ISSN 1085-0708

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Summer 2010

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A publication of

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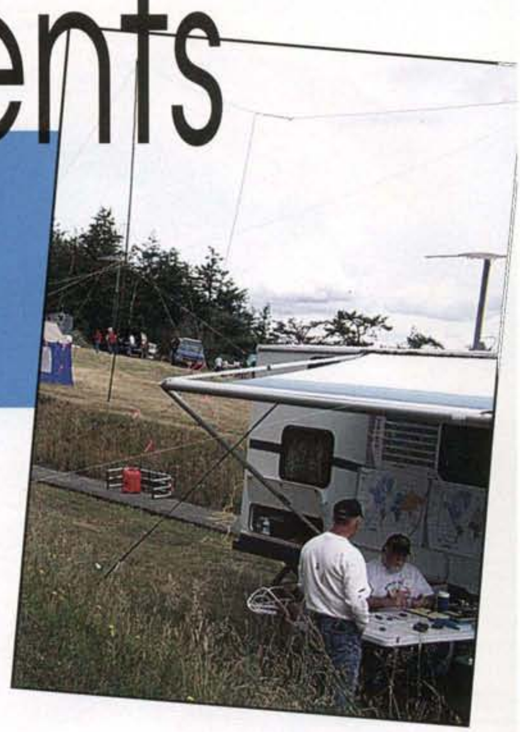
Offices: 25 Newbridge Road, Hicksville, New York 11801. Telephone: (516) 681-2922. FAX: (516) 681-2926. E-mail: cq-vhf@cq-vhf.com. Website: http://www.cq-vhf.com. CQ VHF (ISSN 1085-0708) is published quarterly (4 times a year) by CQ Communications, Inc. Periodical postage paid at Hicksville, NY and additional offices. Subscription prices (all in U.S. dollars): Domestic—one year $25.00, two years $50.00, three years 75.00; Canada/Mexico—one year $37.00, two years $74.00, three years 111.00; Foreign—one year $48.00, two years $96.00, three years 144.00. Government Agencies: Subscriptions to CQ VHF are available to agencies of the United States government, including military services, only on a cash with order basis. Requests for quotations, bids, contracts, etc., will be refused and will not be returned or processed. Entire contents copyrighted CQ Communications, Inc. 2010. CQ VHF does not assume responsibility for unsolicited manuscripts. Allow six weeks for change of address.

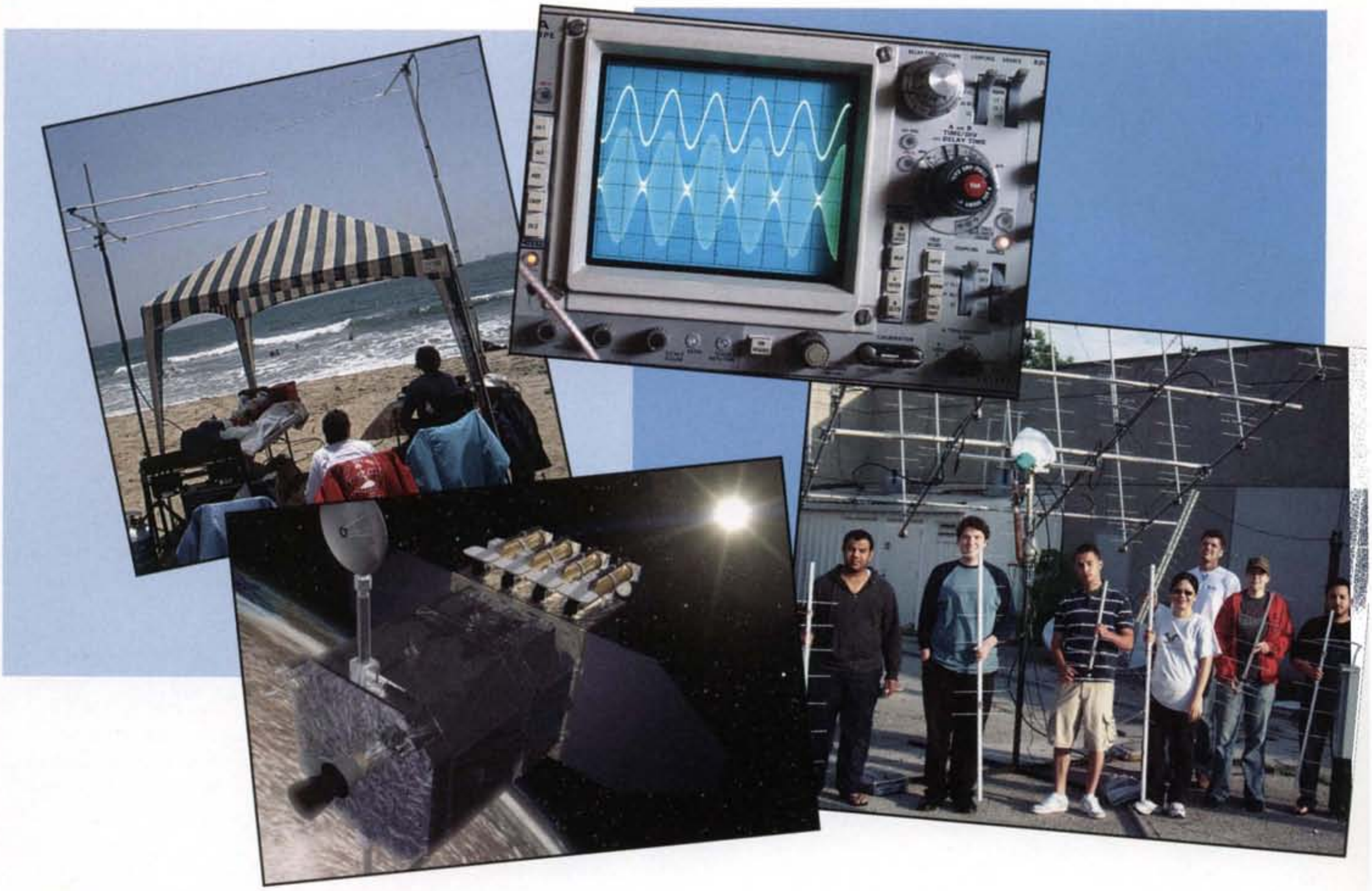
Printed in the United States of America.
Postmaster: Please send change of address to CQ VHF, 25 Newbridge Road, Hicksville, NY 11801.

contents



Summer 2010
Vol. 14 No. 2

FEATURES



COLUMNS

DEPARTMENTS

On The Cover: On the way to the Gregorian dome of the Arecibo Observatory; for details see "Echoes of Apollo EME/Arecibo 2010, Part 1," by AA6EG, on page 8. Inset: WB4SUV shows kids about finding radio transmitters; for details see the "Homing In" column by KØOV on page 58.

CQ VHF Ham Radio Above 50 MHz

LINE OF SIGHT

A Message from the Editor

A Big Dish and a Little Dish and Education Partnerships

This issue generally is focused on antennas. Two antennas that get special attention are the big dish at Arecibo and the little dish, the parabolic dish created from an umbrella.

The Big Dish

Regarding Arecibo, this past April several amateur radio operators made the trip to the Arecibo dish in Puerto Rico as part of the ongoing Echoes of Apollo celebration that Pat Barthelow, AA6EG, along with Robert Brand initiated last year (see <http://echoesofapollo.com> and the Spring 2009 issue of *CQ VHF* magazine). Barthelow's article "Echoes of Apollo EME/Arecibo 2010: Part 1" begins on page 8. Following his article is regular features writer Mark Morrison, WA2VVA, with Part 5 of his series "Amateur Radio and the Cosmos," in which he details the building of the Arecibo dish.

Mentioned in Morrison's article is William E. "Bill" Gordon, who is known as the father of the Arecibo Observatory because of his efforts to design, arrange funding, and shepherd it through its construction. He was its first director. After his tenure at Arecibo, he served a number of years as a professor and later dean and provost at Rice University. The university maintains his papers between 1947 and 1994 in the Woodson Research Center. Among with them are a number of papers on research that he conducted using the big dish. Gordon passed away this past February 16, at the age of 92.

The Little Dish

Concerning the little dish, Doug Quagliana, KA2UPW/5, writes about his construction of "A Homemade Collapsible Parabolic Dish Antenna" beginning on page 44. Following his article, John Jaminet, W3HMS, and Curt Wann, K4ITO, pen an article entitled "Parabolic Antenna Calculations." Kent Britain, WA5VJB, adds his insight on the construction of feeds in his "Antennas" column, which follows the Jaminet and Wann article.

Other Antennas

You will find other antenna-related articles and references throughout this issue. For example, in Barthelow's article he mentions the work of Professor Tommy Henderson, WD5AGO, at the Tulsa Community College, where he guided his students in their individual construction of WA5VJB's Cheap Yagi design antenna for 432 MHz.

Education Partnerships with Public Schools

Mentioning my friend WD5AGO causes me to reflect on the potentially huge opportunity for us hams beginning this fall—the opportunity to partner with public schools. The ominous headlines this past April warned of massive layoffs of teachers and staff of public schools. Secretary of Education Arne Duncan warns that between 100,000 and 300,000 public school jobs could be lost due to budget cuts.

While the public school situation is dire, I believe that this is a tremendous opportunity for amateur radio clubs to respond to the immediate needs of local public schools. I do so because my wife, Carol, W6CL, and I have been involved as education partners with a local public school, Hamilton, in the Tulsa Public Schools district for more than six years.

Education partnerships with Tulsa Public Schools include banks, faith-based organizations, the local Bar Association, the local medical association, museums, universities, Tulsa Air and Space Museum, and the Oklahoma Air National Guard.

Because Carol and I are both amateur radio operators, one way in which our hobby has played a role in our education partnership with Hamilton occurred a few years ago in connection with the International Space Station (ISS) and the ARISS program.

In December 2004, Keith Pugh, W5IU, the satellite columnist for this magazine, notified me that the nearby Tulsa Air and Space Museum was scheduled to be in contact with the ISS later that month. Several students from area schools were already scheduled to ask questions during the ten-minute contact. I got the okay from Keith for the possibility of some of the Hamilton students to be observers of the contact.

Then I contacted Ms. Rita Balleu, one of the science teachers at Hamilton, to see if she could arrange for a few students to go to the museum despite the school being on winter break. She got four students to be observers during the contact. Following the contact, Keith wrote an article for the Winter 2005 issue of *CQ VHF* magazine. As editor, I made sure that Ms. Balleu and her four students' photos were in the article.

Most recently the Oklahoma Air National Guard piloted an after-school program at Hamilton. Known as Starbase 2, the program is sponsored by the Office of the Assistant Secretary of Defense for Reserve Affairs (http://www.starbasedod.com/index.php). Hamilton was one of five pilot sites for the new program which included STEM and social skills instructions for the students.

Naturally, Carol and I became mentors in the program. For two hours during several Wednesday afternoons last spring we and others from the Air National Guard, Tulsa Technology Center, Langston University, and classroom instructors mentored Hamilton students. Nationally, the program has been deemed such a success that it will be expanded to ten schools across the country next fall and will include a return to Hamilton.

Just before we left for Dayton this past May, we learned that another Starbase 2 pilot site is in Dayton and is sponsored by Wright-Patterson AFB. We visited that site a couple of days before Hamvention® began. It was very interesting to compare the two sites.

My encouragement for us is this: The dire times for public schools can be huge opportunities for amateur radio clubs. Club members can be volunteers. Club houses can be sites for after-school programs. Your club's involvement is only limited by your imaginations. Incidentally, the ARRL has lots of resources for amateur radio in the classroom. For details, see: <http://www.arrl.org/amateur-radio-in-the-classroom>.

Our involvement with Hamilton began through an established education partner program. Even though there may not be a program in your area, I am sure that your local school officials will be appreciative of your offer of assistance.

If you have a story to tell about your education partnership or something else related to the wonderful world of VHF Plus, please e-mail me at: <n6cl@sbcglobal.net>. Also be sure to check out our website (http://www.cq-vhf.com/), which now has current events (including time-sensitive and time-value items) as well as live links.

73 de Joe, N6CL

QUARTERLY CALENDAR OF EVENTS

Current Contests

August: There are two important contests this month. The **ARRL UHF and Above Contest** is scheduled for August 7–8. The first weekend of the **ARRL 10 GHz** and above cumulative contest is scheduled for August 21–22.

September: The **ARRL EME 2.3 GHz and Up Contest** is September 4–5. The **ARRL September VHF QSO Party** is September 11–13. The second weekend of the **ARRL 10 GHz and Above Cumulative Contest** is September 18–19. The following are the dates for the **Fall Sprints**. The **144 MHz Fall Sprint** is September 20 from 7 PM to 11 PM local time. The **222 MHz Fall Sprint** is September 28 from 7 PM to 11 PM local time.

October: The first round of the **ARRL 50 MHz to 1296 MHz EME Contest** is October 2–3. The **432 MHz Fall Sprint** is October 6 from 7 PM to 11 PM local time. The **Microwave (902 MHz and above) Fall Sprint** is October 16 from 6 AM to 12 PM local time. The second round of the **ARRL 50 MHz to 1296 MHz EME Contest** is October 30–31. The **50 MHz Fall Sprint** is October 30, 2300 UTC to October 31, 0300 UTC.

For ARRL contest rules, see the issue of *QST* prior to the month of the contest or the URL: <http://www.arrl.org>. For Fall Sprint contest rules, see the Southeast VHF Society URL: <http://www.svhfs.org/2010fallsprintrules.pdf>.

Current Conferences and Conventions

August: The **14th International EME Conference** will be held this year in Irving, Texas, August 12–14, at the Westin at the DFW airport. This conference will be an excellent opportunity to meet a number of international EME enthusiasts. For more information and registration, see: <http://www.ntms.org/eme/>.

The annual **Huntsville, Alabama Hamfest** will be August 21–22 in the usual South Hall of the convention center. There are several VHF-related forums scheduled. For more information, see: <http://www.hamfest.org/>.

September: The 2010 **TAPR/ARRL Digital Communications Conference** will be held September 24–26, in Vancouver, Washington, at the Heathman Lodge. For more information, see the URL: <http://www.tapr.org/dcc.html>.

October: The 2010 **AMSAT-NA Space Symposium and Annual Meeting** is to be held October 8–10, Elk Grove Village, Illinois,at the Elk Grove Holiday Inn Hotel. For more information, see the AMSAT URL pertaining to the symposium at: <http://www.amsat.org/amsat-new/symposium/2010/Hotel.php>.

The 2010 **Microwave Update** conference will be held in Cerritos, California the weekend of October 21–24 at the Sheraton Cerritos Hotel. For information, check the Microwave Update website: <http://www.microwaveupdate.org>.

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, e-mail, etc., please contact the person listed with the announcement. The following organizations or conference organizers have announced a call for papers:

Microwave Update: This year's **Microwave Update** conference will be held in Cerritos, California the weekend of October 21–24, at the Sheraton Cerritos. This is a call for papers and talks. They are looking for presentations on all aspects of microwave equipment and antenna construction, theory, propagation, operating, design modes, just to name a few. Frequency range is 900 MHz through LASER. They have already had quite a few early volunteers, which they always appreciate, but they are looking for more presenters. If you are interested in presenting, please contact Frank Kelly, WB6CWN, via the website link. They are also looking for papers for the *Proceedings*. You do not have to be a presenter to have your paper included in the *Proceedings*. Papers for the *Proceedings* can also just be short pieces on any topic microwave related. If you are interested in making a contribution to the *Proceedings*, please contact Frank Kelly, WB6CWN at the website link on the conference website at: <http://www.microwaveupdate.org/>. The deadline for papers is Monday, August 31. The *Proceedings* Style Guidelines page can also be found on a link on the conference website.

AMSAT-NA 2010 Space Symposium: Technical papers are solicited for the 2010 AMSAT Space Symposium and Annual Meeting to be held October 8–10 in Elk Grove Village, Illinois. Proposals for papers, symposium presentations, and poster presentations are invited on any topic of interest to the amateur satellite program. Papers on the following topics are solicited: Students & Education, ARISS, AO-51, P3E, Eagle, and other satellite-related topics. Camera-ready copy on paper or in electronic form is due by September 1 for inclusion in the printed symposium *Proceedings*. Papers received after this date will not be included in the printed *Proceedings*. Abstracts and papers should be sent to Joanne Maenpaa, K9JKM, at: <k9jkm@amsat.org>. For more information see: <http://www.amsat.org>.

Quarterly Calendar

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

Aug. 1	Moderate EME conditions
Aug. 3	Last quarter Moon
Aug. 8	Moderate EME conditions
Aug. 10	New Moon and Moon perigee
Aug. 12–13	*Perseids* Meteor Shower
Aug. 15	Moderate EME conditions
Aug. 16	First quarter Moon
Aug. 22	Poor EME conditions
Aug. 24	Full Moon
Aug. 25	Moon apogee
Aug. 29	Poor EME conditions
Sept. 1	Last quarter Moon
Sept. 5	Good EME conditions
Sept. 8	New Moon and Moon perigee
Sept. 12	Poor EME conditions
Sept. 15	First quarter Moon
Sept. 19	Poor EME conditions
Sept. 21	Moon apogee
Sept. 22	Fall equinox
Sept. 23	Full Moon
Sept. 26	Poor EME conditions
Oct. 1	Last quarter Moon
Oct. 3	Very good EME conditions
Oct. 6	Moon perigee
Oct. 7	New Moon
Oct. 14	First quarter Moon
Oct. 10	Moderate EME conditions
Oct. 17	Poor EME conditions
Oct. 18	Moon apogee
Oct. 21	*Orionids* meteor shower
Oct. 23	Full Moon
Oct. 24	Poor EME conditions
Oct. 31	Excellent EME conditions
Oct. 30	Last quarter Moon
Nov. 3	Moon perigee
Nov. 6	New Moon
Nov. 7	Moderate EME conditions
Nov. 13	First quarter Moon
Nov. 14	Poor EME conditions
Nov. 15	Moon apogee
Nov. 17	*Leonids* meteor shower
Nov. 21	Full Moon; Poor EME conditions
Nov. 24	Moon first quarter
Nov. 28	Last quarter Moon; Very good EME conditions.

—EME conditions courtesy W5LUU

Meteor Showers

August: Beginning around July 17 and lasting until approximately August 24, you will see activity tied to the *Perseids* meteor shower. Its predicted peak is between August 12, 2010 at 2330 UTC and August 13, 2010 at 0200 UTC. The *κ-Cygnids* meteor shower is expected to peak on August 18. The visually-impossible *γ-Leonids* is expected to peak August 25, around 1600 UTC. However, this shower may have gone dormant. The *α-Aurigids* is expected to peak around September 1.

October: The *Draconids* is predicted to peak somewhere around 2245 UTC on October 8. The predicted ZHR varies, but never rule out the remote possibility of a storm level peak. The *Orionids* is predicted to peak on October 21. The Full Moon will obliterate any visual sign of the shower.

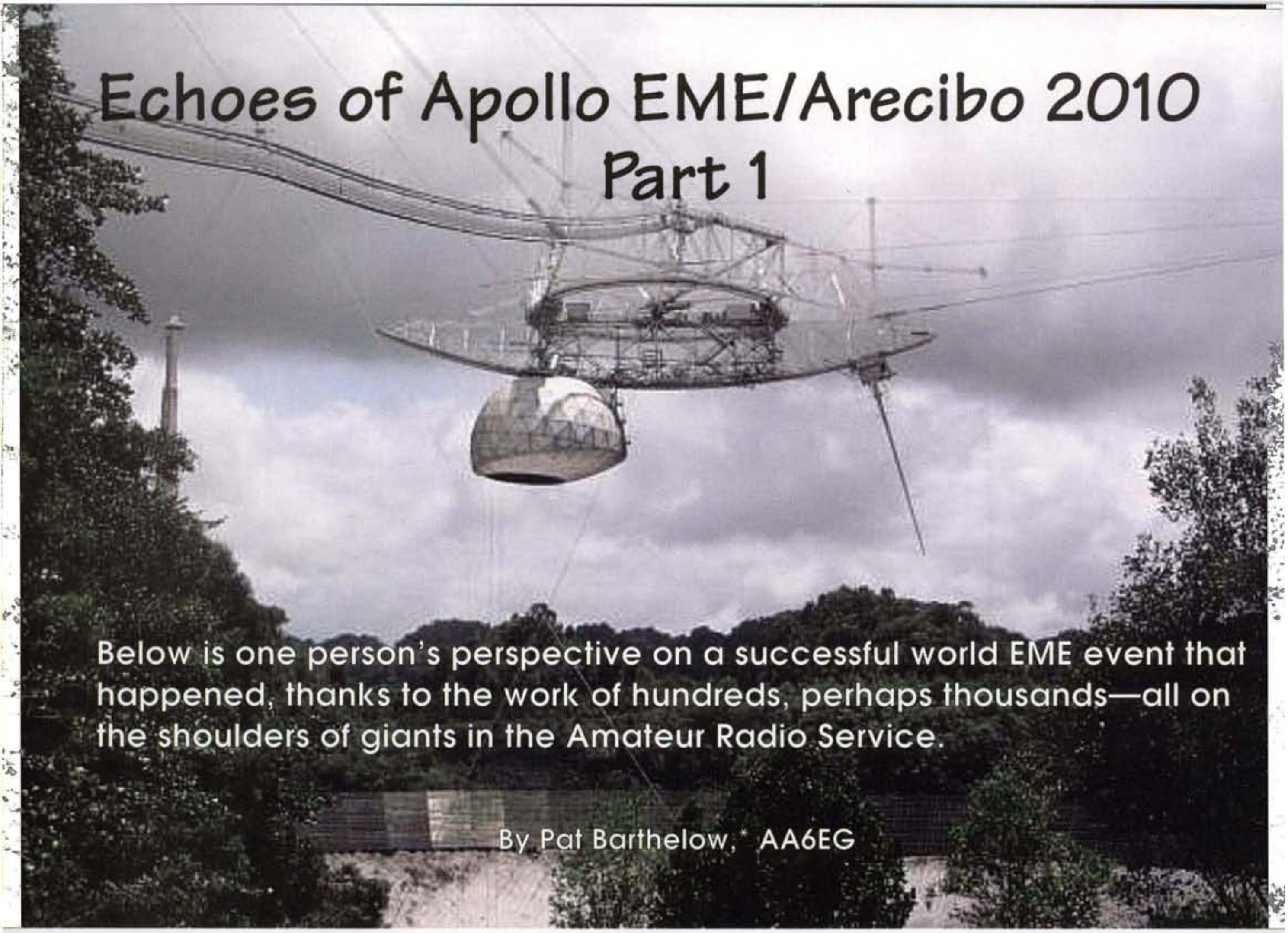
November: The *Leonids* is predicted to peak around 2115 UTC on November 17. As with last year's shower, this year's peak may go largely unnoticed.

For more information on the above meteor shower predictions see Tomas Hood, NW7US's propagation column beginning on page 76. Also visit the International Meteor Organization's website: <http://www.imo.net/> or download this pdf: <http://www.imo.net/docs/cal2010.pdf>.

Echoes of Apollo EME/Arecibo 2010 Part 1

Below is one person's perspective on a successful world EME event that happened, thanks to the work of hundreds, perhaps thousands—all on the shoulders of giants in the Amateur Radio Service.

By Pat Barthelow,* AA6EG



The Arecibo Observatory with access catwalk. (Photos courtesy of the author)

After a wonderful experience in setting up a big dish EME event for Echoes of Apollo 2009 during Field Day weekend, I took a relatively long rest, as did some of the teams who made that happen. In our case, it was the guys at the 45-meter SRI dish overlooking Stanford University.

A lot of wonderful feedback seems to indicate that there were newly inspired folks who were getting into EME (Earth-Moon-Earth), either as small stations encouraged by the existence of larger dishes, or by QRP offered by JT65 modes, or folks who were noticing large dishes within geographic reach of them that might be able to be groomed for EME use.

As a newbie to EME, and one who enjoys teaching—both professionally, and for years in the fun, art, and science of ham radio—I realized that recent focus and growth of large-dish EME opened new doors for EME on many levels. In order to bring interest from outside amateur radio to EME, and therefore perhaps new blood, I concluded that SSB EME brings maximum interest and impact to the new observer.

Hearing human voices coming off the Moon has a similar magic to me as did my first view of Saturn's rings or Jupiter's moons in my early astronomy experiences. Big dishes help a lot in enabling the SSB EME mode even for first-time EMEers, but especially for today's young people. Additionally, the big dishes may be surprisingly available if you think/look outside the box.

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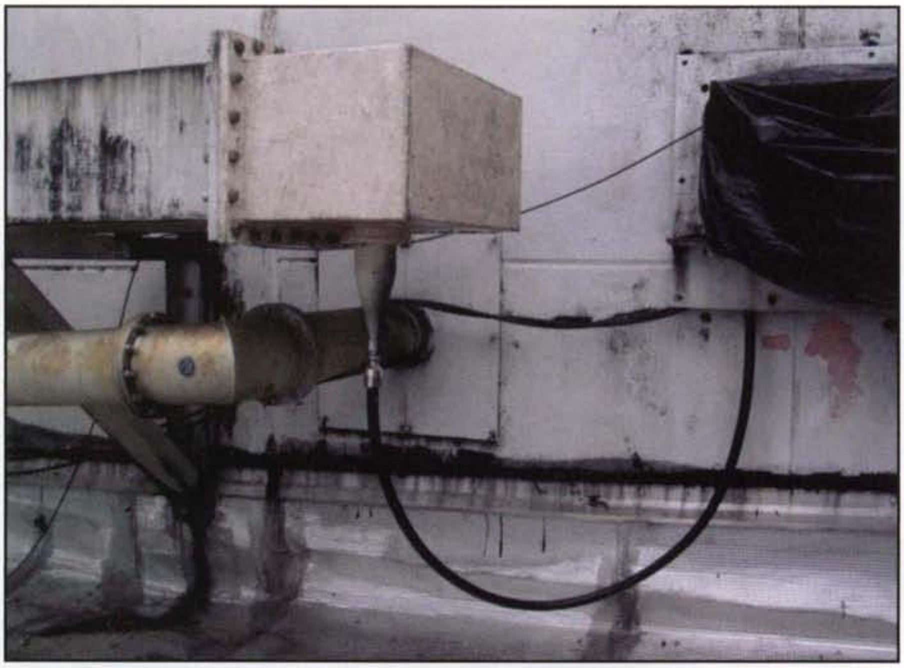
Planning for Echoes of Apollo 2010

Sometime in October 2009 I thought of the idea that NAIC (National Astronomy and Ionosphere Center) Arecibo might be interested in some good publicity and fun by opening up for some EME event activity. I approached the Cornell University Senior Staff, and Dr. Mike Nolan, NAIC Director Arecibo to see if it was possible to set up an EME event. I wanted to do another Echoes of Apollo event, targeting the 40th anniversary of Apollo 13's return to Earth, which was on April 17, 1970. It turns out that April 17 was an ideal date in terms of Moon visibility from Arecibo.

I was pleased to find supportive responses to my inquiries. Dr. Nolan looked at the dish booking schedules, and it looked like mid-April EME was good for them. This was fortuitous, because Arecibo, the world's biggest single dish, tracks objects overhead by moving the feed, not the dish, which at 305 meters in diameter and firmly precision-anchored on the custom-sculpted Puerto Rico ground, would be rather difficult to move.

Arecibo's precision movable feed tracking system can point the beam (approximately 8 arc-minutes at 432 MHz) with extreme precision within a local zenith-centered window of a radius of 20 degrees. Unlike most large dishes, which can point close to the horizon, this small window to the sky makes shorter operating windows and scheduling—which is an important part of EME missions—tougher, but not impossible. For EME planning programs one must use 70 degrees as the minimum elevation angle to which the dish can point to determine Arecibo schedules. This limited tracking window also, unfortunately, makes Arecibo EME impossible to work for some of the significant EME community, such as our EME friends in Australia.

I knew that there existed an active amateur radio club at the observatory, but did not know its history, interest, or EME station building skills. Early on, Dr. Nolan mentioned that they would be interested, and would be the logical hands-on lead for station building and event planning at the dish. I knew that Jim Breakall, WA3FET, a former professor at Naval Postgrad School, Monterey, California, my home town, and now a Professor at Penn State, was an active contester who partnered with Angel Vazquez, WP3R, in building the famous WP3R contest station near the dish. No doubt Jim would be on the KP4AO EME team.



The WR-210000 waveguide at the transition junction.

Gondola at the ground station.

Once the Apollo 13 anniversary date was given a tentative go-ahead by NAIC Arecibo, the Arecibo Observatory Radio club, KP4AO, highly skilled in the EME Arts and Sciences, took command and collected the required equipment and operating team to put an Arecibo 432-MHz EME station on the air. The last time this was accomplished was in the 1980s. Early discussions also considered—and later dismissed—23-cm operations. Operating on this band may be possible in the future, if/when enough advance planning and time can be allocated to a (remote-controlled) 23-cm EME system. The operating position is approximately 1500 feet from the antenna feed point.

In the months leading up to the April event, I worked to spread the word about the new Arecibo EME opportunity, with strong encouragement for folks—particularly SWLs, amateur satellite operators, and young people—to come on board for the event using small antennas that could work the 60-dBi gain Arecibo dish, fed with about half a gallon of RF. A key objective was to present EME to the non-ham or non-EME operator, especially young people, as we did for EOA 2009. This effort was made exceptionally easier with the 60 dBi at 432-MHz gain Arecibo dish on board. Pre-event calculations predicted success could be had for CW and JT65 with small hand held Yagi antennas. It was also determined that larger but easily manageable single Yagis should be able to pick up SSB. In some cases actual results were better than predicted. For stories and more information check my Facebook page (http://www.facebook.com).

Arecibo and the Event

As the EOA/Arecibo time drew near in early April 2010, I booked flights to San Juan, Puerto Rico for the April 16–18 event. Travel and lodging were dicey. The ride from San Juan to Arecibo was an hour.

I was on a severely limited budget. I arrived at the San Juan airport at 9 PM on Wednesday, April 14. I had contacted some academics and students at the

University of Puerto Rico, Mayaguez, who had an interest in space science, and some of them became interested in knowing more about EME at Arecibo.

Even so, I was still looking for overnight accommodations near Arecibo, but not having much luck. Everything seemed booked, and hotel prices were on the very high side for me. The observatory was about a 20-minute drive into the country, south of the City of Arecibo.

Earlier this year I developed a Facebook account for the purpose of distributing information to the ham, SWL, and EME communities. Facebook is quite a useful tool, and it allowed me to develop online Arecibo/EME friendships/networks, in Puerto Rico, prior to my arrival.

Structural repair site, with the main dish surface 450 feet below.

Dr. Nolan and Angel, WP3R, on the way to the Gregorian dome.

I was able to connect with a Telecommunications professional, William Longo Torres, who became interested in moonbounce. He was a great host for me at his residence in San Juan for a day until we headed to the dish, about an hour and a half away by toll freeway. William and I had a wonderful dinner, and he helped a lot in my orientation to Puerto Rican culture and island geography.

William and I arrived at NAIC Arecibo on Thursday. We were immediately welcomed by some of the core Observatory Radio Club folks and NAIC staff, Angel Vazquez, Angel Padilla, Israel Cabrera, and Director Mike Nolan. Dr. Nolan had good news. A major steering committee meeting was going on, with attendees filling up all the VSQ (Visiting Scientist Quarters).

Arecibo was at serious risk of a forced, permanent shutdown due to budget cutbacks, and this steering committee meeting was fighting the good fight for preservation. It apparently won, as the future of Arecibo is now assured, at least for a few years. As luck would have it, there was a VSQ cancellation, and I was able to check into VSQ F-1, a wonderful family cottage, "The Jodie Foster Suite" on the top of the highest hill adjacent to the dish.

The F-1 cottage is featured early in the movie *Contact*, which I had just watched from beginning to end. In the movie, Jodie Foster's character and Matthew McConaughey character spent some quality time in the same F-1 cottage that I stayed in. Complete with kitchen (by the way, it has no microwave!), bath, master and guest bedrooms, living room, study, fiber-optic internet connectivity, and authentic tropical-forest *loud* critter sounds outside, particularly the well-known tiny but loud frog called *El Coqui*. The tropical forest just outside made me feel like I was on the set of the Bogart movie *African Queen*.

The KP4AO club assembled a Kenwood TS-700 supplied by Israel, KP4LCL, an ARR P432VDG 0.5-dB NF preamp, and two power amps, one a homebrew 3CX-800 and another a very fine 20-dB gain single active package by Freescale Semi that brought 5 watts input to over 500 watts output. This small powerhouse was a miracle of lightness and compactness, with the toughest engineering in heat-sink design, cooling the single-package pair of active devices.

During the first day operation, and sometime during the second day, a recurring tube flashover problem in the tube amp was encountered, which caused a series B+ power resistor inside the amp to act like a protective fuse. This forced initial power levels at the feed of about 60 watts, which limited some of the potential contacts for the EME community. This problem also caught the attention of all the very capable operating crew, comprised of well-known ham and Nobel Laureate, Dr. Joe Taylor, K1JT; Dr. Jim Breakall, WA3FET, Electromagnetics professor at Penn State; and highly skilled Arecibo staff/hams, which included Angel Vazquez, WP3R, Pedro Piza, NP4A, Angel Padilla, WP4G, Israel Cabrera, KP4LCL, and NAIC Arecibo transmitter engineer Alfredo Santoni, WP4HZ.

This incredible group made for a wonderful social and technical work party after hours on Friday. Work was at the same time fun, spooky, informative, and satisfying to poke and measure things around the Big B+ supply and its interconnects with the RF deck, to see where the B+ was interrupted from getting to the tube plate. Later, due to the repeated flashover problems, the amp of choice became the very impressive looking and performing small, single active package SSPA, 20+ dB 600-watt amp which performed superbly at full output for the remainder of the weekend.

The TX output was fed via hardline to a rooftop coax to WR-21000 waveguide adapter, a piece not often seen in ham radio, then the WR-21000 waveguide, running the 1500 feet to the Arecibo phased-array feed with about 1 dB total loss. The transition piece was and is key to the easy implementation of this and future 432-MHz ham radio Arecibo EME operations. It was found and readily installed in the existing 430-MHz Arecibo Planetary Radar waveguide. Kudos and credit to the radio club, especially Angel Vazquez, WP3R, for implementing that efficient changeover piece.

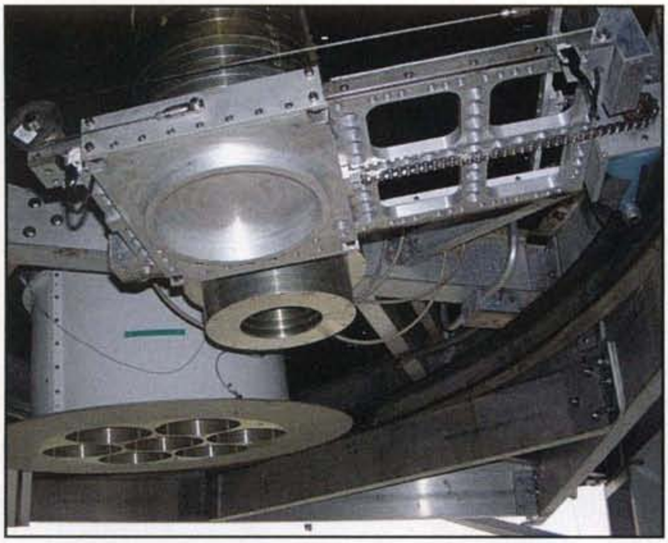
The Arecibo dish, particularly the focal platform, is a true wonder of the world. Suspended 450 feet above the spherical dish, the 2-million-pound structure is held in place by massive cables from three concrete pylons oriented at 120 degrees. The whole system of suspension cables, triangular platform base, rotating catenary rail structure, with suspended Gregorian feed, its own secondary and tertiary mirror optics, and a 100-foot long 430-MHz phased array, has an active system for precision positioning of the selected feed antenna.

Lasers at fixed locations on the ground constantly view and measure distance to reflective targets at the three corners of the structure, continuously deriving coordinates of the platform structure and, therefore, the 3-D coordinates of the selected feed horn, or array, at the focus. This system achieves an X-Y positioning accuracy of ±2 mm and Z tolerance is only slightly larger. Positioning error contributors at this level include correcting for thermal expansion of the support cables when they are unevenly illuminated by the sun, at sunrise, or any time during the day.

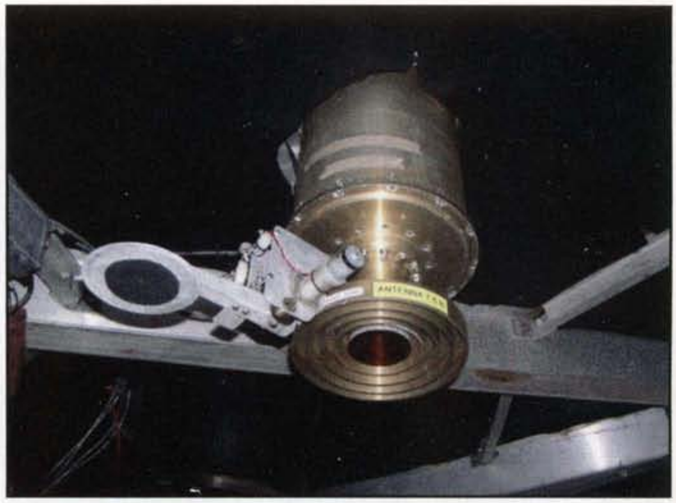
From the ground I could hear "creaking" noises, as if a wheel needed some

Angel squeezes through the center hub of the rotary platform.

The 85-foot secondary mirror.



Left rear: 7-pixel receiver feed. Middle: water-cooled 2-megawatt transmit feed. Right: covered receiver horn.



Arecibo feed with remote-control cover.

grease, and commented such to Dr. Nolan, who said the sound heard actually was a an active audio beeper whose purpose was to remind everyone on the platform that it was "alive" with motion, which is easy to forget because the motion is so slow and smooth. At various locations there were constantly slow-moving wheels and bearings that you would not want to touch or get caught in, for obvious reasons.

The structure is absolutely awesome in every way. I was given the privilege of a guided tour by Mike Nolan and Angel, WP4G. I had hoped to go up Friday, but the dark-gray skies and raindrops present at that time caused Dr. Nolan to say no for Friday, but maybe Saturday, because of the real risks posed by lightning activity. Dr. Nolan, with a very serious look, said, "You don't want to be up there during lightning activity." His was the voice of experience.

The next day, Angel Padilla, WP4G, and Dr. Nolan, and I donned hard hats and walked to the cable-car gondola launch

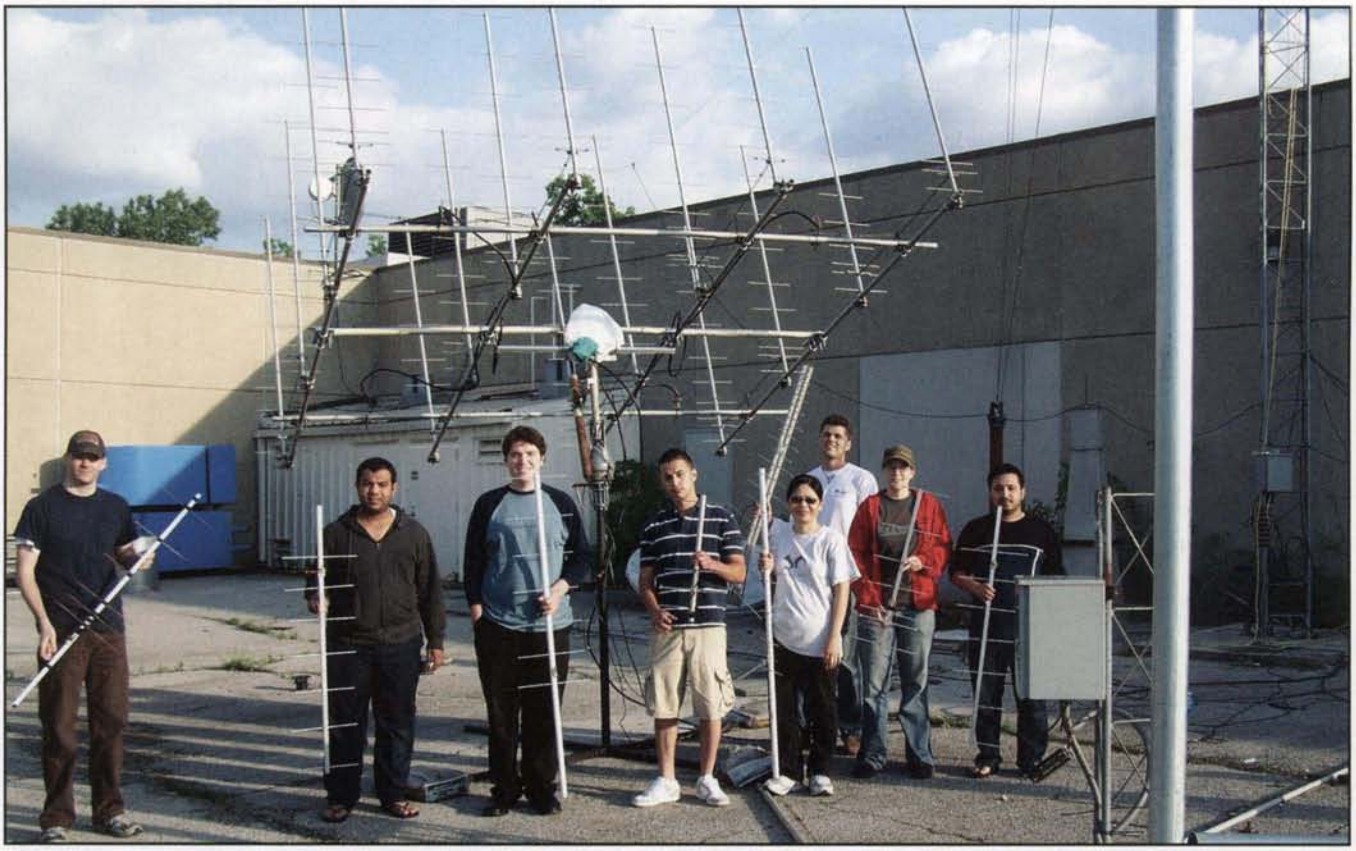
Dr. Nolan phones for a gondola car.

house, got in the tiny gondola car, and with the press of a button were on our way to the focus platform, an exhilarating ride. The ride is not for the faint of heart, but it gives great views of the dish and platform during its climb to the 450-foot level. The views on top were breathtaking and to the human sense of scale very deceptive. It is hard to get your mind around a precision, moving, 2-million-pound, suspended structure longer than a football field, 150 meters above a 305-meter spherical dish. A Google search produces a master's thesis analysis of the kinematics, and dynamics of the platform.

We took some spectacular photos, including a look at a part of the platform that was being repaired at that time, notable for riggers' boson chairs present and of the gray primer paint over a nor-

The gondola was not available. Therefore, we walked the 1500 feet back to the control room, which can be seen in the distance in the upper left of this photo.

The author logging for Joe Taylor, K1JT, during a CW QSO run.



Tulsa Community College students posing with their antennas in front of the sixteen 10-element K5GW EME array. The students are (from left to right): Tim Vanderslice, Ahmed Al Mlihi, Joey Hirsch, Ed Cano, Giao Lai, Chris Churchill, Lauren Young, and Ali Al Zahrani.

mally white painted surface. A platform structural member had suffered a crack only a month or so before our visit. The structural failure captured the full attention of the engineering department of the dish and their contractors. The crack could have cancelled the event because of a required analysis and repair, prohibiting normal operations. Fortunately, however, a repair was performed promptly and we were able to operate on schedule.

From the platform top level, Angel, Mike, and I descended towards the Gregorian dome, passing the base mount of the 430-MHz phased array, and squeezed through a tight spiral staircase at the center bearing of the circular rotary platform. Then it was down to the Gregorian feed dome entrance.

Once inside the Gregorian feed, we saw the secondary and tertiary mirrors, complex-shaped surfaces, approximately 15 and 85 feet in diameter, respectively, along with some surveying instruments that are permanently positioned for checking dish metrology. We went to stand next to the massive Klystron for the interplanetary radar. Fed by a 65-kV DC line supplying high voltage, and a massive water cooling system, the tube provides tremendous amounts of continuous CW RF to the antenna for interplanetary radar studies.

Then we walked the upper surface of the rotary floor which was jam packed with feeds, cryogenics, and receivers of all types. We sat down below that floor on a platform, in awe of the variety of feed horns poking through the rotary platform and just above our heads. Most were receiver horns, but I could tell which one was the 2-megawatt planetary radar horn from its massive construction and water cooling hoses.

All the receivers had remote-control covers for their horn throats to protect the delicate receivers from the 2-million watt radar blowtorch that was positioned just inches away. It was awesome to be inside the Gregorian dome, so close to the feeds, and at the same time be able to look over the rail, down at the tertiary, and up at the secondary mirrors and *way* down to the primary mirror surface 450 feet below.

After a feed horn looksee, we moved on and looked at and photographed the 430-MHz phased-array stinger feed and eventually walked to the call booth to send the gondola up for pick up and transport to the ground level. Unfortunately, the gondola was not available at the time, so we walked the long, narrow catwalk back to Earth and to the ham shack. This experience is not for the faint of heart or acrophobic.

The Operation

KP4AO began EME operations on Friday at noon, on time, and Angel, Jim Breakall, and Joe Taylor were the first operators in the line-up. The pile-ups were enormous, perhaps unprecedented in EME operations. CW and SSB were early event priorities, with JT65 planned and done later during the event.

I was allowed an operating stint on Sunday, but my ham career experience is on HF, with CW a priority. I worked pile-ups, but haven't played the DX role in pile-ups, nor have much EME pileup QSO experience. The demand and pile-ups were so intense that after a few QSOs I happily gave the mic to Angel,

Tulsa Community College students built their own WA5VJB 1-meter, 432-MHz Yagis. The students are (from left to right): Adrian Diaz; Brandon Fugate; Danny Vo; Brian Kettler, KE5WZA; Eric Govea; Bob Hanna, KF5EAF; Pete Gunderson; and Paul Chorley, KF5EAG.

the seasoned Arecibo op and club president, in order to maximize the QSO rate and volume of contacts during the short operating windows we had each day. I also logged for Joe , K1JT, during a CW QSO run.

I don't remember when we went on-line with a webcam, (see: http://www.usstream.com), but a nice webcam presence was set up by Angel and the crew, providing a constant worldwide view inside the operating shack during the event.

Huge post-event feedback says we were successful, with approximately 250 total EME QSOs, SSB, CW, and JT65, over the three days. Additionally, many You Tube videos have now been posted of small-antenna portable operations from parking lots and at conferences. (Google KP4AO, or list it at the You Tube website to see them.)

Summary

There is not enough space to tell the many stories that evolved out of this year's EOA at Arecibo. Even so, I hope that the one I told here is of interest to the readers and will inspire you to look further using You Tube and general Google searches. A very productive key word to use is KP4AO, the club callsign used for the EME event at NAIC Arecibo. A very good website overview of Arecibo exists at: <http://www.filepie.us/?title=Arecibo_Observatory>.

Regarding You Tube, a particularly impressive parking-lot Arecibo event operation was produced by Dave, K1WHS, and included a giant figure in astronomy, Dr. Gordon Pettengill, listening to KP4AO in the parking lot of the 36th Eastern VHF Conference crowd. This and other postings show Arecibo being heard faintly (but not copied) with dipoles, and copied with small Yagis.

Dr. Pettengill was present with Dave, listening in. He was the director of Arecibo in the 1960s and a pioneer of the 1960s Arecibo moonbounce, then with the callsign KP4BPZ. See: <http://www.youtube.com/watch?v=ZutOfYLPIMY> for a You Tube video of their activity. The QSO takes place around seven minutes into the video.

An exceptional effort and learning activity was led by Professor Tommy Henderson, WD5AGO, of Tulsa Community College, who taught his electronics students the basics of EME and had them design and build WA5VJB "Cheap Yagi" antennas with booms less than one meter and made of wood and welding rod. (See Cheap Yagi antennas: <http://www.wa5vjb.com/yagi-pdf/cheapyagi.pdf>.) Tommy and his class also had built and tested a large EME array which was successfully used in early test operations for the Arecibo event.

An accompanying photo is of Tulsa Community College students posing with their antennas in front of the sixteen 10-element K5GW EME array. Another is of some of the students who built their own working WA5VJB 1-meter, 432-MHz Yagis.

Acknowledgements

Tremendous thanks go to so many! Special thanks and acknowledgement go to the directors and staff of the Arecibo Observatory; Dr. Donald Campbell, Cornell University; Arecibo Director Mike Nolan; and NAIC folks Angel Vazquez, WP3R, Dr. Jim Breakall, WA3FET, and Dr. Joe Taylor, K1JT. Gosh, sorry, but there are just too many to name them all. Mega thanks goes to NAIC Arecibo for allowing this amateur radio education, science outreach moonbounce event to happen at this magnificent facility. Joe, K1JT, thinks we probably only worked ten percent of those who were trying and capable of working us. I hope we can do this again very soon.

Part 2 of this article is scheduled to appear in the Fall 2010 issue of *CQ VHF* magazine. It will focus on success stories and techniques used by small-antenna stations hearing/working Arecibo April 2010 from around the world, the future of Arecibo or possibly other large dish EME, and how EME is being seriously looked at as a viable STEM (science, technology, education, and math) activity by NASA, among other educational entities.

Amateur Radio and the Cosmos
Part 5 – Changes in the Weather

In AA6EG's "Echoes of Apollo" article, which begins on page 8, he tells his story of the most recent use of the Arecibo dish for EME communications. Here WA2VVA tells about the history of the big dish. Thanks to Gordon Pettengill, W1OUN (ex-KP4PBZ), for his immense assistance to both authors.

By Mark Morrison,* WA2VVA

In September 1938 a freighter captain just north of Puerto Rico recorded a drop in barometric pressure as an ominous cloud deck loomed overhead. Thinking a hurricane might be developing, he radioed his observations to the weather bureau. The weather experts predicted a hurricane would hit Miami before heading harmlessly back out to sea. To be sure, the hurricane did move offshore, but as it receded from view of mainland observers, it intensified and made its way north. Nobody knew what it was doing out in the vast ocean, for lack of weather observers, but when it finally came onshore on the south shore of Long Island, New York, there was no doubt that trouble had arrived. The storm surge and high winds caught everyone by surprise and would go down in history as one of the most damaging storms ever to hit New England.

Known as the "Long Island Express," this storm demonstrated the need for reliable weather observations, and what could happen without them. This fact was not lost on aviator Howard Hughes, ex-5YC, who just a few months earlier, in July 1938, had lifted off from Floyd Bennett Field, Long Island on his record-breaking flight around the world. For this venture Hughes summoned all the resources available to him at Hughes Aircraft, including a personal weatherman (and future ham) whose customized weather reports guided him day and night.

In those days, weather reports consisted of simple atmospheric observations, such as temperature, barometric pressure, wind speed, and cloud cover, all relayed to central stations via telegraph or other means. From there, weathermen would piece together the patterns of cold fronts, low pressure zones, and winds aloft that became the weather forecast. To track the progress of storms, this process was repeated at regular intervals. Weather reports were transmitted to ships at sea from Navy stations, such as NAA in Arlington, Virginia, using weather code that consisted of long strings of numbers. This required uninterrupted copy and a good ear, and was usually done from the relative comfort of a ship's wireless station. However, for the airborne operator, whose aircaft was buffeted by winds and updrafts, this could be a real challenge.

So it was that for his globe-girdling adventure Hughes's personal weatherman W. C. Rockefeller (W6???) would be stationed on the ground, rather than aboard "The 1939 World's Fair," collecting weather reports from around the globe, processing the data, and transmitting weather forecasts to Hughes in flight. To gather reports from far-off stations, such as those broadcast from Siberia, Rockefeller needed experienced radio operators with proven track records copying long strings of numbers over extended periods of time. As an example, the reports from Siberia alone took over an hour to copy. For this challenge, Hughes turned to the top amateur contest stations of the day. One was W2UK, operated by Ralph Thomas of Quogue, Long Island. Another was W6CUH, owned by Charles Perrine of Hermosa Beach, California and operated by Dave Evans, W4DHZ. The third station was W2GOQ, located in Wayne, New Jersey and operated remotely from Flushing Meadows, New York. Thus, in the fall of 1938 when people

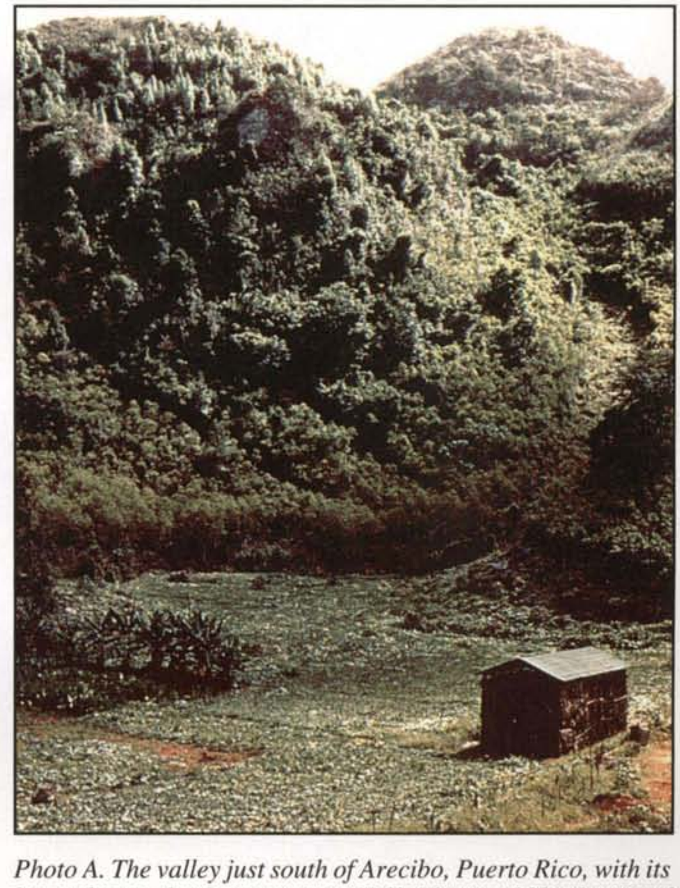


Photo A. The valley just south of Arecibo, Puerto Rico, with its lone tobacco shack, as it was in 1960. This would be the site of the Arecibo Observatory.

*5 Mount Airy Rd., Basking Ridge, NJ 07920
e-mail: <mark1home@aol.com>*

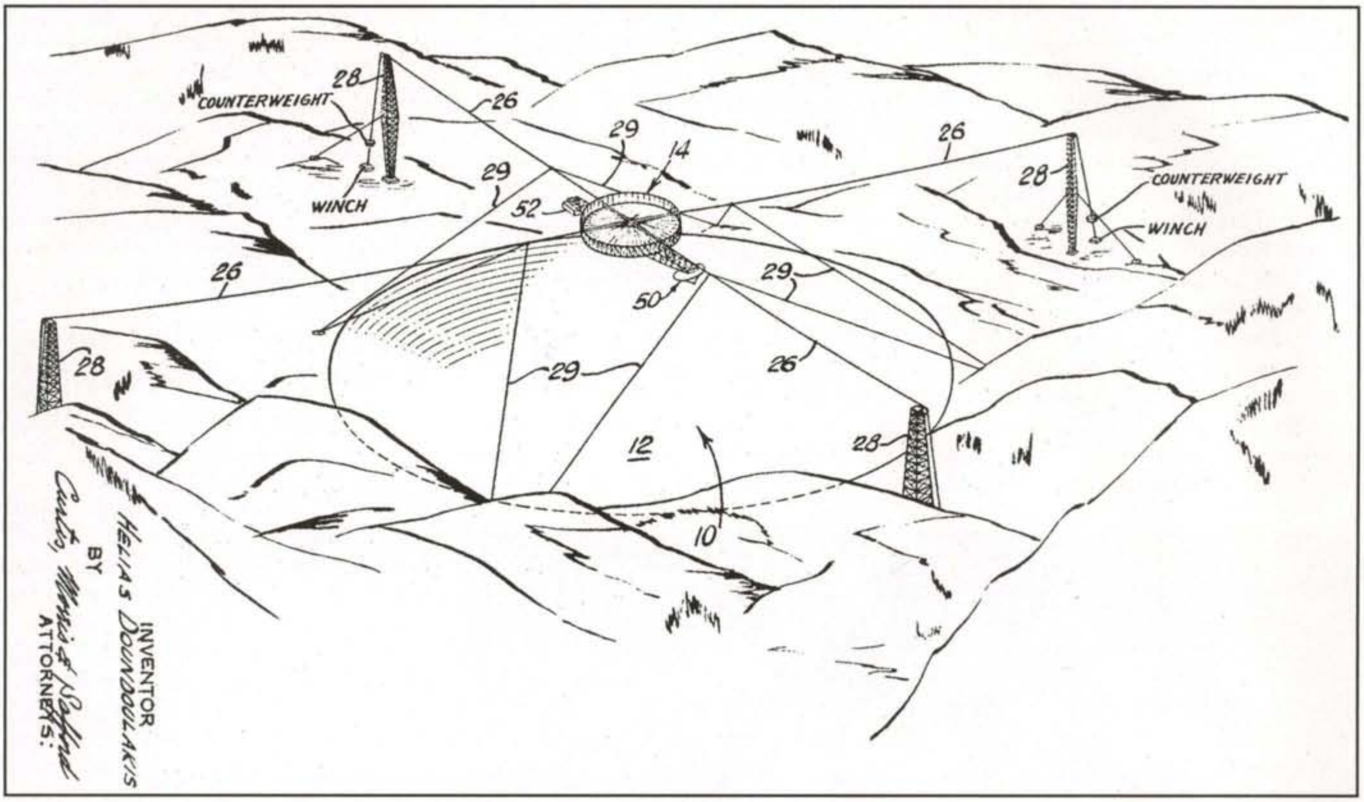


Photo B. The contractor selected to build the Arecibo dish, the General Bronze Corporation of Garden City, New York, filed this patent in 1961. The patent describes the entire dish supported by metal supports from below and anchored to the ground on concrete piers.

talked of the weather it was more than just a conversation starter—people's lives depended on it.

Weather, Radar, and Propagation

Some have said that radar is the weapon that won the war, but without a clear understanding of the weather those words may never have been spoken. Indeed, when radar first came on the scene it was quickly realized that interference from rain and clouds could be significant. Also, with the development of the cavity magnetron, something that pushed the resolution of radar into the centimeter range, the first "precipitation echoes" would be reported in England. In addition, in 1949 lightning discharges would be reported by M. G. H. Ligda of Cambridge, Massachusetts.

In 1942, the Army Air Corps assigned a young meteorologist, William E. Gordon, to investigate the effects of the weather on the propagation of radio waves then used in radar. This would begin a lifelong study of radio-wave propagation and scattering, first in the troposphere and later the ionosphere.

When the war finally ended, Gordon pursued his interest in weather at New York University, where he taught and studied meteorology until 1946, when he received a degree in the subject. After a brief move to Texas for further study, he found a home at Cornell University, an institution becoming well known for ionospheric research. After receiving his PhD in 1953 Gordon became a professor in Electrical Engineering, and worked alongside his advisor, Dr. Henry Booker.

Photo C. Contrary to the patent filed by the General Bronze Corporation, the final design of the Arecibo dish used steel cables draped across the valley and used to support a wire mesh surface.

Together, Gordon and Booker worked out the principles of various scatter techniques, including tropospheric scattering, already in use by VHF men of the day. This weather-based phenomenon allows VHF signals to travel hundreds of miles and, under certain conditions, results in long-range ducts that can span oceans. Ralph Thomas, KH6UK/ W2UK, who had provided weather reports to Howard Hughes in 1938, used tropospheric ducting to set a new 2-meter DX record in 1957, exchanging reports from Kahuku, on the island of Oahu, with John Chambers, W6NLZ, near Los Angeles, California. This particular contact was a highlight of the International Geophysical Year (IGY) and received much attention at the General Assembly of the International Scientific Radio Union attended by Dr. Booker's son John Booker, K2SKB, and many other scientists.

Another technique discovered by Booker, called ionospheric scattering, would be used by VHF pioneers Jim Kmosko, W2NLY, Walt Bain, W4LTU, and Paul Wilson, W4HHK, for some interesting VHF work. Other hams were involved in ionospheric research, too, including Jack Belrose, VE2CV, who in 1962 participated in the first Canadian satellite, Alouette 1, designed to transmit VHF signals through the ionosphere from above. Although the Alouette program was a certain success, another scatter technique discovered by Gordon, known as incoherent scattering, would allow probing of the ionosphere from below. Using this technique[1] it would be possible to determine the temperature, pressure, and velocity of electrons in the ionosphere. However, to make it work Gordon needed powerful radar waves, more powerful than any that yet existed.

Photo D. The dish feed was also suspended by steel cables, but from three great towers as shown in this photo from 1961.

Photo E. The massive size of the feed assembly of the Arecibo dish.

The History Behind the Arecibo Observatory

When Gordon considered ways to generate the powerful microwaves needed for incoherent scattering, he naturally considered the largest antennas of the time. One was the 250-foot dish at Jodrell Bank, operated by Alfred C. Lovell and used to study aurora and meteor scatter. Another was the 650-foot dish under consideration by the U.S. Navy at Sugar Grove, West Virginia. Neither of these would do for Gordon's project, as they were just too small! For his project Gordon needed something at least 1000-feet across!

To gather support for his project, Gordon first approached the military with the idea of eavesdropping on Soviet radar signals bounced (unintentionally) off the moon. However, a similar proposal made for the Sugar Grove dish made a larger dish seem unnecessary. It wasn't until Gordon approached the Advanced Research Projects Agency (ARPA) that a serious partner would be found. As it turns out, ARPA had already started its "Project Defender" program, something intended to detect approaching Inter-Continental Ballistic Missiles (ICBMs) by the telltale signs they left in the ionosphere. A dish the size of Gordon's would be of real value to this project. So it was that when Gordon approached ARPA his proposal was quickly embraced.

Following the suggestion of Cornell Civil Engineering professors, Gordon proposed a fixed parabola pointed toward the zenith with the entire structure supported over a natural bowl-shaped depression in the earth. Although the dish would be fixed, and necessarily shared with ARPA, it would more than serve Gordon's purposes. However, when it was realized that such an arrangement could also be used for radar astronomy as well as radio astronomy, the idea of a steerable feed was added to accommodate these applications. Eventually it was decided that a spherical dish would bet-

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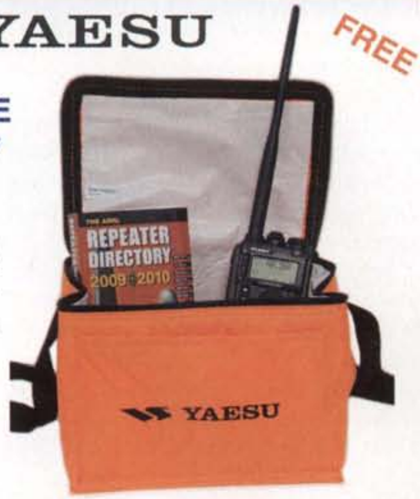

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ter serve a steerable feed and bids went out to build it, with the support of ARPA. In order to view the nearby planets a location near the equator would be needed, and although a few had been proposed, a valley just south of Arecibo, Puerto Rico was found to be ideal. Photo A shows the valley and its lone tobacco shack as it appeared in 1960.

The contractor selected to build this dish was the General Bronze Corporation of Garden City, New York. Not only did it work out the details of the steerable feed system, and build the entire affair, but it also filed for a patent in 1961 (see photo B). The patent describes the entire dish supported by metal supports from below and anchored to the ground on concrete piers. However, the final design would use steel cables draped across the valley and used to support a wire mesh surface, as shown in photo C. The feed would also be suspended by steel cables but from three great towers as shown in photo D from 1961.

Due to the length of cables required, temperature fluctuations had the potential to move the feed out of the focal zone through expansion and contraction. This was solved using an adjustable feed mechanism, something that allowed precise positioning of the pickup using a counterbalanced track system. The picture in photo E shows the massive size of the feed assembly. Note the size of the trucks in the picture!

Bill Gordon would supervise the construction, and as it turns out, our own Gordon Pettengill, W1OUN, would be there as well. Gordon was a member of Lincoln Laboratories and during the mid-1950s had already done research using the great dish at Millstone Hill for some of the earliest work in the detection of ICBMs. Of particular interest were anomalous ionospheric echoes caused by aurora, meteors, and the moon. That such echoes were possible was confirmed by John Kraus, W8JK, who had detected the reflection of WWV time signals from the electrons bunched up in front of the Sputnik satellite as it passed overhead.

Pettengill visited Arecibo many times during its construction and provided all of the color pictures used in this article. In a recent e-mail to this author he had this to say about those early days.

> I visited Arecibo 12 times between my first trip down in June 1960 and my moving there in July 1963. I took tons of photos myself, to track the construction, and I picked up a few from Cornell, as well. While there for a few days each time, I usually stayed with the Gordons, who were extremely hospitable. Remember, they had moved down as a family (their kids went to high school at Ramey AFB) in May 1960. Bill really tried to integrate into the local community by learning Spanish and joining the local country club, where the local movers and shakers met and schmoozed.

Photo F. The dedication ceremonies for completion of the Arecibo Ionospheric Observatory, held on November 1, 1963, with Bill Gordon at the podium.

When construction of the Arecibo Ionospheric Observatory was completed in 1963, Bill Gordon would serve as its first director and Gordon Pettengill as its Associate Director. Photo F shows the dedication ceremonies, held on November 1, 1963, with Bill Gordon at the podium. Photo G shows a view of the main lobby as it appeared in 1965.

Photo G. A view of the main lobby as it appeared in 1965.

Radar Astronomy and Arecibo

Although much was learned about the ionosphere in the next few years, Pettengill would pursue his interest in radar astronomy by using the dish to probe the nearby planets. First would be his discovery that the orbit of Mercury is not 88 days as was previously believed, but rather just 59 days. Second would be his continuing work with the planet Venus, probing its atmosphere from millions of miles away. Such achievements would prove without a doubt the value of radar astronomy as a valuable alternative to the more traditional optical astronomy. Photo H shows some of the equipment used in the receiver room, with the master clock and frequency standards. Photo I shows the controls for the 430-MHz klystron transmitter, with power levels of 2.5 Mw peak, 150 kW average.

Prior to arriving at Arecibo, Pettengill had been the acquaintance of yet another ham, one of the men credited with the first successful amateur moonbounce QSO, Sam Harris, W1FZJ. It is interesting to note that the 50th anniversary of that historic QSO coincides with the printing of this article. When Pettengill came to Arecibo in 1963, he brought Sam with him and on at least two occasions arranged to use Arecibo for amateur moonbounce communications. Since dish time was at a premium, Pettengill and Harris were fortunate to have Bill Gordon as director. As Pettengill recently commented, "I never could have scheduled the EME stuff over the July 4th holidays in 1964 and 1965 without his permission." Sam Harris must have been thinking about that as he built a 100-foot diameter "mini Arecibo" in a nearby valley as illustrated in photo J.

When Frank Drake took over as director of the observatory in 1966, he brought with him his passion for radio astronomy. Up to this time, Arecibo had been a radar facility, probing the limits of the ionosphere and the disks of nearby planets.

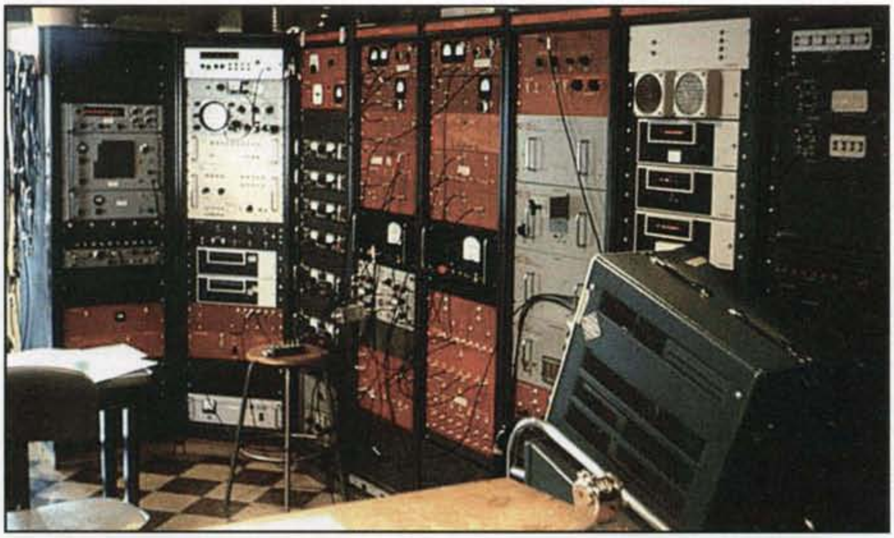

Photo H. Some of the equipment used in the receiver room, with the master clock and frequency standards.

Photo I. The controls for the 430-MHz klystron transmitter, with power levels of 2.5 mW peak, 150 kW average.

Photo J. The 100-foot diameter "mini Arecibo" built by Sam Harris in a nearby valley.

Now it would grow into a world-class radio astronomy facility as well. In 1968, Pettengill would return to Arecibo once more, this time as its director. Pettengill recalled his acquaintance with Drake as follows.

> . . . we have known each other quite well since I first met him at Greenbank in 1958. I took over from him as director at Arecibo in 1968, renting the house he had been living in there. And, of course, over the years, our paths have crossed on numerous occasions, most recently several years ago in Puerto Rico, although I have not participated in his SETI work.

By 1974 the dish at Arecibo would complete an upgrade that increased its sensitivity 2000 times and added a 450,000-watt radar transmitter, which, according to a Cornell University press release, had:

> . . . an effective power 100 times greater than the total electric power production of all the generating plants in the world. This is the strongest signal now leaving Earth. The beacon is a manifestation of mankind powerful enough to be detected by instruments similar the Arecibo telescope located anywhere in the Milky Way. Indeed, to the eyes of creatures of far distant stars, the Arecibo telescope would gleam 10 billion times more brightly than our sun.

The official press release photograph (photo K) shows an aerial view of the dish, with the control room complex and office buildings in the lower center, factory and service buildings on the lower left, and a helicopter landing pad on the far left.

Shortly after the upgrades were completed, in 1974 Joe Taylor, K1JT, and Russel Hulse, WB2LAV, used the dish at Arecibo to discover the first binary pulsar—two neutron stars orbiting in close proximity, with one generating powerful radio waves. That this was a binary pulsar could be determined from the shift in frequency observed as the radio star alternately approached and receded from the Earth, a clear indication of the Doppler effect. By detecting subtle changes in this

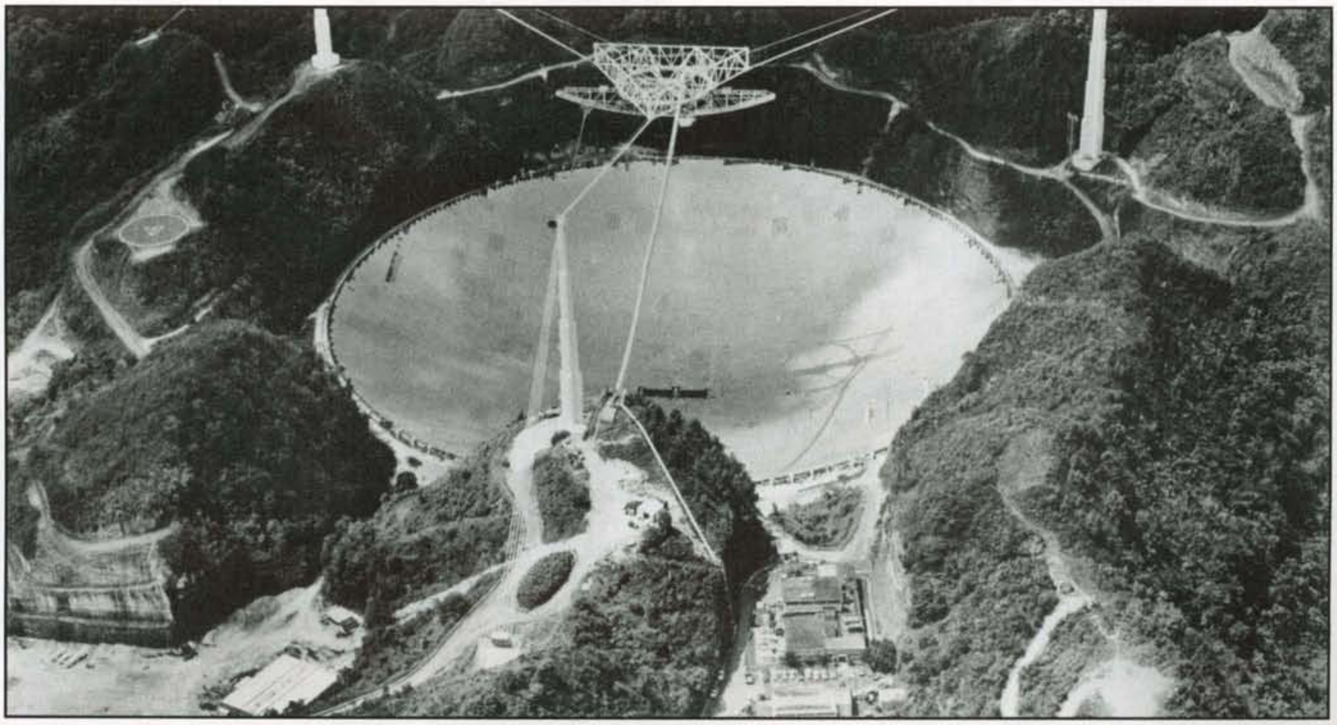

Photo K. The 1974 official press release photo showing an aerial view of the upgraded Arecibo dish, with the control room complex and office buildings in the lower center, factory and service buildings on the lower left, and a helicopter landing pad on the far left.

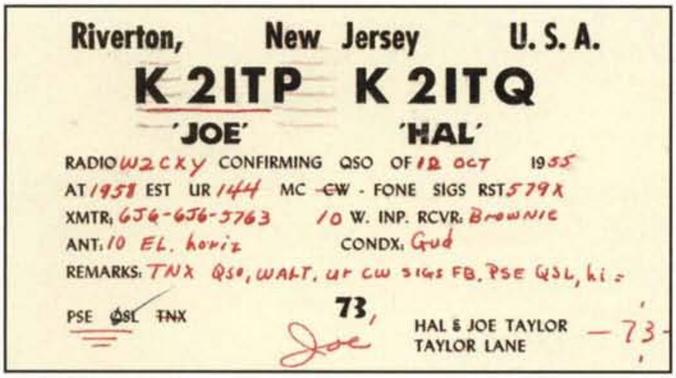

Photo L. The shared QSL card of Joe Taylor, K1JT, and his brother Hal (then K2ITQ, later K2PT, and now a SK), documents a 2-meter QSL between Walt Morrison, W2CXY, and Joe (then K2ITP) when he was just 14 years old.

binary system over the next few years, Taylor and Hulse concluded that the orbital period of the two stars must be changing, indirectly confirming the existence of gravitational radiation predicted by Einstein's General Theory of Relativity. In 1993 Taylor and Hulse shared the Nobel Prize for their discovery.

In earlier years, Joe had teamed up with yet another person, his brother Hal (then K2ITQ, later K2PT, and now a Silent Key), on the 2-meter band. Their shared QSL card, shown in photo L, documents a QSL between Walt Morrison, W2CXY, and Joe (then K2ITP) when he was just 14 years old. Joe is now widely recognized as the creator of the WSJT signal processing software which applies his knowledge of radio astronomy techniques to weak-signal amateur radio communications. With this software amateurs around the world can now communicate via the moon and ionized meteor trails using modest equipment practically any time of the day or night.

In later years, Arecibo underwent another yet upgrade, further improving its receiving and transmitting capabilities. The amateur radio tradition continues even today, as described elsewhere in this issue of *CQ VHF* magazine.

In the 1930s, weather observations were limited to simple observations of the temperature, pressure, and velocity of air within the troposphere. In the 1950s, weather observations were extended to include the electrons and particles of the ionosphere, and by the 1960s scientists were probing the atmosphere of distant planets millions of miles away. How remarkable are these changes in the weather!

In Closing . . .

I wish to thank Gordon Pettengill, W1OUN, not only for the many pictures used in the preparation of this article, but for his unwavering support of amateur radio over the years. His professional as well as amateur achievements surely rank him as one of the great VHF pioneers of the 20th century.

Sadly, Bill Gordon passed away in February of this year. On the 40th anniversary of the observatory he remembered those who expressed doubt in the project, saying, "We were young enough that we didn't know we couldn't do it."

Note

1. For an interesting explanation of how incoherent scattering works, refer to <http://www.haystack.mit.edu/atm/mho/instruments/isr/isTutorial.html>.

The Tropo Trigger

For decades amateur radio operators and others who use the VHF and above frequencies (such as airplane pilots) have been fascinated by the tropospheric ducting that takes place between Hawaii and the North American west coast. Here is an explanation of what triggers such propagation.

By Gordon West,* WB6NOA

Gordo and Chip Margelli, K7JA, set up to work Hawaii from the beach in southernn California. Hawaii has just been worked from La Paz, Mexico, with what could be a record distance as the tropo season opens in June 2010.

Summertime is the exciting time for temperature-inversion tropospheric-ducting long-range VHF/UHF DX. The action begins around Field Day the end of June and may extend well into September. July and August are the hot months for this predictable atmospheric-range enhancement.

VHF/UHF and microwaves *normally* travel 1.1 times farther than the optical horizon. With normal air refraction, the optical horizon is generally 1.2 times farther than the geometric horizon, influenced by the curvature of the Earth.

The formula used to calculate the distance of the radio horizon, in kilometers, is the following:

$$D = \sqrt{17h}$$

where:

D = distance to the radio horizon in kilometers

h = height of antenna above Earth or water

To illustrate this, let's take a 432-MHz signal transmitted from an antenna up 100 meters on a small hill:

$D = \sqrt{17 \times 100} = \sqrt{1700} = 41.23$ kilometers to the horizon

The other station is also on a hill, 64 meters in height:

$D = \sqrt{17 \times 64} = \sqrt{1088} = 32.9$ kilometers transmission distance

Now add 32 .9 km to 41.2 km, and expect 74-km range.

During the summer months, many times UHF stations will communicate well over 300 kilometers on the flat land, with minimal antenna height! Some may call this "super refraction," and the condition is most prevalent when a static high-pressure system is overhead both stations with stratified, smoky air hanging on the horizon.

Air pressure normally decreases with altitude in an approximately logarithmic manner:

The higher we go in elevation, the less air pressure there is. Air temperature also decreases with altitude, approximately 20°F for every mile of increased height, up to 40,000 feet.

The number of water molecules also decreases with altitude, resulting in atmospheric density decreasing with height above the surface of the Earth.

Both light waves and radio waves normally travel in a straight line, with the top portion of the wave front in thinner air accelerating faster than the lower portion of the wave front which drags in denser air. This is normal refraction of both radio and light waves, with radio waves being more refracted than light waves.

The bending of both kinds of waves in "normal" air is a slightly higher number than unity, around 1.000345 to 1.000310. To determine refraction, or N, we use the following equation:

$$N = 10^6 (n - 1)$$

where n = refractive index value

This normal air is what we breathe and feel for about ten months out of the year. In the summertime, large high-pressure cells begin to form and sometimes remain stationary for up to a week, causing

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stuffy, smelly, stratified layers of air overhanging your favorite ham shack. In California, we call it smog!

These high-pressure systems are tracked hourly by weather forecasters all over the world. You can receive free weather system forecasts with emphasis on enhanced VHF/UHF ranges at <www.dxinfocentre.com>, known as the Hepburn weather charts. These charts are amazingly accurate in describing the areas where "subsidence" is taking place. Subsidence is the fallout of a high-pressure cell where heavier air begins to sink and stratify above oceans and flat land masses. The stratified air is squashed by descending air above and more dense air directly below. When air gets squashed, it heats up and becomes higher in pressure than the air above and below it. It sometimes also may pull in moisture from summertime hurricanes just south of the static high-pressure system.

As the high-pressure system builds and stalls across the country, some amazing long-range paths open up on VHF, UHF, and the microwaves:

1. The Atlantic high, between the East Coast U.S. and Europe (yet to be worked on VHF and UHF).
2. The Pacific high, between the West Coast U.S. and the Hawaiian Islands. (We work this path every July and August.)
3. South Pacific Island highs, and Indian Ocean high.
4. The regular high-pressure system between South America and Africa.
5. Summertime stalled high- pressure cells traveling west to east, across the United States.

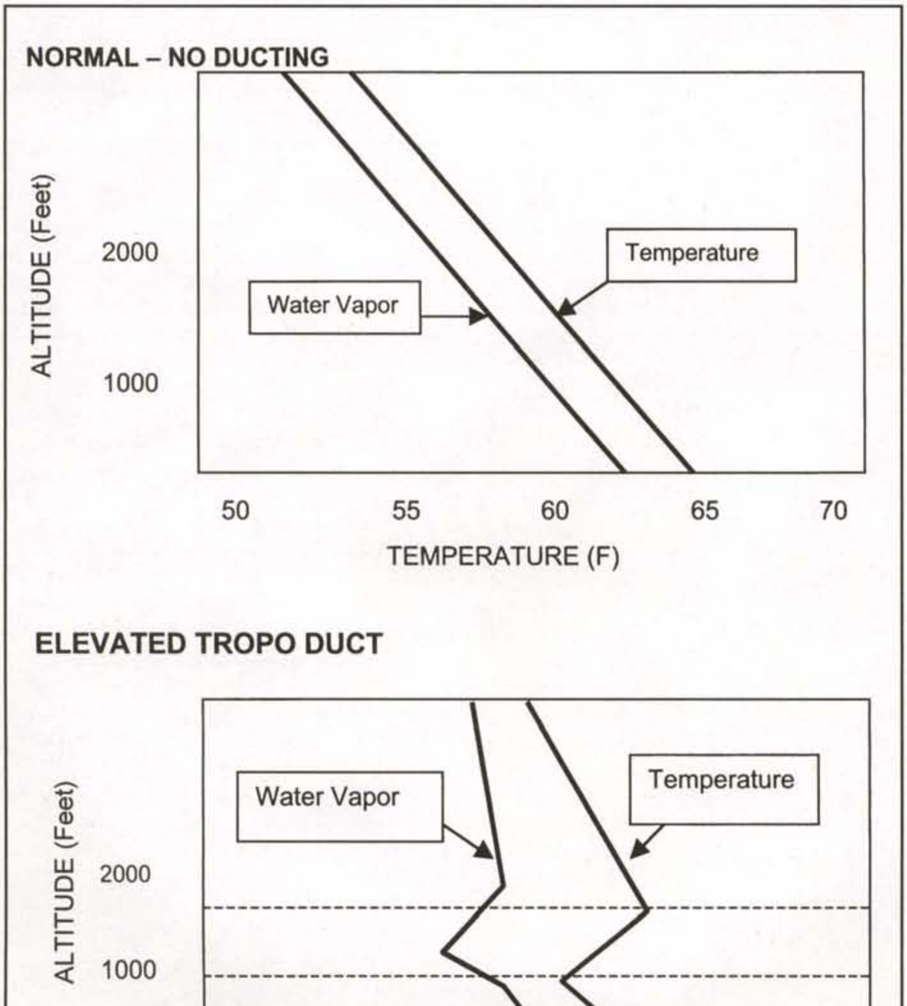


Fig. 1. Types of temperature and water-vapor inversion.

You can generally see a "tropo" and many times you can feel it! What you see is a band of smoke and smog that goes horizontally at about 500 to 1000 feet up. It smells like pollution, and weather conditions are hot and sticky. There is very little wind, and the weatherperson says you have two or three more days of this uncomfortable hot weather ahead. This is the perfect time to fire up the VHF/UHF/microwave gear!

When the subsidence develops an air pressure below, reaching 1,026 millibars, an extended radio path begins to form. Here is where a DSP (digital signal processing) add-on speaker may hush background noise and let you tune the beacon portion of the bands for distant signals. Most beacons are horizontally polarized, yet even a vertical antenna may be a great way to tune in a National Weather Service FM transmitter at 162 MHz up to 700 miles away!

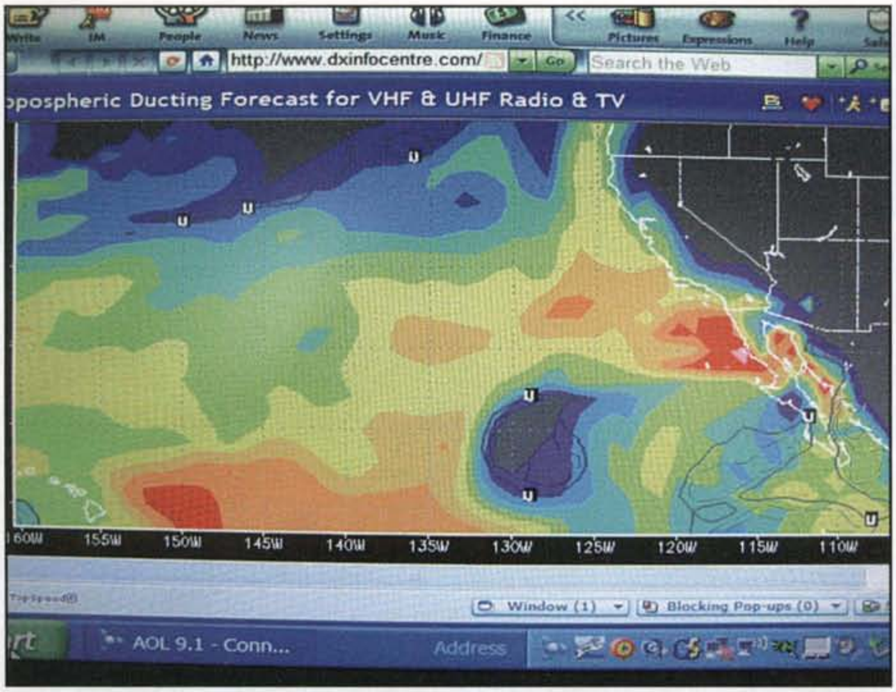
"At the height of the tropo duct, I did a scan of my over-the-air digital TV channels and received some amazing television signals 600 miles away," comments Bill Alber, WA6CAX, an avid West Coast microwave enthusiast.

Your location in altitude is one component of a successful tropo-ducting long-range contact. Don't run to the top of the hill until you know if your end of the tropospheric duct is high or low. Here in southern California, the Hawaiian KH6HME beacon at 8000 feet elevation on the Big Island is best received "on the deck" here in coastal regions. Although we have a mountain range to climb, up to 7000 feet, this is *almost always* far above the tropo duct with absolutely no reception of the distant 2500-mile-away signal! However, those down at the shore may be hearing the far-away beacon with not much more than a single loop antenna!

Commercial airline pilots have told stories of distant air traffic controllers coming up on a local channel as they begin their approach to a regional airport. The pilots say they can actually see their entrance into the band of smog and nearly instantly hear calls from 500 miles suddenly coming over their VHF AM aircraft transceivers.

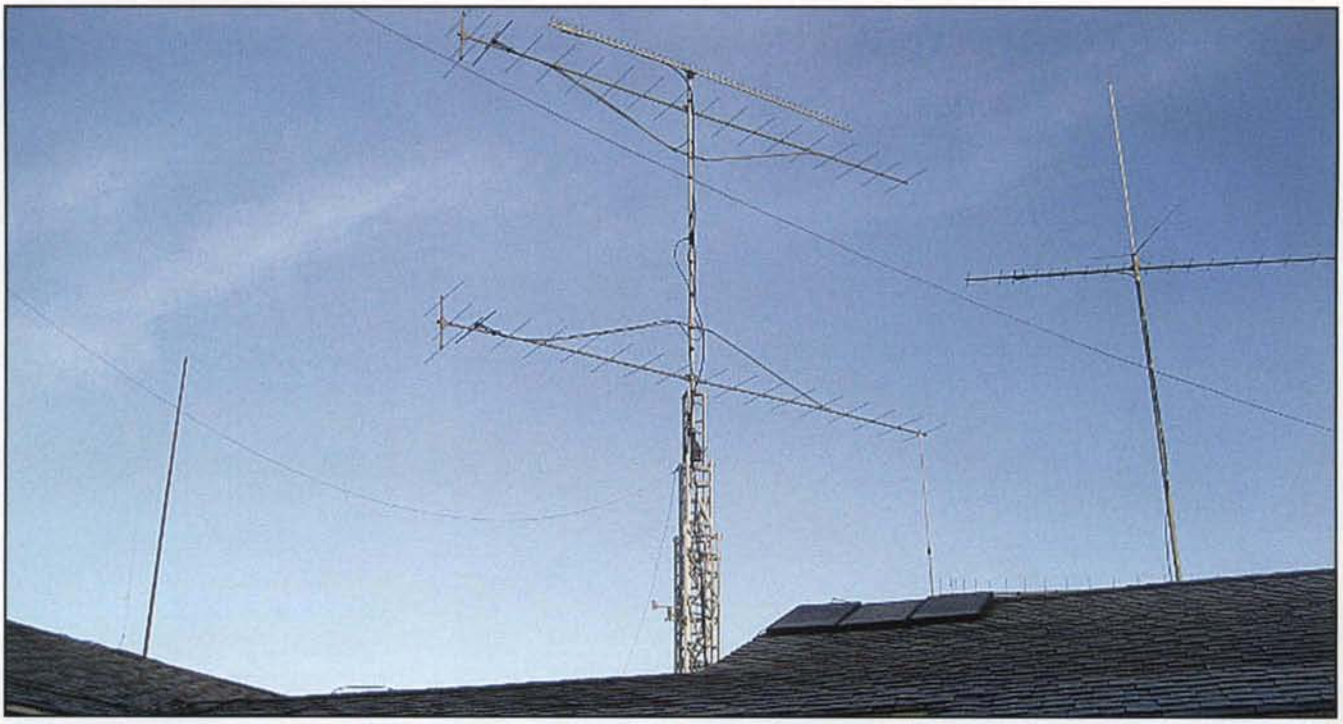
The tropospheric duct will also move laterally, much like a garden hose that wanders in slow motion unrestrained across the lawn or driveway. As little as 5 miles separation between two receiving stations may allow an 800-mile-away beacon to be heard at one station S-9, while the other station hears nothing. Be patient. About an hour later the situation may reverse! Lateral selective fading is very common with long-haul tropo, even in still air.

Studies in polarization reveal that a transmitted horizontal signal is seldom received with a vertically polarized beam. Tests between my station and KH6HME in Hawaii have compared vertical-to-vertical and horizontal-to-horizontal performance and they have shown to be almost equal. However, since most long-range DX tropo beacons and tropo stations work horizontally, your best



The Hepburn tropo forcast shows good conditions from southern California to Hawaii, with a hurricane showing up just below the path, marked with a "U" for unsettled weather.

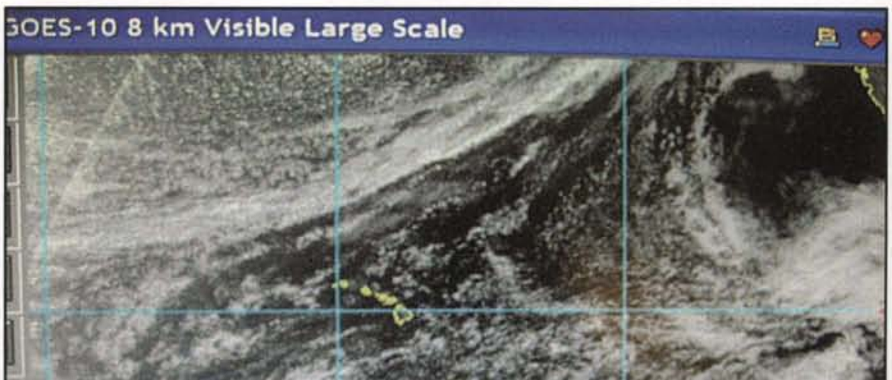
Two hurricanes spinning off southern Mexico, which often will lead to great California/Hawaii tropo conditions.



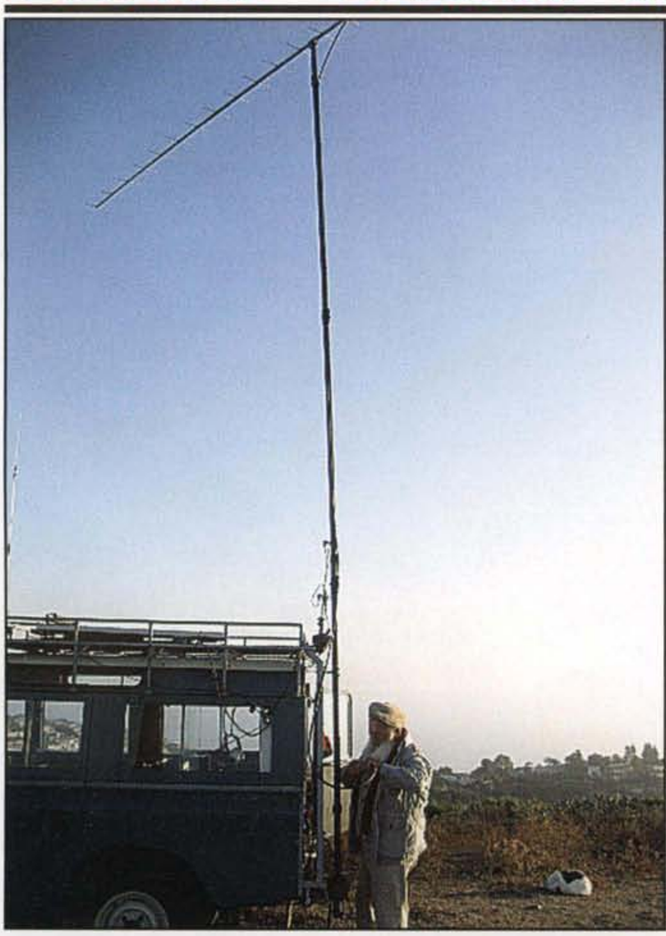
The author listens for tropo from Hawaii using this stack of 144-MHz long boomers. Topping the boomers is a 1296-MHz loop.

reception will also be horizontal 100% of the time. We have never seen a polarization change.

Many times long-range tropospheric ducts intensify in the presence of a low-pressure hurricane to the south. Warm tropical air feeds into the stratified tropo duct and the temperature increases where Delta 15 degrees will almost always lead to long-range VHF/UHF contacts. During the yearly Pacific high tropospheric ducts between California and Hawaii, my records dating back to the late 1970s *always* show amazing signal enhancement with a hurricane spinning to the south. Satellite imagery shows a



When the warm waters north of the equator move closer to Hawaii, tropo-ducting conditions between the West Coast and Hawaii usually improve.



John Kountz, KE6GFF, works Hawaii on 432 MHz mobile at rest on a hill overlooking the ocean.

telltale undisturbed, light-gray smooth haze overlying the Pacific Ocean between Hawaii and California.

The Hepburn charts are indispensable in their accuracy of predicting upcoming long-range VHF/UHF band openings. The color calculations come from multiple meteorological sources and soundings. If it doesn't show yellow or red between your location and your friend's a thousand miles away, don't expect the band to be open!

Never before have manufacturers made it so easy for beginners to explore weak-signal VHF and UHF SSB and CW propagation. No longer must we go out and buy a $600 multimode single-band transceiver, although I still have my trusty Kenwood 751 A. I have Kenwood, Yaesu, and ICOM HF rigs each with multimode capability on 2 meters and 440 MHz, and they are just as hot as my older single-band multimode gear with a GasFet front end.

As more sensitive weather satellites go into orbit, predicting high-pressure stratified-air tropo paths will be far easier than ever before. But one thing for sure, the best time for tropospheric ducting is between Field Day in June and back-to-school time in September. July and August will give newcomers with horizontal antennas some real excitement down in the beacon portions of the VHF/UHF bands.

Let's all get those new Techs and Generals to better understand that their equipment for HF with included VHF and UHF multimode capability can lead to some heart-pounding thrills when the high-pressure cell moves in and the tropo paths begin to build.

Beginning Experiments on the VHF Amateur Bands – Part 3

In this, the third part of a four-part series, KK7B discusses modulation and adds some simple and fun experiments to do with friends.

By Rick Campbell,* KK7B

In the last two issues of *CQ VHF* I described a VXO signal source to generate a low-power sine wave on 50.1 MHz and an assortment of 6-meter receivers suitable for experiments. My students have been exploring low-power two-way communication at the 10-milliwatt level on 50.1 MHz using the VHF signal source and some very simple electronics described in the book *Experimental Methods in RF Design*.[1] Some of those experiments are described on the VHFkits Yahoo Group site. In this issue we will explore the topic of modulation, along with some simple and fun experiments to do with friends.

On-Off Keyed Waves

"Aha," you say. "KK7B is trying to trick me into using Morse code!" Well, perhaps. However, in order to understand modulation, you need to start from the beginning, and the beginning of modulation is taking a constant signal and adding a message. Let's start with flashlights.

In order to experiment with communications, you need more than one person. If your friends are reluctant to learn Morse code, you will need to round up a couple of kids. Ten- to 12-year-olds are ideal. Write out the Morse code on two pieces of paper, write out your callsigns, and offer some reward when they can reliably send messages through the dark with flashlights. Typical Cub Scouts take about a week to master this, and summer is ideal, when they are not in school and may be bored. Speed is not an issue. As soon as they know all the letters and numbers, they are fast enough for either flashlights or moonbounce.

You can also try laser pointers and see how far they can go. Even grown-up kids think that is a lot of fun. Figure 1 shows the block diagram of the basic communications system.

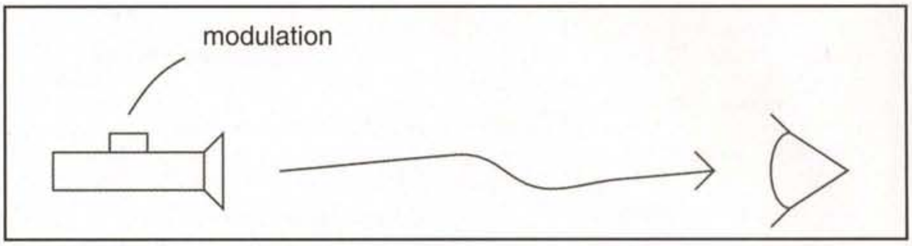


Figure 1. A simple modulation system is your finger on the button of a flashlight. This basic form of communication has been practiced by generations of Cub Scouts and is still used to communicate between ships. (Figures and photos courtesy of the author)

Photo A shows a jumper on the VHF CW signal source to put a push-button switch for chirpless on-off keying. You don't have to use a telegraph key if you dislike Morse code, but kids think keys are really cool. Now do the same experiment using VHF signal sources instead of flashlights or laser pointers. Using very simple direct-conversion receivers, my students have reliably communicated over a mile using less than 10 milliwatts and 6-meter dipoles. Figure 2 is a block diagram of the basic communications system, using 10-mW 6-meter CW sources instead of flashlights. You can still see all the parts, and it is an ideal project for a grandparent or Elmer to introduce basic communications electronics to the younger generation.

Here's a final editorial comment on the use of Morse code. You may be right that it isn't worth your time to learn 35 words per minute to exchange 599 signal reports during a contest on 40 meters. I won't

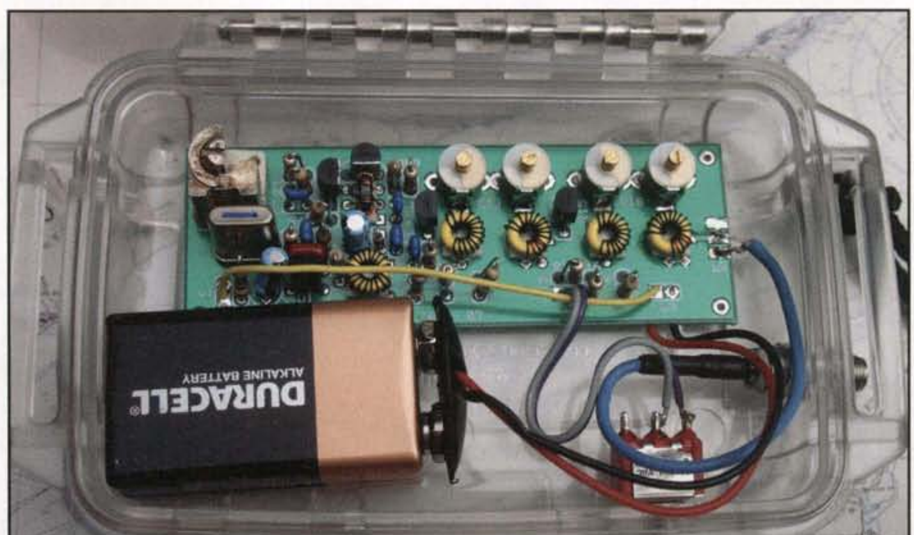


Photo A. A simple push-button telegraph key replaces the jumper on the VHF signal source.

*e-mail: <ecekk7b@gmail.com>

argue with you there. However, a grandparent who learns Morse along with a grandchild creates a priceless bond, and passes along a lifelong love of learning. Just getting to the point where you can exchange messages with flashlights, on the air, or with the silent touch of a hand is the reward. It's not about speed; it's all about the message. It doesn't have to be Morse code—it could be sailing, hunting, fishing, or anything else you enjoy. Pick something you love and take the time to pass it on. ...But kids do think Morse code is cool.

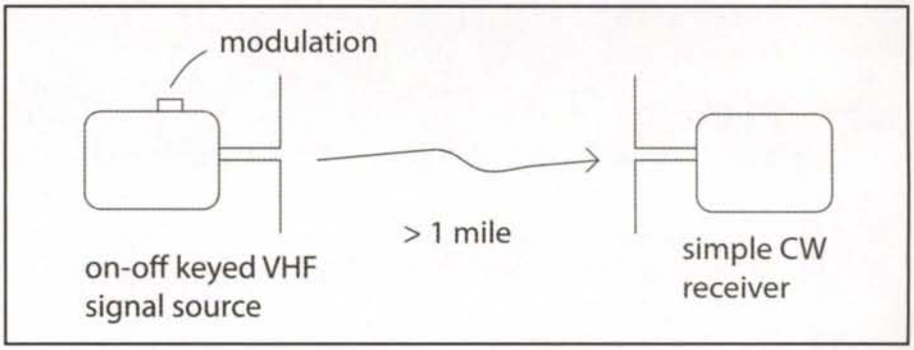


Figure 2. The flashlight can be replaced by a simple CW source with a push-button switch, and the receiver may be a simple CW receiver. The author's students have routinely communicated over a mile using less than 10 milliwatts of CW, 6-meter wire dipole antennas, and simple direct-conversion receivers.

Analog Modulation

On-off keyed RF signals are kind of boring on the oscilloscope, but envelope modulation is interesting. Photo B shows the output of an AM transmitter, with the audio sine wave on top, and a radio signal with amplitude modulation on the bottom. Clearly we are using the analog information contained in the audio to control the amplitude of the radiowave. Amplitude modulation (AM) is not hard to do. First we need a microphone and audio amplifier to obtain the waveform shown in the top trace. We also need an oscilloscope. The oscilloscope is the most basic tool for experiments with modulation—but experiments with modulation are also the most basic way to learn how to use an oscilloscope. If you have always wanted one, or an excuse to get to know the guy down the street with a nice home lab, now is the time. The price of a new oscilloscope is about the same as a handheld radio. Basic models are a few hundred dollars, and very capable imports with more digital features than I care to use are under $500. For AM you need two input channels so you can compare the modulation and resulting RF waveform, and enough bandwidth to display a sine wave at the operating frequency.

Once you have a voice waveform displayed on the oscilloscope, find a connection on the VHF transmitter that changes the power output when you vary the voltage. The power-supply terminal is a good place to start your experiments, but you don't want the oscillator to quit working in the dips of the voice waveform. Connect a constant DC power supply to the oscillator, and modulate the power-supply voltage to the later stages. The VHF signal source has separate power-supply connections to the oscillator and later stages that make this easy. Modulating the last two stages of a solid-state transmitter is ancient practice I read about as a child. Not every good idea is new.

Once you have found a power-supply terminal on the transmitter that allows you to smoothly vary the RF output from zero to maximum, you need a way to add a variable audio voltage to the fixed DC power-supply voltage. The DC power and modulated voltage are both connected to the same terminal. A graph of what we want is shown in figure 3. Note that the voltage in figure 3 has two variables: the DC offset voltage and the AC peak-to-peak voltage. When we adjust the transmitter using the oscilloscope, we will vary both the DC power-supply voltage and the gain of the audio amplifier. There are many ways to obtain a power supply with an output that consists of an AC component with a DC offset, but one of the easiest is to add an audio transformer in series with a variable DC power supply, as shown in figure 4. The available audio output power should be about the same as the DC input power required by the transmitter. Having more DC and audio power available than needed is a good idea, particularly for low-power experiments, where DC and audio power are inexpensive and readily available.

A transformer used as shown in figure 4 is called a *modulation transformer*, and

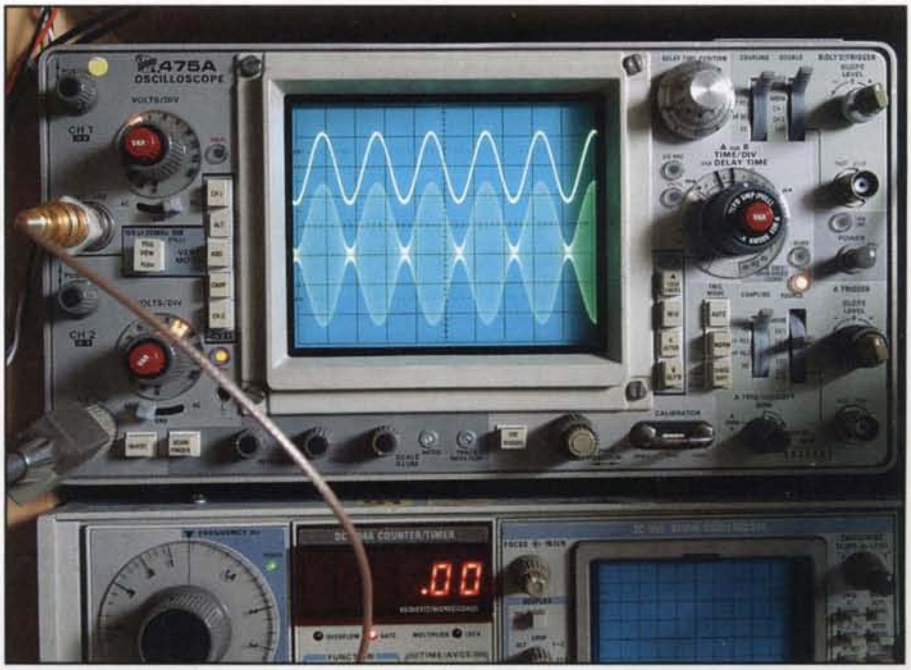


Photo B. This audio waveform on the top and the RF output waveform on the bottom show excellent modulation of the VHF signal source using an audio amplifier and filament transformer from the author's junk box. Having more audio power available and a larger modulation transformer than needed makes it easy to obtain high-quality amplitude modulation.

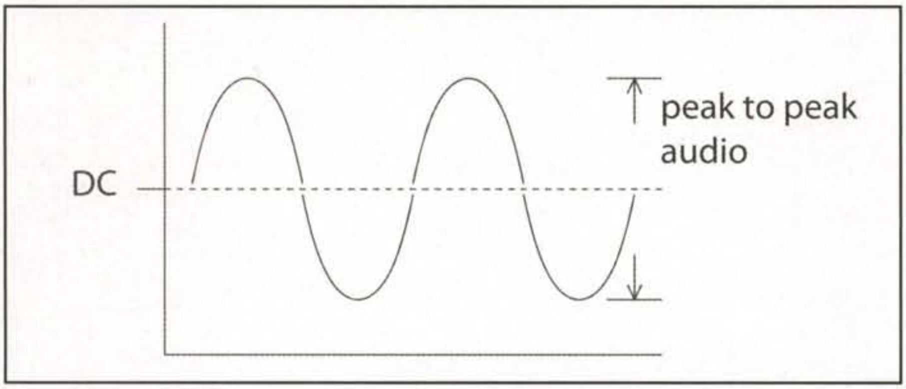


Figure 3. To amplitude modulate a CW transmitter, use a power-supply voltage shown here graphically. An audio voltage is added to the DC power supply so that the power output follows the variations in the audio waveform.

if you find a new-old-stock transformer in a box labeled "Modulation Transformer" it probably will be expensive and not have the correct turns ratio. We don't care about the label. A transformer is just a core and a few windings. What you need are the right number of turns, thick enough wire, and a core that will do the job. Picking a transformer is easy if you don't mind using a larger one than you need. There is an old saying: "Anyone can build a bridge; it takes an engineer to build one that just barely stays up."

Most of the old textbook formulas for choosing a modulation transformer are used to pick the smallest, least expensive model that will work in our transmitter. Thick wire and a big enough core are heavy, so we need to ask: Is the modulation transformer heavy enough? For our low-power experiments a good rule of thumb is that the modulation transformer should weigh almost as much as the power transformer in the DC power supply. If you look inside old AM transmitters, you will see that they followed that rule as well. We still need to figure out the turns ratio in the windings. This is not hard, and the surprising result is that suitable transformers are common and inexpensive.

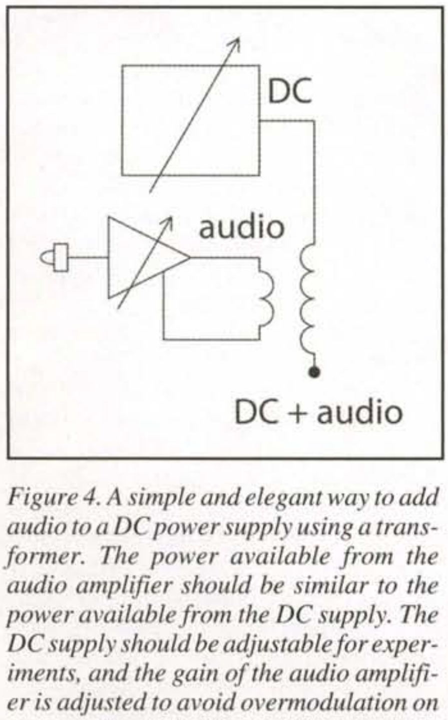


Figure 4. A simple and elegant way to add audio to a DC power supply using a transformer. The power available from the audio amplifier should be similar to the power available from the DC supply. The DC supply should be adjustable for experiments, and the gain of the audio amplifier is adjusted to avoid overmodulation on voice peaks. Both of these adjustments are made while observing the AM transmitter output on the oscilloscope.

The transformer turns ratio determines both the voltage ratio and impedance ratio between the primary and secondary windings. For example, a 12-volt transformer with a 110-volt primary will have about 10 times as many turns on the primary as on the secondary. If you took it apart, you would also find that the 12-volt winding is made of thicker wire, because it carries more current. The power in each winding is nearly the same. A transformer is bi-directional; it doesn't much care which winding we use as the primary or secondary.

Transformers for audio are usually specified in terms of primary and secondary impedance, rather than voltage. The impedance ratio is the turns ratio squared. If the turns ratio is 10 to 1, then the impedance ratio is 100 to 1. A core that works at 60 Hz is okay at audio. If we connect the 12-volt winding of our example transformer to the 8-ohm speaker connection of an audio power amplifier, the output voltage is about 10 times higher, and the impedance is roughly 100 times higher, or 800 ohms.

Just a little more arithmetic, and we're done. What is the impedance of the VHF signal-source power-supply connection? On the VHF signal source, the 12-volt connection to the multiplier and amplifier draws about 14 mA. Using Ohms Law, 12 volts divided by 14 mA is about 850 ohms. That makes it a very good match to a 12-volt transformer driven by an 8-ohm audio amplifier.

Finally, 14 mA from the DC power supply will be flowing through the winding connected to the VHF signal source, so we should measure the DC resistance. My transformer measures 27 ohms, which means I will have less than half a volt DC drop across the winding resistance. Note that AC impedance (about 800 ohms—when driven by 8 ohms) and DC resistance (27 ohms) of the transformer are significantly different. This interesting concept is worth pondering, even if you are a retired electrical engineer. It never hurts to review the fundamentals, and you will learn something from experiments with a simple AM transmitter whether this is your first project or your profession. Modulation transformers engineered to be as small as possible also take into account the DC flowing in the windings, but we minimize those issues by using a large transformer.

Now that we've looked at the block diagram and done the rough calculations, let's dig into the junk box and select some parts. To obtain the waveform shown in figure 2 we need a variable DC power supply and a transformer. The "ugly constructed" VHF signal source shown in photo C has the same schematic as the Kanga kit (it was one of the prototypes I built during development of that project.). The 12-volt filament transformer is an unmarked junk-box special. The black wires are a common color code for AC line voltage, and the green wires are for low voltage. I have designed and built a number of good audio power amplifiers, but the old Radio Shack power booster in the junk box already had a connector attached to plug into my iPod, which made testing very easy. Any audio amplifier with a microphone input and a speaker output will work. Generating a high-quality AM signal using junk-box components is in the finest traditions of amateur radio, and using parts you find in your own junk box gives your station the experimental pedigree.

For an example of a modern AM transmitter engineered to use currently available commercial components, I encourage you to study Dave Benson's Retro-75 transceiver kit available from Small

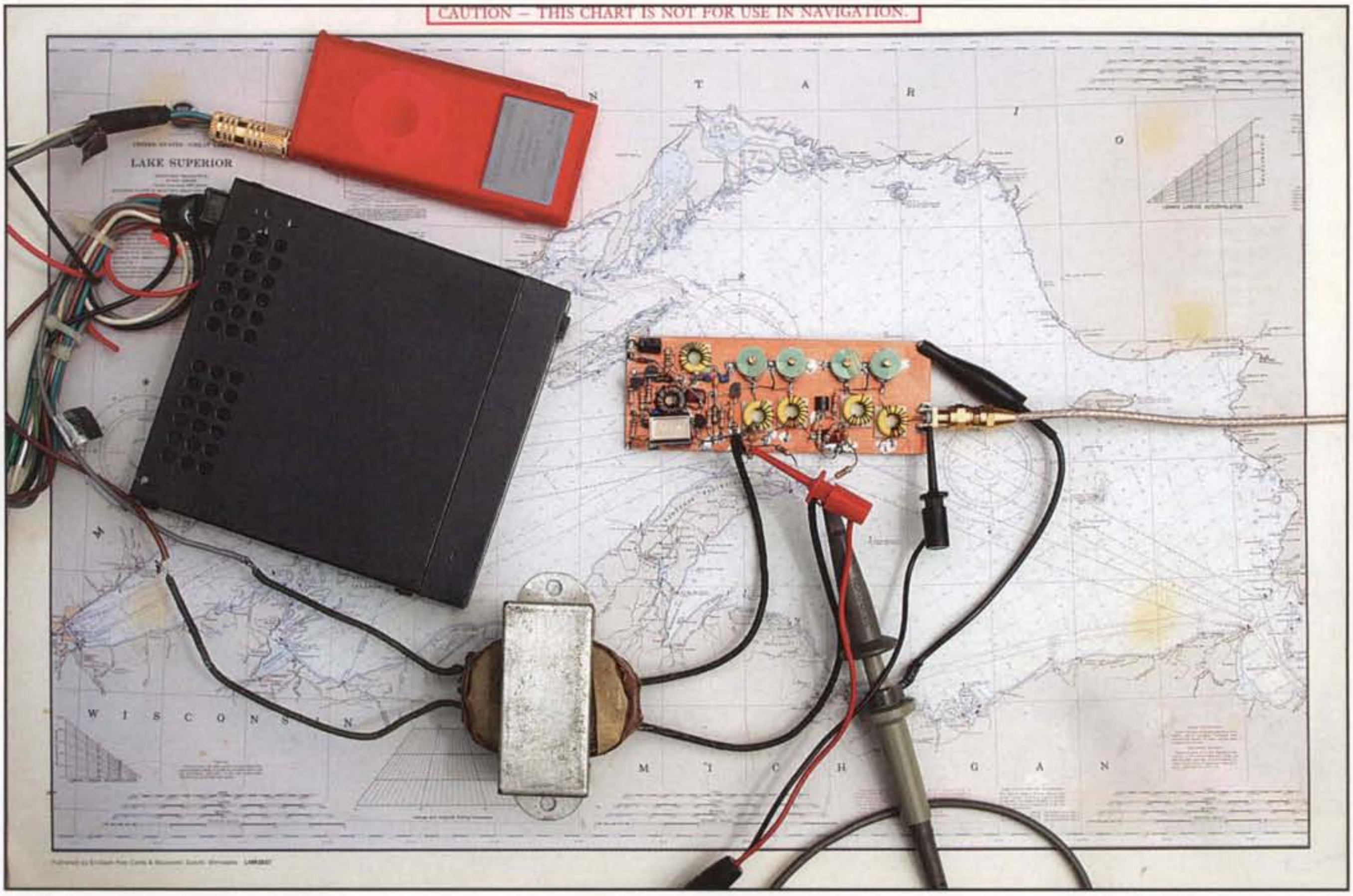


Photo C. The simple AM transmitter on the bench. Various test waveforms are stored in the author's personal audio device, making it easy to run tests without needing a dedicated audio signal generator.

Wonder Labs (<www.smallwonderlabs.com/>).

Figure 4 is the block diagram of a modulator power supply that may be used with any small solid-state CW transmitter. On my bench, the DC voltage is variable from 5 to 15 volts, and audio voltage is added with the audio power amplifier and 12-volt transformer. The lash-up on my bench is ideal for experiments, but once the desired DC voltage and audio power levels are found, a dedicated power-supply modulator may be built. For low-power battery operation, the appropriate number of AA cells can replace the DC power supply. You can test the audio system by talking into the microphone and listening on the speaker. That's what it will sound like on the air, when everything is working well.

Here is a review of some bits of old wisdom regarding amplitude modulation:

1. When designing a high-quality low-power AM transmitter, have more DC and audio power available than you need, and use a bigger modulation transformer than your calculations suggest.

2. Adjust the transmitter so the output looks good on an oscilloscope. If it looks good, it *is* good.

The first point is easy to explain. If audio power is inexpensive—a junk box Radio Shack power booster and 12-volt filament transformer—then the audio amplifier and transformer are loafing along and there is little distortion in the audio signal—like a high-fidelity audio system.

The second point is more subtle. Go ahead and do all those notebook calculations and equations, but the AM transmitter is actually optimized by looking at waveforms on the oscilloscope. Sure, the math can be even more fun than learning the code, but rough approximations do not mean poor performance. In the 1950s and '60s on VHF, AM was an experimenter's mode, and those stations sounded good.

The little 6-meter AM rig in photo C is a lot of fun on the bench and sounds very good on the air. It is just the thing for a couple of grandparents and kids communicating a few hundred yards with home-built rigs and dipoles on 6 meters, and the first contacts should involve lots of clip leads and open circuit boards. You don't need to wait for both stations to be built. One station could be a low-power all-mode battery powered rig such as a Yaesu FT-817. A few handhelds such as the Yaesu Vx7R include 6 meters AM. Perhaps someone in the local area has an interest in vintage 6-meter AM gear such as the Gonset Communicator. It all is good, and on AM, grandfather sounds like himself—not the octopus-head admiral on the rebel alliance cruiser from *Star Wars.*

Total output power from the modulated Kanga VHF signal source is less than 40 mW PEP, so you might want to add a linear amplifier. When a low-power AM transmitter like this one is followed by a linear amplifier, it is called "High Level Modulation of a Low Level Stage." It works very well, but with lower efficiency than might be achieved with other approaches. That is okay. Remember that when AM ruled the amateur VHF bands, transmitter power was regulated by DC input, not power output, so efficiency was critically important. Most VHF AM and SSB signals that sound exceptionally

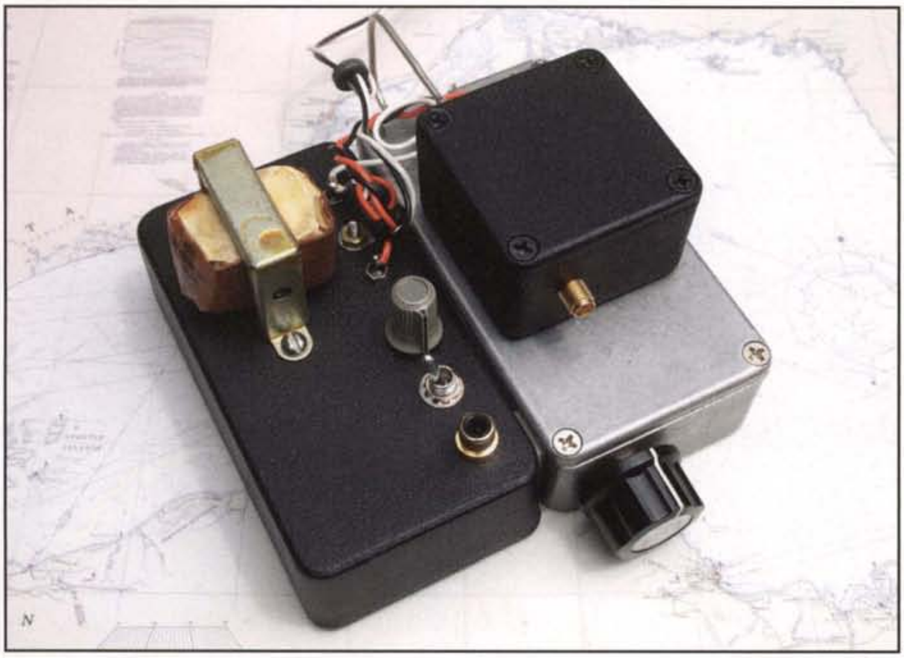


Photo D. After the experiments, the next step is to package the transmitter in a convenient form. This version is a 100-mW carrier or 400-mW PEP 2-meter AM transmitter using a 144-MHz VHF signal source, a simple two-stage class C RF amplifier, the audio amplifier from an R2pro kit, and a small transformer. The total DC power drain from the AA cell pack is less than needed to power the author's 10-mW SSB exciter. Below 1 watt output, AM can be more efficient to generate than SSB.

good sacrifice efficiency for signal quality. Efficiency is still a worthwhile goal, but at low power levels we can better save the planet by turning off the lights when we leave the room than by extensively re-engineering our transmitters.

High Level Modulation of a Low Level Stage has several advantages over the heavy iron transmitters of the past:

Since the linear amplifier provides both gain and high power output, we can adjust the modulated stage for a clean signal and good audio without worrying about a particular output power. Furthermore, those adjustments can be set once and then left alone, because the linear amplifier isolates the modulated stage from changes in antenna impedance. Finally, we can easily experiment with other modes by substituting a different low-power exciter at the input of the linear amplifier.

After the initial experiments, it is interesting to sketch and package a little rig that will work without clip leads. Photo D is a 100-mW 2-meter AM transmitter built using the principles described here. The silver box has a 144-MHz VHF signal source from Kanga. The small black box on top is a simple 100-mW class C amplifier with two 2N5179 transistors. The larger black box has a quarter-watt audio amplifier, with a small audio transformer mounted on top. A schematic and photograph of the 100-mW class C amplifier for 2 meters is on the VHFkits website. As a side note, the total DC power from AA cells for the 400-mW PEP 2-meter AM transmitter shown in photo D is less than the DC power needed for my 10-mW PEP 2-meter SSB exciter. At power levels less than 1 watt, AM can be more efficient to generate than SSB. If the signal strength is too weak to carry on an AM conversation, it is easy to key the carrier on and off. CW is a more effective weak-signal mode than SSB.

SSB, FM, and Digital Modulation

If you'd like to try generating an SSB signal, several approaches are covered in *Experimental Methods in RF Design*. An easy way is to use the Kanga microT2 SSB exciter PC board. For VHF, leave off the crystal oscillator, but include the buffer amplifier that drives the hybrid into the mixer. Notes on building a 6-meter SSB exciter using a VHF signal source and microT2 SSB generator are included on the Kanga VHF Kits web page. However, I encourage you to play with low-power AM first. It is easier, you will learn quickly, and you will be following in the technical footsteps of the generation of VHF amateurs who designed communications systems the astronauts used on the Moon.

FM also has its place, but that is usually in the hands of someone who needs to communicate without fiddling with dials, adjusting signal levels, or looking at an oscilloscope. FM works best with strong to moderately strong signals, so it is not a weak-signal mode, and not the best choice for the basic experiment of seeing how far apart two VHF stations can maintain reliable communications. Effective receivers for FM are more complex to build and understand that receivers for AM, CW, or SSB. However, the main reason experimenters avoid FM is that these days the likelihood of encountering another experimenter on FM is low. FM is fine for communications, but not so much fun for experiments anymore. That was not the case when the VHF bands were populated by technicians who ran converted commercial VHF FM gear, but those days seem to be in the past. Hmm . . . things are awfully quiet on 2 meters. I have an old Motorola receiver in the garage that would be compatible with a simple homebrew 10-mW 2-meter FM exciter and a small Yagi. ... The mode is not important as long as the soldering iron is warm, the brain is engaged, and the next generation finds it interesting.

As for digital modulation, with a few exceptions, digital communicators prefer appliance radios connected to appliance computers. The challenge is in the software. That can be interesting, but it's not a topic for this column. I'm sure it is adequately covered elsewhere.

In the next issue we will finish up this four-part series by combining all of these basic experiments into a few stations. The emphasis will be on simple, portable gear that can be taken to interesting locations with sandwiches, simple antennas, and a few tools to fix the little problems that can crop up when experimental gear is taken into the field.

Reference

1. *Experimental Methods in RF Design*, by Wes Hayward, W7ZOI, Rick Campbell, KK7B, and Bob Larkin, W7PUA. Published by the American Radio Relay League, copyright 2003– 2009, <www.arrl.org>.

Tips on Portable VHF Antenna Setups

We rovers and portable operators often lack a way of using a beam antenna for our outings. Here WB2AMU presents several setups that have worked for him.

By Ken Neubeck,* WB2AMU

In my article in the Spring 2010 issue of *CQ VHF* I discussed the viability of portable operations for VHF contests. In this article, I will describe some of the antenna setups that can be used for VHF portable operations, whether for contest work, grid hopping, or ordinary day-to-day portable operations.

Generally, there is no comparison between a well-put-together VHF station at home and one that is portable. However, portable operations have some major advantages for VHF, particularly during contests when a hilltop location can be selected. Hilltop locations are particularly effective for line-of-sight on the VHF bands, beginning with 6 meters.

Does a hilltop location or height make a difference with sky-wave-signals such as sporadic-*E*, aurora, and *F2* on 6 meters? In general, the answer is yes. However, in some cases the difference may not be that noticeable when signals are very strong during great conditions.

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Vertical Mag-Mount Antennas

A vertical magnetic-mount antenna on the car (for cars with metallic roofs) is a start for those who initially do not have any type of portable setup. Typically, the common size for a quarter-wave vertical that is used for the low end of the VHF bands

Photo A. This 1/4-wave vertical for 222 MHz is a simple antenna that is a baseline and takes the least amount of effort to set up. Different length antennas for 6 meters, 2 meters, and 432 MHz can also be used on the same mount through the use of an Allen key on the mounting piece. (Photos by the author)

Photo B. This photo shows the use of a telescoping tripod to mount a 3-element 2-meter Yagi on top of the author's car. This setup is good when the portable arrangement is in the middle of open space with no trees or other support available.

for weak-signal work is 56 inches for 6 meters, 19 inches for 2 meters, 12.5 inches for 222 MHz, and 6.5 inches for 432. I usually use a 220-MHz HT for my VHF contest efforts and find that a mag-mount vertical is far superior to a rubber-duck antenna. See photo A for an example of a 222-MHz vertical mag-mount setup.

The vertical is an omni-directional antenna with no gain in any direction. When conditions are strong on 6 meters with sporadic-*E* activity, many stations can be worked via this method. However, weaker stations may not be heard. A simple $^{1}/_{4}$-wave vertical antenna obviously cannot "hear" as well as a directional antenna, such as a 2- or 3-element Yagi. I was able to confirm this several times while listening on 6 meters when comparing my 3-element Yagi at home to a $^{1}/_{4}$-wave vertical on the car. The difference in signal reception is staggering at times, even with skywave signals such as sporadic-*E* because of the directivity of the beam. However, the vertical is at least an entry into the game, if you have nothing else. When conditions are marginal, the vertical shows its limitations.

However, one thing that the vertical has as its greatest advantage is that it has less wind resistance on the roof of the car. If you do a lot of driving, the vertical will be the type of antenna that you can put on the roof and not worry about it falling off at high speeds (if the installation is done correctly).

Portable Directional Antennas

A directional antenna such as a 3-element Yagi for 6 and 2 meters is generally small enough to be handled in practical terms and also can give you the most performance for the amount of effort it takes to raise it. However, that being said, there may be practical limitations for portable stations with regard to how high a directional-style antenna can be put up at some locations.

One solution that I came up with was using a telescoping tripod to mount a 3-element, 2-meter Yagi on the roof of my car (in a fixed portable situation). The beam gives more punch than a vertical for this band and the setup is fairly easy, as can be seen in photos B and C. This is partly because the antenna can be adapted fairly easily to the telescoping mounting bracket of the tripod.

I also have run a homemade 2-element Yagi for 6 meters using the telescoping tripod on the car roof setup as shown in photo D. Since the antenna setup is not really as high as it should be (6 feet above the car roof and about 10 feet from the ground), it will not have the same performance as a similar beam antenna that is situated higher.

Photo C. This closeup shows how the antenna can fit into the telescoping attachment of the tripod using bolts through the telescoping bracket. The author has yet to use this tripod for its intended use over the four years he has owned it.

For 6 meters, the vertical is a start and the beam on the roof is a better setup, but generally a more significant setup will be needed for more significant results. Therefore, unless you are going to a location with a trailer and a crank-up tower, such an improved antenna setup for 6 meters probably will consist of a base and a number of mast sections to hold a directional antenna such as a 3-element Yagi. Mast sections for this type of setup are still available from RadioShack in 5- or 10-foot sections as shown in photo E. However, to procure one, you may have to point it out in the catalog, as many people are not aware of these sections, which originally were used for on-the-air TV.

There are a couple of base styles that can be used to hold the mast sections. One style that has been used by portable stations consists of a plate that a car tire can drive onto to hold in it place. Another style that I use is an umbrella stand I modified by adding some concrete for weight

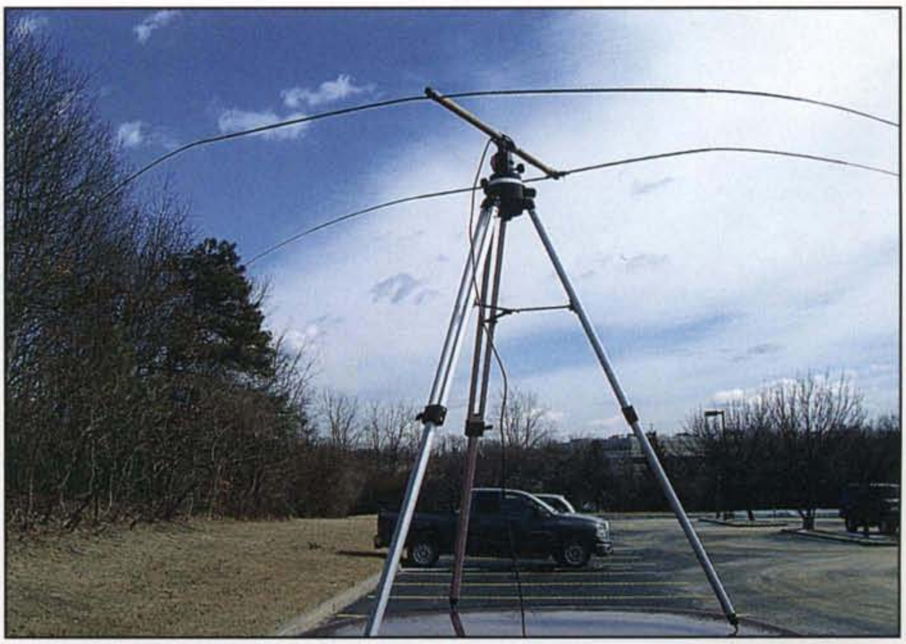

*Photo D. Here is the same telescoping tripod used to now mount a 2-element 6-meter Yagi on top of the author's car at one of his work locations a few years ago. This setup was suitable enough to work stateside stations via sporadic-*E *as well as some DX into Europe, with Italy being worked in June 2006.*

Photo E. The 6-meter setup that the author uses for his portable operations during VHF contests and other events. There is an umbrella stand with concrete added, the 3-element 6-meter Yagi, three 5-foot mast sections, and the six elements for the Yagi. Mast sections can be found at RadioShack, but some catalog searches may be required. Newer mast sections are painted in gray compared to yellow used in the past.

and better stability, as shown in photo F. With either of these setups, the maximum practical height for the antenna is on the order of 15 to 20 feet, as shown in photo G. Wind becomes a major factor, particularly on top of hills, and sometimes 10 feet may be the highest you can raise a directional antenna.

During the great sporadic-*E* 6-meter opening on the Saturday of the ARRL June 2006 VHF Contest, I was besieged by strong winds at my hilltop location in Long Island, New York and could only raise the 3-element Yagi 10 feet. However, the signals were very strong and I was able to work many stations, including double-hop skip into the western states and western Canada. I am sure that signals would have been a bit stronger given more height of the antenna, but when there are many strong signals present, it may not mean a heck of a lot at that point.

During the 2010 ARRL June VHF contest, there were several sporadic-*E* openings that occurred on 6 meters during the weekend. Many of these openings came in the form of waves where signals would be strong for a few minutes and then fade. This type of condition allowed for some interesting comparisons with the different antennas I have. In particular, I observed in terms of received signals that there was a significant difference with respect to a 3-element Yagi situated on mast at 15 feet or higher compared to a simple mag-mount antenna. The 2-element Yagi on the car roof provided more

Photo F. This is a view of the umbrella stand with concrete added and the first mast section installed. A piece of cloth held by electrical table is wrapped around the connecting area between the stand and the mast in order to stop movement during windy conditions. This base is not quite flat and so a wrench was placed underneath one side for more stability. Caution must always be exercised when considering how high an antenna can be placed. If it is windy, it is best to keep the height to 15 or 10 feet.

punch than the vertical mounted on the car, although not in the same league as a Yagi up higher than 15 feet. Either beam setup was more receptive of the signals a little longer than a vertical with regard to fading sporadic-*E* signals.

Typically, it takes five to ten minutes to set up the 6-meter antenna for which I use a homemade 6-meter beam on a 4-foot beam section that has to be assembled, in comparison to a ready-made 2-meter beam. As most of my portable locations are in parks and parking lots, my setups are not planned to be permanent, so there is both setup and teardown involved.

Photo G. This photo shows the three different portable antennas described in this article: the 220-MHz vertical positioned on the car roof, a 3-element 2-meter beam on a tripod positioned on the car roof, and the 6-meter beam mounted on mast sections off to the side of the car (at 10 feet in height due to strong winds that were present at the time in Long Island during the January 2010 VHF contest).

The feedline for these antennas can be brought into the car through the driver's side car door to a radio such as the Yaesu FT-100 or FT-857. Setups involving permanent mounting of radios in car consoles or on dashboards is another subject altogether. In my case, for portable or contest activity I usually place my FT-100 on top of the dashboard, with the feedline carefully routed so I do not get tangled up in it.

This article has provided a few ideas for portable setups. There are many more ideas out there, including commercial products such as the Buddipole™. Also, there are a lot of clever hams with some unique ideas as well. I even know of a Canadian ham who has a somewhat permanent 6-meter Yagi setup on top of his van and can point the van in the direction of the signals he hears.

The IDOLL Project

Because ATV columnist Tom Dean, KB1JIJ, is on assignment, his advisor for the Cadet Amateur Radio Club, Stephen Hamilton, KJ5HY, submitted the following article about using amateur radio for keeping track of the Boy Scouts who checked in to the West Point Scout Jamboree.

By Stephen Hamilton,* KJ5HY

Each year, the Cadet Amateur Radio Club provides communication support for the Boy Scout Jamboree at West Point. In the past, voice communication was all that was provided, and a few times packet radio was set up but the Cadet Scoutmaster Council never used it due to difficulty of use. This past year, the cadets in the ham club worked with the Scoutmaster Council to determine exactly what would be the ideal information to be shared between the check-in site at Camp Natural Bridge and the campsite at Lake Frederick, about a 2.5-mile hike over rough, mountainous terrain.

It turned out that for each troop that checked in, they needed to track the number of Scouts, number of adults, check-in time, camp site location, and license-plate number of their one vehicle allowed near the camp area. This seems like a small enough amount of data so that it *could* be transferred over packet radio.

The previous year a few tests were conducted to try and extend 802.11g wireless using highly directional "can"-tennas. Although they did extend the range greatly, it was proving to be too difficult to set up multiple bridges at each hilltop and find power to keep them running. The other potential way of making this work was the cell-phone data networks. However, at Camp Natural Bridge, where the check-in took place, there is no cell phone coverage. This brings the project back to the one digital communication that works in that area—packet radio.

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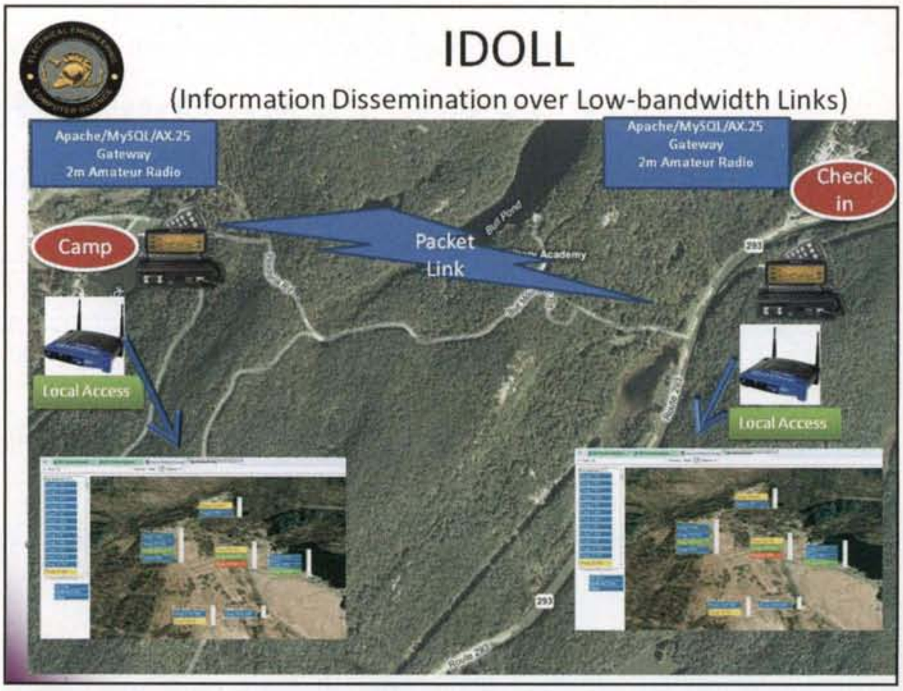


Graphic display of the IDOLL project.

In today's internet age where everything is web-based, it was only logical to determine how we could make a web-based system. After some initial tests, we determined that trying to send HTTP traffic over packet was impossible due to the delay and the amount of bandwidth required. Therefore, in order to solve this problem, we took a completely different approach—embrace the low bandwidth. Instead of trying to send web traffic, the solution was to send only the required traffic by having two websites that synced up their back-end data. Since MySQL is free and has a very efficient replication engine, it was the obvious choice for this application. In addition, Linux was chosen as the operating system, since it natively supports the AX.25 protocol.

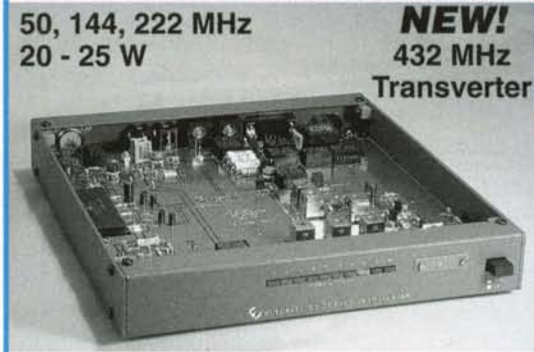
In the initial setup, the MySQL replication began working, but would stop suddenly. After a day of troubleshooting, it turned out that if the query or result was too long it would stop working. The problem came from an MTU size that was set too large by default. After reducing it, the replication appeared to work flawlessly in the classroom. Later, during testing at the campsite, it proved to work well even at 5 watts on 2 meters.

Once the proof-of-concept was finished, we built a simple website and used PHP to integrate it with the database. The initial setup worked. However, Cadet Thomas Dean, KB1JIJ, decided to take the whole project one step further. Instead of just a standard web page database form, he created a map that had the locations on it, and used a Javascript Abstraction Library called J-Query to create a professional-looking interface, and drag-and-drop capability with the troops. Once this was working, he realized one small issue: How could the remote site see a troop arrival without having to refresh the web page?

Initially this could be solved with a meta-tag refresh on the web page, but it turned out there was another way of solving this using Asynchronous Javascript and XML (AJAX). This is the same technology that Google uses to begin your search as you type before you hit the search button. Cadet Dean utilized this by writing a J-Query function call that automatically updates unit locations every ten seconds. Since the refresh only happens locally, and does not affect the packet link, several clients could be connected without this causing any performance degradation. The result was fantastic: Scoutmaster Council cadets at either end could see in near real time which units had checked in, and as they checked in the troop would show up on screen within ten seconds (plus packet transmission time) at their camp location. In addition, once a user rolled the mouse cursor over a troop, they found out all the information about that troop that was gathered during check-in, from the number of Scouts and adults to their car's license-plate number. This allowed the Scoutmaster Council to track which troops had arrived and which ones had not made it to their site following the hike.

This combination of packet radio technology and modern web techniques using AJAX potentially can be used for many other applications. One example is that once the Camporee system was in place, another test was performed by creating a small blog website with Ruby on Rails, and it maintained a perfect database synchronization as well. Based on this example, we believe that many off-the-shelf web applications that use MySQL can easily be set up for use over packet.

This goes to prove that even if a disaster prevented internet communications, amateur radio could still provide emergency communications that would provide web-based interfaces!



A Homemade Collapsible Parabolic Dish Antenna

For years KA2UPW/5 has been fascinated by umbrella antennas. Finally, his interest overtook his curiosity and he decided to build one. Here is the result of his creative use of an umbrella.

By Douglas D. Quagliana,* KA2UPW/5

Sometimes there is an idea that's just so neat, you have to build one and try it for yourself. For me, the idea of a parabolic satellite dish that would fold up and collapse like an umbrella was one such idea. Parabolic dishes aren't new, and there have been several umbrella-like parabolic dish designs over the years, but little has been written on making your own homemade collapsible parabolic dish antenna.

A long time ago, I visited the headquarters of a major news-reporting organization and got to see some of the satellite equipment that their reporters used while out in the field. Of particular interest was an umbrella-like satellite dish for sending and receiving voice and data signals via a commercial satellite service. While that was inspiring, there wasn't anything similar I could find that was both inexpensive and readily available for amateur radio use.

Several years later, I still wanted something that I could use to receive amateur radio satellite signals in the 2.4-GHz band. My 19-turn helix was working okay (11 dBic gain), but a parabolic dish would be better. However, I wanted something that I could carry around with me but wouldn't take up a lot of space. I really wanted something like a parabolic dish that would fold up so that I could just throw it into the back of the car for mobile and portable use. Since this would be for temporary setup and use, it wouldn't have to be a rugged metal dish, and it wouldn't have to withstand rain or temperature extremes.

A classic satellite dish is shaped like a mathematical curve, a parabola. A special feature of this particular curved surface is that when radio signals strike a surface with this shape, they will be reflected in such a way as to focus all of the energy from the whole surface into one point. This is similar to the way that you can use a magnifying glass to focus the rays from the sun onto an area smaller than the size of the magnifying glass. The curve is important. If the surface of your dish is flat, it will just reflect radio signals, but it will not focus the energy. If the surface is a perfect parabola, then it will perfectly focus all of the energy into a single point. However, if the dish surface is curved, and the shape of the curve is close to parabolic in shape, then it will still focus the energy, but not as well as a perfectly shaped parabola curved dish.

There is a difference in performance between the "perfect parabola" and something that is "close to parabolic." However, when using a larger diameter dish you still come out ahead with more than enough gain to make it all worthwhile. In my case, since I really wanted it to be collapsible, I was willing to sacrifice a little gain, and the results still measured better than my helix.

The Process

If you have something that is metallic and is almost parabolic, then you can put a small antenna at the focal point and use the combination as a parabolic-dish antenna system. The small antenna at the focal point is commonly called the "dish feed." It is usually chosen so that the radi-

Photo A. The thread that I used is J&P Coats metallic Knit-Cro-Sheen. A close inspection of the thread reveals it is composed of several fibers, one of which is actually silver-metallic in color. (Photos by the author)

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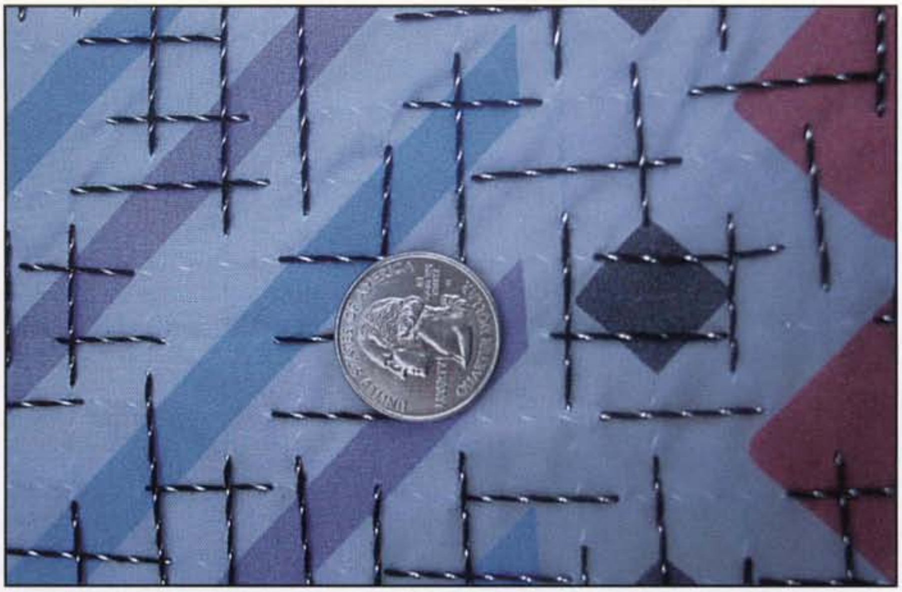

Photo B. One thing that is important is the spacing between parallel threads. The highest frequency I wanted to use was 2.4 GHz, so this works out to about half an inch between threads. Have some metallic thread about every half-inch that goes vertically and horizontally.

ation pattern of the small antenna placed at the focal point expands to fill the dish to the edges.

Backing up one step, if you have something that is almost parabolic, but not metallic, then you can try making it metallic so that you can use it as a dish antenna. For example, you could try covering it in aluminum foil. In a previous iteration of this project, I started with a plastic snow sled and covered it in adhesive aluminum tape obtained from the local hardware store. This worked, but the resulting antenna did not fold up.

Umbrellas, on the other hand, do fold up. However, you need to choose your future parabolic dish umbrella with some care. You want one that opens up to a large enough diameter, that has a non-metallic handle and pole, and that approximates a parabolic shape when fully opened. The non-metallic handle is possibly the hardest part. Look for an umbrella with a handle made of wood, carbon-fiber, or some kind of fiberglass. You can estimate whether it is a parabolic shape by measuring the sideways shadow cast by the dish on a wall or by holding it next to something that is known to be parabolic. In a pinch, grab something long and bendable, such as a wooden dowel or a yardstick, hold one end of it steady and pull at a 90-degree angle on the other end. The resulting curve is almost parabolic.[1]

After rejecting many umbrellas that wouldn't work (and a few expensive umbrellas that might have worked), I finally found one with a wooden handle in a discount merchandise store for the low, low price of only $4.00. It is adorned with a recognizable cartoon character, which led to a number of pun-filled (pun-derful?) jokes. It has some narrow metallic spreaders and spokes, but these are small and thin enough that they can be ignored.

The umbrella surface is actually cloth, which will not reflect radio waves. You could remove the cloth and replace it with something such as metal window-screen material and this will work, but the resulting dish won't fold up.[2]

Some more searching and further contemplating on the cloth led me to a craft store where I found metallic thread. The actual thread that I used is J&P Coats metallic Knit-Cro-Sheen. The label says "86% Mercerized Cotton" and "14% Metallic Yarn." It comes in a couple of colors. I chose black. A spool of 100 yards of size 10 metallic thread costs only a few dollars. A close inspection of the thread reveals it is composed of several fibers, one of which is actually silver-metallic in color (photo A).

In order to convert the umbrella into a parabolic dish, you just need to sew enough metallic thread into the cloth of the umbrella so that you reflect enough energy up to the focal point. There are a few tricks involved here, though. You want to sew or stitch the metallic thread into the fabric of the umbrella in two directions so that the threads go in both a vertical and horizontal direction. This creates a grid of metal for the reflector. The individual thread "lines" do not need to touch where they cross, and it doesn't matter if you go over or under at the intersection of

Photo C. The threads in different wedges are not parallel but appear rotated relative to the adjacent wedge.

the perpendicular threads. The size of the stitches doesn't matter either. I used a method that just has the thread go over the cloth of the umbrella for about an inch and then under the cloth for about an inch. There are no fancy knots or stitches.

One thing that is important, though, is the spacing between parallel threads. This should be less than one-tenth the wavelength of the highest frequency that you want to use with the dish. The highest frequency I wanted to use was 2.4 GHz, so this works out to about half an inch between threads. Don't worry if your threads are not exactly parallel, or your stitches aren't neat and straight. Just have some metallic thread about every half-inch that goes vertically and horizontally (photo B).

Photo D. Start with the umbrella locked in the open position.

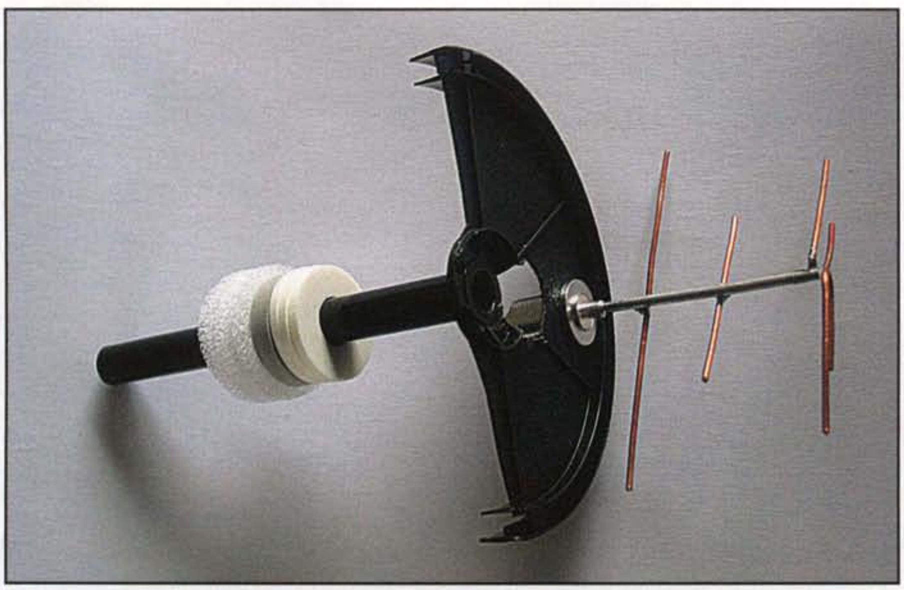

Photo E. As a quick hack for the antenna range at Microwave Update 2009, the antenna was mounted through a piece of plastic (half of the plastic base and the spindle from a stack of 100 DVDs with a hole for the umbrella handle) and held in place with a few rubber bands.

Sewing Method

I don't claim to know how to sew, but I will explain the method I used. Since the spreaders of the umbrella already divide the umbrella up into eight triangle-shaped wedges, I chose to work on one wedge at a time. This means that the threads in different wedges are not parallel but appear rotated relative to the adjacent wedge (photo C).

Start with the umbrella locked in the open position (photo D). Take an arm's length of thread on a needle; start near the center of the umbrella, and stitch one thread into the umbrella radially outward by just going over and under the umbrella cloth. This divides the wedge in half, right up the middle. When you reach the far edge of the cloth (the outer edge of the umbrella), just move over to the left a half inch, and start sewing inward parallel to the first thread. This thread line will be a little shorter, since it won't go all the way to the center of the umbrella. It will intersect one of the spreaders about an inch away from the center. When you get to the spreader, move a half inch to the left again, and go back up towards the outer edge. Repeat until you need more thread or until you finish the left half of the wedge. Then use the same sequence to add the threads to the right half of the wedge.

If you think of these as columns of thread, then the next step is to add the rows of threads at 90-degree angles to the columns. I found it easier to start near the center and work outward. Each row across is about half an inch farther from the center as the previous row. When you reach the farthest row from the center, nearest the edge of the cloth, then you can consider that wedge to be finished.

My umbrella has eight wedges. Sewing each wedge took between 45 minutes and an hour. While the work is monotonous, you can get it done by working on it a few minutes at a time, because it is very easy to stop and then pick up the work right where you left off.

Dish Feed

Lastly, a dish feed is needed. If the umbrella has a non-metallic handle, then you can use a number of different dish feeds. Originally, I used a simple three-turn G3RUH helix feed made of a piece of PC board as a reflector, an N connector, and a copper wire for the helix.[3] If you cut a hole in the PC board, then you can lower the helix into position and clamp the dish feed to the umbrella handle.

While the helix worked well as a dish feed, it wasn't mechanically strong enough to survive extended riding in a car. For the antenna range at Microwave Update 2009, I used a dual-band dish-feed design by Kent Britain, WA5VJB. (Kent writes the "Antennas" columns for *CQ* and *CQ VHF*.) The complete details of the dual-band dish feed are on Kent's website.[4] This same feed will let you use the dish on both 1.2 GHz and 2.4 GHz. Variations on the antenna let you optimize it for the terrestrial or satellite subbands of either band.

As a quick hack for the antenna range, the antenna was just mounted through a piece of plastic (half of the plastic base and the spindle from a stack of 100 DVDs with a hole for the umbrella handle) and held in place with a few rubber bands (photo E).

A few words of caution are in order here: A horizontal fully opened umbrella has a very large cross section and presents a large wind load even at slower wind speeds. The umbrella parabolic dish doesn't weigh much, and it doesn't take much wind to completely blow it away. Be careful and use adequate mounting techniques to make sure that your dish, dish feed, and radios are not blown away in the slightest breeze (don't ask how I know this.).

Conclusion

The measurements from the antenna range at Microwave Update 2009 came out to about 16 dBi of gain. This probably could be improved further by adding more metallic threads, adjusting the curve of dish to be more parabolic, and more carefully matching the illumination of the dish by the dish feed. However, 16 dBi gain is pretty good for a $4.00 umbrella and couple dollars of thread!

Notes

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2. Long, Howard. "A Brolly Dish for AO-40." http://www.g6lvb.com/brollydish.htm.

3. Miller, James, G3RUH. "A 60cm S-Band Dish Antenna." http://www.amsat.org/amsat/articles/g3ruh/116.html.

4. Britain, Kent, WA5VJB. "Dual Band Dish Feeds." http://www.wa5vjb.com/references/dualbanddishfeeds.pdf.

Parabolic Antenna Calculations

Calculating the dimensions of a parabolic dish can be duanting—unless one knows of a tool for making it easy. Here W3HMS and K4ITO use Excel to greatly simplify those calculations, which may help you construct an umbrella antenna. (See KA2UPW/5's article beginning on page 44 for information on doing so.

By John Jaminet,* W3HMS, and Curt Wann,† K4ITO

The charts in *The ARRL Handbook, The ARRL Antenna Handbook*, and on the F4DAY website have the calculations for common-size dishes and the formulas. The modern Excel spreadsheet just cries out to be used so that a microwave or EME operator can determine gain and ERP for various dish sizes and ERP power levels. This is very helpful for planning your station. It could also be helpful, after some modification, to permit economic analysis of the best tradeoffs/costs in additional dish size and/or power. We did not do the economic analysis here, but we mention the idea as food for thought for downstream use by someone.

Using the Spreadsheet

The following explains how to use the spreadsheet:

Use 1: Print completely and use as a printed document.

Use 2: Bring up this Excel spreadsheet and change the frequency, dish size in feet, or value of RF power at the feed. You can also change *k* for different feed efficiencies to see what the effect is with a different dish feed. These actions may answer the question of what the ERP will be with, say, 250 watts and a dish increase of 1 foot/meter?

The informal conclusion that $^1/_2$ foot increase equals $^1/_2$ dB increase is a simple "rule of thumb," at least on 23 cm. We note, as many will recognize, that a power increase does not increase the gain on receive, so a dish size increase may have more value than a power increase. Please note that we have addressed only round dish sizes often used by a ham. Others are invited to do the same for offset dishes.

The Excel spreadsheet is based on the dish size in feet, but this can be adjusted on any line by "cut and try" to yield a desired metric size—for example, 3.8 meters.

This Excel spreadsheet was developed using the following formulas obtained from the Paul Wade, W1GHZ, *Online Microwave Antenna Book,* Section 4. The authors would like to express their appreciation to Paul, W1GHZ, and to Rex, VK7MO, for their helpful suggestions for both this article and the Excel spreadsheet. The right-hand column, called "Beam Width at –3 dB," was suggested and programmed by Jean-Louis, F6ABX, with our warmest appreciation.

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The referenced Excel spreadsheet is obtainable by sending an e-mail to <W3HMS@aol.com> asking that it be attached. It is on the website of F1CHF, among others.

Assumptions Used

1. Antenna efficiency, *k*, is the standard 55%.
2. Frequency is 1296.050 MHz.
3. Dish in meters is feet times 12 inches divided by 39.37 inches/meter, rounded to one decimal place.
4. Wavelength in meters is 300 divided by the frequency in MHz.
5. ERP is CW key down with stated watts at feed.
6. SWR and reflected power loss occur before the stated power—e.g., 100 watts at the antenna feed point.
7. All round dishes should be 10λ (wavelengths) or more for the calculations to be valid. Paul nicely added a column to the Excel spreadsheet to show that anything less than this will show in red in both the printed and the on-screen versions. Note, for example, that 7.5 feet is 9.7λ.
8. That this Excel spreadsheet shows only the far-field ERP. Rex, VK7MO, kindly observed that it should therefore not be used for near-field calculations to meet EMR requirements.

Formula to calculate dbi gain, G_{dbi}:

$$G_{dBi} = 10 \log_{10} \left(\frac{k(2\pi r)^2}{\lambda^2} \right)$$

where:

k = efficiency

r = parabolic dish radius in meters

$$\lambda = \frac{\text{speed of light in meters}}{\text{frequency in Hz}} = \frac{3 \times 10^8}{F_{Hz}} = \frac{300}{F_{MHz}}$$

Formula to calculate dBd gain, G_{dBd}:

$$G_{dBd} = G_{dBi} - 2.1$$

Formula to calculate power gain factor, P:

$$P = 10^{\frac{GdBd}{10}}$$

W3HMS/K4ITO	EME		Round	Parabolic	Antennas	9-May-10			
Efficiency (55%)	0.55		NOTE: efficiency will be lower when Dish diameter less than 10 lambda						
Freqency in MHz	1296								
Wave length in M	0.23				dBd	dBd	dBd	dBd	Θ
					Input (watts)	Input (watts)	Input (watts)	Input (watts)	Beam Width
		Dish in			100	200	500	800	-3 dB
Dish in FT	Dish in M	Lambda	Gain dbi	Gain dBd	ERP (KW)	ERP (KW)	ERP (KW)	ERP (KW)	
1	0.3	1.3	9.7	7.6	0.3	0.6	1.6	2.6	53.2 °
1.5	0.5	1.9	13.1	11.0	0.7	1.4	3.5	5.6	36.0 °
2	0.6	2.6	15.6	13.5	1.2	2.5	6.2	9.9	27.0 °
2.5	0.8	3.2	17.6	15.5	1.9	3.9	9.7	15.4	21.6 °
3	0.9	3.9	19.1	17.0	2.8	5.6	13.9	22.2	18.0 °
3.5	1.1	4.5	20.5	18.4	3.8	7.6	18.9	30.3	15.4 °
4	1.2	5.2	21.6	19.5	4.9	9.9	24.7	39.5	13.5 °
4.5	1.4	5.8	22.7	20.6	6.3	12.5	31.3	50.0	12.0 °
6	1.8	7.8	25.2	23.1	11.1	22.2	55.6	89.0	9.0 °
6.5	2.0	8.4	25.9	23.8	13.1	26.1	65.3	104.4	8.3 °
7	2.1	9.1	26.5	24.4	15.1	30.3	75.7	121.1	7.7 °
7.5	2.3	9.7	27.1	25.0	17.4	34.7	86.9	139.0	7.2 °
8	2.4	10.4	27.7	25.6	19.8	39.5	98.8	158.1	6.8 °
8.5	2.6	11.0	28.2	26.1	22.3	44.6	111.6	178.5	6.4 °
9	2.7	11.7	28.7	26.6	25.0	50.0	125.1	200.2	6.0 °
9.5	2.9	12.3	29.1	27.0	27.9	55.8	139.4	223.0	5.7 °
10	3.0	13.0	29.6	27.5	30.9	61.8	154.4	247.1	5.4 °
10.5	3.2	13.6	30.0	27.9	34.1	68.1	170.3	272.4	5.1 °
11	3.3	14.3	30.4	28.3	37.4	74.7	186.9	299.0	4.9 °
11.5	3.5	14.9	30.8	28.7	40.8	81.7	204.2	326.8	4.7 °
12	3.6	15.6	31.2	29.1	44.5	89.0	222.4	355.8	4.5 °
12.5	3.8	16.2	31.5	29.4	48.3	96.5	241.3	386.1	4.3 °
13	3.9	16.8	31.9	29.8	52.2	104.4	261.0	417.6	4.2 °
13.5	4.1	17.5	32.2	30.1	56.3	112.6	281.5	450.4	4.0 °
14	4.2	18.1	32.5	30.4	60.5	121.1	302.7	484.3	3.9 °
14.5	4.4	18.8	32.8	30.7	64.9	129.9	324.7	519.5	3.7 °
15	4.5	19.4	33.1	31.0	69.5	139.0	347.5	556.0	3.6 °
15.5	4.7	20.1	33.4	31.3	74.2	148.4	371.0	593.7	3.5 °
16	4.8	20.7	33.7	31.6	79.1	158.1	395.4	632.6	3.4 °
16.5	5.0	21.4	33.9	31.8	84.1	168.2	420.5	672.7	3.3 °
17	5.1	22.0	34.2	32.1	89.3	178.5	446.3	714.1	3.2 °
17.5	5.3	22.7	34.5	32.4	94.6	189.2	473.0	756.8	3.1 °
18	5.4	23.3	34.7	32.6	100.1	200.2	500.4	800.6	3.0 °
18.5	5.6	24.0	34.9	32.8	105.7	211.4	528.6	845.7	2.9 °
19	5.7	24.6	35.2	33.1	111.5	223.0	557.5	892.1	2.8 °
19.5	5.9	25.3	35.4	33.3	117.5	234.9	587.3	939.6	2.8 °
20	6.0	25.9	35.6	33.5	123.6	247.1	617.8	988.4	2.7 °
20.5	6.2	26.6	35.8	33.7	129.8	259.6	649.0	1038.5	2.6 °
21	6.3	27.2	36.0	33.9	136.2	272.4	681.1	1089.7	2.6 °
21.5	6.5	27.9	36.2	34.1	142.8	285.6	713.9	1142.3	2.5 °
22	6.6	28.5	36.4	34.3	149.5	299.0	747.5	1196.0	2.5 °
22.5	6.8	29.2	36.6	34.5	156.4	312.7	781.9	1251.0	2.4 °
23	6.9	29.8	36.8	34.7	163.4	326.8	817.0	1307.2	2.3 °
23.5	7.1	30.5	37.0	34.9	170.6	341.2	852.9	1364.6	2.3 °
24	7.2	31.1	37.2	35.1	177.9	355.8	889.6	1423.3	2.3 °
25	7.5	32.4	37.6	35.5	193.1	386.1	965.3	1544.4	2.2 °
26	7.8	33.7	37.9	35.8	208.8	417.6	1044.0	1670.4	2.1 °
27	8.1	35.0	38.2	36.1	225.2	450.4	1125.9	1801.4	2.0 °
28	8.4	36.3	38.5	36.4	242.2	484.3	1210.8	1937.3	1.9 °
29	8.7	37.6	38.8	36.7	259.8	519.5	1298.9	2078.2	1.9 °
30	9.0	38.9	39.1	37.0	278.0	556.0	1390.0	2224.0	1.8 °
31	9.3	40.2	39.4	37.3	296.8	593.7	1484.2	2374.7	1.7 °
32	9.6	41.5	39.7	37.6	316.3	632.6	1581.5	2530.4	1.7 °
33	9.9	42.8	40.0	37.9	336.4	672.7	1681.9	2691.0	1.6 °
34	10.2	44.1	40.2	38.1	357.1	714.1	1785.3	2856.6	1.6 °
50	15.0	64.8	43.6	41.5	772.2	1544.4	3861.0	6177.7	1.1 °
85	25.5	110.2	48.2	46.1	2231.7	4463.4	11158.4	17853.5	0.6 °
150	45.0	194.4	53.1	51.0	6949.9	13899.8	34749.4	55599.0	0.4 °
1000	300.0	1296.0	69.6	67.5	308883.5	617767.0	1544417.4	2471067.8	0.1 °

Formula to calculate ERP:

ERP = kwP
where:
k = efficiency
w = power in watts
P = power gain factor

Example: Parabolic dish is 10 feet in diameter (radius r = 1.5 meters), power is 100 watts at the feed, and frequency is 1296.05 MHz.

$$G_{dBi} = 10\log_{10}\left(\frac{k(2\pi r)^2}{\lambda^2}\right) =$$

$$10\log_{10}\left(\frac{0.55 \times (2 \times 3.14 \times 1.5)^2}{\left(\frac{300}{1296.05}\right)^2}\right) = 29.6 \text{ dBi}$$

$$G_{dBd} = G_{dBi} - 2.1 = 27.5 \text{ dBd}$$

$$ERP = kwP = 0.55 \times 100 \times 10^{27.5 \div 10}$$
$$= 55 \times 10^{2.75} = 30890.7 \text{ watts}$$

Sources for formulas:
<http://www.sengpielaudio.com/calculatorVoltagePower.htm>
site provides a calculator to convert dB to watts
<http://www.mogami.com/e/cad/db.html>
site shows formulas to covert dB back to watts

CQ's 6 Meter and Satellite WAZ Awards

(As of July 1, 2010)

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	16,17,18,19,21,22,23,24,25,26,28,29,34,39
11	GØLCS	1,6,7,12,18,19,22,23,28,31
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	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
77	K5NA	16,17,18,19,21,22,23,24,26,28,29,33,37,39
78	I4EAT	1,2,6,10,18,19,23,32
79	W3BTX	17,18,19,22,23,26,34,37,38
80	JH1HHC	2,5,7,9,18,34,35,37,40.
81	PY2RO	1,2,17,184OM,19,21,22,23,26,28,29,30,38,39,40
82	W4UM	18,19,21,22,23,24,26,27,28,29,34,37,39
83	I5KG	1,2,3,6,10,18,19,23,27,29,32.
84	DF3CB	1,2,12,18,19,32
85	K4PI	17,18,19,21,22,23,24,26,28,29,30,34,37,38,39.
86	WB8TGY	16,17,18,19,21,22,23,24,26,28.29,30,34,36,39
87	MUØFAL	1,2,12,18,19,22,23,24,26,27,28,29,30,31,32
88	PY2BW	1,2,17,18,19,22,23,26,28,29,30,38,39,40.
89	K4OM	17,18,19,21,22,23,24,26,28,29,32,34,36,38,39.
90	JHØBBE	2,33,34,40
91	K6QXY	17,18,19,21,22,23,34,37,39
92	JA8ISU	2,7,8,9,19,33,34,36,37,38,39,40
93	YO9HP	1,2,6,7,11,12,13,18,19,23,28,29,30,31,40
94	SV8CS	1,2,6,7,18,19,23,26,28,29
95	SM3NRY	1,6,10,12,13,19,23,25,26,29,30,31,32,39
96	VK3OT	2,10,11,12,16,34,35,37,39,40
97	UY1HY	1,2,3,6,7,9,12,18,19,23,26.28,31,32,36

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
23	VR2XMT	01 May 06	2,5,8,9,10,11,12,13,23,34,40
24	XE1MEX	19 Mar. 09	2,17,18,21,22,23,26,34,37,40

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, P.O. Box 449, Wiggins, MS 39577-0449. 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>.

**P.O. Box 449, Wiggins, MS 39577-0449; e-mail: <n5fg@cq-amateur-radio.com>*

By Kent Britain,* WA5VJB

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Connecting the Radio to the Sky

Multiband Antennas

Multiband Yagi antennas are very common on the HF bands, so why not on the microwave bands? This time we have a family of easy-to-build small Yagis that can be used as low-gain antennas, but where they really shine is when used to feed a small dish such as the one shown in photo A.

The basic design is not all that different from an HF multiband Yagi. It's just that 20 years ago I was dragging a heck of a lot of equipment around to Central States VHF Society conferences. Marc, WBØTEM, did the 50–432 MHz portions of the antenna contests, and I did the 902-MHz and up parts. Well, with seven or more bands of antennas to test, I hauled a lot of stuff to the conferences.

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Photo A. Dish and a multiband feed. (Photos by the author)

I came up with a family of feeds for the 2-foot dish I used as my 3.4-, 5.7-, and 10.3-GHz source antenna. The feed shown in photo B allowed me to replace the 902-MHz and 1296-MHz loop Yagis I had been using as source antennas, and a smaller version took care of 2304 MHz.

While these simple feeds are not as efficient as a proper scalar feed, they are a lot easier to build and the second band is often very handy. Therefore, for portable operations do you want to haul two 2.5-foot dishes with scalar feeds, or just one 3-foot dish with a multiband feed? Or how about the multiband umbrella Doug Quagliana, KA2UPW, covers in his article in this same issue of *CQ VHF*? Now that umbrella, or any of other type of small dish, can be used on a variety of bands.

Construction

First, take a look at figures 1 and 2. The driven element is made out of bare #12 copper (2 mm) wire. I don't suggest a different diameter wire unless you have the test equipment to measure SWR on these bands. Changing the diameter will change the tuning. The reflector elements are made from 1/8-inch (3 mm) copper or brass hobby tubing. No. 10 and #12 copper wire has also been used to make the reflectors. I formed the driven elements by bending the wire around the shank of a screwdriver. You want the elements parallel and 1/4 inch (6.5 mm) apart measured from the center lines. For the boom I used 1/8-inch hobby tubing, the same as the reflector elements, but the 1/8-inch square hobby tubing is easier to work with.

The reflector elements are soldered to the boom and then soldered on one side of the driven element. Semi-rigid coax such as .141 works great, but Teflon versions of RG-58 can also be used. I haven't had very good luck with regular RG-58. Soldering it to the boom turns it into melted goo. However, the Teflon® types

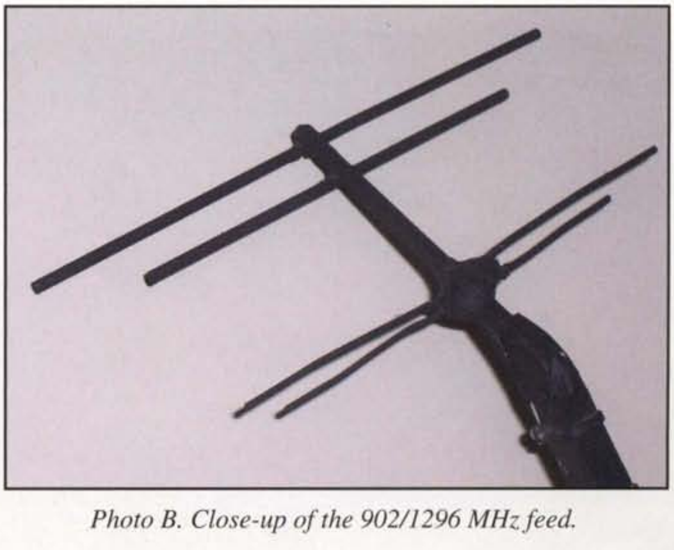

Photo B. Close-up of the 902/1296 MHz feed.

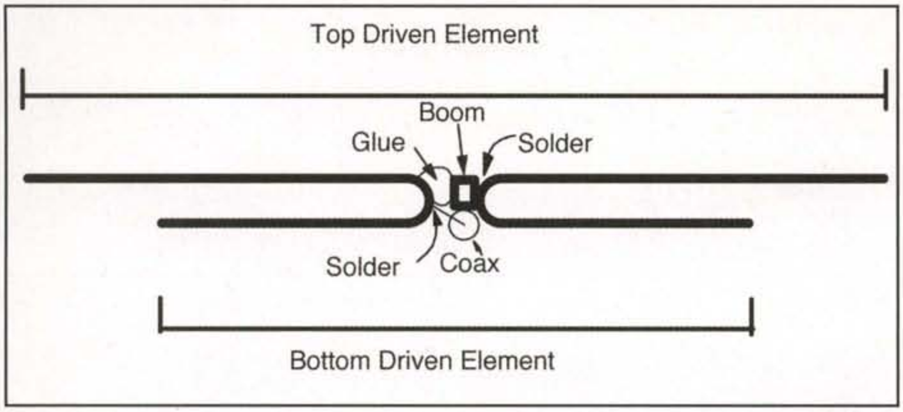

Figure 1. Length and position of the two driven elements on the multiband feed. (All figures by the author)

of coax solder work pretty well. After soldering the free end of the driven element to the center conductor of the coax, hold it in place with a drop of RTV/silicon glue, or my personal favorite, a construction adhesive such as Liquid Nails. The blob of glue does change the tuning a bit. I measured a 10-MHz shift at 2400 MHz, and this shift is already figured into the final dimensions in Table 1.

The antenna support can be metal or wood. In this example, the support is metal and runs to the bottom edge of the dish. The support can also be run back to the center of the dish. I wouldn't use more than one support unless you really think you need the extra strength. The extra struts just block part of the surface of the parabolic dish causing side lobes and lower antenna efficiency.

Tuning

Built to the dimensions, these feeds work pretty well. However, if you want that last fraction of a dB and have test equipment, then the ends of the driven elements can be trimmed for best SWR.

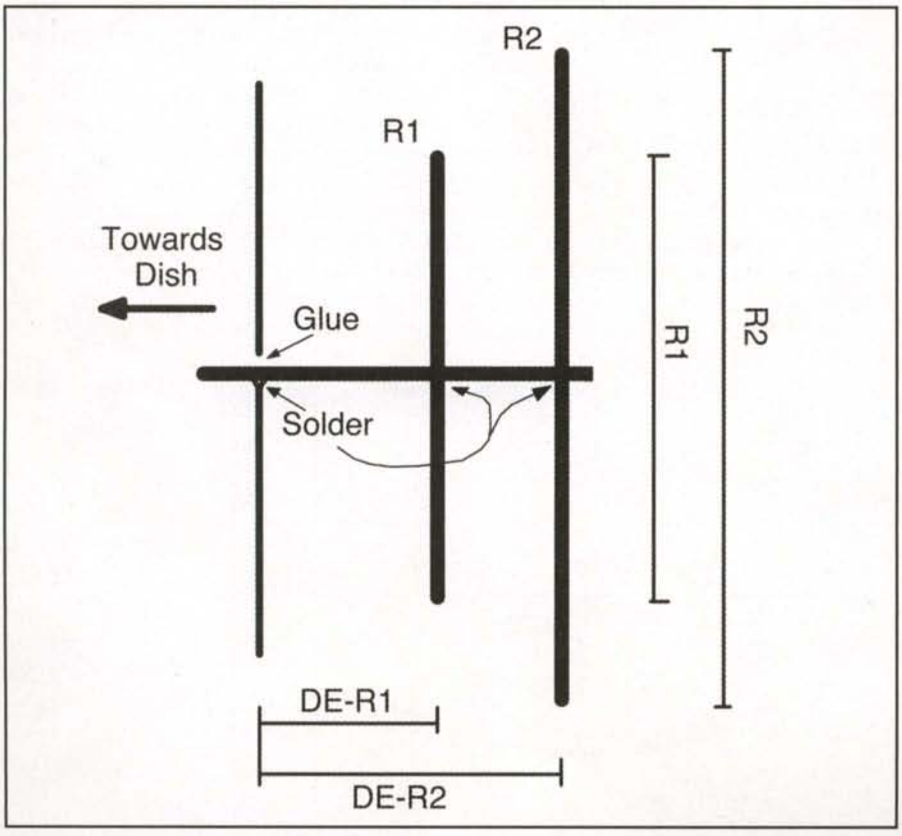

Figure 2. Relative size and position of the elements on the multiband feed.

Band (MHz)	Top Driven Element	Bottom Driven Element	DE-R1	DE-R2	R1	R2
902/1296	5.9	4.5	1.9	2.4	4.8	6.8
1296/2304	4.2	2.5	1.25	2.25	2.8	4.8
1269/2402	4.3	2.4	1.2	2.3	2.7	4.9
1296/1691	4.2	3.4	1.75	2.25	3.7	4.8
2304/3456	2.5	1.75	.80	1.25	1.9	2.6
Cell 800/1900	6.4	2.8	1.4	2.7	5.2	7.2
WiFi 915/2400	5.8	2.4	1.2	2.25	4.75	6.7

Table 1. Multiband Yagi dimensions (in inches).

Photo C. True edge of a parabolic dish.

It works best if you tune the low-frequency, or longest, part of the driven element first and then trim the high-frequency section.

Off Subject a Bit: The Focus of a Dish and f/D

The focus of a dish is calculated from the formula Focus = Diameter^2/16c, where c is the depth of the dish as shown in figure 3. Measure the diameter of your dish, and measure its depth as in photo C. Let's say you have a 24-inch dish and it is 4 inches deep. Then the focus would be (24 × 24)/(16 × 4), or 576/64, or 9 inches. You would want to mount the feed 9 inches from the back of the dish.

A very common mistake is to measure the diameter of the entire dish, not the part that is doing the work. As you can see in photo D, most dishes have a rolled edge. This area should not be part of your diameter calculation.

If the dish has a fairly polished surface, a quick reality check is to point the dish at the sun. If there is a bright spot in the middle of the feed, you're pretty close to the focus. This is a quick measurement unless you like your feeds well done. As a side note, back in the early days of TVRO satellite systems one of the lads I worked with was very good at working with sheet metal. He acquired a sheet-metal template such that when 12 of them were riveted together they formed a 12-foot parabolic dish. Being the good sheet-metal worker he was, he used aircraft-skin aluminum, which is very strong and nice shiny stuff. One evening he came home from work and no signal. He walked out to the dish and the LNA was black with the bottom of the feed completely melted off! The sun had aligned with the Clarke Belt and his big solar cooker had been cooking. Now you know why most commercial dishes are painted that flat white color.

For that last fraction of a dB, you really need to find the focal point by moving

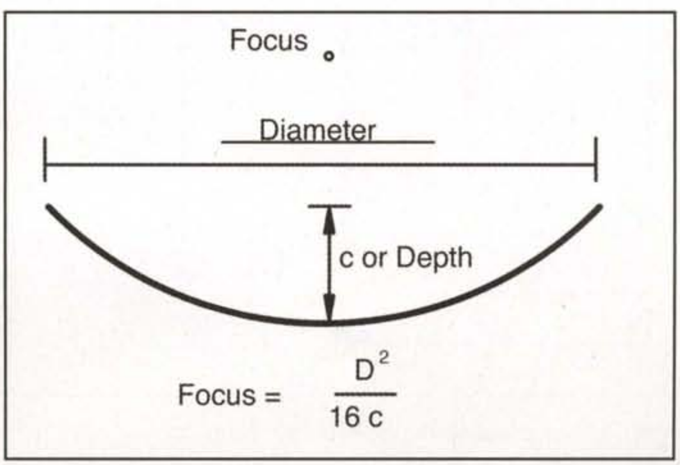

Figure 3. Calculating the focus of a parabolic dish.

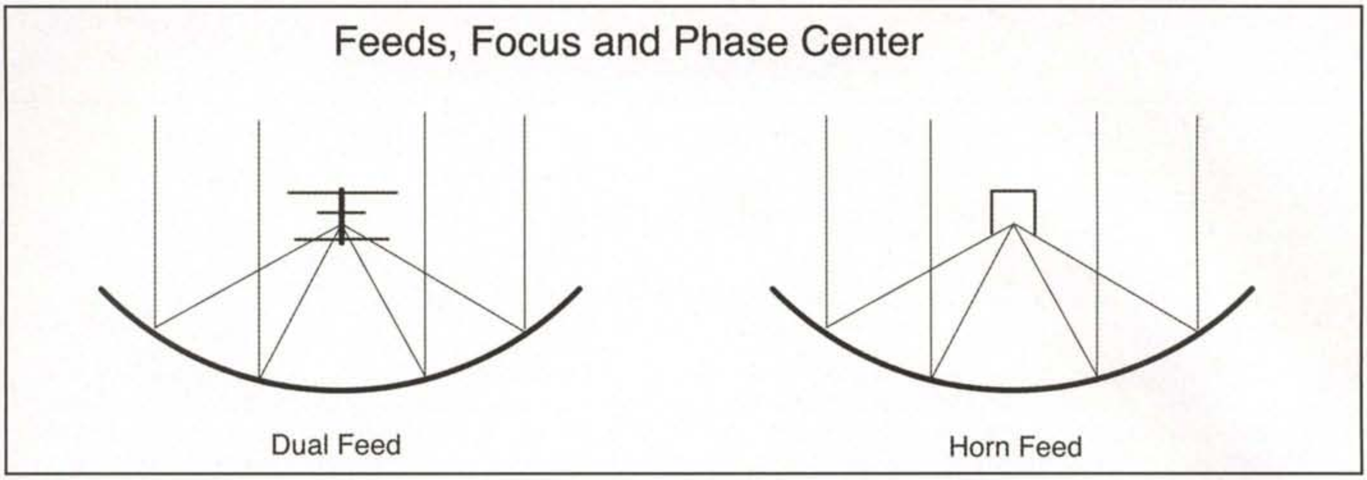

Figure 4. Relative position of the feed and the focus of the parabolic dish.

the feed in and out on an antenna range, but these calculations will get you pretty close. You want the "phase center" of the feed to be at the focus of the dish, not just at the edge of the feed (see figure 4). For the multiband feed this is about the center of the antenna; for horn type feeds the phase center is just inside the opening of the feed.

Now you have the numbers to look at the f/D (focus/diameter) of your dish. This value is very important in deciding what feed to use and for the ultimate efficiency of your parabolic dish antenna. For the last example, the f/D for this dish would be 9"/24", for a .375 f/D.

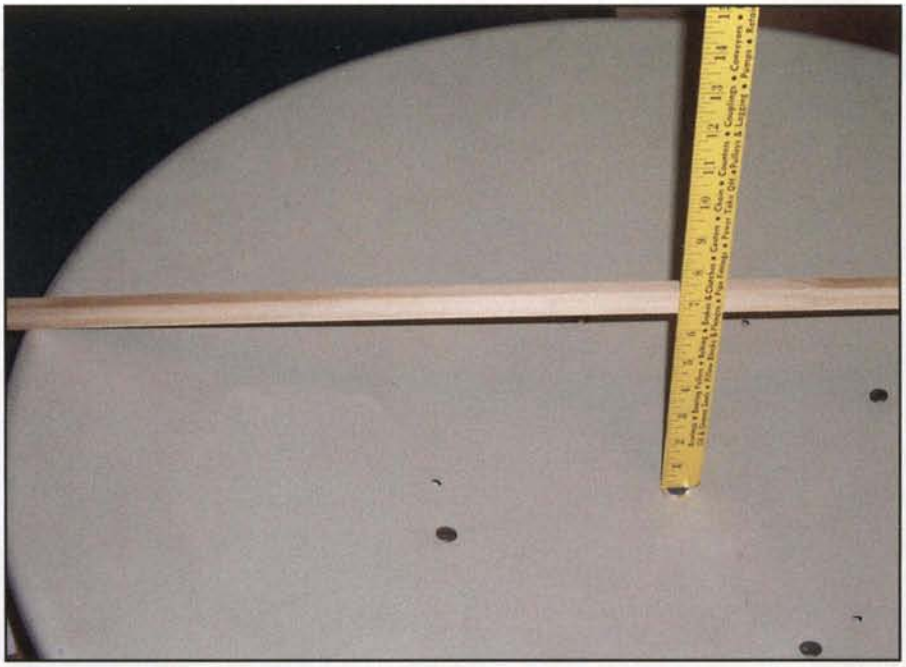

Photo D. Measuring the depth of a parabolic dish.

Use

This feed works best with deep dishes having an f/D of .3 to .35, but it will give good results with dishes having a f/D from .25 to .4. As a note, the satellite TV dishes have the feed *way* out in front. Their typical f/D is .7. Why you would want a .7 versus a .25 f/D can be the subject of many future columns.

The feed is a little more fragile than I would like. If you are mounting one outside for the long term, I would suggest some kind of cover or radome for it. The reflector elements seem to be the most likely to break off. Successful field repairs have been made with duct tape, twist ties, a super glue, cable ties, and even chewing gum.

As always, we like to hear from you if you have any antenna questions or suggestions for future topics. E-mail to <wa5vjb@cq-vhf.com> works, or even snail-mail to my QRZ.com address. You can also visit <www.wa5vjb.com> for additional antenna articles; look in the Reference section. 73, Kent, WA5VJB

By Joe Moell,* KØOV

HOMING IN

Radio Direction Finding for Fun and Public Service

Championship RDF Returns to the Woods of Ohio

"Let's play again!" A chorus of little voices clamored as Mike Minium of Orienteering Cincinnati (OCIN) went off to hide the transmitter once more at a preschool on the campus of Miami University in Oxford, Ohio. He was helping Dick Arnett, WB4SUV, on May 21, 2010, the first day of the Tenth USA Amateur Radio Direction Finding (ARDF) Championships.

These little tykes wouldn't be competing for medals, of course. The preschool just happened to be next to the parking lot where hams from around the country were gathering to test their equipment and prepare for two competition days that lay ahead. When my wife April, WA6OPS, went into the building to inquire about the availability of restrooms for the hams, the director was very interested in what we were doing out there. "Could the kids try it?" she asked.

Of course they could! After lunch and nap time, all of them assembled on the lawn. Dick told them about the sport of ARDF, which is also called foxhunting and radio-orienteering because it combines ham radio with map-and-compass navigation in the woods. He showed them a simple 2-meter Yagi antenna made from measuring-tape material[1] that makes it possible to home in on signals with a handie-talkie and an offset attenuator.[2] Then he let them try it for themselves.

They loved it! Hide-and-seek was never this much fun before. They kept asking that the transmitter be hidden one more time for them. When they are older and are able to hold up an antenna for a longer time, I hope there will be "Elmer" hams to teach them how to become truly proficient at the sport and to get their own ham radio licenses.

Buckeyes Host Again

This was the second time that hams from all over the country had come to the Buckeye State to strive for ARDF medals. The first time was in July 2003, with participants lodged in dormitories on the Miami University campus. This time the headquarters was in nearby Franklin, Ohio, with more participants from more states.

Championship ARDF events take place in large forests with up to five transmitters to be found by each hunter, depending on age and gender. The start and finish are in separate locations. Total distance from the start to each of the five transmitters in optimum order and then to the finish is typically three miles or more.

Of course the preschool kids didn't have nearly that far to go, just about a hundred feet on the big lawn, to find a transmitter that was on continuously. In the competitions to come, the five transmitters would be all on one frequency in a five-minute cycle. First #1 transmits for a minute, then #2 for a minute, and so on, with #1 returning to the air after #5.

The sport of all-on-foot transmitter hunting began informally about six decades ago in Europe. It gained popularity in so many countries that the first World Championships were organized in 1980. The five-fox cycle and other rules were established by a committee of the International Amateur Radio Union (IARU) to standardize the sport so it would be the same in all countries as hams trained for international events.

Besides being open to stateside residents, our national ARDF championships welcome visiting competitors from other nations. There are two sets of medals. Everyone competes for one set, while the

Are they future hams and ARDF champions? Dick Arnett, WB4SUV, took time away from his championships organizing duties to show the kids at a nearby day-care center all about finding radio transmitters. (All photo by Joe Moell, KØOV)

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Awaiting the signal to start out on the 2-meter course at the USA ARDF Championships in Ohio are three competitors in separate age categories: Jay Hennigan, WB6RDV (M50), Leszek Lechowicz, NI1L (M40), and Bob Cooley, KF6VSE (M60).

other is just for USA's competitors. Gathering in Ohio on that cloudy Friday were radio-orienteers from 15 states plus representatives from Australia, Canada, Germany, and Sweden. Out on the campus were three 80-meter CW "fox" transmitters and three more on 2-meters AM[3] in a "model event" for practice and equipment testing.

For sixteen of these people, this was their third day of practice. On Wednesday and Thursday, the event organizers had staged an optional "training camp" for both newcomers and experts. The beginners' first session was all about ARDF equipment, how it works, and how to use it. Since the ability to navigate in the woods is just as important as direction-finding skill for success in ARDF, there was a session on topographic map reading and compass use. That was followed by an orienteering session in which participants had to go out and find flags that were marked on the map, with no radio gear.

The rest of the training camp was filled with 2-meter and 80-meter international-rules foxhunts, including short courses with low-power foxes and long ones with full-powered transmitters. It was a chance to become proficient in finding transmitters while navigating from the start to finish locations on a map in an unfamiliar forest. The large number of wooded areas that have been mapped by OCIN made it possible for camp students to hunt in four separate sites, one in the morning and one in the afternoon of each day.

With all of this training, nobody became lost in the woods this year. However, more than one person had trouble just driving to the training venues. According to Matthew Robbins, AA9YH, "We are definitely not on a grid system. The roads in southwest Ohio are at the mercy of the rivers and streams. It's easy to get confused. For example, we have highways numbered 126, 127, 128, and 129, all intermingled."

The organizers thoughtfully provided addresses for each site that could be entered into vehicular navigation systems. Taking GPS devices into the woods to help find your way isn't permissible in ARDF championships, but GPS was quite helpful for getting to the gathering point each day.

It takes a lot of work to organize and stage the national ARDF championships, starting with site selection. Radio-orienteering venues must be of sufficient size to meet the transmitter separation requirements of international rules. Standard orienteering maps must be available and permission to use the land must be obtained. After that come the details of finding lodging, publicizing, and registering the attendees.

Most of the volunteers who put on this year's championships were experienced, having done it in 2003 in the same region, but different woods. Heading up the effort were Bob Frey, WA6EZV, of Cincinnati, Ohio and Dick Arnett, WB4SUV, of Erlanger, Kentucky. Both of them have collections of medals earned at previous USA championships and each represented the USA at the World Championships in 2000, 2002, 2004 and 2006.

Many helping hands are needed to verify the maps, assemble competitor packets, staff the start and finish areas, and so forth. Stepping forward to assist were members of the OH-KY-IN Amateur Radio Society, Butler County VHF Association, and OCIN. Coming from California to operate the electronic scoring system[4] was Marvin Johnston, KE6HTS, of the Los Angeles Orienteering Club.

Both WA6EZV and WB4SUV wanted to compete this year, too, so they figured out a way to make that possible. Bob teamed up with Brian DeYoung, K4BRI, to plan and execute the 2-meter event on Saturday. Dick, who was told nothing about this course, ran that day with all the other competitors. Sunday's 80-meter course was laid out and set by WB4SUV and AA9YH, allowing WA6EZV to compete on that day.

As participation in ARDF has grown around the world and the ham population has increased in average age, IARU has increased the number of age categories. With this year's addition of categories for men over age 70 and women over 60, there are a total of 11. The pre-registration list for our championships in Ohio included at least one person in every category.

Slogging Through Hueston Woods

After finishing his demonstration of ARDF for the preschool kids on Friday afternoon, WB4SUV went out to pick up the model event transmitters on the Miami U campus. It was then that the skies opened up. Torrents of rain and hail buffeted the area for several hours. By the Saturday morning starting time of the 2-meter contest at Hueston Woods, the skies were cloudy, the trails were extra muddy, and the humidity was high.

Hueston Woods State Park is about four miles east of the Ohio-Indiana border near the town of College Corner. The name came from Matthew Huestion, who purchased the land and established a farm in 1797. The state of Ohio bought it in 1941 and built a dam across Four Mile Creek in 1956 to form Acton Lake. Most of the lakeshore is now a vacation playground for swimming, boating, camping, golf, and hunting in the warm months, as

Ruth Bromer, WB4QZG is a long-time orienteer who went to her first ARDF championships last year in Massachusetts. She won gold medals on both bands this year.

Skidding to a halt at the 2-meter finish line is Paul Gruettner, WB9ODQ. After years of enjoying mobile transmitter hunting, he tried radio-orienteering for the first time at the USA championships in 2007.

well as cross-country skiing and ice fishing in the winter. Fossil collectors come from around the world to find the remains of ancient marine animals preserved in the dolomite limestone.

Fortunately, part of the eastern shore is undeveloped. The area mapped by OCIN along that shore makes an ideal ARDF location. Our gathering point was next to the main lodge and competitors started on the eastern edge.

To provide adequate detail of the terrain, the maps for both competition days were on 11 × 17 inch paper. Competitors received them ten minutes before their scheduled start times. They could fold them or mount them on a flat surface if they wished. Large map boards made from discarded political campaign signs were provided for those who wanted them.

In accordance with IARU rules, competitors are individually timed. They start out on the course in groups at five-minute intervals, with the starting horn coinciding with fox #1 coming on the air. No two people in a group are in the same age/gender category, and since each category has a different set of three, four, or five foxes to find, there are no follow-the-leader problems.

The order of starting had been determined by a drawing and announced at a meeting of all the competitors on Friday evening. Also at that session, Bob and Dick reviewed the rules and procedures for everyone. Participants also learned about potential hazards in the Ohio woods—no poisonous snakes, but there might be bears. Each person was given a commemorative coffee mug.

As it turned out, the biggest danger was the wet conditions. Besides mud all over their shoes, competitors crossed the finish line with mud on their knees, backsides, and faces as evidence of the unsure footing. Fortunately, there were no serious injuries, but WA6OPS was ready at the finish line with first-aid supplies, just in case.

Watch Your Watch

ARDF scoring is primarily by number of transmitters found and secondarily by elapsed time. There is a time limit— three hours at this event—after which a contestant is disqualified. That makes it important to keep track of your time on the course. If you have found all but one of your required transmitters and time is getting short, you have a decision to make. Do you go to the finish and be listed after all those who found all the foxes for their category, or do you press on for that final fox and risk losing it all by being a few seconds or minutes over the limit?

Bryan Ackerly, VK3YNG, of Ferntree Gully, Australia didn't have to worry about being overtime. His marathon training made him the fastest of the day, finding all five 2-meter foxes and getting to the finish in an hour and 24 minutes. Bryan turns age 47 this year, so he could have competed in category

You could say that Bryan Ackerly, VK3YNG made a big splash at the USA Championships. His elapsed time for finding all of the 2-meter transmitters was the best. In this picture, he's crossing the creek just before the finish line of the 80-meter event, where he placed second.

M40 and only have to find four of the transmitters. "No way," he told me. "I'm not flying all this distance just to leave an unfound fox in the field."

On that day, Bryan finished 20 minutes ahead of 25-year-old Ian Smith of Somerville, Massachusetts. This was Ian's second year of competition and his training under ex-Russian expert Vadim Afonkin, KB1RLI of Boston has already made him one of our country's best. Ian was determined to take the overall gold from Bryan in the upcoming 80-meter event.

Stateside hams won almost all of the other overall gold medals in categories for men on 2 meters. Addison Bosley, KJ4VCV, of Erlanger, Kentucky was first in M19; Matthew Robbins, AA9YH, of Cincinnati, Ohio got the gold in M40; and George Neal, KF6YKN, of Maspeth, New York was best in M50. Two years ago, George became the second Team USA member to capture a medal at the ARDF World Championships.[5] Longtime orienteer Bob Cooley, KF6VSE, of Pleasanton, California won first in M60.

No Americans competed in the new category for men over age 70. That 2-meter gold went to Per-Axel Nordwaeger, SMØBGU, of Bromma, Sweden. P-A was course-setter of the 1994 World Championships in Stockholm, and he is still a leading competitor for his country as he turns age 72 this year.

In the categories for women, 2-meter overall gold medals were captured by Lori Huberman of Cambridge, Massachusetts (F21); Susanne Walz, DG4SFF, of Reutlingen, Germany (F35); Judy Taylor, WD8EOP, of Huntington, West Virginia (F50); and Ruth Bromer, WB4QZG, of Raleigh, North Carolina (F60). USA gold in F35 went to Jennifer Harker, W5JEN, of Austin, Texas.

Sunday's 80-meter event was in the Miami University Natural Area, just northeast of the main campus. It's a patchwork of developed and undeveloped parcels with plenty of trails. WB4SUV and AA9YH decided to spice up the contest by placing the finish corridor through Harker's Run, a creek that bisects the mapped area from north to south. The recent rains had doubled the water volume in the creek that day, but it was still crossable and a good way to wash the mud from pants and shoes.

Eighty-meter signals aren't reflected from hills and wet trees like 2-meter signals can be, so bearings are much more precise and competitor times are usually better. The five-fox course time of Ian Smith, just 53 and a half minutes, was amazing. It was 15 minutes faster than the excellent time of second-place VK3YNG.

With AA9YH not competing in the M40 category because he designed the course, the overall gold went to Matthias Kuehlewein, DL3SDO, of Tuebingen, Germany, followed by USA gold winner Leszek Lechowicz, NI1L, of Bridgewater, Massachusetts. All other category gold winners were the same as on 2 meters except F50, for which no medals were awarded.

USA's best radio-orienteers in these competitions and the ones near Boston last year are receiving offers to join ARDF Team USA to compete at the Fifteenth ARDF World Championships on the coast of Croatia in September. The roster isn't firm as of this writing, but our team's trip will be a topic for my next "Homing In" column.

All of the organizers and volunteers deserve a hearty "Well done!" for their efforts in putting on this year's USA ARDF Championships. Full results for both competition days are in files for downloading at the championships website.[6] Many more photos are in my "Homing In" website.[7] I am already discussing sites and dates with groups that might organize the USA championships in 2011 and 2012. If your club is interested in hosting an event like this, please contact me.

Mark that Foxbox!

Just after noon on April 19, 2010, two police volunteers were flagged down in a parking lot in Anaheim, California, just three miles from my home. They were asked to report a blue sedan containing two men that had pulled into a corner of that lot. One of the men had gotten out, walked over to a light pole in the corner, and opened the hatch at the bottom. Then he had taken a small container out of a canister, placed it in the bottom of the pole, and put the cover back on.

The report was made, and minutes later about a dozen fire trucks converged on the lot. A nearby bank and two other businesses were evacuated, then the bomb squad's high-tech equipment went to work. It was not until 5 PM that the little package in the base of the pole was opened. Inside was a note that read, "Congratulations, you found it."

The container was merely one of over 78,000 geocaches that have been set out here in California. News reports don't tell if the persons who put it into the pole were located. A police spokesman said that no laws were broken, but it was unfortunate that so many people had to be inconvenienced and so many resources had to be expended in this investigation.

This incident prompted the Orange County Intelligence Assessment Center to issue a training bulletin to law enforcement agencies and private security companies explaining geocaching and the behaviors of those who participate in it. The bulletin mentioned "mugglers," who are non-geocachers that sometimes steal or alter the caches. Hiders often scout an area for mugglers before setting out a cache, which can lead to reports of suspicious activity, according to the bulletin's author.

The bulletin made no mention of ham radio transmitter hunting. Weekend mobile hunts have taken place for decades in southern California, so most sheriff and police officers have encountered our vehicles with strange antennas. However, they are less familiar with the miniature transmitters that have become popular for both mobile and on-foot hunts.

Could this happen to your unattended hidden transmitter? Would its antenna make authorities even more concerned? Sometimes it adds fun to camouflage a transmitter to make it harder for foxhunters to identify it, but any foxbox should be marked to plainly show what it is.

One of the photos shows a 2-meter transmitter for this year's USA ARDF championships, housed in PVC pipe and fittings. A prominent label tells what it is. The sentence about monitoring may discourage someone from stealing it, but it doesn't take the place of a bicycle chain or similar lockdown. In addition, the markings should include the cell-phone or pager number of the owner so authorities have an immediate contact.

The 2010 USA Championships took place during the 13th annual CQ Worldwide Foxhunting Weekend. If you weren't walking or running in the forests of southwest Ohio, then I hope you were participating in a transmitter hunt around your home town. I am getting results and photos of Foxhunting Weekend activities from around the country and I'm starting to compile them, so if you haven't sent yours in yet, please do so. My full report with your input is planned for an upcoming issue of *CQ* magazine. Some of the photos might end up here in *CQ VHF*, too.

73, Joe, KØOV

Notes

1. http://www.homingin.com/equipment.html
2. http://www.homingin.com/joek0ov/offatten. html
3. AM with tone-modulated Morse code is the international standard for ARDF transmitters on 2 meters.
4. http://www.homingin.com/epunch.html
5. http://www.homingin.com/korea08.html
6. http://www.usardf2010.com
7. http://www.homingin.com

At the award ceremony on Sunday afternoon, Ian Smith (at right) received medals for posting the fastest times of all the USA competitors on both 2 meters and 80 meters, presented by Dick Arnett, WB4SUV. Looking on from behind is 12-year-old Addison Bosley, KJ4VCV, who won gold medals on both bands in the category for males under age 20. Addison is Dick's grandson.

This is one of the USA championships' 2-meter AM fox transmitters before attachment of the turnstile antenna rods. Note the prominent label to allay suspicions and discourage theft.

By Bill Brown,* WB8ELK

UP IN THE AIR

New Heights for Amateur Radio

Huntsville, Alabama Field Day Balloon

To celebrate the start of Field Day 2010, I hitched a ride on the weekly ozonesonde that is launched every Saturday at 1:00 PM from the National Space Science and Technology Center (NSSTC) building in Huntsville, Alabama (photo 1). In addition to my 2-meter FM transmitter, members of the Makers Local 256 club flew a cell-phone GPS tracking experiment to see how it compared to using amateur radio systems.

After running the flight path prediction, I told the Huntsville Amateur Radio Club that their Field Day site near Integraph in Madison was my target and I was going to try to land everything right smack dab in the middle of their location.

Multi-Mode GPS Tracker

I flew the latest version of my multi-mode tracker on 144.34 MHz FM sending out DominoEX22, 300-baud ASCII RTTY, Hellscreiber, and CW (photo 2). In order to keep things as lightweight as possible, I didn't put the 250-milliwatt amplifier section onto my tracker board and just attached a quarter-wave wire whip (supported by soda straws) directly to the output of the synthesizer chip for a whopping 8 milliwatts of output power. Total weight including the built-in Inventek GPS, four AA lithium batteries, duct tape, and three layers of bubble-wrap insulation was 4.5 ounces. The Multi-Mode Transmitter (MMT) is frequency agile and can be programmed to just about any frequency from 1.6 MHz up to 160 MHz. It has a built-in Inventek GPS receiver and a small helical GPS antenna which makes for a very lightweight single-board balloon tracker. In addition to DominoEX (my favorite balloon telemetry mode), it can transmit RTTY, Hellscreiber, CW, and in the near future APRS. MMTs are available from: <www.elktronics.com>.

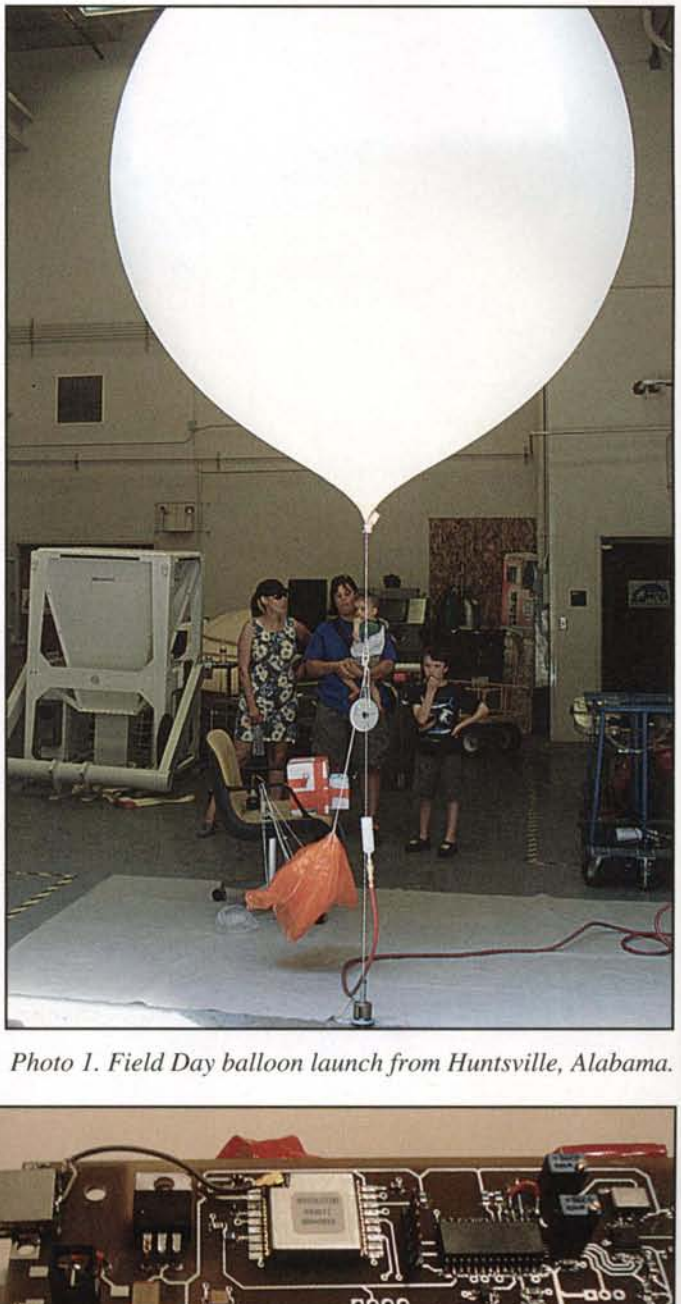

Photo 1. Field Day balloon launch from Huntsville, Alabama.

SpaceNear Tracking Map

I had two ground stations set up about 20 miles apart (as well as in my car) to receive the DominoEX and 300-baud ASCII RTTY telemetry and decoded it via a modified version of FLdigi (called dl-FLdigi), which sends checksum validated telemetry data directly to a server in the UK which plots the positions onto the <http://spacenear.us/tracker> Google map display. The SpaceNear tracking map is a project done by James Coxon M6JCX, Robert Harrison, 2EØRJH, Ed Moore, MØTEK, Alexei Karpenko, and other members of the UK High Altitude Society (UKHAS) as well as the Cambridge University Space Flight (CUSF) group. It is programmed specifically to track high-altitude balloon flights. They have modified W1HKJ's popular FLdigi soundcard digital-mode decoding program to allow it to send bal-

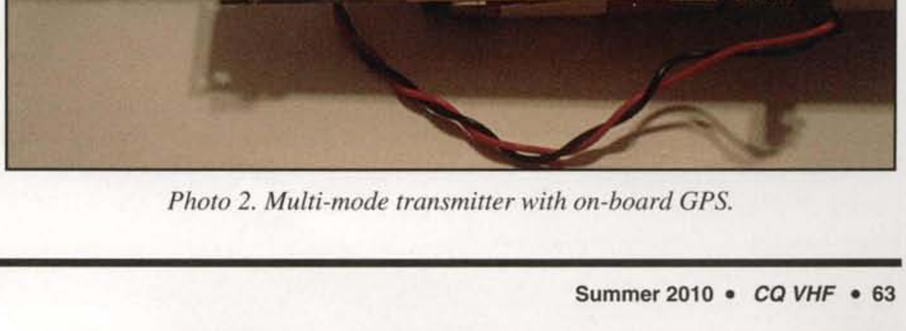

Photo 2. Multi-mode transmitter with on-board GPS.

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loon telemetry that it receives directly to their server to plot onto a Google map. Sidebar fields show various parameters such as battery voltage, altitude, and temperature. A chart of the altitude versus time is also plotted below the map. During the ascent portion of the flight, it shows a weather-balloon icon and during the descent stage it shows a parachute. In addition, it now shows the predicted landing spot in real time. You can download the balloon modified version by doing a Google search on "dl-FLdigi." Photo 3 shows the actual flight-path map of our Field Day 2010 flight as decoded by my two ground stations and my mobile unit and displayed on the NearSpace.us tracker.

Ground Zero Huntsville Field Day Site

The balloon stayed over Huntsville during most of the flight due to very light

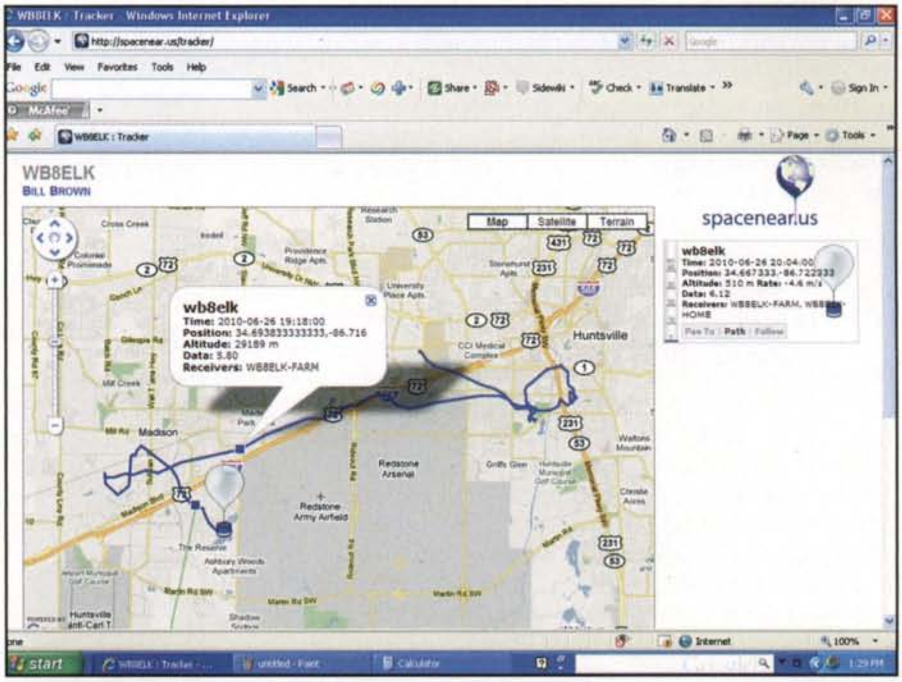

Photo 3. NearSpace.us online tracking map of the flight.

Photo 4. Watching the payloads as they parachute across the Huntsville Amateur Radio Club's Field Day site.

Photo 5. Ethan Chew recovers the payloads from Lady Ann Lake.

Photo 6. Successful recovery from the lake. Left to right: Bill Brown, WB8ELK; Barry Lankford, N4MSJ; Ethan Chew; and Shane Wilson, N4XWC.

winds aloft. Alan Sieg, WB5RMG, was able to visually see the balloon from his location at the Marshall Space Flight Center's Field Day site and actually watched it burst at 97,100 feet. Meanwhile, at the Huntsville Amateur Radio Club's site we could see the parachute as it descended below 15,000 feet, and a large group of those in attendance watched in fascination as it slowly drifted directly across their Field Day site (photo 4). We could clearly see the orange parachute and the flash of the sun off the payloads for over 10 minutes. It landed just 0.75 miles east of us. I'm getting closer each year ... last year I told the Eva, Alabama Field Day site I'd land on them and missed them by one mile.

Shane Wilson, N4XWC, Ethan Chew of the Makers Local 256 Club, Barry Lankford, N4MSJ, and I could hear the signals as we drove down Zierdt Road along the west boundary of the Redstone Arsenal. We were surprised to see it all floating on top of Lady Ann Lake in the Edgewater subdivision about 200 feet from the nearest shore. Curiously enough, this was only a few hundred feet away from where I landed the 2008 Field Day balloon two years ago, inside the Arsenal.

As we approached the shoreline of the lake nearest to the payloads, we noticed a very conveniently located kayak lying inside a gazebo. We asked the homeowner if we could borrow his kayak and he gave us permission. Ethan Chew paddled out and successfully rescued everything in good shape (photo 5). All payloads were still operating even after 30 minutes in the lake (photo 6). We brought it all back to the Huntsville Field Day site and had a nice show and tell during the cookout.

Although the 8-milliwatt signal from my transmitter was a real challenge to receive when directly below its vertical whip in the "cone of silence," I did manage to get perfect copy from my farmhouse remote base 20 miles away and never missed a transmission throughout the flight. As expected, the Makers Local cell-phone experiment dropped out right after launch but did manage to send a position report just prior to landing as well as while floating in the lake. So how did cell-phone balloon trackers stack up against amateur radio position trackers? Amateur radio wins the day.

By Mitch Gill, NA7US

EMERGENCY COMMUNICATIONS

The Role of VHF in EmComm

Volunteer Opportunities and Emergency Preparation

Over my years of working in emergency communications I have learned that preparing for a major disaster is a never-ending and challenging endeavor and we need to be a part of the solution. As the, what they call in the National Guard, Subject Matter Expert (SME) in communications, I have been exposed to a lot of different systems and ideas for improving emergency communications. For this reason, I think, I was invited and accepted an offer to assist the State of Washington in developing its emergency communications plan for 2010. The reason I bring this up is that I realized that there were no representatives from ARES , RACES, or MARS, to name but a few of the potential experts in this area. I was there representing the National Guard but since I am a ham, I had to bring up the fact. The response I received was that they wanted to include these people but failed to contact them because they did not know whom to contact. They then asked to meet with me and to get the names of those who could assist in writing the plan.

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Here is the bottom line: I don't blame them for not knowing who we are, yet I do blame the ham radio community (which includes me) for not getting more involved with such emergency preparedness plans.

Now some of you may not know how to proceed, so I am going to give you some ideas, while some of you who have already made these advances are already working with the government. I commend the latter group, as I know that there are many of you, but I believe that "many" is not enough.

There are many hams who would like to volunteer and assist but are not sure what to do or whom to contact. Hopefully this will help.

How to Start

The first thing you should do is find the emergency operations center for your city or county (photo A). If you call the police or fire department's non-emergency line, it should be able to direct you to the right person and number. Your local ARES group will probably have these numbers as well, and joining it is most likely the best way to volunteer.

Now here is where you have to make a decision. If you want to volunteer for the city or county, then tell the person with whom you speak. However, if you want to volunteer for the state Emergency Operations Center (EOC), ask for a contact person there. The state EOC is usually, but not always, located in the capital of the state. Even if the state EOC is too far away from you and you choose to

Photo A. The Frisco, Texas Emergency Operations Center. (For details go to <http://www.ci.frisco.tx.us/departments/fire/emergencymanagement>)

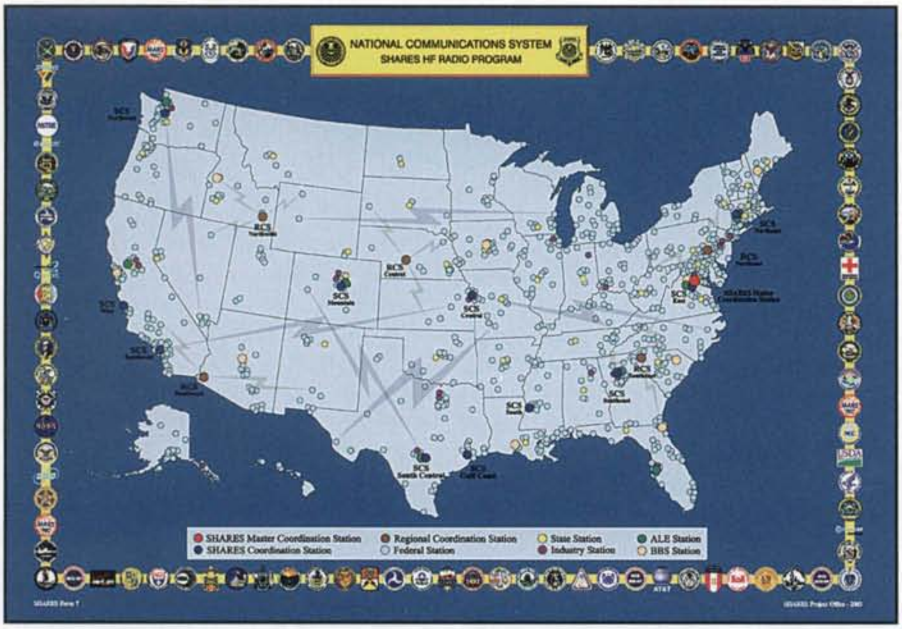

Photo B. There are several nets for which you can get licensed to assist in emergencies. SHARES (Shared Resources High Frequency Radio Program) is one. The net meets weekly and includes many federal, state, and local governments, as well as a large group of commercial companies

volunteer more locally, you can assist the EOC in getting assistance from other ham clubs or groups.

You can be extremely effective and helpful by contacting the local clubs and finding the contact people at ARES, RACES, and/or MARS. (Remember that there are different MARS organizations—USAF, US Army, and US Navy). Get to the top person and ask him/her to get involved. Help the EOC by volunteering to assist in its communications plan. You are important and can make a difference in the community or the state.

There are several nets for which you can get licensed to assist in emergencies:

SHARES (Shared Resources High Frequency Radio Program, photo B) is one, and you can find some information at <www.ncs.gov/shares/>. This net meets weekly and includes many federal, state, and local governments, as well as a large group of commercial companies.

A very important person whom you want to find is the FEMA HF Manager in your FEMA region. I met ours in mid June, and he is now going to check into our National Guard net and give us frequencies and nets for us to check in. I met him working with the group on the state HF emergency communications plan. Working with the state opens a lot of doors where we can volunteer and offer assistance.

Field Day: Ideas and Thoughts

The ARRL's Field Day in June is a great time to hone your skills in emergency communications and also a place to get some great ideas in the event of an actual emergency (photo C).

I love Field Day. I enjoy meeting and talking with other hams and with curious onlookers who come to see what is going on. I love helping and watching the towers and antennas go up for the event, the tents and the radios. My favorite station to work is VHF/UHF. I like to see how

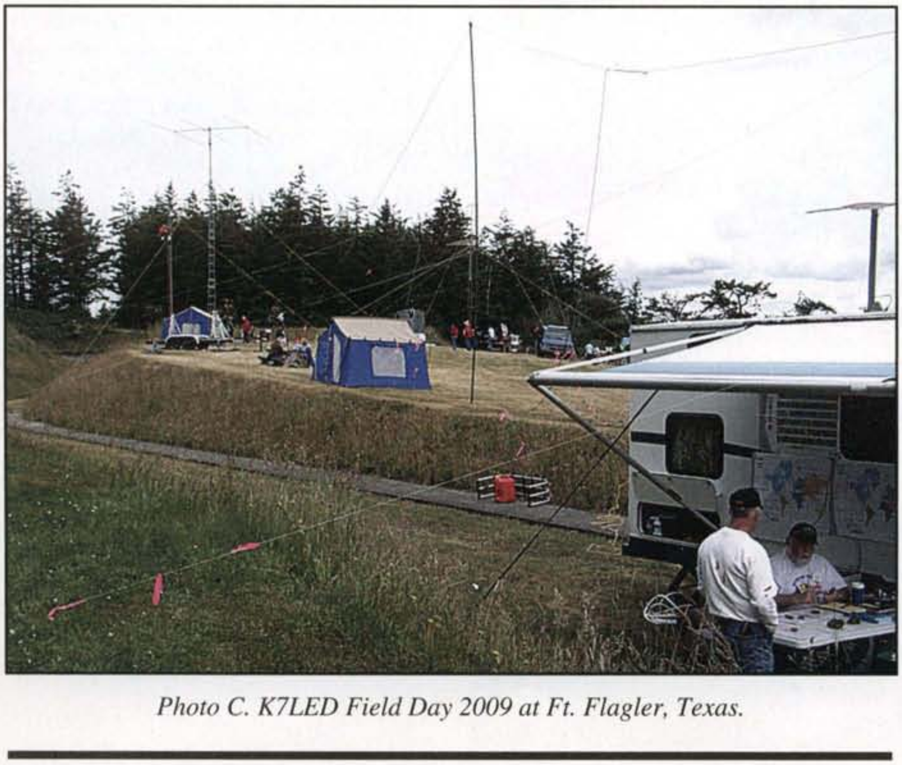

Photo C. K7LED Field Day 2009 at Ft. Flagler, Texas.

far I can get with 100 watts SSB, and during some Field Days I have been astonished at how far a small beam can make that signal go.

With all that said, I am personally disappointed that Field Day has turned into more of a contest rather than the original intent of testing our emergency communications capabilities. My reason for this is that I have become much more focused on emergency survival than at any other time in my life. It is a combination of living through an earthquake, becoming more and more involved in emergency communications and operations, and being aware of the many disasters that have occurred and can occur anywhere and at anytime. In addition, our economic status both here in the U.S. and globally has given me a change in my focus: How do we communicate in an emergency and how do I run a radio when the generator runs out of gas?

I know that there are many clubs out there that are operating based on the true spirit of a Field Day, but I have not seen them. Thus, I am challenging you to tell me how your club operates on Field Day, with the 2010 event over by the time you read this, and please include pictures. As for myself, I have decided to test my capabilities. The assumption I will start with this year is that I have run out of gas for the generator and am now totally on battery power. I have two deep cell batteries for my travel trailer and a third for my radio, and one 15-watt solar panel. Will that be enough to keep operating and have basic lights for the trailer? I doubt it, but it will be good practice and give me an idea of what I need. This is something you all should do as well.

"GOOD," or Make Friends with "BOB"

All of us should have a "Get Out Of Dodge" (GOOD) or Bug Out Bag (BOB) that contains the basic emergency essentials as well as our emergency radios. The purpose of a GOOD or BOB that is in the event that you are caught away from your home or you have to leave it, you have the necessities ready to go. I carry mine in my truck.

Field Day is a great way to practice to see if we have all the right stuff in those bags in order to survive and to see how long the water and food will last. Here is a list of what is in my Bug Out Bag:

Food and Water: 6 boxes of water; twelve 200-calorie food bars (2400 calories); 10 water-purification tablets.

Light and Communication: Mini-scan radio with headphones and batteries; rechargeable squeeze flashlight (contains lithium batteries which last up to 30 hours and also is able to generate power through squeezing); 30-hour emergency candle (can also be used as a mini stove); box of 50 waterproof matches; Bic®-style lighter.

Accessories: 5-in-1 survival whistle (loud, shrill whistle the sound of which travels over a mile); a flint starter, signal mirror, compass, and lanyard.

Radio Gear: 2-meter FM transceiver with lithium-ion rechargeable batteries; handheld CB radio.

Shelter and Warmth: Emergency survival blanket; poncho with hood.

Tools: 16-function knife.

Hygiene and Sanitation: Soap, toothbrush, toothpaste, and wet wipes; three pocket tissue packs.

First Aid: 42-piece portable first-aid kit containing 10 spot bandages, 10 sheer junior, 5 sheer medium, 5 sheer strips, 2 antibacterial, 3 clear strips, 2 fabric strips, 1 extra large, 2 alcohol pads, and 2 gauze pads. Also don't forget to have any medications you need.

Other: Deck of playing cards for entertainment; infectious-waste bag.

So what's in your bag? Am I missing anything? Please give me your feedback at <na7us@yahoo.com>. Also remember to send me reports of your 2010 Field Day experiences.

73, Mitch, NA7US

By Bob Witte,* KØNR

FM

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

DVAP: Your Personal D-STAR Access Point

D-STAR technology continues to grow in popularity with more repeaters coming on the air. I've written about this trend in previous columns, most recently in the Fall 2009 issue of *CQ VHF*. Since D-STAR is an emerging technology, the overall repeater coverage is still small compared to conventional FM repeaters.

What do you do if you are beyond repeater range? One solution is the DV Dongle, which allows a radio amateur to connect to the D-STAR network using a PC or Mac. It gets the name "dongle" because it is a small box that attaches to the computer using the USB interface. The DV Dongle has turned out to be a popular way to access the D-STAR system without the need for a D-STAR radio. The DV Dongle is a product of Internet Labs, Inc., which is owned by Robin Cutshaw, AA4RC.

Figure 1. The DVAP Dongle with antenna attached.

DV Access Point

Earlier this year, Internet Labs introduced the DV Access Point Dongle (or DVAP Dongle). This gizmo looks a lot like the original DV Dongle, but it has an SMA connector and a small antenna attached to it (figure 1). I refer to it as the DVAP, since its function is to be a DV Access Point. The DVAP is analogous to a WiFi access point, which provides a local RF connection between the internet and computer users. The DVAP does the same thing for the D-STAR system; it provides a local "hot spot" of D-STAR wireless coverage. Simply put, you plug the DVAP into an internet-connected computer, which allows you to talk to the D-STAR network via your 2-meter D-STAR radio.

When I heard of this device, I immediately thought about the lack of D-STAR coverage at my family's mountain cabin. We have internet there but no D-STAR repeater within range. Then I realized I could also take the DVAP with me when traveling and connect into the D-STAR network. Of course, I could have done that using the original DV Dongle, but having a hotspot of wireless D-STAR coverage just seems more like ham radio to me. In addition, I really like the idea of being able to operate with my handheld radio and not be tethered to a computer.

The DVAP Dongle is supported on Windows® (XP/Vista/7), Mac OS X 10.5 (Leopard) or later and most Linux distributions. The minimum suggested computer requirements are a 1.6-GHz processor with 1 GB of RAM and a full-speed USB 2.0 port. On the ham radio side, the DVAP can operate from 144 to 148 MHz, with 10 mW of RF output power.

Using the DVAP

The DVAP is connected to the computer using the supplied USB cable (mini

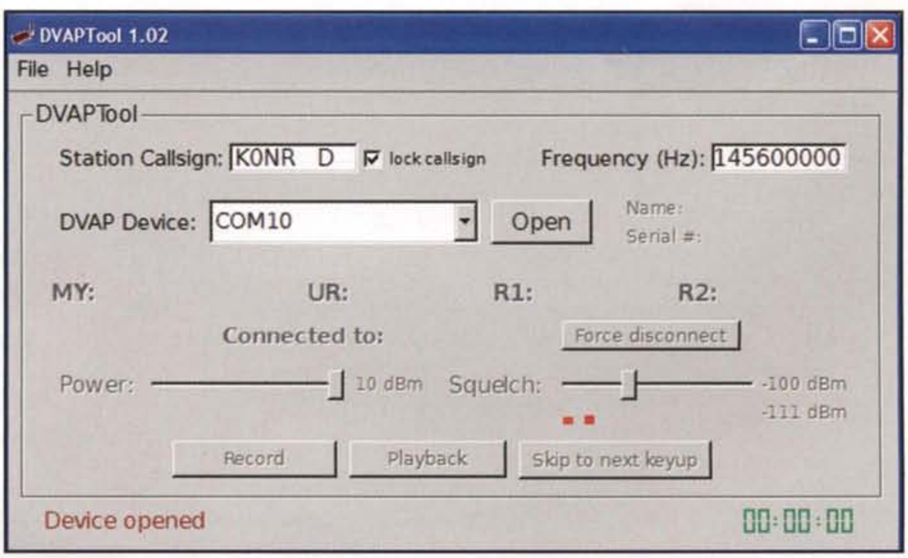

Figure 2. The DVAPTool software shows this window.

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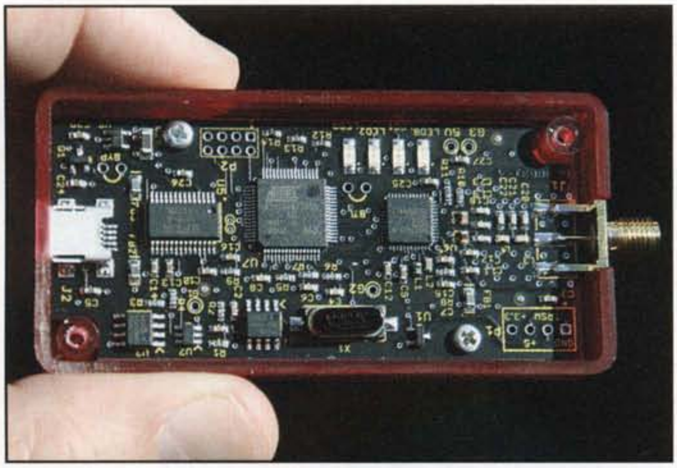

Figure 3. A look inside the DVAP Dongle shows three main integrated circuits.

B port on the DVAP). The DVAP is powered by the USB port, so no additional power supply is required. My computer runs Windows XP, which found the drivers for the device without any problem. Then I went to the DVAPDongle.com website and downloaded the program that controls the DVAP (called DVAPTool) and installed it on my computer.

You must be registered on the D-STAR system to make use of the DVAP. Most D-STAR users probably have already registered with one of their local D-STAR gateways. If you are new to D-STAR, then you'll need to get registered. (I won't go into the details here.)

The next step is to run the DVAPTool, which goes out and checks for the presence of the DVAP and brings up a window shown in figure 2. The two main parameters that need to be entered are your callsign and frequency of operation. I entered my callsign (KØNR) and chose to use "D" in the magic 8th character space to indicate "DVAP." The frequency defaults to 146.55 MHz, but I changed it to 145.600 MHz, which is in the experimental subband in the U.S. You'll want to be very careful about what frequency you choose, as you could end up causing interference to other users on the 2-meter band. The output power level and squelch settings are adjustable via software. Click the "Open" button and your DVAP is on the air.

Now the control shifts to your D-STAR radio. Set your D-STAR transceiver for DV mode simplex on the DVAP 2-meter frequency and enter your callsign into the MYCALL field of your radio. The RPT1 and RPT2 fields are ignored by the DVAP. The UR CALL field (see Table 1) is used to send commands to the DVAP. The first thing you might try is to have the DVAP identify by putting "DVAP I" in the UR CALL field and transmitting. It should respond with the default voice ID (which can be customized for your particular use). There is also an Echo test to check that your audio sounds OK at the DVAP. But then you'll want to try linking to one of your favorite D-STAR repeaters, using the link command. Later, when you are done operating, you send the Unlink command to drop the link.

With only 10 mW of output power, the DVAP is intended for only short-range operation. So how far does it transmit? That's difficult to say, because it depends on a lot of variables, but I can tell you my experience. With just the supplied mini-antenna on the DVAP, I was able to access the DVAP up to about 200 meters away using an ICOM IC-91AD radio. When I connected a 1/4-wave mag-mount antenna to the DVAP antenna port the range increased to about 600 meters. This matches the intended purpose of the device—very local coverage.

Technical Details

Removing the cover of the DVAP (figure 3) reveals there are three ICs that constitute the main circuitry of the DVAP design: the FTDI FT232RL Serial-to-USB converter, the Atmel AT91SAM7S256 ARM7-based CPU, and the Analog Devices ADF7021-N Narrow-Band Transceiver. The FTDI chip handles the USB interface operation, while the Atmel CPU is the compute engine for the DVAP. The ADF7021 transceiver is used to transmit and receive D-STAR's GMSK signal. (For a deeper dive on the D-STAR modulation format, take a look at the "FM" column in the Winter 2009 issue of *CQ VHF*.) The block diagram of the DVAP is shown in figure 4.

Noticeably absent is an AMBE Vocoder IC (such as the DVSI AMBE2000). The original DV Dongle included an AMBE decoder. In fact, the main function of that device is to handle the encoding and decoding of the AMBE-formatted signal. The DVAP does *not* need an AMBE vocoder because that function exists in the D-STAR transceiver talking to the DVAP. The DVAP just receives the over-the-air D-STAR signal, captures it in digital form, and passes it on to the network. This means that the DVAP does not support D-STAR communication using a headset directly connected to the computer.

It may be tempting to think about boosting the output power to support a larger coverage area, but this is not recommended. The spectral purity of the DVAP is fine for its 10-mW power level, but amplifying the output runs the risk of creating interference to other radio users. Also, the receiver performance is not that robust, both in terms of sensitivity and selectivity. Remember, the DVAP was designed for local, micropower radio coverage.

Software Features

Since the DVAP is software driven, the DVAPTool can be updated to add new capabilities. There have been a few revisions in the short time I have owned the DVAP, and Robin Cutshaw indicates there will be ongoing enhancements to the software.

Although the main purpose of the DVAP is to handle D-STAR, it turns out that the Analog Devices transceiver chip can handle conventional FM just fine. There are two software utilities available on the DVAPDongle website: DVAPUtil and

UR CALL Field	Command
DVAP I	Request Voice ID from the DVAP ("I" is in the 8th character position)
DVAP E	Echo test on DVAP ("E" is in the 8th character position)
xxxxxxmL	Link to a D-STAR repeater xxxxxx is the repeater callsign m is the module (band) you want to link to L indicates "Link"
U	Unlink (U in the 8th character position)

Table 1. Use of the UR CALL field, which sends commands to the DVAP.

DVAPFM. The DVAPUtil scans the 2-meter band (or a portion of it) and provides a bandscan plot of the signals captured. This could be useful in finding a clear spot to operate your DVAP with minimal interference. The DVAPFM program configures the DVAP hardware as an FM receiver, with the audio routed to the PC soundcard. This provides a way to monitor a specific FM frequency and hear the activity on the channel. Both of these programs are simple demonstration utilities, so it will be interesting to see what other software-enabled features emerge over time.

The documentation for the DVAP is basic but sufficient to get you on the air. If you do run into trouble, helpful advice is available from the DVAPDongle Yahoo group. It is also the place to find out about software upgrades and other DVAP news.

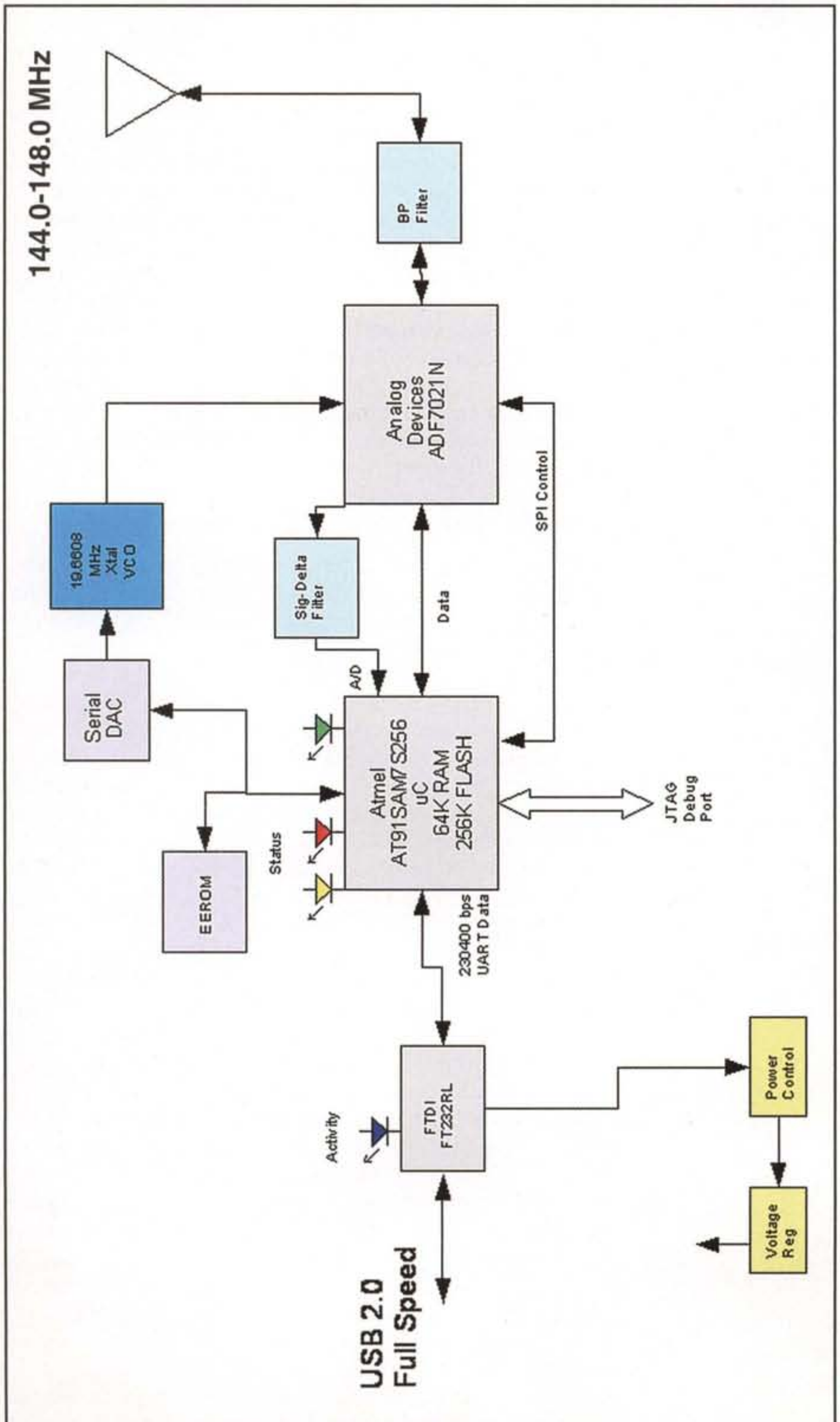

Figure 4. The block diagram of the DVAP Dongle.

Thanks for taking the time to read another one of my columns on the *utility mode*. I always enjoy hearing from readers, so stop by my blog at <http://www.k0nr.com/blog> or drop me an e-mail.

73, Bob KØNR

References

DV Dongle: <http://www.dvdongle.com>

DVAP Dongle: <http://www.dvapdongle.com>

DVAP Dongle Yahoo Group: <http://groups.yahoo.com/group/DVAPDongle/>

"A Look Inside D-STAR Modulation," Bob Witte, KØNR, *CQ VHF*, Winter 2009

By Rich Arland,* K7SZ

BEGINNER'S GUIDE

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

On Building a "Fun" VHF+ Station

I originally started this column prior to the ARRL's June VHF QSO party on the weekend of the 12–13, and it had a much different title. I had so much fun in the QSO party, especially on 6 meters, that I just had to change gears and tell you about my experiences.

Unfortunately I do not have a competitive VHF+ station. I am still awaiting the installation of some decent directive antennas for 6 and 2 meters and 70 centimeters. Therefore, I used what I had on hand: three halo-type omnidirectional antennas on a 20-foot mast in the back yard and a 4-element 2-meter Arrow beam in the attic.

There was virtually no activity on 70 cm that I could detect during the entire weekend, which I thought was rather unusual. The action on 2 meters was not much better, having worked only two stations during the QSO party. However, 6 meters was something else entirely! Not being an avid 6-meter fan, I never really put much stock into putting together a really efficient station. The weekend of the QSO party changed my thinking entirely. This band needs some serious attention at K7SZ! My 20-plus year-old Yaesu FT-726 only has two band modules—one for 2 meters and the other for 70 cm. I have one vacant slot inside the 726 reserved for a 6-meter module, should I ever be lucky enough to find one at a decent price. The only radio in the shack that will tune 6 meters is my Yaesu FT-817 with a mighty 5 watts RF output. Hey, you gotta play the cards you're dealt, right?

After hooking up the 817 to the 6-meter halo, I started tuning around and was astounded at the number of stations on the band. The area between 50.087 to 50.103 MHz sounded like the low end of 40 meters during a major HF contest. Never, ever did I think I would have to use the narrow CW filter in the 817 on VHF, but that sure helped me make contacts during very crowded conditions. Let's face it: With only 5 watts to an omnidirectional antenna at a low height, I wasn't expecting much in the way of contacts. Boy, was I surprised!

On Sunday afternoon I managed about 18–20 Qs with distances all the way out to Oklahoma and mid-Texas. All with only 5 watts! Don't get me wrong, as I would have dearly loved to have had a 100-watt linear amp and 5-element Yagi. However, I think that I did pretty well with what I had to work with. I even heard (and desperately tried to work) "Mr. AMSAT" himself, Bill Tynan, W3XO/5, who put in a whopping S-9 signal into to my north Georgia QTH. I also heard (but couldn't work) an XE3 in EL06 who was putting in an S-8 to S-9 signal from the northeast corner of Mexico. I think that both Bill and the XE3 had multiple paths open to their locations, and that would have put my paltry QRP signals way down in the noise at their end. I now have a much better idea as to why they call 6 meters the "Magic Band"!

In assessing my humble entry for the 2010 VHF QSO party, I am obliged to say that I have a few areas to improve upon before next year's event. In addition to directional, steerable antennas, I need to explore procuring linear amplifiers for 6 meters and 70 cm (I already have a Mirage BG-310 100-watt linear amp for 2 meters), and as long as I am making a "hit list" of things I want, let's not forget some mast-mounted pre-amps for all three bands. Wow! That's quite a list, and I haven't even gotten into the murky area of roof-mounted towers, rotators, and low-loss coaxial cable. I'm either going to have to come out of retirement to fund these requirements or have my editor, Joe, N6CL, adopt me!

A VHF+ Station in "Bite-size" Chunks

OK, let's concentrate on breaking down these requirements into manageable bite-size chunks with an eye toward the frugal approach that won't necessitate a second (or third) mortgage on the family farm.

In this installment of my column, we are going to start building a "fun" VHF+ station from the ground up . . . literally. The object of any hobby is to have fun. I know that this sounds like an obvious statement, but sometimes our focus gets blurred, and our hobby takes on a life of its own and becomes a lifestyle. It is no secret that I love amateur radio. I have been involved with the ham radio hobby for almost 50 years and I never get tired of the experience of making contacts using HF, on the satellites, and counting grid squares on the "high bands"—VHF+.

Unless you've been living in a cave in the U.S. the last couple of years, you know that the economy is in serious trouble. For the vast majority of us, large expenditures of money have to be planned in detail. Discretionary income levels have shrunk dramatically, or dried up altogether. To enter into a hobby like amateur radio and do it on a budget that won't adversely impact the family funding takes some planning and homework. That's where we are going to start.

To be sure, there are a lot of radios out there on the new and used market that will enable you to cruise the VHF+ bands in style. I have often said that procuring the transceiver is one of the least expensive items on the list of the ham radio station. The "real" expense comes from all the other stuff you have to procure in order to get the radio gear on the air! That includes things such as coaxial cable, coax fittings, power supplies, antenna switches, and transmatches. Then let's not forget ground rods, ground wire, coaxial feed-throughs, antennas, masts, tie wraps, coax sealant, and electrical tape, all of which will take their toll on your wallet. Then there are RF amplifiers, receiver pre-amps, clocks, computer(s), rotators . . . and the list

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goes on seemingly endlessly. As I said, the actual transceiver is pretty inexpensive when compared to all the other things needed to make the shack an operational radio station.

Buy New or Used?

Let's start with the radio. There are a lot of sources for obtaining a rig. Of course, you can by new. This gives you a manufacturer's warranty, which you won't get with a piece of used gear. It also means you are going to pay a lot of money up front for the radio and that will leave less money for other shack accessories.

Buying used has its benefits in lower overall cost, but unless you can check out the radio before purchasing it, you might get burned in the transaction. Many hams use one of the on-line auction houses to acquire gear. I have done this and to date I have not been disappointed. However, that possibility always lurks in the back of my mind when bidding in an auction for a piece of radio gear.

Probably one of the best sources for used gear is a local amateur radio club. There is always gear floating around between club members, so this would be a good source of information and a possible source of equipment, since you could check out the radio before you buy it.

Other good places to look are radio retailers such as Universal Radio and Amateur Electronic Supply, which take used gear on trade for new equipment. I've known Fred Osterman from Universal Radio for almost thirty years and have done business with his firm many times and have never had a problem. Fred's technicians put used gear taken in on trades on their test bench, go over it with a fine-tooth comb, and when it passes muster, place it on their used gear list. Universal is only one retailer that offers used gear with a warranty. Amateur Electronic Supply (AES) is another, and I have used it on occasion, too.

We've outlined several options to procure new and used gear. However, before you settle on a dealer or auction house, you need to outline your goals and buy the equipment that ultimately will fulfill those goals. That's where a little homework comes in. Checking the product reviews in *CQ* magazine, other ham radio periodicals, and on internet ham radio sites can prove quite enlightening.

More Insight

Several years ago Yaesu introduced the FT-817 QRP radio which covers 160 through 10 meters on HF, plus 6 meters, 2 meters, and 70 cm using CW, SSB, FM, AM, and data modes with 5 watts RF output. This one radio completely revolutionized the QRP (low power) radio fraternity. To be brutally truthful, the FT-817 does a lot of things well, but none are terrific. There are trade-offs, to be sure. Shortly after the release of the FT-817, Yaesu marketed its FT-857 mobile/base radio that, on the surface, looks a lot like the FT-817 on steroids. That's where all similarities end. The 857 offers 100 watts output on HF and 6 meters, 50 watts out on 2 meters, and 20 watts output on 70 cm. The FT-897 is basically an 857 in a base-station box. Any of these three radios (new or used) would provide a good starting point for your VHF+ station. I personally have owned and operated all three of these rigs and I can say, without a doubt, they are great rigs for the money.

The majority of my experience has been with the aforementioned Yaesu rigs, so that is what I tend to gravitate towards. I know they are good, solid radios that will work and provide lots of entertainment for your money. While Yaesu has its trio FT-8XX series of all-band rigs, ICOM and Kenwood have similar radios that will provide years of maintenance-free fun on HF and the high bands. This is where talking to owners of the various radios will provide invaluable information and a realistic basis for selection of the radio you will want to purchase.

Going back to my Yaesu roots, I *really* love the old FT-726, a tri-band VHF/UHF multi-mode rig that was the first on the market with a full-duplex feature allowing the operator to hear his/her downlink from the satellites in real time while transmitting to the "bird" on the uplink! This is a great feature to allow tracking of your Doppler shift during a satellite QSO. The 726 also performs well as a 10-watt exciter for terrestrial weak-signal work. My present VHF+ station (using the 726) runs a barefoot 10 watts on 70 cm (until I can get a 100-watt UHF linear amp) and 100 watts on 2 meters using a Mirage BG-301 with an 18-dB receive pre-amp included inside the amp case. The tiny Mirage is a nice little linear that really makes a difference. The UHF version of this amp will yield medium power (100 watts) on 70 cm. While both of these amps are a bit pricey when procured new, you should always look at hamfest flea markets, which will often yield an odd 2-meter or 70-cm amp for pennies on the dollar.

About five years ago, at a very small hamfest in northeastern Pennsylvania, I found an older Tokyo Hi-Power 2-meter linear amp with 15-dB receiver pre-amp—for $20! Of course, I asked if it worked and the seller replied,"Last time I used it, it did." While no guarantee, I figured for $20 it was not a bad risk, as I could use the parts and heatsink on another amp project I was contemplating. After getting it home to the shack, I found that it did, in fact, put out 80 watts of RF on 2 meters and the pre-amp worked great! Why was it so cheap? Physical condition, I would guess. It looked like it had seen better days, but that just goes to show that even the "ugly ducklings" have a place in the shack!

Thick as a "Brick"

Fact: These self-contained 80–150 watt RF linear amplifiers (most of which include some form of receiver pre-amplification) are called "bricks." I really don't know why, other than the fact they look *somewhat* like a brick—flat, oblong, etc. Anyway, to be on the cool side of VHF+, you need to remember "brick amplifiers." It's the little things in life!

Brick linear amps have been around for over 30 years. With the advent of VHF power transistors, it became quite fashionable for various companies catering to the VHF+ crowd to manufacture and market several brick amps hyping the idea of fairly large power output levels (for the time) using solid-state technology. Of course, the addition of a receiver pre-amplifier inside the linear box was touted as an easy way to get better receiver performance, in addition to some healthy RF output at VHF and above. For reasons we will leave for another segment of this column, let's just say that the receiver pre-amp included inside the brick amp is *not* the best solution to improving VHF/UHF receiver sensitivity and weak-signal performance.

OK, gang, that is it for this time around. Hit the hamfests this summer/fall and find some great bargains! They are out there, so don't be shy. There is no reason to spend gobs of money buying new gear unless you absolutely have to. Don't forget to give me feedback! This column runs on input from you, the readers.

VY 73 es GUD DX, Rich, K7SX

By Keith Pugh,* W5IU

SATELLITES

Artificially Propagating Signals Through Space

Satellite Potpourri: A Variety of Amateur Radio Satellite Topics

Correspondence regarding my last column in the Spring 2010 issue of *CQ VHF*, discussions at this year's Dayton Hamvention® and Ham-Com in Plano, Texas, along with current amateur radio satellite events prompted short discussions of the following topics.

Satellite Operating Rewards and Awards

For me, just knowing that I am communicating through a satellite in orbit around the Earth is ample reward for the effort expended. Accomplishing this on various VHF, UHF, and microwave bands is the "frosting on the cake." I also enjoy keeping up with satellite telemetry and the technology involved in working the "birds." For others, who are more operation oriented, there are additional rewards and awards.

The first reward I will mention is being able to work great distances and many stations with low power, simple radios, small antennas, and very little cash outlay. Amateur radio satellites make this possible due to their relatively high altitude, sensitivity, and strong signals. The simplest effective station is a dual-band VHF/UHF handie-talkie (HT) and a simple homebrew (or store-bought) antenna. As an example, I saw a post recently on amsat-bb (the AMSAT bulletin board) regarding an operator who had completed the requirement for Satellite VUCC with an Arrow antenna and a Yaesu FT-60R HT. VUCC is an acronym for VHF/UHF Century Club. The requirements for the satellite endorsement are working and confirming 100 Maidenhead Grid Squares via the satellites. This takes patience and perseverance but is a worthwhile goal.

For the new operator, satellites are a good place to start your QSL collection. Most satellite operators are eager or at least willing to exchange QSL cards, especially for first contacts, new grids, new states, etc. Armed with contacts and QSLs there are a number of operating awards available.

WAZ—Worked All Zones: *CQ*'s WAZ Award is available for satellite contacts. It requires that the applicant submit proof of contact with at least 25 CQ Zones. Endorsement stickers are issued at the 30, 35, 36, 37, 38, 39, and 40 zone levels. The satellite (and EME) awards are not band specific, so you can apply QSOs from multiple bands. More information can be found on the *CQ* website: <www.cq-amateur-radio.com>. Also see the "CQ's Satellite and 6 Meter Award Update" by N5FG elsewhere in this issue of *CQ VHF*.

Most of the standard ARRL awards are available for satellite operations. The exclusion for use of repeaters is waived for satellite operations. The awards are as follows:

WAS – Worked All States: This award is challenging for making contacts via the the LEO (Low Earth Orbit) birds from some parts of the country. The lower East Coast of the U.S. to Hawaii or Alaska is difficult but doable if you are able to work SSB/CW on birds such as AO-07, FO-29, and HO-68. New England to Hawaii is not possible at the present.

VUCC—VHF/UHF Century Club: Work 100 Maidenhead Grid Squares. Hunting grid squares is the most popular operating activity on the LEO birds, since there are more than 100 grids available within the footprint of LEO satellites and a simple exchange of callsign and grid square is a short exchange that is compatible with the short passes and the crowded conditions available on the FM birds.

DXCC and **WAC**–DX Century Club and Worked All Continents: These awards were possible with the HEO (High Earth Orbit) birds, but are not possible for a U.S. station on the LEO birds. Many satellite DXCCs were awarded during the days of AO-10, AO-13, and AO-40. Hopefully, these days will come again when we can find an affordable launch for a high altitude orbit.

A complete listing of satellite awards is available at <http://www.amsat.org>. Many of these awards are sponsored by AMSAT and other agencies throughout the world. Some examples are:

Satellite Communicator's Club
Satellite Communications Achievement
South African AMSAT Award
OSCAR Sexagesimal Award
OSCAR Century Award
WA4AMI 1000 Award
WA4AMI 5000 Award
51 on 51 Achievement Award

Complete rules governing these awards and a list of recipients for each are available on the AMSAT web page. As awards are given, the recipients are mentioned in the *AMSAT Journal*, in the AMSAT News Service Bulletins, and on the AMSAT nets.

New Satellite Radios

Two new satellite radios were announced at Dayton and Ham-Com. Kenwood unveiled a new full-duplex, dual-band replacement for the TH-D7 HT, the TH-D72, and ICOM displayed a new base-station radio, the IC-9100, which will replace the IC-910H and add HF capabilities as well. Neither of these offerings is available as of this writing, but they should be by this fall. *(For more information on both of the above, see the article "The 2010 Dayton Hamvention® Safari, Part 1," by John Wood, WV5J in the August 2010 issue of* CQ *magazine.—ed.)*

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Flex Radio should be shipping the new VHF/UHF front ends for their radios by the time you read this.

I'm sure there were other satellite-related offerings, but I didn't get a chance to look around much due to duties in the AMSAT demonstration area.

ARISSat-1

As this is being written, the designers and builders of ARISSat-1 are participating in a NASA safety review to ensure that ARISSat-1 is safe to carry up to the ISS (International Space Station) on a Russian Progress supply ship, undergo final assembly on the ISS, and deploy from the ISS during a space walk or EVA (Extra Vehicular Activity).

A prototype of ARISSat-1 was shown and demonstrated at Dayton this year and drew a lot of attention. Thermal vacuum and vibration testing is nearly complete in the US. By the time you read this, ARISSat-1 should be in Russia being used to train the cosmonauts and astronauts in its handling and use during final assembly and deployment. It should be taken to the ISS on board a Progress this fall and should be deployed during a Russian EVA this fall or winter.

With a myriad of interesting capabilities, this satellite should provide challenges to the amateur radio community and should be very useful for education. Stay tuned in for further developments!

Field Day 2010

Field Day 2010 has just concluded as i write this, and amateur radio satellite activity was excellent this year. I worked all of the available transponders this time, except one. FM transponders (birds) were AO-27, AO-51 Mode V/U, AO-51 Mode V/S, SO-50, SO-67, and HO-68. Somehow I missed HO-68. Available linear transponders were AO-07, FO-29, and VO-52. The "Grand Old Satellite," AO-07, accounted for the most contacts. It sounded like 20 meters on each of its passes. I had difficulty with the DC feed through a "Bias-T" to my S-Band down converter during the first AO-51 mode V/S pass, but was able to correct the problem before the second pass. Working Mode V/S is truly delightful.

I believe more operators followed the "one contact per FM transponder rule" this year. The FM birds were crowded, but not quite as bad as in previous years.

Summary

Work towards your favorite amateur radio satellite rewards and awards. Have patience and use these activities to spark your activity on the "birds."

Follow this column for future information on all of the amateur radio satellites and related topics. Attend the AMSAT Space Symposium and General Meeting on October 8–10, 2010 in the Chicago area to catch up on all of the latest activity and future plans. The AMSAT Board of Directors meets on October 7–8 at the symposium and all AMSAT members are welcome to attend.

Please continue to support AMSAT's plans for the future of the amateur radio satellites. AMSAT is now updating its web page at <http://www.amsat.org> on a much more regular basis. Satellite details are updated regularly at <http://www.amsat.org/amsat-new/satellites/ status.php>.

'Til next time . . . 73 de Keith, W5IU

By Tomas Hood,* NW7US

VHF PROPAGATION

The Science of Predicting VHF-and-Above Radio Conditions

Sunspot Cycle 24 is Progressing Slowly, Yet Normally

From December 2009 through the beginning of July 2010 there have been few days when the sun went spotless. However, there has been a significant variation each month in the monthly sunspot count, sometimes dipping lower than previous months. Is this normal, or does it signify that this new cycle, sunspot Cycle 24, is abnormal?

At press time, solar scientists who do the math to determine the very end and start of sunspot cycles had determined that December 2008 is the mathematical start of solar Cycle 24. This is based on smoothed sunspot numbers, and also on the magnetic polarity of the sunspots observed.

Let's compare the first 18 months of Cycles 23 and 24 (figure 1). While it is true that the general level of activity during most months of Cycle 24 (since January 2009) have been somewhat lower than the same months at the start of Cycle 23, the trend, generally, of the new cycle has been upward. In other words, Cycle 24 seems to be quite normal in that there is an upward trend and that the monthly counts vary greatly. The dips we see are expected. They do not indicate that Cycle 24 has died or is acting abnormally.

Remember, a full sunspot cycle is approximately eleven years in duration. In the past, but not recently in our lifetime, there have been long drawn-out minimums, such as we've seen between Cycles 23 and 24. It is not that unusual, in the larger recorded history. However, because it is unusual from the perspective of our lifetime, mainly the last two or three cycles, we think it is strange. As we can see in the comparisons with other cycles, though, and when we take the longer history of the sun's cycles, this current solar activity is not unusual.

Another measurement of overall solar cycle activity can be seen in the hard X-ray background flux (measured in the 1 to 8 Angstrom wavelengths). This measurement is a more useful reference for assessing the level of ionizing solar energy reaching the ionosphere than the 10.7-cm flux. This is due to several factors. First, the X-ray flux comes from regions more centrally located on the visible hemisphere of the sun, resulting in a significant fraction of these X-rays reaching the ionosphere. Second, it takes 10 electron-Volts (eV) of energy to ionize the various ionospheric layers in our upper atmosphere. The energy of these hard X-ray (1 to 8 Angstroms) photons exceeds that by over a factor of 100.

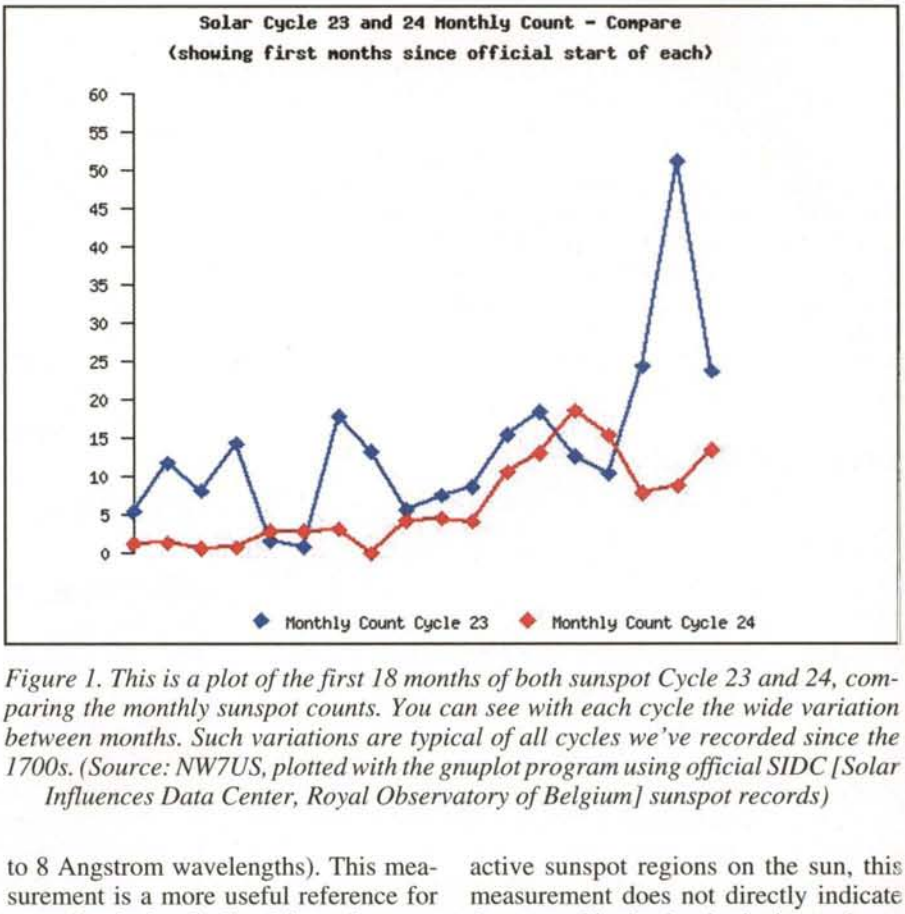

Figure 1. This is a plot of the first 18 months of both sunspot Cycle 23 and 24, comparing the monthly sunspot counts. You can see with each cycle the wide variation between months. Such variations are typical of all cycles we've recorded since the 1700s. (Source: NW7US, plotted with the gnuplot program using official SIDC [Solar Influences Data Center, Royal Observatory of Belgium] sunspot records)

Compare that energy level to that of the 10.7-cm flux. The energy of 10.7-cm photons is .00001 eV, a factor of 1,000,000 too low to ionize anything in our atmosphere. While the 10.7-cm flux indicates the presence and intensity of active sunspot regions on the sun, this measurement does not directly indicate the state of ionization in the ionosphere.

The GEOS satellites measure these wavelengths, and the resulting measurements are reported as the "background X-ray level" throughout the day. A daily average is reported, as well.

Just like X-ray flares, the background hard X-ray level is measured in watts per square meter (W/m^2), reported using the categories, A, B, C, M, and X. These letters are multipliers; each class has a peak flux ten times greater than the preceding one. Within a class there is a linear scale from 1 to 9.

When one graphs the daily and monthly averages of the background X-ray flux, one will notice that during solar cycle minimum periods, the background X-ray levels remain at the A class level. During

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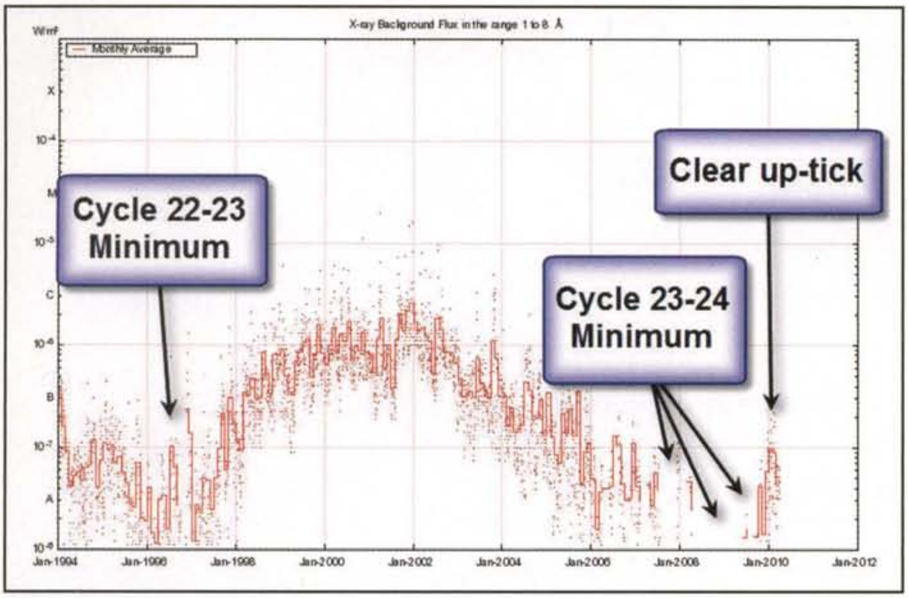

Figure 2. This graph plots the daily (red dots) and monthly (red line) average of the background "hard" X-ray energy in the 1 to 8 Angstrom wavelengths, as measured by the GEOS satellite. It is clear from this plot that sunspot Cycle 24 energy is rising. (Source: GEOS-14 data, plotted with the gnuplot program)

the rise and fall of a solar cycle, the background X-ray energy levels remain mostly in the B range. During peak solar cycle periods, the background energy reaches the C and sometimes even M level.

Armed with this information, can we discover any clues as to the current status of sunspot Cycle 24? Figure 2 is a graph plotting the background hard X-ray energy reported by the GEOS satellites since the end of sunspot Cycle 22. Clearly, we see a noticeable rise in Cycle 24 activity. We're seeing the energy rise to the B level more often as 2010 progresses, supporting the view that Cycle 24 is alive and moving along toward an eventual sunspot cycle peak in several years.

The New Eye on the Sun

On February 11, 2010, NASA launched a United Launch Alliance Atlas V-401 rocket with a new spacecraft tasked with observing the sun and solar dynamics (space weather). This spacecraft is called the Solar Dynamics Observatory (SDO). SDO is the first satellite under the Living With a Star (LWS) program at NASA, and is the most advanced spacecraft ever designed to study the sun (figure 3). During its mission, it will examine the sun's magnetic field and also provide a better understanding of the role the sun plays in Earth's atmospheric chemistry and climate. Since launch, engineers have been conducting testing and verification of the spacecraft's components. Now fully operational, SDO will provide images with clarity 10 times better than high-definition television and will return more comprehensive science data faster than any other solar observing spacecraft.

SDO is unlike any other satellite. It will be collecting huge amounts of data every day. In fact, SDO will produce enough data to fill a single CD every 36 seconds! Many satellites share a ground system (place on the ground where they send data and photographs) and have recording systems to save the data collected until they can talk to their ground station. Because SDO has no recording system and will be collecting so much data, the SDO mission has to build its very own ground station. For this to be possible, SDO has to be placed in a geosynchronous orbit (GEO). This means that it will rotate at the same speed as the Earth and will always be directly above and in constant communication with its ground station in New Mexico.

Already SDO is returning early, stunning images of our nearest star (figures 4 and 5). Some of the images from the

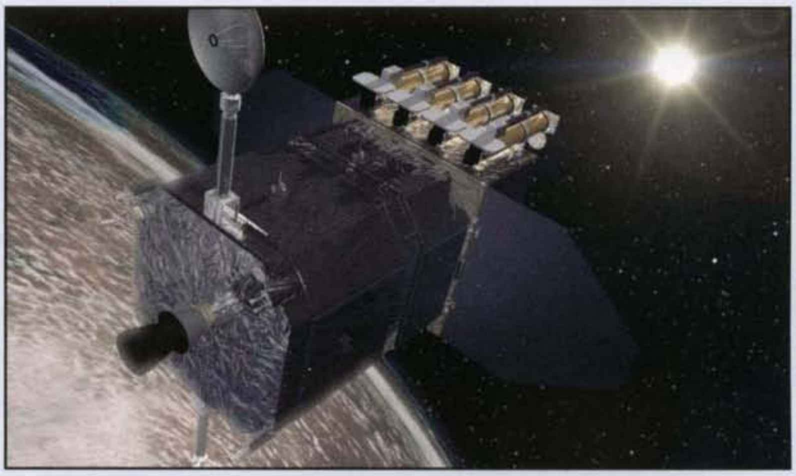

Figure 3. The Solar Dynamics Observatory (SDO) spacecraft. The SDO satellite is the most advanced spacecraft yet deployed to study space weather and our nearest star. (Credit: NASA)

spacecraft show never-before-seen detail of material streaming outward and away from sunspots. Others show extreme close-ups of activity on the sun's surface. The spacecraft also has made the first high-resolution measurements of solar flares in a broad range of extreme ultraviolet wavelengths.

The successful launch and deployment of SDO is great news for radio hobbyists, on many levels! "SDO is our 'Hubble for the sun,'" says program scientist Lika Guhathakurta of NASA headquarters. "It promises to transform solar physics in the same way the Hubble Space Telescope has transformed astronomy and cosmology."

"No solar telescope has ever come close to the combined spatial, temporal and spectral resolution of SDO," says Alan Title of Lockheed Martin, principal investigator of the Atmospheric Imaging Assembly (AIA; a group of four telescopes aboard SDO designed to photograph the sun's surface and atmosphere). "This is possible because of the combination of 4096 × 4096-pixel CCDs with huge dynamic range and a geosynchronous orbit which allows SDO to observe the sun and communicate with the ground around the clock."

Armed with such rich views of the sun, as well as the wealth of new space weather data, the radio communicator will be equipped to better plan communications and to understand current conditions.

With the stunning high-definition imagery being captured by the new Solar Dynamic Observatory we can see in nearly real-time breath-taking views of the living sun. This affords us great opportunity to learn more about how the sun works, and aids in our understanding of the sun-Earth connection. As radio amateurs, having a greater understanding of this science equips us to be more effective communicators. The latest SDO images, as well as live space weather information and commentary on current conditions, are available at my website, <http://prop.hfradio.org>.

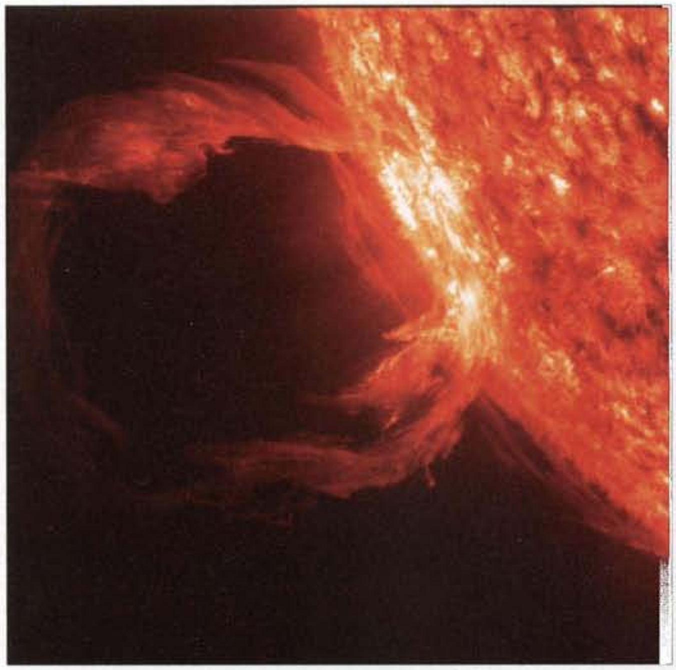

Figure 4. A stunning high-definition image of a solar prominence eruption on March 30, 2010. Seasoned solar observers were stunned with the new breathtaking images captured by SDO. In the full movie captured of the erupting prominence, the twisting motion of the material is the most noticeable feature. (Credit: NASA/SDO/AIA)

The *Perseid* Meteor Shower

Regardless of what the sun is doing, VHF radio enthusiasts can count on working meteor showers. One of the most reliable yearly meteor showers is the *Perseid*. The *Perseid* meteor shower, like other meteor showers, is named after the constellation from which it first appeared to have come. This shower's constellation is Perseus, which is located near Cassiopeia. *Perseids* favor northern latitudes. Because of the way Comet Swift-Tuttle's orbit is tilted, its dust falls on Earth's Northern Hemisphere. Meteors stream out of the constellation Perseus, which is barely visible south of the equator.

Lewis Swift and Horace Tuttle, Americans working independently, discovered a comet in August of 1862. Three years later, Giovanni Schiaparelli (of Martian "canali" fame) realized it was the source of the August *Perseid* meteors. The comet, known now as Comet Swift-Tuttle, leaves a trail of dust that Earth passes through during August.

This year, the shower will be active from mid-July through late August. The peak is expected to be between August 12 and 13. The number of visual meteors is expected to be as high as 50 to 70 per hour. Using modes such as CW or FSK441 (using the WSJT software by K1JT found at <http://physics.princeton.edu/pulsar/K1JT/index.html>), it is possible to work plenty of VHF DX during this shower.

The *Perseid* shower begins slowly in mid-July, featuring dust-size meteoroids hitting the atmosphere. As we get closer to August 12, the rate builds. For working VHF/UHF meteor scatter, this could prove to be an exciting event.

The best time for working the *Perseid* VHF/UHF meteor scatter in North America is during the hours before dawn, as early as midnight, but more likely peaking after 2:00 AM until about 5:00 AM local time.

The *Draconids*

As a preview to fall, look for the *Draconids*, a primarily periodic shower which produced spectacular, brief meteor storms twice in the last century, in 1933 and 1946. Most recently, in 2005, we saw the return of the stream's parent comet, 21P/Giacobini-Zinner, returning to perihelion. This year's peak is expected to occur on October 8, but this shower is not expected to produce many meteors each hour. The shower should be active from October 6 through October 10. The *Draconid* meteors are exceptionally slow moving, a characteristic that helps separate genuine shower meteors from sporadics accidentally lining up with the radiant. This is a good shower to work meteor scatter mode, since we might see storm-level activity this year. For more information, take a look at <http://www.imo.net/docs/cal2010.pdf>.

The Solar Cycle Pulse

The observed sunspot numbers from March through May 2010 are 15.4, 7.9, and 8.8. The smoothed sunspot counts for September, October, and November 2009 are 6.1, 7.0, and 7.6. The smoothed monthly sunspot numbers forecast for August through October 2010 are 31, 34, and 37.

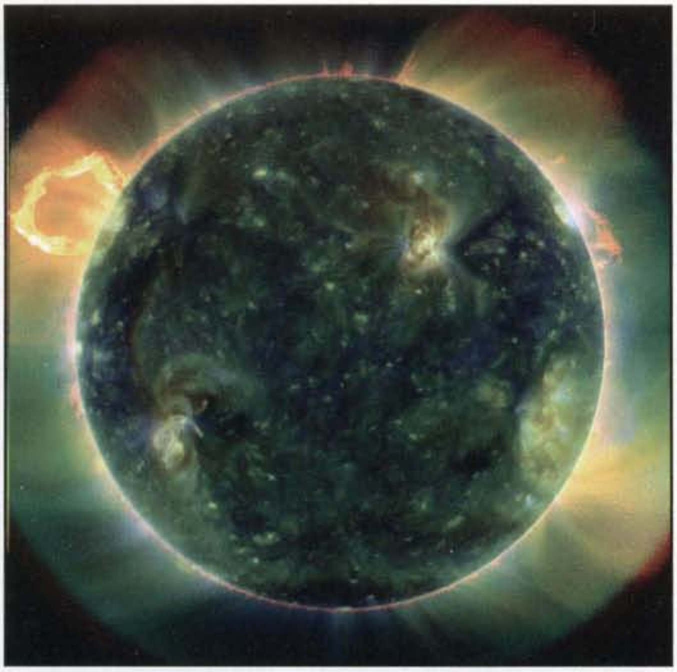

Figure 5. A full-disk, multi-wavelength extreme-ultraviolet image of the sun taken by SDO on March 30, 2010. False colors trace different gas temperatures. Reds are relatively cool (about 60,000° K, or 107,540° F); blues and greens are hotter (greater than 1,000,000° K, or 1,799,540° F). (Credit: NASA/ Goddard/SDO AIA Team)

The monthly 10.7-cm (preliminary) numbers from March through May 2010 are 83.3, 75.9, and 73.8. The smoothed 10.7-cm radio flux for September through November 2009 are 73.3, 74.1 and 74.5. The smoothed monthly 10.7-cm is predicted to be 90, 92, and 94 for August through October 2010.

The smoothed planetary *A*-index (*Ap*) numbers for September through November 2009 are 3.8, 4.1, and 4.5. The monthly readings for March through May 2010 are 5, 10, and 8. Expect periods of minor to moderate geomagnetic storms during August and September.

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

Feedback, Comments, Observations Solicited!

How was your sporadic-*E* season this year? 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. I'll create summaries and share them with the readership. I look forward to hearing from you. Up-to-date propagation information is found at my propagation center, at <http://prop.hfradio.org/>. If you are using Twitter, follow @hfradiospacewx for space weather and propagation alerts, and follow @NW7US to hear from me about various space weather and amateur radio news. Facebook members should check out the *CQ VHF* Magazine Fan Page at <http://tinyurl.com/cqvhffb>, and the Space Weather and Radio Propagation Page at <http://tinyurl.com/fbswx>.

Until the next issue, happy weak-signal DXing!

73 de Tomas, NW7US

By Mark Thompson, WB9QZB

DIGITAL RADIO

Digital Technology on VHF, UHF, and Microwaves

Digital at the Dayton Hamvention®

The Hamvention® held each year in May at the HARA Arena in Dayton, Ohio is the world's largest ham radio event with over 15,000 attendees, several hundred commercial vendors, and many, many flea market vendors.

I have attended the Dayton Hamvention® since 1985, during the early days of the packet radio revolution. Over the subsequent years new digital voice and data technologies have been featured at Dayton, including sound-card data modes such as PSK-31 and digital voice modes such as D-STAR.

This year, as in prior years, there were several digital voice and data events resources available during the Hamvention® weekend.

D-STAR Digital Voice and Data at Dayton

D-STAR digital voice repeaters at Dayton were operating on 2 meters and 70 cm and were connected to the D-STAR worldwide network. They were sponsored by DARA (the Dayton Amateur Radio Association), the host of the Hamvention.

Dayton D-STAR Repeater Reflector Linking: DARA again this year linked a D-STAR reflector to a DARA D-STAR repeater over the Hamvention weekend. The W8BI C 2-meter repeater was linked to reflector 30-B. The repeater was linked to a reflector last year as well. A reflector allows all repeaters, DV Dongles, and DVAPs (DV Access Point) linked to it to communicate as a group and monitor D-STAR repeater activity in Dayton over Hamvention weekend.

Hamvention D-STAR Repeaters. For the last four years at the Hamvention ICOM has had D-STAR digital voice 2 meters, 70-cm and 23-cm digital voice repeaters, and radios on demonstration. These repeaters are often connected to the D-STAR network. The callsigns and frequencies of the demonstration repeaters were available at the Hamvention.

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Dayton Social Events

On Thursday night prior to the Hamvention there was a D-STAR Meet, Greet, and Eyeball QSO over dinner at Marion's Pizza in Beavercreek, Ohio. More information about the event is available at: <http://hamvention.org/events.php#dstar>.

For the last four years there has been a Friday night D-STAR Get Together hosted by the Texas and Alabama D-STAR groups. The event has been an opportunity to hear talks by experienced D-STAR repeater operators and innovators and meet with other D-STAR users.

This year the Friday Night D-STAR Get Together was at the Drury Inn North, the same location as last year. The Georgia D-STAR group hosted this year's event. The format was a bit different from previous years, with a few short presentations to start the evening followed by an open session with D-STAR experts on many topics stationed around the room to answer questions.

Forums

There were several digital forums at the Hamvention both Friday and Saturday.

Friday morning's digital activities started with the TAPR Forum hosted by me this year. The presentation topics and speakers were:

- TAPR Update, by Scotty Cowling, WA2DFI
- The WL2K Network and its RF Portals, by Rick Muething, KN6KB and Vic Poor, W5SSM
- TAPR Project Design for Manufacturing, by Scotty Cowling, WA2DFI
- Putting HPSDR on the Internet, by John Melton, GØORX/N6LYT

The TAPR Forum was followed by the APRS (Automated Position Reporting System) Forum hosted by Bob Bruninga, WB4APR. The APRS event is always well attended, and this year was no exception, with a standing-room-only crowd.

The presentation topics and speakers at the APRS Forum were:

- APRS Developments, by Bob Bruninga, WB4APR
- New Byonics APRS Products, by Byon Garrabrant, N6BG
- New VHS Products APRS Products, by Allen Lord, AF6OF
- New Argent Systems APRS Products, by Scott Miller, N1VG
- New RPC Electronics APRS Products, by Jason Rausch, KE4NYV

The D-STAR Forum followed the APRS forum. It was hosted by ARRL Southeast Division Director Greg Sarratt, W4OZK. Like the APRS Forum, the D-STAR Forum had a standing-room-only crowd.

The presentation topics and speakers at the D-STAR Forum were:

- DVAP/DV, Dongle/D-PLUS, Multiple Software Packages, by Robin Cutshaw, AA4RC
- Homebrew D-STAR repeater, by David Lake, G4ULF
- D-RATS, D-STAR Digital Data Software, by Dan Smith, KK7DS

On Saturday the RTTY Forum was hosted by Shelby Summerville, K4WW. The RTTY Forum presentation topic was: RTTY Contesting at the Stanford University Amateur Radio Club station, by the Stanford Amateur Radio Club, W6YX.

TAPR at the Hamvention

TAPR is the national premiere digital ham radio organization, and during the Hamvention it hosted the TAPR Digital Forum and co-hosted the AMSAT/TAPR Banquet.

TAPR's booth at the Hamvention was

behind the AMSAT booth in the Ball Arena of Hara. The TAPR booth had a lot of information about TAPR's developments in SDR technology. More information about TAPR and its Dayton activities is available at: <www.tapr.org>.

Over the last four years, TAPR and AMSAT have held a joint banquet featuring an interesting speaker. It has been very well attended. The fourth annual AMSAT/TAPR Banquet was held on Friday night at the Kohler Banquet Center. The presentation was by Dr. Bob McGwier, N4HY. More information about upcoming banquets is available at the banquet link on the AMSAT website: <www.amsat.org/amsat-new/hamvention/2010/Dayton.php>.

I look forward to seeing you at the Dayton Hamvention next year and at the many digital events and activities occurring during the Hamvention.

Digital modes are the source of much of the innovation of new technology in ham radio, and I hope everyone explores and uses digital voice and data technologies. Until next time . . .

73, Mark, WB9QZB

Advertisers' Index

By Dr. H. Paul Shuch,* N6TX

DR. SETI'S STARSHIP

Searching For The Ultimate DX

Big Enough

Regular readers of this column may recall the W2ETI Moonbounce Beacon, which we've discussed on these pages on several occasions. A precisely calibrated 1296-MHz transmitter bouncing carefully timed CW signals off the Moon, this facility was built and operated by members of the non-profit, membership-supported SETI League, and used for several years by dozens of the world's amateur SETI enthusiasts to ensure the proper operation of their backyard radio telescopes. It was even used by scientists at the great Arecibo radio observatory in Puerto Rico, and the Jodrell Bank radio telescope in the UK, to verify the sensitivity of their research systems. Unfortunately, this useful facility, once operational whenever the Moon was above the horizon from its New Jersey QTH, is no longer available to the world's amateur and professional radio astronomers. It seems we improved it to death.

When first activated in 2001, The SETI League's Lunar Reflective Calibration Beacon sported a modest antenna array consisting of eight small helices on an automated azimuth-elevation rotor (see photo A), built for us by Dave Clingerman, W6OAL. The relative low gain of these antennas facilitated ready tracking of the Moon under computer control. Their beamwidth was sufficiently broad as to be quite tolerant of tracking imprecision, affording us high system reliability and minimal downtime.

The downside of this arrangement is that the effective isotropic radiated power (EIRP) of the beacon was relatively low, producing weak echoes receivable by the likes of Arecibo and Jodrell Bank, but only the best-equipped amateur SETI stations. Clearly, if the beacon were to perform its intended function of providing calibration signals that could be used by the average amateur, it was going to need to shout more loudly. This could be accomplished in one of two ways: We could add more transmitter power or a bigger antenna.

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Photo A. Original helix array at the W2ETI EME Beacon.

Ultimately, station trustee and SETI League president Richard Factor, WA2IKL, opted to do both. A quarter-kilowatt, solid-state power amplifier from Kuhne Electronics in Germany replaced the less-reliable 100-watt homebrew PA, and the helix array was removed (photo B) to make way for a new array of Directive Systems long loop Yagis (photo C). Between these two upgrades, system EIRP was effectively increased by over 7 dB, placing our echoes well within the grasp of modest receiving stations using the ubiquitous 10-foot–diameter backyard TVRO dishes which dot the countryside.

Photo B. Helix array removed from service to make way for new loop Yagis.

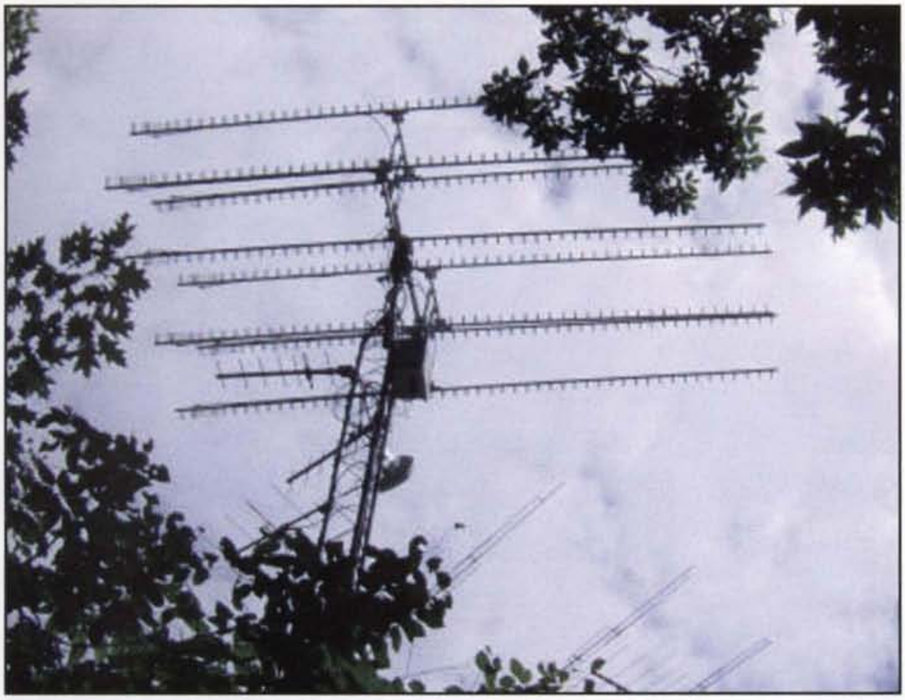

Photo C. Array of eight long loop Yagis installed at W2ETI Moonbounce Beacon.

Photo D. The winter storms of March 2009 rendered the loop Yagi array a jumbled mass of aluminum, proving that the antenna was indeed big enough.

Winters in the northeast U.S. can be especially harsh on antennas. The late EME pioneer Sam Harris, W1FZJ, participated in the first-ever EME contact from this region and was always rebuilding his antennas. Sam knew a thing or two about SETI, and radio astronomy, having built the parametric amplifier used by Frank Drake for Project Ozma, the first modern SETI experiment, conducted in Green Bank, West Virginia in 1960, and later working as the chief engineer of the monster Arecibo radio telescope in Puerto Rico. He used to say that if your antenna didn't come down in last winter's storms, it wasn't big enough!

The new W2ETI Moonbounce Beacon's antennas, it would appear, were big enough. Photo D shows what happened to the big loop Yagi array during its very first winter in service. Since The SETI League is a private ham club, receiving no government funds whatsoever, it lacks the resources to replace the array, nor would it be prudent to do so even if we could afford it. The same thing would probably happen again the following winter.

Moonbounce guru Allen Katz, K2UYH, who chairs The SETI League's EME Committee, is of the opinion that Yagi arrays are not the best solution for 23-cm EME. He prefers big dishes, and has for years operated a 28-foot–diameter Kennedy parabolic reflector from his QTH within line of sight of the W2ETI beacon facility. Allen maintains that a 10-foot TVRO dish (the same antenna many amateur SETIzens use for their receive stations) would make an ideal uplink antenna for the W2ETI beacon. If it sits close to the ground, rather than being installed at the top of a tower, such a dish at least has a fighting chance of surviving the winter wind, snow, and ice.

The challenge is automating the aiming of such a dish so that it will track the Moon in real time, unattended. That problem was solved with both the helix and the Yagi arrays through the use of a Yaesu G5600B Az/El rotator, driven by the popular Nova software by Mike Owen, N9IP. However, the Yaesu rotor can't handle a 10-foot dish, so some other arrangement will be necessary to get the station back on the air.

Until the antenna challenge is resolved, the W2ETI Moonbounce Beacon remains off the air. Thus, until such time as it is restored to service, SETI League members will have to use something else to calibrate their stations. I suggest that a confirmed extraterrestrial signal would do nicely! 73, Paul, N6TX

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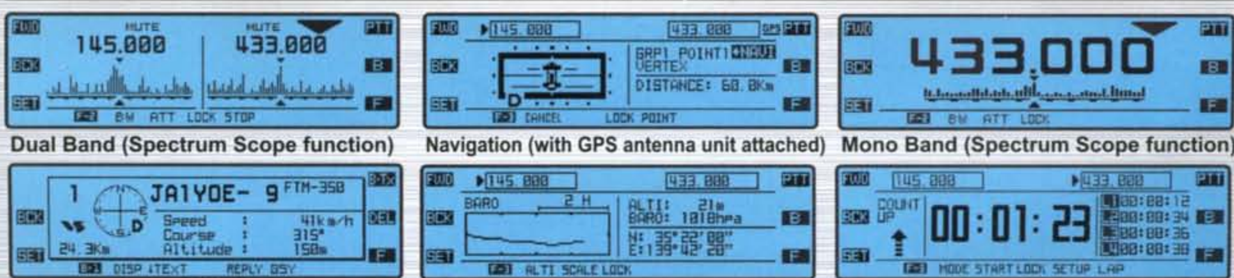
Screen Example



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