronic Engineers) is currently developing industry standards for LANs as well as standards that will allow users' computers to communicate with each other directly—"ad hoc" or "peer-to-peer" networking. Development of products for the 2.4-GHz band has reportedly accelerated in anticipation of the IEEE standard for wireless LANs, the increasing congestion of the 902- to 928-MHz band, and the greater amount of bandwidth available compared to the 900-MHz band.

Spread Spectrum and the Radio Amateur

In 1959, John Costas, K2EN, wrote a canonical paper[6] that challenged the conventional wisdom of the day: that relief from congestion in the radio frequency spectrum was best achieved by dividing



Frequency-hopping is one of two commonly used methods of S/S communications. An introduction to S/S technology can be found in "Digital Data Link" in the May, 1997, issue of CQ VHF. (N2IRZ graph)

the available bandwidth into channels as small as possible. This is a principle we know today as *frequency allocation*, and he argued that it was not based on any fundamental physical principles:

> The inherent communication capacity of the spectrum can be shared in ways other than by frequency allocation and for many applications the frequency division approach represents a very poor choice indeed.

Using Shannon's statistical methods, Costas was the first to suggest that the best way to improve spectrum crowding was to use wide band techniques:

> The frequency diversity [S/S] system is intuitively ridiculous because it apparently "wastes" bandwidth rather indiscriminately. As we shall see, intuition is a poor guide in these matters. The feeling that we should always try to "conserve bandwidth" is no doubt caused by an environment in which it has been standard practice to share the RF spectrum on a frequency basis. Our emotions do not alter the fact that bandwidth is but one dimension of a multidimensional situation.

Costas knew about the chaotic use of amateur frequencies. Strangely enough, the only other communications service that closely resembles the amateur service is the military. The amateur bands are similar to the spectrum used by the military, not so much in intentional jamming, but simply in casual interference when two opposing forces attempt to operate independently using the electromagnetic spectrum.

To Learn More...

For further reading on the fascinating subject of the origins of S/S communications, consult Reference 1. For the history of amateur S/S, *The ARRL Spread Spectrum Sourcebook* is a good guide. And you'll find more general information on amateur S/S in the May, 1997, issue of *CQ VHF* ("Digital Data Link") and on TAPR's S/S Web page, at <http://www. tapr.org/ss>.

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6. J. P. Costas, "Poission, Shannon, and the Radio Amateur," *Proc. IRE*, vol. 47, no. 12, pp. 2058–2068, December, 1959.

"The inherent communication capacity of the spectrum can be shared in ways other than by frequency allocation and for many applications the frequency division approach represents a very poor choice indeed."
—John Costas, K2EN, 1959.

Amateur Experimentation

Amateur experimentation started innocently enough, with a short note in the June, 1980, AMRAD newsletter (*AMRAD is a Washington, DC-based group dedicated to **AM**ateur Radio **R**esearch **A**nd **D**evelopment—ed.).* Paul Rinaldo, W4RI, spread the word that the FCC had some interest in amateur radio experimentation with wideband techniques. A special interest group was soon formed for the purpose of exploring S/S techniques in the amateur bands. The next step was to obtain a Special Temporary Authority (STA), which was granted on March 6, 1981. The AMRAD experimentation, chronicled in *The ARRL Spread Spectrum Sourcebook*, led directly to the FCC's general authorization for S/S emissions by amateurs in 1985. (These are the rules in effect today.)

The AMRAD tests of the '80s were followed by more experiments in the '90s under an STA granted to Tucson Amateur Packet Radio (TAPR). The TAPR STA experiments led to the ARRL's petition for rule making and the FCC's Notice of Proposed Rulemaking (Docket WT 97-12) to liberalize amateur S/S rules. This proposal, and comments on it, are discussed elsewhere in this issue, or may be found on the S/S page on TAPR's Web site, <http://www.tapr.org/ss>. ■

Editor's Note: This article was based on a piece in the May, 1996, issue of Tucson Amateur Packet Radio's Packet Status Register *newsletter and is used with permission. For more on the current FCC proposal on amateur spread spectrum and the arguments on all sides, see "Debate Over Spread Spectrum," elsewhere in this issue.*

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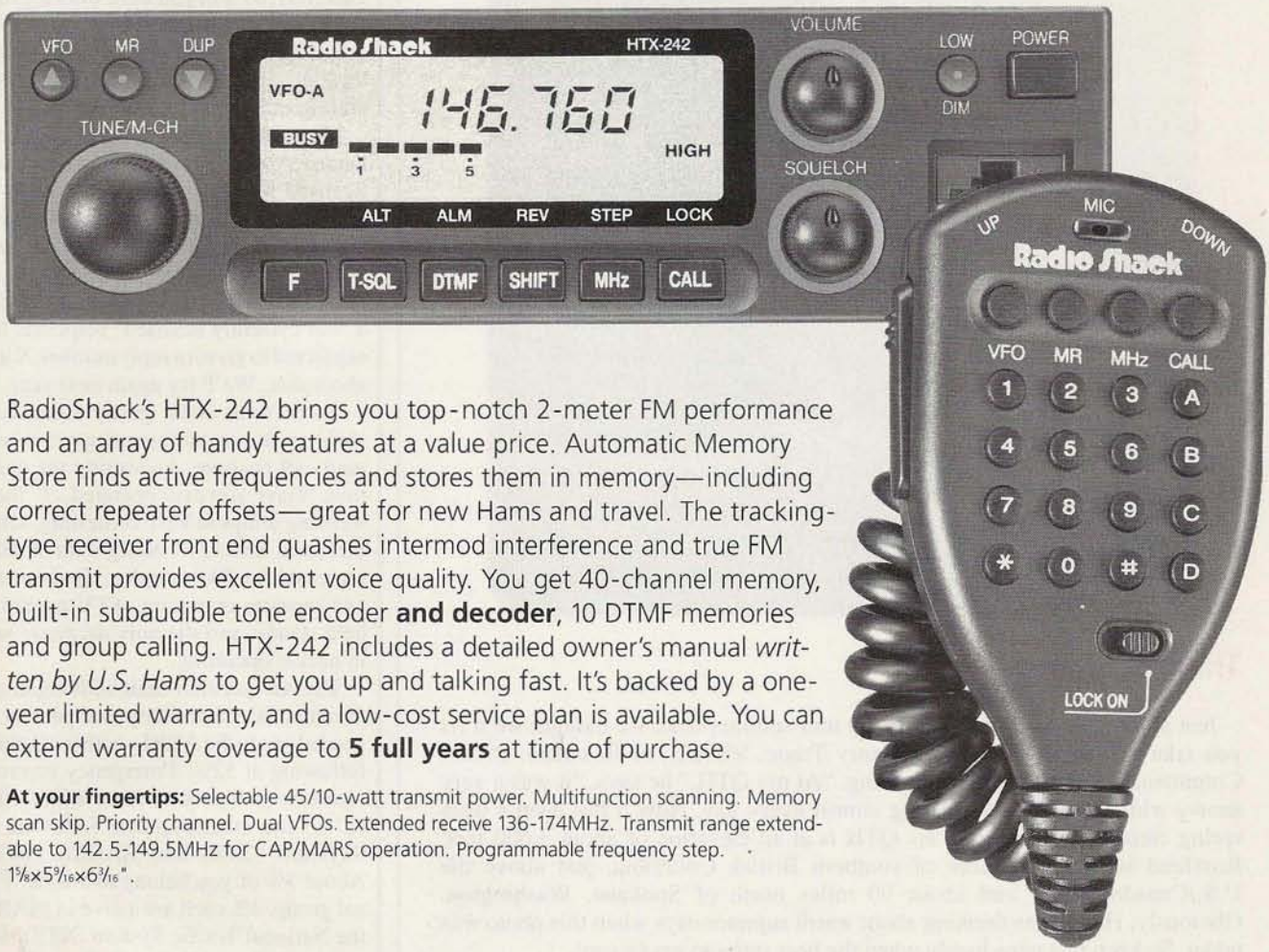

RadioShack's HTX-242 brings you top-notch 2-meter FM performance and an array of handy features at a value price. Automatic Memory Store finds active frequencies and stores them in memory—including correct repeater offsets—great for new Hams and travel. The tracking-type receiver front end quashes intermod interference and true FM transmit provides excellent voice quality. You get 40-channel memory, built-in subaudible tone encoder **and decoder**, 10 DTMF memories and group calling. HTX-242 includes a detailed owner's manual *written by U.S. Hams* to get you up and talking fast. It's backed by a one-year limited warranty, and a low-cost service plan is available. You can extend warranty coverage to **5 full years** at time of purchase.

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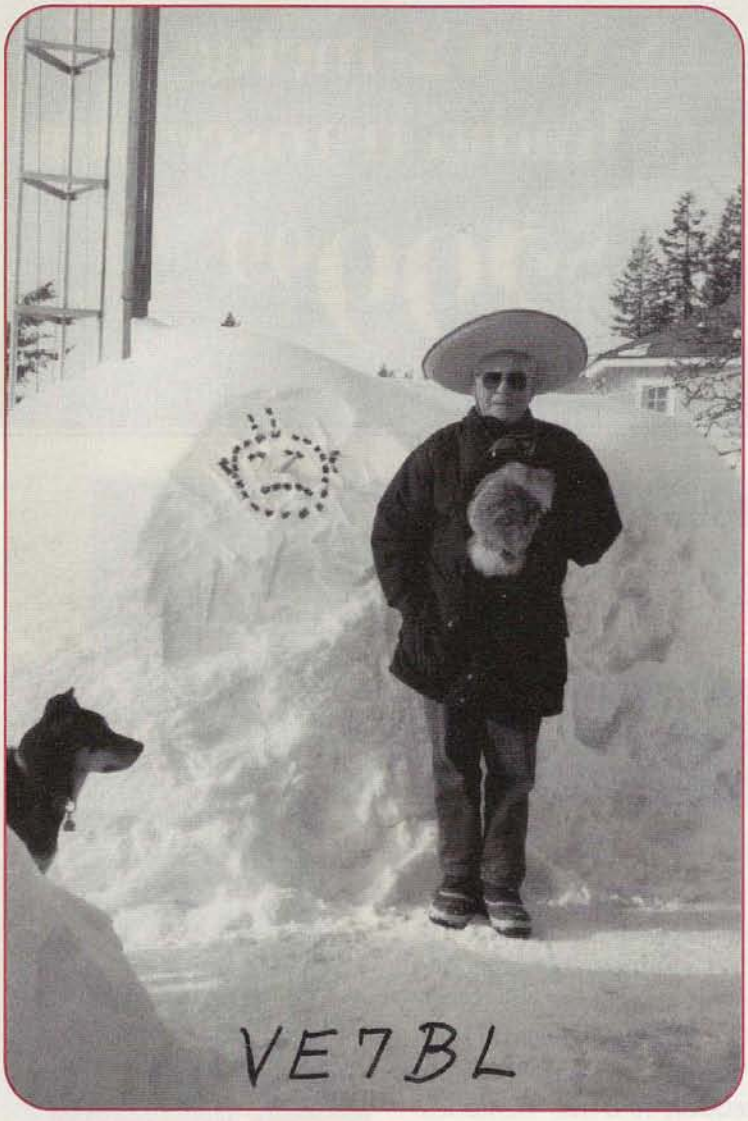
CIRCLE 99 ON READER SERVICE CARD

Reader Snapshot!



Think Snow!

Just in case you're sweltering in the mid-summer heat, we thought we'd let you take a look at what reader Henry Traue, VE7BL, of Rossland, British Columbia, had to deal with this spring. "At my QTH," he says, "it was a very snowy winter, with snow clearing almost every day. Now it has been a busy spring cleanup." Henry says his QTH is at an elevation of about 3,600 feet. Rossland is in a rural area of southern British Columbia, just above the U.S./Canada border and about 90 miles north of Spokane, Washington. Obviously, Henry was thinking about warm summer days when this photo was taken. So keep this page handy when the heat starts to get to you!

If you'd like to be considered for our "Reader Snapshot" column, please tell us about yourself in 150 words or less and mail, along with a photo, to: CQ VHF *Reader Snapshot, 76 N. Broadway, Hicksville, NY 11801. Entries become our property and cannot be returned. If we publish your "snapshot," we'll give you a one-year gift subscription (or extension) to* CQ VHF.

What You've Told Us

Our May survey was a repeat of the same questions we asked in May of 1996: about jobs, upgrading, and on-air activity. Let's take a look at the current results

First, a bunch of you retired this year. Last May, 69% of you were working full-time, and 19% were retired. This year, only 63% are employed full-time, while 26% are retired. There was no significant shift in other employment categories.

More of you are upgrading your ham licenses. After eliminating those of you licensed less than two years (16%) or holding an Extra class ticket for more than two years (10%), 20% of you said you'd upgraded in the past two years, up from 18% last year. This year, we added a "not currently licensed" response, but neglected to give it a reply number. Sorry about that. We'll try again next year.

There were some pretty significant shifts in the operating categories—virtually all positive. Answering the question, "Have you ever operated...?" there were big jumps in VHF contesting, satellites, and SSB/CW, along with smaller increases in FM simplex, foxhunting, and repeater operating. ATV operation held steady, and the only *decrease* was in packet operating.

The last question dealt with organization memberships. Sixty-one percent of you belong to the ARRL, with local clubs following at 52%. Emergency communications groups were next, with ARES (27%) the most popular, followed by Skywarn (22%) and RACES (14%). About 7% of you belong to a weak-signal group, 4% each are active in MARS, the National Traffic System (NTS), and packet clubs, while only 2% are members of the Civil Air Patrol (CAP).

Next month, we'll look at your responses to our contesting survey. This month's winner of a free one-year *CQ VHF* subscription is Dennis McKinney of Denver, Colorado. As always, thank you for sharing your views with us.

CQ VHF Ham Radio Above 50 MHz

Reader Survey—August, 1997

We'd like to know more about you...about who you are and where you live, about the kind(s) of work you do and about your ham radio interests and activities. Why? To help us serve you better.

Each month, we'll ask a few different questions, and ask you to indicate your answers by circling certain numbers on the Reader Service Card and returning it to us (we've already paid the postage).

And, as a bit of an incentive, we'll pick one respondent every month and give that person a complimentary one-year subscription (or subscription extension) to CQ VHF. *This month, we continue with questions about your reactions to* CQ VHF *and its contents:*

1. Please indicate which segments of *CQ VHF* you generally read in each issue (circle all that apply):

	Circle Reader Service #
Feature articles	**1**
Monthly columns	**2**
Basics section	**3**
News/Opinion/Letters	**4**
Product news	**5**
Advertisements	**6**

2. *CQ VHF* covers a wide range of topics and activities. Please indicate whether your regularly read:

Only articles about my area(s) of interest	**7**
Articles about topics or activities that are new to me	**8**
A mix of both types of articles	**9**

3. If you purchased this copy of *CQ VHF* "off the shelf" at a newsstand, bookstore, ham dealer, or hamfest, please indicate the one factor that *most* influenced your buying decision:

Enjoyed previous issue(s)	**10**
The title (*CQ VHF*)	**11**
The topic (Ham Radio Above 50 MHz)	**12**
Cover info about the articles	**13**
A specific article	**14**
A combination of the above	**15**
None of the above	**16**
Don't know	**17**

4. If you are a *CQ VHF* subscriber, please indicate how likely you are to renew your subscription when it expires:

Will definitely renew	**18**
Will probably renew	**19**
Undecided	**20**
Probably won't renew	**21**
Definitely won't renew	**22**

Thank you for your responses. We'll have more questions for you next month.

902 FM—UHF's Final Frontier

The 902 MHz band is the one of the last outposts for hams who enjoy converting surplus commercial radios for amateur use.

By Dave Page, KD3NC*

Editor's Note: Just because it's FM doesn't mean that this is a beginner's article. It's not.

If you want to find out what it's like to share a ham band with other services, come on up to 902. In the 902- to 928-MHz band, industrial, scientific, and medical users (ISM), government services and Automatic Vehicle Monitoring (AVM) have priority over amateur users. There are also unlicensed "Part 15" users (cordless phone operators, for instance) on the band. They're not protected against interference *from* licensed users and are prohibited from causing interference *to* licensed users.

The biggest differences between sharing here and on, say, 2 meters, are:

1) the band is 26 MHz wide, and

2) there are far fewer amateurs using the band (of course, if we want to keep it, we need to change that).

This article will introduce you to some of our "partners" on the band, propagation characteristics, and sources of equipment that can be converted to amateur use (there's virtually no commercially made ham gear for 902).

You can modify cellular telephone equipment to operate on the 902- to 928-MHz ham band, but you'd better know what you're doing...and be prepared for a lot of work!

Getting Along with Other Users

ISM users don't receive, so we don't have to worry about interfering with them (but we must tolerate whatever interference they generate). Government use is very infrequent in most areas of the country; AVM, on the other hand, is quite another story.

The original idea behind AVM was to provide a commercial service to locate and monitor vehicles in an urban area; say, a home office keeping track of service or delivery trucks. This application hasn't become particularly popular, but the service has now been expanded to include other related vehicular applications, such as automated toll booth collection. Oh, well.

Practically speaking, I haven't had a significant problem with cordless phones and other Part 15 devices in the Albany, New York, area interfering with my ARRL-bandplan FM repeater. But, the incidence is likely to increase if we eventually adopt the Southern California bandplan nationwide (see below), as this more closely approximates the frequencies used by cordless phones.

The FM Bandplan(s)

According to the current *ARRL Repeater Directory*, FM repeater inputs are 906.0 to 909.0 MHz and the outputs are 918.0 to 921.0 MHz (12-MHz split). However, the League says it's developing a new bandplan that "reflects our need not to cause interference to AVM...." The Southern California Repeater and Remote Base Association (SCRRBA) adopted a bandplan designed specifically to preclude interference to AVM. It has repeater inputs on 902.1 to 903.0 MHz and outputs on 927.1 to 928.0 MHz (25-MHz split). The SCRRBA bandplan also specifies narrow channel spacing (12.5

"The 900-MHz trunking services provide an excellent source of FM radios for ham use. The 800-MHz services are a good source of equipment, too, but amateur use requires fairly extensive modifications."

"I'm using analog cell site transceivers for the core of my repeater....In order to do this, I had to retune the VCOs..., replace some [bandpass filters], and write some firmware to program the PLLs....It's a substantial amount of work."

kHz), which makes the use of modified cellular gear difficult. But that's only one source of equipment that can be modified—with considerable effort—for amateur use on the band.

Equipment Sources

Bands adjacent to 902 to 928 include paging (just above 928), 900-MHz trunking (898- to 902-MHz input, 937- to 941-MHz output, 39-MHz split), and, of course, the 800-MHz cellular and trunking services. The paging systems at 928 and up are high power and make receiving at the high end of the ham band difficult at hilltop sites. The 900-MHz trunking services provide an excellent source of FM radios for ham use. The 800-MHz services are a good source of equipment, too, but amateur use requires fairly extensive modifications. To give you an idea of what's involved in putting up an FM repeater system on 902, let me tell you about mine:

I'm using analog cell site transceivers for the core of my repeater. I've modified a GE cellular RCU (the full-size 19" rack mount variety) for use on 902 to 928. In order to do this, I had to retune the VCOs (voltage controlled oscillators), replace some GigaFils (the ceramic RF bandpass filters they use), and write some firmware to program the PLLs (phase locked loops). I also had to re-tune the power amplifier. It's a substantial amount of work.

For talking through the repeater, I've modified GE CF-1000 cellphones. This also was a lot of work. I replaced the duplexer with a T/R (transmit/receive) relay, built a squelch circuit, hacked the VCO, and ported my "TMX" software to it. These modified cellphones will do about 1 to 1.5 watts on 902 to 928.

There's a problem with residual FM, though. I had to spend a fair amount of time with a spectrum analyzer to kill some of the biggest transmit spurs (spurious signals). GE relies on the duplexer to remove some ridiculously strong garbage. Its engineers cost-optimized a lot of bypassing out of the +10-volt bus, so the reference oscillator buffer, in particular, AMs the RF VCO buffering. It'll take some work to get a clean signal out of these on 902 to 928.

The easiest way to get onto 902 FM, in my opinion, is to use a GE TMX 10-watt 900-MHz radio. It can be modified for 902 by reprogramming with a custom ROM (socketed, so there's no messy unsoldering/soldering of big chips) and can be completely programmable from the headset. Simply replacing the EPROM with my firmware makes the radio usable. Replace the RX GigaFils, and it makes a pretty good 902 mobile radio. The "good" surplus price seems to be about $200.

"The reflectivity of signals at 902 makes for some interesting effects, both positive and negative. For example, a low cloud layer tends to improve coverage. But nearby aircraft and some cloud formations can result in multipath fading."

Thoughts on 902 Propagation

The 902 to 928 band is quite a bit more optical than the typical amateur repeater bands. Signals are attenuated more heavily by green vegetation and are more readily reflected off of solid objects such as buildings, hills, trucks, etc. This is an advantage in that a 902-MHz repeater in an urban area may provide better penetration into and around structures than one on 440. The disadvantage is that 902 has deeper and more distinct phasing nulls than 440 for the same average signal strength. For example, while a 440-MHz signal with an average quieting of 10 dB may vary from 7 to 13 dBq (decibels of quieting) as a receiver moves, an equivalent 902 signal may vary from 3 to 17 dBq (and do so twice as fast as the 440 signal, due to the shorter wavelength). This multipath fading makes the 902-MHz received signal unusable sooner than the equivalent 440 signal.

The reflectivity of signals at 902 makes for some interesting effects, both positive and negative. For example, a low cloud layer tends to improve coverage. But nearby aircraft and some cloud formations can result in multipath fading, if the direct path is sufficiently attenuated. It's interesting to be parked, hear rapid mobile flutter, look up, and discover an aircraft or a lone cumulus cloud. In addition, cars and trucks moving around nearby can cause fading as well.

RF Safety

As far as RF safety goes, the government-recommended exposure levels at 1 GHz are lower than at 450 MHz, but since most mobile radios only produce 10 watts or so, the hazard—if any—is minimal. A commercial handheld radio might put out 2 watts, so is doubtless the worst offender from an RF exposure standpoint. Typical output for a repeater is about 50 watts, so you may need to conduct a "routine evaluation" when the FCC's new RF exposure rules take effect next year.

Is This Band for You?

If you love nothing more than digging into a piece of surplus commercial gear and magically making it work on a ham band, then 902 may be for you. Even if that's not your "thing," but you have a friend who enjoys it and is willing to modify a radio for you (he'll need someone to talk to), then by all means, join us on UHF-FM's "final frontier." ■

Resources

For more information on Dave's modifications and repeater system, visit his World Wide Web page at <http://www .rpi.edu/~paged2/projects.html>. In addition, Dave can provide customized firmware and EPROMs for certain radios (as noted above). For information, contact Dave Page, KD3NC c/o Dynamic Systems Inc., P.O. Box 1234, Poestenkill, NY 12140; Phone: (518) 283-5350; Fax: (518) 283-3160; Web page: <http://www.gleeble.com/>.

(Editor's note: CQ VHF *thanks Dave Hockaday, WB4IUY, for sending some of this information our way. Dave is another excellent resource for 902 MHz information. You can visit his Web page at <http://www.ipass.net/~wb4iuy/>.)*

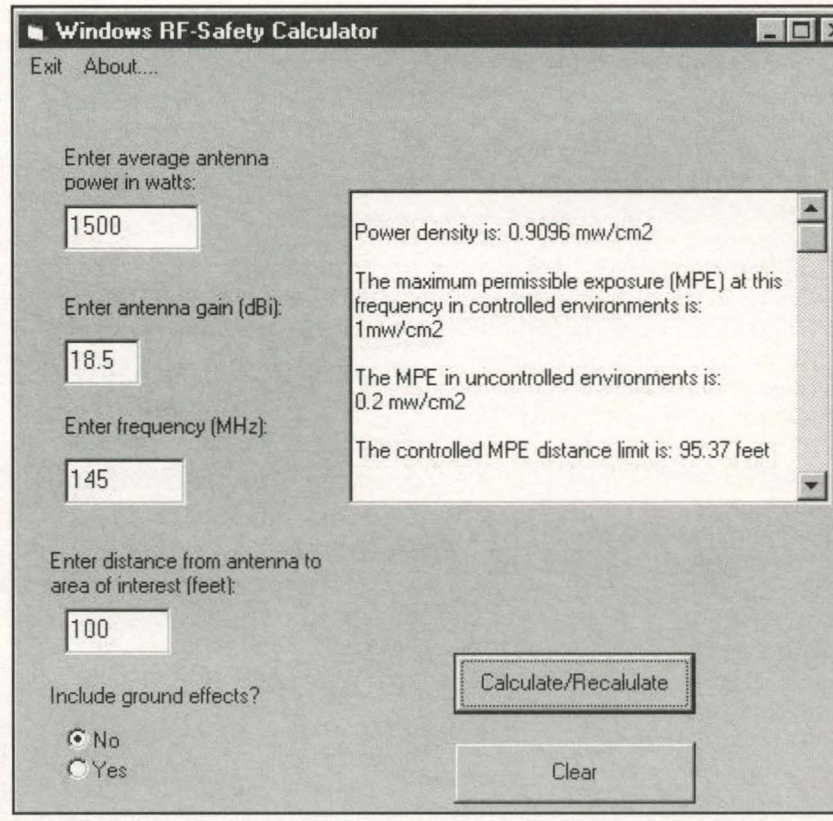
VHF-Related Web Sites & Mailing Lists

"Notes from the Net" of interest to VHF+ hams (seems we've got more every month!)

"RFSafety" for Windows is a Windows™ version of the "RFSafety" program by Wayne Overbeck, N6NB, which was first published as a BASIC program here in *CQ VHF* in January, 1997. "RFSafety" can help you perform the RF exposure level evaluations which the FCC will require of amateurs starting next year.

The Windows version of the program was written by Stacey "Chuck" Mills, W4SM. It is compatible with both Windows 95 and 3.1, and may be downloaded from his Web site at <http://www.med.virginia.edu/~sem2r/ham1.html>.

Also available on Chuck's Web page is another Windows program that calculates grid squares, latitude/longitude, and distance/headings to other stations, plus two "DLL" files that are necessary to run the programs.



You can run N6NB's RF exposure evaluation program, "RFSafety," under Windows®95 or 3.1 with W4SM's adaptation, available from his Web site.

Ballooning Sites

Ham radio and high-altitude weather balloons have really been gaining in popularity lately (see "Flight of the Isaac Asimov" in the May, 1997, issue of *CQ VHF*). Most of the active ham-ballooning groups have home pages on the Internet, and you'll find links to just about all of them from AMSAT's ballooning page at <http://www.amsat.org/amsat/balloons/balloon.htm>. The AMSAT site also contains general ham/balloon information. (Tnx KG5OA)

A step closer to space is the "Rockoon." This is a combination rocket/balloon which includes ATV and APRS transmitters. Rockoon updates can be found at WB8ELK's Web site: <http://hiwaay.net/~bbrown>.

From "Across the Pond"...

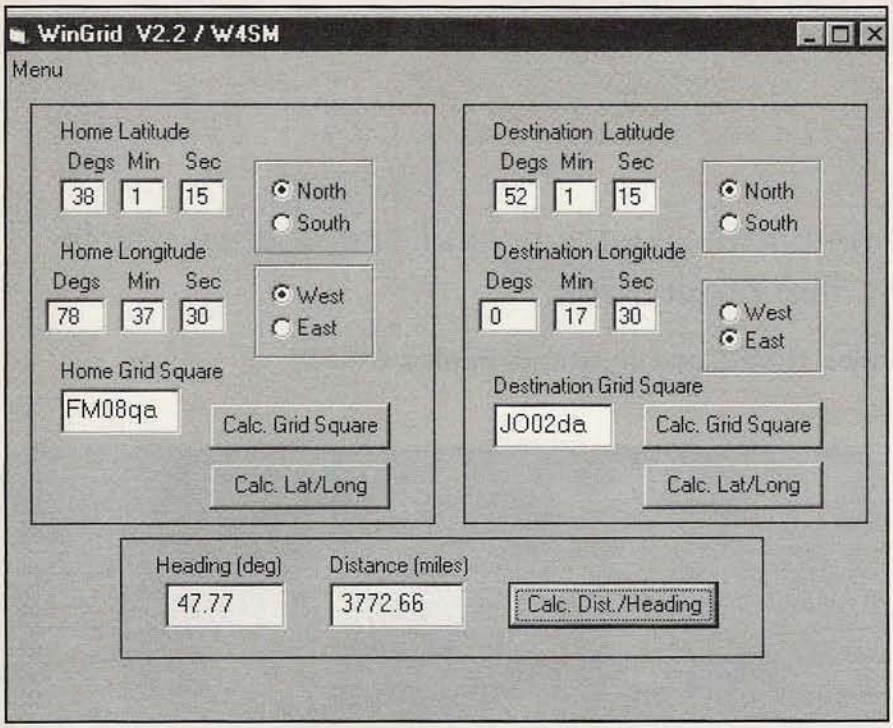
A couple of sites of interest in Europe include: "The First Polish 50 MHz Pages" —in English—at <http://www.it.pw.edu.pl/~babut>, which is an interesting collection of history and activity information provided by SP5XMU, and a list of European and world microwave DX records on G3PHO's home page at <http://freespace.virgin.net/p.day/ghz.htm>. U.S. records are listed only if they are world records. G3HPO is Editor of the Radio Society of Great Britain (RSGB) Microwave Newsletter.

...And "Down Under"

Jim Cotterill, VK1ZFG, has put a "no-frills" 6-meter page on the Web, at <http://www.qsl.net/vk1zfg>. Jim says it will download quickly and "lists 98% of all resources on the Web pertaining to 6 metres," noting that he's still chasing the other 2%.

Three New E-Mail "Reflectors"

E-mail "reflectors" are mailing lists devoted to a specific topic. A message sent to the list is retransmitted as an individual e-mail message to each member. K7ON has recently started three new ham reflectors: "Ham-Books" is devoted to the literature and periodicals of amateur radio; "Ham-Software" covers all types



W4SM has also written a Windows® program to calculate grid squares, beam headings, and distances between two stations. It's also available from his Web page.

of computer software used for amateur radio; and "Mobile-Portable" is for messages about mobile and portable operation, both high and low power, HF and VHF, including GPS and APRS.

To join (subscribe to) any of these lists, send an e-mail message to majordomo@qsl.net>, leave the subject line blank if you can, and in the body of the message, type **subscribe [list-name]** (without the brackets). For example, **subscribe hambooks**. You may post messages to any of the reflectors by sending e-mail to **[list-name]@qsl.net**. (Tnx KE7GH)

Editor's Note: We haven't had a chance to check out these sites, so we can't vouch for them one way or another. You should be aware that people are still changing Internet providers about as often as they change their socks, so don't be too surprised if you go to one of these addresses and find that the page you wanted has moved. One Web site we can vouch for is our own—http://members.aol.com/cqvhf/>—and we have checked out all of the links we have from there to other VHF+ sites. ■

How Ham Radio Saved the Movie

N1MZZ tells the story of ham radio's vital behind-the-scenes role in an award-winning student film production.

By David L. Bowles, N1MZZ, and Chester S. Bowles, W1CSB*

"Action!" My dad's voice sounded a little tinny coming from the speaker of the HT, but there was no mistaking what he said. I put the truck in gear and started driving down the road, just as we had rehearsed. As planned, I turned when I got to the side road and stopped when I got to the designated place. I picked up the HT and asked, "How was that?"

"Pretty good," said my dad, "but Brian wants to do it one more time for good measure."

"OK. I'll get back in position. This is N1MZZ," I signed.

"I'll let you know when everything is set again. This is AA1EX," said my dad (this was before he got his new vanity callsign with his initials, W1CSB).

The film crew on location near the authors' house—ham radio played a big role in the film. David Bowles, N1MZZ, is wearing the straw hat.

Columbus Day Weekend in New Hampshire

It was a beautiful fall weekend in New Hampshire—Columbus Day weekend, to be exact. Bright sunshine. Not a cloud in the sky. The foliage was at peak color. And it was cool and crisp with a touch of frost each morning.

My brother, Brian, a film major at Pratt Institute in New York City, had come home for the weekend to shoot his senior project on location in the woods which surround our house. The location was important because the film detailed the exploits of two hapless spies who were sent to blow up a radio tower. Of course, my dad's ham radio tower was the perfect prop. Unfortunately for the spies, the script places the tower right on the line between two time zones. The two spies get hopelessly confused over what time to set the bombs for and how quickly they need to get away before the tower explodes. The results are predictable.

Brian and I had spent a weekend at our family cabin during the preceding summer and worked together on the script. Except for the fact that Brian fell off a cliff and nearly broke his shoulder, we had a great time, laughing and sharing ideas until we had the script almost complete. Brian put the finishing touches on the script once he got back to school. He also had to do lots of work laying out scenes, gathering props, and arranging for all the film and sound equipment.

It was fun to finally see everything come together during the filming of the movie. It was also fun because I was playing the part of one of the spies—my first film role! Three of Brian's classmates had come home with him to help with the production. Even though they were college students, I was amazed at how much they knew and how professionally the whole thing came together. They really seemed to work as a team.

There was certainly some tension. We were using expensive 16-mm color film and the filming had to be completed in just three days. And even though we finished the filming on time, Brian still had to do a tremendous amount of editing once he got back to New York.

What About Ham Radio?

At this point, you must be asking, "What does all this have to do with ham radio?" Well, in my humble opinion, ham radio saved the movie. Here's how:

Remember our hapless spies who were sent to blow up the radio tower? Well,

David Bowles, N1MZZ, is a TV/Radio Communications major at the University of Montana in Missoula. He received a 1995 QCWA scholarship. Chester (Chet) Bowles, W1CSB, first licensed in 1967 as WNØRKL, holds several amateur radio positions including ARRL New England Division Assistant Director.

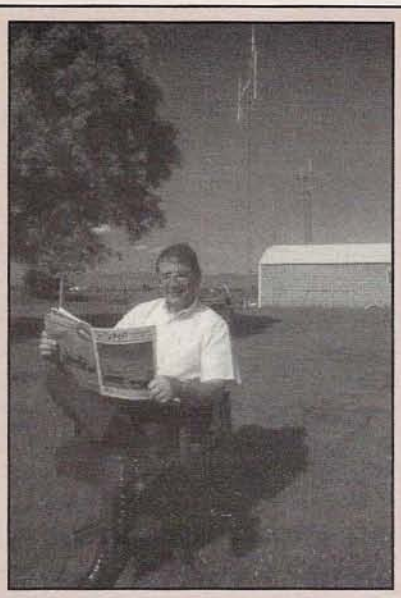
Producer/director Brian Bowles, David's brother, talks to the actors in the truck and makes sure the camera is set correctly for the next scene.

"headquarters" had outfitted them with a fabulous truck filled with electronic gear. (Actually, our family's 1986 GMC go-to-the-dump truck outfitted with a variety of my dad's mobile antennas.) There were several scenes which called for me to drive the truck to specific locations or to drive along selected roads while the camera crew filmed the action. The problem was that Brian had no way to tell me when to stop and start. And in almost every case, I was starting and stopping in places where I could not see Brian, so hand signals were of no use.

The answer to the dilemma should be obvious by now. My dad and I used 2-meter HTs to communicate. Sounds like

"The answer to the dilemma should be obvious by now. My dad and I used 2-meter HTs to communicate."

When Brian (holding clapper board) says "ACTION!" the actors off-site get the word via ham radio...and the activity begins!



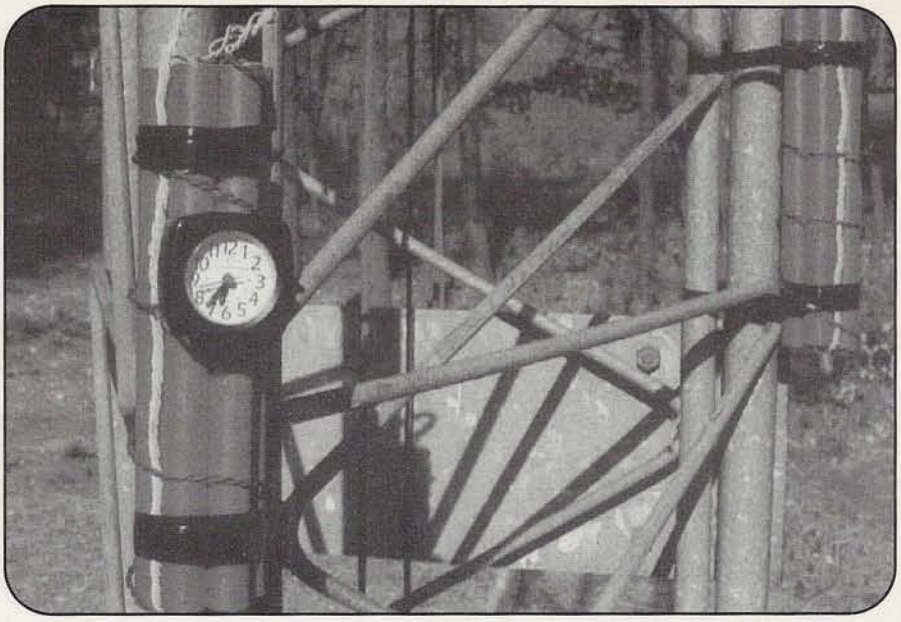
On the Cover

Ahh, summertime...relaxing in the back yard with a copy of your favorite magazine. That's where we found Rod Greene, W7ZRC, of Boise, Idaho. Behind Rod is what makes the picture interesting to VHF+ hams: the shop building that houses his shack and two towers full of VHF and UHF antennas.

The tower in the foreground contains four 2-meter Yagis on an H-frame (they're 15-element "Quedees" from Sweden). The rear tower holds four 33-element, 70-centimeter K1FO Yagis from Rutland Arrays, and within that stack are two 44-element Down East Microwave loop Yagis for 1296 MHz. Rod operates VHF and UHF exclusively with transverters (Microwave Modules on 2 and 432; SSB on 1296), feeding his Kenwood TS-950SDX HF transceiver, which acts as an IF.

Rod says he used to do a lot of EME (moonbounce) work on 432, but now mostly enjoys terrestrial weak-signal work on 2 meters, getting on the higher bands only during contests. Rod has qualified (but hasn't applied) for the VUCC award on 2 meters, with 120 grids confirmed, and has "right around" the 50 grids required for the 432-MHz version of VUCC.

First licensed in 1954, Rod let his license lapse in 1961, but got back on the air in 1977 and has been active ever since, both on VHF and HF, where he especially enjoys CW contesting. Rod is a 30-year resident of Boise, where he also works, managing the city's computer operations. (Cover photo by Larry Mulvehill, WB2ZPI)



W1CSB's backyard tower played a major supporting role in the film. Luckily for Chet, the "plot" to blow up the tower failed.

a simple solution. And it was. Besides, there really was no useful alternative.* We used our local ham radio club's simplex "chat channel" (my dad and I are both members). Given the rural nature of our part of New Hampshire and the mountainous local terrain, I doubt that any of the other club members could even hear us, let alone suffer any interference.

So, even though Brian and I didn't plan it that way when we wrote the script, ham radio played a major part in the movie. From the tower which got blown up, to the antennas on the truck, to communicating with HTs, ham radio became a central element of the movie. Brian even recorded some ultra-fast CW on 20 meters, which he used as background sound when the spies contact their "Spymaster General" to ask for help in resolving the dispute over the time zone line and in setting their watches.

I've seen the final version quite a few times and, to say the least, I'm really quite impressed. Apparently, Brian's professors were impressed as well, because his production received the film department's award for excellence.

Practical Training

Since we shot Brian's film, each of us has gone on to other things. I ended up receiving a scholarship from the Quarter Century Wireless Association and am now attending the University of Montana, majoring in TV/Radio Communications and minoring in Theater Arts. Brian graduated with honors from Pratt Institute and has worked as an assistant sound editor on two films which were shown at the famed Cannes Film Festival in France. He's even told my dad that he wants to study for his ham radio license!

"...even though Brian and I didn't plan it that way when we wrote the script, ham radio played a major part in the movie."

I guess ham radio ended up as such a prominent part of the movie because of our conditioning. After all, Brian and I learned a lot about ham radio by osmosis from all those years of seeing various pieces of radio equipment around the house, listening to Dad talk on the radio, and going to flea markets. Of course my dad, a ham for 30 years, was thrilled. He got his reward in the film credits—Brian listed him as "Communications Expert."

** Editor's Note: Using ham radio as a production tool was OK in this case, because it was a student production for which no one was getting paid. Had this been a professional production, it would have been more appropriate to rent business band or GMRS handhelds for communications during the shoot.* ■

Announcing

ARRL 10 GHz + Cumulative Contest

August 16–17 and September 20–21, 1997

Microwaves will be "cooking" on the third weekend of August and again in September. So gather up your gigahertz and head for the hills!

The object of the ARRL's annual 10-GHz And Up Cumulative Contest is to promote amateur microwave activity in North America. All licensed amateurs operating in North America and authorized to operate on the frequencies above 10 GHz are eligible to participate. Here are this year's complete rules, courtesy of the ARRL Contest Branch:

1) Object: To work as many amateur stations in as many different locations as possible from as many locations as desired from 10-GHz through Light.

2) Contest Period: 8 a.m. to 8 p.m. local Saturday and 8 a.m. to 8 p.m. local Sunday for the weekends of August 16–17 and September 20–21, 1997.

3) Categories:

A) 10 GHz only.

B) 10 GHz and up.

4) Exchange: Six-character Maidenhead Locator (see April 1994 *QST*, p 86, or write to Special Requests at HQ for a reprint). Signal report is optional.

5) Miscellaneous:

A) Scheduling contacts is both permissible and encouraged (*but see Rule 7A—ed.*).

B) Stations are encouraged to operate from more than a single location. For purposes of the contest, a change of location is defined as a move of at least 16 km (10 miles). A station may be reworked on each band for additional credit by either end of the contact moving to a new location.

C) Contacts may not be duplicated on the second weekend (that is at least one end of the QSO must be from a different location).

D) Contacts must be made over a minimum distance of 1 km.

E) A transmitter used to contact one or more stations may not be used subsequently under any other call during the contest period. The intent of this rule is to prohibit "manufactured" contacts.

F) Contacts with aeronautical mobiles do not count.

6) Scoring:

A) Distance points: The distance in km between stations for each successfully completed QSO is calculated. Distance = distance in km.

B) QSO points: Count 100 QSO points for each unique call sign worked per band. Portable indicators added to a call sign are not considered as making the call sign unique.

C) Total Score: Equals distance points plus QSO points.

D) There are no multipliers.

E) In making the distance calculations, a string (or ruler) and map may be used. However, calculations by computer program are preferred. Several such programs are available in the commercial market, including a basic program listing in *The ARRL World Grid Locator Atlas* ($5). For purposes of making calculations, stations are defined as being located in the center of the 6-character locator sub-square (most computer programs make this assumption).

F) Scoring example: On the first weekend, KB9NM operating from Mt Greylock, MA works W1VD (distance 97 km) and W1LJ/1 (distance 107 km) on 10 GHz; and W1LJ/1 (distance 107 km) on 24 GHz.

On the second weekend, KB9NM/1 operating from Pack Monadnock, NH works the following stations: W1VD (154 km), KH6CP/1 (205 km), W1LJ (157 km), and AA2Z (147 km) on 10 GHz; and AA2Z (147 km) on 24 GHz.

Distance points = 97 + 107 + 107 + 154 + 205 + 157 + 147 + 147= 1121

QSO points = 100 X 6 = 600 (10 GHz: W1VD, W1LJ, KH6CP/1, AA2Z; 24 GHz: W1LJ, AA2Z)

Final Score = 1121 + 600 = 1721

7) Scheduling and Reporting:

A) Schedules may be set up by use of the HF calling frequency of 3818 kHz on the evenings of Tuesday, Wednesday and Thursday before the contest weekends starting at 7p.m. local. Also, 144.230 and 146.55 MHz can be monitored during the contest to arrange schedules with other stations. Paired stations should move off these frequencies once contact has been made.

B) Official forms are available in the ARRL Contest Yearbook.

C) Logs should indicate band, date, time, call sign, the exchange information plus distance of contacts in km.

D) Logs must be submitted no later than 30 days after the end of the contest to ARRL Contest Branch, 225 Main St, Newington, CT 06111.

8) Awards: Suitable awards will be presented.

9) Disqualifications: See Contest Disqualification Criteria. ■

Announcing

The 1997 ARRL August UHF Contest August 2–3, 1997

If you're active on the bands above 2 meters, then this event's for you! (And if you're not, it's a good chance to try them out.)

Here are the complete rules for the 1997 ARRL August UHF Contest, courtesy of the ARRL Contest Branch:

1) Object: To work as many amateur stations in as many 2 degree by 1 degree grid squares as possible, using authorized amateur frequencies above 222 MHz and all authorized modes of emission.

2) Contest Period: Begins 1800 UTC Saturday, August 2 and ends at 1800 UTC Sunday, August 3, 1997. Entrants may use as much of this time as they wish.

3) Categories:

(A) Single operator: One person performs all operating and logging functions, as well as equipment and antenna adjustments.

(1) Multiband.

(2) Single band: Single-band entries on 222, 432, 902 and 1296 MHz, and 2.3-GHz-and-up categories will be recognized both in *QST* score listings and by awards offered. Contacts may be made on any and all bands without jeopardizing single-band entry status. Such additional contacts are encouraged and should be reported. Also see Rule 8 (Awards).

(B) Rover: One or two operators of a single station that moves among two or more grid squares during the course of the contest. A rover vehicle may transport only one station using a single call sign; thus a rover may not operate with multiple call signs under the family rule 7 (C). Rover vehicles must transport all the equipment, power supplies, and antennas used at each operating site. This rule is not intended to prevent an operator from using the same call sign to submit separate logs for single operator (fixed station) and rover entries. Rovers sign "rover" on phone and /R on CW after their call sign. All Rovers are encouraged to adopt operating practices that allow as many stations as possible to contact them.

(C) Multioperator: Multioperator stations must locate all equipment (including antennas) within a circle whose diameter does not exceed 300 meters (1000 feet).

4) Exchange: Grid-square locator (see April 1994 *QST*, page 86). Example: W1AW in Newington, CT would send "FN31." Exchange of signal report is optional.

5) Scoring:

(A) QSO points: Count three points for each complete 222- or 432-MHz QSO. Count six points for each complete 902- or 1296-MHz QSO. Count 12 points for each 2.3-GHz-or-higher QSO.

(B) Multiplier: The total number of different grid squares worked per band. Each 2 degree by 1 degree grid square counts as one multiplier on each band it is worked.

(C) Final score: Multiply the total number of QSO points from all bands operated by the total number of multipliers for final score. Example: W1AW works W3CCX in FN20 on 222, 432 and 1296 MHz. This gives W1AW 12 QSO points (3+3+6) and also three grid-square multipliers. Final score is 12 QSO points X 3 multipliers, or 36.

(D) Rovers only: The final score consists of the total number of QSO points from all bands times the sum of unique multipliers (grid squares) worked per band (regardless of which grid square they were made in) plus one additional multiplier for every grid square activated (made a contact from). Rovers are listed in the contest score listings under the Division from which the most QSOs were made.

6) Miscellaneous:

(A) Stations may be worked for credit only once per band from any given grid square, regardless of mode. This does not prohibit working a station from more than one grid square with the same call sign. Such a roving station, however, must submit a separate entry for each grid square from which the operation takes place. In this situation, the entrant may opt to waive rule 6 (C) and use a single different call sign from each different grid square. Crossband QSOs do not count. Aeronautical mobile contacts do not count.

(B) Partial QSOs do not count. Both calls, the full exchange and acknowledgment must be sent and received.

(C) A transmitter, receiver or antenna used to contact one or more stations under one call sign may not be used subsequently during the contest period under any other call sign (with the exception of family stations). The intent of this rule is to accommodate family members who must share a rig, not to manufacture artificial contacts.

(D) All equipment and antennas used by entrants must be owned and operated by amateurs. Use of non-amateur- owned gear is not prohibited, but use of such equipment places the entrant in a separate category, ineligible for awards.

(E) While no minimum distance is specified for contacts, equipment should be capable of real communications (i.e., able to communicate over at least 1 km).

(F) Contacts made by retransmitting either or both stations, whether by satellite or terrestrial means, are prohibited. Frequencies regularly occupied by a repeater in a locality may not be used for contest work, even if the repeater is turned off.

(G) A station located precisely on a dividing line between grid squares must select only one as the location for exchange purposes. A different grid-square multi-

plier cannot be given out without moving the complete station (including antennas) at least 100 meters.

(H) Above 300 GHz, contacts are permitted for contest credit only between licensed amateurs using coherent radiation on transmission (e.g., laser) and employing at least one stage of electronic detection on receive.

(I) Marine Mobile (and Maritime) entries will be listed separately as "Marine Mobile" in the score listings and compete separately for awards.

7) Reporting:

(A) Entries must be postmarked no later than 30 days after the end of the contest. No late entries can be accepted. Use ARRL UHF Contest forms, a reasonable facsimile, submit your entry on diskette, upload your entry to the ARRL BBS, or send your entry to ARRL HQ via Internet.

(1) Official entry forms are available from HQ in the *ARRL Contest Yearbook*.

(2) You may submit your contest entry on diskette in lieu of paper logs. The floppy diskette must be IBM compatible, MS-DOS formatted, 3.5 or 5.25 inch (40 or 80 track). The log information must be in an ASCII file, following the ARRL Suggested Standard File Format, and contain all log exchange information (band, mode, date, time in UTC, call of station worked, exchange sent, exchange received, multipliers [marked the first time worked] and QSO points). One entry per diskette. An official summary sheet or reasonable facsimile with signed contest participation disclaimer is required with all entries.

(3) You may submit your contest entry via the ARRL BBS (860-594-0306), via Internet to contest@arrl.org, or anonymous FTP to ftp.arrl.org. Send your summary sheet file (Make sure it includes all the pertinent information outlined in the official ARRL summary sheet.) and your log file following the ARRL Suggested Standard File Format.

(B) Logs must indicate band, mode, date, time in UTC, calls and complete exchanges (sent and received), multipliers and QSO points. Multipliers should be marked clearly in the log the first time they are worked. Entries with more than 200 QSOs total must include cross-check sheets (dupe sheets). Send entries to: ARRL Contest Branch, 225 Main St, Newington, CT 06111.

8) Awards:

(A) Single operator

(1) Top single-operator score in each ARRL Division.

(2) Top single operator on each band (222, 432, 902, 1296 and 2304-and-up categories) in each ARRL Division where significant effort or competition is evidenced. (Note: Since the highest score per band will be the award winner for that band, an entrant may win a certificate with additional single-band achievement stickers.) For example, if K2SMN has the highest single- operator multiband score in the Atlantic Division and his 432-MHz score is higher than any other Atlantic Division single-op's, he will earn both a certificate for being the single-operator Division leader and an endorsement sticker for 432 MHz.

(B) Top multioperator score in each ARRL Division where significant effort or competition is evidenced. Multioperator entries are not eligible for single-band awards.

(C) Additional certificates, such as for Novices, may be awarded where significant effort or competition is evidenced.

9) Disqualification: See the Contest Disqualification Criteria for details.

UHF Participation Pins

Here's an award you can earn, whether you're a first timer or a weathered veteran of the sport. The ARRL is offering a handsome UHF participation pin to qualified participants in the ARRL August UHF Contest.

Anyone who makes at least five contacts (any mode, any band or any combination) during the 1997 ARRL August UHF Contest will qualify for a UHF participation pin. Also all the individual operators of a multioperator station (that qualify) are eligible for their own pins. The handsome pin is marked with the year, making it a possible collector's item. Don't miss the chance to be among the first to have them! Wear them proudly in support of the August UHF Contest.

To order, include with your log entry: (1) a mailing label (preferably self-adhesive label. (2) A check or money order for $5 for each pin, payable to the ARRL (includes the price of the pin, packaging, padded envelope and postage). Your pin will be shipped after your contacts have been verified and the results printed in *QST*. ■

CQ Books & more...

NEW!

33 Simple Weekend Projects

by Dave Ingram, K4TWJ

A wide ranging collection of do-it-yourself electronics projects from the most basic to the fairly sophisticated, and even touching on the frivolous. You'll find an interesting and very do-able array of useful devices: station accessories for VHF FMing, working OSCAR satellites, joining the fun on HF, trying CW, building simple antennas, even a complete working HF station you can build for $100.

Add a measure of practical tips and techniques on how to build electronic projects yourself, and you've got an information-packed book that will keep the newcomer or the most experienced homebrewer busy for many a pleasant weekend.

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The NEW Shortwave Propagation Handbook

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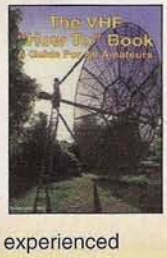

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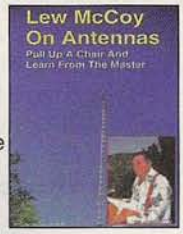

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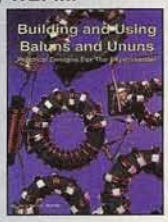

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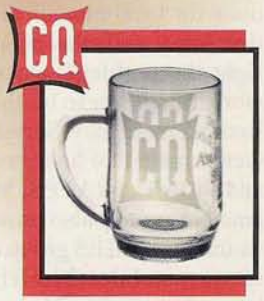

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Floodwaters of the Red River in East Grand Forks, Minnesota. Damage from the flooding was in the billions of dollars, and hams helped provide essential communications for more than a week, often operating around the clock.

center in Crookston where unbelievable amounts of food, bottled water, personal items and cleaning supplies were being handed out to several thousand evacuees in the Crookston area who were living in shelters and private homes. The morning we arrived at the distribution center, a large truck had arrived from Florida, completely equipped with portable shower facilities for the evacuees to use at a central location.

The communications facility at the Crookston site consisted of a small operating position with a dirt floor in a dark, cold corner of the warehouse. Local amateurs were manning the radios from 8:00 a.m. to 6:00 p.m., and had been on duty for several days, helping the Salvation Army and providing a link for supplies back to Grand Forks. The folks in Crookston earned a well-deserved pat on the back for providing this service! Crookston is not a large place—its population is just over 8,000—but, luckily, the local amateur radio group had just completed a license exam session and there were approximately 20 new operators to choose from. Talk about a challenge the first time out!

A Shock in East Grand Forks

Our arrival in East Grand Forks, Minnesota, on Monday morning was a shock! The bridge between East Grand Forks and Grand Forks, North Dakota, was just in the process of reopening, and the flood waters were slowly going down. Roads were beginning to dry out, but now the wind was whipping up the dust, blowing trash and who knows what else all over the place.

The base of operations for ARES was the Comfort Inn in East Grand Forks. As one of the only places in town that had electricity, it became the temporary City Hall and Emergency Operations Center. When we pulled into the parking lot, we saw helicopters landing and taking off at regular intervals, vehicles parked there from every conceivable agency, and dozens of porta potties. As soon as we found the EOC, we met John Engle, WAØLPV, ARRL Emergency Coordinator (EC) for East Grand Forks.

The moment we met John, we saw that he was a very qualified, but very tired, individual. John hadn't been home in over a week, his family was in Fargo and he and the EC from Grand Forks, Gerry Nies, NØNGW, had been running ARES for the entire disaster from their two positions. Gerry was on the North Dakota side, operating from a cafeteria at the University of North Dakota, and John was on the Minnesota side. They were only 300 yards apart, but with the bridge closed, going from one side to the other required a 180-mile trip through Fargo to the south!

Communications and More

ARES played a vital role in handling the flood disaster, as operators coordinated dike patrols and restored communication links for emergency services. In fact, East Grand Forks ARES members dispatched fire units in that city for over a week while the 911 telephone lines were out. It is extremely difficult to get an accurate count of how many ARES members participated during the flood, but I would guess from conversations that it exceeded 100 operators from various cities in North Dakota and Minnesota.

Of course, when you are in an area marked "EOC Communications," people think you know everything about radios, cellphones,

"...the local amateur radio group had just completed a license exam session and there were approximately 20 new operators to choose from. Talk about a challenge the first time out!"

answering machines, pagers, etc. The East Grand Forks operators were also in charge of distributing VHF public service radios to National Guard, Public Safety, Emergency Management, Salvation Army, etc. I was somewhat astounded to look at the area where the public service equipment was kept and see 40 to 50 handheld radios ready to go wherever they were needed.

Comforts of Home Left Behind

It was great to have had so many volunteers from so many places, but many others had to be turned away. The biggest problem with volunteers coming into the area was housing and feeding, and there simply wasn't enough housing to go around. We were lucky enough to be able to borrow a brand new pop-up camper free of charge, so we were self-contained and could park in the lot at the motel. But others had to be sent home (see "Suggestions for Next Time").

All of our meals at the site were provided by the motel, with food supplied from various donations. The meals were good and hot, and that boosted the spirits a lot for anyone taking part. Unofficial estimates place the number of portions served in a small room at the motel as 300 per meal. There seemed to be a lot of beans and wieners, but it all tasted good!

All of the water we drank was bottled. It came from various sources and we became very conscious of cleanliness. There was no ice and everyone carried around small packs of alcohol prep pads for wiping their hands after touching door handles, equipment, contaminated clothing, or their cars! There was a real concern about disease and the lack of flush toilets.

Showers weren't a viable solution. Before you went into the restaurant, there was antiseptic soap and hot water for rinsing, followed by alcohol prep wipes. Contact lenses were not good. If the dust got in your eyes under the contact lenses and you rubbed your eyes, the contamination from either source could be dangerous. Polk County public health was giving free tetanus shots just outside our communications room, and business was brisk. Medics were stationed in the motel, along with stress management people who were assisted by clergy in dealing with some of the emotional issues of the residents and workers. All of this activity was in a wide open room.

Suggestions for Next Time

1. Every operator going into the scene of a disaster has to be pre-cleared, as was the case in this instance. Housing is limited, facilities are poor, and we don't need to be a drain on the local efforts. Only registered ARES operators will be permitted in to the scene of a disaster.
2. All out-of-town ARES units should be self-contained, e.g. motorhomes, campers. Do not come in thinking you will have a place to sleep, because you won't. Bring five days' supply of drinking water and food. There are no stores open and you cannot buy necessary things like medications, etc. Check the *ARES Field Resources Manual*. It's a good start on what you will need.
3. Plan on getting dirty.
4. Plan on boring duty at times.
5. Plan on seeing a lot of grief.
6. Plan on getting depressed.
7. Don't plan on anything!!
8. Be willing to work with local officials. You are there to work under them. We do not direct their people unless requested.
9. Have a briefing with your people every morning and evening.
10. Bring extra radios, HTs, etc. HF communications is a must for keeping in touch with home base, wherever it may be.

A Thank You to All

Several other hams from southeastern Minnesota traveled up with Gladys and me as well. They were Warren, KAØKXI, Mike, KCØAQX, Joe, KBØVUR, Jeremiah, KBØOFF, and Scott, NØJLP. There were also many more operators in the Rochester, Winona, Houston, and Goodhue County areas who were prepared to travel up to relieve us at the end of the week. These operators all took time off from their jobs, brought their own equipment, and stood ready to serve our fellow amateur radio operators and the flood disaster area in any possible way. It is such a pleasure to be associated with these people, both those who came and those who were ready to go. I simply can't thank them enough.

Of special note is the work of members of the Rochester Amateur Radio Club, the Winona Amateur Radio Club, and the Redwing Amateur Radio Club, who volunteered their time and equipment to help others. The combined efforts of the Grand Forks, East Grand Forks, and Crookston radio club members supplied communications for over two weeks.

The role of the out-of-town amateur radio operators in East Grand Forks was somewhat limited as the majority of the "tense stuff" had already passed, but all of the operators felt their presence gave the locals a chance to survey the damage to their own homes and to start putting their lives back together. For this, we are grateful that we could play a meaningful role in providing help.

On Reflection...

After returning home from the flood area, I finally had the chance to reflect on what we had just seen. A large area of the downtown was burned, streets were blocked by debris and dikes, and there were 40,000 people displaced for a long time. It would be weeks before water, sewers, and electricity would be restored. So when you go home tonight and make supper on your stove, wash your hands in the sink with clean water and take a shower before going to bed in your own home, think of the folks who cannot do that, and will not be able to do it for several weeks. We are fortunate, and maybe by reaching out as human beings and amateur radio operators, we can make someone else's life a little better.

In Other News...

Weather Service Works on Getting the Word Out

New technologies and unmet needs were on the agenda of a recent Dissemination Technology Conference sponsored by the National Weather Service and attended by officials of both public and private agencies. Two areas of interest to hams were the needs of schools and hospitals to get local weather information. School administrators are interested in temperatures and road conditions or severe storm conditions to decide how to keep the students safe. And hospital emergency rooms need to know if they're going to have an influx of weather-related injuries.

Both of these scenarios offer the possibility for amateurs to introduce ham radio and the weather-related uses of APRS (Automatic Position Reporting System—see June, 1997, *CQ VHF*) to schools, hospitals, and emergency managers. Learning the value of the amateur service in times of need may help interest schools in using amateur radio as an educational tool as well.

Ham Radio Featured in NWS News Release

Each month, the National Weather Service suggests various topics of interest to the news media. Recently one of the "tips" featured ham radio, providing an excellent opportunity to publicize

your local Skywarn activities. Here's an excerpt from the NWS release:

Did you know that volunteer spotters and HAM radio operators help the National Weather Service track severe local storms and tornadoes? Each weather office coordinates a network of spotters who support their local forecast offices by calling in eyewitness reports of storm activity. In addition, more than 10,000 citizen volunteers known as cooperative observers dedicate their time daily as weather observers for local National Weather Service offices. These volunteers collect regular measurements of weather data that help meteorologists improve local forecasts and contribute to the nation's climate records. Your local weather office can identify interesting volunteers in your community who contribute to the National Weather Service mission of protecting lives and property.

Pennsylvania Amateurs Cited for Help During Tire Fire

Members of the Washington Amateur Communications Group provided emergency communications over a 36-hour period last March in support of efforts to fight a dangerous tire fire in East Washington, Pennsylvania. According to the "WACOM Ham" newsletter, club members WB3BZK, N3YHW, N3NEL, KA3UDR, KA3MZS, N3VBU, N3WLA, N3IDH, AA3KC, and N3WMV provided communications assistance to the local American Red Cross, which was sheltering nearby residents who had to be evacuated because of heavy smoke from the fire. Within minutes of being contacted, WACOM members were on site and ready to operate.

As a result of this effort, on March 20, 1997, WACOM was cited along with other groups with a Proclamation by the Washington County Commissioners declaring the week of March 16 through 22, 1997 as "Emergency Service Providers Week." This shows again that, even in this time of cellular telephones, amateur radio provides a valuable service to emergency personnel. The Proclamation says, in part:

WHEREAS, the citizens of Washington County benefit daily from the services, knowledge and skills of paid and volunteer emergency service providers as they endure conditions that are stressful, dangerous, and hazardous to themselves so that they may protect lives and offer security to others;

WHEREAS, these people include police officers, firefighters, medical and health professionals, rescue service personnel, emergency service dispatchers, amateur radio and public utility personnel, volunteers and countless other public servants offering aid and assistance to the public and members of the public who aid their neighbors in a genuine expression of community; and...

WHEREAS, without proper recognition and support for the activities that benefit emergency services, we place at risk the many important programs that make up Washington County's emergency services and we endanger the public.

"East Grand Forks ARES members dispatched fire units in that city for over a week while the 911 telephone lines were out."

Send Us Your News

Do you have a story to tell about ham radio public service or emergency communications in your area? Is your ARES/RACES group doing something new and unique? Please send your news reports and newsletters via e-mail to <bjosuweit @aol.com> or by regular mail to "In the Public Interest," c/o *CQ VHF* magazine, 76 N. Broadway, Hicksville, NY 11801.

Field Day...A State of Mind

As you start to read Peter's column this month, you might begin to think he's spent too much time in the Florida sunshine—without a hat. But stick with him to the end and it'll all make sense—lots of sense.

Field Day. Gee, wasn't that in June? Why are you writing about it now? It's over until next year, right?

No.

Huh?

On the fourth full weekend in June each year, hams from all over the U.S. and Canada pack up their rigs, portable towers (what a concept!), generators, spare batteries, and whatever assortment of camping/survival gear they deem necessary and head for the great outdoors. For a little over 24 hours, all the bands, HF through UHF, are alive with contest-like activity from people who would never dream of entering a "test." But Field Day is more than a contest. It's an attitude that permeates and lasts 365 days a year.

Wait a minute. I know. You're going to tell me that I should start thinking about getting ready now for next year's Field Day, right? That way, I'm sure to get a better score?

You could think of it that way, but the Field Day I'm talking about is a lot more than that. In a sense, Field Day represents ham radio at its highest level.

Because you prepare for emergencies and check your rig out so you can help your community in an emergency, right?

Well, yes, but it's still more than that—a lot more. There's an underlying attitude behind Field Day that generalizes to the whole hobby and makes ham radio the great pastime it is. And it's this same attitude that has probably kept the politicians from abolishing our hobby over the years. We've got some pretty valuable RF real estate. Why do you think they've let us keep it? Let me explain.

Even a small Field Day station—such as this one set up by the West Essex, New Jersey, ARC—requires planning and preparation...and questions you don't realize you're asking.

It's Not about the Radio

How is a ham's HT or mobile FM radio different from your local Sheriff's Department radio? At a technical level, there isn't much difference at all. Both are narrow-band FM systems, operating on VHF and/or UHF bands. Commercial equipment often costs four or five times as much as ham equipment, but the quality of the commercial rigs is only a little bit better than that of the ham rigs. Why, then, is it that hams often step into emergency situations and provide the lion's share of emergency communications?

Two possible reasons come immediately to mind. First, the government system may not have adequate capacity for the volume of traffic that an emergency brings. More likely, though, is the fact that few of these radio operators have any training in even the most basic repairs or the most basic RF theory. So, if the deputy's radio stops working, his *only* possible action is to call the radio repairman. If the office is big enough, there may be one or more full-time repairmen. Small offices usually contract out radio servicing to local two-way shops. So, maybe the radio gets repaired today, and maybe it doesn't.

"In a sense, Field Day represents ham radio at its highest level."

What happens when the *ham* discovers his radio isn't working properly? He checks the microphone cord for breaks by wiggling the cord while transmitting. He checks the coax connector and the bat-

By Peter O'Dell, WB2D

tery/power supply. He makes sure that everything is plugged in. And he checks the fuses. Any ham can do that much troubleshooting without any test equipment, or even a whole lot of experience. The ham simply has *more options* than the deputy. Why?

It's about the Hams

You just mentioned training, right?

Yes, but I don't think that's what makes the real difference.

Well, then, it's the stuff that we have to learn to pass the exams, right?

Again, I don't think so. I think the key is the questions that we ask *ourselves* without ever being aware that we're even asking them.

Personally, I am beginning to think your little red choo-choo has gone around the bend. What questions? I don't get it. What are you talking about?

OK, let's back up just a second. Are you utilizing all your potential?

Well, honestly, no.

That's right. But do you know anyone who is?

There is probably someone out there who is, right?

I don't think so. I have no idea how you could begin to measure this sort of thing, but one figure that you see tossed around a lot is that the average person only uses about four or five percent of his potential. And the people who talk about these things estimate that Einstein only used maybe 10 percent. So, what stops us? What keeps us from using more?

I don't know.

Once, again, I think it's the questions that we ask, mostly without ever even knowing we're asking them. Here, let me show you. Look around the room you're in right now and notice everything that's the color *green*. Notice every green item in the room....OK, now close your eyes and tell me everything in the room that's colored *red*.

What? That's not fair.

Who said life is fair? Keep your eyes closed. What items in this room are red?

Well, I don't know. But I can tell you that there are about 25 things in the room that are green.

That's my point.

I still don't get it.

The world is far too complicated for us to consciously deal with every single detail. We have to focus on certain things and delete everything else from our awareness. Otherwise, we would go stark raving mad from what academia calls *sensory overload*. So, somewhere along the line, we make decisions about what is important and what is not. Then we filter out what we *believe* is not important. Unless something or someone calls our attention to it, we act as if we have all the possible information held in our conscious awareness.

"...the average person only uses about four or five percent of his potential....So, what stops us? What keeps us from using more?"

Now, with your eyes open, just look around the room at the different things that are red, including my necktie and the all the red on the cover of *CQ VHF* that you were just looking at two minutes ago. I think you'll find that the red to green count actually runs about two-to-one in favor of red. But a minute ago, you said you could name 25 things that are green and nothing that is red!

Well, I'll be...

Careful, this is a G-rated column.

But What about Field Day?

So, what does any of this have to do with Field Day?

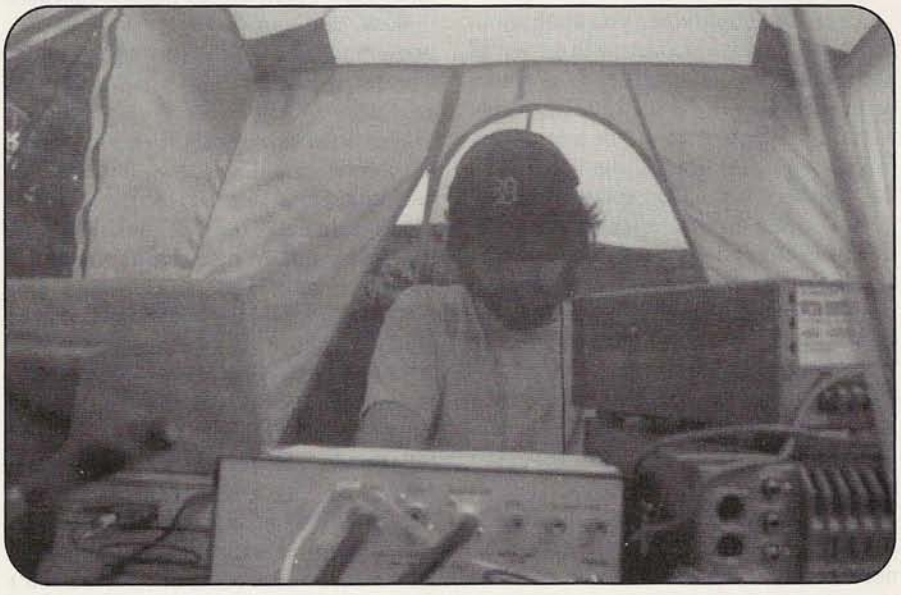
I thought you'd never ask *that* question. What does it have to do with Field Day? It has to do with Field Day *questions*. Do you just get up that fourth Saturday in June and throw a big bunch of stuff in your car, hoping that you'll have everything you need to set up a portable station?

Of course not. You start to think weeks or months ahead of time about what you need to set up a portable station. What's essential? What can you get by without? Most hams are on limited budgets, so another factor gets thrown into the equation: How can I do what I want to do economically? What happens when you begin to ask yourself these kinds of questions? Your brain, being the wonderful servant it is, goes about finding answers for you. Some answers are more useful than others, but you get answers to the questions that you ask yourself. And most of us are not aware that we're even asking ourselves these questions.

Look what happened here a few minutes ago. I asked you to notice what in your room is green. And your brain did a wonderful job of noting many, if not most, of the green things in the room. Then I threw you a curve and asked you to list the red items in the room with your eyes closed.

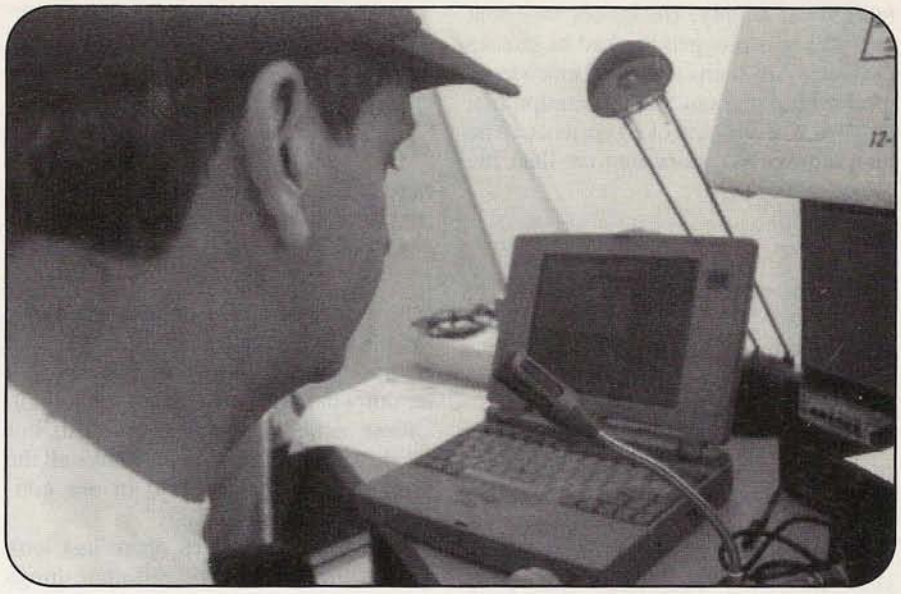
Okay, now I'm beginning to see what you mean.

Sure. It's not rocket science. I'll give you a couple of examples of how this attitude carries over. A couple of months ago, Wendy, my significant other, and I vacationed at a beach for a week. We deliberately picked a place that had no phone just for the peace and quiet. Well,



What's absolutely necessary? What can we do without? These questions apply not only to Field Day but to many other areas of ham radio activity.

"What's essential? What can you get by without? Most hams are on limited budgets, so another factor gets thrown into the equation: How can I do what I want to do economically?"



Hams' ability to get on the air and stay on the air, regardless of difficulties, is what sets us apart from other radio users.

it didn't have cable TV either, just an old TV set that had a small UHF antenna on it. For the most part, that was no big deal, but there was one show that Wendy wanted to see that was on channel 11. As it was set up, the old TV didn't receive channel 11 at all.

I noticed a piece of 75-ohm cable in the closet, but it wasn't connected to anything and the center wire was broken out of the connector. The only "tool" that I had with me was a pocket knife. So, being the dyed-in-the-wool ham that I am, I asked myself, "How can I make an effective channel 11 antenna out of what I have here?" I got an answer.

What if I had asked myself, "Why did we pick this stupid place to stay this week?" or "What's wrong with these people that they don't have a decent antenna on this TV?" If I'd asked myself those questions, I would have gotten answers to *those* questions. Those answers might have made me irritable enough to go find the owner of the "resort" that we were in. And you can imagine where that conversation would have gone.

What did you do?

It's really simple when you think about it. What's the easiest antenna in the world to make? A dipole. Channel 11 is somewhere between 144 and 222 MHz, right? Actually, I knew it would be a lot closer to 222. So I guestimated the length of a 222 quarterwave, added about an inch to it, and peeled off that much outer insulation from one end of the cable. Then I separated the braid just enough to pull the center conductor through it, and peeled the braid back along the next quarterwave section. Instant dipole.

What about the connector? You said it was broken.

No problem when you think about it. I pried off the compression ring, pulled off the connector body, and prepared the end of the cable. Then I just pushed the connector body back onto the cable. For the short time that we needed the antenna, we could easily get by without the compression ring. We had a perfect picture on channel 11 for the show.

What did Wendy think of this?

She's used to me making things work. All she said was, "As soon as I saw that look in your eye, I knew you would find a way for us to watch the show."

Take a "Walk" with Me

Let me show you another "Field Day" project of mine. Come on out to the garage where I have the supplies for my little mail-order business. See that tape dispenser that holds the two-inch-wide tape? How much do you think it cost me?

Well, you can buy the one-inch dispensers for under $5 at any office supply store, so a two-inch one would probably cost $7 to 10, right?

That's probably what it ought to cost, but the "discount" price on those things is around $50. I needed a second one but didn't want to lay out that kind of money. So, we have this "homebrew" version. I bought a handheld packing-tape dispenser at a yard sale for 50¢ and an old wooden cutting board for another 50¢. All I had to do was unbolt the tape holder from the handle and screw it down to the board with four wood screws—the holes were already drilled in the tape holder. So, my total investment in this second tape dispenser was $1, a $49 savings. Very functional, but rather homely. However, no one comes in here, so I don't have to be concerned with looks, just function. And it functions perfectly.

You be the judge. Is it worth noticing the questions you ask yourself? I could have just continued asking myself why "they" charge so much for the commercial dispensers. And I'm sure that I would have gotten a whole bunch of answers, but none of them would have been particularly useful.

"...the spirit of Field Day is 'how can I make this work with what I have on hand?' That spirit carries over to what we hams do in life."

The Spirit of Field Day

So, you see, the spirit of Field Day is "how can I make this work with what I have on hand?" That spirit carries over to what we hams do in life. Our hypothetical deputy is asking himself "Who can I get to fix this $#@! radio?" The ham would be asking, "What can I do to keep this working?"

It's the questions that hams ask themselves that are the spirit of the hobby. Field Day exemplifies those questions and that spirit.

For the true ham, there are 365 Field Days every year. I think that's why hams handle so much emergency communications. I think that's why the government has let us keep our frequencies. We ask the right questions. ■

A Poor Man's Antenna Range—Experiments You Can Do with a Field Strength Meter

This month, Don shows you how to measure antenna patterns with the remote field strength meter he described in June...and how to build a five-element beam in the process.

In June's "In Theory" column, I described how to build a remote field strength meter (FSM). To recap just a bit, the antenna/detector was attached to a length of shielded cable; a meter, which would indicate the amount of signal being received by the antenna, was attached at the other end. This design lets you make tests, measurements, and experiments using various antennas configurations, while letting you monitor results from a convenient location.

This month, we'll give you a sense of how you can use your FSM to measure signal strength and front-to-back ratio with a simple experiment. Then we'll complete the description by adding the sending end of the system.

A Simple Experiment

Here's an easy, but practical, test you can perform with just the meter and a commercial beam (Yagi) antenna.

Point your beam at the FSM's receiving antenna and set the meter near full scale. If you can't get the meter to read this high, move the detector closer to the antenna being tested. Now, turn the antenna so it's cross-polarized (beam vertical, detector horizontal, or vice versa). The meter reading should drop to near zero. When the polarizations match and you point the beam at right angles to the detector (90 degrees), the same thing should happen. Next, point the antenna directly away from the detector (180 degrees). You should notice a slight rise in the signal level compared to the 90-degree reading. The difference between the meter reading with the beam pointed toward the detector, and 180 degrees away from it, is the front-to-back ratio. The greater the difference between these two readings, the better the antenna.

Why is the front-to-back ratio important? If you're just going to use your VHF/UHF station for working local repeaters, it probably isn't. But if you want to talk long distances (DXing) on FM or SSB, it can be crucial for minimizing interference from other stations doing the same thing. On the high frequency (HF) bands, a good front-to-back ratio is even more important for pulling out weak DX stations with a minimum of interference from other directions.

A "Poor Man's Antenna Range"

We're now ready to finish up June's remote FSM project by putting together the necessary hardware for testing antennas at the "sending end" of the system—the source of the signals to be measured.

When you've completed the two ends (receiving and sending), you'll have constructed a "poor man's antenna range" that can be used for various experiments or as a school science project. It's not accurate enough for FCC tests or to make any technical claims for a specific antenna, though—a range of that nature, used by equipment and antenna manufacturers, costs many thousands of dollars and must be certified (see "Inside an Antenna Range," elsewhere in this issue).

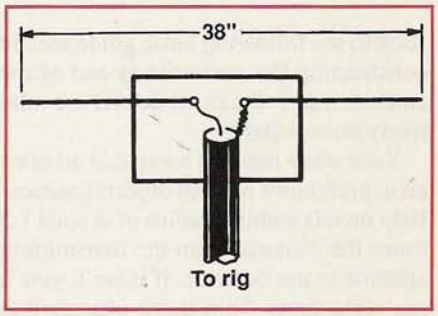


Figure 1. The basic attachment of the dipole and feedline for beginning your five-element beam. Use a 4 x 6-inch piece of insulating material, such as Plexiglas™, and attach the wires with nuts and bolts.

Basic Guidelines

Since the FSM's detector is in a fixed location, the antenna under test must be mounted on a rotating base so the field strength radiated by the antenna can be measured as it is rotated. By plotting the points in 10- to 20-degree increments, it's possible to draw a pattern of the antenna radiation similar to those you see in amateur radio magazines.

I'll leave most of the details about how to construct the rotating antenna mount up to you since everyone has different materials available. Also, I would rather spend as much of the space available in this article discussing how to perform interesting antenna experiments using this simple antenna range. As long as you

By Donald L. Stoner, W6TNS

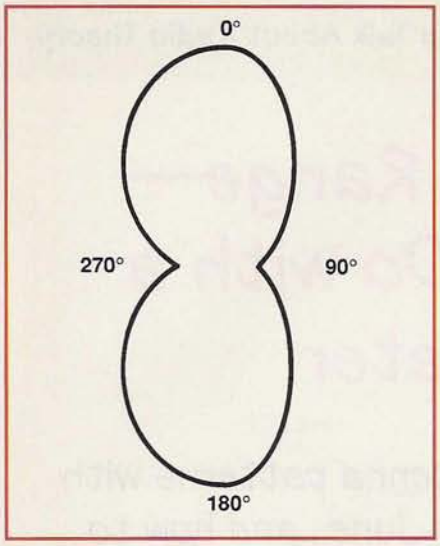


Figure 2. Radiation pattern of a typical dipole antenna fed with coax or other unbalanced feedline. Note that the pattern is canted, or shifted, to one side.

stick to the following basic guidelines in constructing the transmitting end of the antenna range, the exact details are relatively unimportant.

Your setup must be located in an open area, preferably with no objects (particularly metal) within a radius of at least 1.5 times the distance from the transmitting antenna to the detector. If it isn't, you'll see reflections from these objects that will distort the graph you make of antenna radiation (see below).

On top of the rotating base, you'll need to construct a turnstile that can be used to rotate the antenna under test through a full 360 degrees. As you rotate the antenna, take a meter reading every 10 to 20 degrees and write down the value. When you've rotated it through 360 degrees, use the measurements to draw a graph of the antenna radiation. You'll want to draw this on circular graph paper, commonly available at Staples, Office Depot, or other office supply stores.

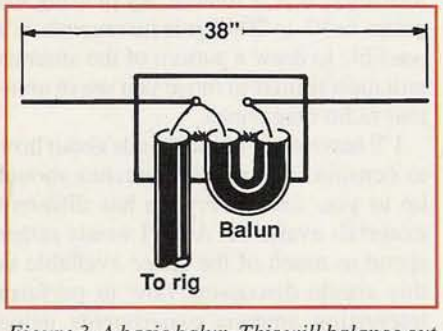


Figure 3. A basic balun. This will balance out the radiation pattern seen in Figure 2. See text for construction details.

The mount for the antenna should be wood, plastic, or fiberglass, rather than metal, and it should be strong enough so a six- or seven-foot length will not wave around in the wind (if it does, your meter readings will dance all over the scale). There should be a 360-degree compass mounted at the rotation point so you can move the antenna in 10- or 20-degree increments, take a reading, and/or be able to repeatedly reset the antenna to a specific angle. It should be possible to mount the antenna above your head so you can adjust it (while standing under the centerline of the boom) without any significant change in the antenna reading. You can, of course, adjust the antenna and then walk away over to the indicator location, but this is rather awkward and you won't be able to see the effect of changes as you make them.

Build a Dipole, Build a Beam

Let's start our project with a simple dipole and, later, add parasitic elements to make a five-element beam. First, cut two 19-inch lengths of #12 copper electrical wire and strip off the insulation. Bend each piece so there's a loop at one end, and secure the wires with nuts and bolts to a piece of 4 x 6-inch insulating material similar to that used in the first part of this project in June.

Next, connect a suitable length of coax cable to the bolts, as shown in Figure 1. By suitable length, I mean long enough to hang straight down from the dipole when it's mounted on the turnstile and to connect to the 2-meter radio you're using as a signal source. If you use either a handheld or a mobile rig, set it to the low power level (approximately 1-watt power output). Don't use an excessive length or you'll have to coil up the coax and this could affect readings. If you mount the radio away from the antenna, go straight down, then across the ground to reach the antenna connector.

Mount the dipole on the turnstile so the element is horizontal. When you measure the radiation pattern of this antenna, you should find that it's the same whether the dipole is 0 or 180 degrees with respect to the detector. If your setup is reasonably accurate, your drawing will probably look like Figure 2. The two "bumps" are called lobes, and these represent the major radiation lobes of the antenna.

But why are they canted, or shifted to one side, rather than forming a true figure 8, such as you commonly see in antenna articles? It's because you're feeding a balanced antenna (both dipole halves are identical) with unbalanced coax. For a correct pattern, you need to feed a balanced antenna with balanced cable. Although you can buy balanced feedline, it's a lot less expensive to make a device that will convert the unbalanced coax to a balanced feed. You do this with a *balun*.

Build a Balun

A *balun* is so-named because it converts *balanced* to *unbalanced*. Fortunately it works both ways or we would have to call the one you're about to make an "*unbal*."

Cut a 29.5-inch length of the same type of coax as you're using for the feedline (hopefully a low-loss 52-ohm cable) and strip back 1.5 inches of the insulation at each end. Then unbraid the shield strands and twist them together to form a "wire." Remove .5 inch of center insulation. Be careful not to nick the center conductor or it will probably break when you try to twist the wire in a loop. Do this at both ends. Presto! You've made a balun!

Now, reconnect the feedwire to the dipole as shown in Figure 3. This time, the measurements should produce a true figure-8 pattern, such as that shown in Figure 4.

Standing Wave Ratio

So far, I've neglected to mention antenna resonance. If you use the dimension given (38 inches), the antenna will be resonant near the low end of the 2-meter band. If you have an SWR meter available, you can find the resonant point by adjusting the frequency of your radio in half-megahertz (500 kHz) steps. It should be resonant at approximately 144.5 MHz. If you get a lower reading at 144.01, trim .5 inch off each end of the antenna and make the SWR measurements again. If you don't have an SWR meter, make all your measurements at 144.5 MHz. (And, by the way, don't forget to give your call letters at least every 10 minutes as required by the FCC. Also, remember that voice is not permitted below 144.100 MHz and that FM should not be used in the SSB area between 144.100 and 144.300 MHz.)

I should also mention that the SWR will increase as you add parasitic elements to your dipole (which we'll be doing soon). This is because the feed impedance keeps dropping, but your coax

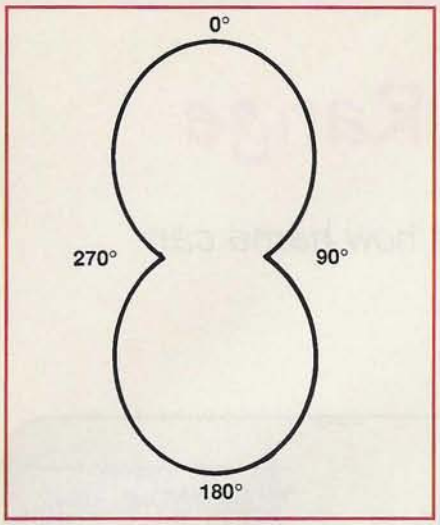


Figure 4. Here's the radiation pattern of a dipole after a balun has been added to the coaxial feedline. Note that it's symmetrical both left and right of center.

stays at 50 ohms. The SWR should not be excessive, however, and the basic principles of adding elements to make a beam won't be compromised.

Make a Beam

Start by making a trip to the hardware store or lumber yard and purchasing a 5-foot length of 2 x 2 lumber for the boom. Also buy four adjustable C-clamps that will open wide enough to attach to the boom. You'll also need some hardware to attach the boom to the rotating mast, but, again, I leave the specifics of this to your inventiveness.

First, make a *reflector element* by cutting another length of #12 gauge electrical wire. You don't need to strip the insulation from this wire. How long a length? A reflector should be 5% longer than the driven element. If you used the 38-inch length for your dipole, then you'd multiply 38 times 1.05 and get 39.9, close enough to 40 inches. Attach the C-clamp at the center of the reflector element using some epoxy.

Mount the 4 x 4 insulator that secures the antenna to the boom 18 inches from one end. This will be the rear of the beam. Make sure the antenna element is horizontal with only a slight droop at the ends. Now fire up your antenna range and point the boom at the detector. Set the meter so that it reads approximately half-scale.

Next, lightly attach the C-clamp near the end of the boom away from the detector. The clamp can lay down on the boom so that the reflector and driven element are in line. As you slide the reflector back and forth, you should see the meter peak well above half scale. The peak will probably occur approximately 15 inches behind the driven element.

Now, rotate the antenna and make measurements just as you did before. This time, you should see a distorted figure-8 pattern. The lobe pointing toward the detector should be significantly larger than the lobe pointing away from the detector (see Figure 5). In other words, you'll start to see a front-to-back ratio.

Adding Directors

Now, it's time to make a *director*. The director should be 5% shorter than the driven element, so multiply 38 times .95 and you get approximately 36 inches. Just as you did before, attach the director to a C-clamp. Position this element about 10 inches in front of the driven element (toward the detector). As you slide this element back and forth, you should see a peak occurring at 11.5 inches or so. At this point, you probably will have pinned the meter scale. If so, go back to your two-element configuration and set the meter for half scale. Make another measurement of the antenna in the three-element configuration, as you rotate it through 360 degrees. This time, you should note that the front or main lobe is narrower than before and the minor lobe (from the rear) has been reduced even further.

You may also see some tiny peaks of signal from the sides of the antenna. These are called *side lobes*. They are inherent in any beam antenna but designers try to minimize them to concentrate the signal toward the front end. The strength of the side lobes will probably increase slightly as you add directors. You may even detect a second one appearing on each side if you make measurements in small enough increments. This is hard to avoid (see Figure 6).

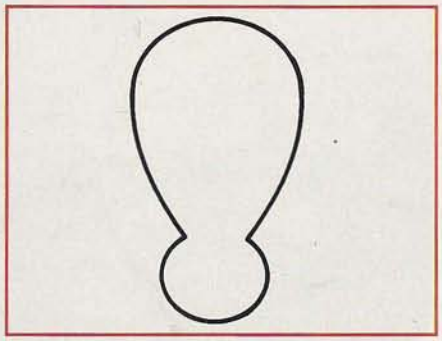


Figure 5. Adding a reflector to the dipole makes it directional, and you'll start to see a front-to-back ratio appearing in the radiation pattern. This lobe pattern is typical.

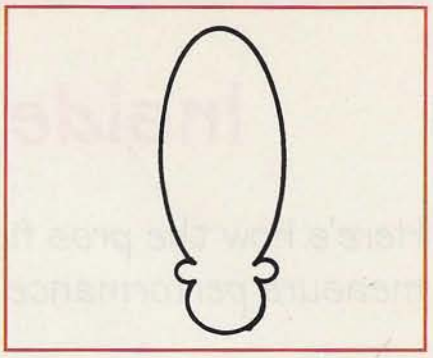


Figure 6. As you add directors to your beam, the front lobe will get longer and narrower. You may also begin to see some "side lobes." While you want them as small as possible, they're impossible to avoid altogether.

You can continue the experiments by constructing the remaining two directors. They will each be 36 inches long as well. As you add these, you'll probably notice diminishing returns. In other words, adding the second director will not produce as much increase in the meter reading as when you added the first director. Adding a third director will produce an even smaller increase. A five-element beam exhibits excellent general performance. The added gain and narrower beamwidth of additional elements often isn't worthwhile for the beginner (you can actually miss contacts if the antenna's beamwidth is too narrow).

Although the antenna you've made is a bit flimsy, it will astound you if you use it in connection with your 2-meter radio. If you point it in the correct direction, you'll be able to hear and trip repeaters that were unusable before (*If you're planning to use this antenna for FM work, be sure to mount it so it's vertically-polarized.—ed.).* If you really "get into" antennas, you can reproduce the beam just described by using aluminum tubing from a discarded TV antenna.

Moving Inside...Your Radio

I've digressed somewhat from the usual thrust of the column, that is, discussing the theory behind the questions that newcomers are asked on their FCC test. However, even if you don't make a beam antenna, the principles are fascinating and simply reading about it will increase your knowledge of ham radio. Next month, we'll discuss those weird looking components you see inside of an electronic device. Until then,

73 de Don, W6TNS

Inside an Antenna Range

Here's how the pros figure out antenna gain and how hams can measure performance of home-built arrays.

By Rich Moseson, W2VU*

Antenna gain is one of the factors that goes into determining how "good" a specific antenna is. But how do the manufacturers figure out just how much gain an antenna has? And how can you determine the gain of an antenna you've built yourself?

The answer to both questions is something called an *antenna range*. An antenna range is a location where the performance of any *test antenna* may be compared with that of a *reference antenna* of known gain.

Commercial antenna ranges must meet exacting professional standards, but we hams generally don't need that same level of precision and accuracy, and we can get very useful results from a makeshift antenna range. The key elements of any antenna range are a signal source and source antenna, a reference antenna, the correct spacing between source and test antennas, and a measuring device to compare the relative gain of the test antenna and the reference standard.

Don Stoner, W6TNS, explains in this month's "In Theory" column how to build a "poor man's antenna range" for approximate comparisons. But if you want to get more precise gain measurements, you've got to either go to the pros (easier said than done) or go to where the pros come to you—typically at one of the several weak-signal VHF conferences held around the country each year.

CQ VHF caught up with Joe Reisert, W1JR, President of New Hampshire-based Antennaco, Inc., as he set up an antenna range at a recent Eastern VHF/UHF Conference in Connecticut, and he was kind enough to explain how it all works, which we relate to you here.

W1JR's Antenna Range

The heart of the test range, said Reisert, is a $35,000 piece of test equipment

**Rich Moseson is Editor of* CQ VHF *magazine.*

Photo A. The antenna range at a recent Eastern VHF/UHF Conference. The car contained the "source" antenna, while the test antennas were held above the ladder at the opposite end of the range. (Photos by the author)

Photo B. John Rose, WW1Z, uses a homebuilt 222-MHz antenna standard (based on an NBS/EIA design) as a reference antenna to calibrate the range. Joe Reisert, W1JR, is seated at the table, adjusting the network analyzer.

Photo C. Master at work. Joe Reisert, W1JR (on right) quickly assembles a 432-MHz Yagi for Ron Klimas, WZ1V. The beam was used as the 70-centimeter reference antenna.

called a *network analyzer*, which he was able to borrow for the weekend. Joe's analyzer was a Hewlett-Packard HP-8753C. The analyzer sends a signal on a specified frequency to the *source antenna*. The transmitted signal is received by the *test antenna*, which is also connected to the network analyzer (remember, an antenna's receive gain is equal to its transmit gain).

At the conference, Joe set up the antenna range in the parking lot of the host hotel, and the source antenna was chosen from the many antennas attached to the mobile "rover" vehicle of Stan Hilinski, KA1ZE (see Photo A).

"The height of both the source and test antennas and the distance between them are critical elements," said W1JR, who explained that the minimum separation is determined by using the formula

$$\frac{2\pi D^2}{\lambda}$$

in which D is the maximum *aperture*, or signal capture area, of the antenna, and λ is the wavelength of the transmitted signal (see the *ARRL Antenna Book* for additional details).

Once the minimum distance was determined, a ladder was put in place as an an-

"...the reference antenna was John Rose, WW1Z's, homebuilt NBS/EIA Standard—a set of four dipoles mounted over a chicken-wire screen...with a known gain of 7.7 dBd (decibels over a dipole)."

Photo D. Ron Klimas, WZ1V, holds up his new 10-element 432-MHz Yagi, which became the 70-centimeter reference antenna.

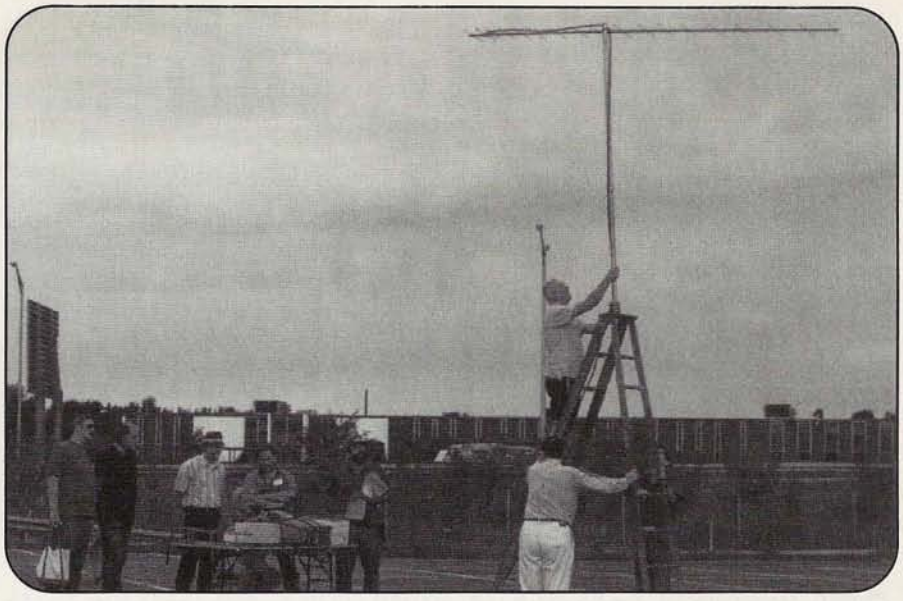


Photo E. Here Stan Hilinski, KA1ZE, tests his 18-element 432-MHz Yagi. Its gain was measured at 14.12 dBd.

tenna support, and a reference antenna of known gain was used to calibrate the system and determine the necessary height of the test antennas. In this case the reference antenna was John Rose, WW1Z's, homebuilt NBS/EIA[1] Standard—a set of four dipoles mounted over a chicken-wire screen (see Photo B), with a known gain of 7.7 dBd (decibels over a dipole)[2]. Readings from the reference antenna showed that the test antennas needed to be held four to six feet above the source antenna. Once the height was determined and everything was calibrated to the known standard, the antenna range was ready to go.

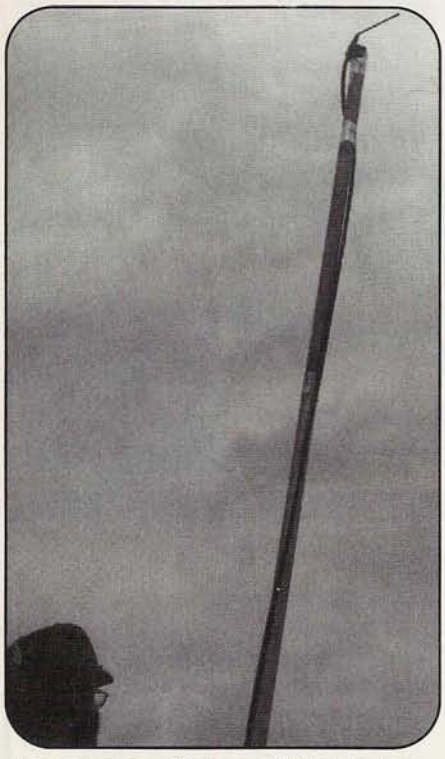


Photo F. Steve Finberg, W1GSL, tests the "gain" of a bent rubber duck antenna. It came out to -4 dBd, or 4 dB loss compared with a dipole.

The Inside Workings

As Reisert explained the setup, "the HP network analyzer is able to compare the performance of each test antenna in receiving the source signal to that of the reference antenna." This means that, on 222 MHz, all test antennas were compared with the 7.7-dBd gain figure of the reference antenna, with the results showing the difference, or *delta*, between them. So an antenna showing a delta of +1.5 dB relative to the reference antenna would have a gain figure over a dipole of 9.2 dB (7.7 + 1.5). Likewise, an antenna with a delta of -3.5 dB has an actual gain figure of 4.2 dBd (7.7 – 3.5).

When There's No Standard

After all 222-MHz antennas had been tested, several hams asked for gain readings on their 70-centimeter antennas. There was no NBS standard antenna available for the band, so a new antenna, made by Joe's company and purchased that morning by Ron Klimas, WZ1V, was put to use. After Joe assembled it (in less than five minutes, see Photo C), he tested the antenna and found that its measured gain matched the gain claimed in the specifications (11 dBd), so it was used as a 70-centimeter standard (see Photo D).

Several 432-MHz antennas were then tested, including WZ1V's old 28-element Yagi (measured at 15.3 dBd), KA1ZE's 18-element beam (with a "delta" of 3.12 dB, for a gain figure of 14.12 dBd, see Photo E), and W1VT's homebrew 6-element Yagi, which measured 8.5 dBd total gain, with a delta of -2.5 dB compared with the reference antenna. Finally, just for fun, W1GSL stuck a bent rubber duck on top of a pole and measured its gain...or rather, loss (see Photo F). It came in with a delta of -15 dB compared with the 11 dBd reference antenna, giving it a total "gain" figure of -4 dBd, or 4 dB *less* than a dipole.

So if you ever wondered just how inefficient rubber ducks are, you've got your answer—thanks to an antenna range. ■

Notes:

1. NBS is the National Bureau of Standards, now the National Institute of Standards and Technology (NIST), and EIA is the Electronics Industry Association.

2. A note on decibels and gain figures: Antenna gain is measured in decibels (dB) over either an *isotropic* antenna (dBi), which is a theoretical antenna that radiates equally in all directions, or a real-life *dipole* antenna (dBd). Since a dipole has 3 dB gain over an isotropic antenna, dBd figures are generally 3 dB lower than dBi figures (5 dBi = 2 dBd). Don't confuse the two.

More on Eye Diagrams...Plus a Test Transmitter You Can Build

An oscilloscope and a low-power test transmitter (plans included) are the basic tools you need to get the most out of your high-speed data radio.

Wouldn't it be great if you could just look at your modem's signal and know whether it's good enough to meet your needs? Well, if you have an oscilloscope, you can. This month, we'll continue last month's higher-speed data topic by taking a closer look (no pun intended) at *eye diagrams*. I'll also show you how this applies to the popular G3RUH modem, and then I'll provide the details for constructing a simple but effective test transmitter.

Shaping Data Signals

If you were to look at the data your TNC is sending to the modem, you'd see a stream of logic 1s and 0s, like a square wave with a few teeth missing. These nice, clean square waves are easy to work with (and to draw!), but have a very wide bandwidth because of the sharp rise and fall from one voltage to the other. To ease the task of transmitting the data, we use a modem (MOdulator/DEModulator) to shape these bits, reducing the signals' bandwidth. Some data bits and a typical modem's low-bandwidth translation are shown in Figure 1.

The eye diagram is a powerful technique for seeing how "good" the shaped signal is. Once the data is shaped, transmitted, and received, we can look at this received data as it appears at the input to the receiving modem's *decision circuit*. The decision circuit is where the receive modem decides whether a given bit is a logic 1 or a logic 0. Obviously, any errors that occur at this point mean that data has been corrupted.

To generate an eye diagram, we set the oscilloscope to display all the received bits, overlaid upon each other. This lets us see the trend of the data, instead of each individual bit. The data decision is made at a certain point in time, the *decision point*, which is determined by the rising edge of the receive data clock signal recovered from the incoming data. So, if we trigger the oscilloscope to start each sweep at the same time, relative to the receive clock, all of the decision points will pile up on each other.

When everything is right, these bits all follow similar paths, and converge at the decision point, near either the 1 or 0 voltage level. It is at exactly these points in time that the modem decides whether the received signal represents a 0 or a 1. If all the bits converge into very small areas

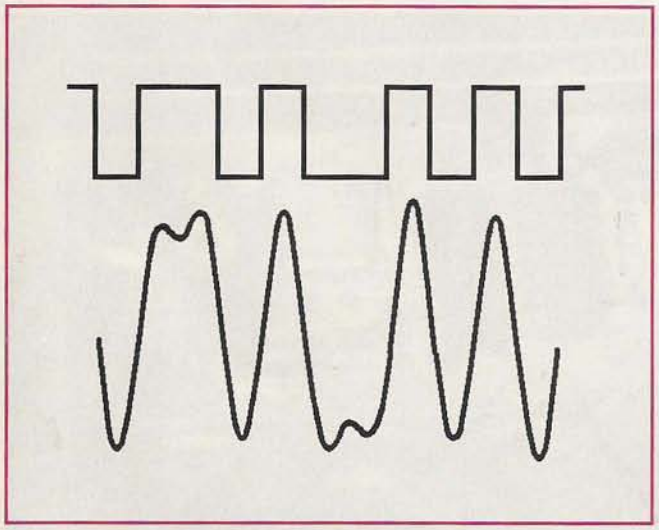


Figure 1. The original data signal (top) and the same signal after the modem optimized it for transmission.

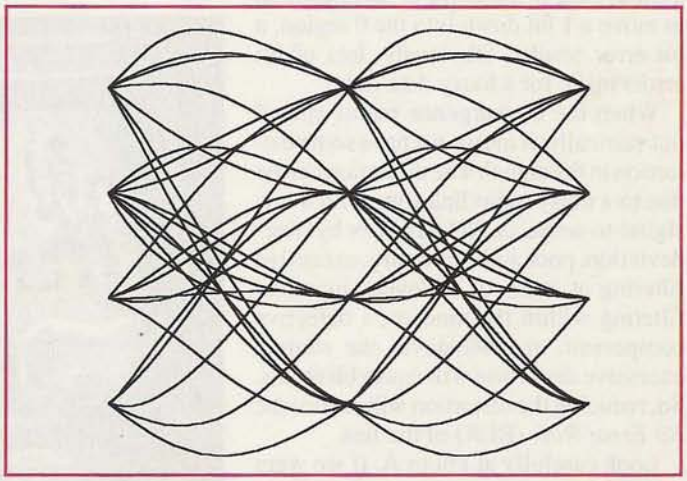


Figure 2. An eye pattern for a 2-bit (4-level) system. Each time the signal is sampled, it has one of four possible levels, and thus passes two bits of information for each sample time. As with a 1-bit eye, the convergence points should be as small as possible.

By Don Rotolo, N2IRZ

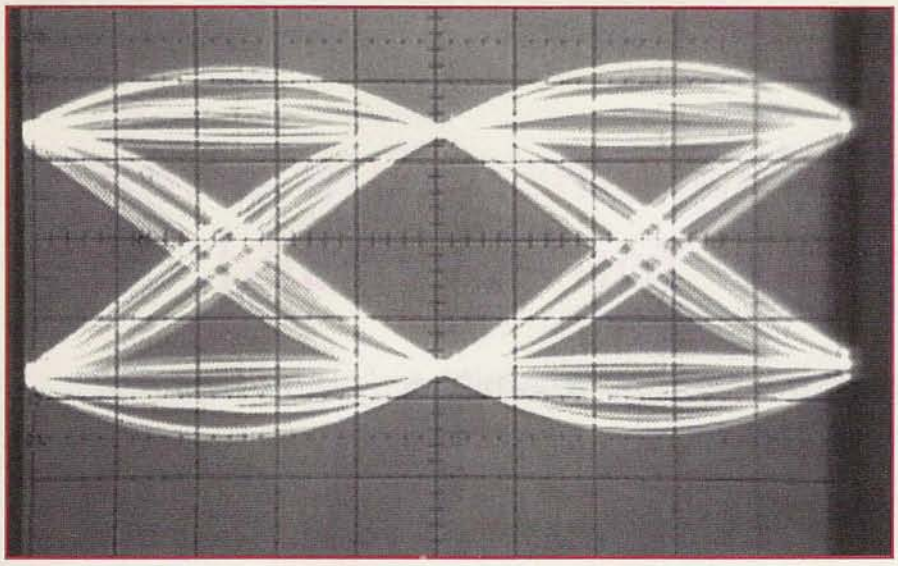


Photo A. A nearly ideal "eye" pattern. The center of the waveform pattern looks like an eye, hence the name. Note how closely the data waveforms bunch together in the center—these are the convergence points, the optimum point in time to decide whether a bit is a "1" or a "0."

(for the 1s and 0s), the modem has an easier time of deciding, and you have very few bit errors.

A good eye pattern for a system which has only two bit levels, namely 1 and 2, is shown in Photo A. The idea is to keep all the 1s together, all the 0s together, and each far from the other.

Noise and Distortion

If the voltage levels at the convergence points are not consistent, the modem has a harder time of deciding whether a certain bit is a 1 or a 0. Random noise tends to move the voltage levels up and down a little, and, if the noise is great enough to move a 1 bit down into the 0 region, a bit error results. Obviously, lots of bit errors make for a lousy data link.

When the convergence points spread out vertically, it means we have some distortion in the signal. The distortion can be due to a noisy radio link (one with a low signal-to-noise, or S/N, ratio), or by overdeviation, poor audio circuitry, excessive filtering at audio or IF levels, incorrect filtering within the modem, a defective component, etc. Whatever the source, excessive distortion will cause bit errors. So, reducing the distortion will reduce the *Bit Error Rate* (BER) of the link.

Look carefully at Photo A. If we were to sample the signal at the wrong point in time, such as at the edge of the eye, we would also encounter an excessive BER. Determining the optimal decision point is the job of the *Receive Clock recovery circuit*. The recovery circuit takes the received data signal, processes it, and extracts the timing signal hidden within it, creating the RX Clock signal.

If the received signal has too much jitter in it (perhaps from multipath distortion), or the recovery circuit is less than ideal, we introduce another source of bit errors, namely sampling the received signal at some less-than-ideal point in time. Clearly, the smaller the convergence points at the decision point, both horizontally and vertically, the better the system BER and performance.

By the way, eye diagrams are not used only in 1-bit systems—a typical eye pattern for a 2-bit system (4PSK) system is shown in Figure 2. In such a system, each time the waveform is sampled, you decide which of four levels it is, and thus get two bits of information with each sample. Again, note how the data tends to clump at the convergence points. In such a system, noise effects and RX clock errors are much more damaging to data integrity.

So, to view the eye pattern for any particular modem, we need to look at the received signal waveform where it enters the decision circuit (after receive filtering) and to trigger the oscilloscope sweep with the recovered RX clock. In a G3RUH modem, there are easily accessible test points for these signals: TP4 and TP8, respectively. In the popular 1200-baud TCM-3105 modem, these signals are not accessible outside the chip, so it isn't practical to view the eye pattern.

One common use for an eye pattern is to adjust transmit deviation. While looking at the eye pattern at the receive side, adjust the audio output level from the transmitting modem for the best eye pattern. This method is actually preferable to just setting the deviation to some fixed value, such as 3 kHz. If the receiver and transmitter are separated by any appreciable distance, you need someone at each site. While the adjustment can be coordinated by voice, here is an ideal use for an ATV link—you can watch the oscilloscope screen from miles away, and you can even do it alone. In the G3RUH modem, a perfect test signal can be generated by simply keying the PTT line; the modem is always sending "scrambled" data, even with no input data, and this is

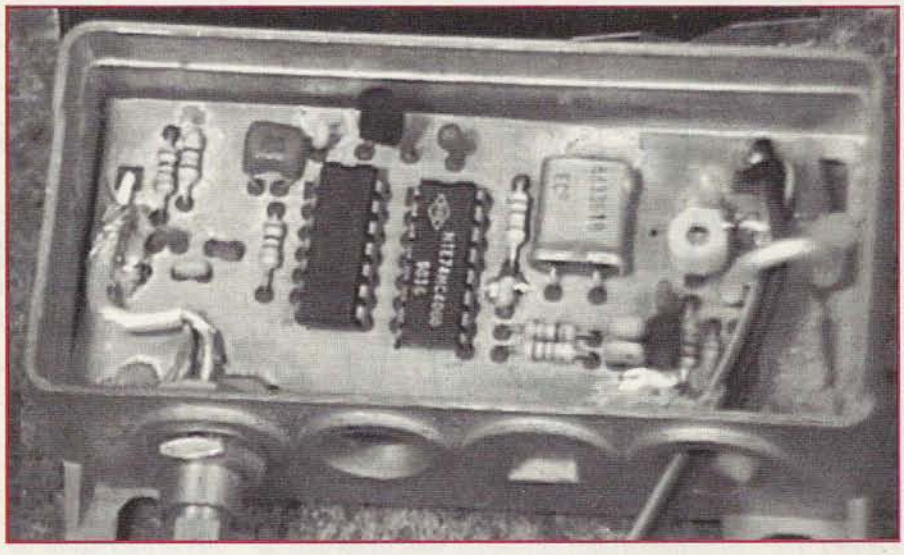


Photo B. A prototype of the Test Transmitter, mounted in a shielded metal housing. See the text for construction details.

sufficiently random to generate a good eye pattern.

G3RUH Data Rates

One nifty feature of the G3RUH modem is that it can be used for many different baud rates. The only modifications required for a different modem speed are changing the values of a few components used in the receive filter, the transmit (anti-alias) filter, the DCD detector and the RX Clock recovery circuit (10 capacitors and a resistor). I covered this topic last month, including the new component values, so look there for details. Remember that some manufacturers don't list all of the parts you need to change. The important point here is that it takes a only dollar's worth of parts to play with different data rates.

So, if you ever wondered if the radio you have will work well at a certain speed, it isn't expensive to try it out, and using an eye diagram, you can tell instantly how good—or bad—it is.

The Test Transmitter Project

As I mentioned last month, it's rare that the transmitter can't handle higher data rates, such as 9600 or 19200 baud, so we have to concentrate on the receiver.

If you're a regular reader, you know what I think of those great little UHF TEKK radios. Their main advantage is price—about $120 each—but they have only 2 or 5 watts output power (depending upon model). Another alternative is the older commercial gear made by Motorola, GE, and the like. Since it's old, it's cheap. Commercial equipment is also rugged, well-built, and usually has 25 to 100 watts output power, which is sometimes too much power.

Sticking with Crystals

One thing I've noticed is that, unless specifically designed for data service, PLL-based synthesized radios tend to perform poorly at 9600 and above. The problem is that the PLL tracks the very low frequency (under 10 Hz) component of the data signal, essentially filtering it out. For this reason, it's best to stick with crystal-controlled radios for 9600 and above, unless you have the big bucks for the latest and greatest.

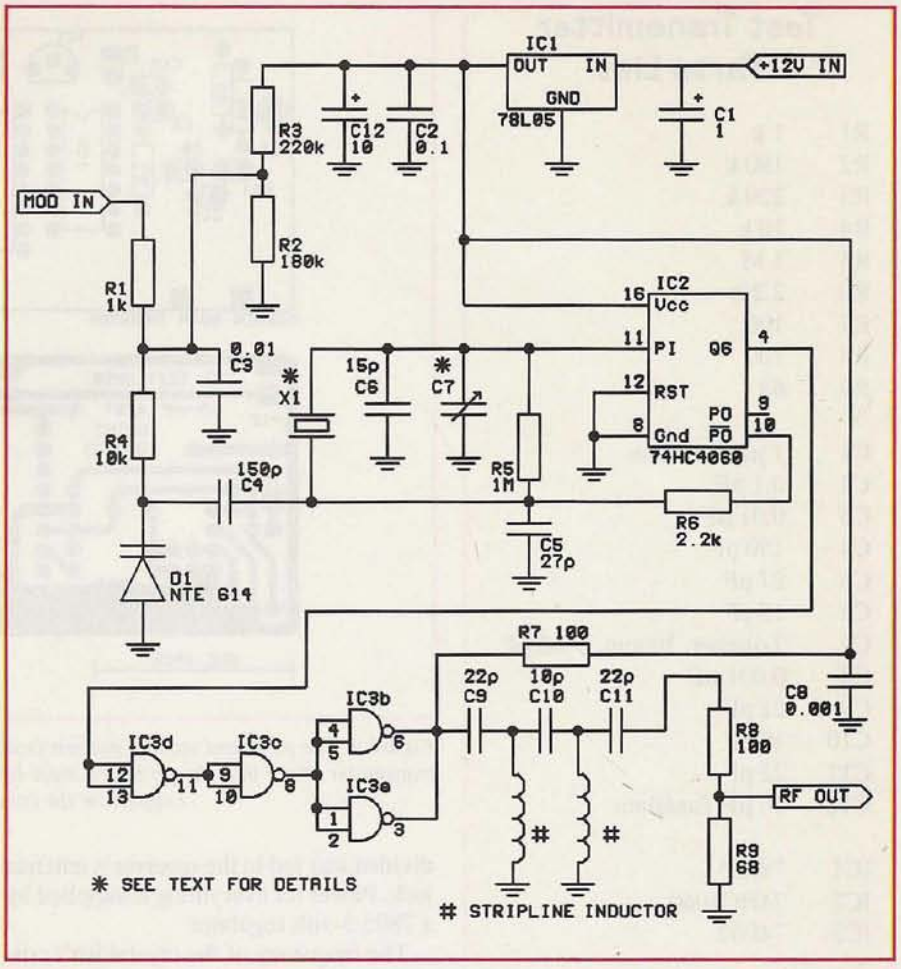


Figure 3. Schematic for the test transmitter. See text for construction and component details.

So, assuming you've got yourself a rock-bound radio as a potential victim, just how do you generate a decent signal you can use to check and align the receiver? Easy...you build one (see Photo B).

The DF9IC Transmitter

The following circuit (see Figure 3), developed by Henning Rech, N1EOW/DF9IC, was published in *ADACOM* magazine* and gleefully stolen by me for this article (with permission, of course). It's basically a simple marker generator, producing harmonic spurs out into the 23-centimeter band, which (unlike a typical marker generator) can be modulated with a data signal.

Using this circuit, you can generate a low-level RF test signal, modulated however you like at bandwidths from DC to over 10 kHz. Using a trimmer capacitor, you can then "pull" the crystal so it generates a signal on the exact frequency you desire. It's small, simple, easy to build, and deserves to be on any test bench. Lastly, it makes a fine marker generator!

Inside the Circuit

Here's how it works: The modulating signal causes the voltage-variable capacitor (D1, see "Parts List") to "pull" the frequency of the crystal with a modulating voltage, generating a true FM signal. A trimmer capacitor allows you to pull the crystal a little more, so one of the harmonics lies on your receive frequency. The relatively few components between the input signal and the crystal allow faithful reproduction of the modulation signal, even at wider bandwidths.

The signal at the crystal frequency enters IC2, a divider, and is divided down

*Rech, Henning DF9IC, "Einfacher FSK-Testsender" (Simple FSK Test Transmitter), *ADACOM* Magazin (*ADACOM* e.V., Faehrstrasse 28, D-53773 Hennef, Germany), Issue #4, pp 26–29, 1992. Published in German. Used by permission.

Test Transmitter Parts List

R1	1 k
R2	180 k
R3	220 k
R4	10 k
R5	1 M
R6	2.2 k
R7	100
R8	100
R9	68
C1	1 µF Tantalum
C2	0.1 µF
C3	0.01 µF
C4	150 pF
C5	27 pF
C6	15 pF
C7	Trimmer, 10 mm, 5–65 pF
C8	0.001 µF
C9	22 pF
C10	10 pF
C11	22 pF
C12	10 µF Tantalum
IC1	78L05
IC2	74HC4060
IC3	74F00
X1	4.33 MHz (approx., see text)
D1	NTE 614, BB909, or similar

Misc.: Printed Circuit board (self-made—see template); connectors for modulation and DC power inputs, and RF output, as desired; shielded (metal) housing (optional).

Component listing for the test transmitter. All resistors are 1/4 watt, 5% or better. Capacitors are either ceramic disk or monolithic, whatever is available, except as noted. See text for additional details.

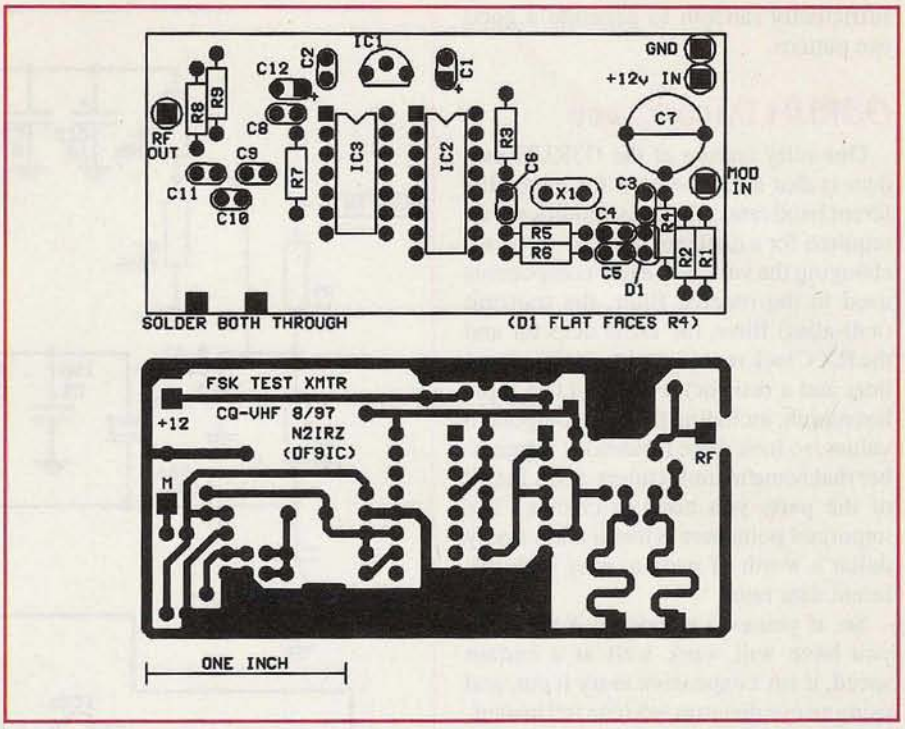


Figure 4. The pc board etching pattern (solder side) and component placement for the test transmitter. Note that the pc board must be double-sided, with a ground plane (unetched copper) on the component side. See text.

in frequency by 64, to the kilohertz range. This signal is then run through IC1, an F-series (Fast) NAND gate, which gives the signal extremely fast rise and fall times. These fast rise and fall times generate the broadband harmonics—just the opposite of what we want from a modem. After filtering out the fundamental and the lesser harmonics into the low Megahertz range with a stripline filter (to reduce IF overload), the output voltage is divided and fed to the receiver's antenna jack. Power for everything is supplied by a 7805 5-volt regulator.

The frequency of the crystal isn't critical. I used a 4.433-MHz crystal, since I had one handy, but you can use anything in that range. But don't stretch the range too far. Using too *low* a frequency for the crystal will result in signals being too close together, and not enough signal at higher frequencies. And if you use too *high* a frequency, your trimmer capacitor won't be able to pull the crystal far enough to reach certain frequencies.

In fact, I first tried using a 6.5-MHz crystal and a 33-pF trimmer (101 kHz between harmonics). I could move the frequency only about 30 kHz in each direction, leaving a 40-kHz gap between harmonics that I couldn't reach. What made it worse was a weak spur every 50 kHz, just enough to break the squelch, but very noisy and distorted. Until I tried a 1-kHz modulating tone with my mobile 440 rig, I couldn't figure out why the signal was so bad. It was only then that I found that the tuning range was insufficient.

Construction Notes

IC1, the NAND gate, really needs to be a 74F00 type or the circuit won't generate enough harmonics to work properly. Also, I admit that the connection of two gate outputs in parallel isn't really the best design practice, but we're not building a moon rocket here. Note that the circuit *must* be built on double-sided pc board. Without a ground plane on the component side, nothing will work right. Standard 1/16" glass-epoxy material should be fine.

Figure 4 contains the solder-side etching pattern and component placement guide for the test transmitter. I didn't provide the etching pattern for the component side, since it's essentially all copper, with clearance holes around the ungrounded component leads. There's a simple trick you can use to make the clearance holes: Etch only the solder side, leaving all the copper on the component side intact. After etching and drilling, provide clearance for all non-grounded component leads by drilling into the component side with a 1/8" drill, going only as deep as necessary to cut the top copper layer. The result is a neat round area where the copper is removed, with the 1/8" drill guided by the pre-drilled component holes.

Note that the two inductors for the output filter are made of stripline, those two squiggly lines on the pc board. The far ends of these stripline inductors (closest

to the pc board's edge) need to be grounded, so be sure to solder a small wire *through* the holes, connecting both sides of the board together. When building the project, use standard UHF construction techniques: keep all leads as short as possible, try to solder all grounds to both sides of the board, and don't use sockets for the ICs.

I've selected the components for easy availability in North America. Certain components, such as the voltage-variable capacitor, also called a varicap or tuning diode, can be substituted if required (use something with a nominal capacitance in the 35- to 40-pF range, such as a BB909). Everything else should be readily available throughout the world.

Although it's desirable to put the whole circuit inside a case (a simple tinplate box will do), it isn't absolutely necessary. I mounted mine inside a small cast-aluminum box I had in the junkbox, using existing holes for DC power, modulation input, and RF output. I punched a small hole in the tin cover for access to the trimmer capacitor for easy tuning. One point to remember: don't put it inside the box until you're sure it's working. I made that mistake and had to pull it out again when I found I'd installed the tuning diode backwards. Live and learn.

Using the Test Transmitter

To use the test transmitter, connect the modulation input from the modem. In a G3RUH modem, this can be found on one side of JP6, the audio loopback jumper. I didn't have much luck with the TX Audio output from the modem, though, in principle, it should also work. For lower frequencies, it may be necessary or desirable to attenuate the signal a bit, ideally with a variable attenuator. A direct connection didn't hurt my 2-meter mobile radio, but the signal was much more than the S-meter could read, and IF overload from a strong signal might cause some measurement errors.

Initial Adjustments

Adjust the output frequency to the desired receive frequency by turning the variable capacitor. Watch the receiver's output signal with an oscilloscope and adjust for a symmetrical waveform, but be wary of those between-harmonic spurs I got fooled by—repeat the tuning process a few times to be sure.

Now adjust the deviation of the signal to a reasonable value with the modem's output potentiometer. For deviation, you can either adjust it for a good-looking eye pattern, or take a more precise approach by measuring the crystal frequency at pin 9 of IC2 with no modulation input. Then, supply a known DC voltage to the modulation input and measure the change in the crystal's frequency. Divide the change by the crystal's (unmodulated) frequency in MHz, then multiply by the receive frequency (also in MHz)—the result is the deviation.

For example, 1 volt DC caused a 40-Hz change in a 5-MHz crystal. At 440.5 MHz, the deviation from a 1-volt peak-to-peak modulating signal would have a deviation of

$$\left(\frac{40}{5}\right) \times 440.5 = 3524 \text{ Hz } (3.524 \text{ kHz})$$

Practical Uses

Using the eye pattern, you can tweak your existing 9k6 or faster links to optimum performance. You can also spot, in an instant, whether the radios you're using are really up to the task. The G3RUH is the easiest modem to work with, since it was designed with eye patterns in mind, but the technique is valid for most other modems. If you don't have a good FM signal generator for aligning your data receivers, you can build this simple one for a few dollars. I urge you to try it.

Next Month: Crystal Ball Time

Well, once again, I've run out of space for the month. Next month, we'll take a look at where we are, and we'll make some guesses at to were we should be going in terms of Amateur Radio and Digital Communications. Hope to hear from you in the meantime. Until then, 73, N2IRZ

Introducing Digital Television—Part 1

The future is digital for broadcast television...but what about ham TV? This month, KB9FO explains how DTV works, and, in Part 2, how it can work for hams.

You may have noticed that there's a lot of talk about digital TV (DTV), high definition TV (HDTV), and advanced TV. There's probably as much confusion over these terms as there is about the properties of coax and VSWR (another endless debate).

Will digital TV make its way into ham TV? Absolutely. In fact, some hams say it's already time to switch. But I suggest we look before we leap.

To understand the future of ham digital TV, we have to understand just what is *meant* by digital TV. It's more than simply converting an analog signal into a digital stream, as is done with music to make a CD from a tape master that was previously used to make LP records. There are several "digital" forms, ranging from simple data streams to complex mathematical recreations and representations. Furthermore, "digital" in the production area refers to something completely different than it does in the transmission area, and is different still within computerized digital imaging you may have at home now in the form of video games, WEB TV, or even "CU-SeeMe" software and "QuickTime" movies.

The Question of Quality

There's also a huge difference in "quality" between various digital systems. People who say that ham TV should go digital, and that "chips are available now," are promoting a very low resolution video signal that requires home-based computers and a frame and line rate similar to the first pictures from space 30 years ago (about four frames per second or less, with a resolution of 120 lines and 200 or fewer pixels per line). Those of you who saw the Fisher-Price toy video camera a couple of years ago, or who use "CU-SeeMe" on the Internet for video phone, have an idea of what this looks like. Yes, it is a picture, and, yes, you can see movement. But it's of poor quality, jerky, and certainly not suitable for mobile, portable, R/C (radio control), or other applications. It does, however, send a video picture over "voice grade" telephone circuits.

The HDTV touted as the next best thing to 35-mm film is not likely to be seen for decades, except in certain exclusive venues. The 16:9 aspect ratio of the HDTV format is more likely to be seen very soon, provided you can afford $5,000 for a TV set. But it won't have the high definition pictures shown at the CES (Consumer Electronics Show) or the NAB (National Association of Broadcasters) conventions. Here's why:

The broadcasters want to provide a digitally transmitted signal in order to overcome some of the inherent problems associated with analog signals, mainly the slow degradation of the signal-to-noise ratio with distance, commonly known as snow. Any digital delivery system will provide "snow free" pictures. But there are also two major drawbacks to digital video transmission.

First, it takes a lot of electronics processing to convert a traditional analog TV signal to a digitally encoded signal and then to reduce the bandwidth to fit it in the same spectrum as the original analog signal. Why? Because it takes eight to 16 times more data in digital form to send

By Henry Ruh, KB9FO

Don't Throw Away Your Analog TV Set

Givens

Fact: The government says all broadcasters need to switch entirely to digital transmissions by the year 2006, at which time the current analog (NTSC) TV channels are to be handed back to the FCC for a monster-moneymaking auction.

Fact: According to an article in the May 5 issue of *Broadcasting* magazine, Congress and the White House agree that auctions of the analog TV channels will generate $5.4 billion in revenue for the government. The federal budget anticipates raising $24.3 billion overall from spectrum auctions, including $5.4 billion from analog TV spectrum, $15.7 billion for PCS licenses (made up from broadcasters' news gathering channels at 2 GHz), $2.5 billion from auction of TV channels 60 through 69, and $700 million for 888 toll-free phone numbers.

Fact: A manufacturer (AI Tech) has just announced that it will sell set-top NTSC-DTV converters for $500 each, allowing viewers to receive DTV signals on their current televisions, and perhaps delay the need to invest several thousand dollars in a new DTV set. (Contact: AI Tech, 47971 Fremont Blvd., Fremont, CA 94538; e-mail: <info@aitech.com>.)

Question Marks

Question #1: If only half of the public has put up $2,000 to $5,000 for new DTV receivers or converters (converters for four TV sets at $500 each = $2,000; two large-screen (over 19") DTV TV sets at $2,500 each = $5,000 — after all, how many TV sets are in YOUR home?) will Congress tell the other half of the population they can no longer watch TV?

Question #2: Can the five tower crews in the country who know how to build the tall TV towers needed to hold the 1,400 new TV station antennas build 1,100 towers in five years, considering it takes 14 months to erect a 2,000-foot tower and six months to erect a 1,000-foot tower?

Question #3 (from W2VU): If spectrum auctions continue to generate a few million dollars for the government (as did the most recent one), instead of the billions envisioned by budget writers, how long will the auctions continue?

the same information that was in analog form. In a common form, known as CCIR-601 (nomenclature for a digitized TV signal used to pass the information around inside a TV station or over short distances), the data rate is 57 Megabytes/second, which requires a bandwidth of 19 MHz. Compare that to the 4.2-MHz bandwidth of analog video.

Second, in any digital system there is a *cliff effect*. Because the errors introduced by noise and distance are concealed, there is no easy measurement to determine when the signal will contain so many errors that the correction system can no longer reconstruct a picture. At that point, unlike an analog picture that starts to fade, the digital picture simply disappears. It's like turning the picture on and off. Now you see it, now you don't.

Digital Compression

The size and bandwidth of the data stream are reduced through a type of processing called *compression*. The most common formats are called JPEG (for Joint Picture Experts Group) and MPEG (Motion Picture Experts Group). The data stream is reduced by using complicated math called algorithms to remove data which is redundant from line to line and field to field. What remains is a "skeleton" of the original picture. This is further reduced by not sending every frame and line, but by sending only key frames, such as 1 in 7 or 1 in 11, along with information about where certain items should be if the motion is predictable. .

In simple terms, the system converts a continuous data stream of consecutive picture frames into a "comic strip" where the picture is presented at "slices" in time, and the stuff between the frames is filled in by the computer "guessing" what happened in between. It's like sending the image of the pitcher about to throw the ball, and then a picture of the catcher beginning to stand up as the batter is seen at the end of his swing, and filling in the details between the two pictures...the ball traveled 66 feet, was hit by the bat and is now somewhere in the playing field. A few clues are sent along so that the reconstructed information is not completely wrong, but there are motions which cannot be represented accurately.

Continuing with the sports examples, say we were following the action of a race horse. The digital "compression," or rate reduction, causes the "unimportant" parts to blur out, or freeze, to "catch up" later when the amount of motion decreases. This causes the horses' legs and feet to disappear, or the background fence to smear, or portions of the picture to be displaced then suddenly shift into position. Perhaps you've seen the hand-held game in which you move 15 letters or puzzle pieces around 16 spaces to form words or a picture. Each tile has a proper place, but only when you get the tiles in the right order do you get the correct picture.

Out of the Studio

Sending compressed video images around a TV station or other small area is one thing. But sending digitized video out on the air is a whole different ball game. There are over a dozen schemes to achieve this level of data reduction to convert from short in-house signal paths to a delivery/transmission system path. None is cheap. If you have a computer that captures video, using a video capture board, such as a Truevision Targa or a Video Toaster, you can see this type of data stream generation, from analog to a compressed digital signal. Depending on the compression ratio, the system works and looks acceptable, the trade being storage space versus resolution. This can range from acceptable to downright crude.

"[Compression] causes the horses' legs and feet to disappear, or the background fence to smear, or portions of the picture to be displaced then suddenly shift into position."

The FCC's chosen transmission method for digital TV employs eight vestigial sideband signals, stacked one above the other, in spectrum, with a low-level pilot carrier. The signal must be amplified with great fidelity (linearity), as any degradation in the data signal can make it

"...the FCC says broadcasters must convert to digital transmission by 2006, but it has made no mandate for cable, satellite, or Direct Broadcast satellite systems to go digital!"

unwatchable. The system uses various error correction systems to maintain receivability of the signal until the BER (bit error rate) "cliff" is reached and, suddenly, there is no picture.

The systems proposed by the broadcasters were based on HDTV concepts using a 50 to 100% or greater increase in scan lines (vertical resolution), and a significant increase in the number of pixels per line (horizontal resolution). The computer industry, on the other hand, pushed for "compatibility" with its phone-line-base "Web" video, and delivered a signal which relies on sequential scan (versus alternating, or interlaced, scanning on broadcast TV) and completely different color construction. Not wanting to pick one format over another, the FCC made almost no specification for what the content or format of the DTV signal should be. As a result, today there are 18 scan systems that meet the FCC DTV definition. But none is compatible with the others, since each requires a different decoding scheme.

The least expensive of the lot is the 480-line SDTV (Sequential Scan Digital TV) system, which is equivalent to 525-line NTSC, the current analog standard. By using a switchable CCD device, either 3:4 aspect-ratio NTSC video or 16:9 aspect-ratio SDTV video can be generated at the camera.

Confused? So are we! Even the major networks can't agree on which system they will use. ABC likes 1080 I (interlace) and 720 P (progressive scan); CBS likes 720/1280, 24 fields per second (film speed); and NBC likes 1080 I and 480 P! With all this, that old standby—35-mm film—looks pretty good as a production/distribution standard!

Where's the Improvement?

The FCC has said that broadcasters must deliver an NTSC *equivalent resolution* signal on DTV. Remember, this is not *better* than current analog, only *equal*.

The cheapest and easiest method is to simply convert the current NTSC signal from interlace to sequential scanning, and to add a few pixels to compensate for the different width of 16:9 versus 3:4 aspect ratio! This is the signal already chosen by one network. Hardly a giant step in picture improvement!

Meanwhile, the FCC says broadcasters must convert to digital transmission by 2006, but it has made no mandate for cable, satellite, or Direct Broadcast satellite systems to go digital! So your current NTSC TV set will continue to receive those signals just fine. But in order to receive the DTV broadcast signals, you'll have to buy a DTV set. The manufacturers have already announced that, starting in 1998, they'll introduce top-of-the-line units which will receive only four of the 18 systems. These will run about $5,000 list, but smaller, less expensive, sets may be added later.

Meanwhile, there are the problems of finding transmitters and antenna sites, of zoning restrictions, of environmental protection groups that don't like towers or RF, and there's almost no equipment to generate DTV signals! The considerations involved in each TV market to build a new DTV transmitter plant are enormous, not to mention expensive!

The most optimistic projections say that 48 million households will spend $33 billion for DTV service, via DBS, cable, digital video disc, or DTV broadcast. The pessimists say fewer than 1% of households will spend less than $100 million by the year 2001. But both groups seem to think that 30 to 40% of U.S. households will have some form of DTV by 2006, when broadcasters are supposed to turn off their NTSC transmitters and give back 2,000 6-MHz TV channel allocations to be sold at auction by the FCC to pay the government's expenses.

Other Systems

As for VDT (Video Dial Tone), the phone company says it can provide a VHS-comparable signal on your existing twisted pair, for one—and if you're not too far from the central office, for two—channels of on-demand video. Compare this to 100-plus channels for coax cable, 500-plus for satellite and millions via fiber optic cable.

Meanwhile, in the United Kingdom, a pay-TV service called "BSkyB" has ordered one million set-top converters for its digital service, and NewsCorp (Rupert Murdoch, Fox TV, etc.) is waiting for the launch of the Pan AM Sat 6 satellite to add 36 Ku-band (a satellite video band) transponders for digital TV service to Latin America and Brazil.

A Rising Tide

The digital video wave is here, and, over the next few years, we can have fun watching how it develops at the various beach fronts.

How can hams use DTV? Well, now that we have a basic understanding of what it's all about and have looked at where commercial digital TV is now, we have the background we'll need for the next column (in October), when we'll look at digital TV for hams. 73,

Henry, KB9FO

Q & A — Questions and Answers About Ham Radio Above 50 MHz

Q: What all is involved with weak-signal propagation? I know what it is, but what equipment is needed to enjoy this part of amateur radio? Obviously, a 5-watt HT with a rubber duck antenna doesn't qualify. What would one need to do DXing on 6 and 2 meters?

Austin Kyser, KB9PCW
Apleton, Wisconsin

A: At the risk of sounding self-serving, you'll find the answers to many of your questions right here in CQ VHF. *Weak-signal communications applies generally to any non-FM voice or CW operation on VHF/UHF. The name comes from the ability of most stations to* receive *weak signals, since many of the top "weak-signal" operators use the maximum legal power focused into highly directional antennas. In Europe, what we call weak-signal work is known as VHF DXing, which is probably much more appropriate.*

Weak-signal modes include various forms of tropospheric enhancement (tropo scatter, ducting, etc.), sporadic-E, aurora and meteor scatter, as well as EME (moonbounce) and such exotic types of propagation as transequatorial, field aligned irregularities (FAI), and ionoscatter. Learning about all these propagation modes and how to take advantage of them for VHF DXing is part of the fun of weak-signal operation.

You'll find information about these modes and how to work them in various issues of CQ VHF, *as well as in* The VHF How-To Book *(CQ), the* "Getting Started in VHF" *video (CQ),* The ARRL Operating Manual *(ARRL), and* The VHF/UHF DX Book *(Radio Society of Great Britain, available through CQ).*

Q: I have a problem that would be easier to solve at HF than at VHF. I'm using a Create Logperiodic 5130-1. It works well as long as it's horizontal. When I moved it to vertical, things changed. First, my SWR went higher in the middle of 6 meters. Not too high—2.0:1—but not real great, either. It seemed fine on 2 meters and 440.

I started trying to solve the problem by replacing the mast with PVC with a wood center. That helped somewhat, bringing my match at 52.525 down to 1.7:1. But the match isn't what's really bothering me. The fact that I seem to have *no* pattern at 6 meters is the real problem.

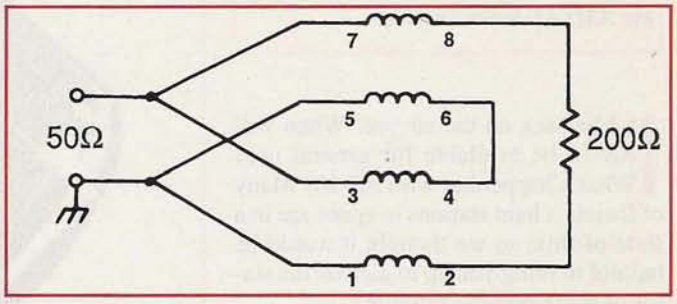
Here's my theory: I can't pull my feedline (9913 coax) away at a right angle for much distance, and I think it is coupling. I think a balun might be the answer, but how do I make one for 6 meters through 1300 MHz? If that's too broad a range, is 6 meters through 440 possible? Also, is there something I'm overlooking? Is there any way to shield the feedline to keep it from coupling with the antenna?

Jim Whitaker, N8XYN
Blanchester, Ohio

A: Well, Jim, I'm sure I'll get at least part of this wrong and we'll hear from our antenna experts among the readers with more precise and accurate information. First of all, have you contacted the manufacturer to see what they might suggest? Second, you don't mention the length of your feedline, which leads me to wonder whether it's some critical fraction of a wavelength (or critical length over a wavelength) at 6 meters, but not at 2 meters or 70 centimeters since this seems to be exclusively a 6-meter problem.

As for baluns, we checked a couple of sources and came up with some indirect conclusions. As a starting point, the ARRL Antenna Book *says that impedance-matching theory is the same above 50 MHz as below, and baluns tend to be inherently broadbanded (although there's clearly a big difference between "broadbanded" applied to a range of 27 MHz (3 to 30 MHz) versus "broadbanded" applied to a range of 1.2 GHz (50 to 1300 MHz). Next, we took a look at* Building Baluns and Ununs, *by Jerry Sevick, W2FMI, and looked under 4:1 baluns (since most log periodic antennas have a 200-ohm impedance). He describes a Guanella, or "current" balun, in which transmission line is coiled around a metal core, as follows:*

It uses two coiled transmission lines (on separate cores) connected in parallel on the 50-ohm side and in series on the 200-ohm side....In order to have "flat" transmission lines and obtain the highest frequency response, the characteristic impedance of the coiled transmission lines should be equal to the loads they see—namely, $^1/2R_L$ and, in this case, 100 ohms. As Guanella said...this balun is literally "frequency independent."



The above diagram shows what Sevick described. Again, there are probably readers out there with far greater specific knowledge of this topic, so stay tuned for further input.

Q: At a recent hamfest I bought some coax cable that I was told was a flexible version of 9913. I have not been able to find any specs on it. The labeling on the cable is "INTERNATIONAL ELECTRONICS W&C 9096-2A." Do you know anything about the specs of this cable or were I could find them?

Bill Michael, N3TZD
Essex, Maryland

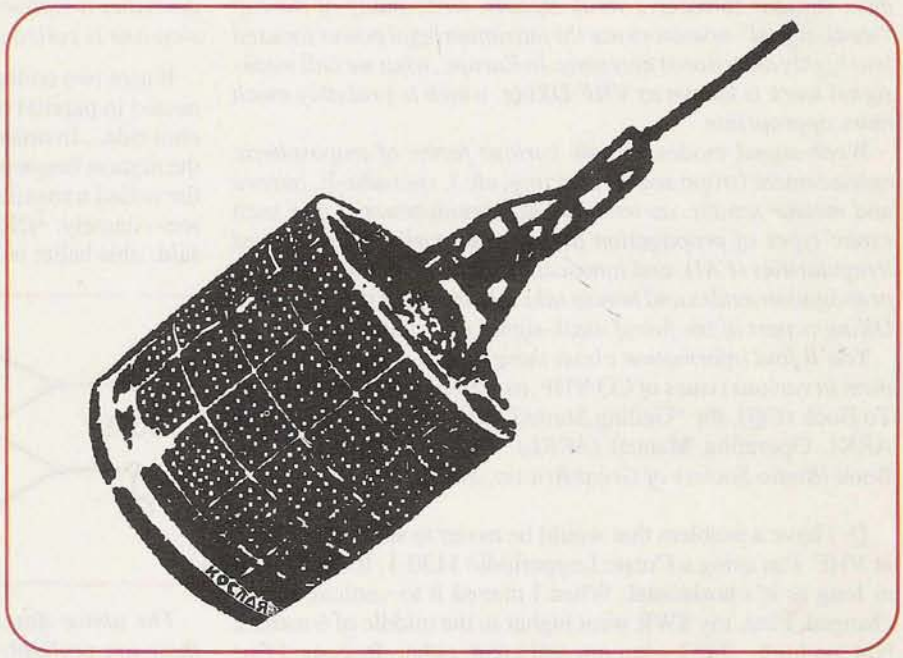
A: Sorry, Bill, but we don't have anything on that right here. Antenna experts out there...while you're correcting me on the previous answer, please tell Bill where he can find the specs on this feedline. Thanks in advance!

Do YOU have a question about any aspect of "Ham Radio Above 50 MHz"? We'll do our best to give you a clear, concise answer—or if it's not a question that has just one easy answer, then we'll invite readers to offer their solutions. Send your questions to: Q & A, *CQ VHF* magazine, 76 N. Broadway, Hicksville, NY 11801; via e-mail to <CQVHF@aol.com> or <72127.745@compuserve.com>; or via our Web page at <http://members.aol.com/cqvhf/>. Be sure to specify it's a question for "Q & A."

Update on Russia's Ham Satellites

The RS series of satellites is among the easiest to use and most popular of all amateur satellites. And Mir is back on the air after some "down time." Here's an update on the Russian birds.

Editor's Note: "Orbital Elements" columnist Gould Smith, WA4SXM, has been out of the country on business and was unable to prepare his regular column this month. Watch for his column on telemetry next month, but, in the meantime, we bring you this update on the various RS satellites and on Russia's Mir space station, courtesy of the AMSAT News Service.



RS-10/11 and RS-12/13 both share space on a single satellite. RS-10/11 was launched 10 years ago, in June, 1987, and RS-12/13 has been in orbit since 1991. Both satellites are working well.

Is Mir back on the air yet? When will RS-16 be available for general use? What's happening with RS-10? Many of Russia's ham stations in space are in a state of flux, so we thought it would be helpful to bring you up to date on the status of these popular satellites.

Russia's Fleet of HamSats

Russia's amateur satellites, known by the designator RS (for *Radio Sputnik*), followed by a number, have often been called the "easysats," because operating them requires a minimum of specialized equipment. Most of the RS "birds" operate either in "Mode A," with a 2-meter SSB or CW uplink, and a 10-meter downlink, or in "Mode K," with a 15-meter uplink and a 10-meter downlink. One—RS-14 (also known as AO-21)—even featured a crossband FM repeater, with its uplink on 435 MHz and its downlink on 145 MHz. This satellite has been off the air for several years, but, as we'll learn below, it might be coming back.

In addition, Russian cosmonauts and U.S. astronauts aboard the Mir space station have been regularly keeping in touch with hams on Earth via Mir's ham station. Plus the SAFEX experiment on the space station has provided hams with an orbiting FM repeater on 70 centimeters. For some time after last spring's fire and other difficulties aboard Mir, the ham stations were shut down. Now, here's an update on each "bird," as of mid-June:

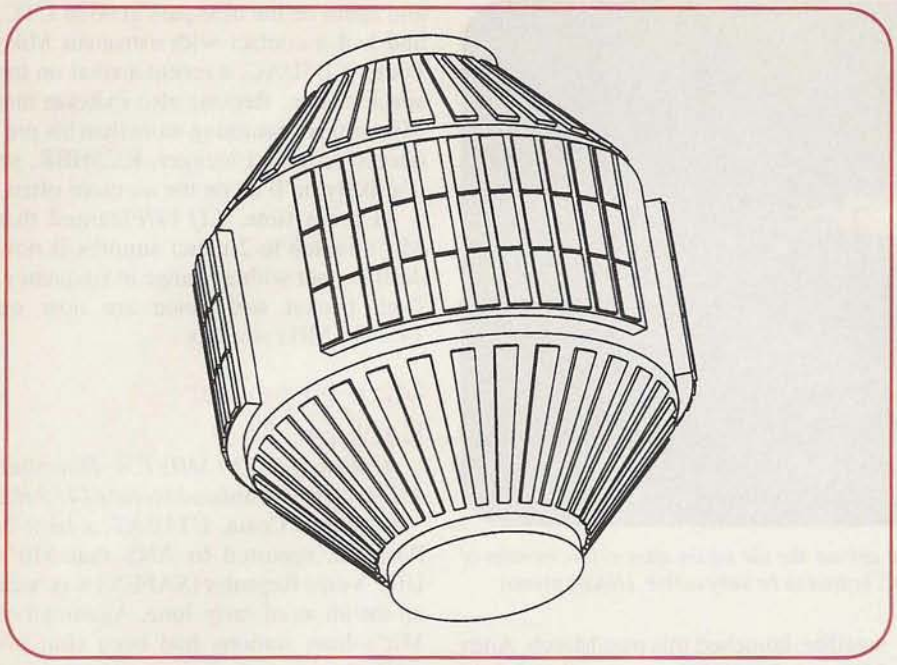
RS-10: Off the Air in Early June

(Uplink: 145.865–145.905 MHz CW/SSB; Downlink: 29.36–29.4 MHz CW/SSB)

RS-10's beacon, ROBOT, and transponder were silent while designer and builder Andy Papkov carried out experimental work with the satellite from the RS3A command station. Leonid Labutin, UA3CR, reported that he hoped RS-10 would be active again in time for its 10th

"RS-10's beacon, ROBOT, and transponder were silent while designer and builder Andy Papkov carried out experimental work with the satellite from the RS3A command station."

By G. Gould Smith, WA4SXM



RS-15 doesn't share space in space—it has a whole satellite to itself, and is currently operating in Mode A (see text). However, it has been having battery charging problems.

birthday on June 23. RS-10 and RS-11, two separate transponders on the same satellite (a COSMOS 1861 navigation satellite), were launched on June 23, 1987. The RS-10 transponder has been active for the vast majority of the time.

Once the satellite is back on, RS3A will need some SWL reports. Please note the date and time you heard RS-10 and send the info via packet to Andy, RS3A, at RK3KPK@RA3KP.MSK. RUS.EU.

RS-10 Birthday Party

From June 21 to 29, a group of RS enthusiasts consisting of G4CUO, G4ZHG, G6HMS, GØMKA, G7MUB, G8DYK and GØMKA planned to celebrate the 10 years of faultless operation provided by the Russian RS-10 satellite. They planned to be active with the call-sign GBØRAS on all modes on each and every pass of RS-10 (assuming it's back on the air), RS-12, RS-15, and the Japanese FUJI satellites. Each QSO was to receive a serial number, and a very special QSL card will be sent to each station contacted or SWL report received.

RS-12: Rollin' Along

(Uplink: 21.21–21.25 MHz CW/SSB; Downlink: 29.41–29.45 MHz or 145.91–145.95 MHz CW/SSB)

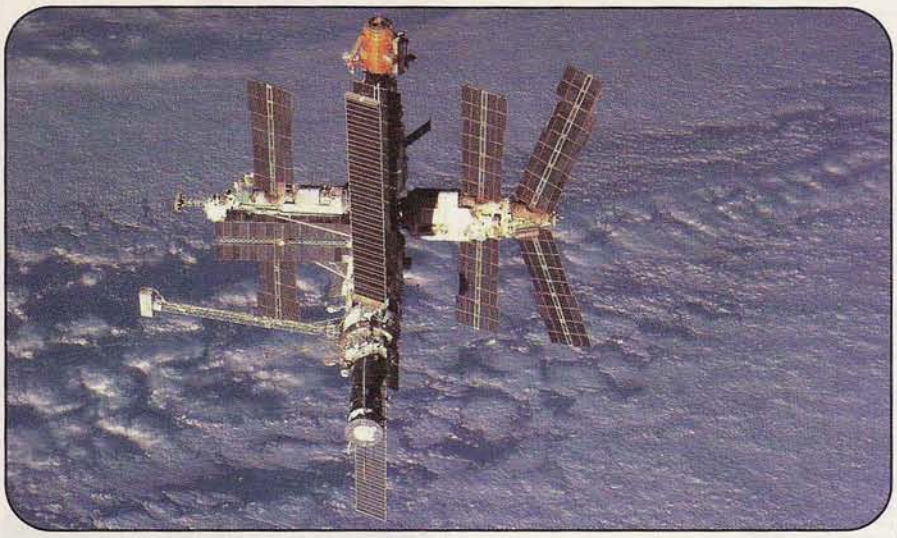
Signals on RS-12 in North America during May and June (almost exclusively daylight passes) were weakened by increased ionospheric activity, which kept 15 meters active during the day. This made it especially important for the "old timers" to warn newcomers on RS-12 to set their uplink frequency and leave it alone to prevent sweeping across the 15-meter band and causing QRM to terrestrial QSOs in progress. On this bird, you should compensate for Doppler shift by changing your receive, or downlink, frequency (normal practice is to leave your receiver in one place and adjust your transmit frequency).

For newcomers to amateur satellites, RS-13 shares space on the same satellite with RS-12 (like RS-10/11), and, generally, only one is turned on at a time.

"Rumors are circulating that...the command problems with OSCAR-21 (alias RS-14) may soon be resolved [and] that this highly popular but long-silent satellite may reappear shortly."

RS-14/AO-21 May Return

Rumors are circulating that a strong possibility exists that the command problems with OSCAR-21 (alias RS-14) may soon be resolved. It's not impossible that



The ham stations aboard the Mir space station are on the air again after a few months of silence, and astronaut Mike Foale, KB5UAC, is said to be very active. (NASA photo)

this highly popular but long-silent satellite may re-appear shortly. *(This was written in June. Listen for the possible return of RS-14/AO-21 on 145.983 MHz with FM voice or digital signals.—ed.)*

RS-15 Users: Turn Your Power Down!

(Uplink: 145.858–145.898 MHz CW/SSB; Downlink: 29.354–29.394 MHz CW/SSB)

The RS-15 satellite has been having battery charging and switching problems since early 1997. As of the beginning of the year, it was self-switching all its systems off soon after entering eclipse (the nightside of Earth); then, in April, it was continuing to function well into shadow; and, as of June, RS-15's transponder and beacon were switching off even when under solar cell battery charge in daylight. This effect is seen whenever high power (QRO) uplink stations come up on the transponder. The satellite normally re-covers within a few seconds, only to switch off again when the QRO operator(s) reappear.

The lesson to be learned is for users to improve their downlink reception and *not* to increase their uplink power in order to hear (just) themselves. An ERP (effective radiated power) of 100 watts is more than enough to produce an adequate signal from RS-15, provided that other users do not run more than this. (Hint: If SSB doesn't work for you, try CW. CW is very easy to hear on the downlink!)

RS-16: Making Progress

Testing continues on this brand new satellite, launched this past March. Andy Mirinov, RK3KPK, reports that RS-16 "now has a new voice on CW." All of the reports received by Andy of this newest Russian satellite will be answered by him with a QSL card.

As of mid-June, RS-16's 435.504-MHz beacon was active, but the 10-meter beacon and the Mode A transponder were not. However, transponder information on RS-16 has finally become available. When the satellite is ready for general use (again, listen), the transponder will be using the following frequencies:

Uplink = 145.915–145.948 MHz
Downlink = 29.415–29.448 MHz
10 m Beacons = 29.408, 29.451 MHz
Pwr 29 MHz Down = 1.2 W/4 W
70 cm Beacon 1 = 435.504 MHz
70 cm Beacon 2 = 435.548 MHz
Pwr 435 MHz Beacons = 1.6 W

Mir—Back on Simplex

*(**New frequency**: 145.985 MHz simplex, FM voice, and packet)*

After about two months off the air, ANS began receiving many reports that both the voice and packet stations aboard Mir were operating on 145.800 MHz *simplex*, along with reports that the Mir packet station, RØMIR-1, was back on the air as well.

Greg, KO6TH, told ANS that RØMIR-1 was using 145.800 simplex, not the usual minus 600-kHz offset, when he managed to digipeat through RØMIR to KJ7UI and exchanged a quick greeting. And Gene, N7CKA, reported that he worked MIR on packet and voice (on simplex) twice on June 8. He made a contact at 0652 UTC and again on the next pass at 0828 UTC, and had a contact with astronaut Mike Foale, KB5UAC, a recent arrival on the space station. Reports also indicate that Mike enjoys hamming more than his predecessor, Jerry Linenger, KC5HBR, so it's likely he'll be on the air more often.

At press time, *CQ VHF* learned that Mir's switch to 2-meter simplex is now definite, but with a change in frequency. Both packet and voice are now on 145.985 MHz simplex

Mir's Repeater Back on, Too!

(Uplink: 435.750 MHz FM; Downlink 437.95 MHz FM, Subaudible tone 141.3 Hz)

Francisco Costa, CT1EAT, a ham in Portugal, reported to ANS that Mir's UHF Voice Repeater (SAFEX) was back on the air as of early June. Again, all of Mir's ham stations had been shut off while the space station was experiencing problems with its oxygen and power supplies. CT1EAT said he worked ON6GP (in Belgium) on the June 7 pass over Europe, between 1952 and 2001 UTC.

The AMSAT News Service

Anyone with Internet e-mail service may receive amateur satellite news directly from AMSAT, the Radio Amateur Satellite Corp. Just send a message to <listserv@amsat.org>, saying SUBSCRIBE ANS in the message text and giving your e-mail address. You may also be interested in bulletin lists for SAREX (Shuttle Amateur Radio EXperiment) info (SAREX), updated Keplerian elements for tracking satellites (KEPS), or an e-mail "reflector" for satellite users to compare notes (AMSAT-BB). Use the same address to sign up for any of these; *don't* send such requests to the lists themselves.

ANS receives its information from a variety of sources. The reports contained in this article, for example, are based on information from the following: Pat Gowen, G3IOR; Andy Mirinov, RK3KPK; Dick Montgomery, N3DV; Claudio Ariotti, IK1SLD; Geoff Perry; Chuck Duey, KIØAG; and Francisco Costa, CT1EAT. Both ANS and *CQ VHF* thank them for their contributions. ■

Resources

For more information on operating the RS satellites, see "Orbital Elements" in the July, 1996, issue of *CQ VHF*; or contact AMSAT, P.O. Box 27, Washington, DC 20044; Phone: (301) 589-6062.

Op-Ed

One Reader's Opinion

Reinvigorating the Culture of Ham Radio: A Third Model

We continue this month with reader comments and proposals in response to our May editorial outlining proposed changes for amateur licensing.

In a *CQ VHF* editorial (May, 1997), W2VU proposed ham license upgrade restructuring based upon the "Pilots'" and "Broadcast" models. I believe he's right on target—we're failing to promote and maintain a ham radio culture. I agree that if we were to restructure licensing and upgrading along the lines of one or both of these models, we might revive the culture of ham radio.

I'd like to suggest a third model that might be useful: Scouting. Rather than turning back the clock and requiring hams to demonstrate that they can send CW in order to upgrade, I believe we ought to consider requiring hams to demonstrate increased commitment to the hobby in much the same way that advancement within the scouting program works. Scouts advance by demonstrating self-improvement through activities or the completion of projects. In the process, the culture of scouting is strengthened and preserved. For hams, self-improvement could entail involvement in education or public service, improving on-air operating abilities, or enhancing ham radio-related technical skills. In the process, the culture of ham radio will, likewise, be strengthened and preserved.

Ham Radio Merit Badges

Back in my scouting days, we used to accumulate merit badges, the equivalent of license upgrades, by doing projects, i.e., by tangibly demonstrating that we were learning and improving ourselves, thus contributing to society by becoming better citizens. The same sort of standard could be applied to ham radio license class upgrades. For example, if a ham activated and maintained logs for a base station of just about any sort (packet, HF, VHF, QRP, satellite, etc.) for a year, that could satisfy the self-improvement requirement for the General class upgrade. Alternatively, a ham could satisfy the requirement by attaining basic DXCC (100 countries, any band, any mode), or even by demonstrating code proficiency at 10 wpm.

A higher level of activity and involvement might be required to satisfy the Advanced or Amateur Extra class self-improvement upgrade requirement. Some possible examples include maintaining a packet BBS, designing or building a piece of gear (not a "blinky" kit, but something a bit more involved), publishing an article in a ham journal, performing traffic handling for a year, making a presentation before a ham club or other public group, or passing a code test at 20 wpm. Of course, hams would still have to pass the appropriate theory tests as well.

This sort of scheme emphasizes both self-improvement and active involvement in the hobby while, at the same time, giving hams choices for improving themselves. It would encourage active hamming and breathe new life into the culture of ham radio. Ham clubs, independent VEs, or ordinary Elmers would supervise and certify the attainment of self-improvement activities and projects which would give them a bit more to do than just

Giving a talk at a hamfest or convention might qualify you for a ham-upgrade "merit badge," under KK3K's proposal. This is a presentation by Al Ward, WB5LUA, at the 1996 Central States VHF Society Conference.

"...we ought to consider requiring hams to demonstrate increased commitment to the hobby...by demonstrating self-improvement through activities or the completion of projects."

"...if a ham activated and maintained logs for a base station of just about any sort (packet, HF, VHF, QRP, satellite, etc.) for a year, that could satisfy the self-improvement requirement for the General class upgrade."

By Jim Kelly, KK3K

**Jim Kelly, KK3K, has been a ham since 1982. Active on HF, VHF, UHF, and microwaves, with a particular interest in satellites, he holds both HF and satellite DXCC (with 210 countries confirmed via satellites). Jim lives in Philadelphia, Pennsylvania.*

"This sort of scheme emphasizes both self-improvement and active involvement in the hobby while at the same time it gives hams choices for improving themselves. It would encourage active hamming and breathe new life into the culture of ham radio."

proctor tests. Just think how this might serve to reinvigorate our hobby. The emphasis would be more on active hamming, improving ham skills, and enjoying ham radio, and the result would be a more viable ham radio culture.

How would this new program be implemented? It could be implemented in much the same way as the scouting program worked during my scouting days. As I remember, the scout organization published a book full of projects from which scouts could choose. Scouts did the project of their choice, then got somebody—parents, I believe—to sign off, certifying that they had completed the project. They then received credit for that project at the next scout meeting.

Hams could institute a similar arrangement. Basically, VEs could suggest and certify self-improvement projects or proposals that would be appropriate for different license class upgrade credit. Individual hams would then select the project/ activity they want to concentrate on, complete it, then get two other hams to certify as to what they had done. At upgrade time, they would present the signed certification and get credit for the project, thus satisfying the self-improvement requirement for the upgrade.

On Your Honor...

I realize that this implementation scheme is a variation of the honor system among radio amateurs and that some cheating would inevitably occur. Nevertheless, I still think it makes good sense because of the potential positive effect on the culture of our hobby. And it wouldn't require government involvement; we hams could institute and manage the program by ourselves.

I agree with *CQ VHF*: in place of a CW send and receive requirement, we ought to institute a requirement that contributes to the overall reinvigoration of our ham radio culture, one that encourages active hamming and self-improvement, and one that brings hams together for their own benefit, and for the benefit of the hobby and society. The scouting model which focuses on self-improvement is appropriate. ■

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The opinions expressed in this column are those of the author and do not necessarily reflect the views of CQ VHF *or its publisher, CQ Communications, Inc.*

If you have an opinion on this issue or another matter of importance to the VHF ham community, we'd like to hear from you. Well-reasoned, well-written commentaries will be considered for our Op-Ed page. If we publish your Op-Ed article, we'll give you a complimentary one-year subscription (or extension of your current subscription) to CQ VHF. *Submissions not accepted for the Op-Ed page may also be considered for Letters to the Editor.* CQ VHF *reserves the right to edit all submissions for length and style.*

Oops...

Guess it's time to feed the gremlins in the composing room computer again. In case you hadn't figured it out for yourself, we accidentally swapped two photo captions in last month's "In the Public Interest" column. The caption beginning, "Three nets, three bands..." (p. 53) belongs with the photo of the three operators (p. 51). And the caption beginning "Amateur television..." (p. 51) belongs with the photo (p. 53) that shows a TV monitor.

And, due to government cutbacks, it's only possible to see *part* of the U.S. Capitol building clipart in last month's "Op-Ed" on page 75. Using the additional ink necessary to show you the entire building would have upset the budget compromise between Congress and the President, deepened the deficit, and possibly caused a government shutdown in September. So, we felt it was our patriotic duty to conserve ink and let you guess what the picture was supposed to be. (*Thank you to our Washington bureau for this explanation. For the benefit of readers who are not conversant in Washingtonese, the translation reads: "We messed up. Sorry."—ed.)*

Henry Traue, VE7BL, of Rossland, British Columbia, also pointed out an error in our "Ham Radio Glossary." It appears we've put Johannes Kepler, the astronomer who formulated the laws of planetary motion, in the wrong century, and occasionally in the wrong country. Just to set the record straight, Kepler was born in Germany in 1571. Thanks for the catch, Henry.

Unlike the folks who inhabit the building you couldn't see, we do occasionally make mistakes, and we do correct them whenever we notice them or one of you points them out. If you see something that slipped by us, drop us a note at <cqvhf@aol.com> or by mail to *CQ VHF* magazine, 76 N. Broadway, Hicksville, NY 11801.

Hamfest Calendar

The following hamfests are scheduled for August, 1997:

August 2, U.P. Hamfest, City of Houghton's Dee Stadium facility, Houghton, MI. For information, contact Roland Burgan, KB8XI, (906) 482-2403; e-mail: <rburgan@up.net>; Packet: <KB8XI@W8YY.#UPMI.MI.US.NA>.

August 2, 14th Annual Hamfest, Weedsport Speedway/ Fairgrounds, Auburn, NY. Talk-in: 147.00-WA2QYT. For information, contact Dick Bardin, KA2EGA, 14005 Martville Rd., Martville, NY 13111, or call (315) 564-6570.

August 2, 9th Annual Memorial Hamfest, National Guard Armory, High Point, NC. Talk-in: 147.765/.165. For information, contact Judy Walker, HPARC Hamfest Publicity Chair, P.O. Box 1163, Jamestown, NC 27282, or call (910) 887-3281. (exams)

August 2, Annual Hamfest, Eagles Alps, Quincy, IL. For information, call N9JF at (217) 336-4191. (exams)

August 2, Athens Hamfest and Computer Expo, Oconee County Civic Center, S. Athens, GA. For information, call George Kelly, (706) 543-9590; or e-mail: <wb4vnt@athens.net>; or write Athens Radio Club, P.O. Box 6337, Athens, GA 30604. (exams)

August 2–3, ARRL National Convention, Amateur Radio/ Computer Show, Prime Osborn Convention Center, Jacksonville, FL. Talk-in: 146.76. For information, contact Greater Jacksonville Hamfest Associations, P.O. Box 27033, Jacksonville, FL 32270; WWW: <http://users.southeast.net/~jrmoore/hamfest.html>. (exams)

August 3, 6th Annual Picnic, Wildwood Park, Marshfield, WI. Talk-in: 147.180. For information, contact Guy Boucher, KF9XX, 107 West Third Street, Marshfield, WI 54449, or call (715) 384-4323. Packet: <KF9XX@W9ITHW.WI.USA.NA> or contact <guyboucher@atznet.com>.

August 3, Portage Hamfair, Portage County Fairgrounds, Randolph, OH. Talk-in: 145.39-.600 MHz, 28.390 MHz. For information, contact Joanne Solak, KJ3O at (330) 274-8240.

August 3, Hamfest, Washington Twp Firehall, North Washington, PA. Talk-in: 146.640- & 44.990+. For information, contact Bob Reihms, N3NOS at (412) 727-2194 after 6:00 p.m. EST.

August 3, Annual Land of Lakes Hamfest, Steuben County 4-H Fairgrounds, Crooked Lake, Angola, IN. Talk-in: 147.180. For information, contact Sharon Brown, WD9DSP at (219) 475-5897 or e-mail: <wnbrown@dmci.net>. (exams)

August 3, 47th Annual Winchester Hamfest and Computer Show, Clarke County Ruritan Fairgrounds, Berryville, VA. Talk-in: 146.22-82. For information, call (540) 955-1745, e-mail: <http://www.w3ic.com/inet/svarc/hamfest>. (exams)

August 3, Swap '97, St. Clair County Community College, Port Huron, MI. Talk-in: 147.3, 146.52. For information, write P.O. Box 611230, Port Huron, MI 48061-1230. (exams)

August 3–4, Amateur Radio/Computer Show, for information, contact Larry Filzen, WB4CGD, P.O. Box 27033, Jacksonville, FL 32205, or call (904) 272-0726.

August 9, First Annual Circus City Swapfest, Sauk County Fairgrounds, Baraboo, WI. For information, contact Yellow Thunder ARC, 1120 City View Road, Baraboo, WI 53913; WWW: <http://www.thelorax.com/~sschulze/hamfest.htm>.

August 9, Hamfest '97, Whitney Senior Center, St. Cloud, MN. For information, contact Charlie Grafft at (320) 251-8008. (exams)

August 9, TARA Hamfest/Computer Show '97, Vet-eran's Memorial Field House, Huntington, WV. Talk-in: 46.76-, 146.64-, 443.85+ (PL 88.5), 146.52S. For information, contact Georgia Overby, KA8QME at (304)552-1811.

August 9, Tacoma Electronics Fleamarket, Charles Wright Academy, Tacoma, WA. Talk-in: 147.28+. For information, contact Alan (206) 840-4947, Bill (206) 584-1086, or Al (206) 474-9023.

August 9, Annual Hamfest, Decatur FC Grounds, Lewistown, PA. Talk-in: 146.91. For information, call (717) 242-1882.

August 10, Hamfest/Computer Show, Hawthorne Race Course, Stickney, IL. Talk-in: 145.250 MHz. For information, contact Hamfest' 97, Edwin Weinstein, 7511 Walnut Ave., Woodridge, IL 60517.

August 10, Ham Radio/Computer Hobbyist Swapfest, Deschutes County Fairgrounds, Redmond, OR. Talk-in: 146.94(-). For information, contact Bill Sawders, K7ZM, 19821 Ponderosa St., St. Bend, OR 97702, or call (541) 389-6258.

August 10, Annual Central Kentucky ARRL Hamfest, Western Hill School, Frankfort, KY. For information, contact Bill De Vore, NF4X, 112 Brigadoon Pkwy, Lexington, KY 40517 or call (606) 257-3343/(606) 273-8345; <devore@engr.uky.edu>.

August 16, Hamfest/Computer Show, Exhibit Hall, Roanoke Civic Center, Roanoke, VA. Talk-in: 146.985(-600). For information, contact Terry, AE4EW, (540) 890-6782; or <ae4ew@ix.netcom.com>.

August 16, 6th Annual Ham Radio, Computer, and Electronic Equipment Swap Meet, Cowlitz County Fairgrounds, Longview, WA. Talk-in: 147.26+, pl 114.8. For information, contact Bob Morehouse, KB7ADO, (360) 425-6076 eves, or write LCARA Swap Meet, P.O. Box 906, Longview, WA 98632; e-mail: <KB7ADO@aol.com>. (exams)

August 16, Fleamarket, Buford Fairgrounds, Buford, Ontario, Canada. Talk-in: 147.150+ (VE3TCR). For informa-

(Continued on page 83)

VHF Conference

August 23–24, Eastern VHF/UHF Conference, Harley Hotel, Enfield, CT, off exit 49 of I-91. Sponsored by the North East Weak Signal (NEWS) Group. For more information, visit the NEWS Group Web page: <http://www.connix.com/nwz1u/newsvhf.html>.

Operating Notes

For August 1997:

2-3	ARRL August UHF Contest (see rules, this issue)
12	Perseids Meteor Shower Peak
16-17	ARRL 10GHz+ Cumulative Contest - 1st wknd (see rules, this issue)
20	Moon Perigee (closest to Earth)

More contest info is available on the CQ VHF web page at: <http://members.aol.com/cqvhf/navhfcom.htm>.

Basics

Touring Traffic Nets

Ham radio "traffic" nets are a good introduction to both net operations and public service. Here's an overview of what they're all about and some information on how you can join in.

Unless you live *really* way out in the sticks, there's a very good chance that, on some repeater near you, there's an "NTS traffic net" that meets there on a regular basis. But exactly what *is* an "NTS traffic net"? Let's work backwards to explain it.

Just What Is a Traffic Net, Anyway?

First of all, a *net* refers simply to any gathering of hams on a specific frequency at a specific time for a specific purpose. Most non-emergency nets are scheduled ahead of time, and many meet daily, weekly, or monthly.

A *traffic net*, specifically, is a net whose purpose is to *pass traffic*. You'll never get a speeding ticket by passing this kind of traffic. In amateur radio, *traffic* refers to *messages*. A message being relayed from point A to point B is called *traffic*. And a net that meets to relay this traffic is, appropriately enough, called a *traffic net*. (The hams who regularly pass traffic are known as *traffic-handlers*.)

An *NTS traffic net* is a traffic net that's part of the American Radio Relay League (ARRL) *National Traffic System*. NTS is a nationwide chain of nets, operating at the local, state, regional, and "area" levels, designed to smooth the flow of ham radio messages being passed along from any one part of the U.S. to any other.

Think Globally, Act Locally

Using NTS's network of nets, messages can be directed to virtually any point in the U.S. or Canada. Most messages are originated and/or reach their final destination on VHF "local" nets. These are also the nets on which most newcomers to traffic-handling start out.

When you first tune into a traffic net, you're likely to be rather confused by some of the jargon being bandied about and by the set order of doing things. So here's a basic guide to the structure and operation of an NTS local net. While there may be some variations from net to net, they all pretty much follow the same basic procedure:

• At the scheduled net time, the Net Control Station, or NCS, will "call" the net, announcing that the net is beginning, briefly explaining its purpose, and inviting everyone using the frequency to "join," or check into, the net (or to stand by or change frequency for the duration of the net). *The NCS is in charge of the net and all participants must follow his or her instructions during the net.*

• The NCS will then ask for check-ins, usually starting with anyone holding "emergency" or "priority" traffic (the two top priority classifications in the standard ARRL message format), followed by "liaison" stations representing other nets, stations "with traffic" (holding messages to be sent), and, finally, stations "with or without traffic." Be sure to go only in the correct category. If there's a specific check-in procedure, the NCS should announce it. If not, general practice is to say the NCS's call, unkey your mic to make sure you're not "doubling" with another station, then announce your callsign and say whether or not you have "traffic" to send (Example: "W2VU"/unkey and listen/"This is N2BFG, no traffic" or "This is N2BFG, with traffic"/unkey and listen).

• After taking a certain number of check-ins, the NCS will acknowledge those stations that have checked in and ask for any additional information he or she may need (such as where your messages are going or, if your callsign isn't familiar, your name and location). The NCS will then continue taking check-ins until everyone waiting has been checked in. (Exception: if there's emergency or priority traffic, it will be handled immediately).

• Once the check-ins are complete, the NCS will begin routing traffic. If there's a message for your town, you may be asked to take it. (All that's involved here is writing down the message as it's read to you, then phoning the person to whom it's addressed and reading it over the phone.) If other frequencies are available, you may be asked to QSY (change frequency) and meet the other station to pass your traffic. Otherwise, all the messages will be handled right on the net frequency. This is slower, but it'll give you a better opportunity to get familiar with formats and procedures.

• If you're on the receiving end of a message, you should always ask for a repeat ("fill") of any words that you're not sure of (*don't ever guess!*) and count the words to make sure that they agree with the "check," or word count, that's given to you as part of the opening information. When you're certain that you've copied the message correctly, say "Roger

Traffic-Handling on MARS

If you decide that you enjoy traffic-handling and want to be a part of a worldwide message-forwarding network, you might consider joining *MARS*, which stands for the *Military Affiliate Radio System*. Operating just outside of the ham bands, MARS members relay messages for members of the U.S. Armed Forces all over the world. You can be the link to home for a serviceman or woman at some remote outpost. There are three divisions of MARS: Army, Air Force, and Navy-Marine Corps.

Army MARS has a World Wide Web site at <http://members.aol.com/ aat6fv/>. Check with local hams for more info on Navy-Marine Corps and Air Force MARS.

number xxx (with xxx being the message number), (yourcall) back to net."

• Don't leave the net until it ends or you are "excused" by the NCS. Even if there's no traffic listed for you at the beginning of the net, someone may check in later with something you can take. If you're not there when NCS calls, you'll be wasting everyone's time. Besides, it's just common courtesy. If you need to leave before the net ends, just drop in your call at a break in the action (such as when a message is finished and both parties go "back to net"). The NCS will recognize you (although maybe not immediately) and you may then ask to check out.

• When all the traffic has been passed, the NCS will ask for last-minute check-ins, then "close" the net, repeating much of the same information from the opening. Once the net is closed, normal QSOs may resume.

Questions? Just Ask

In the very likely event that there's something you still don't understand after listening a few times, or even after checking in and making yourself available to receive messages, don't hesitate to ask the NCS, or a regular participant, to explain it to you. And if you don't understand the explanation, ask for a translation into English! But don't ask *during* the net, unless the NCS has opened up the net to questions and comments (this sometimes happens when there's very little traffic to pass). As a rule, though, you should wait until the net is closed and then call the NCS or another station to ask your question. You'll find most long-time traffic-handlers are more than welcoming of interested newcomers. ■

Resources

For more information on the National Traffic System, we recommend the following ARRL publications:

The ARRL Operating Manual; the *Public Service Communications Manual*; and the *ARES Field Resources Manual*.

All are available from the ARRL, 225 Main St., Newington, CT 06111; Phone: (860) 594-0200; Fax: (860) 594-0259; Internet: <http://www.arrl.org>

Hamfest Calendar *(from page 81)*

tion, contact Richard LaRose, VE3RLX, 153 Dusdon St., Brantford, ONT. N3R 6N3; or e-mail: <rlarose@bfree.on.ca>.

August 16, Tailgate Hamfest & Open House, The New Kosciusko Co. Amateur Radio Center, Kosciusko County, IN. Talk-in: 146.985-. For information, call Loren Melton, WB9OST, (219) 858-9374 eves. (exams)

August 16–17, Huntsville Hamfest '97, Von Braun Civic Center, Huntsville AL. For information, contact Art Davis, WB5KKA, Dealer and Exhibits Chairman at (205) 883-0477, Fax: (205) 880-2265; or write P.O. Box 12534, Huntsville, AL 35815; <www.hamfest.org>

August 17, 40th Annual Warren Hamfest, Trumbull Branch Campus of Kent State University, Warren, OH. Talk-in: 146.37/97 &448.00/443.00. For information, contact Al VanSlyke, N8IKX, Warren ARA Hamfest, P.O. Box 809, Warren, OH 44482, or call (330) 889-3378. (exams)

August 17, Tailgate Electronics, Computer and Amateur Radio Fleamarket, Albany and Main St., Cambridge, MA. Talk-in: 146.52 & 449.725/444.725 - PL2A-W1XM/R. For information, call (617) 253-3776.

August 17, 7th Annual Hamfest, Paulding County Fairgrounds, Paulding, OH. Talk-in: 146.46/46 S, 146.865/285 R. For information, contact Hamfest chairperson, Jerry, KB8MAF, PCARG, 10392 SR 500, Paulding, OH 45879, call (419)399-4507; or e-mail: <jlrhod@Bright.net>.

August 17, Delmarva Hamfest, Deleware Technical and Community College, Georgetown, DE. Talk-in: 147.075 or 224.84. For information, contact Delmarva Hamfest, RT 6, Box 64A, Georgetown, DE 19947.

August 17, Annual Hamfest, Elks Grove, Santa Barbara, CA. For information, call (805) 589-5900.

August 23, SCARS Hamfest, Somerset County 4H Center, Bridgewater, NJ. Talk-in: 448.175 (-5) PL 141.3, 147.135 (+6) PL 151.4. For information, contact Pat, N2CQ, (908) 873-3394 or write SCARS, P.O. Box 742, Manville, NJ 08835.

August 23, 5th Annual Hamfest, Mohawk Drive-in Theater, Gardner, MA. Talk-in: 145.370. For information, contact John, WF1L, (508) 249-5905 from 4 p.m. to 9 p.m.

August 23–24, 14th Annual Campfest, Colorado Lions Camp-grounds, Woodland Park, CO. Talk-in: 146.82. For information, contact MARC, P.O. Box 1012, Woodland Park, CO 80866-1012, or call Don, AAØNW, (719) 687-3692.

August 24, Hamfest, Computerfest, Yonkers Municipal Parking Garage, Yonkers, NY. Talk-in: R/146.865, R/440.150, Simplex 146.520. For information, contact YARC., P.O. Box 378 Centuck Sta., Yonkers, NY 10710-0378 or call Jim (914) 969-5182 or Dan (914) 667-0587.

August 24, VHF/UHF Conference Swap'n Sell Fleamarket, Harley Hotel parking lot, Enfield, CT. For information, contact Mark Casey, (413) 566-2445 (8 a.m.–9 p.m. EST/EDT), or write to 303 Main St., Hampden, MA 01036; e-mail: <N1LZC@juno.com>. (exams)

August 24, Annual Fleamarket, Adams Agricultural Fairgrounds, Adams, MA. Talk-in: 146.910. For information, contact Joel Miller, N1WCF, (413) 442-2609; e-mail: <n1wcf@cbcc.bcwan.net>.

August 31, 4th Annual Hamfest, Radiofest, and Computer Expo, Dubuque County Fairgrounds, Dubuque, IA. Talk-in: 147.84/24. For information, contact Jerry Ehlers, (319) 583-1016, or write to: GRARC, P.O. Box 546, Dubuque, IA 52004; e-mail: <SHEBER@MWCI.NET>. (exams) ■

Advertisers' Index

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WANTED: Older model bugs, unusual bugs, and miniature hand keys. State price, condition. Dave Ingram, K4TWJ, 4941 Scenic View Drive, Birmingham, AL 35210

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Looking Ahead in

CQ VHF Ham Radio Above 50 MHz

Here are some of the articles that we're working on for upcoming issues of *CQ VHF*:

- "An Outboard Noise Blanker for 6 Meters," by Bob Witmer, W3RW
- "Is Anyone out There?—Hams and Project Argus," by Denis Jakac, VA3ZXN
- "DLØART/AM: A Mini-Satellite over Germany," by Oliver Welp, DL9QJ/N3NSF
- "Rockets into the Ionosphere," by Ken Neubeck, WB2AMU

Plus...

- "Build a VHF/UHF SWR Meter," by Dennis Wilkison, KE6UZQ
- "*CQ VHF* Review: Maha 100-Watt 2-Meter Amplifier," by Gordon West, WB6NOA
- Two antennas, plus an antenna tuner, all for 6 meters...in next month's "Project Corner," by Dave Ingram, K4TWJ

If you'd like to write for *CQ VHF*, you may download our writers' guidelines from the *CQ VHF* World Wide Web site at <http://members.aol.com/ cqvhf/> or FTP to <ftp://members.aol. com/cqvhf/general> and look for the file, "writguid.txt." Or, you may send a written request with an SASE (self-addressed stamped envelope) to *CQ VHF* Writers' Guidelines, 76 N. Broad-way, Hicksville, NY 11801.

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