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CQ VHF Ham Radio Above 50 MHz

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Winter 2006

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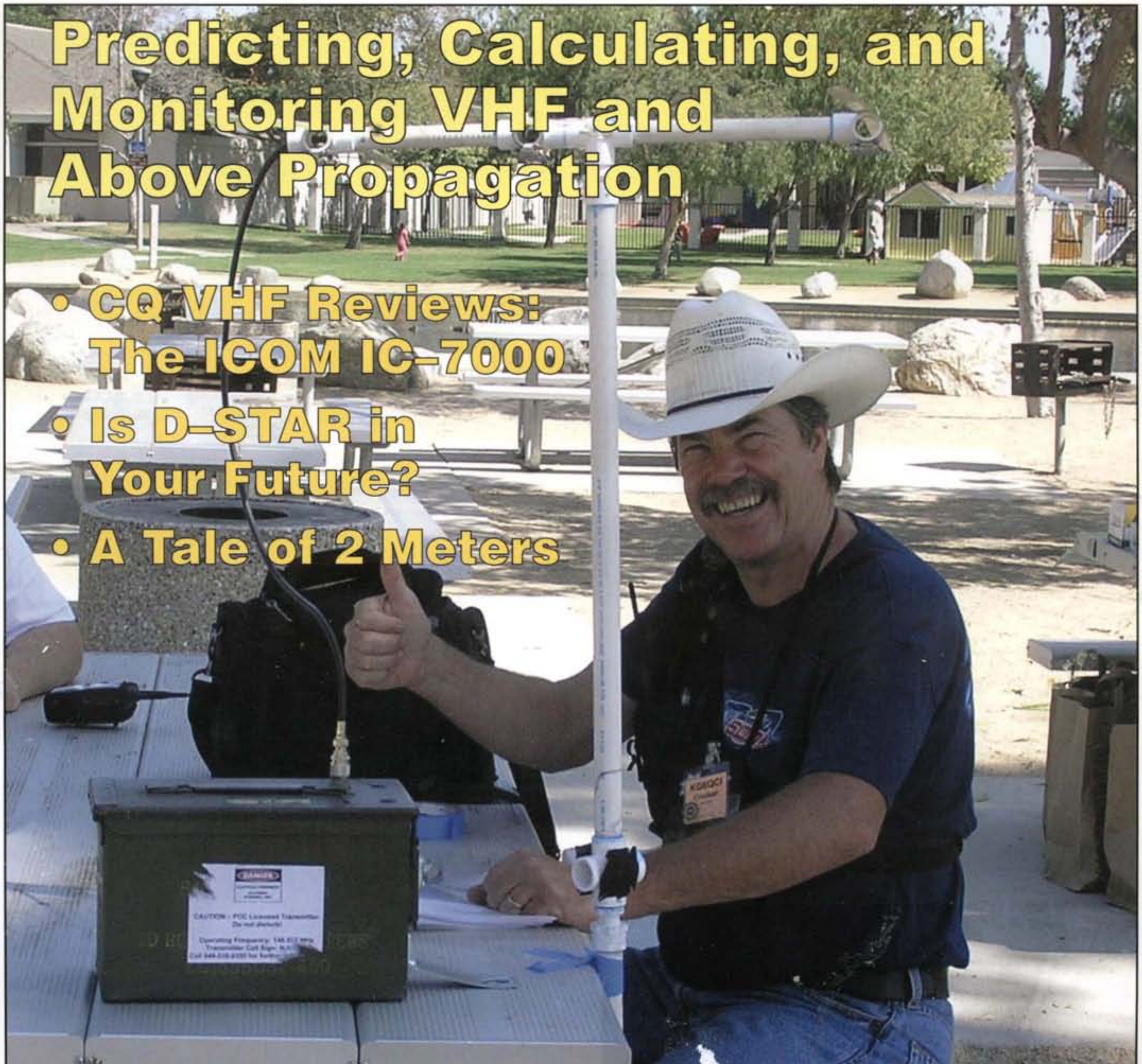
Predicting, Calculating, and Monitoring VHF and Above Propagation

- CQ VHF Reviews: The ICOM IC-7000
- Is D-STAR in Your Future?
- A Tale of 2 Meters



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

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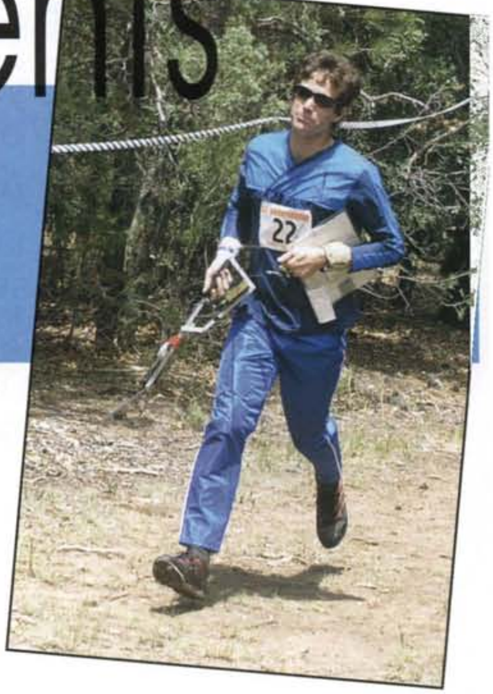


Winter 2006
Vol. 8 No. 4

FEATURES

COLUMNS

DEPARTMENTS

On The Cover: Dave Seroski, KG6QCI, is a regular on the South Orange Amateur Radio Association's mobile T-hunts. In 2005 he tracked down a spurious 2-meter signal in Lake Forest, California during a hunt. For details, see the "Homing In" column on p. 36. *(Photo by Joe Moell, KØOV)*

CQ VHF Ham Radio Above 50 MHz

LINE OF SIGHT

A Message from the Editor

Has It Really Been Four Years?

It was four years ago this past January when I met with Dick Ross, K2MGA, CQ Communications owner and publisher, at CQ headquarters in New York to discuss bringing back *CQ VHF* as a quarterly publication. On my return trip to Tulsa, Oklahoma, I was hanging around the car rental agency in New York waiting for my ride to the airport when my cell phone rang. It was Kent Britain, WA5VJB, who asked me about rumors that he had heard about this magazine being published again.

A bit shocked by Kent's "out of the blue" phone call, I asked him where he had heard the rumors and why he was calling me about them. He replied vaguely about the source of the rumors, and then he told me that because I was the editor of *CQ* magazine's VHF column, I should have known about them.

I then replied that the rumors were true and I had accepted the position as editor. Then I asked Kent if he would consider writing a column on antennas for *CQ VHF*, and he said yes. Then and there I had my first columnist. (It is important to note that both Gordon West, WB6NOA, and Ken Neubeck, WB2AMU, agreed to be feature editors as soon as they learned that I was to be the editor.) It was from that beginning of a few regular writers, along with some seed articles from *CQ* magazine, that we have come to where *CQ VHF* is today, four years later.

A look at the masthead in this issue will reveal that we now have more than a dozen columnists, each writing about his or her particular specialty in our niche of the hobby. The significant crossover among the specialties continues to amaze me as well. This crossover is good for all of us, because we learn from one another how to adapt and improve our particular area of interest by way of the previously traveled learning curves of our colleagues.

This crossing over, or cross pollinating, is the key to the future of our hobby on these VHF and above frequencies. Granted, our hobby is comprised of both the HF and VHF spectrums. However, what can be done on HF is limited by spectrum space and FCC and international regulations. On our VHF and above frequencies there are virtually no limits for us—and thus no limits on our experimentation on these frequencies.

Regarding coverage of specialty areas in *CQ VHF*, I would like to add columnists who will provide material on EME activities, ATV, ballooning, DSP, and SDR, as well as Echolink and VoIP. If one of these is your specialty or you know of someone who could write about these topics on a regular basis, please contact me via e-mail at <n6cl@sbcglobal.net>.

Now that we have looked both back and forward, let's take a look at what we have in this issue. I'm sure you will be delighted with the variety of material and the controversial aspect of some of the topics. Let's begin with the controversial.

Controversial Conclusions

For decades, the differences of opinion over the cause of sporadic-*E* propagation have generated considerable discussion and many articles. Even myself and features editor Ken Neubeck, WB2AMU, take opposite positions as to the cause. (I am a proponent of lightning, and Ken is an opponent.) In this issue of *CQ VHF* Bob Gyde, ZL3NE/1, presents a strong case for weather as the cause of many different forms of propagation, including sporadic-*E*. His article begins on page 12.

Complementing Gyde's article is another paper by Rex Moncur, VK7MO, on the appropriate way to calculate tropospheric scatter losses. Rex's paper was originally presented at GippsTech 2005, the annual Australian conference designed to encourage participation in VHF, UHF, and microwave amateur radio operations. His article begins on page 14.

In addition to these articles on propagation, features editor Gordon West, WB6NOA, gives us insight into monitoring 10-GHz beacons using DSP. His article begins on page 16.

ICOM Insights

Last year ICOM rolled out several new products that hold great promise for those of us who favor the VHF and above frequencies. One is a standalone radio and the other is a whole system. The standalone radio, the IC-7000, is essentially a mobile equivalent of ICOM's upscale radios. Steve Hicks, N5AQ, takes the cover off this new radio, gives us a report on it, and suggests a modification to reclaim a previously advertised but later dropped feature—receiving commercial TV stations. His article begins on page 9.

The whole system, D-STAR, is just beginning to make inroads on our bands. Some of us may be put off by its newness and unknown features. However, FM columnist Bob Witte, KØNR, unpacks the mysteries of the system and encourages all of us to take a good look at the benefits it offers. His column begins on page 42.

Hinterland HSMM

One of the definitions of *hinterland* is a region remote from urban areas. John Champa, K8OCL, uses a hybrid of the word hinterland to come up with a new word, Hinternet. Perhaps its use of the 5.6-GHz band might explain its remoteness on our spectrum. However, John explains, "The Hinternet under development by many individuals and groups is intended to eventually become the ham radio digital WANs (wide area networks) formed by the linking of numerous local HSMM nodes or LANs." You see, it's not so remote after all. His explanation begins on page 31.

Capitalizing on the Classics

Borrowing from the classics, authors Dave Holdeman, N9XU, and Malcolm Mallette, WA9BVS, created titles for their articles. Dave borrowed from Charles Dickens' classic *A Tale of Two Cities* to create the title of his article about two classic 2-meter radios. In it he tells the tale of how he once owned one of the radios for all of two weeks (lots of twos in this article), and how he was able to procure a second nearly identical radio on May 2 (see, I told you lots of twos), 2004, thirty years later. Obviously not in new, fresh-out-of-the-box shape, it needed some loving care. Dave begins his story of restoration and reclamation of memories on page 28.

Malcolm borrowed the Sherlock Holmes character from Sir Arthur Conan Doyle to introduce us to an updated version of his transmitter characteristic detection software, called Sherlock. His article begins on page 61.

In the Next Issue

We have more articles in queue for the next issue of *CQ VHF*. Perhaps one of them could be yours. If so, we look forward to hearing from you.

Until next time . . . 73 de Joe, N6CL

A Low-Loss, Low-Cost, Three-Element Yagi Antenna System for 6 Meters

Take a little junk and a trip to the hardware store, add ingenuity, and what do you have? For K8VBL, the result was an antenna system for 6 meters for under $20.

By Tom Turner,* K8VBL/VP2VEL

For a cost of less than $20, a low-loss, three-element Yagi beam antenna can be built for 6 meters using components from local building and auto discount stores. Over 6 dBd gain can be realized, and the beam is light enough to be supported on a salvaged TV antenna tower and rotor. The following is a description of the 6-meter beam, tower, and rotor put up at K8VBL/KA8EHE.

Over the years, many 6-meter beams have been described in ham publications. Most of them use elements of 1/2-inch aluminum tubing. In a quest for materials to build a beam, a metals supply house was contacted and $60 for three 10-foot lengths of 1/2-inch aluminum tubing was the quoted price!

The high cost of aluminum prompted a search for less costly, locally obtainable element material. Our local building-supply discount store offered 1/2-inch (ID) thin-wall copper water pipe for less than $3 per 10-foot length. The advantages of copper over aluminum are that it is a better conductor and is easily soldered to provide low-resistance connections. Copper pipe is somewhat heavier than aluminum but appears to have about the same mechanical strength.

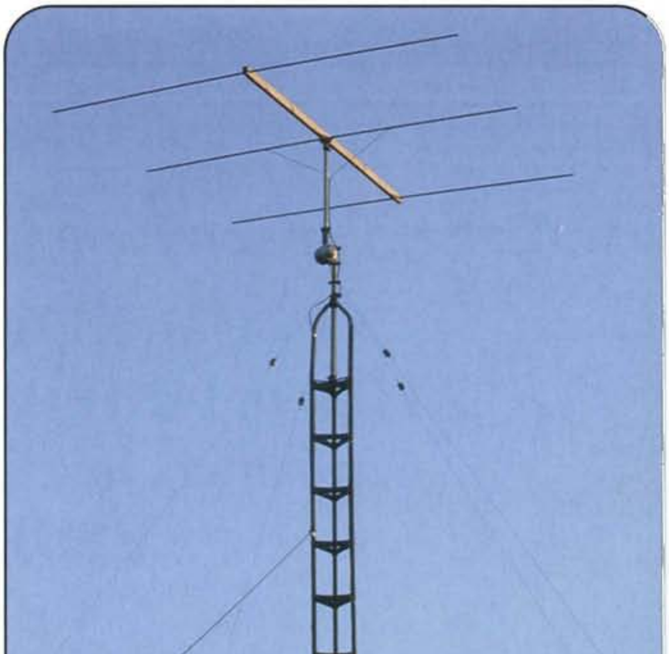
A gamma-matched coax feedline to the driven element was considered but was discarded in favor of a delta-matched ladder-type feedline for the following reasons. A gamma requires several connections, some of which are at low impedance points in the antenna system. Therefore, a few ohms of resistance in these connections will result in losses that seriously degrade the beam's performance.

A delta-matched ladder line requires only two connections, both at points on the driven element where its radiation resistance is relatively high, and provides a fully balanced feed to the driven element to minimize distortion of the beam's directive pattern.

Ladder line has 50% lower loss than coaxial cable at about one third the cost of coax. However, ladder line has the disadvantage of requiring extra care in installation, but by use of an ordinary TV-type lead-in bushing and standoff insulators, a completely satisfactory feedline installation is easily accomplished.

In summary, the completed three-element 6-meter beam has high-conductivity elements, and a balanced high-impedance feed system that provides low loss at low cost (figure 1).

*Apple Hill Farm, 8530 N. Branch Rd., Watervliet, MI 49098



The low-loss, three-element Yagi antenna for 6 meters. (Photos by John Chandler)

A standard three-element Yagi design calls for a resonant driven element, with reflector 5% longer and director 5% shorter, each parasitic element spaced 0.2 wavelengths from the driven element. Element spacing is not critical. Due to the higher conductivity of copper, element lengths are slightly longer than standard designs that employ aluminum elements of the same diameter.

Construction of the Beam

Cut three 10-foot lengths of schedule "M" 1/2-inch thin-wall copper water pipe (5/8 inch OD) to length with a hack saw. (Use

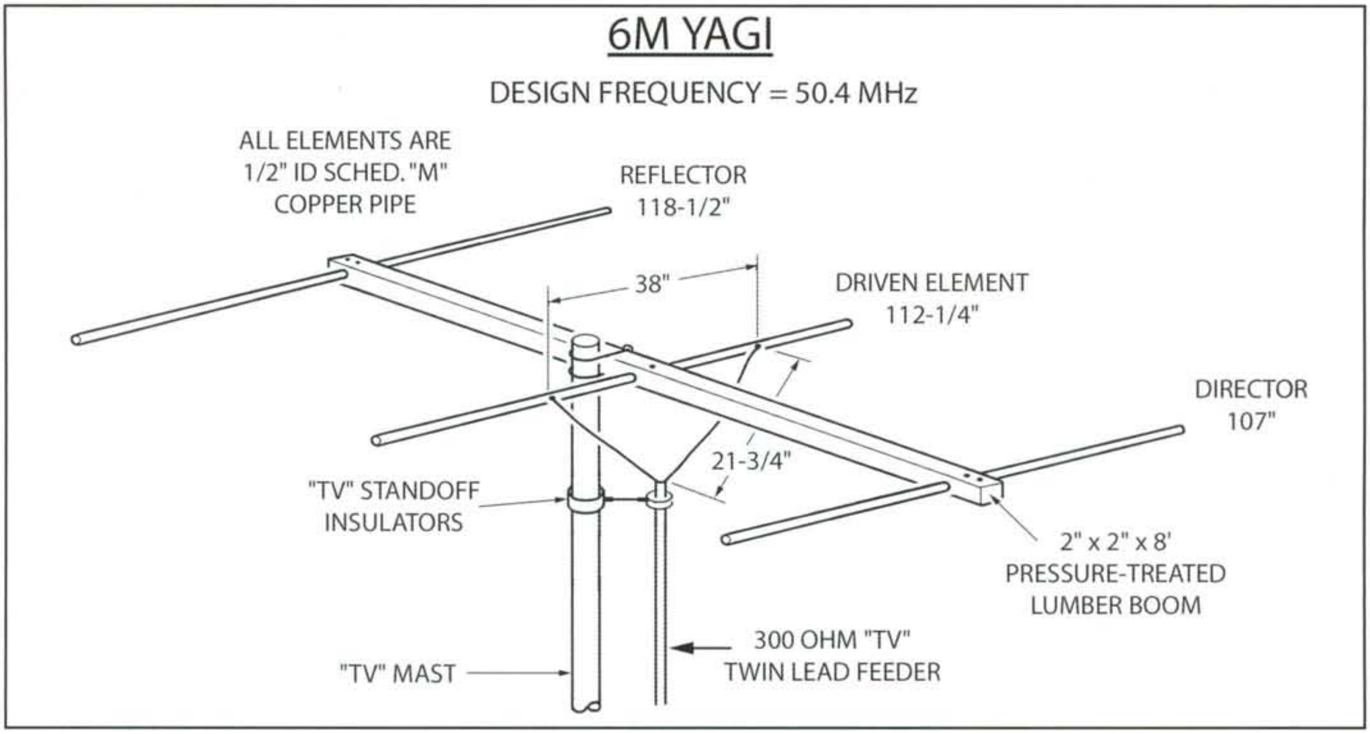


Figure 1. The completed three-element 6-meter beam. (Drawings courtesy Randy Kaeding, K8TMK, Heathkit Co., Benton Harbor, MI)

of a roll cutter will reduce the diameter of the cut end, causing difficulty if "tuning stubs" are inserted in the element ends, as described later.) Remove any burrs from inside the cut ends by reaming with a knife. Chamfer the outside ends of the elements with a file so they can easily be pushed through holes in the wood boom.

To make a light, low-loss boom, select an 8-foot pressure-treated 2 × 4 that is free of large knots along one edge. Rip a full 2-inch wide piece from the "good" edge. Bore a 5/8-inch hole at the center of the boom and 1 1/2 inches in from each end, to accept the pipe elements.

To secure a snug fit for the pipe, file a few thousandths of an inch from each side of a 5/8-inch paddle bit. Use the bit in a drill press, or have someone guide you while boring the holes, to be sure that the three holes are at right angles to the boom so that the elements will be in the same plane.

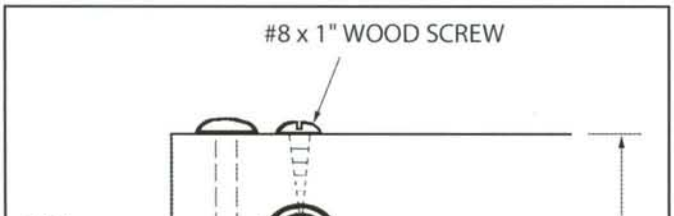


Figure 2. Attaching the elements to the boom.

Slit the ends of the boom back to the 5/8-inch holes, and then drill holes vertically through the slits to accept 3/16 × 2 1/2-inch bolts to clamp the elements in place(figure 2). Center the elements in the boom and tighten the clamp bolts. One-inch #6 wood screws can be driven through the boom into the elements to further hold them in place.

Select a mast stub about 2 1/2 feet long that will fit into the rotor (generally 1 1/2 inch OD). The mast stub should be long enough so that the feedline can be attached to it with a pair of TV standoff insulators, just below the delta fan-out.

Mount the mast to the boom between the reflector and driven element, about 4 inches from the driven element (figure 3). This will be the approximate horizontal balance point of the beam, since the reflector is about 10% heavier than the director, and will allow the delta match feedline to be fastened to the mast stub with stand-off insulators so that it is at a right angle to the driven element.

With two 1 1/2-inch U-bolts with clamps from two 2 1/2-inch U-bolts, clamp the mast to the wooden boom. This method of mounting requires no additional holes in the boom, which would weaken it.

Tuning the Beam and Delta-Match

An SWR analyzer (or transmitter and SWR indicator) plus a balanced antenna coupler and 300-ohm carbon (non-inductive) resistor are needed for the tune-up procedure. Set the analyzer frequency to 50.4 MHz and connect it to the coupler's input with a short length of coax. With a 300-ohm resistor connected to the coupler antenna terminals, adjust the coupler for an

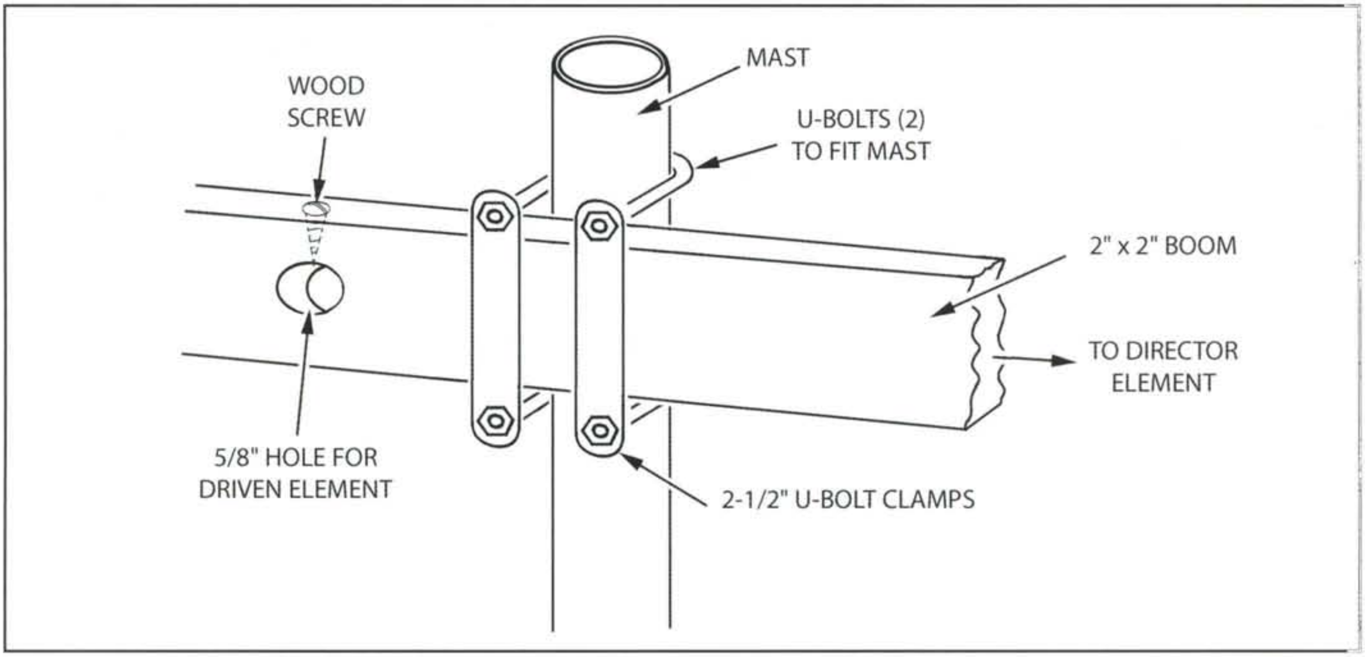


Figure 3. Mounting the mast to the boom.

SWR indication of 1:1. Thus, the coupler is set to "expect" a 300-ohm resistive load at the design frequency.

Support the beam on a wooden patio or on a pair of wooden chairs or saw horses with the beam aimed straight up (reflector element nearest the ground and parallel to it). Keep the beam at least one wavelength (20 feet) from metal such as aluminum siding or lawn furniture.

Make the delta match by separating the conductors of the 300-ohm feedline for a distance of 22 inches and skin the insulation from the ends. Attach the ends of the delta to the driven element at points 19 inches either side of its center by use of "Ideal" #5203 "Micro-Gear" automotive hose clamps. These clamps are tightened with a 1/4-inch nut-driver and facilitate the adjustment process (figure 4).

Remove the resistor from the coupler's antenna terminals and connect the 300-ohm feedline. Do not change the coupler adjustments during the tune-up procedure. Check the SWR indication at the design frequency. If it is not 1:1 at 50.4 MHz, adjust the locations of the delta match on the driven element by 1/2 inch or so, keeping them equidistant from the center of the element to provide a low SWR indication. Then adjust the analyzer frequency for lowest SWR, which is the resonant frequency of the system.

If the frequency is too low, cut 1/4 inch from each end of each element and again check the SWR and resonant frequency, and adjust the delta connecting points for lowest SWR. The driven-element length and the delta-match connecting points on it are the most critical adjustments, while the 21 3/4-inch fan-out length of the delta match appears to be the least critical.

The driven-element resonant frequency is somewhat dependent on the delta-match connecting points on it. This "de-tuning" effect of the delta is caused by a phase shift of current in the resonant driven element by the resistive load of the delta, the same as a resistor connected across a portion of the inductor in a resonant L-C circuit will change its resonant frequency.

The beam's resonant frequency is dependent on the lengths of the reflector and director as well as on the driven element. Thus, when "pruning" the driven element for resonance, also prune the parasitic elements to maintain the reflector approximately 5% longer than the driven element, and the director 5% shorter.

If the beam's resonant frequency is too high, tuning stubs can be used to extend the elements and thus lower the resonant frequency. From the 2-foot or so sections of 1/2-inch copper pipe that were cut off to make the elements, cut six pieces of pipe 4 inches long. Cut a 1/4-inch wide slot lengthwise in each piece using a hacksaw. Squeeze the pieces in a vise on alternate sides to reduce the outside diameter to about 1/2 inch, and chamfer one end with a file and clean with steel wool so that they can be pushed with a snug fit into the ends of the elements.

(Continued on page 74)

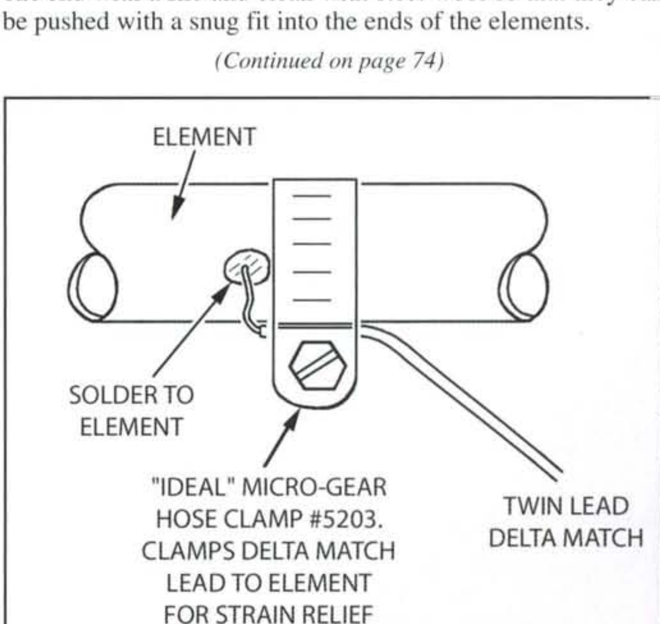


Figure 4. The clamp around the element holding the twin lead in place.

CQ VHF Reviews:

The ICOM IC-7000 HF/VHF/UHF Transceiver

For most of last year ICOM teased us with pictures of its new IC-7000. When it finally arrived in ham radio stores near us, N5AC was among the first in line to purchase one. Here he gives us a tour of the new radio.

By Steve Hicks,* N5AC

The ICOM IC-7000 was released this past December and I picked up mine on Wednesday, December 7th. The IC-7000 is the first truly mobile amateur HF transceiver that has a TFT color LCD display. The 2.5-inch diagonal display shows standard radio functions and is quite similar to that of the IC-756PRO line. The frequency display is large and easy to read from different angles and can be shown in three different colors and a couple of different type styles. It is very well thought out.

The IC-7000 has a beautiful operating display that shows frequency, memory information, power out, SWR, compression, and even radio temperature all at the same time.

The TV

One unique capability of the radio is that as designed in Japan, the radio can display NTSC VHF video channels 2 though 13. As shipped in the U.S., however, this capability is disabled due to potential liability issues. Fortunately, the radio is easily modified to enable the TV feature and simply requires the removal of a diode that is read by the radio's microprocessor on power-up. (See the accompanying sidebar for the modification.)

The IC-7000 also has a beautiful operating display that shows frequency, memory information, power out, SWR, compression, and even radio temperature all at the same time. This has become my favorite radio display (see photo). For times when other information is displayed on the lower half of the screen, you can select which of the meters is displayed just below the frequency readout —power out, SWR, compression, or ALC.

The TV display is nicely done and even has the capability of viewing an NTSC signal on any frequency from 49–218 MHz, in addition to standard U.S. TV channels. Although the TV side will not tune directly to the UHF channels for ATV (I confirmed this with ICOM), downconverters such as the TVC-4G from P.C. Electronics ($59 kit, $99 assembled) should work fine with the IC-7000. This has some nice implications for use in public service, ballooning, rocketry, etc.

The IC-7000 does not have dual-receive like so many of its big brothers, so when watching video, you are not able to transmit (the mic button is disabled) or monitor another channel. Still, the promise of being able to switch over and see a video feed from a descending balloon or for a net control in the local EOC to be able to pull up video at the disaster site is very real.

Much discussion about watching TV while driving down the highway has surfaced on the IC-7000 e-mail reflector. While it seems obvious that this is a "no-no," most who have the 7000 probably will enable the video, and many will run the IC-7000 as a mobile rig. If you're driving home at 6:05 PM and the FM radio station and your local repeater aren't interesting, it would be tempting to turn on the TV and just listen to the local news.

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Modifying the IC-7000 for TV Reception

The ICOM IC-7000 just released in December 2005 promised to have the capability to receive TV broadcasts off air and display these on the IC-7000's 2 1/2-inch TFT display. The feature was disabled at the last minute due to liability concerns, which is understandable given the many disparate state laws on TV displays in vehicles. Re-enabling the TV functionality is simple and can be performed by anyone who feels comfortable with a soldering iron and a pair of tweezers. In addition, the out-of-band transmit modification can also be done at the same time. Keep in mind, though, that making modifications to your new radio may void the warranty. Therefore, proceed accordingly.

Because you will be inside a microprocessor-controlled unit and you will be removing the processor unit itself, it is best to have all tools ready and in one place before beginning. Static discharge can harm or destroy parts of the radio and static buildup is always greater in the dry winter months. Be sure to touch the outer chassis of the radio and discharge any static buildup if you do find yourself walking around the room during this procedure:

1. Remove the top cover of the radio using a Philips-head screwdriver by removing two black screws on each side of the radio holding the top (total of four) and four screws on the top of the radio not immediately adjacent to the speaker (see photo A).

2.The cover of the radio should lift up easily. The speaker cable snakes under the CPU/DSP unit (business-card-size metal enclosure) and can be moved out from under this module. It is not necessary to unplug the speaker. The cover can be just set to the side or if you are more comfortable you may unplug the speaker.

3. Remove two silver screws holding the CPU/DSP module in place (see photo B).

4. Pull up on the CPU/DSP module and remove it from the radio. The unit can be set to the side.

5. Directly under the DSP unit are a number of integrated circuits. Between the two white connectors that the CPU/DSP unit plugs into are four identical integrated circuits, three in a line and one next to the left-most one in the line. These are CMOS 4094 shift registers that are used by the processor to read the diodes on the board that control radio options. All four chips on my radio have the Texas Instruments logo and the part number "HJ4094."

6. Toward the front of the radio are rows of surface-mount (SMT) diodes. The diodes have silver paint on top and the letter "A" clearly marked. Using the supplied photograph, you may remove one

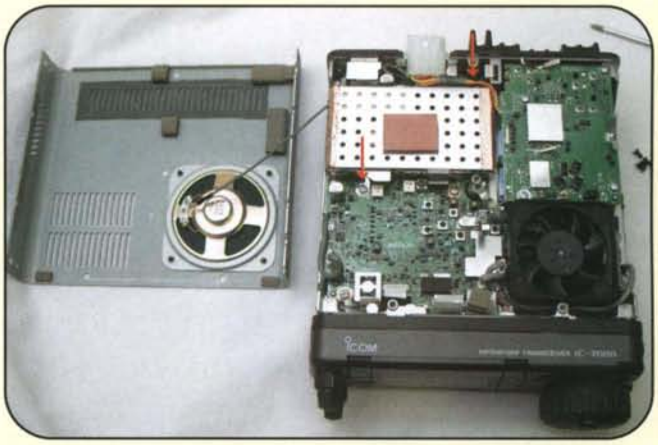

Photo B. Arrows point to the two screws holding the CPU/DSP module in place. Step 3 requires their removal. Step 4 requires the removal of the module.

Photo C1. With the CPU/DSP module removed, the four 4094 shift registers are exposed. They can be identified by the Texas Instruments logo and part No. "HJ4094."

Photo A. The ICOM IC-7000 HF/VHF/UHF transceiver. (All photos courtesy of N5AC)

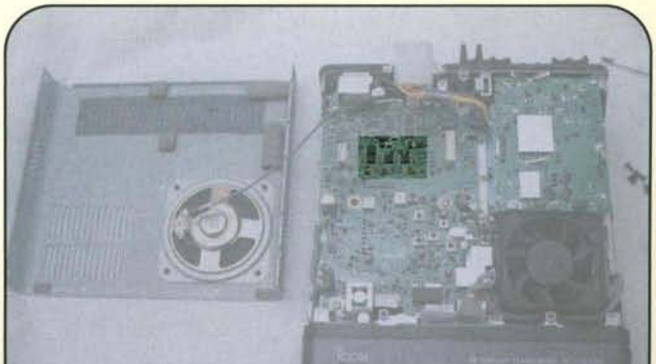

Photo C2. This photo highlights the four 4094 shift registers mentioned in step 5.

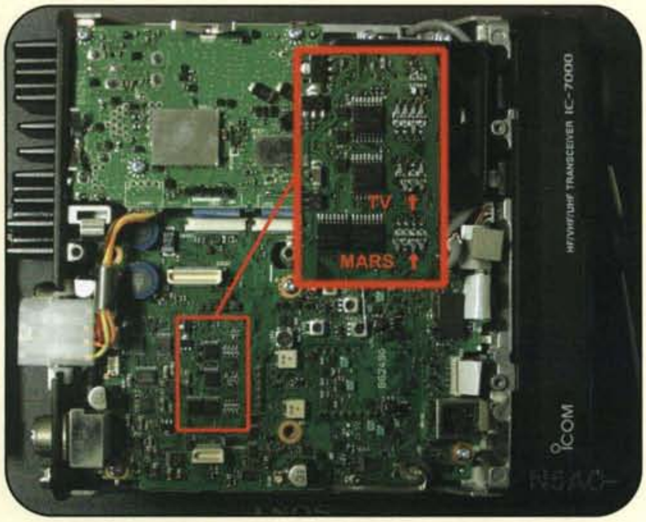

Photo D. Arrows point to the SMT diodes targeted for removal for the modifications. See steps 6 and 7 for instructions on how to remove them. Note that this photo is oriented 90 degrees counter-clockwise from photos B, C1, and C2.

diode for TV reception enable and another diode for MARS out-of-band transmit enable. The diodes may be removed in any number of ways. For most with limited equipment, a good pencil iron and a pair of tweezers can be used. I generally alternate heating up either side of the diode (there are two pads that barely stick out to each side of the diode on the short sides) with the iron and applying gentle pressure to the diode until it moves. Once it moves, it will have moved off both solder pads because it is so small. I then wrestle it into place with just one pad touching and reheat the diode to get it to adhere to the board. This is so that I can go back and add the diode back later if need be. With just one lead soldered, the diode will not operate in the circuit and will be in the radio if you need it later. You may also remove it completely if you like.

7. To enable TV, remove diode number two on the left of the set of diodes in front of the middle 4094 (see photo C).

8. For MARS operation, remove diode number two on the left of the set of diodes in front of the left two 4094s (see photo D).

9. When you are done with the diodes, just reassemble the radio in reverse order. After putting the CPU/DSP unit back into the radio, be sure to slide the speaker cable gently under the upper left and lower left corners of the CPU/DSP module. If you do not do this, you will have trouble putting the top back on the radio.

To use the TV receive mode, press and hold the upper-left knob marked AF(SET) on the radio for one second. The normal radio screen will be replaced with a TV receiver screen. The receiver will tune US TV broadcast channels 2–13 by using either the band-up and band-down buttons or the [M-ch] inner knob on the lower left of the radio. TV channel 2 uses the HF antenna port on the back of the radio, while TV channels 3–13 use the VHF port on the radio. Specific channels can be tuned to a different frequency in the 49–218 MHz range and can be skipped from the channel-up and channel-down function by pressing in the AF (SET) button momentarily and following the prompts.

You can also put an ATV downconverter between the VHF antenna port and your antenna to receive ATV. Such a downconverter is the TVC-4G from P.C. Electronics. The website is: <http://www.hamtv.com>. Unlike your TV set, however, RF can come out of your VHF port, so you will want to be sure not to transmit through your ATV downconverter after you are through watching ATV.

While listening, would you avoid looking at the screen if a video of the overturned tanker on the highway were shown? It's easy for all of us to say that we wouldn't watch TV while driving down the road; it's probably a little more difficult to avoid doing just that if some compelling video were to be shown. Something to think about.

The Scope

While the IC-7000 also has a spectrum scope like the IC-756PRO radios, it is not as functional as the bigger rigs (see photo). The most obvious difference is in the way the IC-7000 sweeps the band scope. While it is not a "live" scope as in the IC-756PROIII or the IC-7800, this is definitely an improvement over the IC-706MKIIG.

As with the IC-706MKIIG, the 7000 does not have a separate receiver dedicated to the band scope; the receiver is taken "off line," muted, and used to create the band scope. In the slow-speed mode, a tick can be heard about every fifth of a second while the receiver is used to get data for the scope. This does not drastically affect intelligibility of the incoming signal, but the scope takes about five seconds per pass to display. At this speed, you could easily find signals that are either always present or are present much of the time.

To find more intermittent signals, the scope can be put in the fast mode. In this mode, the ticks are about every tenth of a second and render virtually unintelligible the incoming audio on the current channel the radio is monitoring (you can also mute the audio entirely). In trade, you get a much more real-time view of the spectrum. The radio takes under a half-second to display the entire range, which can be varied from 10 kHz to 250 kHz. This is clearly a real first for a mobile radio.

Weak-Signal Work

For weak-signal contest work, the question of when and how we might use this scope arises. I wondered how strong of a signal is required in order for it to appear in the spectrum scope. I hooked up my HP 8640B signal generator and put it on 144.100 MHz. I was able to hear a signal at –145 dBm on the IC-7000. I put the band scope on in both fast and slow and found that it took a signal of about –95 dBm before it showed up on the band scope. I have yet to test if this is an absolute or relative value. In other words, if I use a preamplifier that provides significant gain, would this improve the abilities of the spectrum scope? For example, if I have a 25-dB preamp, will I only need a –120-dBm signal before the signal appears in the band scope? This is simple to test, but I've just not had the opportunity.

The question here is if you are meeting someone on 2304 and they're not exactly on channel, would you be able to jump over to the band scope and quickly find them. The received signal would need to be well above the noise for you to spot it on the scope, so conditions and the received signal level will dictate whether you will be able to use the band scope for this purpose. You can also use the band scope as a mini spectrum analyzer for work under 470 MHz.

The DSP

ICOM has moved the DSP functionality from after the AGC to inside the AGC loop. For a mobile VHFer this has the poten-

(Continued on page 76)

Calculating Tropospheric-Scatter Propagation Losses

This article was originally presented as a paper at GippsTech 2005, the Annual Australian Conference designed to encourage participation in VHF, UHF, and Microwave amateur radio operations. The name *GippsTech* is a hybrid name for the technical conference being held at the Gippsland campus of Monash University. Gippsland is a region within the state of Victoria.

By Rex Moncur,* VK7MO

With the advent of Joe Taylor, K1JT's WSJT software program it is possible to work distances of 700 km and more on a regular basis on VHF and UHF using tropospheric scatter. Thus it is useful to have an understanding of tropospheric-scatter losses so we can see what is possible and understand the factors that affect these losses. A number of methods of calculating tropospheric-scatter losses from the amateur literature and Consultative Committee International Radio (CCIR) Report 238-5[1] have been applied, but they produce substantially different answers. The CCIR methods are not easy to apply and this can lead to errors. This paper aims to provide a better understanding of the limitations of the various methods and concludes that CCIR method 1 is to be preferred. Based on this method, look-up tables of propagation loss in temperate climates are developed to make the method user friendly.

Tropospheric Scatter

Tropospheric scatter arises from radio waves being scattered by small cells of different refractive index in the atmosphere. It allows signals to be detected at much greater range than line of sight or by diffraction around the Earth. Figure 1 shows the geometry of a tropospheric-scatter path.

Factors that affect the propagation loss are distance, frequency, and the scattering properties of the common scattering volume. The scattering properties vary with height and climate and the scattering angle. Both the scattering angle and the height of scattering vary as a function of distance due to Earth curvature and horizon obstructions. In addition, the effective Earth curvature is modified by the radio refractive index. All of these factors have an impact on the calculation of tropospheric-scatter losses. Simple methods of calculating tropospheric scatter take into account only distance and frequency, while others also include obstruction angles, climate, radio refractive index, and path reliability. There are also differences in the ways in which these factors are considered, with some being based on approximate empirical formulas and others on graphs derived from experimental results.

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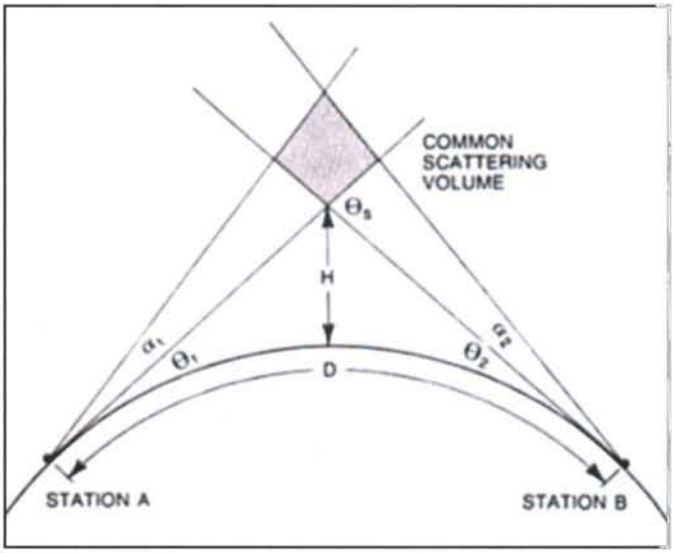

Figure 1. Geometry of a tropospheric scatter path where D (or d) is the distance between the stations, θ_S is the scattering angle, θ_1 and θ_2 are the horizon angles at each station, and $\alpha 1$ and $\alpha 2$ are the beamwidths of the antennas. (From ARRL UHF/Microwave Experimenter's Manual[2]*)*

Example Calculations

In Table 1 a range of methods available in the amateur and professional literature and CCIR report No238-51 are used to calculate the tropospheric-scatter losses for a 2-meter path of 500 km based two situations:

- A smooth Earth (no horizon obstruction) and
- 2.5 degrees obstruction at each end.

In order to give some equivalence to the various methods that include variables, the following are used or assumed:

- The surface radio refractive index is 320
- The region can be classified as continental temperate.
- Aperture to medium coupling losses are zero
- The required path reliability is 50%

Source	No obstruction (dB)	2.5 degrees obstruction at each station (dB)
The VHF/UHF DX Book, edited by Ian White, G3SEK #	–609	–559
ARRL UHF/Microwave Experimenters Manual #	205	256
CCIR Chinese Method	208	237
VHF/UHF Handbook, edited by Dick Biddulph, G8DPS #	208	*
CCIR Method 1	210	233
The VHF Handbook, by William Orr, W6SAI #	210	*
CCIR Method 2	212	238
ARRL *The Radio Amateur's VHF Manual,* by Ed Tilton, W1HDQ #	214	*
IT&T Handbook 4th Edition	222	*

*These methods do not allow for obstruction losses.
Methods do not specify path reliability.

Table 1. Propagation loss for various methods under the conditions listed above.

The method used by the *VHF/UHF DX Book* (White)[3] implies a gain rather than a loss and is clearly wrong and should be discarded. The method used in the 4th Edition of the *IT&T Handbook*[4], was replaced in recent editions by CCIR method 1, so it can be assumed the earlier method was considered less accurate and should also be discarded. The remaining methods give answers within a 7-dB range for a smooth Earth, but with obstructions of 2.5 degrees at each end the range is over 20 dB.

The simplest method is that used in the *VHF/UHF Handbook* (Biddulph)[5], which provides two tables—one for free-space losses and a second for the additional tropospheric-scatter losses. It takes into account both frequency and distance. It makes no reference to path reliability and it applies to a smooth Earth only. For many amateur situations there will be a few degrees of obstruction at each station and the smooth Earth assumption will lead to significant errors. *The VHF Handbook* (Orr)[6] suffers the same limitations.

ARRL's *The Radio Amateur's VHF Manual* (Tilton)[7] goes a little further in that it provides graphs for loss with distance and frequency for path reliabilities of 50% and 90%. Unfortunately, the graphs are the wrong way around, and it suffers the limitation of the prevous methods of applying only to a smooth Earth.

The ARRL's *UHF/Microwave Experimenters Manual*[2] method has a formula that takes into account frequency, distance, and obstruction loss. Obstruction loss derives from scattering angle and is 10 dB per degree of obstruction. Path reliability is not specified.

The three CCIR1 methods all take into account the important variables. CCIR method 1 takes into account eight types of climate, and method 2 two types (temperate and tropical). The Chinese method is

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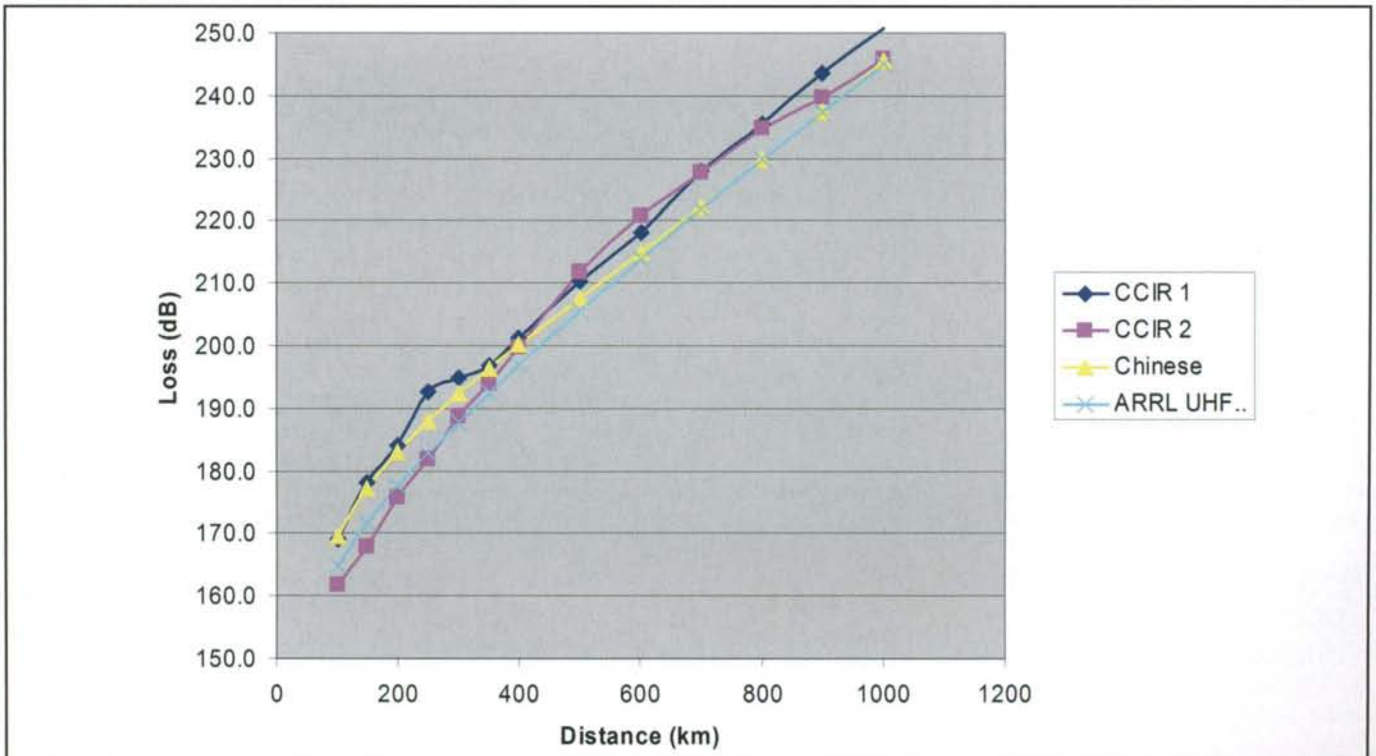

Figure 2. Variation of propagation losses with distance for four methods.

Predicting Propagation on 6 and 2 Meters, with Extensions to 70 cm

What causes sporadic-*E*? Can it be predicted? Answers to these questions have eluded us for decades—until now. In this article ZL3NE weighs into the debate by giving us his well-researched answers.

By Bob Gyde,* ZL3NE/1

It is general knowledge that the *F2*-layer absorbs most of the radiation that enters our planet's solar system and that it is also our shield from intense radiation. The intensity of the solar flux governs the amount of ionization that we can get into the *F2*-layer, and the *F2*-layer controls the ionization available for the *E*-layer. We also know that during the very low part of our solar cycle, *F2* propagation ceases on 10 and 15 meters because the amount of ionization arriving there is too low to support propagation on those bands.

The sporadic-*E* type of propagation, however, takes place regardless of the solar-flux readings. Therefore, the sun has nothing to do with sporadic-*E*—well, not by the previously accepted means. Ionization of the *E*-layer cannot be changed by radiation from outer space *when the observed solar flux level does not change,* and it would have to, to have any effect on the *E*-layer. Extreme flares such as X5 or above can temporarily change things, but only for a couple of days; after that we return to normal. The big thing to come to grips with is that *the ionization from the sun has nothing to do with sporadic-*E *type propagation.*

Determining What Produces Sporadic-*E* Propagation

With this statement as our basis, let us look at what we need to have to determine what produces sporadic-*E* propagation. First, we need an annual cycle to meet the traditional mid-summer peaks of propagation which occur between the December 10 and January 20 in the Southern Hemisphere and June and July in the Northern Hemisphere. Next, we need a means of varying the propagation direction, such as in the Southern Hemisphere. Examples are:

A. Propagation only from southwest to south on a yearly basis here at 37 degrees south.

B. A means of producing propagation only to the west and south on a yearly basis.

C. A means of producing propagation in all directions also on a yearly basis. A study of my extensive log shows that the described conditions do occur as stated, on a yearly basis. A classic example was during Cycle 23 between summer 1998 and 2000. At that time we constantly had the same weather pattern, one which gave us no propagation to the north. Therefore, during Cycle 23 we seldom made the *F2* areas, which in our case are only to the north of us.

D. In addition, we need some means of propagation that is possible even in mid winter.

Now that list was a tall order, but it covered my basic requirements.

It was now a learning curve for me, as I was sure weather could produce most of these conditions. However, how to have propagation in only certain directions for a whole season was hard to understand. Then I contacted our weather-office record department, and I was introduced to Dr. Mullin, who provided me with 50 years of records stating which time of each year the weather pattern was El Niño, La-Niña, and the one I did not know—Normal, or neutral. It was only then that I found I could fulfill all the requirements set by me with *weather conditions.*

By the time I had Dr. Mullin's records, I was well into my study, recording every contact along with the relevant weather maps, temperatures, etc. For several years I included these data sheets with each of my reports sent out annually. I calculated the number of contacts recorded over some 50 years on a yearly basis by each of the three weather patterns. These did exactly as required. El-Niño provided propagation all around, and Normal only west and south. These two gave good results, while La-Niña gave only the path to the south, with about one quarter of the number of contacts I recorded by the other two modes.

I had established a pattern of weather maps which fit in very nicely, and I could watch the propagation moving around each day until it came to here. Every time the weather map repeated itself as in previously recorded propagation, the same propagation re-occurred. In my last year I spent time each day recording the weather patterns that never produced propagation. There are many days of the year with no propagation, and in every case the same weather patterns were observed to be current.

Looking at winter propagation, we have temperatures much lower than in summer. However, even with cooler temperatures, the same weather maps work just as in summer. However, in the case

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of anticyclones, the air pressure needs to be much higher (typically 1036+mb), while with frontal activity it has to be a lot more intense, but propagation can and does take place.

At the end of about five years of study what had we learned? Had we found the missing links? I think so, as I could now predict to where propagation would take place and when. The accuracy of prediction was approaching 95–100% for the next day, equal to predicting the weather! As an aside, a lot of other things were discovered, but I will deal with them latter.

All propagation on 6 and 2 meters, and 70 cm, could now be predicted before it happened. Apart from AU (aurora) and *F2*, all other propagation is by tropo, or weather induced! To prove this you would need a reliable list of all contacts on the band you are studying, with the matching weather maps at the time the contacts took place. Nothing else is required, but it must be accurate. It will show that when propagation repetition occurs, the weather patterns re-occur.

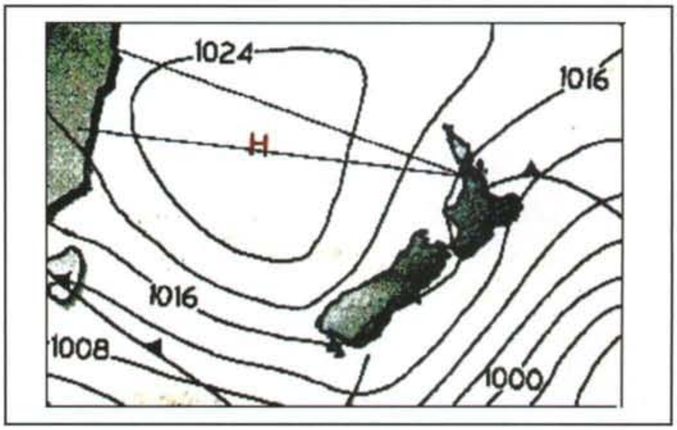

Figure 1. This is a typical anticyclone with 6-meter propagation shown.

Obtaining Provable Data

I found the only way to obtain provable data was by doing the required studies myself. There was some weather-related data (some 50 years of it), which our national weather bureau, NIWA, very kindly supplied. Otherwise the evidence I required was not available.

With this in mind, I undertook a three-year study of all contacts between three areas in Australia—Brisbane, Sydney, and Melbourne—as they were our main contact areas, and from Auckland to Christchurch, as this is a very strong signal area on 6 meters. The fourth year was spent studying North America and Europe to confirm that what was happening in the Southern Hemisphere was also happening in the Northern Hemisphere (and yes, it is).

I used the OH2AQ logging page for Europe and the dxworld.com pages for North America. With these I could compare the propagation taking place and the current weather from European and North American weather maps. While this was happening, I had access to several ionsonde reporting stations to study the *E*-layer ionization level under all conditions. To this day I do not know of anyone who has completed such a complicated study.

(I have been licensed since 1948 and came on to the VHF scene in the early 1950s, spending most of my time on 6 meters. By the mid 1970s I was quite sure weather was the main factor affecting propagation, and for the last 25 years I have been putting forward my beliefs on propagation. During that time I have written many papers on the subject, and even today my extensive study has found nothing different from what I had published!)

For my study, I recorded every contact that took place and the weather maps showing the weather pattern at the time the contacts took place. I recorded the stations heard or contacted on all three frequencies (6 meters, 2 meters, and 70 cm). As New Zealand is an ideal country to do this, with a very limited number of stations and directions in which to beam, I was not confused by secondary weather patterns. Here I was in a position where I could monitor the bands all day, every day, and until around 10 PM. My main monitoring antenna had unre-

(Continued on page 68)

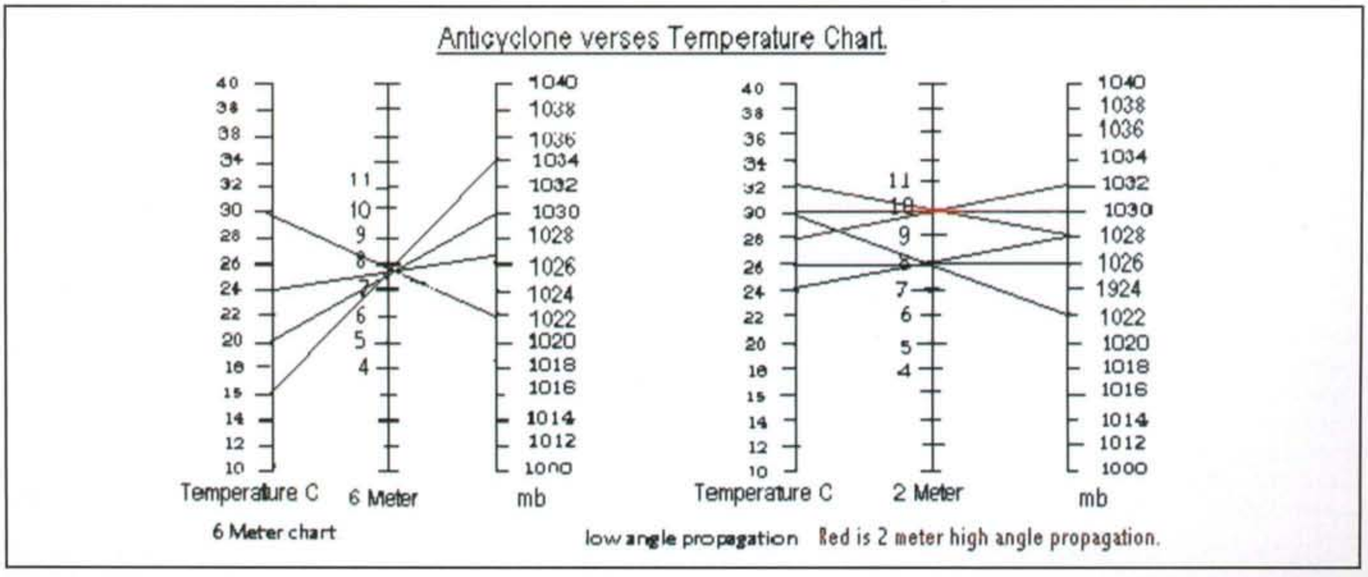

Figure 2. A chart showing the relationship between the air pressure and the air temperature.

Beacon Monitoring with DSP

Monitoring for propagation beacons is far more effective with DSP, rather than just hoping for a strong signal burst to trip your squelch. . . .

By Gordon West,* WB6NOA

When the DX and distant U.S. beacons begin to poke through the squelch circuit on 6 meters, you know the band is open somewhere in time to QSY up to 50.110 and 50.125 MHz to see who is on. Hundreds of 6-meter propagation beacons may be your first alert that the Magic Band is beginning to open!

On 2 meters and 125, 70, and 23 cm, propagation beacons help us keep track of tropospheric ducting opportunities. These VHF/UHF beacons begin to build slowly during a tropospheric duct and provide good clues as to the thickness of the duct, depending on which VHF and UHF bands are best bringing in the distant CW signals.

Propagation alerts over the internet are probably one of the best ways to hear when the bands are open, but for some of us, monitoring for propagation beacons is a passive way to hear the bands slowly or quickly open as the signal punches through squelch. Unfortunately, many new multiband VHF/UHF ham transceivers employ a squelch circuit that is gated either on or off by a transistor. Most of these "hard squelch" circuits also have slight histeresis, which means that any signal that triggers the squelch circuit open must be well above the background noise level. This unfortunate problem has caused many hams to miss a band opening and sometimes entire conversations just below the squelch-trip threshold point.

"I was listening for the Hawaii beacon on 144.170 MHz last Sunday, and I was careful to set the squelch just at the point where the background noise was squelched out. The radio was silent all day until a very noisy Ford drove by, briefly opening up the squelch circuit," comments Bill Alber, WA6CAX. Much to his surprise, there was an ongoing conversation between Bay area distant hams and Paul, KH6HME, in Hawaii. Without squelch, he could hear the signals weak but readable, but with any squelch setting the weak signal was completely taken out.

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Shown here left to right are the GAP in-line DSP system, the SGC noise-subtraction DSP speaker (on top of the Kenwood TS-790), and the Heil Sound speech-amplified DSP speaker. All three systems worked well for monitoring beacons.

Older VHF/UHF multimode rigs—such as the Kenwood TR-751, Yaesu FT-726, and the very old KLM Multi 2000—incorporate a squelch system called the "Fujiama," a soft squelch system. The beauty of this squelch is that it allows you to monitor for weak beacons with your squelch setting right at the noise threshold and an occasional burst of white noise coming through to confirm the squelch sweet spot. Also, this type of squelch circuit has a slow decay, so any small signal opening up the squelch will keep the squelch open for a couple of seconds before the squelch slowly goes back into quiet monitoring. This has made Yaesu 726R and Kenwood TR-751 owners quite happy with their equipment, thanks to "soft squelch" capabilities.

However, there is a better way to monitor for CW beacons—using DSP (digital signal processing) with either a built-in DSP circuit on expensive rigs, or the relatively inexpensive DSP external audio systems from Heil Sound, SGC, and several great DSP add-on devices from Gap Electronics. Each requires 12 volts to power the external DSP module, which is built inside the speaker enclosure. Some of the DSP speaker systems offer up to five individual settings of DSP levels, but just two settings may be perfectly adequate. Plug the DSP speaker system into the external speaker output of your radio, and with 12 volts turned on, the add-on circuit usually comes up in the bypass mode.

Tune to the beacon frequency, adjust the volume to a pleasant level, and click on DSP. For the first couple of seconds nothing seems to happen. This is normal! Then the background white noise begins to slowly disappear. The first-level setting usually cancels about 75 percent of natural background noise. If you want up to 95 percent background noise canceling, go to the next or succeeding DSP levels. Remember, your squelch circuit is turned off all the way, and the DSP network is providing noise canceling.

As soon as that DSP network senses an intermittent incoming tone, such as CW, it instantly will pass that audio through to the speaker system. While the CW signal may sound as if it is wavering a bit, who cares? This is your alert that a CW beacon is beginning to poke through. When it comes time to change frequency and establish CW or voice communications with distant stations, you may wish to reduce the level setting of the DSP network, restoring signals to a more natural sound.

On UHF, you also may find that radar signals sometimes will creep through on every radar sweep. This sometimes is minimized by turning on the noise blanker or automatic noise limiting. Again, squelch off, DSP ON, and NL and NB turned on to help minimize radar.

You may listen all day without hearing a thing, but as soon as the beacon begins to show up on frequency, the DSP instantly will pass the signal through. Again, your radio's squelch is turned absolutely off, so the circuit is listening to nothing but white noise, searching for an intermittent incoming CW or voice signal.

Another bonus with DSP . . . more and more VHF/UHF operators using weak-signal modes at the bottom of the band are finding incessant "birdies" smack dab on the frequency that they hope is clear for monitoring the distant beacon. These birdies come from nearby computers, cordless phones, FAX machines, thermostats, and home entertainment systems all running with some sort of microprocessor clock. These interfering birdies may be a series of interfering tones that will drive you crazy!

Switch on the DSP system, and listen to what happens. Within about 5 seconds the modern DSP circuit analyzes the constant whistles and faithfully cancels them out! As long as the signal is constant, the modern DSP circuit knows not to pass it through and reduce it to nearly zero on speaker output. But guess what? As soon as that CW signal begins to come out of the noise, just a few Hertz different from the annoying whistle, the DSP circuit instantly will pass it through to the receiver. In fact, turn off the DSP circuit, and all you hear are the annoying birdie whistles; yet turn your DSP speaker system back on, and after about five seconds the whistles disappear and the faint sounds of the CW signal you are listening for reappear. Magic!

"It is magic," comments Bob Heil, K9EID, who now manufactures a base-station amplified speaker system with enhanced DSP capabilities. "Weak-signal operators are tired of missing weak band openings due to a squelch set right on the threshold but unable to pass the weak signal they are listening for. With DSP, white noise is cancelled, whistles are eliminated, and the only thing that gets through is CW and voice—exactly what they are listening for!" adds Heil.

So, if you are into monitoring for weak CW beacons, or don't want to miss an extremely weak signal just below your squelch setting, get a DSP system, turn off your squelch, turn on the DSP network, and hear nothing but peace and quiet until this very magic circuit begins to detect meaningful ham radio signals. ■

Public Service Event Guidelines

What makes for a successful public service event? Good guidelines. Here KC5ZQM draws from his experience in order to instruct us on how to have everything go smoothly.

By Douglas D. Lee,* KC5ZQM

Amateur radio has a long-standing tradition of providing communications during emergencies and disasters. To stay prepared for these events, hams also provide communications for parades, bike and foot races, walkathons, etc.

Public service events and emergencies have similar characteristics that affect communications: the need to move information quickly, the need to move information from one point to many, the need for one station to control the flow of information.

I have "worked" or organized close to two dozen public service events. Also, I was an Emergency Management volunteer from 1997 through 2000, with experience in storm spotting and communications. My communications background goes back to my days as a "commo" man in an Army National Guard infantry unit in the last half of the 1970s. My motivation for writing this article comes from my dissatisfaction with the way I have seen some public service events conducted.

My aim in this article is not to present myself as a final authority on the subject, but to suggest some guidelines that others may find useful. These guidelines cover the following:

- group-level preparations,
- individual preparations,
- working the event, and
- after the event.

Group-Level Preparations

If you are the public service officer for an amateur radio club, I know how busy you can be. As I write this, I have been the Activities Chair for the Tulsa (Oklahoma) Repeater Organization for almost two years. My duties include public service, some public relations, liaison with the Tulsa Area Chapter of the American Red Cross and Skywarn, plus organizing Field Day operations. Sometimes keeping everything straight can be a challenge. You need to give yourself every advantage to make things go smoothly. This section is for you.

Early Contact

Contacting the organizers of an event early can be an important key to success. Why? Some events have a different director every year. Some events cover a large area and require large amounts of resources, so the organizers may have a series of meetings you need to attend. For example, the Tulsa Run is a 15K (9.3 mile) race. It happens on the last Saturday in October, but the planning meetings begin in early September.

When you contact the event organizers, always confirm your club's participation and make sure they understand your primary role is communications. Your contact person may be new to his or her job and have no idea of what ham radio is, or what you can do for the event.

You also will need to confirm the particulars of the event:

- What it is, if it is not obvious from the name.
- Where it starts and stops; where the event control will be; how big an area it covers, etc.
- When (date and time); schedule of particular events (some races 5K and up will also have a "Fun Run").
- Number of operators and where they will be needed.
- When operators need to be on station.
- To whom the operators need to report.

You may get some of this information from your first contact, but most will come from planning meetings and/or communicating with the organizers. Do not hesitate to ask questions. Information is the raw material of the process of organization. *You* are responsible for getting the information you need.

Recruiting

Early contact with the organizers gives you a cushion of time that eases the pressure and stress of getting ready for the event. An early start to recruiting does the same. Even the best plans are useless if no one carries them out.

I recommend you start recruiting around one month before the event. Most recruits will volunteer within the last week or two, and during that time you may get all that you need. However, the extra weeks beforehand give you a better chance to get enough people on board. For events needing more than a dozen people, you may need to start recruiting two months in advance. For example, the Tulsa Run requires more volunteers than any other event I have organized. That extra month of recruiting has meant the difference in getting the people needed.

Fortunately, today we have many ways to get out the message about public service events. Of course, local nets on VHF/UHF repeaters are good channels for recruiting. Many of the net regulars will be active club members and ready to help out. Don't forget about DVR announcements on the repeaters, too.

Club meetings are another good avenue for recruiting. I have seen some clubs pass around a sign-up sheet, and

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many times very few will put their names down. Some do not want others to see their names on the list; some cannot commit at that time. On the other hand, I have had people respond positively when I approach them directly and personally. Another tactic I have asked for a show of hands of who has worked the event before and then immediately asked who will work it this year. That helped get about half the people needed for the 2005 Tulsa State Fair Parade.

If the club puts out a newsletter or has a website, make sure to get a short notice to the editor and/or web master. This is a good way to reach members who may not come to a meeting or check into a net, but they have time to spare on a weekend, when most public service events happen.

If you have been the public service officer for a while, you may have the e-mail addresses of volunteers for previous events. A group message will reach a more receptive audience.

If you do not get sufficient results from these methods, you can always grab a club roster and a telephone. I recommend you take a copy of the regular roster and eliminate the names of members you know will not be able to help with the event. This will save you time and frustration later.

As you gather names and callsigns, do not forget e-mail addresses, phone numbers (home, cell, and work), and T-shirt sizes (many events sponsors will give shirts to volunteers). Compile this information into a database; it may come in handy later.

For some events you may be able to accommodate volunteers with special needs, such as a need to leave early or to operate from a special location. Be sure to ask about these conditions.

Predetermine Assignments

As a volunteer, I have shown up at a command post for a public service event, and then waited to receive an assignment. The club officers in charge of the event often waited for maps from the event organizers before making assignments.

I was never satisfied with this practice. The club leaders knew for several weeks or months beforehand that the event was coming up. They also knew how to contact the event sponsors. Why didn't they contact the event organizers, get maps, and have assignments ready before the event? This practice of waiting for maps and assignments once unnecessarily cost me time and gas. I drove about 18 miles from my house in Kiefer, Oklahoma to West Tulsa. Then I drove about the same distance to my assignment between Sapulpa and Kellyville. My post was about 10 miles from my house.

I decided that when I was in charge of organizing communications for a public service event I would do as much planning as I could *before* the event.

My first event was the Maple Ridge Run on Memorial Day, 2004. This is a 5K race that takes place entirely within Tulsa's scenic and historic Maple Ridge neighborhood. This area has plenty of trees and attractive houses. It also has plenty of curvy streets that can easily confuse a visitor. The map the race director sent me only showed the course and not the streets. That was not acceptable as what I wanted to present to my volunteers.

Fortunately, I am a drafter. The race sponsors have a very good map of the neighborhood on their website (www.mapleridgeneighborhood.com). I clipboarded this image into my drafting program and traced over parts of it to create an image I could manipulate. I added arrows to illustrate the route and circled numbers to indicate checkpoint locations. For the 2005 event, I replaced the circled numbers with leader notes (arrows and text). I used a shareware program (PDF995, available from <www.software995.com>) to save it in .pdf format. This allowed me to e-mail the map to my volunteers and they could print out their own copies.

If you are not a drafter, you could find a map on the Internet, print it, make your own marks on it, and scan it back into electronic form. Some mapping sites and programs will allow you to add marks to a map, but I'm not sure you can get the results you want. I do encourage you to experiment with this, especially if you are not satisfied with the map supplied by the event organizers.

Most of the leader notes gave tactical callsigns for the assignments. Tactical calls speed up contacts by the Net Control, because the NCO does not have to remember or look up who is assigned to a specific position. Tactical callsigns are easier to remember because they tend to be descriptive, such as "Turn Two" or "Start Line."

When assigning volunteers, make sure the person matches the position. You want to put your more experienced and competent people in the most important spots. I'm not saying you can't trust newcomers. You just have to match experience and skill to need. Ed Compos, K5CRQ, has been licensed only a couple of years as I write this, and he is one of my best volunteers. He came into ham radio with plenty of experience as a law enforcement officer and firefighter.

Also, consider physical characteristics and needs. If you have someone following the Race Director, the "shadow" must be able to keep up. Someone lean and fit will work better than someone old and overweight.

When considering assignments, don't forget equipment needs. Some locations may require a mobile setup instead of an HT. Will you use VHF or UHF, repeater or simplex, or some combination of these?

Prepare Volunteers

You could send the map and assignments through a group e-mail, but I prefer individual massages. That allows me to give each volunteer the details he or she needs concerning his or her particular assignment. When a club meeting occurred in the week before an event, I handed out maps and assignments then.

You could give out assignments on local nets, but I do not recommend it. Nets should be used to pass on general information, the things all volunteers need to know.

Make sure to give your volunteers *all* the information they need. Here is a checklist:

- Location
- Tactical callsign
- Special duties
- Equipment and accessories (mobile or HT, headphones, flashlight, etc.)
- Clothing (comfortable shoes, rain gear, safety vests, etc.)
- Schedule (when to be on station, when net will start, etc.)
- To whom to report, if the location is staffed by event personnel.

Final Pre-event Contact

At least two days before the event make one more contact with the event organizers, preferably by phone. Assure them your people are prepared. If the event organizers are giving out T-shirts, give them a list of sizes and amount of each size needed. Ask about any last-minute changes.

For the 2005 Maple Ridge Run, Race Director Chip Ard made a last-minute change to the route for the Fun Run. The

1-mile Fun Run uses essentially the same route as the 5K, and it starts before the main event. Chip was concerned about the Fun Runners interfering with the 5K runners staging at the start line. He changed the Fun Run route to move its finish line away from the start line. He wanted a checkpoint half way down the extra leg. Fortunately, I had one more volunteer than I had predetermined assignments. I created a new assignment and tactical call for this volunteer.

Individual Preparations

To me, public service is the most significant, the most satisfying, and the most rewarding aspect of ham radio. When I was out there as a volunteer, I felt I was part of something bigger than myself and I was in a position to make a difference.

During one of my first public service events (PSEs), a bike ride then called the T-Town Trek, I was "sweeping" the route when I found a couple of riders too exhausted to continue. I called for the SAG (support and gear) wagon and stayed with the couple until it arrived. What a wonderful feeling it was to help those who may have been stranded out in the boonies for hours!

Preparation is just as important for the individual volunteer as it is for the public service officer. You can't do any good if you are in the right place and on time, but your batteries give out or your antenna breaks.

Get Informed

Just as the public service officer needs to be sure of the date, time, location, and other particulars of the event, you also need that information as a volunteer. You are responsible for getting the information you need. If you think you need to know something, *ask*, or look around on the Internet.

You have two good reasons for knowing as much as you can about the event: (1) The information gives you an idea of what to expect and prepare for, and (2) members of the public can see you on post and approach you to ask questions. If you can't come up with an answer, you will look bad, the club will look bad, and the event organizers will look bad.

If the club's public service officer notifies you of your assignment before the event, make sure you have complete information (see the bulleted list under the heading "Prepare Volunteers"). Once you have it, use it to prepare yourself.

If you are working a location or an event for the first time, try to familiarize yourself with the area beforehand and determine the best route to get there.

Get Equipped

Check to see if you have the needed equipment, accessories, clothing, etc. Also make sure you have back-ups for vital items: radios, antennas, batteries. Once while working the Tulsa Run, I was sitting in my fold-up camp chair when I noticed something long, skinny, and black on the sidewalk to my left. It was the radiating element from my HT antenna. The antenna was an aftermarket model, and I had the original with me.

The day before the event, charge up any batteries that need it. Fuel up your vehicle, too! You don't want to be late or get stranded.

While going through your preparations, don't forget your personal needs, such as sunblock, insect repellent, water, snacks, medicines, reading glasses, etc.

One thing that can simplify your preparations is a "go kit" or "jump bag." Such kits are designed for local emergency activations, so you may want to keep one in your car. A basic kit should have everything you need to operate for at least 24 hours. Refresh the perishable contents on occasion, such as when you have a public service event coming up. You can get a go-kit list from your local emergency management agency or ARES group. You can also find a list at <www.tulsahamradio.org>.

Working the Event

You wake up early on a Saturday morning, when you would normally sleep in (at least I would!). You packed some things in the car the night before, but after getting dressed, you grab the last few items you need as you head out the door. On your way to your assignment, you stop for a breakfast burrito and a cup of dark-roast coffee.

You think about what you are sacrificing for the sake of amateur radio and the public—sleeping in a comfortable bed with clean sheets; fresh eggs over easy with coffee, toast, jam, and juice for breakfast with the morning paper; the do-it-yourself TV shows you faithfully watch and then dream of replicating their projects with your own tools and your own hands, but you never actually do; the beam in the back yard that needs to go back on the tower.

You arrive at your destination. You have made all the recommended preparations plus some you thought of yourself. You figure all you have left to do is to just work the event. Well not quite. I still have some guidelines for you. however, before I continue, on behalf of amateur radio in general, I want to say thank you for volunteering!

For All Volunteers

Before the event: *Be on time!* The best way to be on time is to be prepared and to be *early*! Make sure you have all the info, gear, and supplies you need. Get plenty of sleep the night before. Get up early enough so you have time to get dressed, eat breakfast, finish packing, and drive to your assignment. Allow extra time for unexpected developments such as flat tires, detours, etc.

While gathering your gear and supplies, take everything you need, but not too much extra. Most public service events last only four to six hours, so you don't have to pack as if you are going on a safari. Take enough to get you through the event. If you can't go two hours without chocolate, take along a candy bar or two, but no more.

If your assigned position is manned by public service event personnel, report to the person in charge if you have not been given a specific name. Tell the person who you are, why you are there, and what you can do—for example, "Hi, my name is Doug. I am a radio operator assigned to provide communications for this water stop. If you need to contact the race director, the water truck, or the police, let me know and I will contact them for you as quick as I can." Explain clearly that your job is communications. If you help with other things, you will not have your attention on the radio, and you may miss an important call.

During the event: Follow the instructions of Net Control, *period!* As a communicator, your job is to make sure the right information gets to the right person or place at the right time by using the best means. The Net Control's job is to make sure all the other communicators do their jobs. public service events tend to be more orderly than the disasters they help us prepare for. In either case, nobody needs someone adding to the chaos.

Use your tactical callsign when making and answering calls. This will help Net Control manage things more smoothly; he or she does not have to look up or strain to remember who is assigned where. Be sure to clear with your FCC-issued callsign according to Part 97 regulations.

Report emergencies *immediately*! If you do not understand why, you do not need to be involved in public service events or emergency communications.

Keep public service event personnel informed! That's why you are there in the first place. Do use some discretion. Do not repeat the name of an injured person, for example, even if someone asks.

Stay focused on the job at hand until the event is over. During long events, you may have to wait through extended periods of inactivity. Your attention could drift, or to break up the monotony, you start up some chitchat. The next thing you know, you've missed something you should have caught. Even if your assignment ends before the event is over, unless you have a good reason to leave, stick around. You may be needed to help another volunteer or to deal with some unforeseen development. This may sound like a yogism, but as long as you have a job to do, you have a job to do.

Even with all the serious aspects of public service events, don't forget to *have fun*!

For Net Controls

Open and close the public service event net with formal announcements. This lets stations not taking part in the net know that someone is using the frequency for a special purpose. Open the net about 15 minutes before the event. Take a roll call 10 minutes before the event to give your volunteers a chance to check their signals and equipment.

If an outside station wishes to make contact, they should ask permission from Net Control first. If the contact is allowed, the outside stations should immediately move to another frequency.

Emphasize tactical callsigns, but remember to have stations clear with FCC-issued callsigns. Some operators may be new to the idea of tactical calls, so they may need reminders.

To speed up communications during races, I usually allow two types of communications to go on without first going through Net Control. First, I let the start-line operator announce when the races have started. I also allow direct contacts with the race director's shadow.

Be sure to thank the volunteers on the air and in person. If you have to hand out T-shirts, you may have your volunteers gather at your location. That will give you a chance to thank them in person. You may also want to hold a debriefing then if you think one is needed.

After The Event

As I mentioned earlier, public service events help us prepare for emergencies and disasters. One big difference is that emergencies and disasters don't happen on a regular schedule. They tend to occur suddenly, at inconvenient times and places. Then how do public service events help us prepare for the "Real Big, Bad Nasties"? By allowing us a chance to practice using our skills at communicating, organizing, and planning. They get us thinking about things such as maps, assignments, controlled nets, batteries, flashlights, etc. After each public service event you have an opportunity to review what worked, what didn't work, and what you can do to be better prepared for next time.

If you are the public service officer in charge of the event, write an article for the club's newsletter and/or website. Don't just say, "The following members went to Suchandsuch Park to provide communications for..." Tell the story. Surely more happened than a bunch of people stood or sat around and talked on radios. Did the experience teach you a new lesson or reinforce an old one? Did you get hot, cold, sweaty, thirsty, tired, gritty, dusty, dirty, grimy, or any combination thereof? Inquiring minds want to know! You don't have to write a tabloid piece. Just tell a story in a conversational style. While writing, imagine you're telling the story to a friend over a cup of coffee.

Your article will do several things. It lets the club members know it is a viable, active group that provides a valuable service to the community. It gives recognition to the volunteers and confirms the value of their efforts. People also enjoy reading about themselves and their friends. Also, on the local nets once again say thanks to the volunteers and give a short report.

If you or someone else hasn't already done so, you may want to start a scrapbook. If such a scrapbook exists, add your article and photos.

Then get to work on your next public service event! ■

SMOGfest 2005
A Major Gathering of 6-Meter Operators

Even without W6JKV's annual barbeque last year, 6-meter aficionados met for a one-time fun-filled event in New England called SMOGfest.

By Ken Neubeck,* WB2AMU

SMOGfest was held in a unique setting—an outdoor barbeque-style restaurant located in Exeter, Rhode Island. (All photos by the author)

A special T-shirt commemorating SMOGFEST was for sale and was a very popular item.

From left to right: Mick, W1JJ, one of the event's organizer, speaking with former QST VHF columnist Emil, W3PP, and current QST VHF columnist Gene, W3ZZ.

More than any amateur radio band, 6 meters has its unique set of propagation modes. The band is loved by a hardcore group of aficionados. On September 24, 2005 an event was held in Rhode Island. Known as SMOGfest (the Six Meter Operators Group 'fest), many of these 6-meter aficionados attended. This was a once-in-a-lifetime gathering for many, and 6-meter operators were able to meet one another in person. Some of these ops had been worked via aurora, sporadic-*E*, and even *F2* on the 6-meter band!

The event was planned when well-known 6-meter DXer Jimmy Treybig, W6JKV, was not able to conduct his annual barbeque on his ranch in Texas in 2005. Acting quickly, several New England hams worked to put together an alternate event at an East Coast location. John (Mick) McManus, W1JJ, along with Dennis Motschenbacher, K7BV, Steve Gilbert, K1SG, Ivan Pagacik, K1MS, and John Allen, K1AE, found a great location with an outdoor-style restaurant known as Yawgoo Bakes and Barbeque in the rural town of Exeter in Rhode Island. Invitations were sent to over 150 six-meter operators.

It was a beautiful fall day for the New England area, with temperatures reaching almost 70 degrees F. Approximately 100 people attended this event—about 80 six-meter ops and 20 YLs. All operators had sent in their QSL cards with payment for SMOGfest, and from these cards some really great badges were made! People came via plane, ferry, and automobile. Most of the attendees were from the East Coast, with good representation from the 1, 2, 3, and 4 U.S. call areas and the VE2 and VE3 Canadian call areas. However, some came from farther away: Pat Rose, W5OZI, from Texas; Ned, AA7A, from Arizona; and Doug, VE5UF, and Andy, VA6SZ, from the western provinces of Canada. Tom Gallagher, N6RA, made the trip from California, and he brought logs and QSLs from his recent DX trip as FP/N6RA. Many others brought QSLs to confirm contacts made with the attendees.

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Another group shot with operators from left to right: Dave, K2SIX, Dennis, K7BV, and Clint, W1LP. Dennis had just arrived after participating in several weeks of health-and-welfare traffic assistance in the Gulf States affected by Hurricane Katrina.

Working on the five-element Yagi is Kaz, K8KS, an eye laser surgeon from Michigan. He is one of the newer operators on 6 meters. Kaz started out on 6 about two years ago, but he has embraced the band in a big way and is very popular with many of the veteran operators on the band.

A thing of beauty—a five-element, 6-meter Yagi in an open field.

Here are two well-known 6-meter operators: VHF contester Bob, K2DRH, on the left and well-known VHF maritime rover operator, Clint, W1LP, on the right. Bob has provided many contacts on 6 meters in contests, while Clint has activated many rare all-water grids on 6 meters over the years!

Several excellent presentations were given in one of the buildings on the site. Among others, these included subjects such as EME, the beacon project, and DXpeditions.

Here are some 6-meter operators from the aurora zone: Bob Mobile, K1SIX, from grid FN43 and Andy, VA6SZ, from DO33. Note the badges, which were specially made for the event.

The owners of two very well-known 6-meter beacons located on the East Coast: Mario Karsich, K2ZD (beacon located in FN20 on 50.068 MHz), and Steve Wilson, W1RA (beacon located in FN41 on 50.071 MHz).

The entire group of SMOGfest attendees sang happy birthday to Jimmy, W6JKV, via video to his home in Texas. This may have been one of the largest gatherings of 6-meter operators at any one time in the history of North America!

A number of operators brought their rover stations with them, including Frank, KB1LKB, with his 6-meter loop antenna situated on the back of his pickup truck.

Here is another mobile station with driver Frank, AA2DR, and passenger Joe, NA2P, talking to bystander Kaz, K8KS.

One of the buildings located on the SMOGfest site was used as a lecture hall for several talks and presentations on 6 meters. Besides N6RA's talk on his FP trip, there were presentations on other aspects of 6 meters, including EME (earth-moon-earth), DXing, and equipment. These were given by Ned, AA7A, Pat, W5OZI, Dave, N3DB, and Dennis, K7BV, among others. Several vendors, such as ICOM and Array Solutions, provided financial support and equipment for viewing. Mike Staal, K6MYC, of M^2 Antenna Systems, Inc., provided special "crying towels" for the 6-meter operators with the apropos saying "No 6 Meter Es . . . poor pitiful me."

During the day there was a five-element Yagi and ICOM IC-7800 (provided on loan) on the air. Unfortunately, there was no propagation brewing and few stations could be worked. Ah, the nuances of 6 meters!

The event began at around 11 AM and ended at about sundown for many of the operators. A number of smaller groups got together afterwards to continue various conversations about 6 meters. One day hardly seemed enough to everything of interest.

Many photos were taken at SMOGfest. This article presents some of the ones I took, but space is limited here. Check the special internet website put together by Al, K3TKJ, where many photos of the different hams at the event are provided by Mike, K8ROX, and Dave, N3DB. The site is: <http://www.smogfest.info>.

Many thanks go to the organizers of the event—W1JJ, K1MS, K1SG, K1AE, and K7BV—for making this a truly memorable experience for those who attended. It was especially gratifying for me to meet about two dozen operators whom I had worked on 6 meters; I had never before had the opportunity to meet them in person. I am sure that many other attendees have the same feeling I do and are also grateful to the organizers of the event for this unique opportunity. ■

QUARTERLY CALENDAR OF EVENTS

Current Contests

European Worldwide EME Contest 2005: Sponsored by DUBUS and REF, the EU WW EME contest is intended to encourage worldwide activity on moonbounce. Multipliers are DXCC countries plus all W/VK/VE states.

The contest dates and bands are as follows: First weekend—50, 144, 432, and 1296 MHz, 11–12 February, 0000 to 2400 UTC, digital only; second weekend—432 MHz and 5.7 GHz and up, CW/SSB, 11–12 March, 0000 to 2400 UTC; third weekend—144 MHz and 2.3 and 3.4 GHz, CW/SSB, 8–9 April, 0000 to 2400 UTC; and fourth weekend—1296 MHz CW/SSB, 6–7 May, 0000 to 2400 UTC.

Sections and awards include the following: QRP 144 MHz <100 kW EIRP, 432 MHz <400 kW EIRP, 1296 MHz <600kW EIRP, but no separate QRP/QRO categories. The QRO category on 144, 432, and 1296 MHz, stations with EIRP equal to or greater than stated above. The PRO category includes non-amateur equipment or antennas. PRO stations will have scores listed separately. CW/SSB: all QSOs in CW and/or SSB mode; no other modes may be used. DIG: all QSOs in digital mode (e.g., all the "JT" modes); no other modes may be used. ASS (Assisted): stations using liaison by any other means (e.g., DXcluster, logger, Internet, telephone) must indicate this and will be marked with an asterisk after their callsign in the results tables. ASS is not a separate section. Multi-operator and QRO stations will be highlighted in the general classifications. All QRP/QRO band winners and QRP/QRO multiband winners will receive a free year's subscription to *DUBUS* magazine. In each band/section, certificates will be sent to the top five entries and to the highest-scoring station in the southern hemisphere.

For a valid QSO, both stations must transmit and receive both callsigns+ TMO/RST/xxdB + R.

Logs: Logs must be separate for each band and should be in normal "logbook" format. Top line: Your callsign, Band. Each QSO: Date/time, Callsign, Report sent, Report received, Points, Multiplier. Bottom line: Total points, Total multipliers, Total claimed score.

QSO Points: 100 points for each random QSO completed. 10 (ten) points for each sked QSO completed on 144/432/1296MHz. 100 points for each random or sked QSO completed on 2.3 GHz or higher bands.

Multipliers: Each DXCC country (except W/VE/VK), or each individual STATE worked in W/VE/VK. States and provinces can be determined after the contest using newsletters, web, or callbooks.

Total Scores: Single band score = [Total of QSO points] × [Total of multipliers]. There will be one QRP winner and one QRO winner on each band. Multiband score = [(Total sum of points on 144–1296MHz) + (2 × total sum of points on 2.3GHz or above)] × [Total sum of multipliers on all bands]. There will be one QRP multiband winner and one QRO multiband winner. Multiband stations will also be listed as an entry on each separate band worked, and can also win single-band awards.

Contest Entries: Copy of the log for each band with details of points, multipliers, and total points. The following information *must* also be included for each band: (1) Output power, transmit cable loss, antenna type, and gain. (2) Categories: QRO/QRP – single/multi operator - ASSisted – CW/SSB –DIG. (3) Name(s) of all operators. (4) Locator/State. Other info is welcome—comments, conditions, locator, station details, photographs, etc.

Quarterly Calendar

Feb. 5	First Quarter Moon. Moderate EME conditions
Feb. 12	Good EME conditions
Feb. 13	Full Moon
Feb. 14	Moon Apogee
Feb. 19	Poor EME conditions
Feb. 21	Last Quarter Moon
Feb. 26	Good EME conditions
Feb. 27	Moon Perigee
Feb. 28	New Moon
Mar. 5	Moderate EME conditions
Mar. 6	First Quarter Moon
Mar. 12	Moderate EME conditions
Mar. 13	Moon Apogee
Mar. 14	Full Moon and Penumbral Lunar Eclipse
Mar. 19	Poor EME conditions
Mar. 20	Vernal Equinox
Mar. 22	Last Quarter Moon
Mar. 26	Moderate EME conditions
Mar. 28	Moon Perigee
Mar. 29	New Moon and Total Solar Eclipse, Central Africa, Central Asia, and Central Russia
Apr. 2	Moderate EME conditions
Apr. 5	First Quarter Moon
Apr. 9	Moon Apogee and moderate EME conditions
Apr. 13	Full Moon
Apr. 16	Good EME conditions
Apr. 21	Last Quarter Moon
Apr. 22	*Lyrids* Meteor Shower Peak
Apr. 23	Poor EME conditions
Apr. 25	Moon Perigee
Apr. 27	New Moon
Apr. 30	Moderate EME conditions
May 5	First Quarter Moon and *Eta Aquarids* Meteor Shower Peak
May 7	Moon Apogee and moderate EME conditions
May 13	Full Moon
May 14	Poor EME conditions
May 20	Last Quarter Moon
May 21	Good EME conditions
May 22	Moon Perigee
May 27	New Moon
May 28	Poor EME conditions

—EME conditions courtesy W5LUU

Sending Your Entry: Contest entries *must* be sent no later than 28 days after the end of the last contest weekend (i.e., in the mail or e-mail by 7 June 2006). Entries for the *first* weekend (Digital) must be send no later than 28 days after 12 February (i.e., in the mail by 12 March 2006).

Mailing address: Patrick Magnin, F6HYE, Marcorens, F-74140 Ballaison, France.

You may also e-mail your contest entry in ASCII format to: <f6hye@ref-union.org>.

All e-mail entries will be acknowledged within one week. For further questions contact: <info@dubus.de>. Complete rules can be found at: <http://www.marsport.demon.co.uk/EMEcont2006.pdf>.

Spring Sprints: These short-duration (usually four hours) VHF+ contests are held on various dates (for each band) during the months of April and May. This year's dates and times were not available at press time. It is assumed based on last year's dates that they will be as follows *(however, please check with the sponsor)*: 144 MHz, April 3, 7–11 PM local time; 222 MHz, April 11, 7–11 PM local time; 432 MHz, April 19, 7–11 PM local time; Microwave, May 6, 6 AM to 1 PM local time; and 50 MHz, May 13–14, 2300 UTC Saturday until 0300 UTC Sunday. Logs and summary sheets should be e-mailed or snail mailed to the addresses below. Logs should be submitted within 30 days of the end of each contest. Contact information: Jeff Baker, WU4O, 2012 Hinds Creek Road, Heiskell, Tennessee 37754; e-mail: <springsprints@etdxa.org>. Sponsored by the East Tennessee Valley DX Association. The up-to-date information on these contests can be found at <http://www.etdxa.org>. At this URL, click on the VHF/UHF link to go to the contest info.

2 GHz and Up World Wide Club Contest: The following is unofficial and is developed from assumptions based on last year's contest *(check with the sponsor for confirmation)*. Sponsored by the San Bernardino Microwave Society, this contest should run from 6 AM on May 6 to 12 midnight on May 7 (36 hours). The object is for worldwide club groups of amateurs work as many amateur stations in as many different locations as possible in the world on bands from 2 GHz through Light. Rules are available at the following URL: <http://www.ham-radio.com/sbms>.

Conference and Convention

Southeast VHF Society Conference: The 10th annual conference will be hosted in Greenville, South Carolina, April 28–29, 2006. The location and registration information were not available at press time. Please see <http://www.svhfs.org/> for the registration forms.

Dayton Hamvention®: The Dayton Hamvention® will be held as usual at the Hara Arena in Dayton, Ohio, May 19–21, 2006. For

(Continued on page 49)

Diversity Reception for Amateur Radio

WB9YBM discusses a "diverse" way of receiving amateur radio signals.

By Klaus Spies,* WB9YBM

Although diversity reception has been used for well over a decade in the commercial side of radio communication, it has been under-utilized (if utilized at all) in amateur radio. One reason may be due to the expense involved with the receivers, as a diversity receiver has two RF and IF stages, instead of just one each, which is typical of common receivers.

For those who are new to the concept of diversity reception, here is a brief explanation: The "diverse" part of "diversity reception" is a diverse antenna location. Instead of using the typical single antenna to receive a signal, two are used. They are spaced one wavelength apart, so that if propagation characteristics or signal-path changes from mobiles occur, signals will fade in at one antenna, while signals fade out at the other antenna. This way, a signal can still be heard. Making certain identical antennas, coax types and lengths, and receivers are used will ensure a fair and equitable chance that the signal will be received with the same chance at either antenna.

Here's how diversity reception can be realized in amateur radio without the need for expensive, specialized receiver equipment. In this example, the receivers available on your ham shack bench can be used—without even requiring modification!

Especially on the VHF and UHF bands, we've all noticed how signals swish-swish through signal nulls either when we ourselves are mobile and listening to our favorite repeater, or when we're trying to work mobile stations on simplex. In extreme cases, we've even lost a signal entirely, only to regain it by rolling our cars forward or back by a few feet.

Experiments in commercial application have shown that having two receive antennas spaced apart by one wavelength is the optimum distance between the two. In other applications (Nissan car radio antennas, circa 1990) when antennas were not spaced one wavelength apart, one was horizontally polarized and the second vertically polarized, which has merit if signals change phase due to path reflections (an example of this can be heard on 10 meters FM during band openings).

Because of the required antenna spacing, diversity reception is certainly easier on the VHF and UHF bands, particularly with

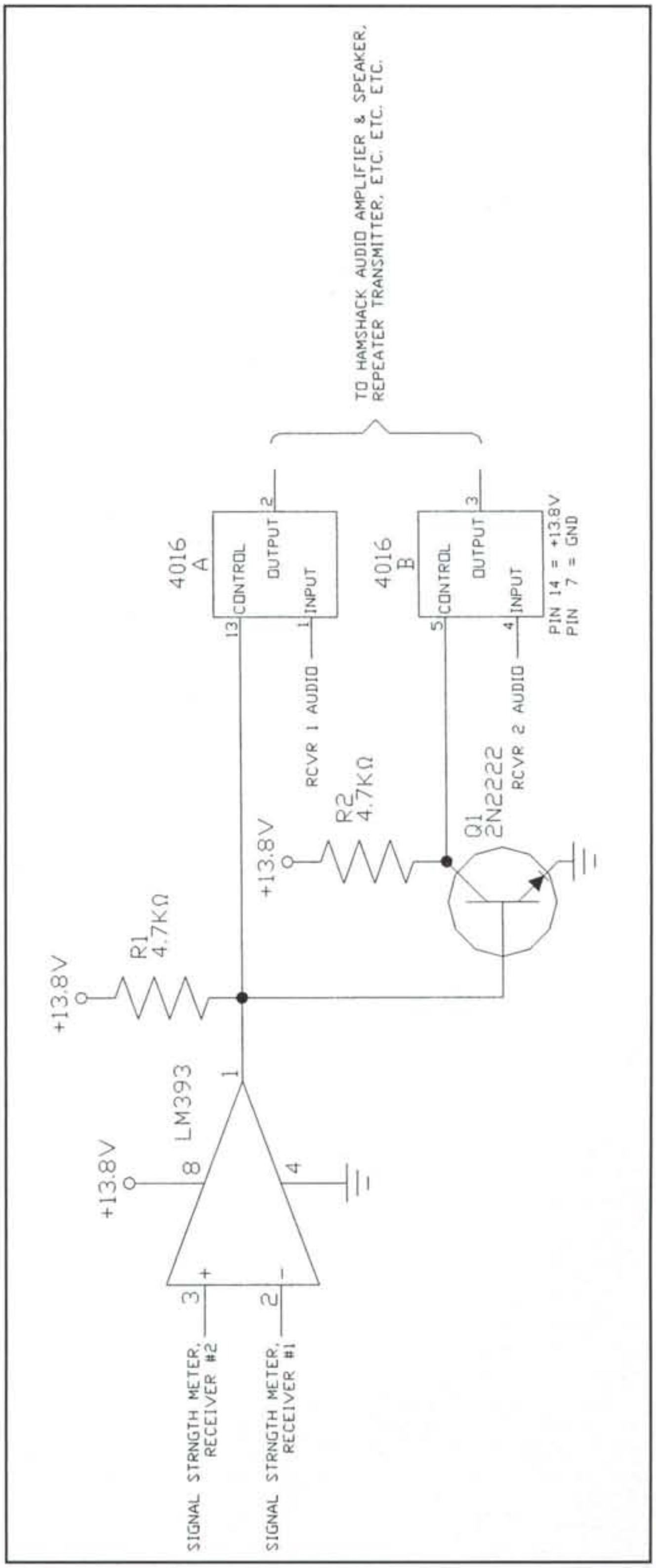

Figure 1. Schematic diagram of the circuit used for combining the signal-strength meters of the two receivers for diversity reception. →

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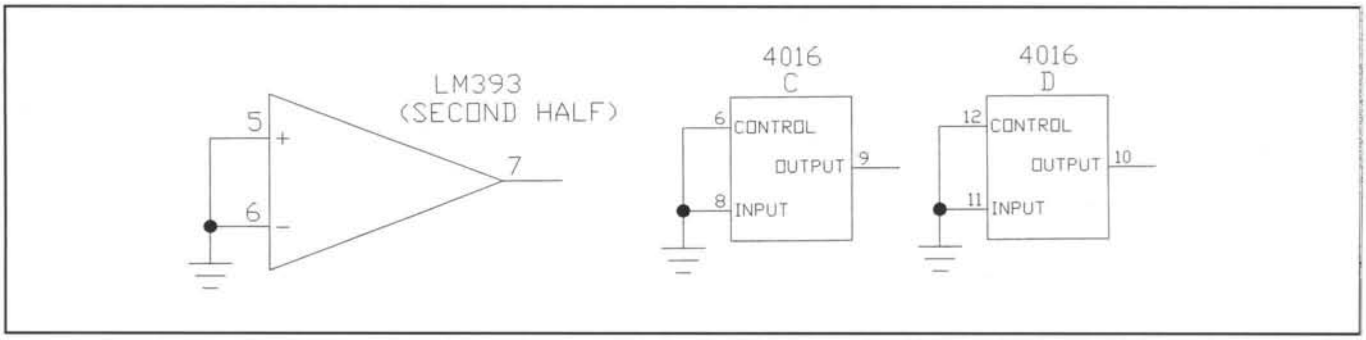

Figure 2. Schematic diagram showing the unused inputs of the gates.

the limited space in a mobile environment. It has been done successfully, though, on HF as well. In this particular case, I had a 10-meter FM to 220-MHz link established at a base station in Niles, Illinois with my friend Joe, W9CYT/SK, operating 10 meters FM in Schaumburg, Illinois, 30 miles due west of Niles. When stations faded out at Joe's QTH in Schaumburg, he heard them fade in at Niles, through the link. He could work DX without missing a beat!

With antennas now established to receive diversity, the next step is the radio aspect. Most people, especially those who have been around enough years to collect a bit of gear, typically have at least two rigs (if not more) for their favorite band. The only thing required of these radios is to tap a signal off the signal strength meter, and feed it into the circuit in figure 1.

When the signal strength at radio 2 is less than that at radio 1, the circuit will stay in the "off" position, and audio from receiver number 1 will be heard. Once the signal strength of radio 2 increases beyond the level of radio 1, the circuit will switch, and audio will be heard from that radio. The same can be applied to repeater operation, in order to make the machine more "bullet-proof" when operators are out near the fringe areas of the repeater's coverage.

There are certain considerations required to make sure we're playing on a level field: having identical antennas at identical heights will make sure we're hearing the signals with equal probability at both points. Identical receivers ensures both have very similar sensitivity and selectivity. These things will ensure that any switching that happens will occur due to a signal fading out in one antenna and fading in at the other, and not because one radio has an advantage over the other—and subsequently is forced to do all of the work.

Construction

In actual application, there are a few additional considerations required for proper circuit operation. Shielding the circuit in a grounded metal box, bypassing all incoming and outgoing leads, and using shielded cables—at least for microphone inputs—is the bare minimum protection against RF in the ham shack causing problems. Also, inputs of unused gates should be grounded (see figure 2).

Cross-Interference Issues

A question might be asked concerning protection of one radio from the other when the other is keyed: Does one need some sort of additional circuit to protect the first radio from being blown up (figuratively, if not literally) when the second radio transmits?

My answer is that no additional circuitry is needed. There might be ever so slight desensitization of a receiver if a nearby transmitter keys up, but that's only an issue for weak signals.

Conclusion

As built, the circuit provides switching speeds limited only by the response time of a radio's signal-strength-indication circuitry. If slower speeds are desired, small capacitors can be installed at the output of the signal-strength meters. ■

A Tale of Two Meters

Combine nostalgia for a radio once owned by the author with the opportunity to restore another radio of the same model, and you have the tale of how N9XU resurrected his interest in operating on the 2-meter ham band.

By Dave Holdeman,* N9XU

The past: It was the best of times. It was the worst of times. Shades of Charles Dickens' *A Tale of Two Cities,* and all that. Seriously, it was early 1974 and I was making good money as a supervisor for AT&T. The Middle East oil embargo was winding down, but there were still spot shortages here and there. It was at this time that I decided to drive up to Amateur Electronic Supply (AES) in Milwaukee and take advantage of a sale on 2-meter gear that they had recently advertised.

I took off for AES at 7 AM on a Monday morning, traveling from my home in Hanover Park, Illinois. Under normal weather conditions the trip should have taken no more than two hours, but I ran into a horizontally blowing ice storm en route that made driving nearly impossible. I arrived at AES at about 1 PM and bought an SBE model SB144—a 12-channel, crystal-controlled 10-watt transceiver with an S-meter, which doubles as a power output indicator.

Shortly after leaving AES, there was a power failure in the southern Wisconsin area, and I was unable to refill the car's gas tank for the trip home because of lack of power at the gas pumps. I was driving on fumes on interstate I-294/94 toward home with my heart in my mouth, and I heard on the car radio that electrical power had just been restored to Union Grove, Wisconsin. Luck was with me, as I spotted the Union Grove exit ramp just ahead. I reasoned that if the power was newly restored, there should be gasoline in town. Sure enough, I coasted into the first gas station I found and the station had plenty of gas. The proprietor said that I was his first customer since the power had been restored.

I arrived safely back home just before dark and installed the radio in my nearly new 1973 Mercury. About two weeks later the radio was stolen from my car before I had much of a chance to enjoy it. It was later recovered and turned over to my insurance company, but that's another story. It ended up being sold to another ham.

The Present (30 Years Later)

On May 2, 2004, I spotted an identical transceiver at the Dekalb County, Illinois hamfest. It carried a $35 price tag, which I thought was too high. About an hour later I offered the seller $10 for it (I'm not sure why, maybe nostalgia was affecting my brain), and he accepted my offer.

The next day I examined my purchase and noticed the following:

1. The rear power receptacle was broken and the positive lead was rubbing against the chassis.

Photo 1. The broken power receptacle on the SB144 was replaced with a small metal plate and rubber grommet.

2. The top and bottom covers were scratched and the crackle finish was chipped in various places.

3. The top cover had four extra holes drilled in it.

4. The mounting bracket that came with the radio was not original.

5. The radio had no operator's manual.

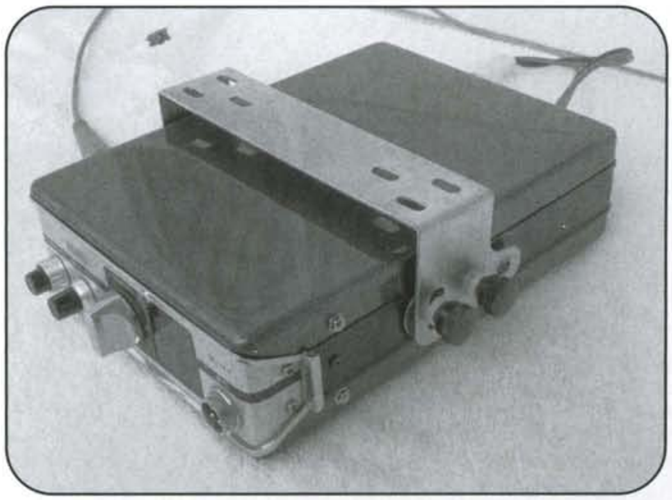

Photo 2. The mounting bracket arrangement

*e-mail: <d.holdeman@att.net>

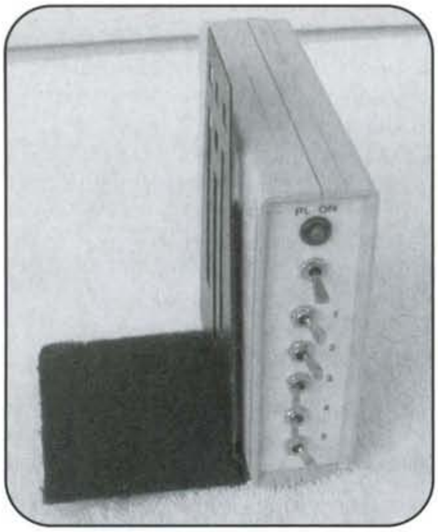

Photo 3. The PL case assembly.

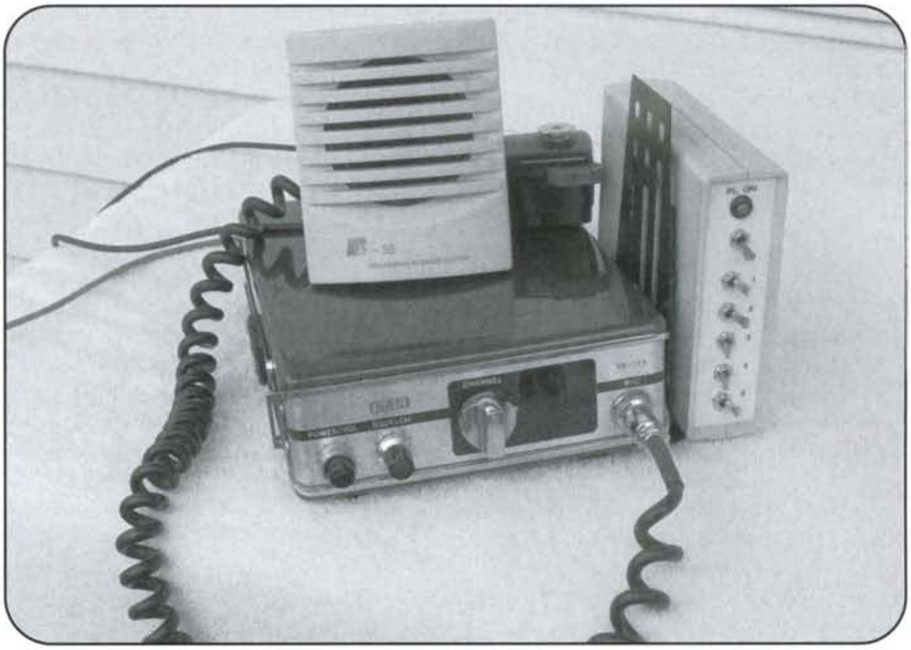

Photo 4. The renovated SB144 and the PL case look very attractive and make a nice addition to the shack.

6. The radio was equipped with six pairs of crystals, only four of which were useful in my area.

I performed an Internet search for an operator's manual and had five replies in about a half hour. Some had extra crystals, but they weren't suitable for this rig. Ed Lambert, K1ZOK, made me a nice, legible copy of his manual and an enlarged diagram, so it was easy to discern what modifications would be necessary to make the radio function in this modern age.

I replaced the broken power receptacle with a small metal plate and rubber grommet (see photo 1). Through the grommet I wired in a new power cable with a modern T connector. The rubber grommet was large enough to pass a small shielded cable alongside the power cable for connection to the phase modulator for the insertion of sub-audible (PL) tones. I had an old Com-Spec 32-bit tone encoder in my junk box. After connecting the transceiver to my dummy load, I was happy to see that the power output measured between 10 and 12 watts.

I cleaned the unit with ammonia and cotton swabs and it started to look pretty spiffy. My son, who runs an auto-body shop, plugged the unwanted holes in the covers and painted them a nice charcoal gray using automotive enamel and clear coat. Since the covers use metric threads, I replaced the old grimy screws with shiny computer hard-drive mounting screws, which made a nice contrast with the charcoal gray. Now the unit looked better than new.

Before ordering crystals, I checked the output frequencies with my counter. The transmit crystals that were common to my area were put on frequency and the unneeded ones removed. Two receive crystals were off frequency when I used my synthesized handheld transceiver as a signal generator. I performed an Internet search for crystal manufacturers that were familiar with the SB144 specifications and placed an order on June 7, 2004.

Finally, I examined the mounting bracket that came with the radio. I found that it would work satisfactorily with the transceiver if I drilled two extra holes in it and used small felt spacers between it and the radio. I stripped the old finish from the bracket and found out that it was nicely plated underneath. It probably wouldn't have to be repainted at all. I most likely will never use the mounting bracket, but just in case, I tapped out the original threaded mounting holes in the sides of the radio from their original metric threads to 8-32 to match four knurled screws that I found at the local hardware store. They are called clamp screws, come in various sizes, and are quite attractive. The mounting bracket arrangement is shown in photo 2.

On July 21, 2004 I installed my new crystals in ascending order by frequency. I noticed that transmitting positions one and two were oscillating on the wrong frequency and were very unstable, although the power output seemed okay. I realigned the transmitter and that cleared up the trouble. I believe I had parasitic oscillations on those two channel positions.

There are three common PL frequencies used in my area. It therefore was necessary to come up with an arrangement to make the changing of PL frequencies easy. In order to do this I removed the tiny DIP switches from my junk-box PL deck and replaced them with miniature toggle switches. I mounted the whole shebang in a small modem case, bringing the toggle switches out through the front panel. At the same time, I added an LED to remind me whether the PL deck was on or off. Voltage for the PL was obtained from a regulated DC wall plug that I found at a surplus store. I then velcroed the PL case to an old metal bookend. The bottom edge of the book end fits under the transceiver, which holds the PL case vertical. The PL case assembly is shown in photo 3.

If one is adding PL to an old transceiver, it is normally good engineering practice to connect it to the modulator via the center terminal of the deviation potentiometer. I was unable to access the deviation pot, but was able to connect to the modulator transistor's base via a 10K series dropping resistor and a 1-mFd capacitor. I mounted these components in the PL case.

The SB144 is capable of 15 kHz deviation and has no automatic audio-level control circuitry. To set the deviation to approximately plus or minus 5 kHz I used the following setup: To the output of my scanner I connected a low-impedance VU meter. I then clamped the microphone of my synthesized 2-meter base station rig about one foot away from the speaker output of an audio oscillator. I connected the RF output of the synthesized transceiver to a dummy load and tuned the scanner and the synthesized rig to a frequency that is common to one of the transmit frequencies of the SB144. I turned on the audio oscillator, keyed the synthesized transceiver, and used the volume control on the scanner to set a reference value on the VU meter attached to the scanner. I then connected the SB144 to the dummy load and clamped the SB144 microphone in place of the synthesized rig's microphone. I keyed the SB144's microphone and adjusted the deviation potentiometer on the SB144 to get the same reference level on the VU meter attached to the scanner. I set the PL level by listening to the output of the scanner and backing it off until it was slightly below the audible point.

The radio looks like something out of the '70s (which it is) with its chrome-plated trim and shiny front panel. It and the PL case look very attractive and make a nice addition to the shack (see photo 4).

I have been using the SB144 when I run our local net and have gotten nothing but praise for its rich audio. The SB144 uses a frequency multiplication of 24, which probably contributes to good audio linearity.

One never knows what one might find at a hamfest. I just recently picked up a Regency HR2B, but what am I going to do with another 2-meter transceiver? ■

By John Champa,* K8OCL

HSMM

Communicating Voice, Video, and Data with Amateur Radio

The Hinternet on 5 GHz

What is the Hinternet? The word, actually an acronym, derives from what NASA loves to do so much—the linking of two or more acronyms. In this case, **HSMM** (high-speed digital multimedia ham radio) plus **Internet** equals Hinternet.

The Hinternet under development by many individuals and groups is intended to eventually become the ham radio digital WANs (wide area networks) formed by the linking of numerous local HSMM nodes or LANs. These HSMM nodes or LANs usually consist of inexpensive 802.11g access points (AP) operated under Part 97 rules in the 2.4-GHz amateur radio band, but could just as easily be an ICOM® D-Star network, or any other source of local HSMM amateur radio traffic.

Now to the 5-GHz Band

David Josephson, WA6NMF (wa6nmf@altaphon.com), suggests:

> If people are looking for a flexible router solution and don't want to learn Linux (or pay thousands for Cisco or Juniper gear) I can suggest Mikrotik. I have no connection with them except as a customer.
>
> Mikrotik is a small company in Latvia (with local support in the U.S.) making a prebuilt Linux-based system that runs from flash ROM. No hard drive is needed. They also make inexpensive single-board computers with Ethernet and mini-PCI slots built in. Anything we would need to do in current 802.11-based amateur radio is covered in the Mikrotik code, including the ability (for $10 more) to operate the Atheros chipset-based radios (CM9 and NL5354 for instance) in the rest of the 5650–5925 MHz amateur band, not just the UNII/ISM segments. This greatly alleviates interference issues with WISPs (wireless internet service providers); amateurs have 100 MHz of spectrum not shared with any unlicensed service. You can download the manual, get further details, etc., at <http:// www.mikrotik.com>.
>
> We are building some stations using this software and 802.11a cards. Mikrotik has a non-ack mode "Nstreme" that allows ranges over 40 miles, and a duplex mode "Nstreme 2" that uses two radios on different frequencies, one for transmit and one for receive. This allows separate transmit PA, if needed, and receive LNA. Together with surplus Telco microwave filters, duplexers, and antennas we are expecting 60+ miles with this, like we presently get with homemade T1 radios using FSK.
>
> As a historical note, we have been operating T1 over 6-GHz FSK radios in northern California since the 1970s and as hams for the Office of Emergency Services since the 1980s. There is a truck on standby operated by Stephen Cembura, N6GVI. It contains a small PBX, phones, a T1 channel bank, and a steerable dish antenna on a hydraulic mast. This was used extensively during the 1989 earthquake and for several smaller events after that. This network predates WISP and VOIP by a "few" years.

*Chairman of the ARRL Technology Task Force on High Speed Multimedia (HSMM) Radio Networking; Moon Wolf Spring, 2491 Itsell Road, Howell, MI 48843-6458
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Some Definitions, by Reader Request
802.11 Standards for Wireless Technology

802.11—refers to a family of specifications developed by the IEEE for wireless LAN technology. The designator 802.11 specifies an over-the-air interface between a wireless client and a base station or between two wireless clients.

802.11a—an extension to the 802.11 standard that applies to wireless LANs and provides up to 54 Mbps in the 5-GHz band.

802.11b–an extension to the 802.11 standard that applies to wireless LANs and provides 11-Mbps transmission (with a fallback to 5.5, 2, and 1 Mbps) in the 2.4-GHz band.

802.11g—an extension to the 802.11 standard that applies to wireless LANs and provides 54 Mbps in the 2.4-GHz band.

802.11n—an extension to the 802.11 standard that in the future will increase the speed to more than 100 Mbit/s. As projected, 802.11n will also offer a better operating distance than current networks.

Dave Stubbs, VA3BHF, writes:

"To anyone experimenting with the market-forgotten-but-still-very-capable 802.11a, here is a list of suggested channels for use in ham applications. I'm basing this on the channels as found in the D-Link DWL7000AP configuration screens.

Bear in mind, of course, that of the most common C.O.T.S. 802.11a gear, only D-Link and Netgear offer channels in the amateur overlap. LinkSys and SMC do not. These are 20-MHz channels, centered as follows:

Ham Disallowed (channels available on all brands)

Channels 36–48: Completely outside the ham band; indoor use only for Part 15 folks.

Channels 52–64: Completely outside the ham band; outdoor use OK for Part 15 folks.

Ham Band Allowed (channels on D-Link and Netgear only)

Channel 149: 5.745 GHz, ham friendly; falls above "Digital" and below "Weak Signal and EME."

Channel 153: 5.765 GHz, ham unfriendly, completely overlaps "Weak Signal and EME."

Channel 157: 5.785 GHz, ham friendly; falls inside "Digital/Video."

Channel 161: 5.805 GHz , ham friendly; falls inside "Digital/Video."

Channel 165: 5.825 GHz, ham unfriendly; partially overlaps "Amateur Satellite Downlink."

Based on all of this, it is probably best to use Channel 149, 5.735 to 5.755 GHz centered on 5.745 GHz, because this channel falls completely outside of any reserved or suggested-use parts of the band plan. Channels 157 and 162 are also workable, as they would easily be classed as "Digital/Video" and thus fall inside the suggested use for those frequencies. Comments welcome, as always.

Dave Stubbs, VA3BHF
(e-mail: va3bhf@rac.ca)

References: <http://www.rac.ca/service/micropla.htm> and <http:// www.arrl.org/FandES/field/regulations/bandplan.html#5650>

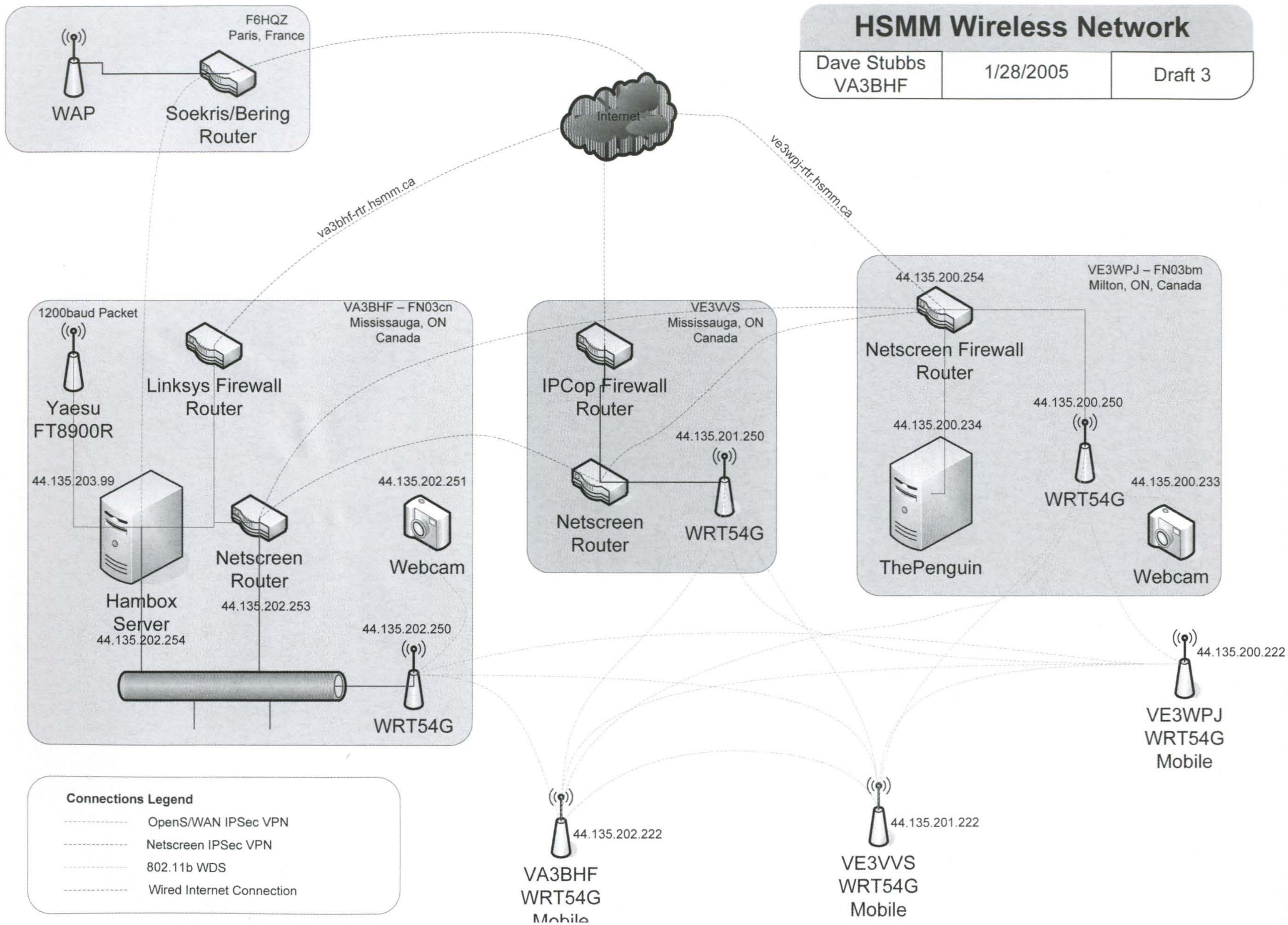


Figure 1. Client solution for DWL-900ap+.

WISPs

Mark Koskenmaki (not a ham, e-mail: <mark@neofast.net>) writes:

I would like to point out that hams should not be feeling like they are competing with WISPs (Wireless Internet Service Providers). On the contrary, think of it as having more people joining your force to do more. Many Wireless ISP types are soul-mates to the ham community, in that they are creative, think fast, and are often single or 1–10 person businesses. They (WISPs) understand working on their own, moving fast, and making do with what you have or can get.

After the initial efforts with Katrina are over, I would suggest that the ARRL and WISPA and maybe Part 15ers, as well, get together and see how each can complement the others in their emergency response roles. The ham community may wish to slightly change its role, if it can partner up with the wireless license exempt community. This isn't a competition; this is about lives and cooperating to save them. There are limitations to the WISP's technology that the ham community has invaluable means of filling. And the reverse is true, as well.

Hams are admirably prepared for such deployments, and have a great structure in place for organization and deployment. WISPs have higher capacity data and voice capabilities in their technological bag of tools. I can imagine no better partnership than the ham community with their extensive networks helping direct and deploy large capacity voice and data. While it is invaluable to have a voice person on the ground, hams partnering with a WISP or other wireless community can multiply the results and impact of their efforts. . . . Ham operators have no competition, in my view, for what they can do best, and that's being the absolute first responders, coordinating those who follow, and the WISP community is a natural second to follow. You (hams) could teach us WISPs a lot about organizing and preparedness.

IPv6

Regarding Internet Protocol version 6, Gerry Creager, N5JXS, Hinternet architect, writes:

One of the things I'm working toward is getting a large IPv6 allocation for our HSMM activities. IPv6 offers several benefits: We can encapsulate callsigns inside the 128-bit address space; it incorporates innate IPSec capability in the protocol stack (is it better than IPv4 IPSec? probably not, but it's built in, not hacked on), and it offers some inherent IP Mobility options. It also puts the ham community on the leading (bleeding?) edge of IP implementation for the USA, as there's a fair bit of research activity, but not too much real action on moving toward IPv6 that is visible.

As we get further into this, I'll be providing information on how to do IPv6<->IPv4 translations, and gateways. It's not too hard, but requires some consideration and thought. One caveat: Win9x, WinME, and Win2k are *not* IPv6 compliant, and thus, we're going to consider backup plans until Bill Gates kills off all those legacy systems. Wimp, Open|Free BSD, and Linux, as well as most all the *nix's, are IPv6 compliant. Linux is actually happier in IPv6 than IPv4 now, although you have to go way under the hood to determine that.

HSMM Fox Hunting

Ending on a fun note about HSMM fox hunting, Dave Stubbs, VA3BHF (va3bhf@rac.ca), suggests, "We need to get some hams doing this kind of stuff. Check it out at <http://wavehunt.redbrick.dcu.ie/>. It is fun to do."

Until next time . . .

73, John, K8OCL

By Joe Moell,* KØOV

HOMING IN

Radio Direction Finding for Fun and Public Service

Spurious Signals and Offset Attenuators

"A mysterious man in a red pick-up truck is driving around and pointing a suspicious device from the window!" That's what a caller told the sheriff's dispatcher in Washington, Iowa last August. Fortunately, there was no overreaction from authorities in this town of 7050 souls about 45 miles south of Cedar Rapids.

As the *Washington Evening Journal* reported, it was just the first in a series of ham radio "foxhunts." From the article: "Tally Ho? Four teams of members from the Washington Amateur Radio Club, with visitors from the Ottumwa club tagging along, all started at different points in the city and then used home-made direction-finding antennas and hand-held radios to converge on the 'fox,' which had been hidden earlier in West Haven Cemetery."

This publicity was excellent, as was an August article about Scott Fenstermacher, AG4GO, in *The Daily Press* of Hampton Roads, Virginia under the headline "Amateur Radio Expert Loves Thrill of the 'Fox Hunt.'" The subheading was "Gloucester man has turned a simple hobby into one that entertains, teaches, and even saves lives." It told how he and his son Phillip, KG4GYT, "serve on the local SKYWARN team and practice radio direction finding (RDF) skills that could find downed aircraft or missing emergency vehicles."

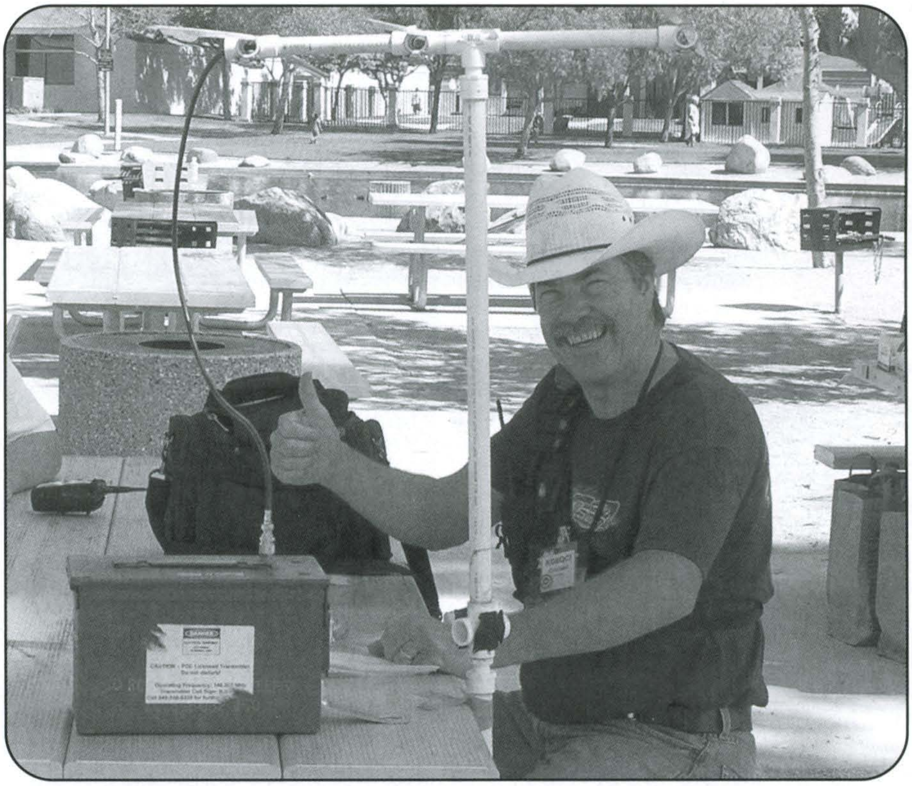
As I have written many times before, the time to learn RDF proficiency is before you need it. Regular practice paid off for hams in the South Orange Amateur Radio Association (SOARA) of Orange County, California in December, as I heard from Richard Saunders, K6RBS. "I keep every southern California 2-meter open repeater in the memories of my FT-857," he told me. "I regularly scan through and listen to what's going on.

"A few weeks ago, I began hearing a strange noise on one of the repeaters," K6RBS continued. "Then I started to hear it on two or three of the repeaters. That got me interested, because one repeater can have a technical glitch, but it would be very unusual for several to have the same problem. I went to VFO mode and tuned around. The noisy signal was moving around on the top end of the band. It was difficult to describe, but sounded sort of like AC hum or video buzz. It would sit on one repeater frequency for a while and then move on to another one."

Richard's beam indicated that the signal was to the north. He phoned and got bearings from Gordon West, WB6NOA, and from Dave Seroski, KG6QCI, his regular partner on SOARA mobile T-hunts. "Gordo announced it on his weak signal net that night," K6RBS explained. "A ham 75 miles to the north in Lancaster could hear it. Another ham 70 miles south in San Diego could pick it up."

The plotted beam headings indicated that the source was in or near the city of Lake Forest. Richard continued:

> Monday evening I went out and found the street that it had to be on. It was very strong and I could also hear its third harmonic in that area. On Tuesday, KG6QCI went out with his Doppler set and I went out again also. The signal was quite unstable, making it very difficult to get reliable beam headings. We narrowed it down to a couple of buildings, but I wasn't going to bang on any doors until I was sure. I had an offset RF attenuator with me, but the battery went dead so I ran out of attenuation.
>
> I got a new battery and went back on Wednesday with the attenuator, a TH-F6A handheld, and a tape-measure Yagi. With that setup, I nailed it to one end of one building. I



Dave Seroski, KG6QCI, enjoys being hider and promoter of SOARA mobile T-hunts. He helped Richard Saunders, K6RBS, track down a spurious 2-meter signal in Lake Forest, CA. (All photos by Joe Moell, KØOV)

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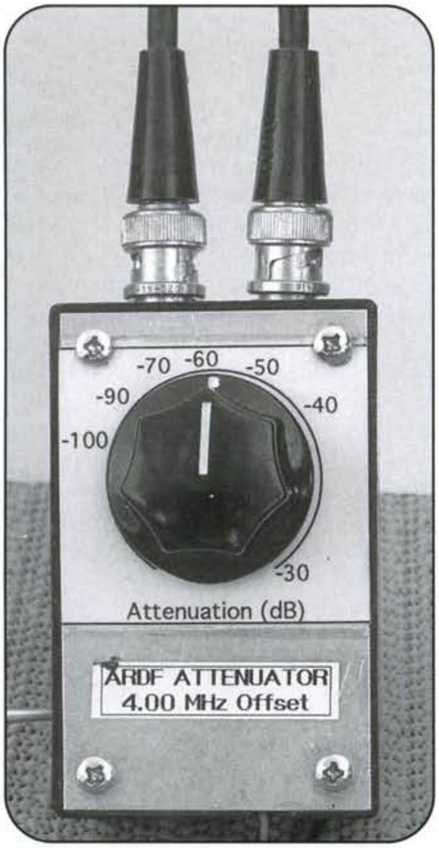


My home-built offset attenuator has been loaned to dozens of new radio-orienteers over the years at our local on-foot foxhunts.

was absolutely convinced of it, so I just went up and knocked on the door. When it opened, I said, "I know that this is a strange request, but do you own or manufacture any equipment that could cause radio frequency interference?" He said, 'We do GPS and satellite navigation systems, so it's quite possible. Come on in!"

After the Vice President of Engineering heard my story and listened to the noise, he got on the phone to an engineer in the back and asked him to turn the satellite link off. The noise went away. He turned it back on and the noise came back. "Well," he said, "we'll send that back to the manufacturer and have it fixed."

The interfering device was a radio modem and transceiver for communication with low-orbit satellites in the 148- to 150.5-MHz range. Its 5-watt transmitter was putting out an unstable spurious emission in the nearby 2-meter band. "The company had no idea what was happening," K6RBS said, "but they were very cooperative. The VP even offered me a job! He said he's been looking for a good engineering technician for some time. A ham who knows RF and troubleshooting would be ideal. I told him that as thanks for his cooperation, I'd put the job notice on our SOARA website."[1]

Jingling Spurs Everywhere

How many blockhouses full of commercial, government, and amateur radio installations are on hilltops in your area? Most of these transmitters operate under remote or automatic control for decades with no problems, but when one malfunctions, it sometimes is not apparent to the owners. Instead, it can become a mystery signal that affects other spectrum users.

The SOARA story brings to mind a similar transmitter malfunction a few years ago in Los Angeles. At that time, most open repeaters operated under carrier access, with no requirement for subaudible tones on the input. Users of these repeaters were used to occasional "kerchunks," but several repeaters began to experience frequent key-ups, often with snatches of medical-related messages in the audio. Monitoring on their input frequencies revealed that a spur from a paging transmitter was slowly sweeping from 146.4 to 146.2 MHz on every transmission, bringing up repeaters as far away as Running Springs in the San Bernardino Mountains.

Apparently, a lot of paging was going on, because there were a lot of these sweeps. It was worst in the late afternoon, making us suspect that the transmitter was in a room that got hot at that time of day, bringing on the spurs. While following the sweeping spur with one receiver, I used a scanner to check all the authorized paging frequencies for southern California. Exactly the same paging audio was on 171.3875 MHz, which was licensed to the Veterans Administration hospital in west Los Angeles.

After using RDF to confirm that the spur was indeed coming from that site, it was time to make contact and get the transmitter fixed. That's when my frustration began. "No problem," said the hospital's Communications Manager. "Here's the number of the dealer. We have a service contract, so just explain the problem and they'll fix it."

That sounded easy, until the manufacturer's representative told me that the contract only covered routine services. "This problem requires replacement of the transmitter, which the contract doesn't cover," he explained. "We sent the VA a memo to that effect."

At that point I became a reluctant intermediary in the middle of the dispute between a government agency, its radio service contractor, and the transmitter manufacturer. The hospital had no incentive to solve the problem without prodding, because its own radios and paging weren't being adversely affected. Administrators didn't seem to mind that their private medical messages were being retransmitted all over the southland. Thus, I had to keep calling the various players, getting responses such as:

Hospital Communications Manager: "We wrote a purchase order for the new transmitter."

Service Contractor: "We haven't gotten any purchase order."

Telecommunications employee replacing vacationing the Communications Manager: "There's no purchase order on file."

Hospital Communications Manager upon return: "The purchase order had an error and had to be rewritten."

Service Contractor: "Not only do we not have a purchase order, we haven't even been told to expect one."

Hospital Communications Manager: "The purchase order is rewritten and is probably in the signature chain."

Contractor's Receptionist: "He's out today."

Communications Manager's Secretary: "She's too busy to talk to you."

If a water pipe on my property sprang a leak, flooded my neighbor's yard, and began filling his basement, that neighbor would have no trouble getting local government to force me to stop the leak in minutes. Weeks of delay would be totally unacceptable. It wouldn't matter if I had a service contract dispute with my plumber or not. Similarly, one would expect that hams whose repeaters were being "flooded out" could get authorities to force the VA to fix its interfering trans-

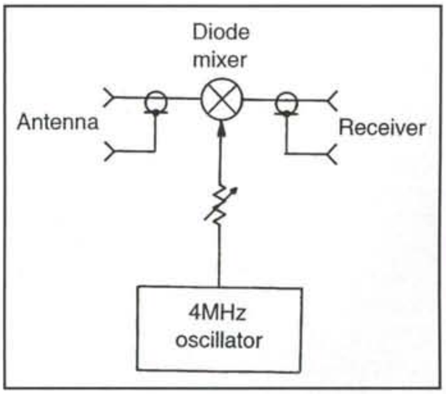
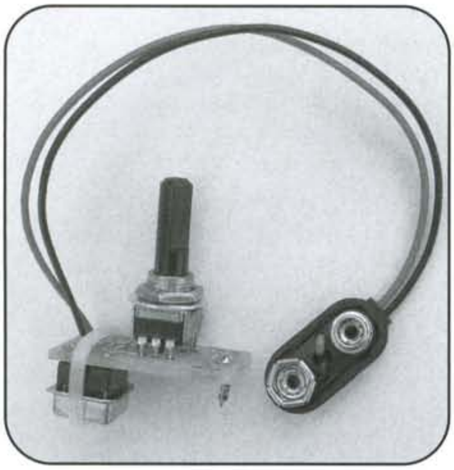


Figure 1. Block diagram of a simple offset attenuator. A potentiometer controls the amount of 4-MHz local oscillator signal into the diode mixer.



Marvin Johnston, KE6HTS, produces this offset attenuator circuit board with either a 2-MHz or 4-MHz crystal oscillator.

mitter immediately or shut it off. However, who's in charge?

What about the FCC? Yes, I tried there. The local Engineer-in-Charge told me that the FCC doesn't have licensing authority over government agencies, so he couldn't issue a notice of violation or intervene in any other way. He wouldn't bump it up the chain to Washington. Another dead end.

After many weeks the problem was finally fixed. Calls to doctors and nurses no longer rang out through southern California repeaters. This was before Riley Hollingsworth began handling ham interference matters in Washington. With that in mind, I wonder if a fix would come faster if the same problem happened again today.

Antidotes for RF Overdoses

Like the majority of 2-meter transmitter hunters in southern California, K6RBS uses a directional antenna and S-meter when tracking VHF spurious signals and hidden transmitters on foot. That requires some method for knocking down strong signals to the point that amplitude changes can be discerned as the antenna is turned. Front-panel RF gain controls are provided in only a few VHF transceivers, usually the relatively expensive multimode models. In most, lowering the RF gain control adversely affects S-meter action, so accurate bearings can't be gotten when gain is not at maximum.

It is possible to add internal RF gain reduction that won't upset S-meter action by controlling supply voltage to the RF preamp and first mixer stages, or by changing bias to FETs in these stages. I have done that with my faithful Drake UV-3 tri-bander for 2 meters, 125 cm, and 70 cm. That transceiver is easy to work on with multiple circuit boards and complete documentation. By contrast, it's difficult to perform similar electronic augmentation surgery inside today's tiny receivers full of surface-mount parts.

A simpler and much more popular way to knock strong signals down to size is to connect an external RF attenuator box between antenna and receiver input. A resistive (sometimes called a "passive") attenuator has several shielded sections in series, each with resistors to soak up the RF signal and a double-pole double-throw switch to bypass each section when not needed.

Attenuator boxes have been around for a long time and have plenty of uses outside of RDF work. You might find a good commercial one at a flea market, but check to make sure that no sections are burned out. You can readily make your own with ordinary carbon resistors, toggle switches, and copper-clad board.[2]

Most mobile T-hunters use these simple step attenuators. However, very strong signals will go around a resistive attenuator and enter directly through the receiver case or the coax between attenuator and receiver, pinning the S-meter. For on-foot hunts, when you may have to probe within inches of a transmitting antenna with a poorly shielded hand-held receiver, an offset-type attenuating system is better. It works by converting the strong on-frequency signal to a weaker and controllable off-frequency signal.

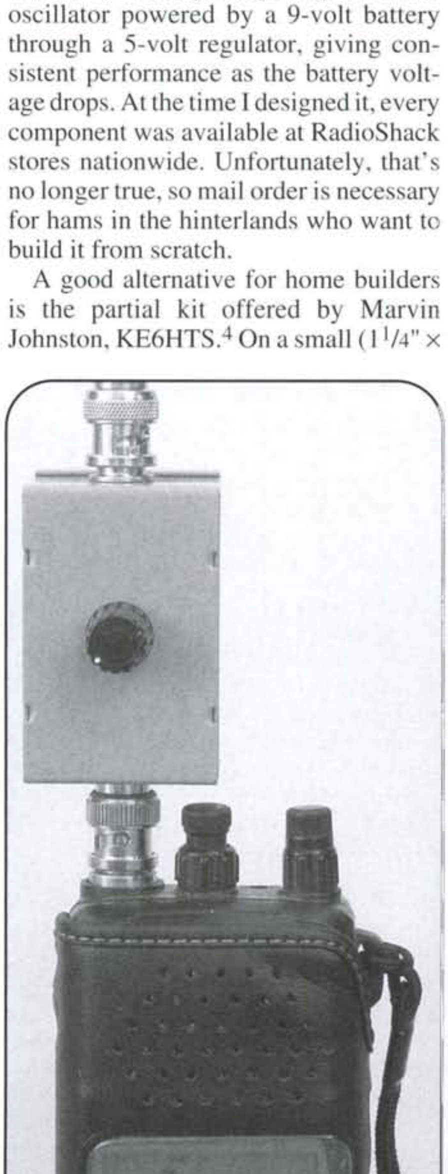
An offset attenuator consists of a local oscillator (LO) driving a diode mixer through the attenuation control, as in figure 1. The higher the LO level into the mixer, the higher the amplitude of the offset signal applied to the receiver from the mixer output. To increase attenuation, decrease the LO signal into the mixer with the control.

The most popular offset for 2-meter RDF is 4 MHz. For instance, to knock down a strong signal on 146.565 MHz, a popular simplex foxhunting frequency, turn on the 4-MHz LO, set the control for maximum LO into the mixer, and tune the receiver to 150.565 or 142.565 MHz. If the receiver does not tune outside the 2-meter band, use a 2-MHz LO instead and tune to 144.565 MHz. Reduce the LO signal until the S-meter is mid-scale and proceed with bearing-taking. The strong signal on 146.565 is still going into the receiver, but it doesn't matter because it's tuned to the offset frequency.

Some offset-attenuator builders use packaged double-balanced mixers, but a single, ordinary silicon diode works just as well for mixing in this application. I have measured up to 120 dB of effective signal reduction with one of my hand-held receivers. Some receivers may not perform as well due to the effects of overload by the non-offset signal.

It is easy to find construction plans for offset attenuators on the web, including the popular version in my site.[3] It has a CMOS- or TTL-packaged square-wave oscillator powered by a 9-volt battery through a 5-volt regulator, giving consistent performance as the battery voltage drops. At the time I designed it, every component was available at RadioShack stores nationwide. Unfortunately, that's no longer true, so mail order is necessary for hams in the hinterlands who want to build it from scratch.

A good alternative for home builders is the partial kit offered by Marvin Johnston, KE6HTS.[4] On a small (1 1/4" ×



The Arrow Antenna offset attenuator box doesn't have labeling or calibration markings, but it's small enough to mount directly on the receiver.

Charles Scharlau, NZØI, sprints to the 2-meter finish line at the 2005 USA and IARU Region 2 ARDF Championships. He and his wife Nadia are the prime movers behind the next national championships in April.

3/4") circuit board are all parts except the RF connectors, battery, and enclosure. The board is so small that Marvin suggests building the attenuator into the handle of your RDF beam.

A new plug-and-play offset attenuator is being offered by Arrow Antenna.[5] Its small aluminum enclosure has a BNC male fitting on one end and a BNC female connector on the other, so it mounts onto the antenna port of many handie-talkies and scanners. Because the 4-MHz CMOS oscillator draws less than 2 milliamperes, Arrow claims that the supplied 3-volt lithium coin-cell battery will last 100 hours before requiring replacement. That's probably true, because the one I am testing has been loaned out on many local hunts and has not run down yet. I think I will add a test point so I can quickly check it with a voltmeter without opening the box.

In summary, an offset attenuator is excellent for on-foot foxhunting, whether you use it for "sniffing" at the end of a mobile hunt or for European/Asian-style in-the-woods radiosports. It works with directional antennas or just with a rubber duckie as an aid to the "body shield" maneuver.

On the other hand, a resistive attenuator is a better choice for mobile RDF in most cases. Passive attenuators avoid the possibility of images and re-radiation from mixer back to antenna, which is more likely in mobile situations than on foot. Also, you won't have to worry about the battery running down!

Medals in Your Future?

An offset attenuator, directional beam, and receiver are all you need to participate in 2-meter on-foot foxhunting under international rules, also called radio-orienteering and Amateur Radio Direction Finding (ARDF). Whether you're a beginner or an expert, you will be welcome at the 2006 USA ARDF Championships April 7–9 near Raleigh, North Carolina. If you are just starting, you will learn from the best. If you're already good at it, you might win a position in our national ARDF team, which will travel to Bulgaria for the 13th ARDF World Championships (WC) in September.

Because 2006 is a WC year, the USA Championships are in spring rather than summer, and are shortened to a weekend to minimize time off and expenditures for those who will take part in both the national and world competitions. Organizers are Charles (NZØI) and Nadia Scharlau, who have won medals at previous USA Championships and competed on Team USA at the WCs. They will be assisted by members of the Backwoods Orienteering Klub.

"At the 2006 USA ARDF Championships, competitors will be expected to provide their own lodging during their stay," says NZØI. "That is customary at most American classic orienteering events. Those who need transportation to and from the airport or the event site should contact us at the time of registration. We encourage all to stay at the suggested lodging. Having everyone housed in or near the same motels will make it easier to arrange for ride-sharing and will facilitate socializing.

"These championships will be ideal practice for those who hope to compete in ARDF internationally," Charles continues. "For beginners, this will be an excellent introduction to how this sport is played world-wide. The 'playing field' and 'referees' will be ready for all comers. Participants can customize their total experience by selecting their own accommodations, transportation, meals, and non-ARDF activities. Those looking for suggestions will find them on our web site[6] or by contacting us. The organizers and the Tar Heels of North Carolina welcome all to the 2006 USA ARDF Championships. We look forward to seeing you in April."

Registration for the USA Championships is now open and forms are at the abovementioned website. More information about the history, equipment, and techniques of ARDF is at my "Homing In" website.[7] Please continue to send me photos and stories of transmitter hunting in your area, whether for sport, interference resolution, or search and rescue.

73, Joe, KØOV

Notes

1. <http://www.soara.org/bbs/index.php>
2. Moell and Curlee, "Transmitter Hunting—Radio Direction Finding Simplified," Tab/McGraw-Hill, Chapter 6 <http://members.aol.com/homingin/THRDFSinfo.html>
3. <http://members.aol.com/joek0ov/offatten.html>
4. 408 Grove Lane, Santa Barbara, CA 93105 <http://www.rain.org/~marvin/k0ov.htm>
5. Allen Lowe, NØIMW, 911 East Fox Farm Road #2, Cheyenne, WY 82007-2588; telephone 307-638-2369, <http://www.arrowantennas.com/4ofha.html>
6. <http://www.ardf.us>
7. <http://www.homingin.com>

By Rich Arland,* K7SZ

BEGINNER'S GUIDE

All you need to know but were afraid to ask . . .

A 6-meter Rig and an Antenna Analyzer

Because this issue of *CQ VHF* will arrive during the winter 6-meter band openings, I decided to present a quick mini-review of a product that I have in my shack. Ranger Communications, Inc. (410 West 35th Street, National City, CA 91950; <http://www.rangerusa.com>) offers what I consider a good deal in a single-band VHF+ transceiver. The RCI-5054 DX-100 is a multimode 6-meter transceiver with variable power output up to 100 watts on SSB (50 watts on AM/FM/CW). The rig covers the complete 6-meter band from 50 through 54 MHz continuously while offering a 10-frequency memory, two programmable scan modes, and programmable repeater splits (for 6-meter repeater operation) up to 2 MHz. CTCSS tone encode/decode is optional.

The RCI-5054 DX-100 is a multi-mode 6-meter transceiver with variable power out put up to 100 watts on SSB (50 watts on AM/FM/CW).

This single-band rig is ideal for someone just getting started in ham radio via the Technician Class license, or for us "Old Timers" who need a rig parked on 6 meters to look for band openings while chasing the VUCC awards program. With up to 100 watts available on SSB and 50 watts on FM, the RCI-5054 DX-100 can provide reliable communications for local-area contacts as well as for some serious DX openings.

Six meters is not called the "Magic Band" for nothing. This unique portion of the spectrum offers great potential for local-area repeaters and simplex FM operation. You can get away from the congestion on 2 meters simply by using the RCI-5045 in the FM mode. Simultaneously, 6 meters can suddenly "open up" and you will be working DX on single- and multi-hop paths out past 3000 miles using the weak-signal SSB mode.

I love 6 meters just for this unusual combination of propagation enhancements. Having a single high-powered radio that I can dedicate to 6-meter operations allows me the luxury of not tying up the main transceiver just to monitor the occasional long-haul opening on 6 meters. The RCI-5054 sits quietly on the shack operations bench tuned to 50.125 MHz, the multi-mode squelch turned up to quiet the receiver, which ensures that I am not bothered by the constant background band noise. Should 6 meters suddenly experience a propagation enhancement such as a sporadic-*E* opening or a tropo ducting event, the squelch will open up as DX stations begin transmitting on the 6-meter calling frequency of 50.125 MHz. Life is good.

With the large, green, easy-to-read digital display it is effortless to QSY off the calling channel and start working stations. Controls are ergonomically laid out and easy to work. The receiver is very quiet and the all-mode squelch is a delight to use, quieting the receiver until something shows up in the receiver passband. This rig is well shielded, and in my TVI/RFI testing I have been unable to induce any of the five television sets in my home to misbehave in the presence of a 100-watt 6-meter signal.

The RCI-5054 DX-100 is at home in the shack as well as in the mobile or camper. Its relatively small footprint will fit most of the physical limitations encountered in today's automobiles. The RCI-5054 is a great addition to your Field Day arsenal. Newly licensed operators can have a station of their own centered around the simple-to-use RCI-5054 transceiver. Knowing that there is a solid 100 watts of RF output on SSB will be the confidence builder needed to help new operators garner QSOs during Field Day and VHF contests. Success is the key in developing and grooming new talent as future contest operators. For most hams, a quick tutorial around the RCI-5054 DX-100's controls is all that is needed to get them into the fray. After that, watch out! They will be hooked on contesting and Field Day.

As long as we are talking about neat things to have in the shack, next let me introduce you to a much-needed piece of test gear/shack accessory that I have come to rely upon constantly and really can't imagine being without.

The MFJ-269 HF + VHF/UHF Antenna Analyzer

Recently, a good friend of mine, Bill Rankin, WAØYPA, in Utah, contacted me and wanted to know what I would recommend as an antenna analyzer. His primary interests lie in 6- and 2-meter weak-signal operating. He was in the process

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of building some Yagi and quad antennas and needed a piece of test gear to optimize his designs. Without hesitation I told him to find an MFJ-259B. I had been using one for several years and really liked the unit, despite its voracious appetite for gobbling up "AA" batteries at a frightening rate.

One thing led to another, and Bill talked me out of my Model 259 (which I'd had ever since the "K7YHA North American Tour—1996," when I went out to play Field Day with the Zuni Loopers in southern California) in exchange for his father's old boatanchor station: Hallicrafters SX-117 receiver, HT-44 transmitter, the PS-150-120 power supply, and Turner +2 microphone. Bill got a great piece of test gear and I got my old college amateur radio club station (WA7CDH, Yakima Valley College) I had lusted for lo these many years!

Now I was faced with a dilemma: I needed to replace my old MFJ Model 259 analyzer. A quick call to Richard Stubbs at MFJ and I had one of the new MFJ-269s on its way to me. The Model 269 is not only newer than the 259, it covers more spectrum. While the older Model 259 covered all of HF plus VHF up through 170 MHz, it was useless at UHF. The Model 269 has all the coverage of the older model, *plus* it covers 415–470 MHz, making it a great piece of test gear for not only ham radio antennas and installations, but commercial public-service/EMS installations as well! At last, I had a way to evaluate performance and adjust my 19-element UHF Yagi!

The UPS truck arrived a couple of days later with the Model 269. The first thing I noticed was that the internal battery pack had been redesigned, and while it was no easier to get into the unit to access the battery pack (you still have to remove eight screws), the new pack is made of sturdier material and utilizes one-piece construction rather than the two "four packs" of AA cells in the older Model 259. The dual meters will instantly show reflected power/SWR and impedance at a glance. The digital multi-line display reads out frequency along with capacitive and inductive reactance, phase angle, and a lot more. All this is just for starters!

MFJ really did their homework and provided the antenna experimenter with a valuable tool for a reasonable price. There is an optional carrying bag and coil set for testing tuned circuits and coaxial cables. The unit will function on internal batteries (10 "AA" cells for a 15-VDC input) or via an optional external "wall-wart" AC adapter. After a short time of inactivity, the analyzer "goes to sleep" to conserve battery power when on internal batteries. This is great, since it is a hassle to get the unit apart to replace internal batteries. Speaking of batteries, this unit has a built-in charger to accommodate rechargeable batteries as well as standard non-rechargeable alkaline AA cells. There is an internal switch that will defeat the charger circuitry so you don't end up trying to recharge non-rechargeable batteries, thereby avoiding the associated leakage and mess along with the distinct possibility of an internal fire!

The really nice thing about the Model 269 is that it is very portable, allowing you to drag it up on the roof, onto the side of the tower, or out to the mobile installation to check coaxial cables, tuning stubs, traps, baluns, and antennas right at the termination point. The multi-line display coupled with the various modes of operation can tell you a lot about your antenna installation and your feedlines. With it you can find shorts in a piece of coaxial cable.

You can also use this unit to measure and cut to proper length those pesky coaxial cable power dividers used to stack VHF+ antennas for added gain. Coaxial stubs got you down? Not anymore! The Model 269 will allow you to accurately measure and cut coaxial cables for matching purposes. Using the optional coil set you can make this unit function like the old grid-dip oscillators and use it to test tuned circuits in transmitters, antenna tuners, etc. Oh, yeah . . . Did I mention that the Model 269 also functions as a frequency counter up to almost 200 MHz?

The MFJ-269 antenna analyzer has all the coverage of the Model 259, plus it covers 415–470 MHz.

Well, it does! Talk about a versatile piece of test gear.

If you are an ardent antenna experimenter, then you *need* this antenna analyzer. Not only can you maintain your antenna farm in fine style, this unit is indispensable when it comes to ARRL Field Day and various VHF/UHF contests where you need to erect and trim antennas under field conditions, and for installing mobile equipment. Interested? Check out the MFJ website at: <http://www.mfjenterprises.com> for further information and pricing. 73, Rich, K7SZ

By Bob Witte,* KØNR

FM

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

D-STAR
Digital Voice for VHF/UHF

VHF/UHF D-STAR radios are making their way into the U.S. ham radio community. What is this new technology and how will it benefit the ham radio enthusiast?

Digital Modulation

Unless you were unconscious for the last two decades, you have noticed that digital technology has swept through most types of electronic devices, creating more capability and changing primarily analog devices into digital wonders. Analog music media such as the conventional LP record and magnetic tape have been replaced by digitally-encoded CD-ROMs. More recently, the rise of the Internet and digital audio formats (e.g., MP3) has changed how music is created and distributed. Closer to home for ham radio enthusiasts, the cellular telephone, originally deployed with analog FM technology, has largely migrated to digital-modulation techniques. Digital technology allows mobile-phone service providers to provide cost-effective voice communications while adding services such as text messaging and web surfing, all while improving the spectral efficiency of their networks.

Meanwhile, those of us who enjoy using FM simplex and repeaters on the VHF and higher amateur bands are still using good old analog FM. Edwin H. Armstrong first described the use of *frequency modulation* in 1936.[1] The first practical two-way FM radio-telephone mobile system in the world was implemented in 1940 for the Connecticut State Police. Let's consider 1940 the start of what we know today as two-way FM radio. That was 65 years ago! Perhaps it is time to move to new technology.

We have already seen digital technology wiggle its way into our inherently analog radios. Modern FM transceivers have digitally-synthesized frequency control circuits, digital storage of channel information, serial ports for loading configurations, and computer software to control these rigs. Packet radio uses AX.25 digital protocols to provide an error-free data transmission mechanism, but the underlying modulation generally is still analog FM. The next step may be a truly integrated approach to voice and data.

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Photo A. The ICOM IC-2200H is a conventional 2-meter FM transceiver with D-STAR digital operation available as an option. (Photo courtesy of ICOM America)

Digital Modulation in Amateur Radio

The Japanese government funded the development of the D-STAR standard, a digital radio format designed specifically for amateur radio. The Japan Amateur Radio League (JARL) administered the development of this open standard, and ICOM is the first equipment manufacturer to market D-STAR radios.

There are three distinct types of D-STAR transmissions with varying bandwidth required. The **DV** format is the narrowest modulation scheme, using a data rate of 4800 b/s to support simultaneous voice and data transmissions. Digitized voice is transmitted using 3600 b/s, leaving 1200 b/s for data transmission. D-STAR transceivers on 146 MHz and 440 MHz use this modulation format, since it results in a narrow 6-kHz signal bandwidth. I think of this mode as having a single voice channel, plus a digital channel similar to 1200-baud packet rates. This mode won't be great at moving large files, but it will handle lower speed data requirements. Photo A shows a 2-meter rig that offers D-STAR operation as an option.

The **DD** format is a *data-only* mode that provides a 128-kb/s transfer rate, occupying a bandwidth of 130 kHz. This mode is too wide for the VHF bands and is

Modulation Type	Band	Digital Rate
DV	146 MHz, 440 MHz, 1.2 GHz	4.8kb/s
DD	1.2 GHz	128 kb/s
Backbone	10 GHz	10 Mb/s

Table 1. Summary of available D-STAR modulation formats.

Photo B. The ID-1 transceiver is a 1.2-GHz transceiver that includes analog FM and D-STAR formats (DV and DD). (Photo courtesy of ICOM America)

offered by ICOM only on its 1.2-GHz rig. (The 1.2-GHz radio also offers DV format, as well as conventional analog FM.) Rounding out the D-STAR system is a 10-GHz backbone link that operates at 10 Mb/s. This radio link is intended for linking repeaters together on the ham bands without depending on any phone line or Internet connection. The data rates listed for these D-STAR formats are the nominal bit rates, but the use of *Forward Error Correction (FEC)* means that the actual throughput will be somewhat less.

I'll focus on D-STAR from the point of view of a typical FM ham radio user, most likely operating on 146 MHz or 440 MHz, using the DV D-STAR format.

D-STAR Technology

D-STAR is an open protocol, but one that was developed with amateur radio in mind. While being ham radio oriented, D-STAR still takes advantage of technology and standards from other communications industries.

Since D-STAR uses digital modulation, the analog voice signal is converted to digital format by an analog-to-digital converter.[2] These digital samples are further compressed by an AMBE® (Advanced Multi-Band Excitation) vocoder circuit. The vocoder takes advantage of the characteristics of human speech to compress the digital data stream into a much more compact set of data, minimizing the on-the-air bandwidth required. Vocoders vary in the quality of speech that they reproduce, and the AMBE vocoder gets high marks for speech quality.

The digital stream of bits goes out over the air using the modulation method known as 0.5GMSK (Gaussian Minimum Shift Keying). Roughly speaking, GMSK passes the digital input stream through a Gaussian low-pass filter which rounds off the edges of the waveform. This rounded waveform drives an FM modulator to produce the GMSK-modulated signal, resulting in a signal that is very efficient in terms of occupied bandwidth.

D-STAR transmissions are not compatible with the existing analog FM and sound like white noise when received on an FM radio. D-STAR radios provide backward compatibility with existing radios by including a conventional FM mode. The user selects whether he or she wants the radio to operate in analog or digital mode.

The D-STAR standard includes a position reporting feature that is similar to APRS®. D-STAR radios have NMEA interface for taking in position information from a GPS receiver. Basically, this data stream transmits the GPS coordinates at a time interval specified by the user. This transmission is *not* directly compatible with APRS, since APRS uses conventional packet radio, while the D-STAR information is encoded in the D-STAR digital format. Some hams are experimenting with gateways that pipe the D-STAR data into the APRS Internet System (APRS-IS), a collection of servers that track APRS reports.

Every D-STAR transmission has the station's callsign embedded in the digital stream. This makes identification automatic, sort of like Caller ID on a telephone. This enables other features such as "call sign squelch" so that you can monitor for transmissions from a specific station.

Repeater Systems

D-STAR supports a comprehensive linked repeater system. Repeaters can be linked together digitally either via the Internet or via radio on the 10-GHz ham band. When you transmit to a D-STAR repeater, your callsign is automatically registered with that repeater and shared around the D-STAR system. Each transmission contains routing information for where on the system the signal should be heard.

This may sound like a capability similar to the repeater linking that can be done using IRLP or Echolink®. These Internet linking systems use conventional FM over the air and convert to digital before sending the information over the Internet. D-STAR uses digital data throughout the system, including the initial RF link. The digital encoding in the signal makes the routing of signals from one repeater to another automatic, without the need for establishing (and later breaking) a communications link. In fact, D-STAR uses a different paradigm entirely, where each transmission is routed according to its embedded callsign-routing information. Since the signal routing is all digital, there will be no degradation of signal-to-noise ratio as the signal traverses the system. Compare this to repeater systems linked via analog methods, where each link tends to introduce a bit of noise.

D-STAR Benefits

Some hams look at D-STAR technology and get hooked instantly because it is new, cool digital technology. Of course, others ask the question "What is the benefit of D-STAR, as my analog FM rig works just fine?" Like most emerging technologies, the benefits of D-STAR may not be understood completely until the technology has been around for a while. The benefits of D-STAR fall into three major categories:

Spectral efficiency. The DV format of D-STAR has a bandwidth of 6 kHz, compared to 16 kHz for analog FM with 5-kHz deviation.[3] This implies that we could at least double the number of repeaters or simplex channels in a particular frequency band. Given that all repeater pairs in the 2-meter band are in use in many locations, this could have a dramatic impact on how the band is used. (Of course, this raises all kinds of sticky issues on how this change would occur. That is, existing repeater owners and users may not be motivated to change out their equipment.)

Routing information encoded in voice channel. The DV format has the transmitting station's callsign, the destination repeater, and other information

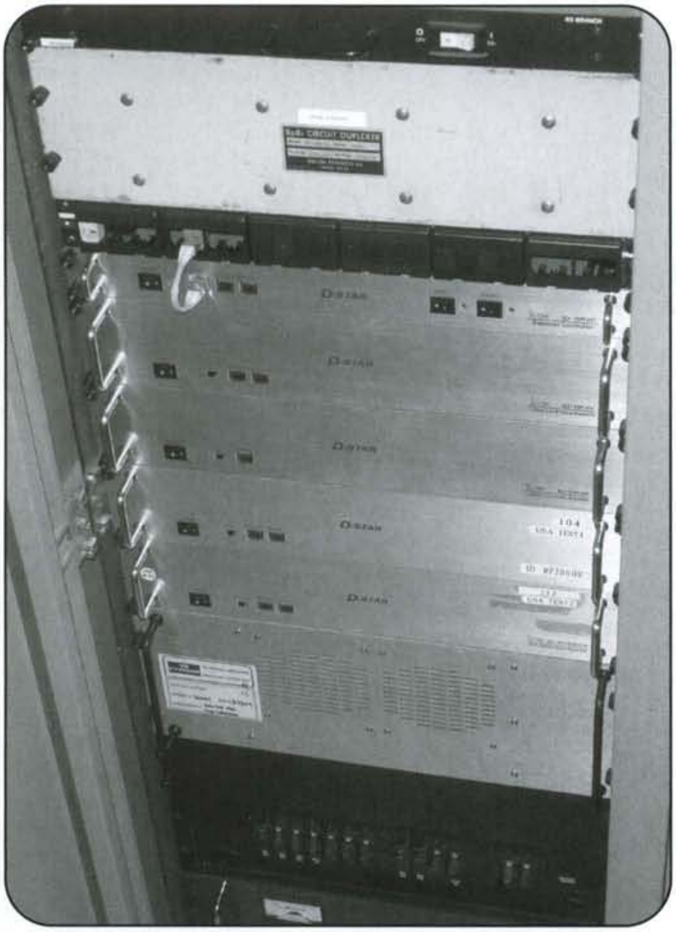

Photo C. The K5TIT rack of D-STAR gear includes (in order, starting near the top of the rack) a D-STAR repeater controller, 1.2-GHz voice repeater, 1.2-GHz data radio, 146-MHz voice repeater, and 446-MHz voice repeater. (Photo courtesy of Jim McClellan, N5MIJ)

encoded into every transmission. This encoded data enables automatic identification ("Caller ID"), selective calling ("Call Sign Squelch"), automatic logging of stations heard, and signal routing through a D-STAR repeater system.

Text and Position Messaging. Digitally-encoded position information can be sent, assuming a GPS receiver is connected to the D-STAR rig. The user can also manually enter the position information or a short text message. An external TNC is not required.

These benefits are from the perspective of an FM voice user. Clearly, D-STAR also offers other benefits for data-only radio use. In particular, the DD format offers the fastest turn-key digital radio baud rates for amateur radio use.

D-STAR Deployments

Not surprisingly, D-STAR usage took off first in Japan, with an unknown number of 1.2-GHz D-STAR repeaters on the air, all operated by the JARL.

This technology is in the early stages of deployment in the U.S., with a number of D-STAR pioneers trying out this new ham radio format. According to Ray Novak, N9JA, of ICOM America, there are approximately 15 D-STAR repeater sites on the air in the U.S., with three of them linked to the Internet. The activity on these three repeaters (and any others that add the Internet connection) is shown on the D-STAR users' website at <http:// www.dstarusers.org>.

The most active D-STAR group seems to be the Texas Interconnect Team, in the Dallas area, with club callsign K5TIT. This group has an active website devoted to D-STAR topics at <http://www. k5tit.org>. They have D-STAR repeaters on these bands: 146 MHz, 440 MHz, and 1.2 GHz (photo C). The group recently conducted the first U.S. field trial of ICOM's 146-MHz and 440-MHz D-STAR repeaters.

The Chester County Amateur Radio Special Interest Group (W3DES) in Chester County, Pennsylvania is a hotbed of activity on 1.2-GHz D-STAR, with several 1.2-GHz repeaters on the air.

New York City also has a 1.2-GHz D-STAR repeater in place. Rich Moseson, W2VU, the editor of *CQ* magazine, recently had the opportunity to use that system to talk with Jim, N5MIJ, on the K5TIT Dallas machine. Rich reports that the system worked well and the digital audio was "crystal clear." A recent article on the ARRL website (December 14, 2005: <http:// www.arrl.org/news/stories/2005/12/14/1/>) announced the deployment of a 1.2-GHz D-STAR repeater at W1AW. This machine was donated by ICOM and is being configured to connect to the Internet.

D-STAR is not just for repeaters, and there are a number of people out there running D-STAR 2-meter simplex. Since the digital transmissions are incompatible with analog FM, it is best to avoid any popular FM simplex frequencies. Most of the 2-meter D-STAR activity takes place in the "miscellaneous and experimental modes" section of the ARRL band from 145.50 to 145.80 MHz. There is no designated D-STAR calling frequency for use on a national basis, but 145.60 MHz, 145.61 MHz, and 145.67 MHz are often used. A recent poll on the ICOM D-STAR forums chose 145.60 MHz as an easy-to-remember D-STAR calling frequency.

Performance

When digital technology is used to transmit a voice signal and compression is used to minimize the required bandwidth, it raises questions about the audio quality. If the audio is not sampled often enough or the analog-to-digital conversion is too coarse, the audio quality can suffer. I have not used D-STAR on the air, but I have listened to recordings of D-STAR transmissions under varying conditions. John Habbinga, KC5ZRQ, recorded a weak-signal audio test using a mobile station and comparing DV audio and analog FM. This audio recording is available in MP3 format on the web at <http://www.lubbock-radio.net/D-STAR -vs-FM.mp3>. My impression is that with reasonable-strength signals, the D-STAR audio quality is very good, with just a hint of the digital vocoder "twang" that is common in digital cell phones. Reports from D-STAR users seem to agree with this assessment.

Like other digital-modulation techniques, D-STAR audio tends to drop out when in a fringe area, as opposed to gradually getting noisy like analog FM. If you listen to the KC5ZRQ recording, you will hear these dropouts when the signal gets weak. When John switches over to analog FM under the same working conditions, the signal is recognizable, but covered in noise. (Make sure you listen to the whole recording, since the weakest signal strength occurs near the end.)

Photo D. A photo of the ID-800H used for D-STAR experimentation by Pierre, AL7OC. (Photo courtesy of Pierre Loncle, AL7OC)

In his report on the Texas Interconnect Team field trial of the VHF/UHF repeaters, Jim McClellan, N5MIJ, writes:

> Range was excellent. The systems were simultaneously compared with a comparably equipped analog FM repeater, located at the same site. The nature of the digital signals used by D-STAR enabled us to have full copy in places where the signal of the FM repeater had dropped into the noise. There was no "noisy but readable" signal as you have on FM.
>
> Intelligibility was also excellent. Even at extreme range, voices are clear and readily identifiable. Voice quality is not as good as experienced on FM, but excellent for digital signals.

The June 2005 issue of *QST* has a great review of the IC-2200H mobile radio and the IC-V82 handheld rig, along with the technical evaluation of the D-STAR performance. (This is available online to ARRL members.) The ARRL performed a laboratory test of D-STAR weak-signal performance using a pair of IC-2200H 2-meter transceivers with the UT-118 D-STAR option installed.[4] They reported a similar result, but gave D-STAR the clear advantage over analog FM:

> We found solid, virtually noise free communication, equivalent to analog "full quieting" at any analog SINAD above about 6 dB. Note that while analog copy was usable at that level it was quite noisy, and a signal at least 10 dB stronger would be required for comfortable copy in analog mode with about 22 dB SINAD required for full analog quieting.

Keep in mind that this is a test on the lab bench in a controlled environment. It shouldn't surprise us if real world, mobile operating conditions produce a different result.

The narrower bandwidth (6 kHz) of D-STAR should provide an advantage over the wider bandwidth of conventional FM (16 kHz), *all other things being equal.* Narrower bandwidth means there is less noise introduced into the receiver with which the signal has to compete.

Pierre Loncle, AL7OC, and Albert Noe, KL7NO, have been experimenting with D-STAR on 146 MHz and 440 MHz simplex around Fairbanks, Alaska. Using two ICOM ID-800H transceivers (photo D), they have compared analog FM and DV in a variety of conditions. Pierre reports:

> The coverage in deep fringe areas is slightly better in FM mode in that the human brain does a better job separating speech from noise than digital processors … if we lose our digital voice channel and switch to analog FM, the FM signal may still be copyable, but very noisy and of poor voice quality.
>
> We have also noted that the digital voice mode is more susceptible to interference from impulse noise … such as digital devices that are radiating a lot of RFI.

Thus we see some variation in the experiences that hams are having with D-STAR, which is to be expected with any new technology. The ham community will gain a better understanding of the fine points of D-STAR operating through experience.

The generally accepted method for specifying analog receiver sensitivity is *signal-to-noise ratio.* More precisely, the method used for analog FM is SINAD (signal-plus-noise-plus-distortion to noise-plus-distortion) ratio. The receiver sensitivity is specified as the signal level that produces a 12-dB SINAD ratio in the recovered audio. Digital modulation has the characteristic of being solid as long as the bits are received correctly, but has audio drop outs when the bits are corrupted. The analog methods of signal-to-noise ratio don't apply directly to digital modulation, and the preferred method for specifying imperfections in the signal is *Bit Error Rate (BER).* For example, the sensitivity specification for the ID-800H dualband D-STAR rig is BER 1% at <0.35-μV signal level. In other words, the receiver sensitivity is specified as the signal level where 1% of the digital bits are in error. This Bit Error Rate specification indicates the need for a different way of looking at amateur radio performance.

Barriers to Adoption

D-STAR clearly is an exciting new technology with great potential. However, any new technology has barriers to adoption. One potential barrier is cost, since a standard 2-meter rig costs about $160, while a D-STAR rig is about twice that. Recent prices on the Internet showed the IC-2200H 2-meter FM rig at $160 and the UT-118 D-STAR option at $200. It's interesting that the D-STAR option costs more than the 2-meter rig. Well, this is only one way to look at it. Another point of view is that for $360 you can buy a transceiver that does both good old analog FM and the latest emerging digital technology. Keep in mind that a basic VHF packet TNC costs about $180, so the UT-118 D-STAR option is similar in cost. Compare the cost of a D-STAR radio to a commercial radio capable of digital communications (APCO-25) and the D-STAR gear looks like a bargain.

Competition generally brings down the price of any product, so that raises the question of what do the other amateur radio manufacturers have planned? Clearly, ICOM is setting the pace in D-STAR equipment, with a complete line of VHF/UHF gear, including repeater equipment. According to Chip Margelli, K7JA, of Yaesu, Yaesu has no plans to offer D-STAR radio gear. The situation at Kenwood is less clear, since there have been sightings of Kenwood D-STAR gear in Japan, but Kenwood USA says there are no plans to introduce D-STAR equipment here. Perhaps more important is that as long as ICOM is the only game in town, it undermines the notion that D-STAR is an open, industry standard.

Another obvious barrier is the lack of repeater infrastructure. Most hams are going to be looking for some kind of repeater coverage in their area before spending extra dollars on D-STAR. Of course, this takes time. ICOM has offered a 1.2-GHz D-STAR for a while now, but repeater equipment for the more popular 146-MHz and 440-MHz bands is just now becoming available. The 146-MHz and 440-MHz repeaters in use at K5TIT are pre-production units, so we can expect to see this equipment available in early 2006. It will be interesting to see how many D-STAR systems pop up on the VHF/UHF bands in the next year or two.

Despite these barriers, D-STAR is a promising new technology. D-STAR is more than just digital modulation, as it provides a system approach to integrating voice and data communications. How the amateur radio community chooses to deploy this capability remains to be seen. Most likely, we can't envision all of the new applications that D-STAR will enable. Ray Novak, N9JA, sums it up well: "D-STAR is new technology. It opens up opportunities for new applications and features. This is fun!"

Wrap Up

For more information on D-STAR, see the web resources listed with this column, especially the ICOM website and the K5TIT website (both with online discussion forums on D-STAR).

My thanks go to these people for their assistance with this article: Ray Novak, N9JA, Division Manager–Amateur Products, ICOM America; Jim McClellan, N5MIJ, Texas Interconnect Team; and Pierre Loncle, AL7OC.

I've started a weblog at <http://k0nr.blogspot.com> that covers VHF/UHF ham radio topics, including D-STAR. Take a look and drop me a note there or to my e-mail address: <bob@k0nr.com>.

73, Bob, KØNR

Notes

1. Armstrong technical paper on FM (IRE): <https://michael.industrynumbers.com/fm.pdf>.

2. For a good overview of digital voice, see Doug Smith's article in January 2002 *QST.*

3. Via Carson's Rule, BW = 2 × (Peak Deviation + Highest Modulating Frequency) = 2 (5 kHz + 3 kHz) = 16 kHz.

4. "Installation and Test of UT-118 Digital Voice Modules," Michael Tracy, KC1SX, *QST,* June 2005.

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Texas Interconnect Team website: <http://www.k5tit.org>.

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"Digital Voice: The Next New Mode?" Doug Smith KF6DX, *QST,* January 2002.Online at: <http://www.arrl.org/tis/info/pdf/0201028.pdf>.

QST Product Review, ICOM IC-V82 2 Meter Handheld Transceiver, *QST,* June 2005 (includes an overview of D-STAR operation). Online at: <http://www.arrl.org/members-only/prodrev/pdf/pr0506.pdf>.

"Digital Connection: D-STAR," Don Rotolo, N2IRZ, *CQ* magazine, February 2006.

By Kent Britain,* WA5VJB

ANTENNAS

Connecting the Radio to the Sky

The 1/4-Wave Whip

The classic 1/2-wave dipole antenna is shown in figure 1. The 1/4-wave ground plane uses the ground reflection to act as the other half of the dipole. Okay so far, but in photo A we have a small VHF transmitter from RF Monolithics®. That half-inch-square board is not going to act like a VHF ground plane; it's far too small. Therefore, a 1/4-wave antenna is simply not going to work well, as it's only half of the antenna.

When you feed a dipole antenna right in the middle, the feed impedance is about 72 ohms (figure 2). There are few fudge factors thrown in for the diameter of the wire, height above ground, whether or not there is insulation on the wire, etc., but 72 ohms is okay for this demonstration.

As the feed point is moved toward one end, the impedance increases, until near the end the feed impedance is close to 1000 ohms. A half-wave antenna is a great antenna. It's just hard to impedance match from the end.

Many of the simple single-chip transmitters or SAW (surface acoustic wave) oscillators are not really designed to drive a perfect 50-ohm load. Most are happy driving higher impedances. How high? Well, we really don't know in most cases. Also, the transmitter usually has switches, batteries, and other pieces hanging off the PC board. I have worked with over 50 different kinds of low-power transmitters, and I've never been able to calculate the best length for the antenna beforehand.

I start with a wire about 1/2 wave long and start snipping while measuring the transmitter's field strength (figure 3). With a few snips, the point where the transmitter impedance is happiest and the antenna is happiest is experimentally found. This is typically about .4 wavelength long. This is quite a bit longer than the typical 1/4-wave antenna, and I have seen as much as a 6-dB improvement.

For those of you who are designing the latest wireless device, trying to put a telemetry transmitter on a salamander, or stuffing a tracking transmitter into your model rocket, I think you'll find that a wire about .4 wavelength long will work a lot better than a 1/4-wavelength wire (photo B).

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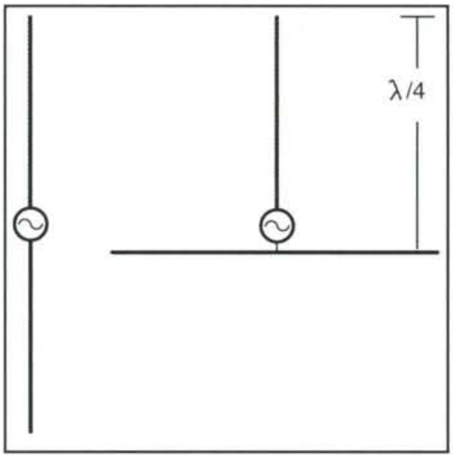


Figure 1. A 1/2-wave dipole and 1/4-wave over a ground plane.

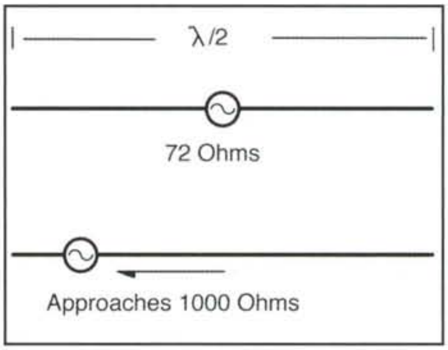


Figure 2. Impedance of a dipole antenna.

Other Radios

I look at my little ICOM Q-7 and I know that radio is not going to act like a 2-meter ground plane. This is why many hams often hang a 1/4-wave "tail" on the walkie-talkie to act as the other half of the dipole and boost its range. If you're playing around with a longer antenna, I think you'll again find that something near .4 wavelength is going to work better than a 1/4-wave whip. Many companies know this, and the antennas often are tuned expecting only a hand as the ground plane, but many aftermarket antennas are not.

Do you like to go backpacking with your Yaesu FT-817 or ICOM 703? Again, on HF you're going to find an antenna slightly longer than a quarter wave often works much better and is easier to match. I know my FT-817 isn't much of a ground plane on 80 meters.

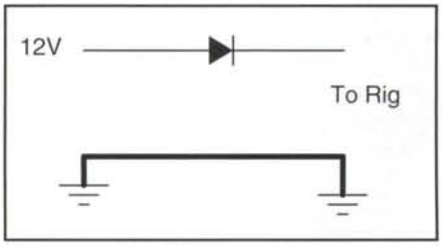
Reverse Polarity Protection

This is a bit off subject, but but N6CL, the editor of *CQ VHF*, is pretty open-minded about these things.

Just about all of my projects have a "reverse polarity" protection circuit, mainly to protect my projects from me! Many a time I've been working on something late at night and the red wire went to ground and the black wire went to power. Woops! I hate letting the smoke of out projects; it's so hard to get it back in.

Many, many years ago I worked my way though college as a bench tech in a CB shop. One poor trucker just couldn't get that red to red, black to black figured out. He blew out his reverse polarity circuit (figure 2) three times. This was really quite an accomplishment, since after the second time I replaced the 1-amp diode with a 20-amp alternator diode! I thus installed circuit 3 (see below), and don't recall seeing him again.

Let's go over the four common circuits, along with the advantages and disadvantages of each.



Circuit 1

Circuit 1. The big advantage of this circuit is simplicity. Just make sure the diode will handle the current. However, you have a .7-volt drop across the diode. Thus,

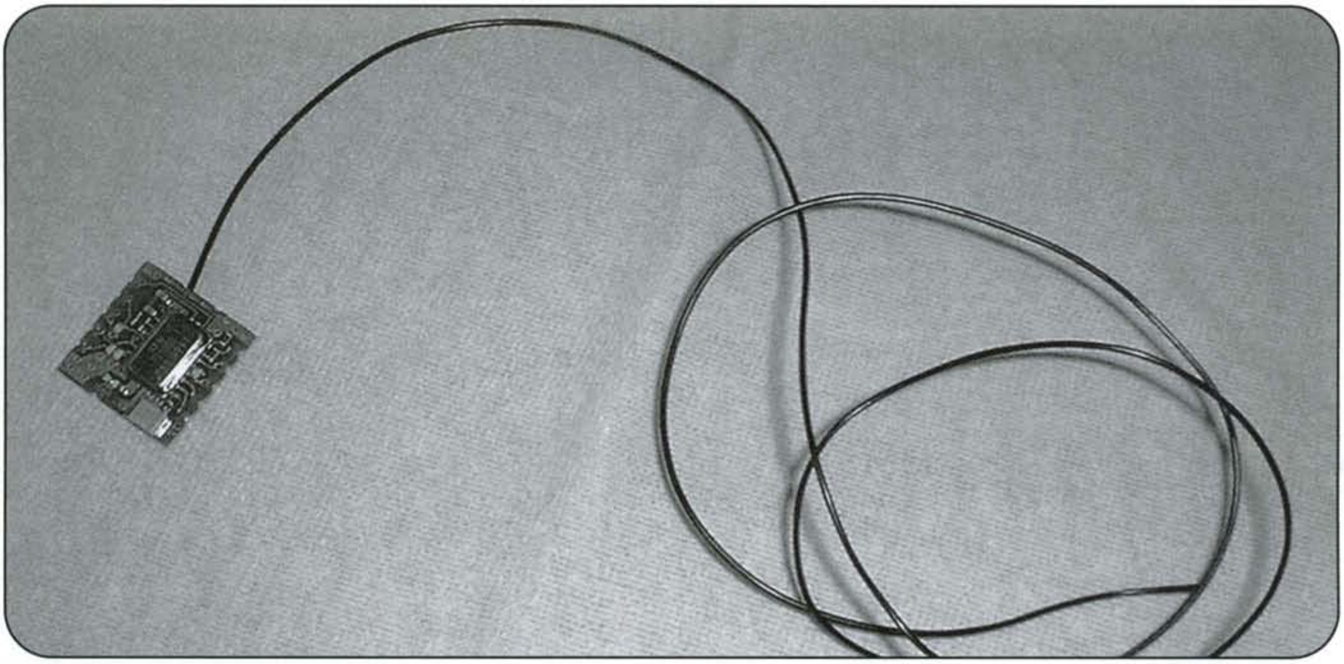


Photo A. Micro transmitter and antenna.

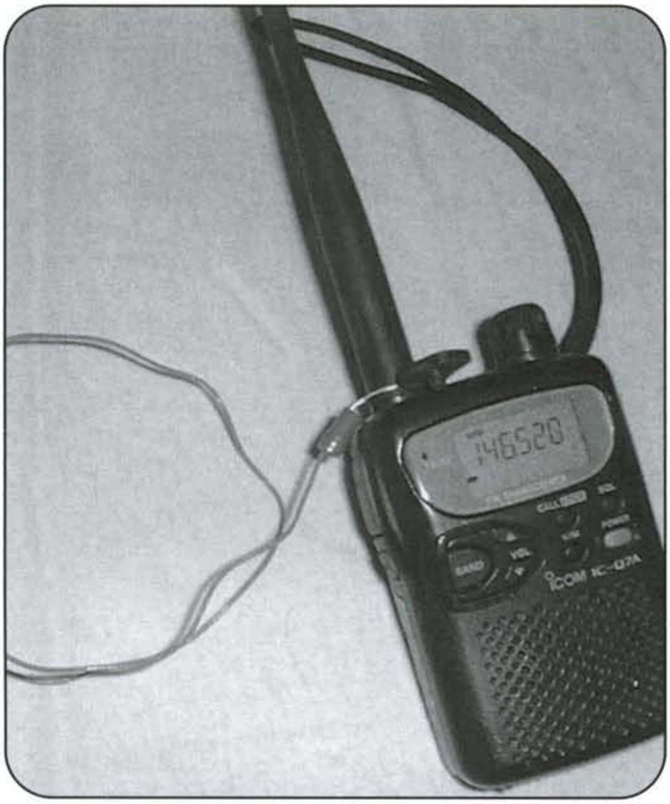


Photo B. Talkie with a tail.

instead of 12 volts you have 11.3 volts. If the circuit has a 5-volt regulator, no problem. But if you put a diode in series with a 10-watt rig, it will drop to 8 watts out or so.

Circuit 2. Again this circuit is pretty simple, and this is the one used in most rigs for reverse protection. Normally the diode doesn't pass any current, but reverse the power and the diode

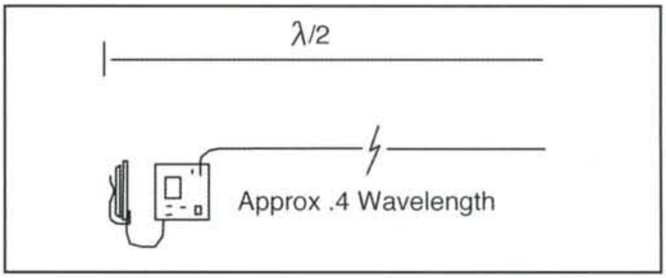
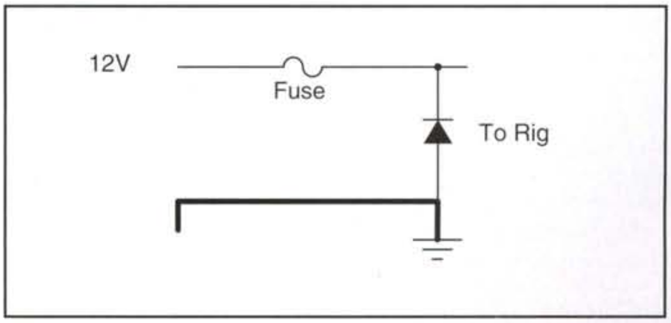


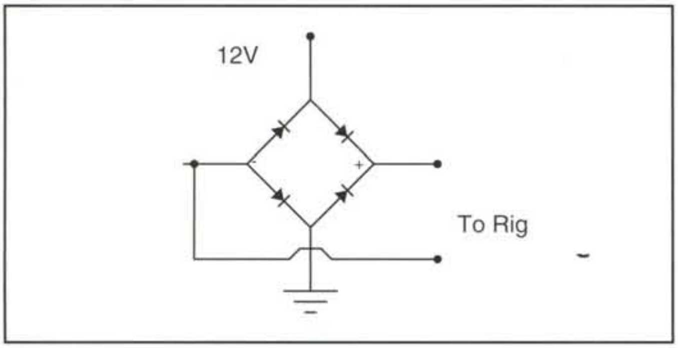
Figure 3. Transmitter and antenna.

looks like a dead short. A few thousands of a second later the fuse blows, protecting the rig. All this time the diode limits reverse voltage across the rig to .7 volt. The down side is that you have to have a fuse, and it had better be the right value for the rig. The trucker mentioned previously used a 35-amp fuse. Now it's not strange that he used the biggest fuse he could find, but 35-amp 2-AG fuses are hard to come by!

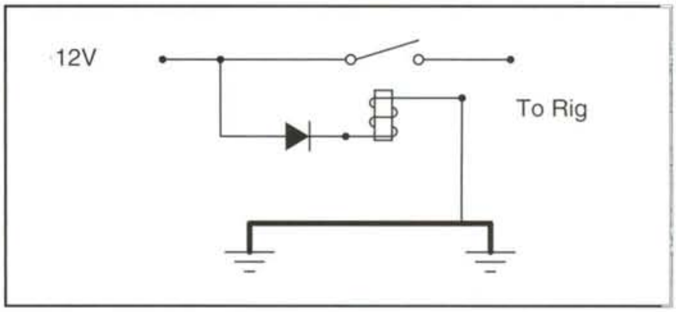
Circuit 3. A good old full-wave rectifier converts AC to DC, so no matter which way you connect the wires, the voltage comes out right. This circuit is especially good for those of you



Circuit 2



Circuit 3



Circuit 4

who like to use two green wires—one for plus and another for minus. However, now the current has to go though two diodes, giving you a 1.4-volt drop. Also, if the rig doesn't have an isolated chassis, the case could be .7 volts above with a negative-chassis car, or even 12 volts above ground with a positive-chassis car. Keep the metal parts isolated!

This circuit is what I put in that trucker's CB. His 4 watts dropped to about $2^1/2$ watts, but as I said, I never saw him again.

Circuit 4. This is a popular circuit among UK microwave operators. If you connect the power correctly, current goes thought the diode, closes the relay, and power is connected to your station. If you don't hook it up right, and the rig doesn't power up. It's about as "idiot resistant" as you can get. It takes a few extra parts, and make sure the relay will handle your rig's peak current, but there is no voltage drop across a diode, making this the best reverse-polarity protection circuit.

Keep that smoke in your rigs. It's so hard to put in back in after that "oops!"

Civil Air Patrol

I was asked by a CAP lieutenant in California to develop a family of 121.5- and 243-MHz Cheap Yagis for CAP to use for ELT (Emergency Locator Transmitter) DFing. I came up with three 121.5-MHz and three 243-MHz versions. If we have a fair number of CAP members among the readership this could become an article, or perhaps it's something we should keep off-line. Let me know what you think.

As always your questions are a valuable source of inspiration for this column. 73, Kent, WA5VJB

Quarterly Calendar *(from page 25)*

more information, see <http://www.hamvention.org>. CQ Communications will have a booth in the arena, and N6CL is scheduled to be one of the speakers for the VHF forums.

Calls for Papers

Calls for papers are issued in advance of forthcoming conferences either for presenters to be speakers, or for papers to be published in the conferences' *Proceedings*, or both. For more information, questions about format, media, hardcopy, email, etc., contact the person listed with the announcement. The following organization or conference organizer has announced a call for papers for its forthcoming conference:

Southeast VHF Society (see conference dates announcement above): The deadline for the submission of papers and presentations is March 3, 2006. All submissions should be in Microsoft Word (.doc) or alternatively Adobe Acrobat (.pdf) files. Pages are $8^1/2$ by 11 inches with a 1-inch margin on the bottom and $^3/4$-inch margin on the other three sides. All text, drawings, photos, etc., must be black and white only (no color). Please indicate when you submit your paper or presentation if you plan to attend the conference and present there or if you are submitting just for publication. Papers and presentations will be published in bound proceedings by the ARRL. Send all questions, comments, and submissions to the technical program chair, Jim Worsham, W4KXY at <w4kxy@bellsouth.net>.

Central States VHF Society Conference: The Central States VHF Society is soliciting papers, presentations, and poster/table-top displays for the 40th Annual CSVHFS Conference to be held in Bloomington, Minnesota (across from the Mall of America) on July 27–29 2006. Papers, presentations, and posters on all aspects of weak-signal VHF and above amateur radio are requested.

Deadline for submissions: For the *Proceedings*—May 1, 2006; for presentations at the conference and for notifying then you will have a poster to be displayed at the conference—July 3, 2006. (Bring your poster with you on the 27th of July.)

Further Information is available at the CSVHFS website: <http://www.csvhfs.org>. Also available are the following: "The 2006 Conference," and "Guidance for Proceedings Authors," "Guidance for Presenters," and "Guidance for Table-top/Poster Displays."

Contacts: Technical Program Chairman: Jon Platt, WØZQ, e-mail <W0ZQ@aol.com>; Proceedings Chairman: Donn Baker, WA2VOI/Ø, e-mail: <Proceedings.WA2VOI@OurTownUSA.net>.

EME Conference 2006: The EME Conference 2006 will be held in Wuerzburg, Germany August 25–27. Interested authors are invited to present a paper(s) for the conference. Electronic submissions in Word97, Word2000, Acrobat5 (PDF), or text format will be accepted by e-mail or CD. Please ask if you are using another format. If you are interested in writing and/or presenting a paper, send an e-mail to Rainer Allraun, DF6NA, at: <df6na@df6na.de>. Please contact him as soon as possible with an abstract or even a general idea. This will help the conference team with its planning activities. For more information about the EME Conference 2006 see: <http://www.eme2006.com>.

Meteor Showers

The *α-Centaurids* meteor shower is expected to peak on February 8 at 0500 UTC. The *γ-Normids* shower is expected to peak on March 13, and again on March 17. Other February and March minor showers include the following and their possible radio peaks: *Capricornids/Sagittarids*, February 1 at 1400 UTC; and *χ-Capricornids*, February 13 at 1500 UTC.

The *Lyrids* meteor shower will be active during April 19–25. It is predicted to peak around 1630 UTC on 22 April. This is a north-south shower, producing at its peak around 10–15 meteors per hour, with the possibility of upwards of 90 per hour.

A minor shower and its predicted peak is *pi-Puppids* (peak around 2130 UTC on April 23). Other April and May minor showers include the following and their possible radio peaks: April *Piscids*, April 20 at 1500 UTC; *δ-Piscids*, April 24 at 1500 UTC; *η-Aquarids*, May 6 at 0600 UTC; *ε-Arietids*, May 9 at 1300 UTC; May *Arietids*, May 16 at 1400 UTC; and *o-Cetids*, May 20 at 1300 UTC.

For more information on the above meteor-shower predictions see Tomas Hood, NW7US's VHF Propagation column on page 58. Also visit the International Meteor Organization's website: <http://www.imo.net>.

By Chuck Houghton,* WB6IGP

MICROWAVE

Above and Beyond, 1296 MHz and Up

Troubleshooting a 10-GHz Converter with a Homemade Noise Generator

My last column, in the fall 2005 issue of *CQ VHF,* covered the relay switching (transceiver) circuit I used for controlling the switching of my microwave converters. Who could have known that I would be trouble-shooting the switching circuits and the entire 10-GHz converter system? What happened follows, along with a description of a simple, homebrew noise head I used to trouble-shoot in my 10-GHz converter system. I will also cover how you can put together a noise head as part of your microwave test equipment.

Trouble raised its head while I was cleaning the shop shelf of my shack, where my 28-volt, 25-amp Astron power supply for my microwave converter's TWT (traveling wave tube) amp is located. I had removed the cover of the power supply while I was making an adjustment. Nearby was a stack of boxed stuff that had previously occupied the shelf. Shop cleanup created the setting for disaster. The 10-GHz rig was working just fine and was tuned to our microwave group's 10-GHz beacon on Mt. Miguel. The rig had just been moved. I was making a quick test of the beacon's signal quality, confirming system operation.

The next thing that happened changed the schedule for the day. I had to solve the problem in the entire 10-GHz system, from the power supply to the dish antenna feed. A metal pin rolled off the top of the pile of boxes where it had been perched and fell into the 28-volt power supply, shorting out the supply. Needless to say, I shut down the power supply and removed the pin ASAP!

I turned on the power supply, and you guessed it. . . . It appeared to have blown and the converter was dead. That started my day. A short beacon check ultimately became a full day of trouble-shooting a power supply, and at that point early in the day, who knew what else. I will describe the procedures I went through to determine what could be repaired.

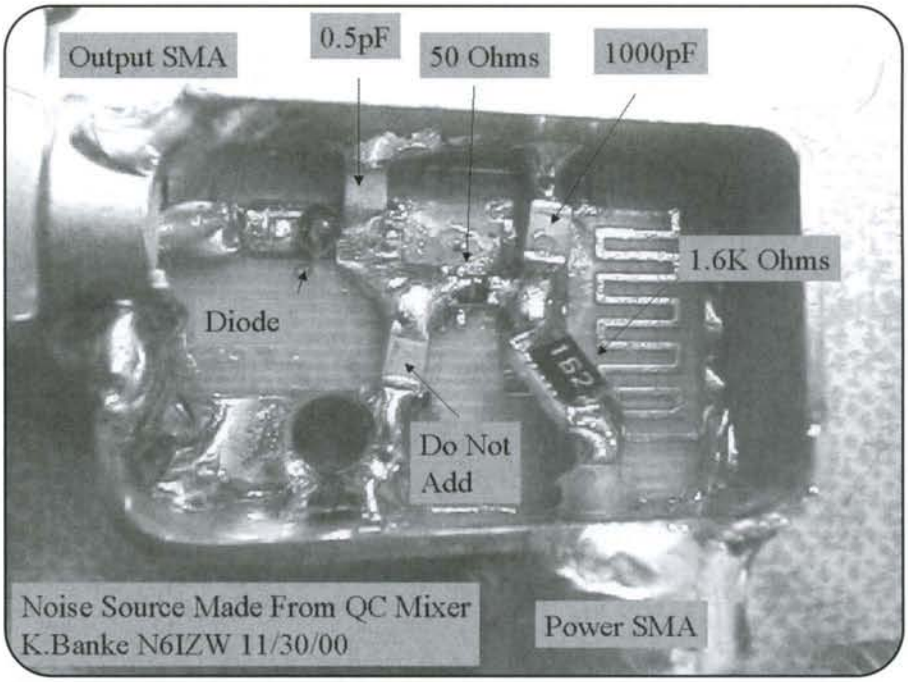


Photo A. Close-up of the surplus PC board and components as placed on the board.

At first, I was almost ready to go out and purchase a new Astron 28-volt LS 25-amp power supply. My supply is a heavy-duty analog supply and is very hefty. There are no meters or other panel controls and it is quite old, but it had worked for a long time. Ultimately, I decided to keep it and started trouble-shooting. With the AC line powered up, I checked for 28 volts DC. There was none. I checked the AC line fuse and it was okay.

I pulled the 35-pound supply from the shelf and put it on the workbench. I went through basic trouble-shooting procedures to verify the AC into the transformer. It measured 30 volts on the power supply to the filter caps through the rectifier stack. All was okay so far.

I then rechecked the DC output at full supply, and to my surprise there was 28 volts DC. I checked for any intermittent connections and found the negative test lead of my VOM had a loose banana plug. I fixed the plug. I next used a 100-watt 5.6-ohm resistor to load the supply. Testing with the resistor as a load verified that regulation would pull about 5 amps. The power-supply regulation was still putting out 28 volts with the test load. The power-supply trouble proved to be a defective test lead on the VOM. I then put the cover back on the power supply and returned it to the shelf.

Getting to the 10-GHz converter and TWT amplifier, I pulled inside the weatherproof case and microwave converter from the back yard for the 10-GHz station. The weatherproof case is an old BC221 frequency meter case that has sufficient space to house my converter and 10-watt TWT amplifier. The rig is constructed using a Frequency West brick local-oscillator microwave miniature mixer, transceiver relay switching with four SMA coaxial SPDT relays for IF, an

**Member San Diego Microwave Group, 6345 Badger Lake Avenue, San Diego, CA 92119 e-mail: <clhough@pacbell.net>*

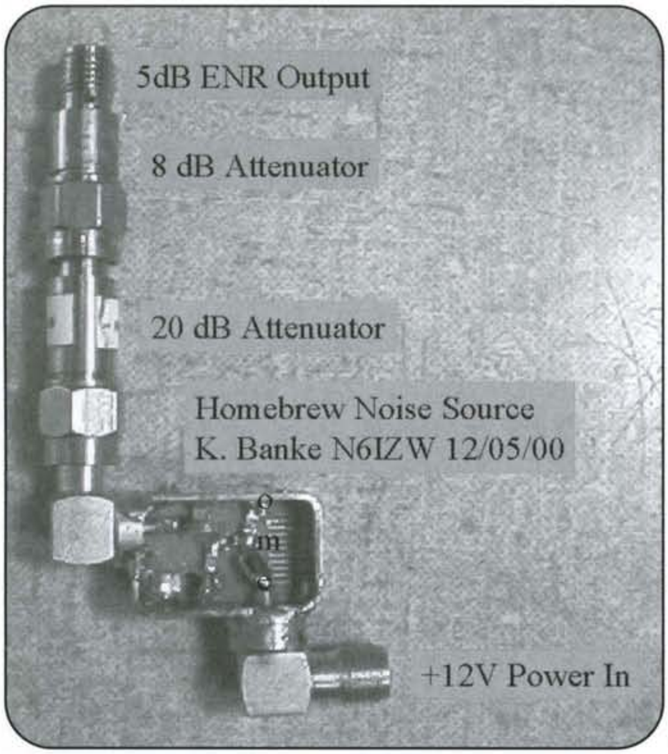


Photo B. The complete picture of the circuit board and SMA attenuators used for output load for the 5-dB ENR obtained on the unit N6IZW constructed.

RF amplifier for the TWT driver and a receiving four-stage FET pre-amplifier, TWT output switching, and main antenna receive transmit switching relay.

Powering up the converter, the first thing I checked was the Frequency West LO (local oscillator) crystal oscillator on its voltage test point, remote to the brick oscillator. It should have been about 1/2 volt DC TOK (tested OK). Next I checked for lock between the crystal and high-power oscillator internal to the brick. Connection to the monitor lead from the brick should have been 4 to 10 volts DC on the phase "zero" monitor lead. Ideally, it should have been midrange, about 7 volts. I readjusted the cavity to obtain 7 volts DC, adjusting the cavity slightly on the high-power internal oscillator. It tested OK. Now that left a two-stage RF amp used in both receive and transmit, a four-stage LNA pre-amp for receive, relay switching, and about 15 miniature 141 hard copper microwave low-loss coaxial-cable connections.

Also, where I feared to tread is on all the low-voltage power supplies for all the pre-amps and other circuitry. They are the +10 VDC, –5 VDC bias supply, an isolated 28- to 12-volt positive ground supply, and a 12-volt negative volt supply that had to be used—as the TWT is a positive grounded system, as is the main LO, a brick oscillator operating with –19 volts at 1/2 amp with the crystal heater.

What's the best choice of test equipment you can use to find the trouble? I usually prefer a signal generator on the frequency of the device being tested. That can be troubling, as it could require several generators to test the IF and RF circuitry. The generators also require the test-frequency source to be very stable. As with SSB bandwidth used on modern narrow-band converters, you have a window of 2 to 3 kHz to find your test sig-

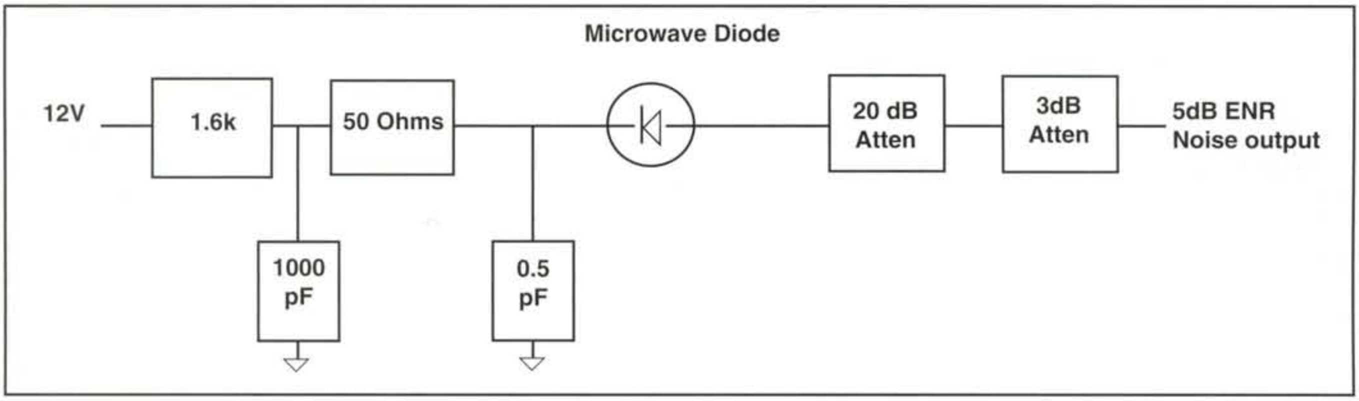


Figure 1. Diagram for the 5-dB ENR (estimated noise reduction) noise source based on surplus Qualcomm 14.5-GHz mixer board. (Courtesy Kerry Banke, N6IZW)

nal. If you don't have a very stable generator, a simpler device can be used—a simple diode connected as a noise generator. If the diode generator circuitry is kept very small, it will have great noise output in the high microwave region, usually just fine at 10 GHz.

Look at web page <http://www.hamradio.com/sbms/sd/>. Look for tech notes from the SD Microwave group for details on building your own noise generator, specifically an article by Kerry Banke, N6IZW. Yes, a commercial noise power supply and noise head could be used, but they are precious devices and should be used carefully. One error, such as transmitting into one, will destroy the "good stuff," a calibrated noise head.

This article will show how a surplus diode that we had in the junk box, plus a few extra components we had on hand, including the PC board, can be used to construct a noise head.

The reason for using a noise generator is simple: It generates noise that can be received on an SSB system from very low frequency (10 to 50 MHz) to 10 GHz, and might even go higher depending on construction. The noise-head diode operates in the zener reverse-voltage region of the microwave diode, limited in current to about 1.5 ma. With the internal 1.6K-ohm series resistor powered with 12 volts DC, you can turn on and off the +12 volts to pulse the noise head on and off. If you have a 28-volt noise figure meter, insert a 22K-ohm resistor in series with the 1.6K-ohm resistor to limit current to 1.3 to 1.6 ma of current. You will have to tinker with the exact value of the resistor value to obtain maximum noise at 10 GHz, or the frequency you are interested in.

The 50-ohm resistor should be a good-quality chip ceramic resistor, but the 1.6K- or 22-K-ohm resistor can be carbon 1/4 watt or even 1/8 watt if you have one. There is nothing fussy here, as the board supplied for this project has two diodes, three of the .5-pF chip capacitors, and two brown miniature chip caps used for bypass on the DC input. I measured the brown bypass caps to be .001-µFd chip caps as on the supplied miniature PC board.

Using the noise head, I connected the head and a 20-dB SMA pad to the RF in the 2-meter multimode receiver. I applied negative ground and +12 volts to the noise head. You should hear white noise increase when keyed with +12 volts DC. In my case, I applied the noise head to the IF cable to a 2-meter IF receiver, and the generator was quite loud. I used an old Kenwood TS700A 2-meter multimode receiver transmitter equipped for SSB. It tested OK here now. I next applied noise to the mixer RF input (IF output SMA) connected to the TS-700 2-meter Kenwood SSB receiver. It was dead—no noise. I checked the LO output from the Frequency West brick oscillator. Using a Hewlett Packard power meter with a 10-dB pad should give a measurement of at least +10 dBm. If you have a frequency counter at 10 GHz, verify frequency of the LO required for a 10-GHz and 144-MHz IF system.

Mine was okay. I changed out the 10-GHz mixer. This turned out well, as now noise from the mixer input (RF port) to the system's IF transceiver was working. I next moved the noise generator to the main antenna RF in/out connector and confirmed that the noise was good here, too,

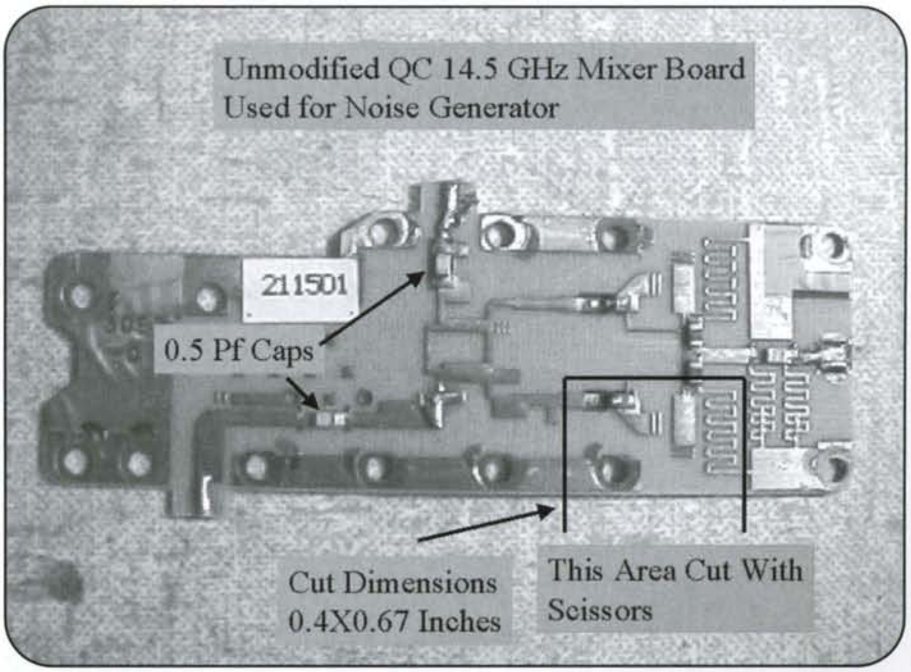


Photo C. The complete surplus PC board before it was cut to size for noise-figure construction.

with the system back in service. Don't ask why the mixer blew and did not affect the pre-amplifiers, as they still worked okay. I just lucked out with the mixer I had as a spare in the junk box. I refer to such microwave mixers and associated parts as piece of "unobtainium." When I find myself at a swapmeet and locate such items at bargain prices, I pick them up for future use such as this. Always save such parts for that rainy day. I just happened to have a few spare mixers in the junk box that were bargain purchases at our local swap meet.

Last but not least, I checked the output on transmit and connected two each 2-watt 10-GHz rated attenuators for additional 40 dB loss. I turned on the transmitter and got a reading on the power meter of slight negative movement, or meter vane, say –0.2 dBm with 40 dB attenuation in series to the meter. That confirmed that the TWT amplifier output was slightly less than 10 watts on 10 GHz. I then shut down the transmitter and TWT.

I next connected the commercial noise head to the RF input to the converter system RF input. With my noise head and 20-dB attenuators in noise connection to the converter, I saw the system's S-meter wiggle and heard the noise pulsing, verifying to my satisfaction that the entire system was operating well. The final confirmation occurred when I attached the converter to my back-yard desk and copied the beacon quite well. It was 10 dB over S-9 using an old S-meter on the Kenwood TS-700A. All this happened after not following the basic premise "keep the junk under control."

The noise head was constructed to keep components tight, and was built on a postage-stamp-size section of Teflon® PC board scrap that previously housed a 14-GHz mixer. The diode and 0.5-microwave-rated chip cap and the PC circuit board were recovered from local scrap and will be made available from the author. The remaining components are a quarter-watt resistor and two SMA pads, which serve as microwave-frequency-rated load for the noise diode. The noise diode is back biased at 12 volts input for 1.6 ma current). A small metal box with two miniature SMA coaxial connectors and a feed-through cap for DC feed finish the parts count for the noise head.

This project is quite simple. The photos tell the story, and the components to construct the noise head are quite easy to obtain. The most difficult thing for me in the construction was holding the miniature chip components in one spot to solder them in place. Try using a drafting variable-width pen tip used as a variable-width clamp to hold the miniature chip capacitor and then tack-solder one end of the component in the exact place. Component placement is not critical, and the only fault of larger construction techniques is poor performance at higher microwave frequency. Yes, the noise is not calibrated, but it will provide you with a very simple indication of go, no-go operation of your microwave system, one which will fit in your pocket, is simple to construct, and is quite inexpensive to put together.

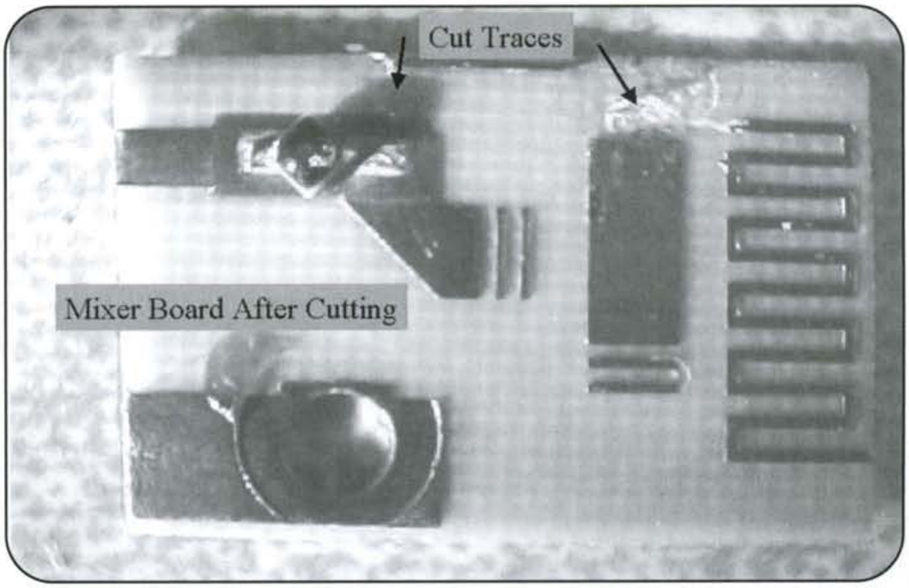


Photo D. The PC board ready for construction of the noise-figure generator.

I could not find the original noise head I had constructed, so I assembled another one to not only work at 12 volts DC, but also at 28-volts DC for my bench AIL 1415 automatic noise-figure meter. The unit I constructed came close to specs on my commercial head.

I would like to thank Kerry Banke, N6IZW, for his design and the photos used in this article. Again, for further details, look at the web page of the San Bernardino Microwave Society (SBMS) at <http://www.ham-radio.com/sbms/sd/>. Look under tech articles from the SD Microwave Group (top of the list) and go to the noise generator by N6IZW.

To facilitate your building the generator, I am making available PC boards with two diodes on each board. They are $3.00 each postpaid, or three boards for $7.00 postpaid. I am trying to locate a supply of .001-μFd chip caps and 50-ohm resistors for this project. If I can find them in surplus, I will include them in the kit. Always try to keep cost at a minimum. Orders for kits with board go to: Chuck Houghton, WB6IGP, 6345 Badger Lake Ave., San Diego, CA 92119.

By Keith Pugh,* W5IU

SATELLITES

Artificially Propagating Signals Through Space

An Update of the World of Satellites

Since the last column, SSETI has been launched along with its fleet of CubeSats; the AMSAT Board of Directors met in Pittsburgh, PA; the Project EAGLE Team met in Pittsburgh, PA; SuitSat deployment is "slipped" until February 2006; and Expedition 12 is *very active* on the ISS. All of the popular "LEOs"—AO-51, AO-27, AO-7, SO-50, FO-29, GO-32, and VO-52—remain active. AO-51 carries on its multi-mode operation/experimentation, and VO-52 has tested its Dutch Transponder successfully.

SSETI Express (XO-53)

The SSETI (Student Space Exploration and Technology Initiative) project has been discussed in some detail in recent columns, so details will not be repeated here. After a series of earlier launch schedule "slips," at last press time the hardware and launch team was in Russia securing the equipment and going back home to wait after another "slip." Launch finally occurred on October 27, 2005 at 06:52 UTC on board a Kosmos 3M rocket launched from the Plesetsk Cosmodrome in central Russia. It was designated XO-53 by AMSAT by request of the SSETI team and was assigned the NORAD ID 28894.

Shortly after launch, SSETI deployed three CubeSat pico-satellites developed by universities. After launching the CubeSats, XO-53's batteries stopped charging and the spacecraft went silent. The control team is hopeful that recovery will be possible, but as of press time there has been "no joy."

If/when XO-53 is recovered, it will also function as an amateur radio transponder for the remainder of the mission. SSETI can also downlink Earth images and demonstrate technology for the European Student Earth Orbiter. Most of the educational goals planned for SSETI have already been realized by the construction, launch, and initial operations, so the mission is already a success.

The three CubeSats deployed by SSETI Express and their status are:

- **XI-V** from Japan, University of Tokyo: Alive and well.
- **UWE-1** from Germany, University of Würzburg: Alive and well.
- **Ncube-2** from Norway, Andoya Rocket Range: After an initial period of about two months without any confirmation of deployment or operation, evidence of probable deployment has been discovered; however, there is still no evidence of operation.

AMSAT BoD Meeting 2005

The 2005 AMSAT Board of Directors Meeting and the 2005 AMSAT Annual Meeting were held on October 6–7 in Pittsburgh, PA. The entire BoD, as follows, attended. Incumbents re-elected are Rick Hambly, W2GPS; Barry Baines, WD4ASW; and Gunther Meisse, W8GSM. New to the board is Emily Clarke, WØEEC. First Alternate is Bob McGwier, N4HY, and Second Alternate is Lee McLamb, KU4OS. Returning BoD members for their second year are Tom Clark, W3IWI; Paul Shuch, N6TX; and Lou McFadin, W5DID. Officers were elected for the following year. The only major change was the replacement of Stan Wood, WA4NFY, by Bob McGwier, N4HY, as Vice President of Engineering.

Complete minutes of the BoD meeting will appear in the *AMSAT Journal.* Reports were given on all operational functions of AMSAT, with major emphasis on budget and plans for the future. Fund raising for major projects such as EAGLE occupied a major part of the time. Gunther Meisse outlined an organized, professional fund-raising effort that prompted much discussion, but ultimately met with approval. Elements of this effort are already in place. Educational outreach was another "hot topic," along with emphasis on the "open source" concept for current and future projects. The place for the 2006 AMSAT Space Symposium was set for the San Francisco Bay area in October 2006.

The AMSAT Annual Meeting was held on Friday evening, October 7, 2005, with those present meeting in the hotel, and for the first time those not present were invited to join the meeting via Echo Link. This method of operation worked well and probably will see much more use in the future. Total attendance was approximately 30 in the hotel and another 30 from around the world via Echo Link.

Project EAGLE Meeting

Two Project EAGLE satellites will fulfill a major part of AMSAT's vision of 24-hour coverage by high-altitude satellites by 2012. The Phase IIIE satellite being developed in Germany will fulfill the first part of this vision. On October 7–9 the program shifted gears for a Project EAGLE Meeting. Additional team members arrived to support the meeting chaired by Project Leader Jim Sanford, WB4GCS.

An overview of the EAGLE architecture developed so far was presented as a starting point for this meeting. Features of this architecture are a software-defined radio based transponder for traditional modes and the C-C Rider concept, introduced by Tom Clark, W3IWI, for expanded-mode coverage at C band. These modes were discussed at length, and initial steps were taken to identify and document the interfaces necessary to support these modes. A paper was presented on the structural aspects of the satellite, and some new, very interesting concepts for power generation and control were presented. These activ-

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ities filled the time allotted on Friday and Saturday, except for the social event Saturday evening at Jim Sanford's house. Sunday morning was filled by discussions of the RF requirements for the satellite and a very inspirational discussion of concepts for an EAGLE Ground Station.

As an interested "outsider" (not a member of the team), this was a very interesting and encouraging meeting. The meeting was well run, and concepts were well thought out and challenging, but practical. Significant progress is being made on all fronts. The design is being documented as it develops, and under the "open source concept," it is being shared via the AMSAT web page. The largest challenge by far is fund raising, and this topic was amply addressed at the AMSAT BoD Meeting. AMSAT members and the public will be hearing from fund raisers soon. Please support this worthy effort!

A follow-up meeting on RF design was held in New Jersey over the Thanksgiving holiday weekend. The list of attendees reads like a "Who's Who" in amateur radio RF design. Assignments were made, lab space was defined, and the team is "charging on."

SuitSat

SuitSat was to be deployed in December via an EVA (extra vehicular activity); however, the schedule slipped and deployment is now scheduled for February 2, 2006. It may already be history by the time you read this, but it bears mentioning again. Watch the AMSAT News Service and the AMSAT and ARRL web pages for updates on both of these items. Links to complete articles on SuitSat are available on the AMSAT web page. An excellent report on SuitSat hardware was presented by Lou McFadin and Steve Bible at the AMSAT BoD meeting. The SuitSat Project will be of great interest to school kids (and older kids as well). Get your equipment ready and make contact with your local schools, churches, scout groups, etc., and enjoy.

Expedition 12 Activity on the ISS

The Expedition 12 crew—made up of Bill McArthur, KC5ACR, Commander, and Flight Engineer Valery Tokarev—has been very active on the International Space Station. School contacts are now being scheduled for two a week and general operations have been greatly increased. The school contact backlog is now being reduced. Recently, the cross-band repeater has also been active. This crew will do assembly and deployment of SuitSat. Finally, Bill has stated goals of WAC (Worked All Counties), WAS (Worked All States), and DXCC while on this mission, and good progress is being made on all of these goals.

Summary

SSETI Express, along with its passengers, was launched and has been declared a success in spite of difficulties. AMSAT BoD and Project EAGLE meetings defined the future of amateur radio satellites. Get ready to fully take advantage of SuitSat and help Bill, KC5ACR, work WAC, WAS, and DXCC from the ISS. Start planning now to attend the 2006 AMSAT Space Symposium in the San Francisco Bay area in 2006. Finally, support Phase IIIE and Project EAGLE with your available resources!

73, Keith, W5IU

By Tomas Hood,* NW7US/AAA0WA

PROPAGATION

The Science of Predicting VHF-and-Above Radio Conditions

What's There To Do in the World of VHF Propagation?

In the last edition of this column, we took a look at dying sunspot Cycle 23 and how we're expecting its end by 2007. With the approach of end of the cycle, is there anything (propagationally speaking) worth exploring on the VHF and UHF bands?

Because of the nature of the Earth's orbit around our sun, we have two seasons each year when any adverse space weather has a greater influence on causing geomagnetic disturbances. The first is known as the Spring Equinoctial Season, and the second is known as the Autumnal Equinoctial Season (see figure 1). These are the two times during the course of the Earth's orbit around the sun when the Earth is in just the right position to be most influenced by solar activity.

The Spring Equinoctial Season peaks between March and April of each year. Is it likely during this final year of the current Cycle 23 that we will have significant geomagnetic disturbances to trigger the sort of auroral activity known to bring VHF activity?

The answer lies in exploring past solar cycles and knowing the nature of space weather during the decline and end of a sunspot cycle. Specifically, the answer is tied to the existence of coronal holes. Last quarter's column touched on the origin of the solar wind and the role coronal holes play in space weather.

One of the "atmospheric" layers around the sun is a region known as the corona. When a large area develops in the corona that is less dense than the surrounding area, a "coronal hole" opens up. These large-scale features are "open" magnetic-field regions that are sources of high-speed streams of solar electrons, protons, and ions (plasma).

Let's look at the relationship between coronal material and magnetic fields. The corona is so hot that the gases in it lose some of their electrons in the powerful collisions between atoms. This plasma is a mixture of positively charged ions and negatively charged electrons. An example of plasma is neon light. Because plasmas are electrically conductive, they can steer, or be steered by, magnetic fields. If the plasma streams out away from the sun, through a coronal hole, it drags a piece of the sun's magnetic field with it. These loops of magnetic force are stretched and dragged into interplanetary space by the inertia of the expanding plasma and the solar wind. When these magnetic forces impact the Earth, they are either diverted by or combined with Earth's magnetic field.

When the solar wind carries the coronal plasma past the Earth, geomagnetic storms may be triggered. The majority of geomagnetic disturbances are generated by the encounter with this passing plasma and magnetic-field flux. The ability to disturb the Earth's magnetosphere is a function of the solar wind speed, the strength of its magnetic field, and the presence of a strong southward magnetic-field component. Strong southward magnetic lines are most prevalent during the two yearly equinoxes.

The Earth's magnetosphere is formed from two essential ingredients—the Earth's magnetic field (which has much the same form as that of a bar magnet and is from pole-to-pole) and the solar wind. When the solar-wind magnetic-field lines combine with the Earth's magnetic field, the shape and intensity of this shield around the Earth are altered. The ionosphere is affected by these changes, either by an increase of ionization, or a decrease or even a depletion of ionization. Depressions in ionospheric density cause major communications problems, because radio frequencies that previously had been refracting off the ionosphere now punch through. The MUF (maximum usable frequency) can be decreased by a factor of two during an ionospheric storm event. Storm effects are more pronounced at high latitudes. When solar-wind magnetic-flux lines are oriented in a southerly

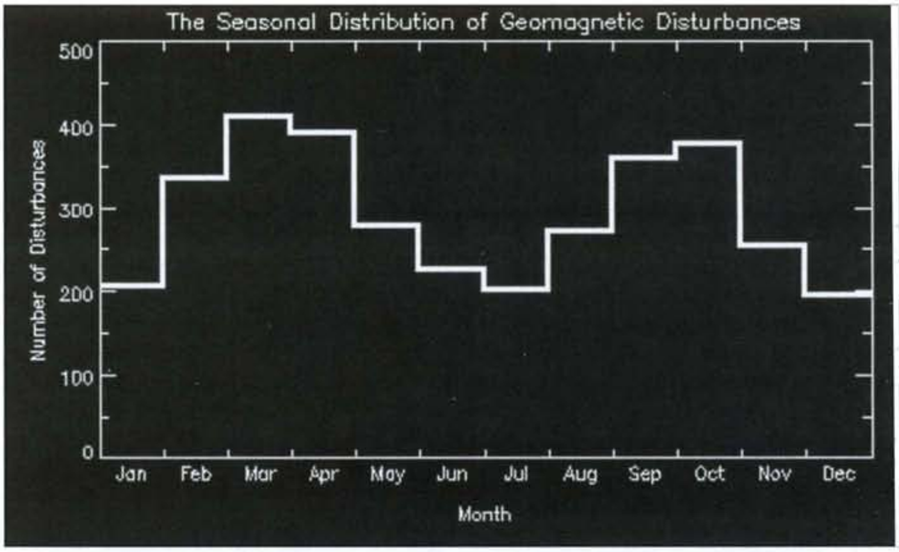

Figure 1. This graph by IPS, Australia shows the two seasonal geomagnetic peaks during the equinoctial periods (see text). (Source: IPS, Australia)

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direction, aurora is possible. Propagation off aurora is an exciting activity.

What is the Aurora?

Aurora is a direct result of solar plasma interacting with gasses in the upper atmosphere. It is common to see aurora during active to severe geomagnetic storms. The magnetosphere is filled with electrons and protons that normally are trapped by lines of magnetic force that prevent them from escaping to space or descending to the planet below. The influence of solar wind that has been enhanced by coronal holes can cause some of those trapped particles to break loose, causing them to rain down on the atmosphere. Gasses in the atmosphere start to glow under the impact of these particles.

Different gasses give out various colors. Think of a neon sign and how the plasma inside the glass tube, when excited, glows with a bright color. These precipitating particles mostly follow the magnetic-field lines that run from Earth's magnetic poles and are concentrated in circular regions around the magnetic poles called "auroral ovals." These bands expand away from the poles during magnetic storms. The stronger the storm, the greater these ovals will expand. Sometimes they grow so large that people at middle latitudes, such as in California, can see these "Northern Lights."

In the early 1970s scientists recognized a connection between the component of the IMF (interplanetary magnetic field) that lies along Earth's magnetic axis (known as "B sub z" [B_z]) and Earth's changing seasons: The average size of B_z is greatest each year in early spring and autumn. So why do these storms increase in strength and number during spring and autumn?

As the sun rotates (one full rotation occurs about every 27 days), the plasma spewing out from the sun forms into a spiral shape known as the "Parker Spiral" (named after the scientist who first described it). This solar wind carries with it an interplanetary magnetic field, which ever expands away from the sun in this spiral. Think of one of those rotating lawn sprinklers with jets of water shooting away from the center; you can see a bending or curving of the water lines. As the Earth moves around the sun, these spiraling solar winds sweep into Earth's magnetosphere. How the magnetic field lines (IMF) in the solar wind interact with the magnetic-field lines of the magnetosphere is the key to geomagnetic storms and aurora.

At the magnetopause, the part of our planet's magnetosphere that fends off the solar wind, Earth's magnetic field points north. If the IMF tilts south (i.e., B_z becomes large and negative), it can partially cancel Earth's magnetic field at the point of contact. This causes the two magnetic fields (Earth's and the IMF) to link (think of how two magnets link with one magnet's south pole connecting with the other's north pole), creating a magnetic-field line from Earth directly into the solar wind. A south-pointing B_z opens a window, through which plasma from the solar wind and CME (coronal mass ejection) can reach Earth's inner magnetosphere, bombarding the gasses of the upper atmosphere.

Earth's magnetic dipole axis is most closely aligned with the Parker spiral in April and October. As a result, southward (and northward) excursions of B_z are greatest then. This is why aurora is most likely and strongest during the equinoctial months. When you see the solar-wind speed increase to over 500 kilometers per second, and the B_z remains mostly negative (the IMF is oriented mostly southward), expect an increase in geomagnetic activity, as revealed by the planetary *K*-index (*Kp*).

During this last year of Cycle 23, the spring equinoctial season will likely be mostly quiet, with few geomagnetic storms. If we do experience moderate to storm-level activity due to recurring coronal holes, look for aurora-mode propagation when the *Kp* rises above 4, and look for visual aurora after dark when the *Kp* rises above 5. The higher the *Kp*, the more likely you may see the visual lights. However, you don't have to see them to hear their influence on propagation. Listen for stations from over the poles that sound raspy or fluttery. Look for VHF DX. Sometimes it will enhance a path at certain frequencies, while other times it will degrade the signals. Sometimes signals will fade quickly, and then come back with great strength. The reason for this is that the radio signal is being refracted off the more highly ionized areas that are lit up. These ionized areas ebb and flow, so the ability to refract changes, and sometimes quickly. I've observed the effect of aurora and associated geomagnetic storminess even on lower HF frequencies.

Radio Aurora

If there are enough solar particles flowing down the Earth's magnetic-field lines and colliding with atmospheric atoms and molecules, ionization occurs. This ionization may be sufficient enough to reflect VHF and lower UHF radio waves, generally between 25 and 500 MHz. This usually occurs in conjunction with visual aurora, but the mechanism is a bit different, and it is possible to have one (visual or radio) without the other.

Using radio aurora, the chances of contacting stations over greater distances than would ordinarily be possible on the VHF frequencies is increased. Like its visual counterpart, radio aurora is very unpredictable. The thrill of the chase draws many VHF weak-signal DXers to working auroral DX.

VHF auroral echoes, or reflections, are most effective when the angle of incidence of the signal from the transmitter, with the geomagnetic field line, equals the angle of reflection from the field line to the receiver. Radio aurora is observed almost exclusively in a sector centered on magnetic north. The strength of signals reflected from the aurora is dependent on the wavelength when equivalent power levels are employed. Six-meter reflections can be expected to be much stronger than 2-meter reflections for the same transmitter output power. The polarization of the reflected signals is nearly the same as that of the transmitted signal.

The *K*-index is a good indicator of the expansion of the auroral oval, and the possible intensity of the aurora. When the *K*-index is higher than 5, most operators in the northern states and in Canada can expect favorable aurora conditions. If the *K*-index reaches 8 or 9, it is highly possible for radio aurora to be worked by stations as far south as California and Florida. Your magnetic latitude can be found using the map at <http://www.sec.noaa.gov/Aurora/globeNW.html>.

It is possible even during this last year of the cycle, because coronal holes continue to occur, that some life is left for seasonal exotic VHF activity via the aurora. It is not likely that we will see major geomagnetic storms during the yearly spring aurora season. However, with even moderate geomagnetic activity triggered by recurring coronal holes, we could be in for a surprise ot two if auroral activity occurs.

Meteors

While there are no major meteor showers during February and March, April has one major shower, the *Lyrids,* which will peak on April 22 at 1630 UTC. While this shower peaks at about 18 meteors per hour, or about one every five minutes on average, radio bursts occur more often. This year we might see the meteor rate reach as high as 90 per hour.

The debris expelled by comet Thatcher as it moves through its orbit causes the *Lyrids*. It is a long-period comet that visits the inner solar system every 415 years or so. Despite this long period, there is activity every year at this time, so it is theorized that the comet must have been visiting the solar system for quite a long time. Over this long period, the debris left with each pass into the inner solar system has been pretty evenly distributed along the path of its orbit.

This material isn't quite evenly distributed, however, as there have been some years with outbursts of higher than usual meteor activity. The most recent of these outbursts occurred in 1982, with others occurring in 1803, 1922, and 1945. These outbursts are unpredictable and one could even occur this year. The best time to work this shower should be from midnight to early morning.

The Solar Cycle Pulse

The observed sunspot numbers from September through November 2005 are 22.1, 8.5, and 18.0. The smoothed sunspot counts for March through May 2005 are 33.6, 31.7, and 29.0.

The monthly 10.7-cm (preliminary) numbers from September through November 2005 are 90.8, 76.7, and 86.3. The smoothed 10.7-cm radio flux numbers for March through May 2005 are 97.2, 95.5, and 93.2.

The smoothed monthly sunspot numbers forecast for February through April 2006 are 11.4, 9.5, and 8.8, while the smoothed monthly 10.7 cm is predicted to be 75.5, 73.8, and 72.7 for the same period. Give or take about 15 points for all predictions.

The smoothed planetary *A*-index (*Ap*) numbers from March through May 2005 are 15.3, 15.7, and14.8. This is just about the same number as the year before. The monthly readings from September through November 2005 are 21, 7, and 8. These are significantly more quiet than last year.

(Note that these are preliminary figures. Solar scientists make minor adjustments after publishing, by careful review).

Space Weather Week

Every year the National Oceanic & Atmospheric Administration (NOAA), the Air Force Research Laboratory, the NSF Division of Atmospheric Science, and the NASA Earth-Sun System Division co-sponsor the Space Environment Center Space Weather Week <http://www.sec.noaa.gov/sww/index.html>. This year it will be held from April 25–28 at the Boulder, Colorado Millennium Hotel. The topics are always pretty hot! The 2005 conference included topics such as "Space Weather Cycles and their Impact," "The Ionosphere and its Impact on Communications and Navigation," "SEC and Space Weather Products," "The Year in Review—Space Weather Storms of 2004 and early 2005," "Solar Wind Forecasting," and many more. This year promises more of the same cutting-edge reporting on current research, discoveries, modeling, and perhaps even details on Cycle 23's ending and highlights. The registration fee is not too high, so if you are in the area, you might want to check it out. I am not yet sure if I will be able to attend, although I hope to. If I do, I'll report on the highlights next time.

Feedback, Comments, Observations Solicited!

I am looking forward to hearing from you about your observations of VHF and UHF propagation. Please send your reports to me via e-mail, or drop me a letter about your VHF/UHF experiences (sporadic-*E*, meteor scatter?). I'll create summaries and share them with the readership. I look forward to hearing from you. You are welcome to also share your reports at my public forums at <http://hfradio.org/forums/>. Up-to-date propagation information is found at my propagation center, at <http://prop.hfradio.org/> and via cell phone at <http://wap.hfradio.org/>.

Until the next issue, happy weak-signal DXing.

73, Tomas, NW7US

"Sherlock" in the XP Age

The author first introduced his system of capturing the turn-on and turn-off characteristics of a transmitter in the September 1996 issue of *CQ VHF*. Now, nine years later, operating systems have changed considerably. As a result, WA9BVS has developed a new system for detecting these characteristics.

By Malcolm C. Mallette,* WA9BVS

Amateur radio repeaters are in a new age. The internet has made it possible to link repeaters across the world. Ever smaller HTs appear with more features than you can learn to use.

From coordinating the choice of a restaurant for a group of hams' Friday lunch to the disaster operations of the Red Cross, VHF and UHF repeaters are very important. They must not be shut down by jammers.

Unintentional Jamming of a Repeater Input

A common problem is a transmitter unintentionally being left on. A microphone is stuffed down between the seats in a car and the microphone button is pushed in. An HT has an electronic failure that results in a signal being transmitted on the repeater input. Those problems generally are solved by direction finding, which is simple if the offending transmitter on the repeater input stays on for long periods.

Intentional Jamming

Another problem is more difficult. That is the intentional jammer who kerchunks the repeater continually, uses obscene language, or otherwise interferes with the operation of the repeater, all without identifying. Jammers make life miserable with their unidentified, sometimes obscene, transmissions.

The easiest way to stop a jammer is to ignore him. *Do not mention or threaten a jammer on the air.* He wants to hear how much you hate him. *Keep your mouth shut.* Do not mention that a direction-finding team is after him or any other means is being used to locate him.

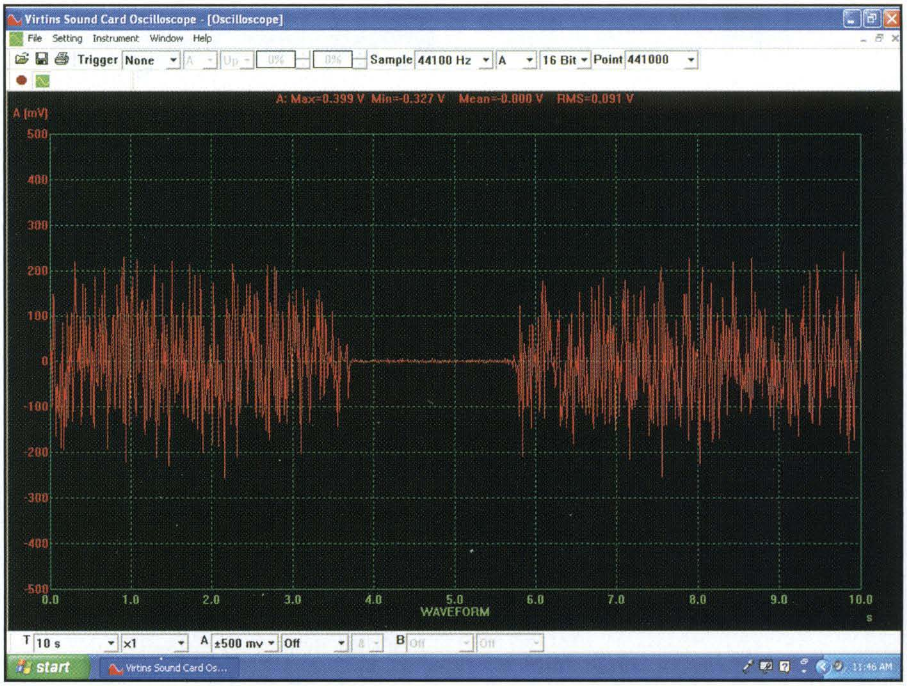

Figure 1. The Virtins Oscilloscope display showing 10 seconds of reception. The first three seconds are noise, followed by a few seconds of a received transmission, then noise again. (All screen shots courtesy of WA9BVS)

DFing is one way to find the jammer. It is more difficult than DFing a stuck transmitter, as the jammer usually does not transmit all the time. The jammer may even be in a moving car.

The 1996 "Sherlock" System and Transmitter "Turn-On" and "Turn-Off" Fingerprints

There is a different approach to finding the identity of a jammer. In the September 1996 issue of *CQ VHF* the author presented "Sherlock," a hardware-software system that captured the turn-on and turn-off characteristics of a transmitter. Modern 2-meter and 440-MHz rigs have hundreds of channels available, with a microprocessor-controlled PLL (phase-locked loop) determining the transmit frequency. When the mic button is pressed, during the first two-tenths of a second the transmitter moves in a pattern around the operating frequency, as the phase locked loop locks up. That is what is meant by the *turn-on* characteristic of a transmitter. Similar movements in frequency when the transmitter is turned off are referred to as the *turn-off* characteristic.

For over 20 years hams have used the turn-on characteristic to help identify a

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particular transmitter. In the old days of tube radios on 6-meter FM, Paul Bohrer, W9DUU, and others would look at a scope across the discriminator output to catch a glimpse of the turn-on of an unidentified transmission.

In 1996 the "Sherlock" system used a homebrew audio amp, followed by an A/D to convert the movement in frequency into a digital representation. The software then converted the digital data into a graph. By comparing the graphed turn-on of an unknown transmitter to the turn-on of a transmitter that was identified, it was possible to determine if the two transmissions came from the same transmitter. Modern rigs that are intended to be used for digital modes may have faster turn-on and therefore less of a "fingerprint," but having the information as to a jammer's turn-on and turn-off characteristics is still helpful, even if only to exclude suspects. The turn-off characteristics should not be ignored, as two transmitters having virtually identical turn-on characteristics may have far different turn-off characteristics.

The Sherlock system software ran under DOS, not Windows®. The hardware required time to build. It is time for a new transmitter fingerprint system.

The Modern "Sherlock" Transmitter Fingerprint System

The discriminator, ratio detector, or other detector of an FM receiver converts the frequency excursions of a transmitter turning on or off into electrical waves.

Windows® computers have sound cards with standardized computer interfaces. That makes it possible to create software that will run on any XP computer and use the soundcard to change analog electrical waves to digital data. To capture a transmitter's turn-on and turn-off fingerprints, the software must capture the frequency movements of the transmitter in the two-tenths of a second when it turns on or off.

Virtins Oscilloscope Software

Writing complicated software is not necessary if there is commercial software that will do the job. A digital-storage oscilloscope is designed to display electrical waveforms as a graph and save the information. There are various software oscilloscopes that work with computer sound cards. As the frequency movement that makes up the turn-on characteristics is a low-frequency audio wave, a software oscilloscope that stores the data is just what is needed.

The old "Sherlock" system ran until an operator heard a jammer. The operator "hit any key" and the program stopped, displaying a graph of the turn-on. It was impossible to find a software oscilloscope having that exact feature. However Virtins, a software company, has an oscilloscope program available at <http://virtins.com> for only $25 (as this article is being written). There is a free-trial period. The program takes in data for a period of time that is determined by the operator. Then the data is presented on the screen as an oscilloscope graph.

Using the Virtins system, the operator can select the settings of the program, start the program running, and wait for a jammer. When the jammer starts transmitting, the operator can wait until the turn-on is captured, turn the data intake off, and save the turn-on.

How the New "Sherlock" System Works

With the sound card "line" or "microphone" input connected to the output of the detector of the FM receiver to be used (how to do that will be explained below in detail), and no signal being received by the receiver, the Virtins Oscilloscope program will show noise. When the operator hears a transmitter he wants to fingerprint, he waits until the transmission shows up in the data. Figure 1 shows 10 seconds of reception, with typical noise for the first 3 seconds, followed by a few seconds of a received transmission, then noise again.

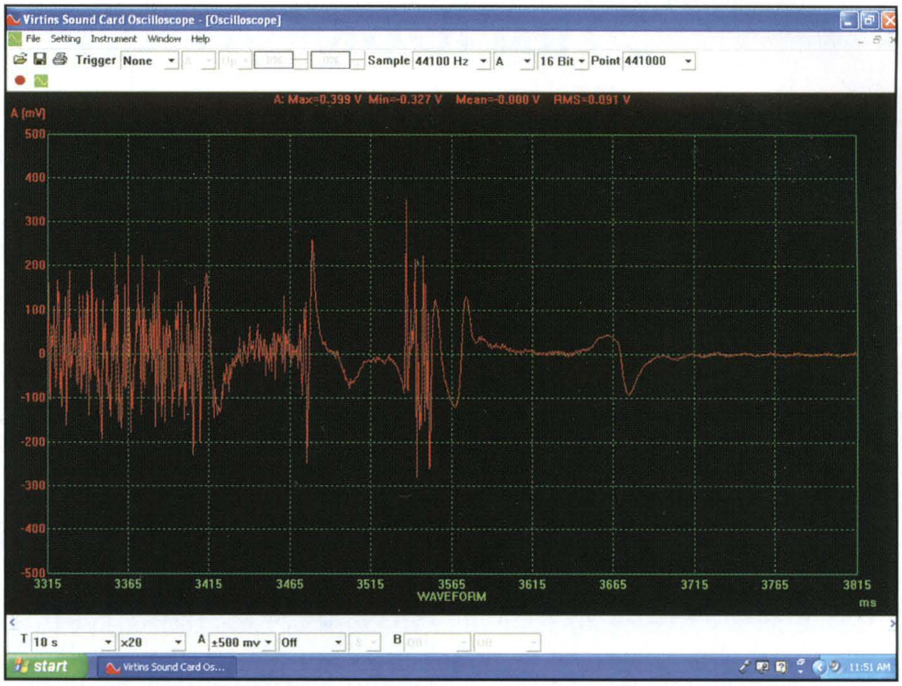


Figure 2. The Virtins Oscilloscope displays the "turn on" signal in figure 1.

The operator stops the data input when he sees the turn on (and in this case also the turn off) appear on the screen. The operator then uses the "Time multiplier" function on the program's control panel at the bottom of the screen to spread out the graph 20 times. He then uses the "slider" at the bottom of the screen to scan through the data until he sees the "turn-on" shown in figure 2. The turn-off is figure 3.

The data can be saved as a wave file. The saved data is audio, which can be played back with the *Windows® Media Player.* The operator can open the .wav file with the Virtins Oscilloscope program and see the graph of the turn-on again. The operator can open more than one copy of the program to compare two graphs.

Connecting Things

Download the oscilloscope program from Virtins. Currently there is a free trial period. You can try any oscilloscope program. When the program is installed, run it and look at the oscilloscope screen with audio from any source. When in doubt, read the help file and other instructions.

You have to use a FM receiver. If you want to identify a transmitter that is an

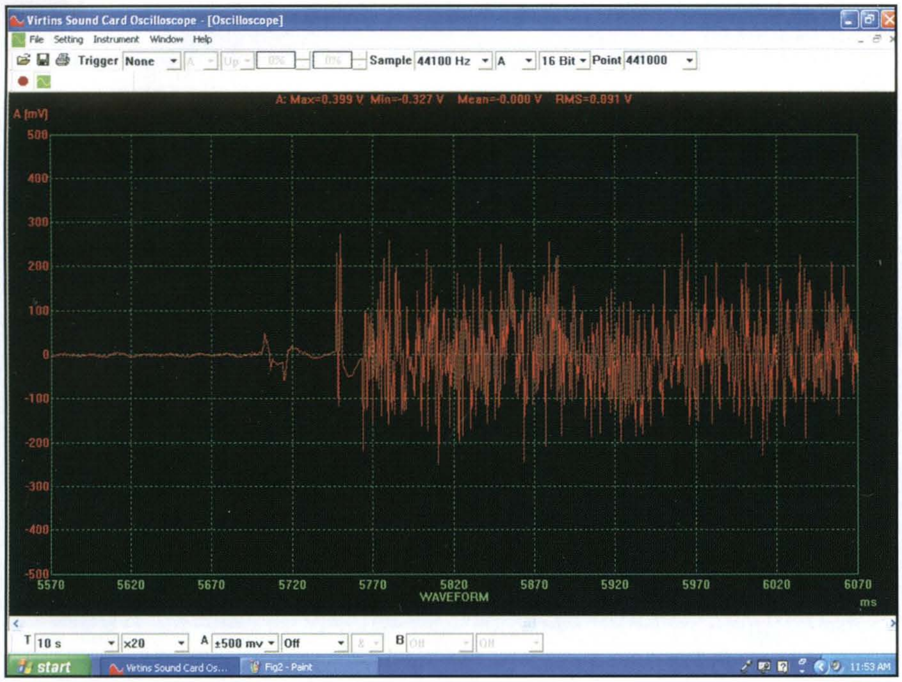


Figure 3. The oscilloscope display of the "turn off" signal in figure 1.

AM transmitter, such as in the commercial aircraft service, you must use an FM receiver to capture the fingerprint at turn-on and turn-off.

Connect the output of the discriminator, ratio detector, or other detector in your FM receiver to the input of your computer's sound card via a shielded cable. A schematic of the FM receiver will be helpful in deciding where to connect the center conductor of the shielded cable. Do not use audio from the speaker or the headphone jack. The receiver has audio circuits that eliminate the sub-audible tones needed to use some repeaters. The circuits that eliminate the sub-audible tones also eliminate the turn-on characteristics. Obtain the direct output of the detector.

Connecting to the Receiver

Since you now have an audio oscilloscope, prepare a shielded cable more than long enough to go from your computer sound card to where you will place the FM receiver. The sound-card end of the shielded cable should have the connector that goes on the line input (or mic input) of your sound card. The center conductor of the shielded cable is attached to either connection on the connector for the A or B channel and the shield is grounded.

At the receiver there may be an output from the detector to use for high-speed data. If there is, try that source. If not, solder one lead of a .1-mFd ceramic capacitor to the center lead of the cable and use a clip lead to ground the shield to the receiver chassis. With the receiver not connected to an antenna, you can use your new audio oscilloscope to look for the detector output, which will consist of noise. The noise will not look quiet like the noise in figure 1, as you will not be using the long sampling period of 10 seconds used to produce the graph in figure 1. You are using the free capacitor lead as a probe to find the detector output. Obviously, look near the detector circuit. Do not short out anything.

When you find the audio noise, turn the audio on the receiver up and down. The level of the audio on the oscilloscope screen should not vary, as you are sampling the audio before the audio-amplifier and volume-control stages. If the amplitude on the screen does vary, you are not connected to the detector output.

When you find the detector output, disconnect the cable from the sound card, turn off the receiver, and remove capacitor lead that is attached to the cable. Being careful when soldering, solder one lead of the .1-mFd capacitor to the component lead or printed circuit trace where you found the audio noise from the detector. Solder the other lead of the capacitor to any type of connector you prefer that you can mount on the receiver case. An RCA audio connector is fine. Be certain that the outside part of the connector is grounded and the inside part is connected to the capacitor lead. Install the appropriate plug, such as RCA, on the end of the shielded cable.

Put the cabinet back on, plug the cable into the sound card and the other end into the new connector on the receiver (or the high-speed data output), and check things out. When the receiver is turned on, audio should appear on the oscilloscope screen.

Operating the System

Run the Virtins oscilloscope software. At the top of the screen there are various options. For "Trigger" select "None." For "Sample" you can use the default rate if you have a new, fast computer, such as a 3-Gig Pentium 4. You may have to change the "Sample" rate to 8000 or 4000 if you have a slower computer to avoid excessive time while the data is being computed and no data is being taken in. Choose "A" or "B" as the channel input, depending on how you wired the sound-card plug.

At the bottom of the screen, "T" for time should be set to *10 seconds.* With that setting the computer will take in data for about 10 seconds, do the computations, and place the entire 10 seconds on the screen. For the time being, leave the time multiplier at "1." The "A" or "B," depending on which audio channel of the sound card you are using, is the gain setting. Set it so that the noise from an unused frequency is about one half of the screen.

Try things out using your HT to generate a turn-on and turn-off. With no antenna on the receiver, put the HT in low-power position and connect it to a dummy load. Turn off the sub-audible tone transmission on the HT. The HT must be transmitting on the frequency the receiver is receiving.

Start the data intake. Nothing will appear on the screen for about 10 seconds. Then you should see noise across the screen. Turn off the data intake. Turn the data intake back on and wait two seconds or so. Make a two-second transmission with the HT. Wait for the data to appear on the screen. It should be similar to figure 1.

Stop the data intake as soon as you see the transmission on the screen. You have now captured the turn-on. As the transmission was short, you have the turn-off also. Go to the bottom of the screen. Change the time multiplier to "X20." Use the slider that will appear at the bottom of the screen to move back and forth through the data until you can see the turn on. Figure 2 is a sample turn-on. Figure 3 is a sample turn-off. Your HT's turn-on and turn-off will be different.

The data can be saved using the save function of the program. As the data is saved as a wave file, it can be played so you can hear what was said, as well as reloaded into the program and displayed.

If the station transmitting is using a sub-audible tone (tone squelch transmission), the sub-audible tone will appear. Figure 4 is a transmission with a sub-audible tone. Figure 5 is a turn-on with a sub-audible tone, using the same transmitter that generated the turn-on and turn-off in figures 2 and 3 when its sub-audible tone was turned off.

Finally, this system produces data that is based on the turn-on and turn-off characteristics of the transmitter being received. However, the receiver being used influences the result. The sound-card performance influences the result. Therefore, the same transmitter may produce different data when received by a different receiver and when a different sound card is used. Only compare samples taken with the same receiver and the same computer/sound card. In addition, it is possible that two transmitters might have the same turn-on and/or turn-off characteristics.

It is a good idea to practice capturing turn-on and turn-off characteristics off the air using a good (high) antenna before any serious use of this system. Note that you can lose a turn-off or turn-on if the computer has completed taking a 10-second sample and is computing the result while the turn-on occurs. Given the price, the fact that the audio being transmitted can be saved as well as the fingerprint, and the fact that there is no hardware to build, this system may be the answer to your jammer identification problems. ■

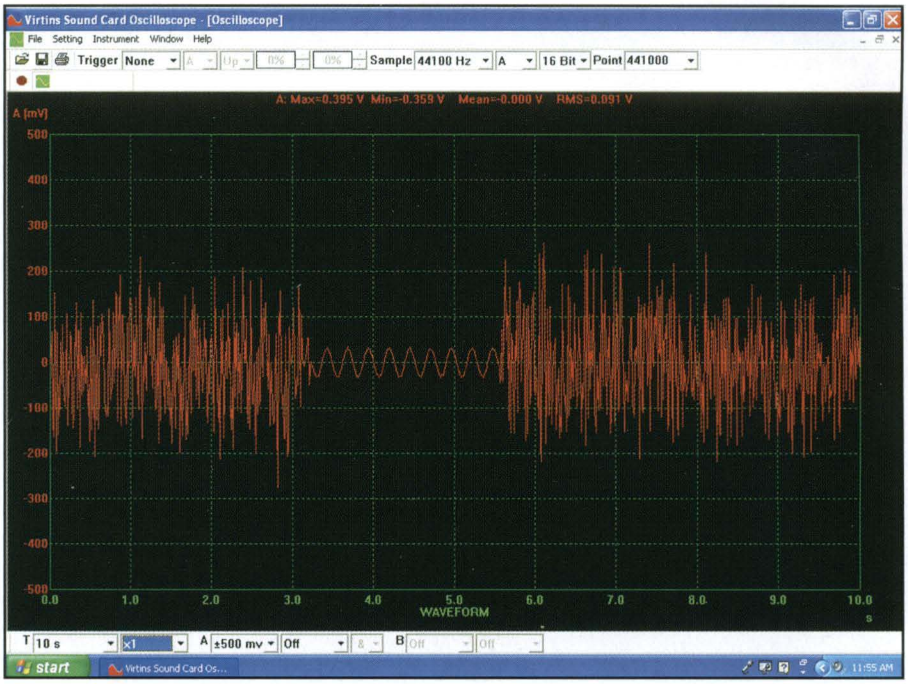


Figure 4. The oscilloscope display of a transmission with a sub-audible tone.

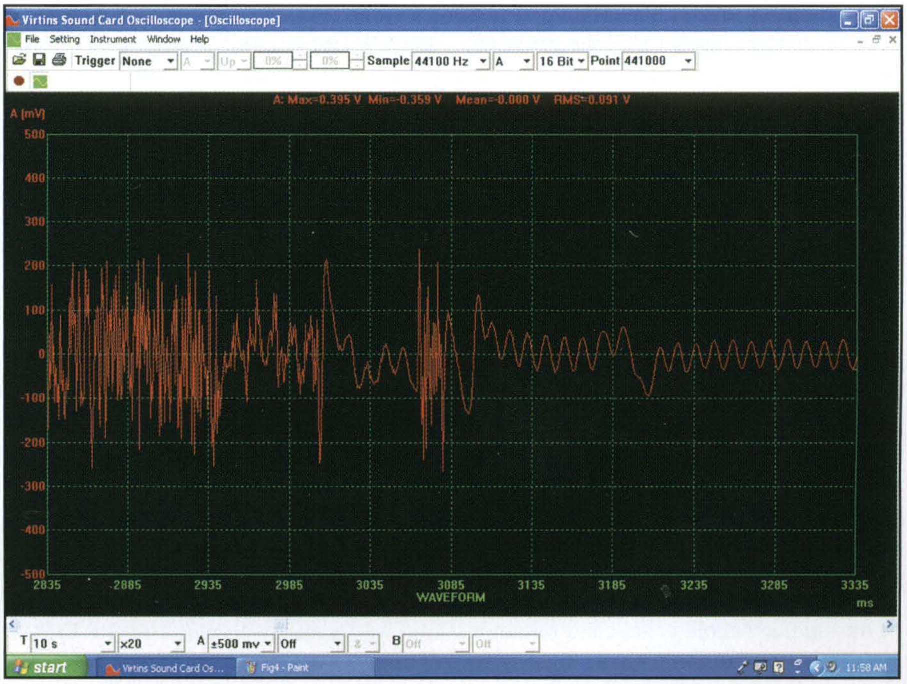


Figure 5. The Virtins Oscilloscope displays the "turn on" signal of the transmission signal in figure 4.

CQ's 6 Meter and Satellite WAZ Awards

(As of January 1, 2006)

By Floyd Gerald,* N5FG, CQ WAZ Award Manager

6 Meter Worked All Zones

No.	Callsign	Zones needed to have all 40 confirmed
1	N4CH	16,17,18,19,20,21,22,23,24,25,26,28,29,34,39
2	N4MM	17,18,19,21,22,23,24,26,28,29,34
3	JI1CQA	2,18,34,40
4	K5UR	2,16,17,18,19,21,22,23,24,26,27,28,29,34,39
5	EH7KW	1,2,6,18,19,23
6	K6EID	17,18,19,21,22,23,24,26,28,29,34,39
7	KØFF	16,17,18,19,20,21,22,23,24,26,27,28,29,34
8	JF1IRW	2,40
9	K2ZD	2,16,17,18,19,21,22,23,24,26, 28,29,34
10	W4VHF	2,16,17,18,19,21,22,23,24,25,26,28,29,34,39
11	GØLCS	1,2,3,6,7,12,18,19,22,23,25,28,30,31,32
12	JR2AUE	2,18,34,40
13	K2MUB	16,17,18,19,21,22,23,24,26,28,29,34
14	AE4RO	16,17,18,19,21,22,23,24,26,28,29,34,37
15	DL3DXX	1,10,18,19,23,31,32
16	W5OZI	2,16,17,18,19,20,21,22,23,24,26,28,34,39,40
17	WA6PEV	3,4,16,17,18,19,20,21,22,23,24,26,29,34,39
18	9A8A	1,2,3,6,7,10,12,18,19,23,31
19	9A3JI	1,2,3,4,6,7,10,12,18,19,23,26,29,31,32
20	SP5EWY	1,2,3,4,6,9,10,12,18,19,23,26,31,32
21	W8PAT	16,17,18,19,20,21,22,23,24,26,28,29,30,34,39
22	K4CKS	16,17,18,19,21,22,23,24,26,28,29,34,36,39
23	HB9RUZ	1,2,3,6,7,9,10,18,19,23,31,32
24	JA3IW	2,5,18,34,40
25	IK1GPG	1,2,3,6,10,12,18,19,23,32
26	W1AIM	16,17,18,19,20,21,22,23,24,26,28,29,30,34
27	K1LPS	16,17,18,19,21,22,23,24,26,27,28,29,30,34,37
28	W3NZL	17,18,19,21,22,23,24,26,27,28,29,34
29	K1AE	2,16,17,18,19,21,22,23,24,25,26,28,29,30,34,36
30	IW9CER	1,2,6,18,19,23,26,29,32
31	IT9IPQ	1,2,3,6,18,19,23,26,29,32
32	G4BWP	1,2,3,6,12,18,19,22,23,24,30,31,32
33	LZ2CC	1
34	K6MIO/KH6	16,17,18,19,23,26,34,35,37,40
35	K3KYR	17,18,19,21,22,23,24,25,26,28,29,30,34
36	YV1DIG	1,2,17,18,19,21,23,24,26,27,29,34,40
37	KØAZ	16,17,18,19,21,22,23,24,26,28,29,34,39
38	WB8XX	17,18,19,21,22,23,24,26,28,29,34,37,39
39	K1MS	2,17,18,19,21,22,23,24,25,26,28,29,30,34
40	ES2RJ	1,2,3,10,12,13,19,23,32,39
41	NW5E	17,18,19,21,22,23,24,26,27,28,29,30,34,37,39
42	ON4AOI	1,18,19,23,32
43	N3DB	17,18,19,21,22,23,24,25,26,27,28,29,30,34,36
44	K4ZOO	2,16,17,18,19,21,22,23,24,25,26,27,28,29,34
45	G3VOF	1,3,12,18,19,23,28,29,31,32
46	ES2WX	1,2,3,10,12,13,19,31,32,39
47	IW2CAM	1,2,3,6,9,10,12,18,19,22,23,27,28,29,32
48	OE4WHG	1,2,3,6,7,10,12,13,18,19,23,28,32,40
49	TI5KD	2,17,18,19,21,22,23,26,27,34,35,37,38,39
50	W9RPM	2,17,18,19,21,22,23,24,26,29,34,37
51	N8KOL	17,18,19,21,22,23,24,26,28,29,30,34,35,39
52	K2YOF	17,18,19,21,22,23,24,25,26,28,29,30,32,34
53	WA1ECF	17,18,19,21,23,24,25,26,27,28,29,30,34,36
54	W4TJ	17,18,19,21,22,23,24,25,26,27,28,29,34,39
55	JM1SZY	2,18,34,40
56	SM6FHZ	1,2,3,6,12,18,19,23,31,32
57	N6KK	15,16,17,18,19,20,21,22,23,24,34,35,37,38,40
58	NH7RO	1,2,17,18,19,21,22,23,28,34,35,37,38,39,40
59	OK1MP	1,2,3,10,13,18,19,23,28,32
60	W9JUV	2,17,18,19,21,22,23,24,26,28,29,30,34
61	K9AB	2,16,17,18,19,21,22,23,24,26,28,29,30,34
62	W2MPK	2,12,17,18,19,21,22,23,24,26,28,29,30,34,36
63	K3XA	17,18,19,21,22,23,24,25,26,27,28,29,30,34,36
64	KB4CRT	2,17,18,19,21,22,23,24,26,28,29,34,36,37,39
65	JH7IFR	2,5,9,10,18,23,34,36,38,40
66	KØSQ	16,17,18,19,20,21,22,23,24,26,28,29,34
67	W3TC	17,18,19,21,22,23,24,26,28,29,30,34
68	IKØPEA	1,2,3,6,7,10,18,19,22,23,26,28,29,31,32
69	W4UDH	16,17,18,19,21,22,23,24,26,27,28,29,30,34,39
70	VR2XMT	2,5,6,9,18,23,40
71	EH9IB	1,2,3,6,10,17,18,19,23,27,28
72	K4MQG	17,18,19,21,22,23,24,25,26,28,29,30,34,39
73	JF6EZY	2,4,5,6,9,19,34,35,36,40
74	VE1YX	17,18,19,23,24,26,28,29,30,34
75	OK1VBN	1,2,3,6,7,10,12,18,19,22,23,24,32,34
76	UT7QF	1,2,3,6,10,12,13,19,24,26,30,31

Satellite Worked All Zones

No.	Callsign	Issue date	Zones Needed to have all 40 confirmed
1	KL7GRF	8 Mar. 93	None
2	VE6LQ	31 Mar. 93	None
3	KD6PY	1 June 93	None
4	OH5LK	23 June 93	None
5	AA6PJ	21 July 93	None
6	K7HDK	9 Sept. 93	None
7	W1NU	13 Oct. 93	None
8	DC8TS	29 Oct. 93	None
9	DG2SBW	12 Jan. 94	None
10	N4SU	20 Jan. 94	None
11	PAØAND	17 Feb. 94	None
12	VE3NPC	16 Mar. 94	None
13	WB4MLE	31 Mar. 94	None
14	OE3JIS	28 Feb. 95	None
15	JA1BLC	10 Apr. 97	None
16	F5ETM	30 Oct. 97	None
17	KE4SCY	15 Apr. 01	10,18,19,22,23,24,26,27,28,29,34,35,37,39
18	N6KK	15 Dec. 02	None
19	DL2AYK	7 May 03	2,10,19,29,34
20	N1HOQ	31 Jan. 04	10,13,18,19,23,24,26,27,28,29,33,34,36,37,39
21	AA6NP	12 Feb. 04	None
22	9V1XE	14 Aug. 04	2,5,7,8,9,10,12,13,23,34,35,36,37,40

CQ offers the Satellite Work All Zones award for stations who confirm a minimum of 25 zones worked via amateur radio satellite. In 2001 we "lowered the bar" from the original 40 zone requirement to encourage participation in this very difficult award. A Satellite WAZ certificate will indicate the number of zones that are confirmed when the applicant first applies for the award.

Endorsement stickers are not offered for this award. However, an embossed, gold seal will be issued to you when you finally confirm that last zone.

Rules and applications for the WAZ program may be obtained by sending a large SAE with two units of postage or an address label and $1.00 to the WAZ Award Manager: Floyd Gerald, N5FG, 17 Green Hollow Rd., Wiggins, MS 39577. The processing fee for all CQ awards is $6.00 for subscribers (please include your most recent *CQ* or *CQ VHF* mailing label or a copy) and $12.00 for nonsubscribers. Please make all checks payable to Floyd Gerald. Applicants sending QSL cards to a CQ Checkpoint or the Award Manager must include return postage. N5FG may also be reached via e-mail: <n5fg@cq-amateur-radio.com>.

**17 Green Hollow Rd., Wiggins, MS 39577; e-mail: <n5fg@cq-amateur-radio.com>*

By Del Schier,* K1UHF

AIRBORNE RADIO

Using Amateur Radio to Control Model Aircraft

Getting Started

For your first model-aircraft flight you need to choose the right equipment and do some homework. This time I will help you pick your first airplane, and in the next few installments of this column I will talk about radios, motors, props, setting up an airplane, and learning to fly.

Sometimes people get their ham license, buy an HT, get on the local repeater, and then quickly become bored. They give up the hobby before they really figure out what amateur radio is about, and go back to surfing the web. You also can easily get turned off by an RC (radio-controlled) model. Some people go out and purchase a poor, ready-to-fly model airplane from a toy store instead of an RC shop. Their first flight is in their back yard with 20-mph winds. Their involvement with RC lasts about three seconds—the duration of the flight. Hopefully, I will not be giving you a "crash" course in RC!

My first RC model was a sailplane called a Gentle Lady. It was a $17 kit glider with a 2-meter wingspan. The Gentle Lady was a very good first choice. I learned with it and flew it for years. Twenty-plus years later, I gave it away so someone else could get started in the hobby. It may still be flying today.

RC airplanes can give years of pleasure, but eventually they are bound to crash or somehow get lost. I personally have damaged more models in transporting them than flying them, but that's not to say I haven't had a few bad landings and other mishaps. With RC, like ham radio, there is always a challenge. Both involve building or setting up, and operating (flying).

You will find that many airplanes are dubbed "trainers," "easy to fly," "perfect for beginners," or some such term. You will find that you get a different opinion from each seasoned modeler with whom you talk, the same as with ham equipment. I will tell you what I think you need to learn and consider before you purchase your first plane.

A beginner airplane needs to be docile. By docile I mean that it should have controls that are not very sensitive and it should like to fly straight and level. To achieve this, it helps to have a top-mounted wing, called a *high-wing* or *parasol* wing. A wing on top gives pendulum stability, just like it sounds.

Another thing to look for is a fair amount of *dihedral.* Dihedral is the V bend in the center of the wing that causes an airplane to roll back to level flight with no control input. Airplanes are controlled in three axes: yaw (left right), pitch (up and down), and roll (rotation around the fuselage center line).

For stability, the tail feathers—the horizontal and vertical stabilizers—should be rather large in relation to the wing and mounted farther aft than normal. This damps and stabilizes the yaw and pitch movements and causes an airplane to fly straight and level. The control surfaces should be relatively small and not have much travel, or the airplane will be overly sensitive to your control inputs. A high-performance aerobatic airplane is pretty much the opposite.

*e-mail: <k1uhf@westmountainradio.com>

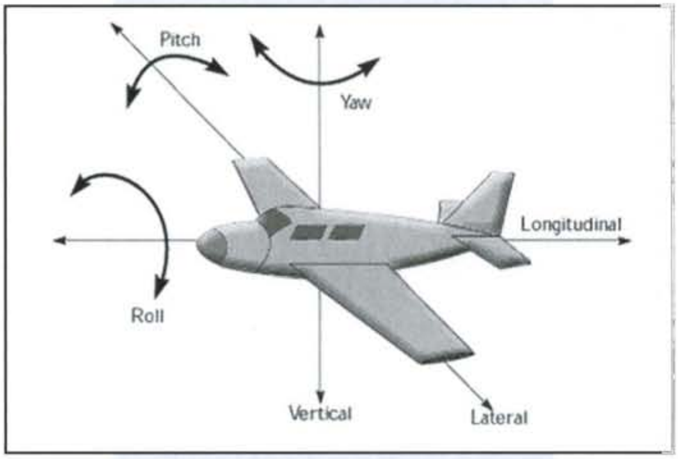


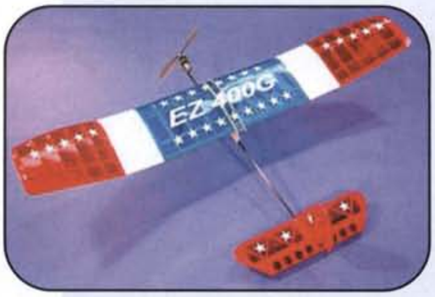
Figure 1. Yaw, pitch, and roll.

This is Not what you want—a 150-mph pylon racer!

The CG, center of gravity, should be set a bit forward. A forward CG causes a stronger balance between the horizontal stabilizer's down force and the forward weight. That's right: the tail (horizontal stabilizer) pushes the airplane down. A forward CG causes the plane to pitch up after dive and the opposite after being nose up. Too much of good thing, however, can make an airplane so stable that it cannot maneuver quickly enough to avoid an obstacle.

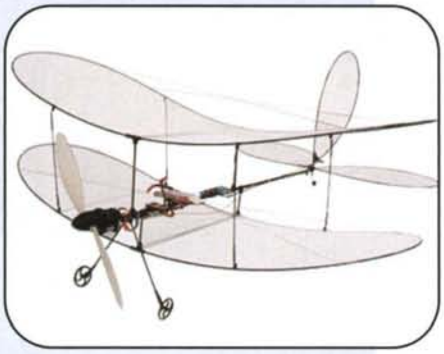
Perhaps the most important thing about a trainer is that it flies slowly. Flying speed is a direct function of wing loading. Wing loading is simply how large the wing is in relation to the airplane's weight and is usually expressed in oz/sq ft. Any airplane under about 7 oz/sq ft. is considered lightly loaded and will fly slowly. A slow-flying airplane is best for a beginner, as it gives you more time to think about things and stay out of trouble. The radius of a turn is directly proportional to flying speed, so a slow-flying plane can make smaller diam-

The Easy Star, a good foam trainer. Notice the prop out of harm's way.



The simple, slow, and good-flying EZ 400G, which is great with brushless power.

A ready to fly, which means it comes complete with radio, but not on 6 meters. The little landing gear may cause it to tip over in grass.



This plane flies very slowly and is very strong for its weight, but it is best for flying indoors without any wind.

The simple, rugged, and inexpensive Slow Stick from GWS. Notice the aluminum-tube fuselage.

The rugged, simple, and easy-to-build SkyGo is made of foam.

eter turns. A down side of light wing loading is that the airplane will be more susceptible to air turbulence and will need to be flown in calm conditions.

There are considerations that may be more up to the individual, but there are certain things everyone should look for. An airplane that is simple in every way is good. Only three channels of control—rudder, elevator, and throttle—are what you need. Look for something easy to build or get an ARF (almost ready to fly) with a good set of instructions.

It should be obvious, but your first plane should be rugged. No airplane will survive a bad crash. If it were that strong, it wouldn't fly. We have a problem here! If it is supposed to be light, how can it be strong? Basically, that depends on how it is designed and what materials it is made from. You can get a clue by studying how the motor and landing-gear areas are built and also by looking at how the wing is attached.

Recently, foam airplanes have become popular, although foam is not always strong. One type of foam that is incredibly tough is EPP, expanded polypropylene. EPP is a foam that when bent or squashed springs back, but it is fairly stiff. You will see the use of carbon fiber to strengthen an airplane, but not usually in a trainer.

The battery is the single component that weighs the most, so in a crash consider what happens with the battery. It really helps to have a strong, light airplane by using a high power-to-weight lithium battery and brushless motor.

You may wish to start out with a glider as I did, but today with electric power it is easy to start out with a motor. You can get a nice-looking airplane with which to learn. It doesn't have to look like a trainer. Many airplanes can be used as trainers, provided they are rigged with forward CG and modest control authority. However, don't get carried away with a fancy-looking first airplane if all you want to do is learn to fly.

73, and happy flying! Del, K1UHF

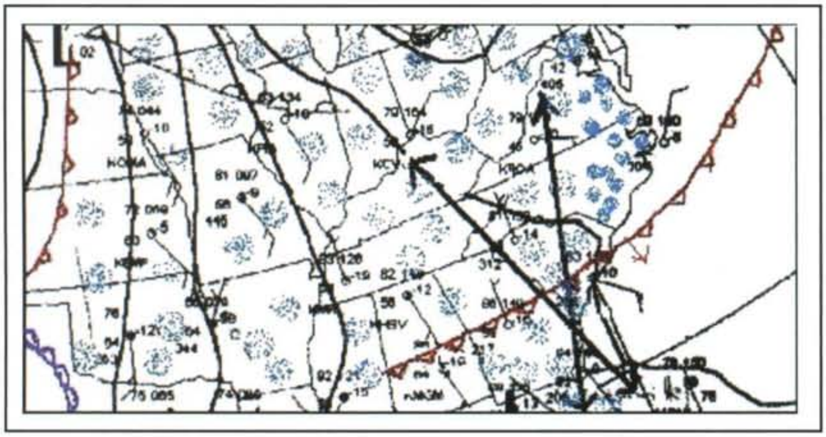


*Figure 3. Frontal activity in North America, with cold fronts. A warm front is also present here in the lower left-hand corner. This map was recorded on May 11, 1999, when a good opening was taking place between W1, 2, 3, and 8 into W4. It shows the front and the propagation called sporadic-*E *taking place over it.*

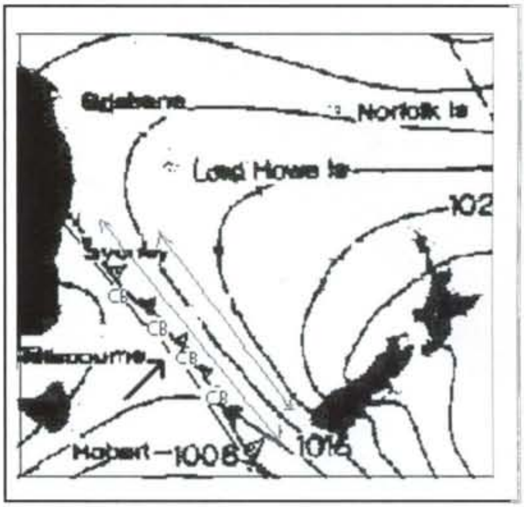


Figure 4. Here is a typical map for New Zealand showing the warm winds. The double-arrow lines are the lines of propagation.

stricted views for 360 degrees at a height of 20 meters above ground, and on top of a 100 meter hill the receiving position was perfect.

It did not take long to establish that a series of weather patterns was evolving. Every time the same weather pattern occurred, contacts with the same place occurred. Things such as air pressure were recorded, as were air temperatures, and again a regular pattern was also shown to exist. I also noted there were several regular weather patterns, and if they were in the line of propagation, no contacts were ever recorded!

From my years of recorded data, I had established that for 2 meters the following seven conditions, or modes, produced propagation. They also do it for 6 meters, but with less intense conditions required. In describing how propagation takes place, there are seasons for each mode! Even the areas where the propagation takes place change from year to year, and this is also predictable. Now for the simple part:

Mode 1: Anticyclones, with an air pressure of 1026 mb and an air temperature of around 28–30° C in the propagation path, produced propagation across the center of the anticyclone out to 2250 km (1100+ km each side of center) (and under very good conditions much farther). This is the shortest distance of interest to me. To achieve this, your antenna needs to be unobstructed and be able to receive signals coming in at or below 3 degrees for at least 10 to 15 km. It was accountable for about 80–90% of all 2-meter propagation in 2004–5!

Mode 2: Anticyclones, with an air pressure of 1032+ mb and an air temperature of 26°+ C, bring much higher angles of propagation, over 8 to 10 degrees. However, they only account for about 2–5% of the propagation.

Figure 2 is my anticyclone chart, which shows how to predict when the anticyclones will produce propagation. Drawing a line between the two basic components, the lowest air temperature along the path and air pressure between you and your intended destination, crossing the center line it must be equal to or above point 8 or 10 on the chart for 2 meters. For 70 cm, look at point 11 on the 2-meter scale. A closer look will show that as one side goes up, the other side comes down. However, there is a point at which things become too low for any propagation. The left-hand chart is for 6 meters, while the other one is for 2 meters and 70 cm. Modes 1 and 2 accounted for approximately 90% of the 2-meter propagation. It is easy to obtain these details from your newspaper's weather map.

Mode 3: Frontal activity associated with warm or cold fronts (see mode 4).

Mode 4: Lightning flashes from thunderstorms, traveling at the leading edge of cold fronts as in figure 3, increase the ionization of the *E*-layer and bring about the propagation that has been called sporadic-*E*, giving us those incredible strong signals we like to hear. One cold front is shown over the eastern side of North America and another on the western side. While moving in an easterly direction, they are also advancing towards the equator. These produce north/south propagation on 2 and 6 meters over the main area of the lightning. While I see it in Australia, North America and Europe, the north/south path does not happen in New Zealand on 2 meters, as the available path length here is too short.

On 6 meters signals reach S9+ 20 dB between Auckland and Christchurch. Excellent propagation occurs here in the east/west paths when the front is lying in a north/south direction in the central Tasman Sea. Propagation percentage on 2 meters may vary from 1% to 5%, while on 6 meters to 35%. Side scatter and most backscatter are by-products of lightning storms. Long warm fronts also contain lightning as they come into contact with cold conditions and can provide spectacular propagation, including on 2 meters.

Mode 5: Ducts traveling in the warm winds ahead of a cold front in the southern Tasman Sea are shown by double-arrow lines in figure 4. Signals can be extremely strong, to the point where we refer to these as pipelines to VK2 from Christchurch. For the Northern Hemisphere they are in the warm southwest winds and can be confused with jet-stream winds.

Mode 6: Ducts traveling in jet-stream winds at a height of 10 km. The spring is the best time of year for these, although they can come during the winter, as the one shown in figure 5. Some years the northern jet-stream winds do not come as far south as us. They are narrow and provide very strong propagation.

Figure 5 was recorded on August 14, 1996, and it shows the duct in the color mauve at a height of 10 km. This gave propagation from Auckland to Brisbane on 6 meters, when it became centered over both cities. The map was by weather fax, and it shows two cloud banks at the leading edge of two cold fronts. During spring, very strong jet-stream winds can occur between 20 degrees south (or north) and 45 degrees south (or north). These have produced incredible openings as high as 1296 MHz here, with extremely strong signals. I have seen them last up to three days, and even handheld transceivers have been able to work over 2250 km! If you have access to this information, you can see them coming for several days. They are very narrow and cannot be accessed from outside the width of the duct.

Figure 5. A duct in a jet-wind stream north of Tasmania.

In New Zealand we have two lines of jet-stream winds, one over northern Australia and the other over southern Australia. I have recorded ducts over 2500 km long coming from Australia to all over New Zealand. My map is from weather fax, but ducts can be seen in newspaper maps by the long, straight cloud formations with very sharply defined edges of cloud on one side, usually on the cold side.

Mode 7, AU: Whether it is AU or AU sporadic-*E*, these should be well understood and need no further comment here.

The mode 1 anticyclones have been known and well accepted for many years. Here I can only make contacts with Australia by mode 2, as I have a 10-degree hill obstruction. The ZL3s in Christchurch can only make contact with VKs on 2 meters when mode 2 is current or when mode 4 is active. They have a mountain range to cross at an average height of 2000 meters and 75 km in front of them.

I have not shown an occluded front. However, when an occluded front is in the line of propagation, I have never seen any propagation take place! You will also see many weak anticyclones—1008 mb to 1018 mb. These are also far too weak and do nothing, so again *no* propagation has ever been recorded under these conditions. We must have very strong action in our weather patterns, high pressure or big differences from the warm to cold side of cold fronts, as these are what bring about real action.

I think many amateurs understand aurora—how it comes about and how the received signals are returned to us, with

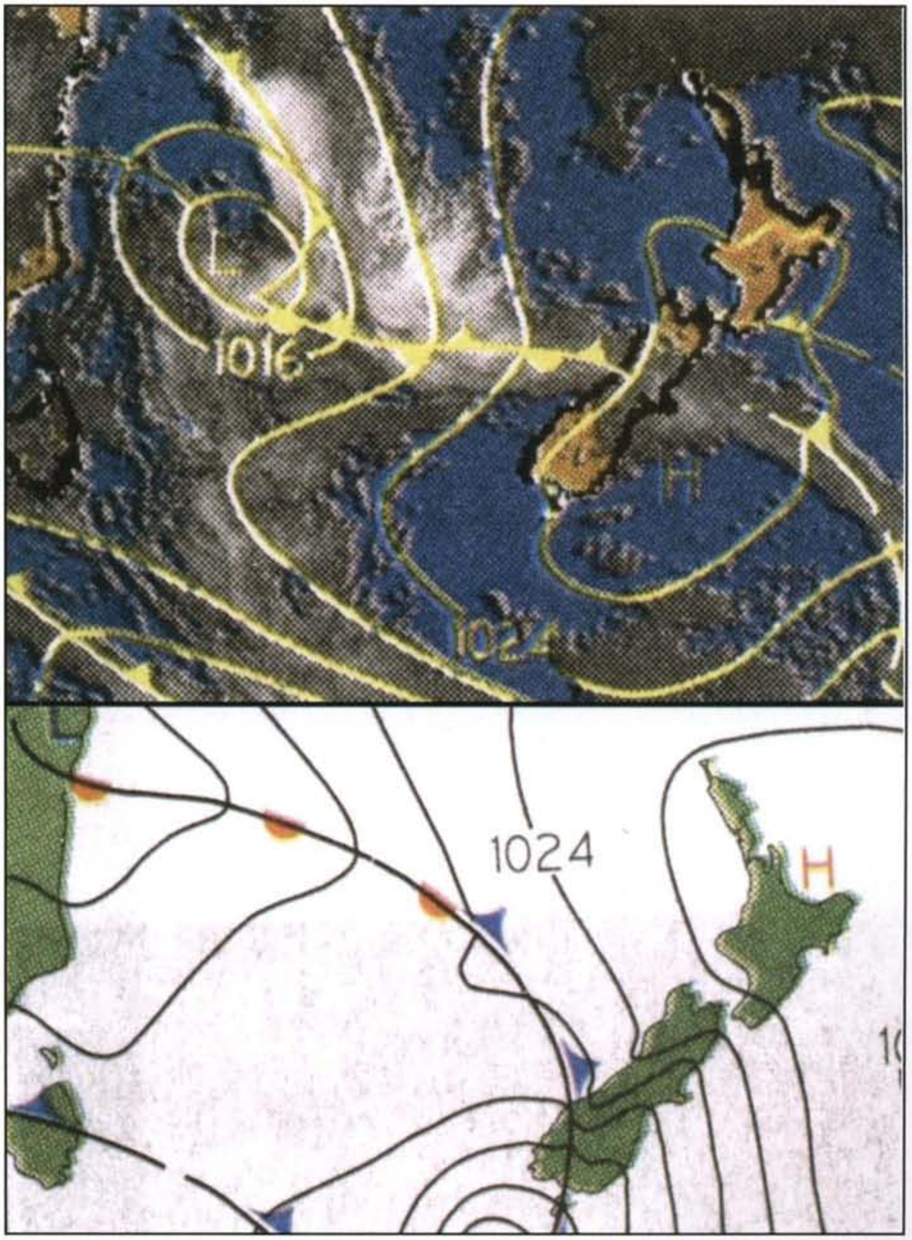


Figure 6. A satellite picture taken on Saturday, September 3, 2005 at the end of winter in New Zealand, along with a sea-level isobar map taken 18 hours later on Sunday, September 4.

Northern Hemisphere* 6 Meter Calendar											
January	February	March	April	May	June	July	August	September	October	November	December
E	ACE, weak	from 21st	D	D	ABCDE	AB	A	A, weak	from 21st	AE, weak	AE, weak
Northern Hemisphere* 2 Meter Calendar											
January	February	March	April	May	June	July	August	September	October	November	December
—	—	from 21st	D	D	ABCDE	AB	A	A, weak	A, very weak	—	—

Legend: A = low-angle anticyclones; B = high-angle anticyclones; C = lightning; D = ducts with jet winds; E = ducts in warm winds ahead of cold or warm fronts.

**For the Southern Hemisphere change January to July. The mode C can occur at any time of the year, but peaks as shown in the list.*

Table 1. Weather conditions to produce propagation.

all the sound distorted, by the distinctive AU buzz. I also take it that many amateurs understand how this area about 70 km high ionizes the *E*-layer and produces both single-hop and double-hop sporadic-*E*. This propagation has been accepted for many years.

Lightning and Thunderstorms

Now let us think about lightning, where we have a very large series of exceptionally strong lightning flashes (a recent storm here produced over 5000 strikes in a small area in a few hours!). From them large sprites develop (examples have been photographed by NASA) which look like large carrot-shaped flashes going up to 70 km in height.

It could be said that sprites are very much like aurora, but fed with energy from nearer ground instead of by radiation from the sun. They are different in their origin, but have the same effect, as they also ionize the *E*-layer and produce what we have called sporadic-*E* for many years. Let me now produce some recorded evidence.

Figure 6 shows a satellite picture taken on Saturday, September 3, 2005, at the end of winter in New Zealand, along with the sea level isobar map taken 18 hours later on Sunday, September 4. The thunderstorm in the cold front gave propagation from Christchurch, ZL3, to VK2, Australia. You can also see how the depression had moved considerably to the southeast overnight, taking the active area of the cold front with it. Winter propagation from the lightning storm as it came in from the Tasman Sea took place while the storm was centered between ZL3 and VK2.

As I prepared to start my study, I wondered just whom to contact for more assistance. The first place I contacted was our local TV weather department, and I put my case to them. Could they give a brief comment each night saying if there were any thunderstorms within 1500 km of Auckland, where they were located, and what the activity was—weak or very strong, etc. After several discussions, they agreed to do this, and I am pleased to say that ten years later they are still doing it every night. In this way I know exactly where these storms are and what fronts,etc., are involved in them.

If you cannot get this information from a source such as that, you will have to use your newspaper maps (see figure 7). First look at the map showing the isobars and see where the fronts, if any, are located. Next look at the satellite map showing the cloud formation. You will notice different depths of color (or gray scale). Near the center of the cloud, look for a small section that is nearly white; this is where thunderstorms are active, as it is the highest point in the clouds. You now have the place to ward which to beam your antenna.

In judging where to point your beam, remember that most of these storms are traveling at an average speed of 25 knots, so allow for the deviation in your beam heading. By this means you can now find the storm and follow it as it travels, even days before it comes between you and any amateur stations, until it places itself in the center of the propagation path you are looking for. Each day have a look at the weather maps, as that is where the information can be gained very quickly. In New Zealand we seldom have more than one weather pattern active, but in big continental areas such North America, Europe, and even Australia, several weather patterns can and do actively provide propagation at the same time in different directions.

Here are some other examples:

May 22, 1999: I was looking at the North American weather map that showed where thunder/lightning storms of high intensity were located. Above the location of the Millstone Digisonde station there was a sign of good activity. This looked interesting, so I looked at the dxworld.com 6-meter page, and here we had contacts taking place from Canada to the United States directly over the lightning storm as shown on the map.

Armed with this information, I connected to the Millstone web page and looked up the time list and downloaded the charts. There it was showing up very nicely. The chart showed that the *E*-layer had reached 12.5 MHz. Taking the usual multiplication factor of 5, we now had propagation recorded for 6 meters. This was a confirmed mode of propagation lightning (otherwise known as sporadic-*E*), because we had the weather map showing the lightning storm, the contacts, and the ionsonde charts showing ionization to 12.5 MHz all at the same time. When the storm died out, the ionsonde data returned to normal and propagation ceased.

December 21, 1995 at 6 PM: From 5 PM to 6 PM I had a poor opening on 6 meters to Sydney. At two minutes past 6 PM the band suddenly opened with Sydney stations S9+. Then I found I had VK6 stations S7 (Western Australia, 5500 km). After exchanging reports with these stations I switched to 2 meters, and yes, the Sydney stations were S9 on 2 meters.

Just before 7 PM I listened to the TV weather for my lightning update. What did they say? A very aggressive thunderstorm started at two minutes past 6, and it was located in the center of the path between Auckland and Sydney. That was exactly the same time when both bands opened here! Local stations farther north

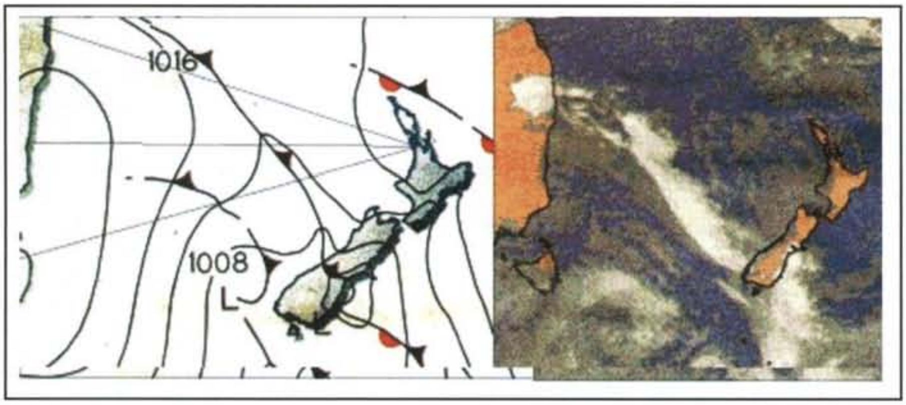


Figure 7. The isobar map and satellite picture were taken on December 27 and December 28, 2004, respectively.

or south of Auckland did not get the propagation we had, as their path was out of the area ionized by the thunderstorm. The next day the newspapers commented that the storm had died out at around 8 PM, and that was the time when 2 meters closed to Sydney. This type of information is a do-it-yourself job. You have to organize these things yourself, as they are not available off the shelf.

Some time back I heard VK9NS in Norfolk Island some 1200 km north of me calling ZL4TBN. Here I had perfect copy of VK9NS by backscatter with a lightning storm centered between me and the ZL4. I called VK9NS and we exchanged reports; I could not hear him on the direct path. This is a perfect example of backscatter, with signals being reflected off the ionization brought about by the lightning flashes. As I have said, we get a lot of propagation like this, as cold fronts sweep up the south island from the south, and these usually have lightning storms in the leading edge of the cold front.

Halfway between Christchurch and Auckland is an area that grows a lot of apples. When they get hail from thunderstorms, we get the report as to how many thousands of cases of apples, etc., were destroyed. Every time we get these reports, I find I have been in contact with amateurs in Christchurch! Again, confirmation of lightning producing propagation.

Here is another good example of backscatter, etc.: The TV weather mentioned that there was a lightning storm traveling south in the northern section of the sea between us and VK4 so I watched for it, and sure enough the VK4 beacon came in, so I telephoned Trevor, VK4AFL, as we did on many occasions during my study, and had a couple of words; can we report on 6 meters? The band was open for the short time as the storm moved south, another lightning opening? While this was happening, another local station (75 km away) from me, was hearing the contact on backscatter although he could not hear the VK4.

I have many openings just like these recorded. In addition, another very interesting opening covering 2 meters took place in December 2004 starting around the 20th. A small depression developed in the North Tasman Sea and moved slowly south. It was fed by two streams of warm moist air. One came from the Coral Sea area, while the other came from east of Fiji. They joined together and fed into the depression as it moved south. By the time it was nearer to the west of us, the frontal sector was around 2500 km long, and in the southern 1000 km there was lightning activity getting stronger as the depression deepened.

Around December 23, it was due west of us and 6 meters was extremely good, with small openings on 2 meters to VK2 and VK4. By December 25, it was west of Christchurch and located in the center of the path between Christchurch and Tasmania. The storm peaked at around 5 PM when the 2-meter band suddenly opened to Tasmania from Christchurch (about 2250 km). Many contacts resulted during the two-hour opening, including ones on SSB, FM repeater, and even with handhelds. It was classic, even though these openings are relatively rare on 2 meters. Patience is very much needed.

While we are on the subject of lightning, the two weather pictures shown in figure 7 relate to a cold front advancing northeast. It produced 6-meter openings on December 27 and 28. The right-hand side shows the satellite map of the cloud formation. On December 27, 6 meters was open all day, and on December 28, 2 meters opened to VK2 and VK4 as well. When the cold front swept over Christchurch around midday on December 28, we had the usual opening from Auckland to Christchurch, another classic example. The weather patterns we have been using are MSL maps (mean sea level).

There can also be times when two different weather patterns are operating at the same time at different altitudes! The TV people brought this to my attention when discussing jet streams, as they showed me a jet stream that had a lot of thunderstorms traveling with it, starting at 10 km high! It was traveling east just north of New Caledonia, and as it happened, a number of VK4s had great propagation to eastern W-land by the lightning storms ionizing the *E*-layer. It only lasted the one day, but all I can say is be aware of this condition. I have missed fronts just the same by not checking higher. If you are very keen, check the upper levels. However, for most of us the MSL maps are fine.

There is one thing I would like, and that is a meter of some kind that would measure the intensity of the lightning ionizing the *E*-layer. We could then gauge when the intensity is strong enough to get propagation.

I think we have discussed lightning enough here. I have given the details so others can try it out and written where to search for the information. You can watch these modes coming in for about a week or even longer!

Anticyclones

Now let's look at anticyclones. The most common ones, around 1024 mb, are very well known. There have been excellent descriptions of how they produce propagation in many publications. Thus, I won't repeat old information, other than to say that propagation takes place at a height of around 2 km. This makes living next to hill hills difficult for propagation to get in or out!

We do have another group of anticyclones that become very intense, reaching 1036 to 1040 mb. These are the ones of interest to me, as they produce propagation from higher angles-10 degrees or maybe higher. It is only when these happen that I can work VK on 2 meters; the same applies for stations in Christchurch. They do work VK, but only with very high readings of air pressure.

This type of anticyclone can come in winter, but the air temperatures are much too cold to produce propagation. Therefore, the best time to look for them is in July in the Northern Hemisphere or in January in the Southern Hemisphere. They can also extend into the next month. I have included my chart showing how air temperatures and air pressures work in conjunction to produce propagation. Read your weather map and get the lowest temperature along the path. However, you need the anticyclone to at least be at the prescribed level of mb, near both ends of the path, and watch out that the air temperature does not go low along the path.

If I find there is a possibility of propagation taking place I look for beacons on 10 meters! Now I know that 15 meters will open on tropo modes before 10 meters does. However, 15 has too many other modes of propagation, so I only use 10 meter beacons. When they appear I look for 6-meter beacons. From there I keep checking 2 meters for any beacons, although I find the 2-meter stations come through just as well, if not better.

Predicting Propagation

When dealing with VHF and UHF, each spring we start a new season, so the first contacts for the Northern Hemisphere begin on March 21 and take place around 20 degrees latitude. This is the time when the sun starts to move back into the Northern Hemisphere, or as the days start to become longer.

We need to realize that propagation comes to us *as the sun brings very active weather and warmer temperatures* into our region. Here we find that the first propagation takes place between New Caledonia and Northern Australia, usually by early October. By October 22 (May in Northern Hemisphere), the first 2-meter contacts between Auckland and VK4 (Northern Australia) could take place. By November 22, possible propagation has come down toVK2 +VK4 into New Zealand, or around 40 degrees south. I would imagine the same latitude applies for the Northern Hemisphere as well.

By December 20, propagation is at the peak, and it will stay like that for about 10–14 days, after which things will change. It is not until after December 20 that we hear VK3 or VK7 on 2 meters, as they are the last areas to be heard. By mid-January here, or mid-July in the Northern Hemisphere, you have the sun moving out of your hemisphere, and all the nasty weather, frontal activity, lightning, and very unstable conditions, which produce excellent propagation, all start to move back towards the equatorial regions.

As the unstable weather departs, we are left with big, stable anticyclones—up to 1040 mb with calm weather—and these can give very extensive propagation, depending on the intensity of the anticyclone up to 1296 MHz. With these, propagation can be very wide, out to several thousand kilometers in each direction. The time for these is the middle of June to the end of August in the Northern Hemisphere (December to February in the Southern Hemisphere), and in the large continental area it is a bit longer. Look for the last of these anticyclones in late August (February in the Southern Hemisphere), as it is nearly all over, with the sun going to the other hemisphere.

For an example, look at figure 1. The quiet winter season arrives, and for 6 meters the intensity of the anticyclones will need to be nearer 1036–1040 mb, instead of the 1026 mb which gave propagation in the middle of the season. However, it is much harder to obtain temperatures that are high enough in winter to make 2 meters possible.

For propagation to take place by frontal activity in winter, we require a big temperature change from the warm side to the cold. Here it is usually accompanied by reports from our weather office of snow down to very low levels, such as sea level at 45 degrees! This is what has happened on July 15. A cold front with snow to low levels swept over the South Island, and yes, there was an opening to ZL3 on 6 meters from Auckland in the mid-afternoon; this was the first opening for winter. Anticyclones need to be very strong, such as 1040 mb.

I have seen years of nothing, and then I have also seen good years when propagation has lasted as long as a week in late August! The mode of propagation was a depression from north which drifted south with a long frontal section up to Fiji, some 3000 km long. However, there is no guarantee that you will get any propagation, and there have been times when we have gone three months without any propagation.

The early propagation here usually comes from very long ducts traveling under jet-wind streams. I have recorded them out to 5000 km long, from Darwin to over the Chatham Islands. Once you know what to look for, you can even get used to picking these by the smell of the moist, humid air! It is like listening on 6 or 2 meters with an old hand can pick—an open band just by the crystal sound of the noise.

Earlier I showed a short duct 2250 km long. It provided propagation up to and possibly above 1296 MHz. I have seen many last three days with excellent propagation on all bands up to 1296 MHz, but remember that if the signal is transmitted on vertical, that is how it comes out at the other end. I have seen a difference of up to seven S points between horizontal and vertical!

During December (or June in the Northern Hemisphere) all modes are available, so we can really get lots of propagation. At that time of the year look for connecting extensions, such as in December 2004, when we had triple hop with two lightning storms and a large anticyclone producing propagation to 5500 km.

There are times during mid-summer when an anticyclone is the current producer of propagation. That propagation dies out between 8 and10 PM and then can suddenly re-occur at 2 AM. This comes about because when the sun goes down, the evening temperatures drop, and this can lead to the equating of temperature to air pressure becoming too low to produce propagation.

Because all weather patterns keep shifting at night, we could have the anticyclone shift to a denser section, giving several more mb of pressure and once again restoring propagation. If propagation was via a duct, it would proceed all night and still can be there in the morning. Cold fronts with lightning can come at any time of the day or night!

Here is the next conundrum: The areas where propagation takes place can vary from year to year. Why?

La-Niña, El-Niño, and Normal relate to the sea temperatures. La-Niña means warmer than usual sea temperatures. El-Niño means the sea is colder than usual. Normal is self explanatory. What does this have to do with propagation? A lot. Cold fronts come from the cold climates. As they move farther towards the equator, the sea temperatures are the biggest changers of temperature or killers of cold fronts.

If you are waiting for propagation from a cold front and the cold front meets warm sea temperatures, the cold front will die out and become an occluded front. Occluded fronts never produce any propagation, as there is very little change in temperature from the warm side to the cold side of the front. The propagation you were looking for will never come! These weather conditions are very important, as for the last 50 years my records prove La-Niña produced very little propagation at 38 degrees south—in fact, only about one third the amount produced by El-Niño and Normal conditions.

Dr. Mullin of our NIWA has kindly supplied me with his list of the three weather types that were current over the last 50 years. The sea temperatures govern how near to the equator the cold fronts proceed, and somehow anticyclones follow a similar path before departing to the east. With La-Niña, frontal activity dies before it gets this far north; all the propagation with it is gone and the anticyclones pass to the south of us at 38 degrees south. If you contact your weather office around May (September in the Southern Hemisphere), you can usually get a prediction for the summer months. If it is going to be La-Niña, plan to paint the house or go on that extended holiday with the family. If it is Normal or El-Niño, get the antennas ready. With La-Niña, I only managed to work to the south of me with the usual number of contacts to that area but very little else.

When Normal is prevailing, the same front or anticyclones would come north to about 35 degrees and then turn to the east, passing nicely over us. Propagation is good for us, as most of our contacts take place here when there is no *F2* propagation. However, with El-Niño the fronts or anticyclones proceed north to around 25 degrees and then swing to the east. These are the ones we really want, as while they give propagation in all directions, it also allows us to use the tropo to make the *F2* areas and bring us our *F2* propagation. That shows you how much variation can occur from those three different patterns of weather! From these alone you can now see how a season can be so different from one year to another!

There is one thing to remember about predicting propagation on these frequencies: The weather that governs the places you contact is located 250 to 1500 km away from your location, so what is happening outside your window has very little effect on what you will work.

You will note that there are many subjects I have not covered in this article, as they require more space than is available. these include important ones such as TEP (transequatorial propagation) and *F2* on 6 meters. For example, to work France from ZL3 entails four tropo hops plus one *F2*! To do it proper justice, it will be covered at a later date. Knowing what to look for and when to look is the key to success on 6 and 2 meters and 70 cm.

All of my comments come from over 50 years of operating on these bands and data from my log books, as well as the four years of study I did in the mid to late 1990s. I am sure there will be variations in the next few years as more amateurs continue to study propagation. To any one else who undertakes this task, my best wishes. To the rest, use this information and enjoy our amateur bands. ■

Use of a mandrel was not necessary; simply squeezing the stubs on alternate sides in a 4-inch wide vise produced sufficiently round diameters to allow them to be pressed by hand into the element ends so that about an inch protrudes from the element. These "tuning stubs" can be withdrawn or inserted into the element ends as necessary to achieve a resonant length at the design frequency. When the beam has been adjusted to frequency, use a propane torch to flow a little solder around the element ends where the stubs protrude. Capillary action will draw the solder into the joint.

A 300-ohm ladder-line feeder was chosen rather the 450-ohm type, because it is more flexible and fits the standard TV standoff insulators and wall feed-though bushings. If 450-ohm line is used, the delta-match lengths will change slightly, but are easily determined by the tune-up method described above.

When the beam element lengths and delta match are adjusted so that the SWR indication on the coax is near 1:1 at the design frequency, the SWR on the ladder line will also be near 1:1. Solder the delta wires to the driven element. The hose clamps are left in place to clamp the insulated portion of the wires to the element as a strain relief.

In running the 300-ohm feedline into the shack, 3/4-inch PVC water pipe can be used as a feed-through bushing. Seal the ends with automotive silicon gasket sealer. Keep all bends in the feedline to at least a 6-inch radius, and maintain the feedline at least 4 inches from metal throughout its length. Another method of running a feedline into the shack is to replace a glass window pane with Plexiglas® that can easily be drilled to pass the line. Silicon sealer can be used to hold the line in place in the Plexiglas® pane.

As an aid to troubleshooting the system after it is erected, measure and record the resistance between the twin-lead wires at the end of the feedline. If the system ever fails to load to the transmitter, check the resistance; one of the wires in the ladder line may have broken.

Refurbishing Second-Hand TV Antenna Rotors

Second-hand TV antenna rotors may be obtained at low cost from TV antenna installers. Problems associated with used rotors are:

• Lubricant in the motor bearings and gears has oxidized to the point that the mechanism is stiff.

• The non-polarized electrolytic phase-shifting capacitor in the control box has failed due to age.

Remove the cover(s) from the rotor gear head and thoroughly clean out the old lubricant with a toothbrush and kerosene. Kerosene is a relatively safe solvent and won't harm electrical parts, but the work should be done outdoors. Carburetor spray cleaner is effective on stubborn lubricant, but may harm the motor winding insulation and other plastic parts. After the solvent has evaporated, re-lubricate the gears with a good grade of grease such as Mobilube EP2, and lubricate the motor bearings with gun oil such as Hoppe's.

Rotor control boxes generally contain a non-polarized electrolytic capacitor of about 50 µFd, 150 WV. Electrolytic capacitors of early vintage have a life of about 10 years, and the symptoms of a failed capacitor are failure to rotate or very slow rotation, much less than the nominal one revolution per minute. Replacement non-polarized electrolytics are available from some electronics suppliers, but two electrolytic caps, each of

Close-up of the 6-meter Yagi antenna.

the same capacitance and voltage as the original NP cap, connected in series (+) to (+) are an equivalent. The modern caps are much smaller than the original, so there is no problem installing two in place of the one original cap.

Bench-check the reconditioned rotor with the length of control cable with which it will be used to assure that the system will work okay. As a final step in the bench-check, position the rotor to "N" and note this on the rotor case with a magic marker, to remind you to orient the beam north when the tower is erected. Before disconnecting the cable, mark the wire colors next to their terminals on both rotor and control box.

Second-Hand TV Antenna Towers

Although TV antenna towers are designed to be free standing guy wires are recommended for the following reasons:

• The tower may have been weakened by rust and wind stress so additional support is advisable.

• Guy wires facilitate raising and lowering the tower to work on the antenna.

The base of the guyed tower can simply be placed on a cement block. Prior to raising the tower, anchor the tower base to a steel fence post or other metal stake driven several feet into the ground to prevent the base from flipping up as the tower is raised. The grounded stake will also provide protection against lightning.

With the beam, feedline, and rotor installed on the tower and properly oriented, attach the four guy wires. Fourteen-gauge galvanized-steel electric-fence wire, available at farm stores, makes excellent guy wire. Anchor the two side guys to the ground at about a 45-degree angle to keep the tower from falling sideways as it is raised, and anchor the back guy so that the tower will stop in a vertical position.

Two people can then "walk" the tower vertical while a third person pulls on the front guy and anchors it when the tower is vertical. Guy wires should not be "banjo string" tight; a slight amount of slack is advisable to minimize stress. Bond the tower base to the stake with heavy wire for lightning protection.

A Simple 6-Meter Balanced Antenna Coupler

A simple 6-meter antenna coupler that will match 50-ohm coax to a balanced 300- or 450-ohm feedline can easily be built using two variable capacitors and a home-brew inductor. The coupler has sufficient range to compensate reasonable values of reactance presented by a feedline so that the SWR on the 50-ohm coax can be adjusted to 1:1.

Although the delta matching system is inherently narrowband, the coupler allows the antenna system to operate over a range of about 0.5 MHz above and below its design frequency, if the coupler is adjusted to maintain the SWR near 1:1 as seen by the transmitter. SWR on the balanced feedline may increase to 3:1 over this range, but because of the low-loss feedline, much less power will be wasted than if coax were used at a high SWR all the way to the antenna.

To make the inductor, obtain 3 feet of $^1/_8$-inch copper tubing or #10 bare copper wire. Tubing is easier to wind than solid wire. Clamp one end of the tubing in a vise. Leaving about 4 inches of tubing as a connecting lead, stretch the tubing straight and begin winding turns tightly together on a broom handle or other mandrel of about $^3/_4$ inch in diameter.

When $7^1/_2$ turns have been wound, allow an additional 4 inches for a connecting lead and cut the tubing. When released, the turns of the coil will spring to a slightly larger diameter and can be slipped off the mandrel. Now take a small piece of the tubing and run it around between the turns of the coil to space the turns from each other about one tubing diameter, or $^1/_8$ inch. Greater spacing between turns will increase the coil's inductance. Solder a wire to the center turn of the completed coil.

Two variable capacitors are required, one of about 100 pF and the second of about 35 pF. For transmitter power of 100 watts or less, the 100-pF cap can be salvaged from an old AC/DC broadcast radio. The smaller (oscillator) section of these capacitors is about 170 pF. The 35-pF cap will have higher voltage across it, so it is best to obtain a "short-wave" type capacitor for this application. Observe that both capacitor shafts are above ground potential, so suitable insulated control knobs must be used to avoid "hand capacitance" effects.

Mount the capacitors on a Masonite or other insulating panel with a coax connector and two binding posts for the feedline. The $7^1/_2$-turn copper-tubing coil is self-supported by soldering its three leads as shown in the schematic. A neat enclosure can be made of squares of Masonite held together by hot glue from an electric glue gun.

Test the coupler by connecting a 300-ohm carbon (non-inductive) resistor to the feedline terminals. Connect an SWR analyzer (or transmitter and SWR indicator) to the coupler input with a short length of 50- or 52-ohm coax. Set the analyzer's frequency to 50.4 MHz. Adjust both variable capacitors for an SWR indication of 1:1. Generally, both caps will be about half mesh (100-pF cap will be about 50 pF and the 35-pF cap about 17 pF).

Development of the Copper-Pipe Beam and Tower

The 6-meter beam was tuned up and then installed with a reconditioned TV antenna rotor on a rickety old 30-foot TV tower. Due to the tower's condition and to avoid anchoring the base in concrete, four guy wires made of #14 galvanized fence wire broken up with electric fence insulators were used to support it. The tower was positioned in the garden such that if it fell, it would not contact the house, garden shed, or other antennas (telephone and power lines to the house are underground).

With the tower on the ground, the back guy wire and the two side guy wires were anchored to old pipes driven about 2 feet into the soil. The assembly was then easily pushed upright by two people, while the tower was kept from tipping sideways by the two side guy wires. A third person assisted by pulling on the front guy wire, and secured it to its stake when the tower was vertical.

During the raising operation, the back guy wire remained slack until the tower became vertical. Apparently, a kink formed in the wire during the time it was slack. After raising

Tips on Soldering Copper Pipe

Non-lead solder must be used to join pipe that will carry potable water; however, ordinary flux-cored "radio-TV" solder is satisfactory for use on antenna projects made of copper pipe or tubing.

The copper must be clean and bright to take solder. With steel wool, buff all areas that are to be soldered to remove all traces of oxide, and then immediately coat the areas with a paste flux such as NO-KORODE, to keep oxygen away from the metal. The paste flux augments the action of the solder's flux core.

Then assemble the joint and heat with a propane torch, while touching the solder to the joint. When the solder melts, feed it into the joint. By capillary action, the solder will be drawn into the joint.

Apply only sufficient heat to allow the solder to flow. Overheating will boil away the flux and the metal will oxidize quickly, so the solder will not "take." If this happens, let the metal cool and then rebuff with sandpaper or steel wool.

Soldering is best done in a warm (above 65° F) environment with no air movement. Trying to solder copper pipe in a winter windstorm can be very frustrating, as the heat is carried away quickly.

the tower, I noticed the kink in the wire, about 5 feet above the ground. I thought, "I'll twist a jumper wire around the kink to strengthen the wire." Of course, I forgot to do this in my excitement in trying out the new antenna system.

The SWR and resonant frequency had not changed noticeably from the tuning that was done with the beam near ground level, and several new 6-meter beacon signals were heard that could not be heard on my 1/4-wave vertical.

About a week later, an evening storm came in from Lake Michigan, with winds up to 70 mph. I watched out the window and observed the feedline whipping vigorously as it disappeared up into the darkness. Suddenly, the feedline went slack!

Sadly, I took a flashlight and went out into the howling storm. On the ground lay my tower and beam; the back guy wire had broken at the kink. The wooden boom was undamaged, but the three copper-pipe elements were bent beyond repair.

Using the dimensions that were recorded when the original beam was tuned up, new copper-pipe elements were cut and installed. Special care was taken when the repaired beam was erected to ensure that none of the guy wires became kinked. The new beam has weathered several wind and ice storms over a period of a year with no problem. A concern that the wooden boom would warp and throw the elements out of alignment has not been realized; the pressure-treated wood is very stable. The reconditioned rotor continues to work even in near-zero weather.

Ordinary solid-web 300-ohm TV line was used as a feeder on the original beam. During rainstorms the SWR went up to about 2:1. However, the SWR could be brought back to 1:1 by adjusting the antenna coupler. Three-hundred-ohm "window"-type ladder line with stranded conductors was used on the repaired beam. Rain has no noticeable effect on this feedline.

Performance

A Yagi with three elements spaced 0.2 wavelength apart typically has a front-to-back ratio of about 12 dB, but the front-to-side ratio can be as high as 20 dB. At my QTH a steady carrier at 50.12 MHz can be heard about S8 (apparently, it is not a 6-meter beacon, as I have heard no modulation or Morse identification). The carrier must be nearby, as it appears to be unaffected by propagation phenomena.

The "mystery" signal provides a convenient means to evaluate 6-meter antennas! Rotating the beam to place its back-side to the signal causes the signal level to drop nearly into the noise level. Off the sides of the beam, the signal completely disappears in sharp nulls.

Postscript

An initial concern about the lack of durability of the wooden boom seems to have been unfounded at this point. From the ground, it does not appear to have warped despite the variables of the Michigan weather, and it is still aesthetically a pleasant sight to see.

In spite of its endurance and eye appeal, however, it has yet to perform during the big opening, the most recent one missed on December 19, 2005. Unfortunately, while my wife Norma, KA8EHE, and I were at a movie, the locals were working hundreds of stations during our absence. Sadly, as of yet the beam has not been able to perform its magic on the Magic Band. □

IC-7000 Review *(from page 11)*

While the IC-7000 has a spectrum scope like the IC-756PRO radios, it is not as functional as the bigger rigs.

tial to drastically reduce the effects of any sort of ambient noise on operation. For example, ignition noise, even when not on channel, can cause AGC pumping that can make reception of a weak signal very difficult. Once the noise has been moved out of the IF passband, this effect is gone, unlike with more traditional configurations where the AGC would pump the receiver gain even from an off-channel signal.

Having said this, I have yet to have an opportunity to test the benefits of this. The IC-7000 also has many of the features of its big brothers, including twin digital passband tuning and dual manual notch filters. The 7000 is the first radio with dual notch filters, which is pretty cool if used to reduce sideband images around a signal. By using the notch to eliminate sidebands that are pumping the AGC, the AGC is allowed to act directly on the signal you are trying to receive (this is a key benefit of having the DSP in the AGC loop). This dramatically affects the S/N radio and causes a signal to just pop out.

Overall

The IC-7000 has a significantly extended set of CI-V commands for remote programming of the radio. It will be interesting to see all of the software programs that emerge to control the IC-7000. Voice record and playback is a new feature for this size radio and one which should help all of us VHF+ rovers who aren't carrying big rigs with us in the field. A high-stability oscillator is now part of the standard radio, which should help out with digital modes.

Overall I'm very impressed with what ICOM has been able to pack into the IC-7000 chassis, and I'm looking forward to gaining more operating experience with such a fine radio. □

Factor	Typical Value
Frequency	144 MHz
Distance	500 km
Climate	Temperate
Surface Refractive Index	320
Obstructions	Nil—smooth Earth

Table 2. Constant values applied to the various factors used in comparison.

based on an empirical formula for a temperate climate only. There are differences of 5 dB among these methods for a smooth Earth, and all give significantly different losses for obstruction. A problem with these methods is that they are complicated to use and this can lead to errors.

Detailed Comparisons

The ARRL's *UHF/Microwave Experimenters Manual*[2] method and the three CCIR methods all take into account the more important variables. These are now compared to see the impact on the calculated results of varying different factors. The factors are individually varied, with the remaining factors being held constant at typical values as set out in Table 2.

Frequency

The four methods are in agreement that losses increase as the cube of frequency or 30 Log f in dB terms. The CCIR report[1] states that the results have not been validated outside the range 200 MHz to 4 GHz. There is some evidence in the amateur literature that at lower frequencies as the wavelength becomes much larger than the scattering cells the relationship with frequency may not hold and this may impact on the accuracy of the methods at 50 MHz.

Distance

As shown in figure 2, there are differences among the four methods over typically a 6-dB range. The odd kink and increased detail of CCIR method 1 reflects the fact that it takes specific account of the variation of scattering losses with height for each climate.

Surface Refractive Index

The radio refractive index at the surface has the effect of bending the wave to the scattering layer, slightly reducing the scattering angle and thus the scattering losses.

Both CCIR method 1 and the CCIR Chinese methods make allowance for surface refractive index as shown in figure 3. CCIR method 2 has separate graphs for temperate and tropical climates, and these may include allowance for radio refractive index. However, they would also be affected by changes of scattering properties with climate, so the refractive index component is difficult to isolate.

CCIR method 1 indicates refractive index is more important at shorter distances and/or low obstruction angles where a significant part of the path is within a few km of the surface. It indicates that a variation of refractive index from 320 to 380 can have an impact of 5 dB at short distances, reducing to 2 dB for long paths (over 500 km) or where there are a few degrees of obstruction. The Chinese method applies a constant correction for surface refractive index independent of distance or obstruction angles; this is not logical, and the approach is considered deficient in this respect.

Climate

The CCIR Chinese method applies only to a temperate climate, and while not generally specified, it is likely that most amateur methods are also based on a temperate climate. Only CCIR methods 1 and 2 take into account different climates. CCIR 2 provides graphs of the basic propagation loss for a temperate and tropical climate and shows a variation that is relatively small at short distances, increasing to 6 dB at 1000 km. CCIR 1 gives information to adjust for six of the eight climates it specifies and shows variations of up to 15 dB between a mar-

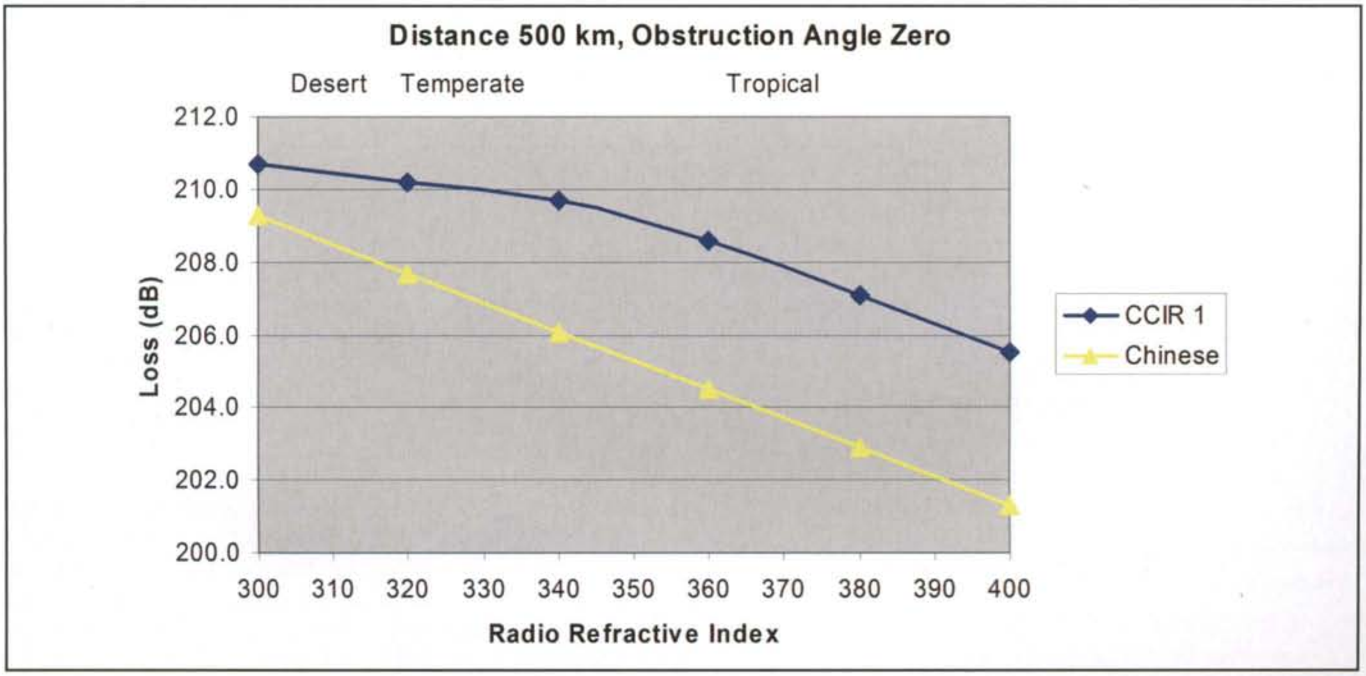


Figure 3. Variation of propagation loss with surface radio refractive index.

APPENDIX A: Propagation Losses

Applies to 50% path reliability, temperate climate, and radio refractive index of 320.

6 Meters

km	0 deg	1 deg	2 deg	3 deg	4 deg	5 deg	6 deg
100	155.3	165.7	171.9	176.6	181.9	187.9	189.9
150	164.4	172.6	180.6	187.0	189.6	191.8	193.7
200	170.3	181.8	186.2	189.2	191.8	195.7	199.1
250	178.8	183.8	187.3	191.6	196.0	199.6	202.8
300	181.1	185.2	190.7	195.5	199.5	203.0	206.2
350	182.9	189.4	194.7	199.1	203.0	206.5	209.5
400	187.4	193.5	198.4	202.7	206.4	209.7	213.9
450	192.1	197.5	202.3	206.3	210.5	214.9	218.9
500	196.4	201.6	206.1	210.9	215.6	219.6	222.8
550	200.6	205.4	210.8	215.9	219.9	223.3	226.6
600	204.4	210.2	215.7	219.9	223.5	227.2	230.7
650	209.2	215.2	219.6	223.5	227.5	231.2	234.6
700	214.2	219.0	223.2	227.6	231.4	235.0	238.2
750	218.2	222.7	227.3	231.4	235.1	238.5	241.6
800	221.8	226.7	231.1	235.0	238.6	241.9	244.9
850	225.9	230.5	234.7	238.5	241.9	245.0	—
900	229.8	234.2	238.2	241.8	245.0	—	—
950	233.4	237.6	241.4	244.9	—	—	—
1000	236.9	240.9	244.5	—	—	—	—

2 Meters

km	0 deg	1 deg	2 deg	3 deg	4 deg	5 deg	6 deg
100	169.1	179.5	185.7	190.4	195.7	201.7	203.7
150	178.2	186.4	194.4	200.8	203.4	205.6	207.5
200	184.1	195.6	200.0	203.0	205.6	209.5	212.9
250	192.6	197.6	201.1	205.4	209.8	213.4	216.6
300	194.9	199.0	204.5	209.3	213.3	216.8	220.0
350	196.7	203.2	208.5	212.9	216.8	220.3	223.3
400	201.2	207.3	212.2	216.5	220.2	223.5	227.7
450	205.9	211.3	216.1	220.1	224.3	228.7	232.7
500	210.2	215.4	219.9	224.7	229.4	233.4	236.6
550	214.4	219.2	224.6	229.7	233.7	237.1	240.4
600	218.2	224.0	229.5	233.7	237.3	241.0	244.5
650	223.0	229.0	233.4	237.3	241.3	245.0	248.4
700	228.0	232.8	237.0	241.4	245.2	248.8	252.0
750	232.0	236.5	241.1	245.2	248.9	252.3	255.4
800	235.6	240.5	244.9	248.8	252.4	255.7	258.7
850	239.7	244.3	248.5	252.3	255.7	258.8	—
900	243.6	248.0	252.0	255.6	258.8	—	—
950	247.2	251.4	255.2	258.7	—	—	—
1000	250.7	254.7	258.3	—	—	—	—

itime temperate climate over sea and a desert climate. For those who might live in the outback or the tropics, the climate variations can be significant and are only fully taken into account with CCIR method 1.

Obstructions

Figure 4A shows there are significant differences between the four methods, and that with 5 degrees of obstruction (2.5 degrees at each station) the differences between the methods are as much as 25 dB. In amateur situations, obstruction angles of 2.5 degrees at each end are not uncommon, and thus this variation represents a major concern in calculating tropospheric-scatter losses.

In order to explore this issue, figures 4B and 4C give the data at 200 km and 800 km. Figure 4C shows that at short distances and small angles there is much closer agreement between all methods. At 800 km, as shown in figure 4C, it is seen that all three CCIR methods are substantially less than the 10 dB per degree approach used by the ARRL *UHF/Microwave Experimenter's Manual*[2] method.

The 10 dB per degree approach and the CCIR Chinese method both are based on empirical equations. It is possible that these equations do not hold over a wide range of distances and angle. However, both CCIR methods 1 and 2 are intended to apply over the range of data graphed and still show large variations. The only

APPENDIX B: Propagation Losses

Applies to 50% path reliability, temperate climate and radio refractive index of 320.

70 cm

km	0 deg	1 deg	2 deg	3 deg	4 deg	5 deg	6 deg
100	183.4	193.8	200.0	204.7	210.0	216.0	218.0
150	192.5	200.7	208.7	215.1	217.7	219.9	221.8
200	198.4	209.9	214.3	217.3	219.9	223.8	227.2
250	206.9	211.9	215.4	219.7	224.1	227.7	230.9
300	209.2	213.3	218.8	223.6	227.6	231.1	234.3
350	211.0	217.5	222.8	227.2	231.1	234.6	237.6
400	215.5	221.6	226.5	230.8	234.5	237.8	242.0
450	220.2	225.6	230.4	234.4	238.6	243.0	247.0
500	224.5	229.7	234.2	239.0	243.7	247.7	250.9
550	228.7	233.5	238.9	244.0	248.0	251.4	254.7
600	232.5	238.3	243.8	248.0	251.6	255.3	258.8
650	237.3	243.3	247.7	251.6	255.6	259.3	262.7
700	242.3	247.1	251.3	255.7	259.5	263.1	266.3
750	246.3	250.8	255.4	259.5	263.2	266.6	269.7
800	249.9	254.8	259.2	263.1	266.7	270.0	273.0
850	254.0	258.6	262.8	266.6	270.0	273.1	—
900	257.9	262.3	266.3	269.9	273.1	—	—
950	261.5	265.7	269.5	273.0	—	—	—
1000	265.0	269.0	272.6	—	—	—	—

23 cm

km	0 deg	1 deg	2 deg	3 deg	4 deg	5 deg	6 deg
100	197.7	208.1	214.3	219.0	224.3	230.3	232.3
150	206.8	215.0	223.0	229.4	232.0	234.2	236.1
200	212.7	224.2	228.6	231.6	234.2	238.1	241.5
250	221.2	226.2	229.7	234.0	238.4	242.0	245.2
300	223.5	227.6	233.1	237.9	241.9	245.4	248.6
350	225.3	231.8	237.1	241.5	245.4	248.9	251.9
400	229.8	235.9	240.8	245.1	248.8	252.1	256.3
450	234.5	239.9	244.7	248.7	252.9	257.3	261.3
500	238.8	244.0	248.5	253.3	258.0	262.0	265.2
550	243.0	247.8	253.2	258.3	262.3	265.7	269.0
600	246.8	252.6	258.1	262.3	265.9	269.6	273.1
650	251.6	257.6	262.0	265.9	269.9	273.6	277.0
700	256.6	261.4	265.6	270.0	273.8	277.4	280.6
750	260.6	265.1	269.7	273.8	277.5	280.9	284.0
800	264.2	269.1	273.5	277.4	281.0	284.3	287.3
850	268.3	272.9	277.1	280.9	284.3	287.4	—
900	272.2	276.6	280.6	284.2	287.4	—	—
950	275.8	280.0	283.8	287.3	—	—	—
1000	279.3	283.3	286.9	—	—	—	—

saving grace is that they are very close at the larger distances that are of most interest (800 km).

Aperture to Medium Coupling Loss

Three of the methods provide a means of calculating the coupling loss which arises when the antenna gains reach a level at which only a small part of the effective scattering volume is utilized (see figure 5).

Both of the CCIR methods give similar results and show that these losses are on the order of no more than a dB, providing antenna gains do not exceed 25 dBi at each end. Thus, for most VHF and UHF amateur situations they will not be a significant factor. The ARRL *UHF/Microwave Experimenter's Manual*[2] method has a constant of 2 dB plus an amount related to antenna gain. It is difficult to see the logic for this constant, so this method is not preferred.

Path Reliability

For amateur operations it is sufficient to work on the basis of 50% path reliability, as if information is missed, it can be repeated. It is likely that most methods in amateur texts are based on 50% path reliability, but few specify the level on which they are based. CCIR method 1 provides data for a range of path reliabil-

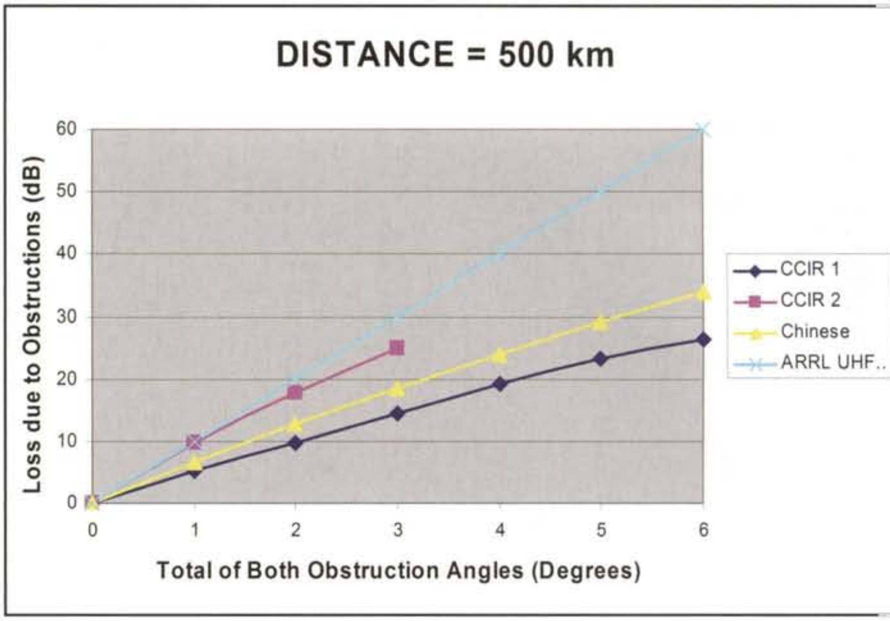


Figure 4A. Variation of loss due to obstructions at 500 km. The graph provided with CCIR-2 limits the calculation of losses with this method to a little over 3 degrees at 500 km.

ities for various climates and distances. The data show that moving from 50% path reliability to 90% can add up to 10 dB to the propagation loss. CCIR method 2 provides similar data for both temperate and tropical climates with similar variations. The CCIR Chinese method is provided for 50% path loss only. Given that the propagation loss is required for 50% path reliability, any of the CCIR methods are suitable, in this respect, and are basically consistent.

Assessment and Conclusion

It is noted that of the four methods considered most promising, there are a number of minor differences. However, a major difference arises in the way that obstruction losses are determined. Both the ARRL *UHF/Microwave Experimenter's Manual*[2] method and the CCIR Chinese methods are based on empirical formulas and could well have limited

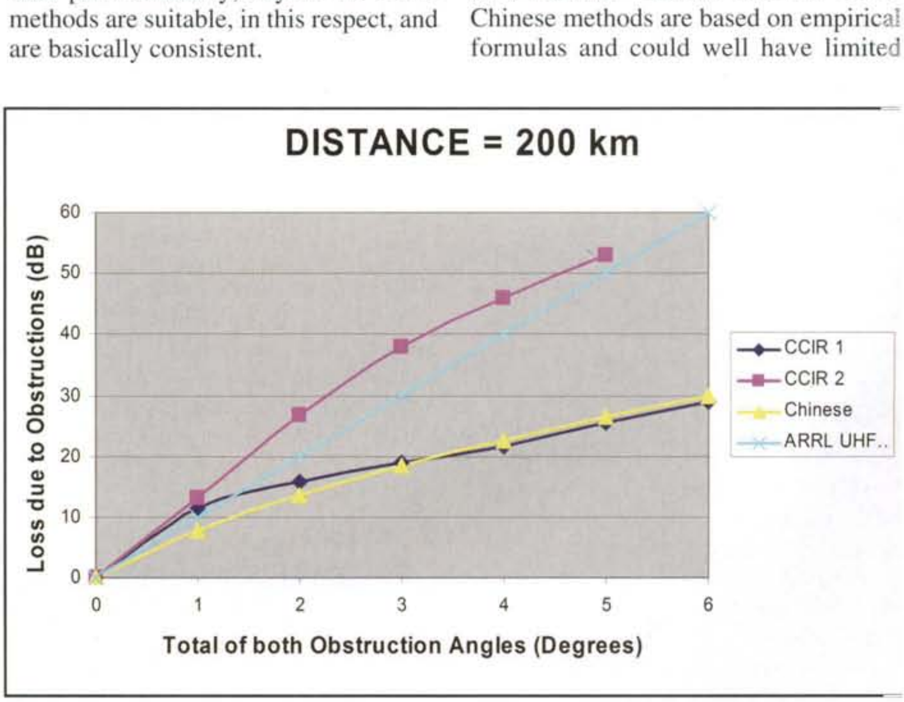


Figure 4B. Variation of loss due to obstructions at 400 km. The graph provided with CCIR-2 limits the calculation of losses with this method to a little over 5 degrees at 200 km.

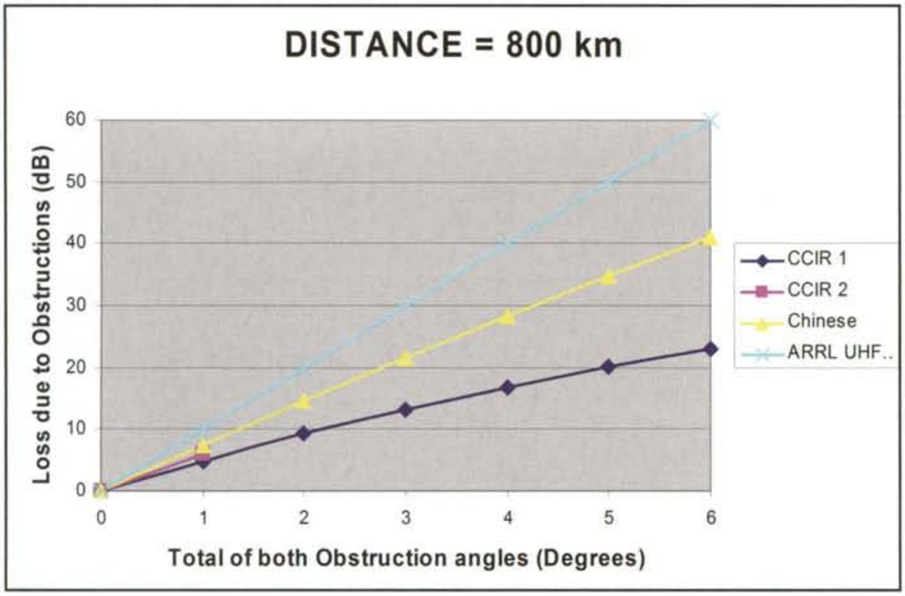


Figure 4C. Variation of loss due to obstructions at 800 km. The graph provided with CCIR-2 limits the calculation of losses with this method to a little over 1 degree at 800 km.

application in the situations thatare of our prime interest—longer distances combined with obstructions. The major differences between CCIR methods 1 and 2 in relation to obstruction loss are a concern, but at least they are close at the longer distances that are of most interest. CCIR method 1 is based on work by the US National Bureau of Standards, which perhaps gives it more credibility. It also includes the widest range of climates and all other variables.

In the absence of an independent way of deciding which is the correct method, I will resort to concluding that on the balance of probabilities, CCIR method 1 is to be preferred. The major problem with this method for amateur use is that it is complicated to use and this can lead to errors. So as to allow amateurs the opportunity to take advantage of it, I have prepared a set of tables at Appendix A and Appendix B that set out the propagation loss based on CCIR method 1 for the bands 6 & 2 meters and 70 cm & 23 cm. These cover distances from 100 km to 1000 km and total obstruction angles (the total of those for both stations) from zero to 6 degrees. Aperture to medium coupling losses are assumed to be small, but should be added if antenna gains are more than 25 dBi at each end (see figure 5). The tables are based on 50% path reliability, temperate climate, and a refractive index of 320 and should be applicable to southeastern Australia. For those who live in other areas, it will be necessary to go to the original CCIR report. As an approximation, applicable for distances beyond 600 km, reduce the figures by 4 dB in the tropics and increase them by 9 dB in desert regions. ■

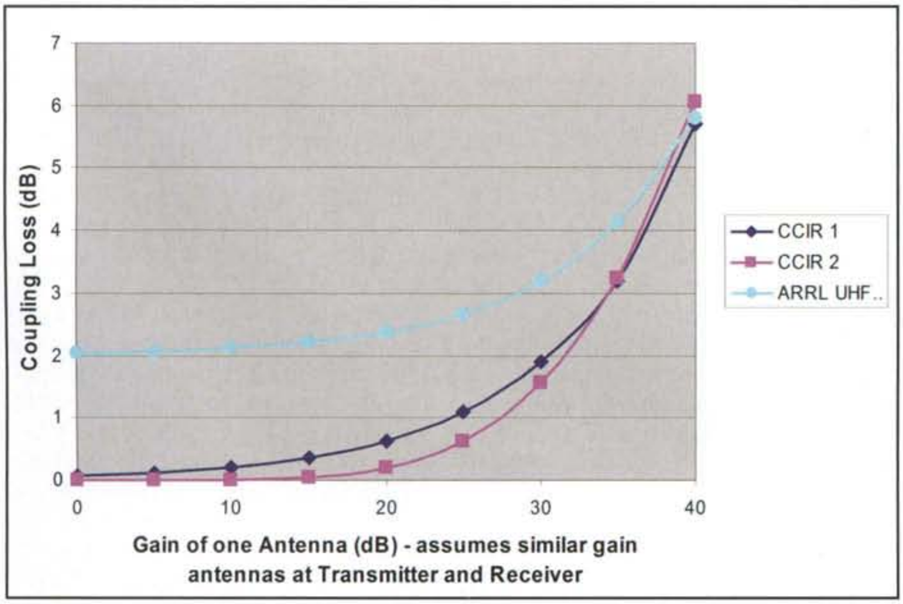


Figure 5. Aperture to medium coupling losses.

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By Dr. H. Paul Shuch,* N6TX

DR. SETI'S STARSHIP

Searching For The Ultimate DX

When Did We Become Obsolete?

Think back, if you are old enough (and if you are a member of The SETI League, demographics suggest you most likely are), to the exciting days of October 1957. The world's first artificial satellite, Sputnik 1, had just been placed in orbit. It was launched by the USSR (that area of the world had been known by this acronym for two generations, although in America they still were collectively referred to as "The Russians"). If you, like me, were living in the U.S. at the time, you were being told that the USSR was an enemy nation, the Russians an enemy people. Your enemy was in space; you could hear them on 20 Mc (this was in the days before MHz)! America was suddenly a paranoid nation.

Think back, if you are old enough (and if you're a radio amateur, statistics suggest you most likely are), to the frantic days immediately following Sputnik. The United States was trying desperately to play catch-up. Your high school guidance counselor was telling you, "You're good at science. You're good at math. Go and become an engineer; we will never have enough engineers to catch up to the Russians." (At the same time, you learned years later, your friend Sasha Zaitsev in the USSR was being told by his high school guidance counselor, "You're good at science. You're good at math. Go and become an engineer; we will never have enough engineers to stay ahead of the Americans.")

Think back, if you are not yet senile (and if you're able to read this, there is still hope), to when you first got your ham radio license. The world that Sputnik had made smaller was suddenly shrinking even more. You could talk (okay, so it was probably via Morse Code) to other hams halfway around the world—maybe even to the dreaded Russians. Maybe they weren't your enemy after all.

Think back, if you are old enough (and if you've read this far, I know you are), to the excitement of December 1961.

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e-mail: <n6tx@setileague.org>

Look around. Do you see many young faces in the crowd at a typical SETI League meeting? Well, neither do I. We all are becoming graybeards, and if that doesn't concern us, perhaps it should. (WA2UNP photo)

With a little help from your USAF friends, a handful of ham radio operators had just launched OSCAR I, the world's first non-government satellite. You could hear it on 145 Mc (this was still in the days before MHz)! Suddenly schools (the same ones that were training Americans to catch up with the Russians, and the same ones that were training Russians to stay ahead of the Americans) were activating ham radio clubs, building antennas, and pointing them . . . up!

Now think back to last week. Surely you're old enough to have noticed your kid (or maybe your grandkid) Instant Messaging to his buddies in Russia. Maybe he/she doesn't remember what USSR stood for, but he/she knows all the countries in the world by their e-mail suffixes. Never mind that those same international suffixes used to be ham callsign prefixes. What matters is that your offspring are talking to the world via IM and e-mail and VoIP (Voice over Internet Protocol) and cell phones—and yes, even via satellite links, links invisible to them. Do you think they have any need for ham radio? Probably no more than we have need for spark. The world has passed us by.

Or has it? Are there a few things we can still teach our kids, our grandkids, before they put us out to pasture? I like to think there are.

Think forward to a world linked by a telecommunications infrastructure that rivals science fiction's boldest predictions. Every man, woman, and child carries a communicator (possibly implanted) that links him or her to everyone else on Earth—instantly, and cheaply, via satellite, in whatever language the participants choose. You thought Paramount Studios held all the patents on the Universal Translator/Communicator? So did I. However, it wasn't long before this technology permeated our society . . . and transformed it.

Now think far forward and about a civilization in decline. For generations, our descendants took for granted a technological base that unified their world. Nobody needed ham radio; it was obsolete, overtaken by progress. Nobody needed The SETI League; it was a vestige of a bygone era, a footnote in the history books. All anybody needed was to think the right words, and the neural interface self-activated, putting any individual in instant contact with any other, at the speed of thought. The omnipresent satellites were invisible not only to their eyes, but to their mind's eye as well.

Until they began to fail. Our machines, like ourselves, are mortal. Suddenly, there was nobody on Earth who remembered Keplerian elements. There was nobody alive who remembered Maxwell's Equations. Right ascension and declination might as well have been mystical incantations to a long-dead god. The global net fell silent, and not a soul had a clue about how to fix it.

Fortunately, a group of anthropologists and historians remembered something from their school days, a primitive creature, cryogenically preserved, who had roamed the Earth in those prehistoric days when satellites were new, and Russians and Americans thought themselves enemies. A being who used ancient, stone-age tools such as dishes and LNAs and frequency synthesizers and digital signal processing to squeeze out crude, low-information-content signals from the stars.

Thus, they thawed out this creature and put him to work, and he saved the world.

He was an amateur radio astronomer.

He was a SETI League member.

He was you.

73, Paul, N6TX

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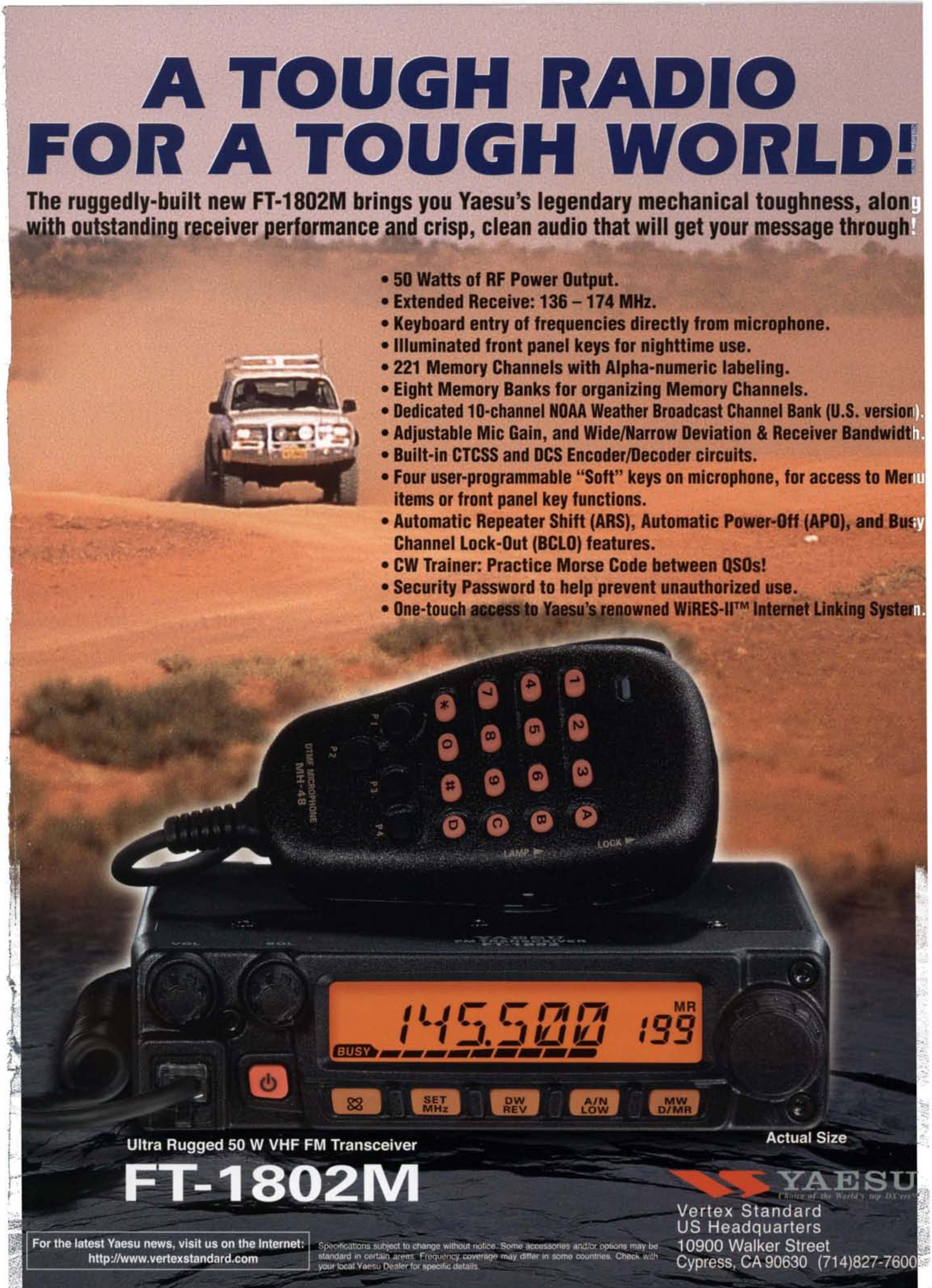
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