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Winter 2011

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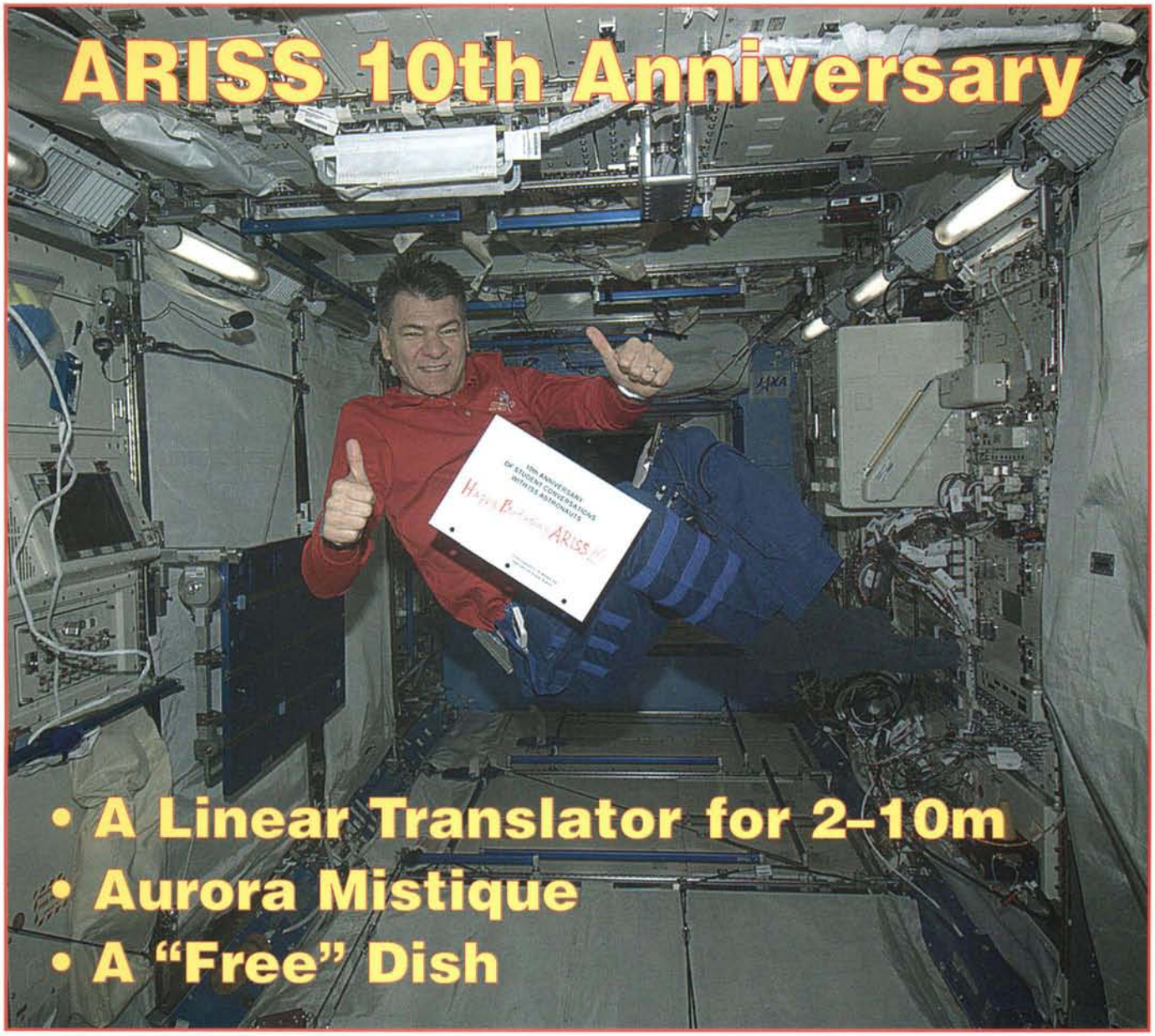


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***Winter 2011***
***Vol. 14 No. 4***


## FEATURES

## COLUMNS



## DEPARTMENTS



**On The Cover:** On December 21, 2010 ARISS celebrated its 10th anniversary of student conversations with the International Space Station astronauts. Shown is Paolo Nespoli, IZØJPA, on board the ISS giving his anniversary greetings to the ARISS community. For more details, see the "Satellites" column by Keith Pugh, W5IU, starting on p. 47.


CQ VHF Ham Radio Above 50 MHz

# LINE OF SIGHT

## A Message from the Editor

# Students' Encouragement and Involvement

I am writing this editorial the day after Auburn University's football team beat the University of Oregon in the BCS National Championship bowl game in January. I found myself cheering for Auburn because I believed that somewhere in the sea of students might be one who came to Auburn as a result of a photo on the cover of the Summer 2007 issue of this magazine.

On that cover was an inset of three Columbus, Georgia high school students, along with their faculty advisor Luther Richardson, KI4AOJ, who was a student at Auburn at the time of the photo. Luther continues to work with students at CHS on balloon and rocket projects. He also continues as a student at Auburn, now working on his PhD.

I mention Luther and the cover photo because at the 2008 AMSAT Symposium a ham told me that when a young man asked him about where to attend college, he gave him a copy of that 2007 issue, pointing out the picture of Luther and his students. The young man read the accompanying article, and then applied and was accepted at Auburn.

I write about this vignette concerning students because of this issue's lead article, "An Experimental Linear Translator for 2 Meters to 10 Meters." The article was written by Mozar Naing, KE5VKO, and Nozar Naing, KE5VKP, sisters who are graduate electrical and computer engineering students at Texas Tech University (along with Michael Helm, WC5Z). The project they describe is a linear translator that they designed and built for their project 1 class while undergraduates at TTU. As part of the class, they also became licensed amateur radio operators. The project is a significant work of which the Nainges can be very proud.

### ARISSat-1

The cover of this issue draws attention to the International Space Station. The photo is of Päolo Nespoli, IZØJPA, who is on board the ISS. With his sign, he wishes the ARISS community a happy birthday. The 10th anniversary of ARISS occurred on December 21, 2010. As of that date the ARISS program had made over 560 school contacts in 40 countries and five continents.

The whole thrust of the ARISS program is student involvement, in particular, getting amateur radio into the classroom. Speaking of the educational aspect of ARISS, in February 2011 the ARISSat-1 satellite is scheduled to be deployed during a spacewalk. The satellite will be "classroom friendly," with many experiments and accompanying lesson plans available for teachers to promote science, technology, engineering, and math (STEM) in education. Complete details can be found in the "Satellites" column beginning on page 47.

### A Free Dish?

How many of us have spotted just the right radio, antenna, or other item that we think we need. We get it for what we perceive as a bargain price—or, like Rick Rosen, K1DS, it's free!

After Rick had acquired his free dish, he soon learned that there is no such thing as a "free lunch." You can read his sometimes comical account of how he is still working on a plan to use his "free" dish antenna, beginning on page 32.

### Other Features and Columns

Regular history Features Editor Mark Morrison, WA2VVA, tells the story of the early VHF pioneers in the mountains of West Virginia. His story begins on page 14. Features Editor Ken Neubeck, WB2AMU, begins the story of his lifelong fascination with aurora on page 20. Ed Gray, WØSD, relates the story of his and Arliss Thompson, W7XU, and their wives, Edith, WØOE, and Holly, NØQJM's DXpedition to The Gambia as a lesson on conducting a successful operation; this story begins on page 26.

As usual, our columnists bring their unique knowledge and expertise to the pages of *CQ VHF* magazine. Check the Table of Contents to see what your favorite columnists wrote about for this issue.

### The Passing of Friends

Shortly after the Fall 2010 issue of *CQ VHF* began to arrive in our mailboxes, "HSMM" columnist John Champa, K8OCL, lost his battle with cancer, on November 12, 2010. I reported his death on Facebook and in my column in *CQ* magazine. Others have commented on what his life meant to them and to the amateur radio fraternity as a whole. Tributes have appeared in all major magazines and on several websites. We certainly will miss John. In honor of his memory and for what he did for the pages of this magazine, we have listed him on the masthead for one last time.

On November 23, 2010, Lloyd Crawford, N5GDB, another HSMM activist, became a Silent Key. A resident of Austin, Texas, Lloyd was responsible for deploying wireless routers throughout the Austin area, as well as other locations in Texas. Lloyd was very active in the Roadrunners Amateur Radio Club. I remember that almost every year I attended the Austin Summerfest or the Belton Hamfest, Lloyd was there supporting the Roadrunners and the weak-signal community.

### WR1B Recovering

As I write this, my friend Larry Wolfgang, WR1B, is recovering from a lingering illness that has kept him from editing *QEX* for the past several months. Subbing for him is Assistant Editor Ray Mack, W5IFS. Hopefully, by the March–April 2011 issue of *QEX* Larry will be back in the editor's chair. Larry, I wish you a speedy recovery, my friend.

### And Finally . . .

For the past several months Carol and I have been operating in a standby mode. We slowed down our travels after an automobile accident (we were rear-ended) aggravated old injuries in Carol's back. Concerning her health issues, we are starting to see the light at the end of the tunnel and believe that this year will be better than the last.

With this issue we complete eight years of the restart of *CQ VHF* with me as Editor; Gail, K2RED, as Managing Editor; my wife Carol as Editorial Consultant; the staff at CQ Communications who make the magazine a print reality; plus all of you who have contributed to the content of this magazine. It has been great fun to be your editor, to get to meet you during our travels, and to publish your articles. I look forward to a future of working with you to continue to serve this niche in our wonderful hobby.

If you have a story to tell or a project to publish, then please send me an e-mail at <n6cl@sbcglobal.net>. I would like to hear from you and give you a venue for your experiences.

Until the next issue… 73 de Joe, N6CL

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# QUARTERLY CALENDAR OF EVENTS

## Current Contests

**European Worldwide EME Contest 2011:** Sponsored by DUBUS and REF. The EU WW EME contest is intended to encourage worldwide activity on moonbounce. Information for this contest is available at the following website: <http://www.marsport.org.uk/dubus/EME Contest2011.pdf>.

**Spring Sprints:** These short duration (usually four hours) VHF+ contests are held on various dates (for each band) during the months of April and May. Please check with my VHF Plus column in *CQ* magazine for a future announcement.

**GHz and Up World Wide Club Contest:** Sponsored by the San Bernardino Microwave Society, this contest runs the second weekend of May. Rules are available at the following URL: <http://www.ham-radio.com/sbms/2011_2ghz-up_test.pdf>.

The **June VHF QSO Party** will be held from June 11-13.

## Conference and Convention

**Southeast VHF Society**: The 15th annual conference will be hosted in Huntsville, Alabama, April 29–30. For information on registering for the conference, check the society's website at <http://www.svhfs.org/>.

### Quarterly Calendar

*The following is a list of important dates for VHF Plus enthusiasts:*

| | |
|---|---|
| Feb. 3 | New Moon |
| Feb. 6 | Moon apogee |
| Feb. 8 | The *á-Centaurids* meteor shower peak |
| Feb. 11 | First quarter Moon |
| Feb. 18 | Full Moon |
| Feb. 19 | Moon perigee |
| Feb. 24 | Last quarter Moon |
| Mar. 4 | New Moon |
| Mar. 6 | Moon apogee |
| Mar. 12 | First quarter Moon |
| Mar. 12–13 | First weekend of DUBUS EME contest |
| Mar. 19 | Full Moon |
| Mar. 19 | Moon perigee |
| Mar. 26 | Last quarter Moon |
| Apr. 2 | Moon apogee |
| Apr. 3 | New Moon |
| Apr. 9–10 | Second Weekend of DUBUS EME contest |
| Apr. 11 | First quarter Moon |
| Apr. 17 | Moon perigee |
| Apr. 18 | Full Moon |
| Apr. 21 | The *Lyrids* meteor shower peak |
| Apr. 25 | Last quarter Moon. |
| Apr. 29 | Moon apogee. |
| Apr. 29–30 | Southeast VHF Society Conference |
| Apr. 30–May 1 | SBMS 2 GHz and Up Club Contest. Third weekend of DUBUS EME contest |
| May 3 | New Moon |
| May 5 | The $\eta$ *Aquarids* meteor shower peak |
| May 7–8 | Fourth weekend of DUBUS EME contest |
| May 10 | First quarter Moon |
| May 15 | Moon perigee |
| May 17 | Full Moon |
| May 20–22 | Dayton HamVention® |
| May 24 | Last quarter Moon |
| May 27 | Moon apogee |
| June 1 | New Moon; partial eclipse of the Sun |
| June 4–5 | Fifth weekend of DUBUS EME contest |
| June 9 | First quarter Moon |
| June 11–13 | June VHF QSO Party |
| June 12 | Moon perigee |
| June 15 | Full Moon; total eclipse of the Moon |
| June 23 | Last quarter Moon |
| June 24 | Moon perigee |
| June 27 | The June *Boötids* meteor shower peak. |

**Dayton HamVention®:** The Dayton HamVention® will be held as usual at the Hara Arena in Dayton, Ohio during May 20–22. For more information, please see the website at: <http://www.hamvention.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 and/or conference organizers have announced calls for papers for their forthcoming conferences:

**Southeastern VHF Society Conference:** Technical papers are solicited for the 15th annual Southeastern VHF Society Conference to be held in Huntsville, Alabama on April 29-30. Papers and presentations are solicited on both the technical and operational aspects of VHF, UHF, and Microwave weak-signal amateur radio. In general papers and presentations on non-weak-signal related topics such as FM repeaters and packet will not be accepted, but exceptions may be made if the topic is related to weak signal. For example, a paper or presentation on the use of APRS to track rovers during contests would be considered.

The deadline for the submission of papers and presentations is March 11. All submissions should be in Microsoft Word (.doc) or alternatively Adobe Acrobat (.pdf) files. Pages are 8-1/2 by 11 inches with a 1-inch margin on the bottom and æ inch margin on the other three sides. All text, drawings, photos, etc. should be black-and-white only (no color). Submissions for presentation at the conference should be in PowerPoint (.ppt) format, and delivered on either a USB memory stick or CDROM or posted for download on a website of your choice.

Please indicate when you submit your paper or presentation if you plan to attend the conference and present there or if you are submitting just for publication. Papers and presentations will be published in the conference *Proceedings*. Send all questions, comments, etc., to the program co-chair, Robin Midgett K4IDC via <K4IDC@comcast.net>. Send all presentations to Steve Kostro, N2CEI, via <SVHFS2011@downeastmicrowave.com>. For further information about the conference please see the society's website: <http://www.svhfs.org>.

**Central States VHF Society Conference:** Technical papers are solicited for the 45th annual Central States VHF Society Conference to be held in the Dallas-Ft. Worth, Texas area. For more information go to the society's website at: <http://www.csvhfs.org>.

## Meteor Showers

The $\alpha$-*Centaurids* meteor shower is expected to peak on February 8 at 1130 UTC. The $\gamma$-*Normids* shower is expected to peak on March 14. Other February and March minor showers include the following and their possible radio peaks: *Capricornids/Sagittarids,* February 1*; and $\chi$-*Capricornids*, February 13*.

The *Lyrids* meteor shower is active during April 16–25. It is predicted to peak around 2200 UTC on April 22. This is a north-south shower, producing at its peak around 10–15 meteors per hour, with the possibility of upwards of 90 per hour.

A minor shower and its predicted peak is $\eta$-*Puppids* (peak on April 24). Other April, May, and June minor showers include the following and their possible radio peaks: April *Piscids*, April 20; $\delta$-*Piscids*, April 24; $\eta$-*Aquariids*, May 6; $\eta$-*Lyrids*, May 9; $\varepsilon$-*Arietids*, May 9; May *Arietids*, May 16; and *o-Cetids*, May 20; June *Arietids,* June 7*; *zeta-Perseids,* June 9*; June *Boötids*, June 27, 2100 UTC; and $\beta$-*Taurids*, June 28. An asterisk (*) indicates that the shower may have multiple peaks.

For more information on the above meteor shower predictions please see Tomas Hood, NW7US's "VHF Propagation" column beginning on page 70 in this issue of *CQ VHF*, as well as visit the International Meteor Organization's website: <http://www.imo.net>.

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**Output Power:**
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**Drain Voltage:**
44V

**Drain Current:**
30A max.

**Input Impedance:**
50Ω (unbalanced)

**Output Impedance:**
50Ω (unbalanced)

**Final Transistor:**
VRF150 x 4

**Circuit:**
Class AB parallel push-pull

**Cooling Method:**
Forced Air Cooling

**Multi-meter (F.S.):**
Output Power Pf 1kW
Reflected Power Pr 100W
Drain Voltage Vd 60V
Drain Current Id 50A

Input/Output Connectors:
UHF SO-239 (Type M-J)

**AC Power:**
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**Dimension:**
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# An Experimental Linear Translator for 2 Meters to 10 Meters

There is nothing for satisfying for a teacher than to watch and marvel at the success of his or her students. Here WC5Z proudly presents the results of two of his students' year-long work on a very practical project for the VHF+ frequencies.

**By Mozar Naing, KE5VKO, Nozar Naing, KE5VKP, and Michael Helm,* WC5Z**

In this article we describe the design and development of a prototype linear translator to translate any type of modulated signal in a small portion of the 2-meter amateur radio band and retransmit it in the 10-meter amateur radio band. The goal application is an experimental payload on a high-altitude balloon flight.

This project was developed over the course of two semesters of undergraduate Project Lab classes in the Electrical and Computer Engineering Department at Texas Tech University in Lubbock, Texas. The prototype was designed and built by KE5VKO and KE5VKP, with WC5Z as the project faculty adviser.

## Project Goals

The project goals were to design and build a prototype "test bed" linear translator for 2 meters to 10 meters. Ultimately this will lead to a final design which can be flown in a balloon payload to altitudes in excess of 80,000 feet and provide sufficiently strong signals to be received by mobile and fixed stations on the ground at a distance of many tens of miles based on line-of-sight coverage. The system should work well with a range of input signals such as might be received from a 50-watt ground station when in the air, and should also function and not be overloaded when the payload is on the ground and nearby low-powered fixed or mobile stations are used to test the system. The system should have sufficient automatic gain control to work under those extremes of input signal levels. The system should translate any type of modulated signal on the input frequency to an equivalent signal on the output frequency. The translator should work for FM, SSB, CW, etc., signals and linearly translate them without adding any significant distortion. The system should be useful to support communications for the balloon chase crew as well as provide a communications mechanism for more distant stations.

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## The Basic Design

An input frequency sub-band in the 2-meter band is filtered and amplified and down-converted to an intermediate frequency in the 87-MHz range. The 87-MHz IF signal is filtered and further amplified, and then further down converted to a small sub-band spectrum in the 10-meter band. The final 10-meter band signal spectrum is further filtered and amplified by a series of linear amplifiers up to the 500-mW power level as the output of the system. Automatic gain control circuitry is included to allow for a wide range of input signals while maintaining a strong output signal.

One early goal of the design was to limit the range of frequencies translated to a somewhat narrow range of frequencies. Our initial goal was that approximately 50 kHz of spectrum in the 2-meter band would be converted to an equivalent 50 kHz of spectrum in the 10-meter band. Since this was an experimental test bed, we decided to initially approach the problem by using multi-pole LC filters. We used a double-conversion design to allow multiple places in the signal path for filtering. This approach allowed us to pre-filter the incoming 2-meter band signal, further filter the 87 MHz IF signal, and provide additional filtering at the 10-meter output frequency. Multi-pole LC filters were designed with the assistance of computer simulation tools. The basic block diagram is shown in figure 1.

One particularly clever and unique aspect of this design is the use of a single local oscillator, even though it is a double-conversion design. To convert from 144 MHz to 28 MHz, we can use a mixer with low-side injection at 116 MHz to yield a difference between the 144 MHz and the 116 MHz of 28 MHz, which is the desired output frequency. We already had available the overtone quartz crystal near 58 MHz which could be used with a doubler circuit to obtain the needed 116-MHz local oscillator frequency. When we analyzed the gain budget for the overall system, we realized that with a single-conversion scheme it would be necessary to have a lot of gain on single frequencies, and this is certainly undesirable due to the potential for overall system instability. We decided to use the 58-MHz quartz crystal to generate a single local-oscillator signal which could be used in a first down conversion from 145 to 87 MHz and then again in a second down conversion from 87 to 29 MHz. This scheme only required one quartz crystal and one local oscillator, and allowed us to distribute the system gain across three different frequencies, which would aid in system stability. In the actual prototype test bed, we did use two separate local oscillators, but could only use a single local oscillator in a final version.

## The Technical Details

**Bandpass Filter.** The desired frequency range of the first bandpass filter is 144.50 MHz to 144.55 MHz. This gives a center frequency of 144.525 MHz. We used a three-section coupled resonator filter. The tapped-L design properly matches the impedance for input and output, since using higher impedance for the resonators yielded more realistic component values. This filter is not perfect for the design, but represents a reasonable tradeoff between bandwidth and loss for our test bed. Capacitors C5 and C6 could be increased to reduce the filter loss, but would degrade the bandwidth perfor-

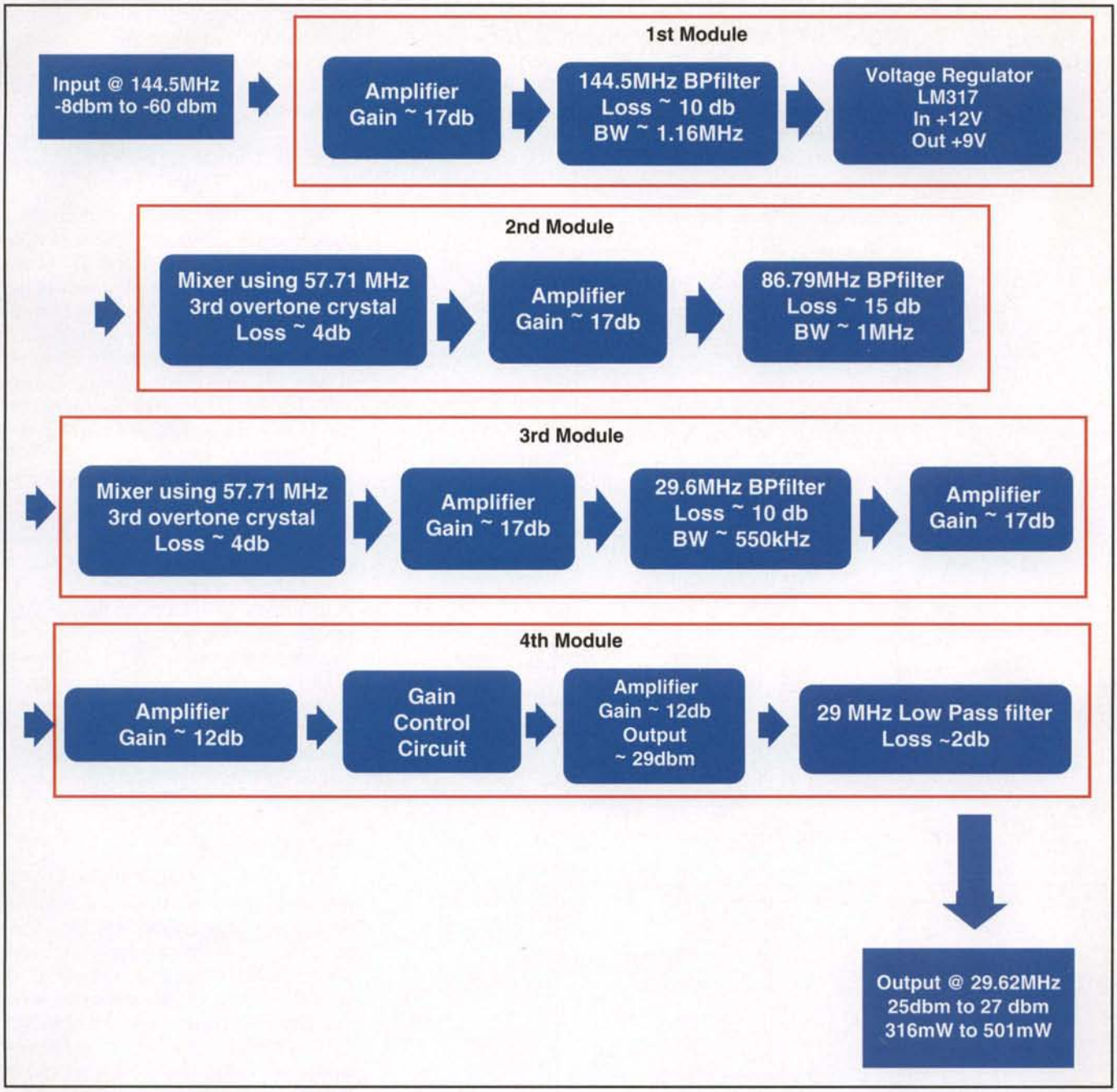


*Figure 1. Translator block diagram.*

mance. Figure 2 shows the final circuit simulation design of the prototype bandpass filter.

The 86.7MHz and 29.6MHz filters are designed in a similar way but use only two coupled resonators (figures 3 and 4).

**Amplifier.** Several low-level basic gain blocks are needed throughout the system. The basic circuit for a wideband amplifier based on the MSA 0886 is shown in figure 5. The RF IN and RF OUT terminals are protected by DC blocking capacitors C1 and C2. Capacitor

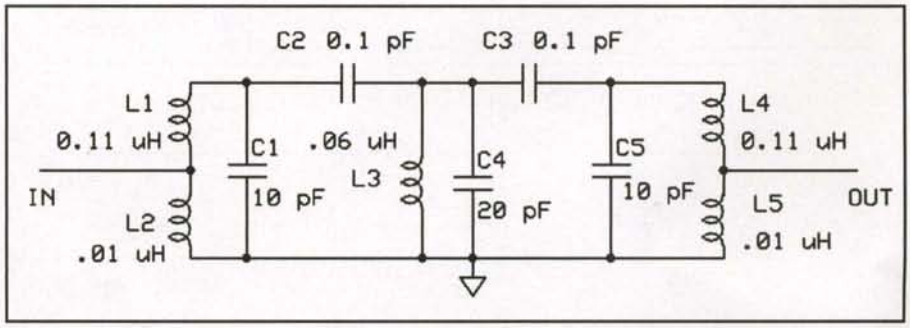


*Figure 2. The 144-MHz bandpass filter simulation design.*

C3 is used for two purposes. It will prevent signals from being coupled to the DC power supply and from there to other circuits. It will also prevent higher frequency signals and noise spikes from outside sources from affecting the amplifier circuit. Capacitors C4 and C5 serve to decouple low-frequency signals and smooth out short-duration fluctuations in the DC supply voltage.

Direct current is fed to the amplifier through current-limiting resistor R1 via the RF OUT terminal on the MSA 0886. The value of R1 is 110 ohms, based on operating the MSA 0886 at 20 mA, which is a reasonable value for this application. As shown in figure 1, this basic wide band amplifier block is used several places in the design.

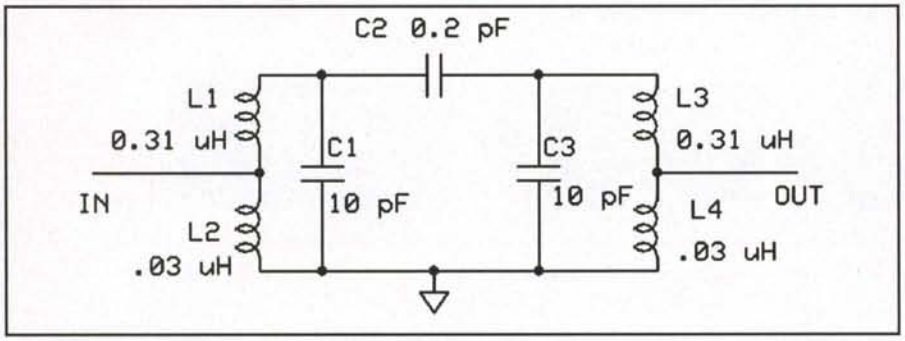


*Figure 3. The 86.7-MHz filter simulation design.*

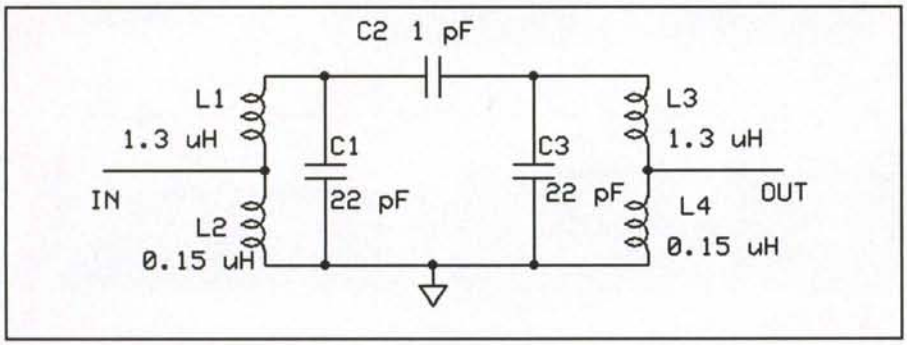


*Figure 4. The 29.6-MHz filter simulation design.*

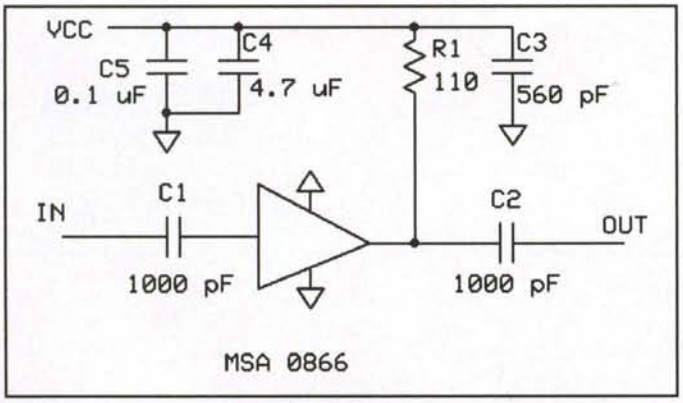


*Figure 5. Basic low-level gain block circuit.*

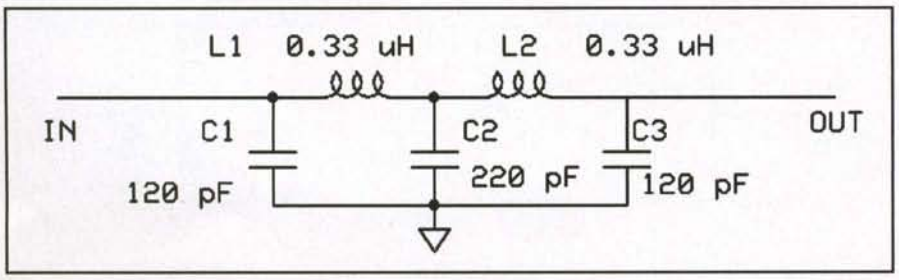


*Figure 6. Final-stage 28-MHz low-pass filter.*

## Attenuator for Automatic Gain Control

We wanted the output at 10 meters to be between 20 mW and 1 W under a wide range of input signals. We used a shunt PIN diode as a mechanism to control the output level in one of the driver stages prior to the final amplifier on 10 meters. We have not yet implemented a full AGC system in our test bed, but have tested the shunt PIN diode attenuator and found that it does give us a significant control range.

## Final Stage Class A Amplifiers and Low-Pass Filter

Since this is a linear translator, the output driver and power amplifier stages must be linear amplifiers. We used class-A amplifiers based around the 2N3866 bipolar transistor in our test-bed design. The output from the amplifier is fed into a 28-MHz low-pass filter in order to reduce any harmonic content and provide impedance matching to the 50-ohm antenna. The low-pass filter schematic can be seen in figure 6. It has a loss of about 2 dB.

## The Prototype

The block diagram of the 144-MHz module is shown in figure 7. It includes the first amplifier and the 144 MHz bandpass filter along with a voltage regulator. The 144-MHz module prototype is shown in figure 8. The output 144-MHz signal is shown in figure 9. The input signal 144 MHz is fed from a signal generator at –8 dBm and —60 dBm, which are the two extremes of input power levels we specified for this project.

## The 87-MHz Intermediate Frequency Module

The block diagram of the second module is shown in figure 10. It includes the first down conversion mixer, amplifier, and an 86.7 MHz bandpass filter (figure 11). The input signal is fed from the first module output. The output signal is shown in figure 12.

## The 29-MHz Module

The block diagram of the third module is shown in figure 13. It includes the sec-

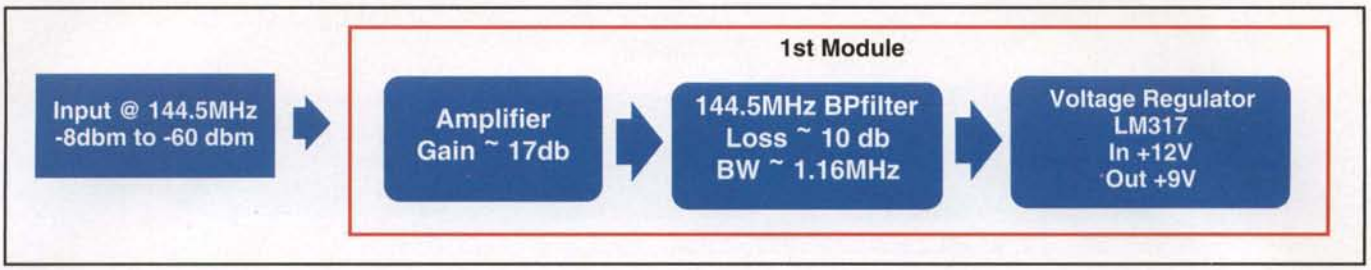


*Figure 7. The 144-MHz module.*

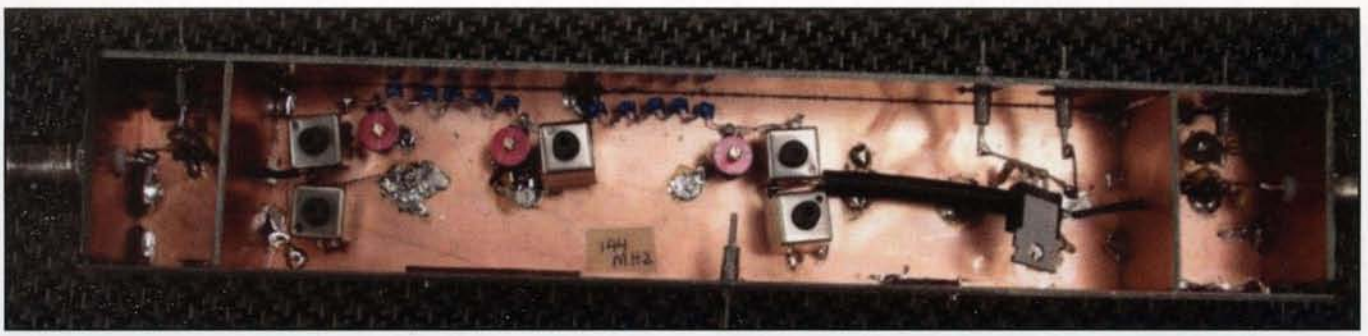

*Figure 8. The 144-MHz module prototype.*

ond down-conversion mixer, amplifier, 29.6-MHz bandpass filter and another amplifier. Input signal is fed from the second module output. The actual prototype is shown in figure 14.

## Final Amplifier Module

The block diagram of the fourth module is shown in figure 15. It includes amplifiers and ~29 MHz lowpass filter (figure 16). Input signal is fed from the third module output. The output signal is shown in figure 17.

## Overall System Schematic

Figure 18 shows the overall prototype test-bed schematic

## System Performance

The goals of the project were that the system would work with a wide range of input signals, from a ground transmitter perhaps 50 miles away, but also would have to work when the payload was on the ground with a nearby transmitter. The path loss equation is:

Loss dB = 36.6 + 20 log (dist in miles) + 20 log (freq in MHz)

With the system as part of a balloon payload, a potential input signal might be a 50-watt mobile signal with a line-of-sight distance of 50 miles. This would yield a path loss of about 114 dB. With a 50 watt (+ 47 dBm) transmitted signal on the ground, this would yield approximately –67 dBm input signal level at the translator. During on-the-ground testing, a low-power transmitter (approximately 100 mW, or + 20 dBm) might be used at a test distance of 200 feet. Path loss in this case would be approximately 15 dB, so the input to the translator could be as high as +5 dBm. This requires a significant dynamic range for the system. Our goal was an input range from –60 dBm to –8 dBm, and this was tested using a signal generator as an input source.

We tested the performance of the system using signal generators and a spectrum analyzer and also did some testing using a PXI automated test chassis.

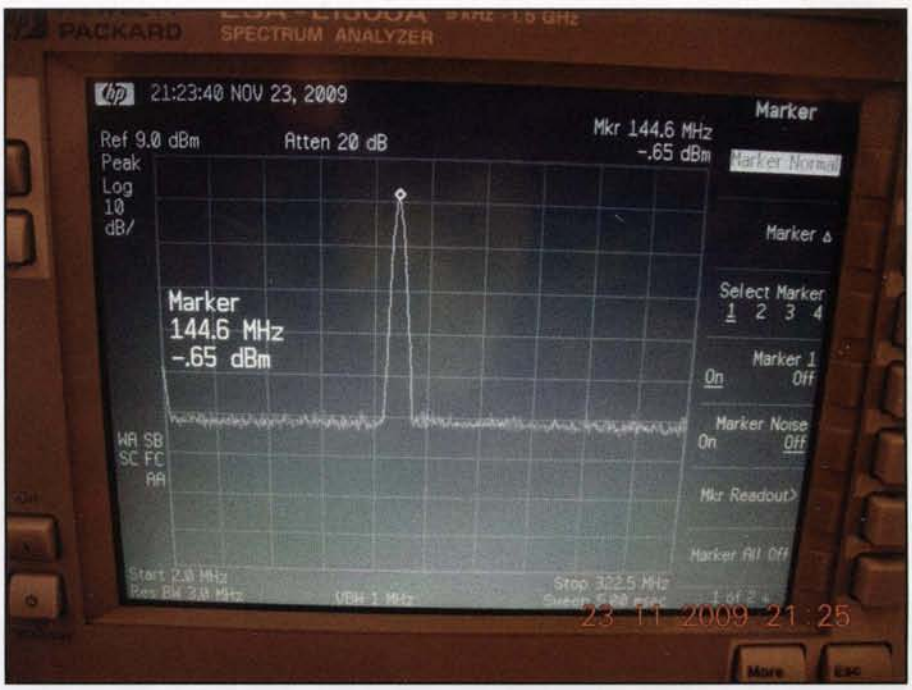


*Figure 9. Spectrum analyzer output results from the first module with input extremes of –60 dBm to –8 dBm.*

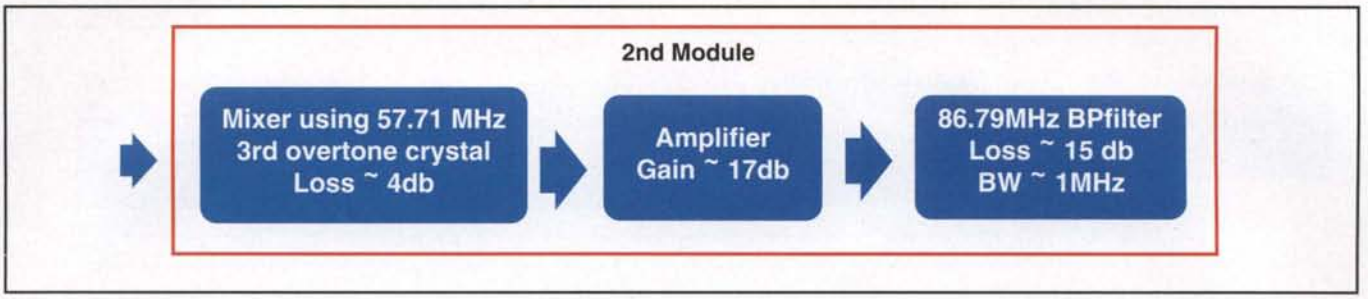


*Figure 10. The 86-MHz intermediate frequency module.*

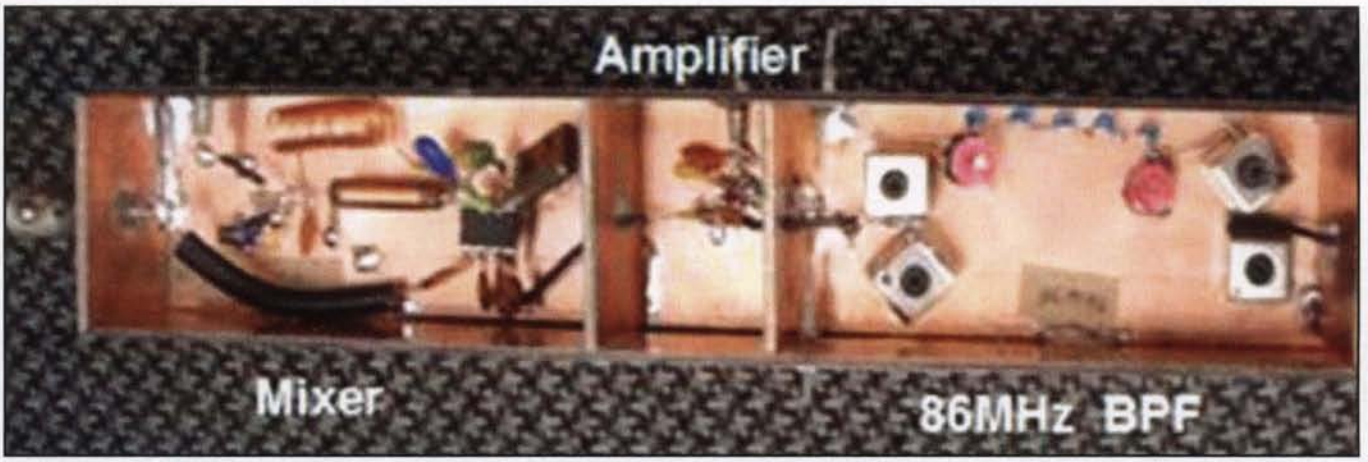


*Figure 11. The prototype 86-MHz module.*


*Figure 12. The output of 86-MHz intermediate frequency module with the extremes of input signal.*

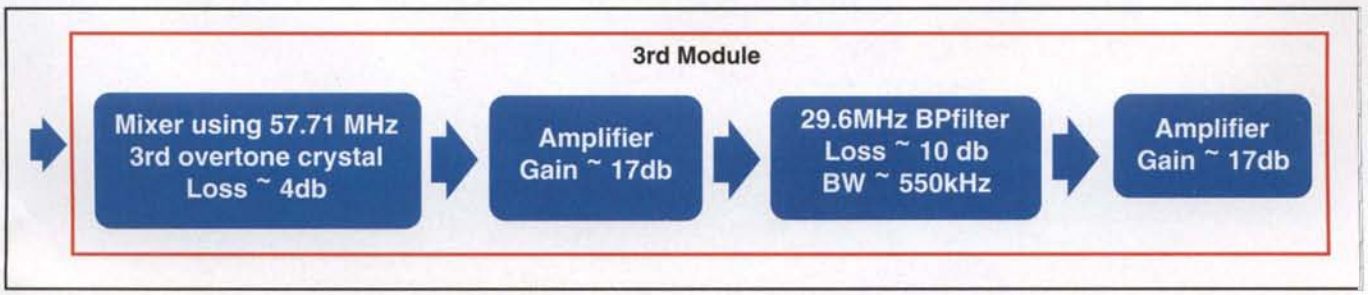


*Figure 13. The 29-MHz module.*

*(Continued on page 79)*

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# Amateur Radio and the Cosmos Part 7 – Smoke in Terra Alta

Behind the smoke that the engine of the B&O Railroad left in the West Virginia mountains is the story of a VHF pioneer who was known as "Smoke." Here WA2VVA smokes out another tale of one of our pioneers of the past as a way of connecting us with the cosmos.

**By Mark Morrison,* WA2VVA**

Sensing a change in speed, the engineer moves the cutoff to 70 percent, allowing steam to fill the cylinders. The fireman nods approvingly as the locomotive begins its assault on the grade leading to Terra Alta, West Virginia. As the throttle is advanced, a great plume of smoke is released over the mountains, announcing the struggle of the locomotive against the forces of gravity. For a moment it appears they won't make it. However, as the driver slows, almost imperceptibly, the great machine awakens, pulling its load to the summit.

The Appalachian Mountains stretch 2700 miles from Alabama to Canada. Among the oldest mountains in the world, they are rich in natural resources. Nowhere is this more evident than in West Virginia, where abundant coal, gas, and timber reserves have fueled an industrial revolution, numerous military campaigns, and the westward expansion of both railroads and people for over a hundred years. The Baltimore & Ohio Railroad first crossed these mountains in the 1800s, reaching present-day Terra Alta in the 1850s. Photo 1 shows a coal drag (2-8-8-0 Mallet engine) with a helper at the rear (0-8-8-0) climbing the Cranberry grade through the Saltlick turns. This picture was taken in 1935 just below Terra Alta in what railroaders called "The Hole."

Terra Alta is widely recognized as one of the highest elevation towns on the B&O line, but less well known are its connections to radio. In the late 1800s Terra Alta was home to a significant but largely forgotten figure in wireless communications. In fact, some believe that the earliest experiments in radio were conducted in this area. In the August 1948 issue of *QST* magazine, Joseph E. Lebo, W2OEU, recounted the story of Dr. Mahlon Loomis. A dentist by trade, Loomis is reported to have demonstrated a form of wireless telegraphy as early 1868, using two copper-clad kites separated by a distance of 18 miles along a ridge of the Blue Ridge Mountains. Rumor has it that a tree

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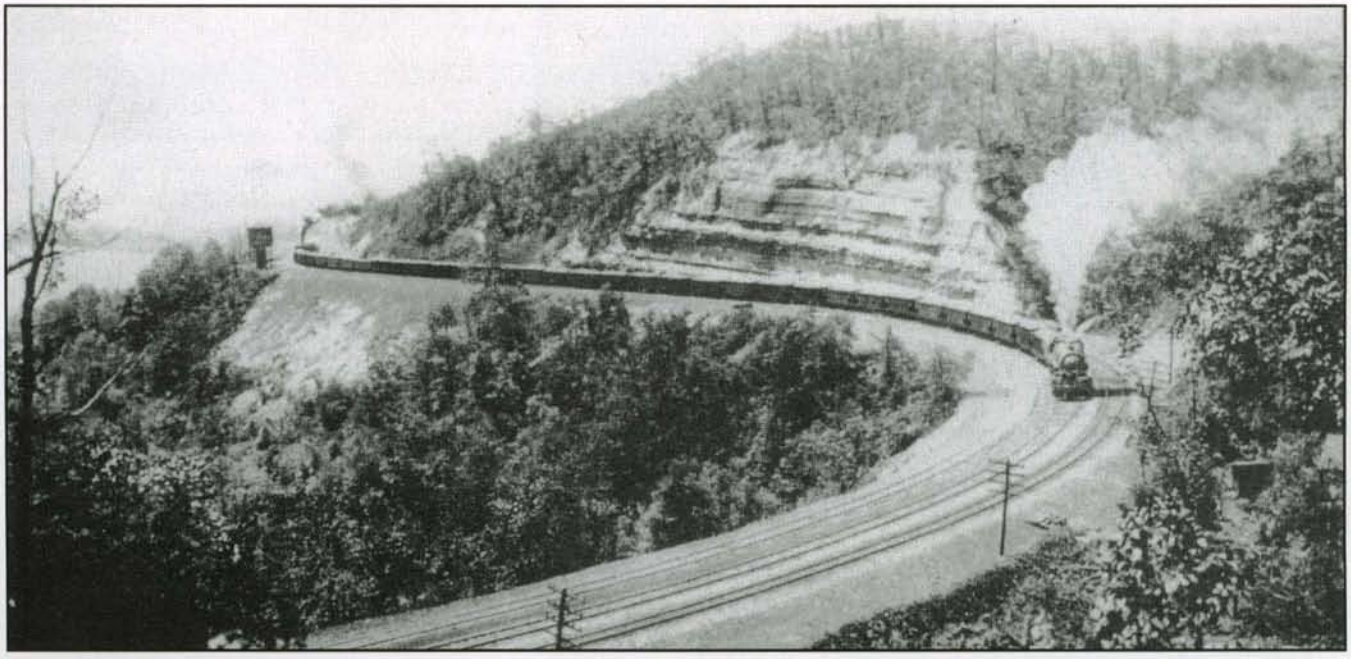

*Photo 1. A coal drag (2-8-8-0 Mallet engine) with a helper at the rear (0-8-8-0) climbing the Cranberry grade through the Saltlick turns. This picture was taken in 1935 just below Terra Alta.*

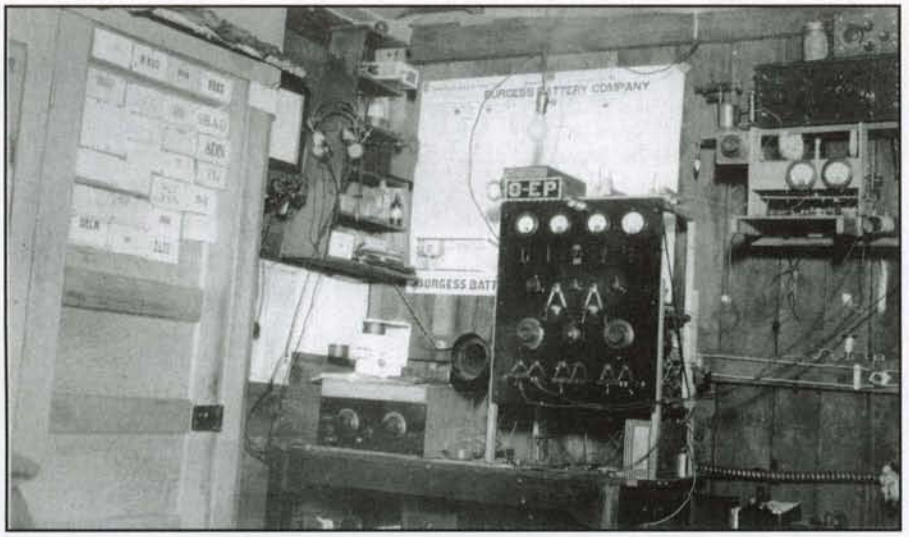


*Photo 2. Amateur radio station 8EP as it appeared in 1926.*

in Terra Alta still bears witness to some of Dr. Loomis's experiments as revealed by the rusting wires embedded within its bark. Separating fact from fiction can be difficult, but there is no denying that the U.S. Patent Office recognized the work of Loomis by issuing Letters Patent No.129,971 for his "Improvement in Telegraphing."

Trains reaching Terra Alta via the Cranberry Grade often begin their journey at Grafton, following a tortuous route of steep grades and winding curves that weave along the base of the mountains. Located 100 miles south of Pittsburgh, Grafton is where the B&O established work shops to maintain equipment and stage the work crews pushing the rails ever westward. In addition to moving people and resources, the railroads brought news from the big cities. However, a change was in the air—literally. In 1920 the first commercially licensed broadcast station, KDKA, went on the air in Pittsburgh. No longer did people have to wait for the trains to climb out of the hole to get news.

Rooted in the amateur activities of one Frank Conrad, 8XK, an electrical engineer working for the Westinghouse Electric and Manufacturing Company, KDKA would bring news, weather, and farm forecasts to the region, scaling these mountains with no smoke at all. During the evening hours the signals from KDKA would carry even farther. Although Westinghouse intended to use broadcasting as a means to sell radio sets to the general public, it was the amateur radio community that formed the first listening audience. There were plenty of amateurs in the area, except perhaps in West Virginia.

In 1923, the United States Department of Commerce published a list of all licensed stations in America. Of the roughly 2500 stations listed in the 8th district, which at that time encompassed West Virginia, Ohio, and portions of Pennsylvania, New York, and Michigan, only 75 were located in West Virginia. Furthermore, only three of these stations were located in Grafton. Earl Cassell, 8BCR, had his 10-watt station on Lincoln Street, while J. Clyde Lewis, 8CXN, had a 12-watt station over on Washington. On North Washington there was A. B. Schwer, 8EP, with his 18-watt station. Photo 2 shows amateur station 8EP as it appeared in 1926.

Schwer described his station on the back of one such photo as follows:

Amateur Station 8EP
Apr 26 1926
Deforest H tube 750V
MG UX112 for modulator
901 N Washington St.
AB Schwer 1st Op.

The large white object hanging on the wall in the photo is a special map of radio districts published for the amateur radio community by the Burgess Battery Company, the well-known manufacturer of dry cells, which were so popular in radios and flashlights of the era. Burgess would later become known the world over for its Ray-O-Vac brand of batteries. At the time this photo was taken, Schwer is believed to have worked in a battery (radio) shop in Grafton. First licensed in 1922, Schwer was affectionately known as "Smoke" for the pipe he so enjoyed. However, unknown to anyone was his destiny to become one of West Virginia's best known VHF pioneers.

By the early 1940s Schwer had relocated W8EP to Terra Alta and modernized his station, adding a Hallicrafters SX-17 with matching speaker as shown in photo 3.

Schwer was mentioned numerous times in *CQ* magazine, making regular appearances in both the 50 Mc and 144 Mc Honor Rolls, beginning in 1948 and

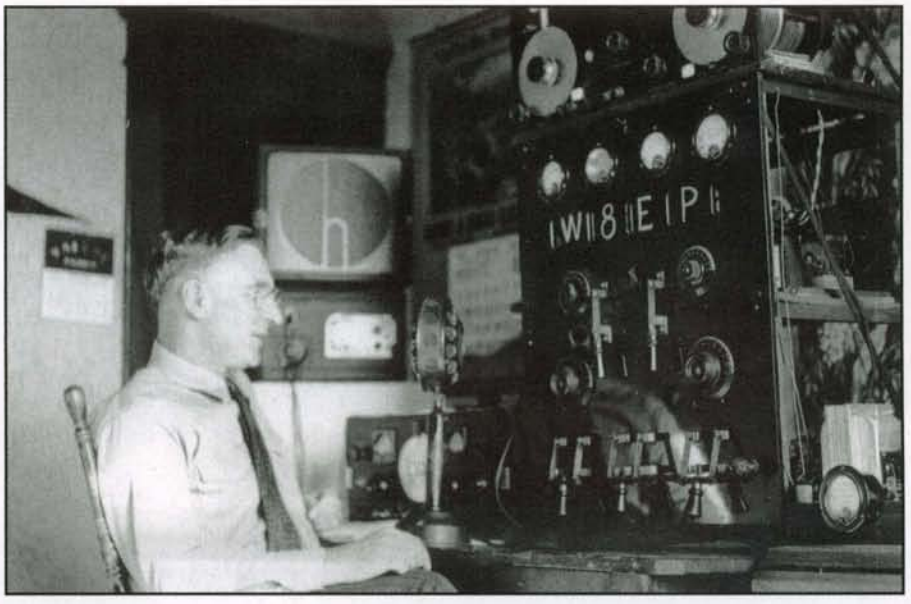


*Photo 3. By the early 1940s Schwer had relocated W8EP to Terra Alta and modernized his station, adding a Hallicrafters SX-17 with matching speaker.*

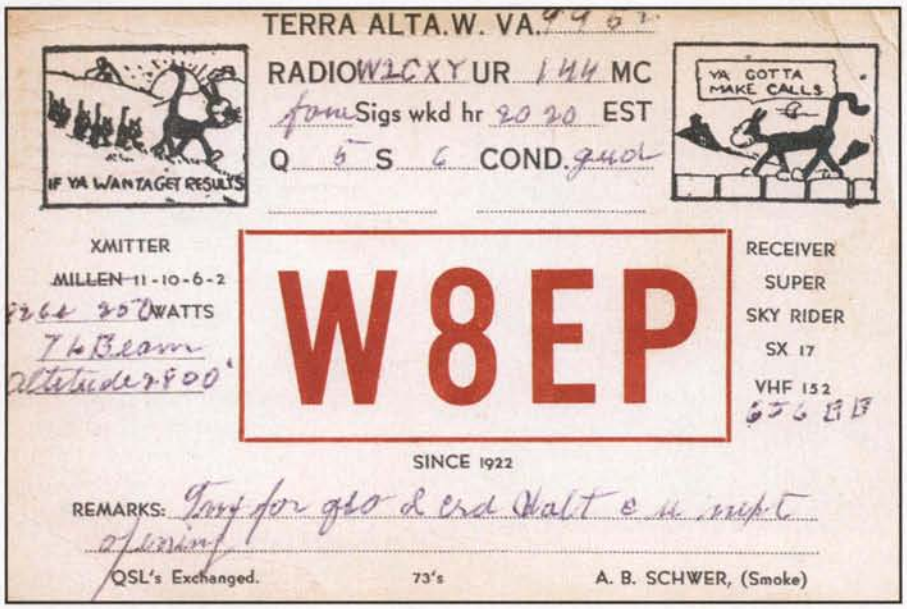


*Photo 4. In 1952, W2CXY picked up West Virginia by way of W8EP.*

continuing throughout the 1950s. During this time, West Virginia was considered a rare state for VHF enthusiasts, but when W8EP added an RME VHF 152 converter to his Hallicrafters Super Sky Rider, things began to change. Starting on 50 Mc, by 1948 Schwer had accumulated 14 states in 2 call areas. Then on 2 meters, running 100 watts into a 4-element horizontal beam, by 1949 Smoke had racked up 6 states in 4 districts. Later, he would turn to 220 Mc and 420 Mc. Working from West Virginia was tough, partly because of the terrain and partly due to the lack of others to talk to. However, Smoke kept at it, calling and listening on a regular basis, and keeping weekly schedules with other amateurs in the region.

By 1950 things were looking up as more and more amateurs were getting on 2 meters and seeking to add West Virginia to their "states worked" list. The December 1950 issue of *QST* recounts how Smoke worked the following VHF stations all in a single October 17th session: W2BAV, W1IZY, W1BCN, W2NLY, W2QHZ, W1MNF, W2AZL, W2GCJ, W1HDQ, W3OXQ, W1DJK, W2FHJ, W1KTS, W2JRP, and W3OWW.

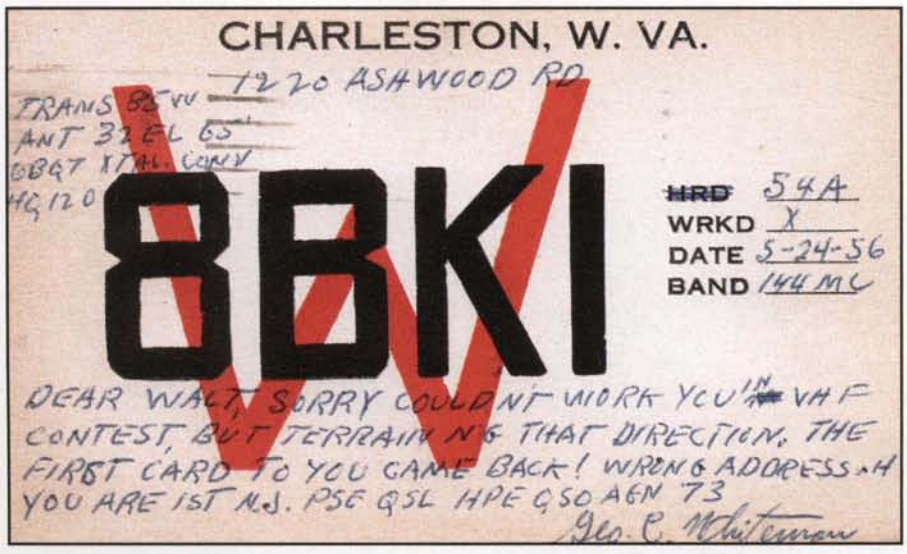


*Photo 5. Well-known West Virginia ham George C. Whiteman, W8BKI, worked for one of the broadcast stations in Charleston. Shown here is his 1956 QSL card.*

Although many VHF pioneers are listed among those calls, note that none are two-letter calls. Schwer seemed to be alone in that department. Born in 1885, or just 20 years after the Civil War, Smoke was already 65 when most other VHF men were likely half that age! Furthermore, Schwer brought to the airwaves an "old-fashioned" fist that *CQ* VHF-UHF Editor E. M. Brown, W2PAU, once referred to as "OT DX swing [and] music to an ol' brass-pounder's ears."

*QST*'s "The World Above 50 Mc." Editor Ed Tilton, W1HDQ, credited Smoke for giving many VHF enthusiasts their first West Virginia contacts on 420, 144, 50, and 28 Mc. A picture of the stacked antenna system used by W8EP appeared in the December 1950 issue of *QST*. That same issue shows what appears to be his first appearance in the 2-meter standings, giving him 17 stations in 7 call areas. One year later, "Smoke Signals" were worked by 13 stations in Indiana, Michigan, and Ohio in another single October session, as reported in the February 1952 issue of *CQ*. Later that same year, W2CXY would pick up West Virginia, also by way of W8EP, as shown in photo 4.

Another well-known West Virginia ham was George C. Whiteman, W8BKI, who worked for one of the broadcast stations in Charleston. His 1956 QSL card appears in photo 5. The first mention of W8BKI in the *QST* 2-meter standings appears to be in the March 1950 issue.

Not far from Charlestown is the town of Cass. Lying along the banks of the Greenbrier River, Cass embodies what remains of West Virginia's proud logging industry. Each year rail fans come to this remote spot to be transported up Cheat Mountain by the same Shay locomotives that once hauled lumber there. Photo 6 shows Shay #5, a 90-ton locomotive still at work after 106 years!

However, in the midst of all this wilderness and smoke lies a uniquely different kind of machine, one that for all its grandeur and majesty makes no noise, creates no smoke, and is ideally suited to the isolation and rugged wilderness surrounding it. Situated roughly 10 miles east of Cass, in the town of Green Bank, is the National Radio Astronomy Observatory (NRAO) and the world's largest fully steerable radio telescope.

The NRAO facility itself is rather flat, being nestled within a valley and largely surrounded by spruce trees rumored to have some RF-absorbing properties. The

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surrounding mountains provide some shelter from errant radio signals, such as those from VHF operators in more populated areas. In 1958, the FCC established the National Radio Quiet Zone here, limiting radio transmissions across a wide area of West Virginia, as a means of further protecting the sensitive work being done in Green Bank. Photo 7 shows the 100-meter telescope shrouded in low-lying clouds and trees.

Although the 100-meter telescope is most imposing, being visible from the surrounding roads, several historic telescopes are represented here. To the right of the main entrance is a full-size replica of the Karl Jansky scope that was constructed here in 1966 by the same Bell Labs carpenter who worked on the original. Then, right in front of the visitor's center entrance, stands the original Grote Reber, W9GFZ, radio telescope.

All the telescopes at this facility are served by a single road where only diesel vehicles are allowed, as shown in photo 8. Note the 85-foot dish used by Frank Drake for Project Ozma just above the trees in the distance.

During a recent visit to the NRAO I watched a public education film that mused how the TV shows of the 1950s are just now reaching a distance of 50 light years from Earth! That is farther than the closest star systems Drake was studying back when those shows were being broadcast. This made me wonder about all those amateur signals generated before and since then. Might the answer to Drake's quest lie not in commercial or scientific facilities, but rather in the dedicated work of thousands of radio amateurs around the world? Who can deny the significant role that radio amateurs played in the International Geophysical Year of 1957–1958, an event in which the scientific community actually encouraged amateurs to participate. Who is to say that amateurs cannot also play a significant role in the search for extraterrestrial life now and in the future?

Scientists familiar with the subject like to point out that in all of human history, our ability to search for life on other planets began just recently, with the discovery of radio. Although light waves may have been favored among the early theorists, it was the discovery of radio that really opened the door to extraterrestrial communications. Radio travels at the speed of light. It is not obscured by interstellar dust nor does it struggle to be recognized among the billions of visible stars. Still,

*Photo 6. Each year rail fans come to Cass, West Virginia to be transported up Cheat Mountain by the same Shay locomotives that once hauled lumber there. This photo shows Shay #5, a 90-ton locomotive still at work after 106 years.*

*Photo 7. The 100-meter telescope shrouded in low-lying clouds and trees at the National Radio Astronomy Observatory in Green Bank, West Virginia.*

radio astronomy is much younger than its optical brother. Everything we know about radio and its place in the cosmos is limited to what we've learned in just these past 100 years, a mere fraction of man's total existence on this planet. Perhaps most significant is that some of that knowledge can be attributed to the efforts of amateur radio enthusiasts.

The fact that amateur radio has contributed to our understanding of extraterrestrial communications cannot be overstated. From a backyard in Wheaton Illinois, where Grote Reber, W9GFZ, first created detailed radio maps of the heavens; to the banks of the Navesink River where Jack DeWitt, N4CBC, first touched the face of the moon; to a cornfield in Ohio where John Kraus, W8JK, detected what was then the most distant object known to man; to the planetary work of Gordon Pettengill, W1OUN; the discovery of the first binary pulsar by Joe Taylor, K1JT, and Russell Hulse, WB2LAV; and the SETI work of Philip Morrison, W8FIS, Dana Atchley Jr., W1HKK, Paul Horowitz, W1HFA, Paul Shuch, N6TX; and so many others—the amateur spirit has been, and continues to be, alive in the cosmos.

In the August 1975 issue of *QST* magazine, R. P. Haviland, W3MR, commented how some of the discoveries made by radio astronomers in the 20th century could have been made by amateur radio operators. All that was needed was the desire to ask questions and not give up trying. Amateurs are willing to put in countless hours waiting for that big break, without any guarantee of success. Witness that evening in October of 1950 when stations in New England were hearing rare "smoke signals" from Terra Alta and again in July of 1957 when John Chambers, W6NLZ, in California heard the even rarer signals of Ralph "Tommy" Thomas, KH6UK, coming in from Kahuku, Hawaii. Of this latter achievement, Tommy once commented how he "must have been crazy listening to static every night" in the months leading up to this historic event. Yet when the conditions were finally right, their persistence paid off. This trans-Pacific QSO went down as one of the greatest amateur accomplishments of the 20th century.

In his book *Boca's Brain* astronomer Carl Sagan hinted at the significant role that "radio hobbyists" may one day play in the search for life in other worlds. Indeed, if the amateur spirit transcends terrestrial boundaries, perhaps others are listening for us, putting in long hours, and waiting patiently for that big break. Perhaps they already noticed something about this planet, be it the faint signals of Dr. Loomis, the first transmissions of KDKA, or "smoke signals" from Terra Alta. Only time, and patience, will tell.

*(I wish to thank Chet Schwer, KD8ZR, son of W8EP, for his assistance with this article, including all of the black-and-white photos.—WA2VVA)*


*Photo 8. All of the telescopes at the NRAO are served by a single road where only diesel vehicles are allowed. Note the 85-foot dish used by Frank Drake for Project Ozma just above the trees in the distance.*

# The Mystique of Aurora

**We amateur radio operators have a dual fascination with aurora. First, it is a scientific wonder to behold. Second, we can use it as a propagation mode. In this article, WB2AMU describes his experiences with aurora.**

By Ken Neubeck,* WB2AMU

*Photo of aurora over Quebec taken by Don Pettit, astronaut on the ISS. (Photo courtesy of NASA)*

In my last article which appeared in the Fall 2010 issue of *CQ VHF*, I discussed some of the things that VHF operators would expect to see with the increasing solar activity that has started with the new sunspot cycle, Cycle 24. One of the propagation modes I mentioned that would be observed more frequently is aurora propagation on 6 meters and occasionally on 2 meters. In this article, I would like to discuss some of the unusual ways in which my ham career and personal life have been impacted by my knowledge of this interesting phenomenon.

## Working Aurora on 6 Meters

My first taste of aurora propagation on 6 meters occurred on May 10, 1992. Beginning at 8 AM, I was hearing some very strange, distorted CW and SSB signals on my Swan 250 six-meter transceiver. By listening to a few of the SSB stations that were on, I learned that a full-fledged aurora opening was in progress and had been since 5 AM that morning. With my drifting Swan 250 transceiver and a vertical antenna I was able to work WA8RCN and WZ8D in Ohio and W8AH in West Virginia over the next 30 minutes. The opening subsided and I even heard some sporadic-*E* activity a few hours later into Georgia. Then aurora activity came back that same day at 10 PM. I worked Lefty, K1TOL, in Maine at 10:30 PM. The *K*-index reached as high as 8 that day, so in retrospect this was a very significant opening.

I then experienced more aurora openings on 6 meters over the next 15 years and upgraded my station to a more modern radio (Yaesu FT-690 plus Mirage amplifier), adding directional antennas such as a two-element Yagi and later a three-element Yagi. With the directional antennas at home as well as for portable operations, I learned that I had to point the antennas north to get the full benefit of aurora backscatter.

As many hams are aware, aurora is both a visual and a radio mode. The visual mode is often referred to as the Northern

*Figure 1. The aurora borealis, commonly known as the Northern Lights. (Photo courtesy of NOAA)*

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Lights (see figure 1). It is of interest that aurora was discovered as a propagation mode by hams on the old 5-meter band back in 1939. Thus, its interest for radio only covers a period of just over seventy years, whereas it has been known as a major visual phenomenon in the sky for several hundred years.

My initial experiences with aurora on 6 meters came less than a year after having experienced my first sporadic-*E* opening on 6 meters (during the June 1991 VHF contest), and I wanted to learn more about these two propagation modes on VHF. This led to many visits to the physics library of my alma mater, Stony Brook University on Long Island. Remember, the year 1992 was well before the full-scale implementation of the internet, and thus science libraries were the major source of information for material on propagation modes in those days.

Over the course of several visits to the library, I found books covering these phenomena, and I discovered that many rocket experiments were conducted at different locations in the study of both sporadic-*E* and aurora propagation. I found out that many of the early sporadic-*E* related rocket launches took place at Wallops Island, Virginia and Eglin AFB in Florida. In addition, many aurora-related rocket launches took place in northern latitudes, primarily in Canada, such as Fort Churchill in Manitoba, using Nike Cajun and Aerobee rockets. A new world was opened to me, as I was finally learning the physical reasons for the VHF propagation modes, and I was copying tons of papers on the library Xerox machine.

From my gathering of material, I was able to write a general article for *WorldRadio* magazine that was entitled "Sporadic-E and Aurora Propagation" and appeared in the March 1993 issue. By standards of today this article was crude, but it was a start into a field in which there was a lot of misunderstanding by hams. Eventually, I got better at collecting more relevant information from additional books and observations and that led to better articles on the subjects. Little did I realize the importance of having written this initial article and how it would affect my personal life a few years later!

## Knowledge of Aurora Proves Useful Outside Ham Radio

In June of 1996, I had just come back to New York from a short trip to the Wyoming and Colorado area, where I did a rover effort during the ARRL June QSO party from five different grid squares. On Monday, my first day back on the job at an aerospace component company on Long Island, I found out that I was being laid off from my job as part of the company's effort to reduce the 500-person work staff by 50 people. This was a rough time in my life, and it was hard to focus on some of the great sporadic-*E* openings that occurred that summer.


*Figure 2. The cover of the now defunct* CQ Radioamateur, *published in France, shows the photograph of an aurora taken by Howard Sine, WB4WXE, when he was stationed in Alaska and announces the article written by WB2AMU. This may very well be the first full-color photo of an aurora that has appeared on the cover of an amateur radio magazine. (Courtesy* CQ Radioamateur*)*

Throughout the summer I was interviewing at a few places while I was extended at my current job on a monthly basis. One of the interesting prospects was a job in the engineering department of a major bank in New York. After undergoing two long interviews over a two-month period, it came down to me and another candidate for the job. The other candidate had software skills, whereas I had reliability and mathematical skills that seemed to better fit the job. The situation came to a third and final interview with the overall manager of the facility in September of that year.

When I walked into the manager's office, the first thing that he said to me was that he was looking at my resume and

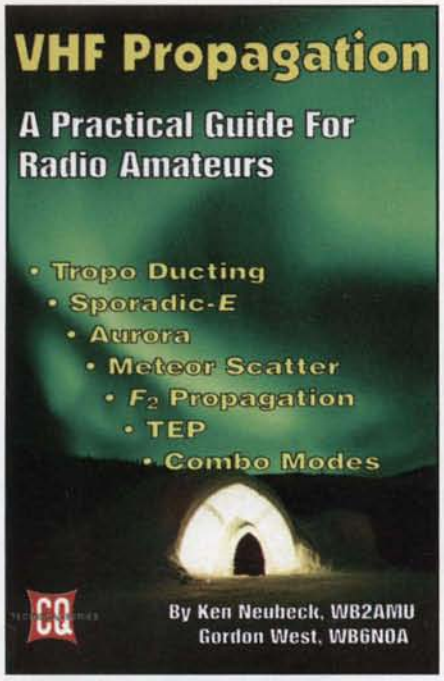


*Figure 3. The cover of the* VHF Propagation *book, written by WB2AMU and WB6NOA and published by CQ Communications, features a phtograph of an active green aurora in Alaska that was taken by Chip Margelli, K7JA. This, too, is another first for the cover of an amateur radio book. (Courtesy CQ Communications)*

*Figure 4. This is one of the first aurora pastel drawings made by WB2AMU. It is based on various aurora photos taken by Gordon West, WB6NOA, on his trip to Alaska. (Artwork by Ken Neubeck, WB2AMU)*

saw my listing of the *WorldRadio* article about aurora and sporadic-*E*. He then mentioned that he had spent over two years in the service stationed at Fort Churchill in Manitoba. I immediately responded and stated that I knew what kind of work he had been involved with, which was supporting rocket launches into the active aurora for collecting data. For the next hour we talked about his experiences with aurora, the colors and even the high-pitched whistle that can accompany it!

At the end of the hour he said, "So why do you want to work here?" and I restated my qualifications. Within a week, I had the answer that the job was mine, and I can state that my knowledge of the aurora was a major factor, not in the fact that the job involved any aspect of it, but because of making a connection with the manager! I bring this up to people all the time: Develop additional interests outside of work, because you never know how important this knowledge may turn out to be!

With 1996 being the solar minimum prior to the beginning of Cycle 23, the subsequent years brought more aurora events. My station was still very modest, with a dipole antenna, and sometimes I had to use QRP power because of RFI concerns, particularly at night. I was surprised at the fact that I could still work stations via aurora when running QRP on 6 meters. Eventually, I was able to upgrade my antenna situation and solve some of my RFI problems and I got better results during aurora openings.

An aurora article that I wrote for *CQ* magazine in the fall of 1997 was translated into French and appeared in the French version of *CQ* in April 1998 (see figure 2). What was unique about this reprint was that one of the aurora photos in the article by Howard Sine, WB4WXE, was used as the cover of the French *CQ* magazine. Remember that these were the days before good digital cameras were available to the average consumer and before widespread use of e-mail, so the original photo was taken with a manual film camera years earlier and sent to me by snail mail. This may well be the first aurora shot ever used on the cover of a ham radio magazine. It is noted that aurora is of major interest in Europe, as 2-meter data collected by hams were used in early aurora studies ("VHF Bistatic Aurora Communications as a Function of Geomagnetic Activity and Magnetic Latitude," Hesse, Arctic Communications, Pergamon, 1964)

I eventually worked 2-meter aurora during the great aurora event that started on March 30, 2001 and carried over into much of the afternoon of March 31st. I had worked quite a few stations on 6 meters and at around 1:30 PM on March 31st. I started working several stations via aurora, including my second DXCC on 2 meters, VE3AX in Canada! One of my longest range aurora contacts on 2 meters was into Indiana on an opening that occurred one month later. The aurora-generated signals on that band all were CW and all were wide!

Beginning in late 2002, Gordon West, WB6NOA, and I embarked on a combined writing project that resulted in the book "VHF Propagation – A Guide for Radio Amateurs," published by CQ Communications in 2003 *(see CQ's Book Shop—ed.)*. Gordon had taken a number of aurora photos during one of his trips to Alaska and one of these was used on the back cover of the book. He contacted Chip Margelli, K7JA, who had taken a number of aurora photos on a trip to Alaska, and a great photo was chosen for the cover, as shown in figure 3. Aurora, the visual mode, was making for great photos on the covers of amateur radio publications!

## Another Aurora-Related Opportunity

When reviewing historical references to aurora, it is interesting to note that it has been referenced in scientific and other literature through the ages. The


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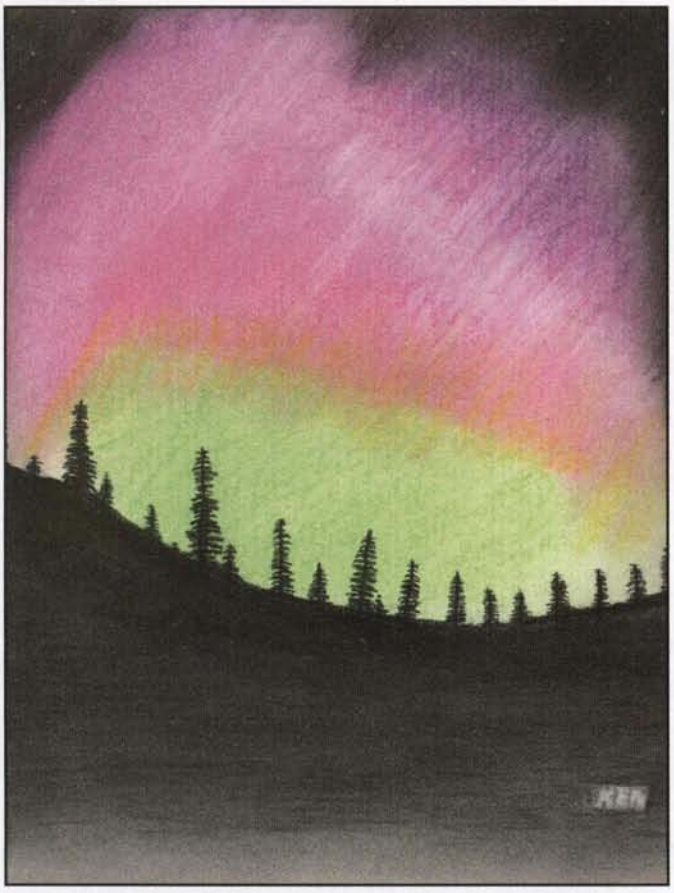


*Figure 5. Auroras with red colors are a bit rarer than the green auroras, and when they combine with the green aurora, they can lead to some very striking combinations. (Artwork by WB2AMU)*

phenomenon was even was noted by Aristotle, who postulated a theory based on heat from the sun. The term *aurora borealis* (meaning "northern dawn"; see figure 1) was coined by the French scientist Pierre Gassendi in 1621 in his book on physics.

In 1773, the explorer Captain James Cook coined the southern aurora counterpart *aurora australis*. Strangely enough, there do not seem to be many drawings or paintings of the aurora prior to the 1800s, even in northern European and US locations.

One early drawing of aurora that is referenced in the book *Keoeeit – The Story of the Aurora Borealis* by W. Petrie (1964) was created in December 1866 and is an interpretation of the auroral light in the Yukon. Early photography of the aurora was in black and white and started shortly after the end of World War II. Unfortunately, there is no way that black-andwhite photographs can really capture the essence of the aurora. Also in the same book there are a series of plates, in color and which appear to have been done in either watercolors or pastels, of an artist's interpretation of aurora in the Canadian towns of Saskatoon and Churchill. However, most of these are more instructive rather than true artistic pieces. It seems kind of amazing to me that the aurora has not been approached as a subject by some of the famous painters in the past.

After a busy period of personal writing projects during 2003, I was looking to get back to doing some art-related projects, including some experimentation in pastels beginning in late 2004. I found that I was able to smear pastels on paper using tissue and cloths to smooth out the pastel effect and I could get good results making aurora scenes, using trees in the foreground as a reference point. Figures 4 and 5 show examples of my early aurora scenes using this technique.

Beginning in 2005, I exhibited some of my aurora artwork pieces in three local shows on Long Island, being restricted in the number of pieces that I could show, so red and green aurora pastels were my main focus. In one show on eastern

*Figure 6. Six of WB2AMU's aurora pastel drawings hanging on one of the walls in an art gallery during a one-man exhibit that was held in an art gallery in Bellport, New York in March 2006. The first drawing on the right is hanging in Ken's work office, and the second drawing on the right was entered in a few shows previously and is now the property of a ham in the aurora zone. (Photo by WB2AMU)*

Long Island in February 2005 with the theme "The sky's the limit," I had a red aurora on display, but the winner of the exhibit did an abstract acrylic painting of the aurora, if you can imagine an abstract interpretation of the aurora! In my mind, my aurora was abstract enough, and I found that pastel smears captured the aurora best, better than conventional paints. After some shows with limited submittals, I finally had a one-man show in March 2006 in an art gallery in Bellport, New York, which featured a whole section of aurora pastels as one part of the exhibit as shown in figure 6.

One of the stations that I had worked during the last solar peak in January 2002 was Garth, VE8NSD, from Hay River, NWT, in the heart of aurora country in northwest Canada. Garth started with a QRP setup on 6 meters, and once he was bitten by 6 meters *F2* and aurora openings that were occurring at the time, he upgraded his station. I corresponded regularly with Garth, both via e-mail and via 6-meter internet ham radio chat pages. I found out from Garth that he was working to set up a 6-meter beacon at the Hay River cultural museum as one of his projects and that he was looking to develop a QSL for the club station/beacon, VE8AU. I also found out that Hay River and other locations in the North West Territories are prime areas for Japanese tourists to visit in order to see the aurora up close.



Through communicating with Garth, a number of art opportunities for me occured such that I could work up a pastel design to be used for the VE8AU QSL card. Then I put together five or six more pastels that I mailed to Garth for sale to tourists in order to raise funds for the town museum. A year later, I received the final version of the VE8AU QSL from Garth, as shown in figure 7, which uses my design. I am very flattered that something I did ended up in one of the far reaches and remote areas of the world!

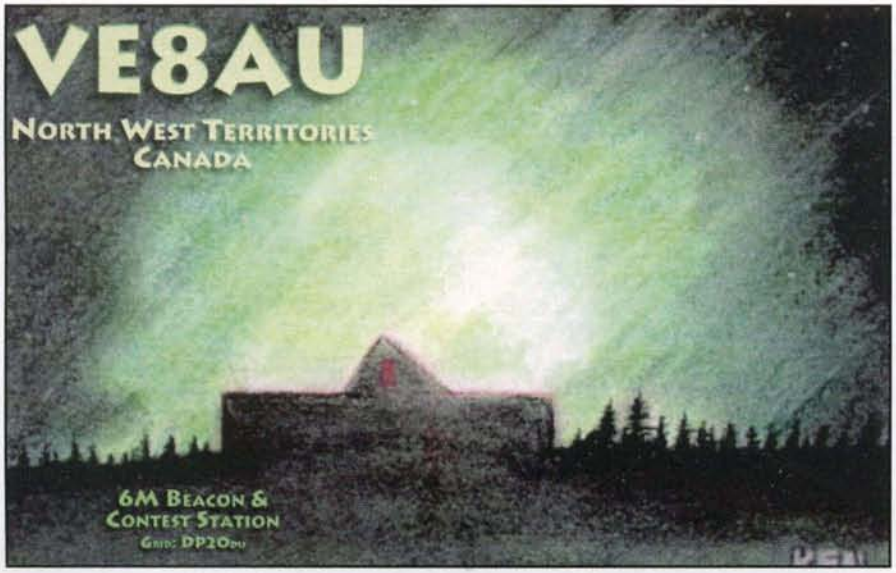



*Figure 7. This is the aurora artwork that WB2AMU made for VE8NSD in Hay River, NWT for the VE8AU aurora beacon station that is located in the town museum. (Original drawing by WB2AMU; QSL VE8NSD)*

In my mind, aurora and art are a great combination. I believe that certain media, such as pastels, are ideal for capturing the image of the aurora. With the advent of digital photography and digital video, there are great images being presented on the internet. Because the aurora is actually a dynamic phenomenon, and is actually "moving," digital videos are a great media in capturing the phenomenon in action.

By the time that this issue of *CQ VHF* reaches your hands, it is will be time to begin the watch for VHF aurora events on 6 meters. As I have mentioned in previous articles in this magazine, please monitor spaceweather.com for announcements of potential solar-flare events that may induce aurora. If anyone is interested in obtaining a new aurora pastel drawing, particularly our northern latitude VHF operators, please contact me at my e-mail or snail-mail address on the first page of this article.

# "Want to go on a DXpedition?

A desire that many of us amateur radio operators have is to be part of a DXpedition. Here WØSD identifies with that desire by reporting on his and his friends recent trip to The Gambia,while at the same time giving some pointers on how to have a successful DXpedition.

**By Ed Gray WØSD,* in cooperation with Arliss Thompson, W7XU**

Have you ever thought of going on a DXpedition? I have always said there are two things every ham ought to do at least once. One is to go to the Hamvention® held each year in May in Dayton, Ohio, and the other is to go on a DXpedition if you like to operate. My call is WØSD and I have been fortunate enough to operate from 9G5KW Ghana; CY9, Saint Paul Island; FP/WØSD Miquelon; XE2/WØSD Mexico; ZS/WØSD South Africa; ZL/WØSD New Zealand; VK2EDG Australia; CE/WØSD Chile; LU/WØSD Argentina; TI2/WØSD Costa Rica; WØSD/KL7 Alaska; WØSD/VO1 Labrador; TO5E St. Barthelemy; TZ6EI Mali; and C56E The Gambia. My wife, Edith, WØOE, has also operated from a number of these places.

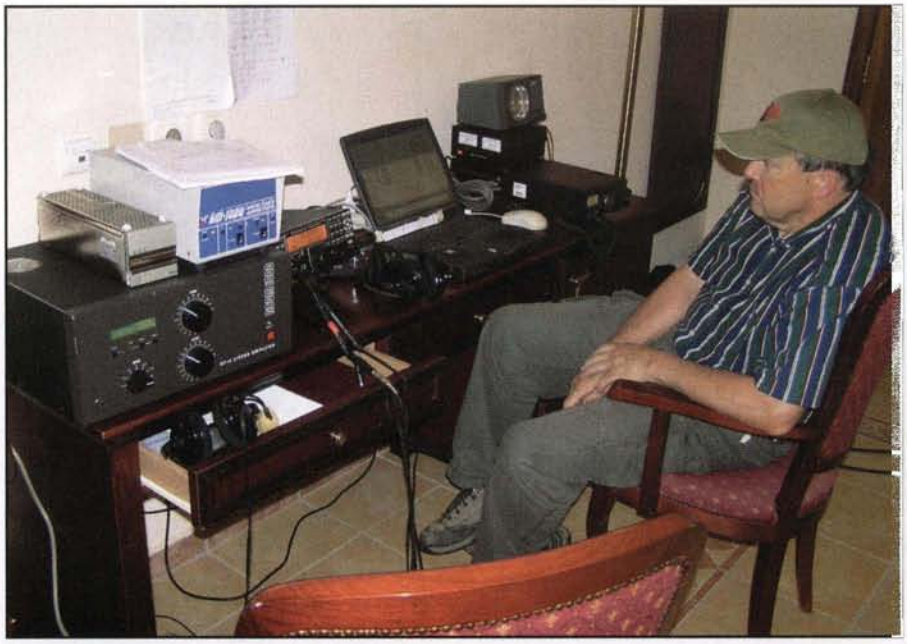
Several of these DXpeditions were made with Arliss, W7XU, and his wife Holly, NØQJM. Arliss and Holly have been to CEØY/W7XU Easter Island and J3/K5HND Grenada, and Arliss has been to VP2V/W7XU British Virgin Islands; FY/W7XU French Guiana, and 8R1/W7XU Guyana. Dick, K5AND, has been with us to a number of these places. A lot of these DXpedition have focused on 6 meters and some 6- and 2-meter EME using JT-65.

The DXpedition to Ghana and Easter Island used *F2* and transequatorial (TE) propagation on 6 meters, while the others had mainly been via sporadic-*E*. We think the longest distance on sporadic-*E* was in 2009 from Bamako, Mali, to Dave, KJØI, in Sullivan, Wisconsin. One of the more memorable for W7XU and NØQJM was to India over the North Pole for several days in a row from Easter Island. On occasion, they could communicate with less than 5 watts.

A question a lot of our non-ham friends ask Arliss and me is why do you do this. As an amateur radio operator reading this you can better understand our answers. For those of you wondering what is involved, I would say a good place to start understanding a DXpedition is to think about your Field Day experiences. These would especially be similar to our DXpedition to CYØ St. Paul Island. which is a deserted island with no facilities of any kind. DXpeditions such as Field Day rely on good planning and knowing how to improvise. Although on many DXpeditions you have good housing rather than, say, a tent, it is pretty normal to have temporary antennas like you often have on Field Day.

One reason why we go on DXpeditions is to travel, and we usually get to know some hams in the country of our destination. We get to see other countries and learn about their people and their cultures. We also learn about propagation and what it takes to transmit and receive well under less-than-ideal conditions. We learn about antennas that work and are simple but effective. We develop our operating skills, and of course have the thrill of being called by many stations desiring to talk to us to confirm a new country for the various awards, etc., they may be trying to achieve.

What continues to be a bigger challenge each year is to get an effective station transported as luggage on an airplane. Recently, there have been some real breakthroughs with the Elecraft K3, with the company soon to release the PA-500 solid-state amplifier. On another front, $M^2$ will have a 1-kw solid-state amplifier for 6 meters, and soon it will have one for 2 meters. There are many other companys that also have good DXpedition equipment, but for us, those I mention here have excellent reliability, very good specifications, and most of all they are of small size and light weight, making them our favorites. In nearly all



*Arliss, W7XU, beaconing and patiently waiting for 6 meters to open from The Gambia.*

*e-mail: <w0sd@triotel.net>

*Six-meter beam with rotor beaming toward Europe from The Gambia.*

the places we have gone, we have had 220 VAC, so all of our equipment works on 220 VAC. Of course, remember to bring the proper adapters for their 220 VAC outlets.

## Where to Start

Where should you start if you like to operate? First I would particiate in Field Day if you have not been doing that, as it is a good way to find out what you like or dislike about that. Another good way to gain experience and determine if you would like to go on a DXpedition would be rovering or operating portable from a fairly rare grid square. If you are ready for more, then look for an easy place to go that is not expensive.

One idea might be an Islands On The Air (IOTA) destination, which can generate quite a pile-up. There are a number of islands from which you can operate within the borders of the USA and thus do not have to have a passport. The Caribbean also holds a lot of possibilities. One thing to consider is the license, and now with a lot of reciprocal agreements it can be very easy to do.

## The Gambia

Arliss W7XU, his wife, Holly, NØQJM, and my wife Edith, WØOE, and I recently went on a DXpedition to The Gambia in West Africa. It is located on the Atlantic coast of Africa. We operated 2 meters, 6 meters, and 20 and 17 meters on CW, SSB, and RTTY. To help you understand what is involved in a serious DXpedition we will describe what took place.

Before I do that, though, we want to emphasize the really difficult DXpeditions such as CY9 Saint Paul, which required lots of planning. Such a trip can be very dangerous, so one needs to gain some experience before trying something like this. You may be able to join up with others who have previous experience, but be sure you check out what is required of you.

With regard to The Gambia, the planning started right after we got back from Mali in 2009. One of the first things we did was to determine how many hops it is on sporadic-*E* to Europe and North America and other places, since our primary mission was on 6 meters for this trip. We could see it was going to be difficult, as the hops at 1200 miles would be 3 to 5 hops to Europe and 5 hops to nearly all of North America. Since we had made a lot of trips, we have equipment lists and other lists we keep that we work on each year to improve and better prepare for a DXpedition.

We started communicating with people who had been to The Gambia and who had operated from there to get ideas from their experiences. We used their input, searched the web, and used "Google Earth" to find a place from which to operate that would look out over the Atlantic Ocean to North America and Europe. We also checked our health requirements for The Gambia and Edith had to get some booster shots. Arliss needed to get a Yellow Fever booster, as it is required for The Gambia.

The big change in equipment for this trip was an $M^2$ solid-state amplifier to cut down on the size and weight of our shipment. For the first time we were 100 percent 220 VAC for a trip. We went through everything for 2 meters, 6 meters, and HF and made sure everything worked and that we were not forgetting anything. We did not test the 2-meter solid-state amplifier, as it was working, but of course when we got to The Gambia it did not work, so on our list for next year we have "Check Everything" no matter if it was working previously.

We started serious work on the license four months ahead of time, The Gambia would not issue a license unless we showed

up in person. This was not good, as it meant we might spend the money for the trip and not be able to operate if we did not get a license. Based on what the licensing official told us, and the experience of others, we were fairly confident we could get a license. However, the question was how long would it take, as we were locked into two weeks maximum for the trip.

One real challenge of a trip is the airline connections and cancellation of flights due to weather. We had weather problems and could not get out of Sioux Falls, South Dakota because of a weather shut down in Chicago. By the time we could fly our flight from Belgium, our connection to The Gambia would be missed. All we could do was go back home and reschedule for three days later, as flights to The Gambia only go on Sunday, Tuesday, and Thursday. We went a day early and stayed with Johan, ON4IQ, and saw some of Belgium. He and ON4GG have fine station for 6 meters.

We arrived in The Gambia and were met by Arliss, W7XU, who was originally coming later due to a work schedule conflict, but because of our weather problem he got there on Saturday morning. In Belgium before we left for The Gambia we got an e-mail from Arliss that he was questioned for 2 hours by The Gambia National Intelligence agency, and the customs officials had confiscated his equipment as he did not have a permit to import radio equipment.

We had been told as amateur operators with our own personal equipment they would just list the equipment and we would check it out when we left. This is the way I had been done in the past. When we got there late Sunday afternoon, we were not questioned by security, but the customs officials confiscated our equipment. I was able to negotiate it down to two K3s and FT-897 and a rotor that they confiscated. We met Arliss and there was a driver he had hired and then we went to the hotel.

To get an amateur license you need a tax ID number so you can pay for it. We spent the day Monday and got the Communications official to convince Gambia security that Arliss was indeed applying for an amateur license and was not a national security risk and that he could leave the hotel. Previously, he had been required by national security to stay at the hotel and not move to another one. After many trips to several offices, one of them five times, we were promised the license and that we could get our equipment at the airport through customs.

Unfortunately, the customs people saw otherwise, and we had to go back to a building we had been to earlier in the day and talk to a high-placed tax official. We were supposed to inventory and value all equipment and pay a 3-percent duty even though it was our own equipment and we would be taking it back out of the country. It was called a temporary importation. Fortunately, the tax official was a very reasonable man, and he called the customs people at the airport and told them to just list our equipment and check it out when we left the country, which was exactly what we had been trying to convince them to do for two days.

We did not have to list it on a tax form or pay the tax, but we did have to have

*Six-meter beam looking over the water to Europe fromThe Gambia.*

our amateur license before going back to the airport. We were also supposed to have our equipment reviewed and approved by the police, but that was also waived.

After a long, tough day we ran out of time and were told we would get the C56E license in the morning. It ended up being about 2 PM the next day before we got our license. and then we had to go to the airport to get our equipment. We had to wait another 2 hours, but we finally got to meet with the head of customs and list our equipment and take it with us to the hotel.

## The Operation

We were able to get 6 meters set up Tuesday night, but were not able to make any contacts. We started operating 6 meters again Wednesday morning and set up the HF station. Fortunately, the hotel was ham radio friendly just as they had told us in advance. All they required was a copy of our ham license. The wives operated RTTY on HF, and Arliss and I operated 6 meters and some HF after 6 meters was closed for the day. We found we needed to beacon on 6 meters, which we did about 18 hours a day. We made one contact on 2 meters with D44TD in the Cape Verde Islands at about 500 miles distance. Here are the results of our C56E DXpedition from The Gambia on 6 meters:

| C56E | 6M CW | 6M PH | Total | % |
|---|---|---|---|---|
| EU | 734 | 0 | 734 | 91.4 |
| NA | 54 | 3 | 57 | 7.1 |
| AF | 10 | 1 | 12 | 1.5 |

Holly, NØQJM, and Edith WØOE, made about a 1000 QSOs on RTTY on 20 and 17 meters. Arliss, W7XU, and Ed, WØSD, made about 900 QSOs on SSB and CW on 20 meters.

We were able to leave The Gambia okay, but after the equipment was checked off the list it was escorted until it was out of our hands for our outgoing flight. The people at the hotel and whom we met at various places were very friendly and helpful.

## Things to Consider

One important thing is the language. The poeple of The Gambia speak English, but the prior year in Mali the language is French, of which Arliss knows a little, but it is definitely a struggle. Thus, it is quite important to know the language, or have someone along who does speak the language of the country, or someone in the country who knows English and who can speak the language of the country. I know Spanish fairly well, and that has been very important in several countries from which I have operated.

Another important thing in many of these countries is a driver whom you hire for the day and who will wait for you. Of course, it needs to be someone you can trust who can speak your language and the local language as well. The hotel can often help with this. The hotel and driver can also give you some very good advice as to security issues. Also research ahead of time on the web can help inform you about this. Getting local money is also an essential thing.

For us North Americans, one needs a GSM cell phone and a local SIMS card. You can buy scratch cards to give you time on the phone. Johan, ON4IQ, gave us a GSM phone and it was extremely valuable. Let's face it: The world now runs with the aid of cell phones, and if you are in a country and don't have a cell phone you are really out of touch and out of the flow and you can waste a huge amount of time without one.

*Arliss, W7XU, foreground, and Ed, WØSD, background.*

We have also found it works well to have breakfast, which is usually included with the reservation, and then just have some snacks in the room and maybe a Coke late in the day so we only have to take time out for one meal. Everyone, of course, is different, and many make their DXpeditions more relaxed. Also, many do a vacation-type DXpedition which allows for operation only at free times.

It is very helpful to have online logs posted daily so people can know if they are in the log or not. It can prevent a lot of duplicate contacts. It has been our policy to not be on the internet much or at all when we operate, but rather just put out news updates and upload the logs. This is a personal preference, but we soon found out you cannot please everyone, so we just do our best to be fair to all parts of the world and try to make a special effort for those who do not have good propagation with us.

This time it was tough to North America, with only 7.1% of our contacts there, as it was so far away. We tried beaconing that way more than normal, but to no avail.

We have found that multi-hop sporadic-*E* does not act like many think it does. It seems to be very common for there to be cloud-to-cloud propagation without hitting the ground. We have observed many times on 3-, 4-, and 5-hop sporadic-*E* paths that we hear no stations in the second reflection area when we know there are many stations on. In fact, a number of times we have not heard any first- or second-hop stations, just ones in the third-hop area. We have also noticed it is very common to just have a few hot spots. It would appear after going three or four hops, the geometry of the reflections are such that only a very, very small area is heard and can be contacted.

These areas can move around very quickly. For example, from C56E we worked stations in the US and Canada 1000 miles apart in just a matter of minutes without hearing a single other station. During these times it seemed as easy to work Ohio as Maine. We were able to work KA9FOX, Scott, in LaCrosse, Wisconsin, quite easily. He was the only station we heard at that time and it lasted only a short time. These openings seem to last from a few seconds to a few minutes. We have also heard some significant meteor enhancement on the multi-hop signals. There are some very good reasons why 6 meters is called the "Magic Band."

## Summary

What did we learn that was new on this trip to The Gambia? In many countries you have a lot of officials from different departments that have requirements. It may be wise to check with the embassy for the country you are going to for its requirements. We have had good success talking to the Gambia's embassy people in the US on the telephone, as they can usually speak good English. If you get even a hint of a problem in any area, be sure and check it out.

Unfortunately, in some countries you have to go to the country ahead of time to arrange things. This can mean two trips, but hopefully one of the members of the team can go a week ahead of time and get everything taken care of and meet the rest of the team at the airport. It seems to be true of nearly all countries that paperwork moves slowly, so don't expect things to happen nearly as fast as you would like. There are, of course, exceptions, and with reciprocal licensing there are many places you can go with no hassle, as you can just use your license with no waiting. We never declare anything unless there are specific instructions about things that need to be declared.

Some countries scan incoming luggage, and this is where radio gear can show up. In the case of The Gambia, it created a problem for us. In the case of Mali, it was not a problem. In all the other places I have been it was not a problem, but Arliss did have a problem in Grenada. One needs to be very careful about bringing in radio equipment in some countries in Asia, where it is strictly illegal unless you have advance paperwork and approval. Don't be discouraged, as there are many countries with reciprocal licensing agreements and absolutely no problem with bringing in radio equipment.

It is important if you don't have a private place to operate with permission that you clear things ahead of time with where you want to stay. Sending them a picture of your DXpedition antenna or antennas via e-mail has worked well for us. We have rarely been turned down by a hotel or other places to stay. Someone local can be of a great help with a place to stay, customs, licensing, where to get money, transportation, etc.

If you would like more information on the 2010 C56E DXpedition, go to: <http://www.w0sd.com/gambia/gambia.htm>. The website for the Mali trip in 2009 is <http://www.w0sd.com/mali/mali.htm>, and TO5E St. Barthelemy in 2008 is <http://w0sd.com/stbart/bart.htm>. Earlier DXpeditions we have done can be found at <http://w0sd.com/dx/dx.htm> .

Are your ready to go on a DXpedition?

# CQ's 6 Meter and Satellite WAZ Awards

**(As of January 1, 2011)**

**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 | K0FF | 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 |
| 98 | JA7QVI | 2,40 |
| 99 | K1HTV | 17,18,19,21,22,23,24,26,28,29,34 |

## 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>

*Tower and dish ring. (All photos courtesy K1DS)*

# There's No Such Thing as a Free Dish

This mildly humorous article is a takeoff on the idea that there is no such thing as a "free lunch." It originally appeared in the 2010 14th International EME Conference Proceedings and is reprinted here by permission of the author.

**By Rick Rosen,* K1DS**

One of my "Elmers," well known worldwide in EME circles, Al Katz, K2UYH, sent me an e-mail in the spring of 2005 alerting me to the availability of a 10-foot TVRO dish at his neighbor's home that was free for the taking. He included a jpg picture of the dish and the contact number of the owner. Since I saw this as an opportunity for myself and other club members to get re-involved in EME on 1296 MHz, I contacted the owner and we agreed for us to take it but decided to postpone the removal until the weather cooled a bit after the summer heat and our schedules permitted time for travel and disassembly. Not knowing exactly how I would need to transport the dish home, I purchased a roof-top carrier for my van for about $60 at the local PEP Boys shop.

My son, Packrat Leon, N1XKT, and I traveled up to the house of the owner of the dish and found it ready for disassembly in the back yard. It seemed to be in good shape, save for some bulges in the bottom part of the square aluminum framing of the dish, where water would obviously collect and then undergo several freeze-thaw cycles over the winters. There was a bit of superficial rust on the elevation jack and motor housing, and most of the bolts were rusty but potentially serviceable with a few sprays of WD-40. It took about four hours to dissemble the parts. I was grateful to the owner for the loan of his industrial-size ratchet set and adjustable wrench, as some of the bolts and nuts exceeded the capacity of the tools that I had brought with me.

Piece by piece we separated the feed and struts, then the upper dish petals, and finally the lower ones, leaving a nice steel ring on the 4-inch center post. This center mount was removed with muscle power from both of us, as it was high and a bit heavier than anticipated. Well, at least this was no flimsy structure, and would hopefully survive several more years in amateur service. The dish petals were stacked on the van's roof, with all the other hardware inside the cargo area, and we headed to the barn owned by Packrat Bob Fox, W3GXB, where all the rest of the Packrat contest antennas, towers, and support gear are stored.

**e-mail: <rick1ds@hotmail.com>*

The EME conference was held nearby in Trenton, New Jersey, and I attended and helped out a bit with some of the arrangements. As a gift to Joe Taylor, K1JT, one of the Packrats and the developer of WSJT, Zdenek Samek, OK1DFC, gave him one of the 1296-MHz septum circular polarized feeds that he manufactured. I had thoughts about asking Joe for that, as I knew he was most active on 144 MHz EME and that he did not at this time have any plans for 1296 MHz. Ask and you shall receive. "Sure!" said Joe, when I asked him for a "loan" of the feed. Now everyone is talking about having a scalar ring for the feed to optimize illumination of the dish. Paul Wade, W1GHZ, and others are experimenting and designing the optimum size and position for the ring. Just my luck, another EME ham is having a local metalworker make a few for about $100 each. Not a bad addition to a free feed and a free dish!

Fall and winter came and I gave thought to using the dish for 1296 EME for myself, propelled by the success of another Packrat, Marc Franco, N2UO, who was using a lightweight 10-foot homebrew dish and all homebrew radio gear, cranking out about 500 watts. Exploring the path loss, some of the capabilities of the "big guns," and some of the stories of the single-Yagi portable ops, I was encouraged that the new 120-watt amplifiers from DownEast Microwave might get me a few EME QSOs. So I bit the bullet and spent the several hundred dollars for a new DEMI transverter, replacing my older KK7B designed unit with a 35W DEMI amp, and also coughed up several hundred dollars more for the bigger amplifier.

*Assembled dish and feed shown with the author.*

Naturally, one has to add some low-loss N-type relays, sequencers, power supplies, low-loss antenna cable, and some of the lowest noise cavity-style receiving preamplifiers in order to be able to hear those signals reflected off the moon. My initial search attempts yielded high-gain, low-noise preamps that could be bought for close to $500. This is almost as much as some of the other components, but something you can't do without on EME. I did hook up with Hubert, DJ3FI, who could supply me with his home-brewed silver-plated cavity LNA for about $250 if I picked it up and paid for it at the EME Conference in the summer of 2006 in Wuerzburg, Germany.

This was a good excuse to solidify plans to vacation in Germany: Start with the EME conference, pick up a few needed parts, and then rent a car and tour a bit of Bavaria, the Black Forest, and the Rhine Valley. An added bonus was the availability of the digital spirit levels that were being purchased from Lidl, the depot-type stores in Europe, as these would come in handy for reading out dish elevation. I won't detail the cost of our Germany escapade, but it was a very exciting and enjoyable trip that included some of the most interesting tourist attractions, including ancient walled cities, the Munich Brauhaus, Dachau (sad, but an important historic and memorial site), the world's largest cuckoo clock in a village in the Schwartzvald, the spa in Baden-Baden, and the historic castles that dot the Rhine and other riverways.

A year had gone by, but no EME QSOs yet. Perhaps it would be easier and faster to get on 2-meters EME, especially as so much activity was and is going on there, and the path and power requirements are less demanding. I resurrected a pair of 32-foot, 5-wavelength Yagis that were donated to the club by Steve, N2CEI, who was cleaning out his old, used aluminum from his shop at DownEast Microwave. With a purchase of some new aluminum rod, they were cleaned and retuned, and one has successfully been used on a moonrise schedule, making a nice CW QSO with Chris, SP7DCS. Now that I had crossed that hurdle and achieved the landmark of my first EME QSO, it was time to get back to work on 1296 and the dish.

WA5WCP came to the northeast in the summer of 2006, pulling a trailer with a 10-foot dish using about 200 watts and was quite successful making several

QSOs on 1296 from some states in New England that previously had not been active on that band on EME. Continued reports of the DXpeditions with portable dishes and power in the 100-watt range gave me a bit more encouragement to continue the quest. Perhaps I would need a trailer also, as I had no place to deploy the dish at my QTH, since I live in an antenna-restricted community. As a rover for the past 20+ years, this looked like a probability. I studied the pictures of his trailer and dish mount, and got several more ideas from websites of other EME active hams. It looked like I'd need some tower to mount the dish, and then a strong mast, powerful rotor, and thrust bearing.

I began to realize that my older laptop computer would not be able to handle the newer programs, potential of driving positioning rotors and motors, and also making use of newer software-defined radios and digital modes, so a new laptop was purchased. Shortly before the new dual-processor models were available, the older ones were selling for $500, so I added that to the collection, and it was not a minute too soon, as the hard-drive died on the old laptop.

As a Packrat, I put out the word that I was seeking a tower section of Rohn 25, and offers came from several sources. A piece from Packrat Russ, K2TXB, was obtained, as it previously had been shortened and would fit the bill. That was a freebee, although I did purchase several other radio parts from him as he was moving.

Thinking about how to mount this, I was inclined to get the hinged baseplate—only $225 including shipping. Now onto the mast, rotor and thrust bearing, another several hundred dollars. "Get the heavy duty rotor and mast as that dish has a big torque," warned my fellow Packrats when they visited. Also, the Yaesu website warns that the most common problem is using too lightweight a rotor for an array with plenty of torque, as the gears can get ground to bits. Therefore, I went for the bigger and heavier stuff; hopefully I chose wisely.

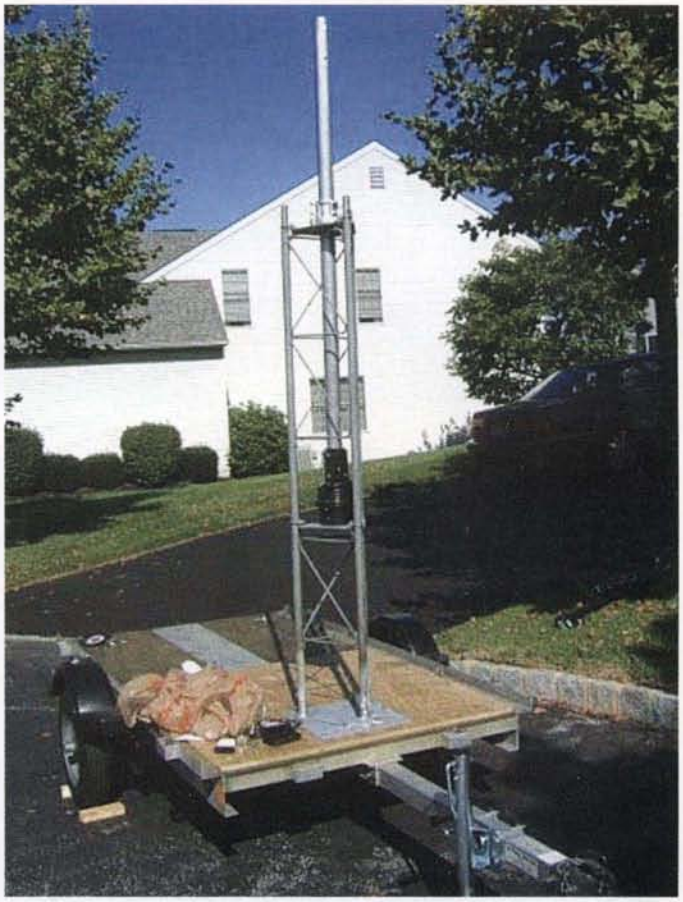
Little by little, I brought the dish parts from the barn back to my home, storing them in basement. Packrat Al Sheppard, N3ITT, took on a small welding job so that I could rework the dish mount from polar to azimuth and elevation. The steel ring that holds the dish petals needed a wire-brushing and a few coats of galvanizing spray paint. Once that was done, the jack motor got the same treatment with rust-proofing black paint. Al was able to purchase a reel of #8 wire for a few bucks at a local ham auction, and that will serve as power cable for the amplifier. A bunch of 75- and 100-AH rated surplus (pulled from commercial service after three years) gel cells were delivered by Packrats John Sortor, KB3XG, and Steve Simons, KF6AJ (now W1SMS), as this would be a battery-powered station, consistent with the power in the rover van. A dozen or so high-current oversize PowerPoles needed to be bought to get this stuff connected soon. I also caught Packrat Steve Kerns, N3FTI, breaking down his rover trailer, and managed to buy a few more N-relays from him in order to complete the RF switching. I was getting close. I won a 100-foot reel of LMR-400 with a pair of connectors at the Northeast VHF Conference banquet. That would certainly come in handy, and the conference and hotel was under $200!

What about a trailer? I made a call to Joe Silverman, K3VEQ, a Packrat who runs an automotive shop; and perhaps he had a lead on something inexpensive. He referred me to another shop that specializes in trailer hitches, and I got a new class III hitch and ball installed for a mere $400. But now for the trailer—eBay and Craigslist. No real bargains were around, and it looked like I would be spending almost a grand for a relatively new 5-foot by 10-foot trailer, and that would need some additional work to carry the tower, dish, and associated stuff. I probably could have gotten a bargain trailer that had been sitting in someone's yard, rotting and rusting, needing new wiring and bearings, but heaven only knows what that would have run.

Next, I thought I might as well throw in a little SoftRock7 building project, as the kits are less than $30. It could come in handy for enhancing received signals. It still sits in the padded envelope awaiting assembly. The SDR-IQ early orders were being taken and that could certainly be of use to look at the spectrum of received signals. I still would need a 144- to 28-MHz receive converter to use these, as my current 1296-MHZ IF is into my FT-100D on 144 MHz. Just a few more bucks to spend.

*W2BVH approximating feed position.*

*Feed and scalar ring.*



*Trailer with tower mount.*

Could I be ready for the fall ARRL EME contest? I'd see if I could find the time to do it with the hectic daily schedule and weekend family obligations.

I watched the newspaper ads for used trailers, as well as eBay and Craigslist. Finally I found one, a mere $900, but the owner was willing to drive it and meet me half-way to consummate the deal. We even managed to find a notary, who for a small fee would sign and stamp the title papers for transfer. We passed the papers and the cash, and I hitched the trailer onto my van and drove home. Not more than a mile from my house I got pulled over by a sharp-eyed policeman who noticed that I had no license plate on the trailer. After explaining the purchase that same day and the plan to get it registered on the next Monday that the registration office was open, he let me go. I drove the last mile and pulled up to my home and backed the trailer up the driveway when I noticed that this 6-foot by 12-foot trailer was about 6 inches too wide to fit through the garage door, as the wheels added the extra width. No trailers are allowed outdoors overnight in our village. Packrat Michael Davis, KB1JEY, was with me and volunteered a parking spot in his driveway until I could find a more suitable winter storage place for the trailer.

*Trailer and dish petals stored in the garage.*

The 2007 Fall ARRL EME contest weekends conflicted with family events, and my gear certainly wasn't ready, but Al Katz, K2UYH, was headed to Aruba for the November weekend, and asked me and Herb Krumich, K2LNS, to operate at his station for the third weekend. It was a thrill to operate at a well-equipped station on CW and JT modes, and we made contacts all weekend, despite a visit from

"Murphy" that stopped the azimuth rotor from turning at 2 AM. In the daylight we noted that the starter capacitor leads had corroded, and once cleaned and reset we were back on the air. Having experienced both modes, when returned home I bought a RigBlaster to facilitate the WSJT modes.

Not being too computer savvy, I seemed to have trouble getting the transmit side of the connection to work. Little did I realize that I needed to get the proper USB to serial cable, and one was quickly ordered from the web. Only $10 and free shipping! It arrived without a driver program, which I didn't even realize it needed, and it was frustrating to find that merely inserting the cable would not get it to work; more instructions in the form of the driver were needed. It turned out that the driver was a free download, once I knew where to find it, but even after installing the small program, I couldn't get a transmitted signal. Putting out a call on the club reflector, I got lots of helpful info, the main culprit being a cheap UBS to serial cable, as not all of them are created equal. Back to West Mountain for the right stuff, another $35 with shipping, and that worked immediately. I spent several hours at the rig, honing my JT65 skills on 20 meters, learning the workings of Joe's fine software.

I found a suitable elevation rotor on eBay for the 2-meter Yagis for about another $100. Back to K1JT's to get a non-metallic cross-boom from his older setup, as he now has four cross-polarized Yagis on an H-frame and no longer had use for the fiberglass mast. It awaits deployment, carefully stored in the garage. Here I am, signed up for the next EME conference in Florence, wondering when the winter winds and chill will end. The XYL and I will be attending our 4th EME conference, as we enjoyed our first one in 2002 in Prague so much. The recent issue of the "432 & up EME" newsletter brought more opportunities to buy 2.3-, 3.4- and 5.7-GHz feeds and more microwave relays. Could I get some of the collected gear on the air this spring and make more EME QSOs before the conference?

Ham radio activities are high on the priority list, but take a back seat to family needs. My daughter Toby got engaged last June and her wedding was planned for May 4th. Preparation for that weekend was intense; so much of the radio business was placed on hold. My son Leon also got engaged that spring, and a new set of wedding planning activities ensued, further distancing the thoughts of active pursuit of EME QSOs. My aging mother and her needs in an assisted-living situation also consumed much of my free time, so the opportunities to try and piece together the gear was very limited.

Between all of this, a local ham was selling off most of his microwave gear and I decided to buy his antennas for 1.2, 2.3, and 3.4 GHz, as they would be useful for the upcoming ARRL VHF QSO Party. Well, another few hundred dollars. Interestingly enough, the 1296-MHz antenna was a long "WIMO" Yagi, with a published 19 dB of gain, marginally sufficient to try and make QSOs with some of the EME big guns on that band, as demonstrated by the success of other European stations who made some portable forays to special DXCC entities such as Monaco. It even came with a nice short piece of LMR600 that was sealed and waterproofed to the antenna. I got everything set up in the driveway to try it out, but neglected a small jumper ground wire for the sequencer and antenna relay, so in the first attempt to transmit, the amplifier went into fail-safe mode with no power output.

Next on the agenda was the ARRL June VHF QSO Party, a four-day weekend activity in which our club has actively participated for many years, continually aiming for the million-point mark. I was the co-chair of the microwave effort, and spent much of the few moments of available time putting together the final touches of the 903- and 1296-MHz stations. Together with Packrat Paul Sokoloff, WA3GFZ, we manned the bands from 903 through 24 GHz from Camelback Mountain and had a respectable result. Now, finally, there are a few upcoming weekends to plan for the dish and feed assembly and mounting.

Back to my Elmer, Al Katz, K2UYH. Now that I realize the important connections regarding the temporary lash-up for driveway operation, the moon was in position for us to try again on 1296 MHz. I carefully aligned the WIMO Yagi with the sun and calibrated the rotor and elevation settings, moved the antenna to the moon position, and tuned to the 1296.065 MHz frequency to see if I could find Al's JT65 trace. I saw something! I clicked on it, and as the minutes progresses, the computer decoded Al's "CQ K2UYH." I came back with my transmission, and in a few short sequences I had completed my first 1296MHz EME QSO. Just in time, too, as the sky opened up with a downpour, as I scrambled to cover up all the gear that was out on the temporary operating table in the driveway next to the van.

I arranged with the help of Al Sheppard, N3ITT, to get the trailer from storage at his workplace, and he towed it to his home to make it easier for me to get to it and tow it to Joe Silverman, K3VEQ's QTH, closer to my home for some of the final dish mounting. However, maneuvering the trailer into a closer spot to home, Joe and I realized that this trailer was going to be too

big and heavy for my needs. That night I made a decision to list it on eBay, and a week later I had a completed auction with a sale for as much as I paid for it the prior year. As the buyer and I made arrangements to have him get the trailer, he mentioned that he needed this bigger trailer for his small tractor and would be selling his 4-foot x 8-foot aluminum lightweight trailer. We quickly arranged a swap-plus cash deal, and three days later I had the smaller, lighter, and more easily maneuverable trailer in my garage, plus a couple of hundred bucks to boot.

It was two weeks from the next DUBUS EME activity. Wiould there be enough time to get the stuff together and be ready for more EME action? Either way, there would still be a lot of fun to be had, as anticipation is 90 percent of the enjoyment. And besides, we were leaving for the 13th International EME Conference in Florence, Italy the weekend after that. You guessed it: We travelled and kept the trailer and dish indoors. Again, Al Sheppard, N3ITT, did some magic working up a special winch and erection fixture to elevate the tower section once the dish was installed on its mounting ring. Oh, and did I mention that I decided to get a set of preamplifiers from Tommy Henderson, WD5AGO? The noise figures and gain are excellent, as well as the reasonable prices. And while we were at it, he had some feeds for 2G, 3G, and 5G. Perhaps they'll come in handy someday.

Then there were a host of family events, business and local obligations, not to mention a ruptured disc in my back, and before I knew it, winter arrived, the trailer went back to storage at Joe Silverman, K3VEQ's QTH, and then made another debut in the spring of 2009.

Lenny Wintfeld, W2BVH, yet another Packrat, showed up to help me assemble the dish petals on the trailer. Everything seemed to fit together nicely, but before we knew it, the afternoon was gone, so we left the dish on the trailer in the driveway overnight and waited until the next day when Paul Sokoloff, WA3GFZ, helped me mount the feed and we did some crude testing for sun noise using the down-converter and SDR. Not bad—8 to 9 dB. But EME success would be deferred yet again for more family obligations, business related issues, and travel. At least I got to work part of the ARRL EME event at K1JT's QTH, while K2UYH put the 3G preamp and feed to work at his 28-foot dish. The trailer went back to storage at K3VEQ, and made another debut in the spring of 2010.

World EME day, Echoes of Apollo, and the Arecibo plans had my juices flowing. Another Packrat, Phil Lanese, K3IB, had a set of four long 432-MHz Yagis for sale at a bargain price. I drove over two hours to his QTH to pick them up, hoping that I could mount one in time for the big weekend. I had the antenna up, the preamp on, and copied all of the KP4AO activity on Saturday, but no QSOs. Sunday was brighter but cooler, and my luck changed. I managed to have a CW QSO with the station with the big dish down in Puerto Rico. Well, now I had one QSO on each of three bands from my own station—all done with single Yagis. However, the dish had to be put into service! So what if there were some "minor" additional expenses along the way? Everything has turned out to be a "bargain." After all, there's no such thing as a *free* dish!

# Microwave Update 2010 a Success!

The uniqueness of the Microwave Update conference is that it travels around the country each year. This time it landed in Cerritor, California. Hosted by the San Bernardino Microwave Society, it proved to be the most well-attended conference to date. WB6NOA reports on its success.

**By Gordon West,* WB6NOA**

Al Ward, W5LUA, chronicles the successes of Microwave Update from the beginning in 1985 to the 2010 Conference, recently hosted by the San Bernardino Microwave Society in southern California.

This yearly event is held all over the United States, and last year was hosted in Dallas, Texas by the North Texas Microwave Society. "This is where we developed the Don Hilliard Technical Achievement award, created in the honor of our founding father, which went to Paul Wade, W1GHZ, in recognition of his many years of service to the amateur microwave community," said Al, W5LUA, speaking of the successful conference in Dallas.

The 2010 MUD (Microwave Update) was held in Cerritos, California, with well-known microwave enthusiast Pat Coker, N6RMJ. "What a success. More than four countries were represented, 300+ registered attendees, and two days of action-packed seminars in our spacious hotel facility," commented Pat. His comments came *after* things got going in the middle of the week with events for both guests and operators, as well as tours of the local southern California microwave surplus stores! Then they added the tour of the Jet Propulsion Laboratory and a peek at the new Mars Survey Lander Spacecraft assembly area.

Early on Friday morning, Dave, WA6CGR, and Doug , K6JEY, brought in the latest of HP microwave test equipment, an HP 8722ES, offering attendees precise measurements of frequency, power output, and microwave receive specifications. "There wasn't much gear left in my lab after I brought it all over here," added Dave, working with microwave test equipment that we all could just drool over.

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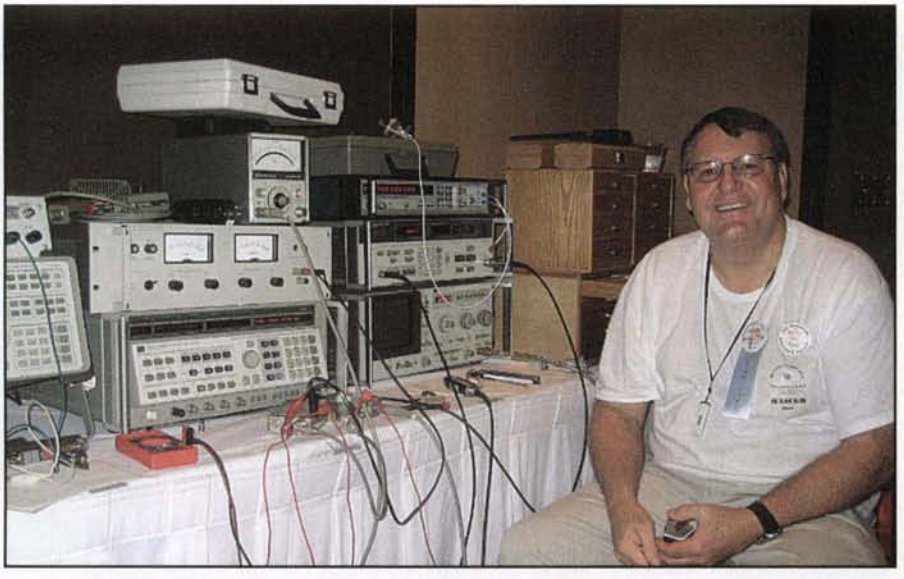
*Registration with lovely ladies to greet the guests!*

Pat Coker, N6RMJ, looking very sharp for his presentation, gave the welcome address, followed by talks on transverters, 10- vs. 24-GHz beacon propagation, physical optics to demonstrate microwave propagation, frequency stability measurement tools, with Paul Wade showing his personal beacon for 10 GHz! That evening, SBMS opened up the hospitality room, and the stories one could hear about "who worked who over 600+ microwave paths from central California into Mexico" were amazing.

Saturday morning through late afternoon, there were twelve more talks in the spacious hotel theater with lots of live equipment demos throughout the day. Also, all day long, over a hundred door prizes were awarded to lucky registrants. In addition, during both days Jim and Carolyn Bogdan brought in tables and tables of microwave accessories and RF parts, keeping the big commercial exhibit hall lively for those of us needing to buy extra spares for the "backups" we already

*Pat Coker, N6RMJ, greets everyone at the registration table .*

*The presentation room was full of attendees*



*Dave Glawson, WA6CGR , with his test gear.*

have on hand. "You can't have enough backups!" declared Carolyn.

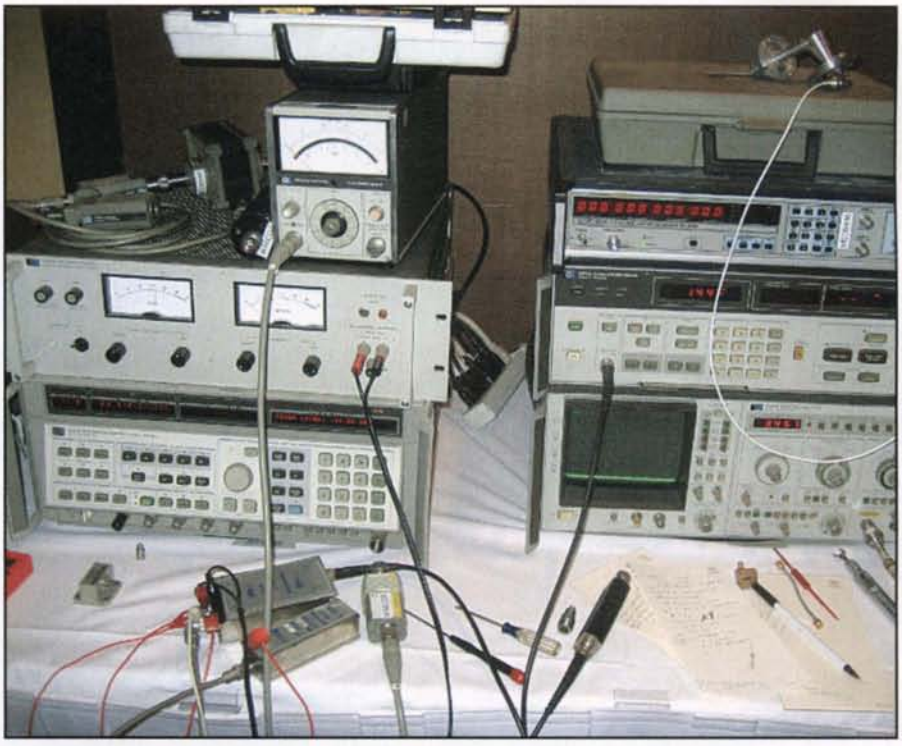
That evening, the banquet's guest speaker was newly licensed ham Dr. Kate Hutton, K6HTN, with the California Institute of Technology, along with Dr. Peter Lyman, K6PTL, former JPL Director of the Interplanetary Communications Group. This was a fitting time for Dr. Hutton's talk, since during that Saturday, southern California presented its yearly earthquake preparation drill, the Great ShakeOut.

Then came the main drawing—the $8000 Agilent 9340B spectrum analyzer, covering 100 kHz to 3 GHz. Jeff, KN6VR, was the *very* happy recipient, with everyone giving big thanks to Agilent for its great spectrum analyzer donation.

The Don Hilliard Award went to Will, WØOEM, for technical achievement. A second Hilliard Award went to Dick Kolbly, K6HIJ (SK), who was the local legend in helping microwave experts and beginners (like me) over the years. Dick's award was received by Phyllis and Kenneth Kolbly. Phyllis, who performed the huge job of on-site registration, was standing strong and tall, greeting each

and every ham when they first hit the registration table. Thanks to Linda and Judy for also being those smiling faces when hams came up to get their SBMS registration badges.

Early Sunday morning it rained in buckets! However, that was before the sun came up, and when it did, the clouds parted and out came the parking lot equipment—dishes and horns for the Sunday



*There was plenty of test gear for attendees to see how their own gear was working .*

*Jim and Carolyn Bogdan brought a room full of microwave parts for sale .*

on-air performance checks. There was not a cloud in the sky, and if there had been, some of the high-powered systems pointed up in the air would surely have cleared the moisture!

For me, one of the best parts of the Microwave Update was to meet the folks I had only heard at the other end of a 10-GHz circuit. The Sunday parking lot trials also gave us all a close look at why certain signals were always so loud over some fairly long paths! Just when you think you may have the ideal microwave setup, looking at some of the other homebrew arrangements leads to some great ideas.

The 216-page *Proceedings* of Microwave Update 2010 is available from the American Radio Relay League. Nearly every page is illustrated, along with almost every single page containing detailed photographs.

"A special thanks to the ladies for putting on the family programs, and thanks to everyone, including SBMS and the San Diego Microwave group for making this 25th year MUD as successful as it was," said Pat, still looking good after multiple days of working the conference.

List of Microwave Update 2010 coordinators:

N6RMJ Chairman
K6JEY Co-chairman
WB6CWN Programs
WA6CGR Prizes and Technical testing
WA6JBD Surplus tour and Technical testing
Phyllis Kolbly Registration
KH6WZ Publicity
KC6QHP JPL tour
WB6DNX Vendor room
W6OYJ Antenna testing
N6IZN Antenna testing

In 2011 the conference will be hosted by the Northeast Weak Signal Group, so you'll get a chance to see fall colors, with the leaves falling off the trees, giving us improved conditions on the microwave bands!



*More gear for sale.*

*Kent Britain, WA5VJB, takes the podium for some show and tell , plus his great humor!*

By Bob Witte,* KØNR

# FM

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

# Get the Tone Right

Radio amateurs use tone signaling over the air for many different purposes. Tone signaling works especially well on FM, since the received audio is spot-on in terms of frequency (unlike SSB, where the precision of the tuning can affect the frequency of the recovered audio). On FM VHF and higher we use tones to perform many functions, including activating repeaters, controlling repeaters, accessing IRLP links, and making autopatch calls. This can be confusing for new Technician licensees (and maybe for the old timers, too?), so this article examines the most common tone systems.

## DTMF Tones

One of the most common sets of signaling tones is called the Dual Tone Multi-Frequency (DTMF) tone system, often known as *Touch-Tones*. This system was invented for use in telephone systems by AT&T in 1963. Today, the pleasant dual-tone sound is very familiar to most people as part of everyday telephone use.

When a key is pressed, two sine waves are produced, as defined by the matrix shown in Table 1.

For example, pressing the number 6 produces these two frequencies: 770 Hz and 1477 Hz. The frequencies listed in the left-hand column are called the "low group," while the frequencies shown on the top are the "high group." Most telephones will just have the keys for 0 through 9, * and #. The amateur radio world makes use of a fourth column of keys labeled A, B, C, and D to provide some additional signaling options.

| | 1209 Hz | 1336 Hz | 1477 Hz | 1633 Hz |
|---|---|---|---|---|
| 697 Hz | 1 | 2 | 3 | A |
| 770 Hz | 4 | 5 | 6 | B |
| 852 Hz | 7 | 8 | 9 | C |
| 941 Hz | * | 0 | # | D |

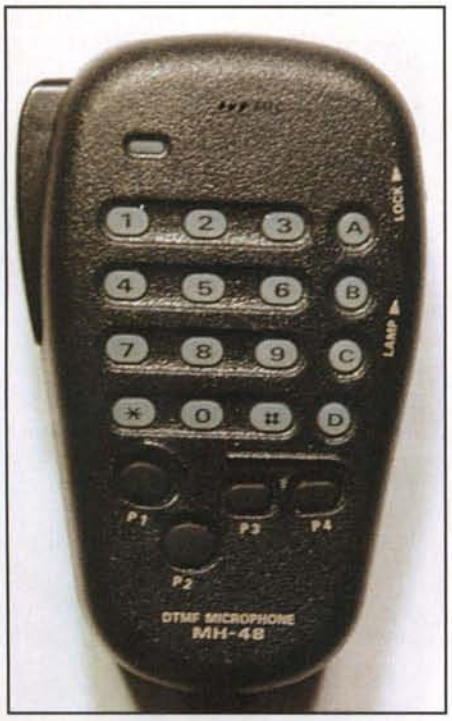
*Table 1. The matrix of DTMF keys and frequencies.*

These frequencies were carefully chosen so that no frequency is a harmonic of another, which would increase the possibility of a decoding error. The frequency accuracy is specified at 1.5%, fairly tight, to keep the tones separated.

Most modern FM radios include a DTMF encoder as part of the radio. Mobile rigs tend to have the keypad built into the microphone (see photo), and handheld radios have a keypad on the front of the rig. DTMF tones are most commonly used for sending commands over the air, including repeater control, autopatch access, and IRLP access. DTMF can also be used for selective calling or alerting another station.

Distortion is the enemy of any tone signaling system, so DTMF levels should not be set too high. Most radios are adjusted at the factory and shouldn't require any tweaking by the user. For most amateur FM systems, we use a peak deviation of 5 kHz. One rule of thumb is to set the DTMF deviation at no higher than two thirds of the maximum deviation (two thirds of 5 kHz equals 3.33 kHz). Most repeater operators I know set the DTMF deviation between 2.5 and 3.0 kHz. If you are using narrowband FM, such as 2.5-kHz peak deviation, the DTMF deviation should be correspondingly smaller, 1.65 kHz or less.

DTMF is an "in band" signaling system, so normally we will hear the tones being transmitted on the air just by listening on the frequency. Be aware that it is common for repeaters to filter out DTMF tones as they pass through the repeater, so you may not hear the tones on the repeater output.




*Most mobile transceivers implement the DTMF keypad on the microphone. Shown here is the Yaesu MH-48.*

## CTCSS

Many FM repeaters operate using carrier squelch, which means that the repeater keys up any time it hears a signal on its input frequency. I've heard some radio technicians refer to this as "going naked," since any signal that comes along can activate the repeater. In today's world, we have many electronic devices with digital circuitry spewing out all kinds of frequencies, just waiting to trigger a receiver. (Walk around a typical office building with a handheld radio; the squelch opens up when you pass a computer or other electronic device due to the frequencies being radiated.)

*21060 Capella Drive, Monument, CO 80132
e-mail: <bob@k0nr.com>

| | | | | |
|---|---|---|---|---|
| 67.0 | 94.8 | 131.8 | 171.3 | 203.5 |
| 69.3 | 97.4 | 136.5 | 173.8 | 206.5 |
| 71.9 | 100.0 | 141.3 | 177.3 | 210.7 |
| 74.4 | 103.5 | 146.2 | 179.9 | 218.1 |
| 77.0 | 107.2 | 151.4 | 183.5 | 225.7 |
| 79.7 | 110.9 | 156.7 | 186.2 | 229.1 |
| 82.5 | 114.8 | 159.8 | 189.9 | 233.6 |
| 85.4 | 118.8 | 162.2 | 192.8 | 241.8 |
| 88.5 | 123.0 | 165.5 | 196.6 | 250.3 |
| 91.5 | 127.3 | 167.9 | 199.5 | 254.1 |

*Table 2. Fifty standard CTCSS frequencies in Hz (not all radios implement all of these tones).*

A more controlled squelch system is called Continuous Tone Coded Squelch System (CTCSS). The idea is very simple: The FM transmitter includes a continuous tone on the transmitted audio. When the receiver (repeater) hears the required tone, the squelch opens. If there is no tone, the receiver stays squelched, no matter how strong the signal is at the receiver.

To make the system flexible, 50 unique tones are defined so that different systems can use their own unique tones. (Some radios do not implement all of these tones, so check your radio's manual.) This tone system is used in the land mobile service to allow multiple users to share the same repeater, but without having to listen to the other users on the channel. Each user group is assigned its own specific CTCSS tone (see Table 2).

The CTCSS frequencies are in the range of 67 Hz to 254 Hz. Unlike DTMF tones, which are sent momentarily as the key is pushed, CTCSS tones are sent any time the transmitter is on. This means that the tones will be present with the normal voice signal. To keep the transmitter from over deviating, we usually set the tone deviation at around 600 to 800 Hz. Because the tone is active the entire time the transmitter is on, we'd like to keep it from being heard in the receiver. Although we call these frequencies *subaudible,* they are within the hearing range of most people. Voice communication systems are designed to use the frequency range of 300 Hz to 3 kHz, which allows for normal speech to be understood. As long as we filter out the frequencies below 300 Hz before the signal gets to the radio speaker, the user won't notice the presence of the CTCSS tone, but we'll still have the desired voice frequencies. Virtually all modern VHF/UHF FM transceivers for amateur use include CTCSS encode and decode standard.

## Selective Calling

Let's look at how we can use CTCSS tones for selective calling. Suppose an ARES group wants to monitor a particular simplex frequency on 2 meters to always be available for a call 24 hours a day. They also don't want to be awakened by a random call (not from the group) in the middle of the night. They all could agree to program their radios to transmit a particular CTCSS tone, for example 100 Hz. To keep their receivers from unsquelching on non-ARES signals, they would set also set their CTCSS squelch for 100 Hz on receive (usually referred to as Tone Squelch in the manual.) The group's receivers will remain silent until a signal shows up with the 100 Hz tone on it.

We can expand this approach to allow another set of users to do the same thing on the same channel, but using a different CTCSS tone (for example, 123 Hz). This second group of users can listen on the same channel but never hear the ARES group.

We do have a very practical problem to deal with, though. If users from both groups try to transmit at the same time, they will interfere with each other. To keep this from happening and to cooperatively share the frequency, everyone needs to listen on the frequency to make sure it is not in use before transmitting. Some radios have a "monitor" button that opens the squelch to check whether anyone is on the channel. Another way to accomplish this is to temporarily turn off the tone squelch, perhaps programmed into a special memory channel.

| 11 Check Bits | Signature | 9 Bit DCS Code |
|---|---|---|
| CCCCCCCCCCC | 100 | DDD DDD DDD |

*Table 3. The 23 bits contain 3 fields of data: 11 error correction check bits, 3 signature bits and 9 bits for the actual DCS code.*

023 025 026 031 032 036 043 047 051 053
054 065 071 072 073 074 114 115 116 122
125 131 132 134 143 145 152 155 156 162
165 172 174 205 212 223 225 226 243 244
245 246 251 252 255 261 263 265 266 271
274 306 311 315 325 331 332 343 346 351
356 364 365 371 411 412 413 423 431 432
445 446 452 454 455 462 464 465 466 503
506 516 523 526 532 546 565 606 612 624
627 631 632 654 662 664 703 712 723 731
732 734 743 754

*Table 4. A common set of DCS codes (from the Yaesu FT-7900R manual).*

CTCSS is the technically correct name for this subaudible tone system. You'll often hear it referred to as "PL," which is short for Private Line, a trademark of Motorola. I always try to remember to say CTCSS, but somehow that does not slide off the tongue as easily as PL.

I already mentioned that many repeaters require a CTCSS tone on the user's signal to access the repeater. You need to find the correct tone in a repeater directory, or obtain it from the repeater trustee. Some repeaters also transmit a CTCSS tone on the *output* of the repeater. You aren't required to use this tone, but you can take advantage of it to control the squelch of your receiver. Why would we want to do that? Suppose there was another repeater on the same frequency that was strong enough to be received by your station. You really want to listen to your local machine, but occasionally the distant repeater pops open your squelch. Assuming the other repeater doesn't use the same CTCSS tone on the repeater output, you can mute the distant repeater using tone squelch. Tone squelch is also useful for suppressing random noise sources on your radio (computer hash, spurious signals, etc.).

Keep in mind that most repeaters do not pass CTCSS tones through the system. Common practice is to filter out anything below 300 Hz on the audio path, so attempting to use CTCSS for selective calling through a repeater does not usually work. Check with your local repeater trustee to find out how a specific repeater handles subaudible tones.

In land mobile radio a different CTCSS frequency may be used on the input and output of a repeater. This is also possible in amateur repeaters, but not commonly used (usually the same on input and output). In fact, many amateur radios cannot be set up for mixed input and output tones.

### Don't Pound My Octothorpe

If you want to spark a conversation at your next dinner party, ask everyone the proper name for this symbol: #. Most North Americans will probably say *pound sign* or perhaps *number sign*. It helps to have an international audience, since a person from the UK will likely call it the *hash* symbol. A musician might claim that it is the *sharp* symbol from musical notation, but closer examination reveals that the sharp symbol is quite different.

The AT&T engineers who invented the original DTMF system adopted the name *octothorpe* for this symbol. There are various explanations and anecdotes that have developed over the years to explain the origin of this word. Various forms of spelling show up in the literature (octatherp, octothorp, etc.). Doug Kerr's story is particularly interesting and available on the internet (see below). The use of the word "octothorp" made it into some US Patent applications. For example, US Patent number 3920926 uses "octothorp" for # and "sextile or asterisk" for the * symbol. The term *sextile* never caught on at all.

Lately, the world of Twitter (and other social media) has made extensive use of # to tag keywords, but referring to it as *hash* mark or symbol. For amateur radio usage (North America bias), I hear mostly *pound* for # and *star* for *. I suspect that will not change any time soon. —*KØNR*

*References*

Wikipedia explanation of the number sign (#): <http://en.wikipedia.org/wiki/Number_sign>

The symbol or the "pound" or "number" key (#) is also called an octothorpe <http://www.todayifoundout.com/index.php/2010/07/the-symbol-on-the-pound-or-number-key-is-also-called-an-octothorpe/>

The ASCII character "Octatherp," by Doug Kerr, <http://dougkerr.net/pumpkin/articles/Octatherp.pdf>

We call these CTCSS tones subaudible but they are not really "inaudible." We try to keep these low-frequency tones from popping out of the audio speaker, but sometimes it still happens. For example, I run a 100-Hz CTCSS tone on the output of my repeater and occasionally I get a report that the repeater transmitter has power-line hum on it. In particular, I have gotten this report from hams using headphones on the speaker jack of their FM rig. What the user is really hearing is the 100-Hz tone that is supposed to be there, and the use of headphones makes it more noticeable.

## Audio Tone Burst

Another repeater access method is to send a short tone burst of 1750 Hz. This method is common in Europe but is rarely used in North America. If you look through your radio manual, you will probably find this feature is available on your equipment. This method is sometimes called "whistle up," since a repeater user with good pitch can access the repeater by whistling a tone into the microphone.

## DCS

Digital Coded Squelch (DCS) is a newer signaling system that now comes standard on most amateur FM transceivers. Although it operates differently, it can roughly be thought of as a digital form of CTCSS. Instead of sending a continuous low-frequency sine wave, DCS sends a 134.4 bits-per-second digital signal on the transmit signal. The FM deviation for DCS is similar to CTCSS—about 600 to 800 Hz.

DCS uses a 9-bit digital number that is the basic DCS code. Rather than just send this binary code out in raw form, DCS makes use of an error correction scheme that can tolerate up to 3 bit errors. DCS actually sends a 23-bit Golay code, a special class of digital numbers that allows for correction of up to 3 bit errors in the code. The 23 bits contain 3 fields of data: 11 error correction check bits, 3 signature bits, and 9 bits for the actual DCS code (see Table 3). The signature bits are always 1 0 0. The 23 bits are each 7.44 msec in duration, for a total time of 171 msec.

From the user's point of view, we only care about the 9 bits of the DCS code, since the 11 check bits are prescribed by the Golay code and the Signature bits are fixed. The 9-bit DCS code is treated as 3 octal numbers, each within the range of 0 to 7. At this point, you might expect that there are 29 = 512 codes available, using the entire 9-bit range. The number of available codes is actually much less than this due to some decoding issues. The DCS system has no start or sync bits, so the DCS decoder is tasked with watching the stream of bits go by and detecting the code. With this limitation, some of the 23-bit codes are not truly unique. (Think in terms of rotating the bits around until they happen to match another code. I won't go any deeper here, but this issue is explained very well at the onfreq.com page listed in the refernces section.)

The specific codes implemented vary among various models of radios, so consult the manual to be sure which codes are supported. As an example, Table 4 shows 104 DCS codes implemented in a Yaesu transceiver. Note that the 9-bit DCS code is represented as 3 octal digits.

Being a digital coding scheme, the polarity of the signal is important. While conventional CTCSS uses a sine wave such that phase or polarity doesn't matter, the DCS system can become confused by a polarity inversion in the audio chain. Most transceivers provide a way to invert the DCS code to compensate for this problem and maintain the proper signal polarity.

From the user's point of view, DCS operates a lot like CTCSS. To access a repeater using DCS, you need to set your radio to the right DCS code (also inverting when necessary). DCS can also be used on simplex frequencies to implement a selective call feature. However, don't count on DCS codes being passed through your local repeater. Just like CTCSS, normally they are filtered out.

## Summary

This has been a quick overview of the most common forms of tone signaling used on FM simplex and repeaters. 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 at the address shown on the first page of this column.

73, Bob, KØNR

## References

1. ITU-T Recommendation Q.23 General Recommendation on Telephone Switching and Signalling

2. Excellent technical explanation of DCS: <http://www.onfreq.com/syntorx/dcs.html>

By Keith Pugh,* W5IU

# SATELLITES

## Artificially Propagating Signals Through Space

# Satellites to Promote STEM in Education ARISSat-1 and FUNcube

In my last column in the Fall 2010 issue of *CQ VHF* I mentioned the 10th anniversary of Amateur Radio on the International Space Station (ARISS) and the 25th anniversary of amateur radio in human space flight. Having just completed a tour of duty as an ARISS Operations Lead, I have gained additional insight into the ARISS purpose, organization, and operations. I would like to share this insight with members of the amateur radio community. This column will be limited to my observations and opinions. Additional details (such as names of current personnel) are available at <http://www.ariss.org> and other sources. Here I will lean heavily towards portraying the day-to-day operations of ARISS. As we approach the launch of ARISSat-1 and continue with the development of FUNcube, we need to review the primary purpose of these amateur radio satellites, the equipment we need to use them, and how they can be used for education and fun.

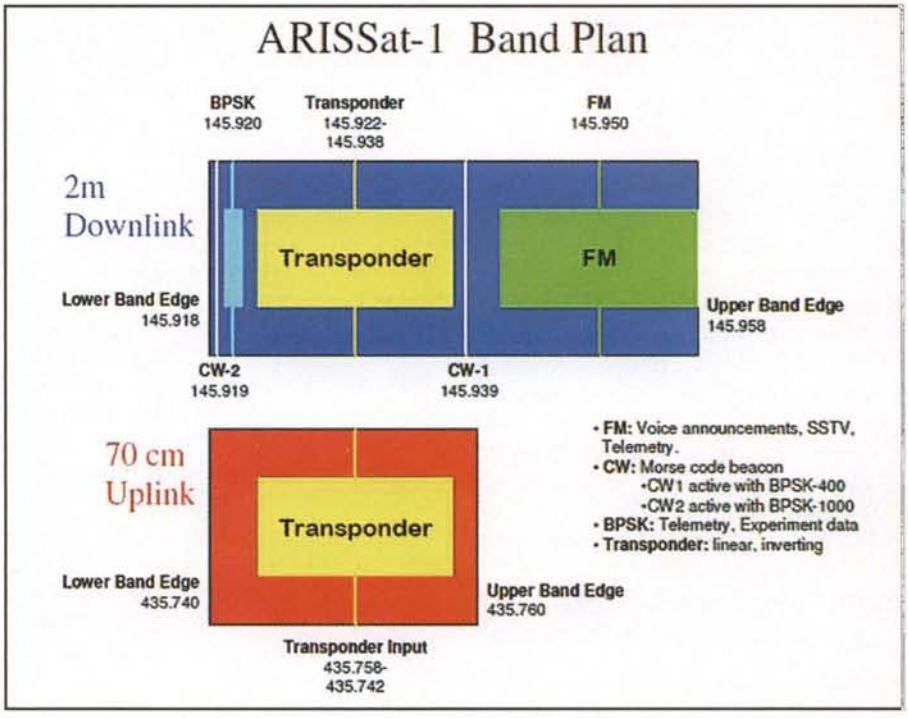



*Figure 1. The ARISSat-1 band plan.*

## ARISSat-1, ARISS Purpose

As this column is being written (20 December 2010), ARISSat-1 is in Russia waiting for final integration of the Kursk experiment and the Russian supplied space suit battery prior to shipment to Baikinor for launch on a Progress supply ship to the International Space Station (ISS). The Progress launch was scheduled for late January 2011, and the deployment from the ISS during a spacewalk (EVA) was scheduled to occur in late February 2011. If things go per this schedule, you should be reading this column just before ARISSat-1 is deployed from the ISS.

ARISSat-1 initially will share the ISS orbit but will be released such that it will not collide with the ISS on subsequent orbits. This orbit is very low and the satellite will decay from this orbit and re-enter the Earth's atmosphere in six months to a year.

Last time in this column I concentrated on the development cycle of ARISSat-1 (and most other satellites). This time I will talk about the functionality of the "Bird," the ground station equipment necessary for its use, and some ideas about how all of this can be integrated into the classroom. An excellent overview presentation regarding ARISSat-1 and its functions is available at : <http://www.amsat.org/amsat-new/images/fck_images/ARISSat-1%20Overview%20Color.pdf>.

## ARISSat-1 Functions

A "bulletized list" and additional descriptions of the ARISSat-1 functions, courtesy of Gould Smith, WA4SXM, AMSAT Vice President of User Services and ARISSat-1 Project Leader, follows:

- The FM transmissions will cycle between a voice ID, select telemetry values, 24 international greeting messages in 15 languages, and live SSTV images.
- The CW transmissions will be callsign ID, select telemetry, and callsigns of people actively involved with the ARISS program.
- The BPSK transmissions will feature a new 1k BPSK protocol developed by Phil Karn, KA9Q, to be readable in low signal level conditions. The BPSK data will alternate between telemetry and Kursk experiment data. Free ground station soundcard demodulator and display software will be available by launch for multiple platforms.
- There also is a 16-kHz wide amateur radio mode U/V linear (SSB/CW) transponder between the BPSK and FM signals.
- The Kursk experiment will be sampling the amount of vacuum each day for 90 minutes and sending down data to map the vacuum change as the satellite slowly spirals into the atmosphere.

Six solar panels supply power to the satel-

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lite and recharge the battery. Once the battery is exhausted the satellite will continue to send data in a low power mode when illuminated. The spoken telemetry values and greetings are to promote science and math education by encouraging school children to listen to the satellite, track its progress, and plot the changes.

There are secret words in most of the greetings for which awards will be given to those correctly identifying these secret words. There will also be a contest to see who correctly copies the most CW callsigns sent. The telemetry data will also be available live and over the internet for schools and radio amateurs to study the operation and changes that the satellite experiences during its orbits around the earth.

The SSTV images are selected from "canned" images on board the spacecraft and the output from four on-board TV cameras pointed in four different directions from the satellite. As the satellite rolls and tumbles, the view of each camera can range from looking at the Earth to the blackness of "deep space." There is logic on board to select the camera with the most pixels of information prior to transmission. All images will be in the Robot 36 format and may be decoded and displayed on a computer running MMSSTV or other free SSTV software.

## Band Plan and Ground Station Equipment

Figure 1 is an illustration of the RF band plan for the Software Defined Transponder (SDX). Figure 2 is a screen capture of the actual SDX downlink as displayed with SpectraVue software running on a computer connected to an SDR-IQ receiver and a 2- to 10-meter converter. Conventional FM and SSB/CW receivers can be used for all of the functions, but use of a Software Defined Receiver such as the SDR-IQ or the FUNcube Dongle (more about this later) will allow all downlink functions to be displayed at once. Signals to process can then be selected on the computer display in accordance with the frequency and modulation type.

A few words of explanation are in order. First, remember the 2- to 10-meter converter. Replace "28" on the display with "145." An FM signal can be seen centered at 145.949 MHz, and a rise in the noise floor from about 145.921 to 145.937 MHz indicates where the linear transponder is located. No SSB/CW signals are shown within the transponder passband. The CW-2 beacon and the BPSK-1000 telemetry are shown close together from 145.918 to 145.912 MHz. The CW-1 beacon is not shown. If it were shown, the BPSK-400 telemetry would be paired with it, and the CW-2 and BPSK-1000 would not be on the display.

Don't let this apparent complexity get to you. It's actually quite easy to operate and runs well on a notebook computer. It's really nice to see the whole passband at once. If you use discrete (conventional) receivers, simply tune in the signal, connect the receiver audio to your computer sound card, and away you go. Signals from the "Bird" should be quite strong. However, I recommend at least simple directive antennas for best operation. Hams will want to have a 70-cm transmitter available to be able to make contacts through the linear transponder.

## What Does It Mean to Education?

That's enough of the "nuts and bolts." What can kids learn from this to "tweak" their interest in science, technology, engineering, math (STEM)—and other topics? I will simply list things that come to mind without any specific lesson plan. Professional educators are working on lesson plans for some of these ideas and ideas of their own. If you know educators who are also hams or are very interested in STEM, please help recruit them for assistance with lesson plans and ideas. Here are some of my ideas:

1. Basic communications theory. Operation of receivers, transmitters, antennas, and computers. Station construction.

2. Orbital mechanics. Ability to track this and other satellites on a computer so that they can plan data gathering. Use and updating of a satellite tracking program. Watch the orbit decay and predict when the satellite will burn up and re-enter the Earth's atmosphere. This can actually be the basis of a "Chicken Little" contest to predict the time and location of satellite re-entry. What did it take to put the satellite in orbit in the first place?

3. The concept of telemetry. Health and welfare of the satellite. Temperatures, charging currents, voltages – keeping the satellite healthy. This telemetry can also be used to determine the attitude and spin rate of the satellite. Data for this can be gathered live from the satellite or shared over the internet with others around the world.

4. Geography. Study the countries that the satellite passes over, particularly those that participate in ARISS and the ARISSat-1 program. Look at the live SSTV images and try to identify locations of the satellite when pictures were "snapped." This would involve knowledge of the time and date the picture was taken and then use of the tracking program and image identification skills to finalize the location. This could become a competitive activity.

5. Language skills. Remember there are 24 messages in 15 languages that contain greetings, telemetry, and secret words. Compare your skills with the rest of the world. Earn rewards for identifying words.

6. Morse Code. Some consider this a dying language skill, but often kids actually enjoy the challenge of copying information with a new (to them) language. There will be live telemetry, satellite ID, and callsigns of contributors to the amateur radio satellite program over the years. Copying these calls can be competitive. Copying can be by ear or by machine (computer).

7. Live lessons in the scientific method of approaching real situations and problems.

8. Make new friends and acquaintances through the linear transponder all over the "footprint."

9. Help quantify the vacuum of space by following the progress of the Kursk experiment.

These are just some of my ideas. What are yours? This "Bird" is a golden opportunity to showcase amateur radio and amateur radio satellites while providing ample "food for thought" and STEM education.

## FUNcube and the FUNcube Dongle

FUNcube is a 1U cubesat (10 × 10 × 10 cm and weighing no more than 1 kg) that is a project of AMSAT-UK and shares many of the educational objectives of ARISSat-1. It also incorporates a mode U/V SDX linear transponder. More information is available at: <http://funcube.org.uk/http://funcube.org.uk/>.

This satellite is planned to be launched into a sun synchronous polar orbit in late 2011. In this type of orbit, FUNcube should have a long lifetime. Development is well under way, and the FUNcube project is actively seeking volunteers who can help define the educational

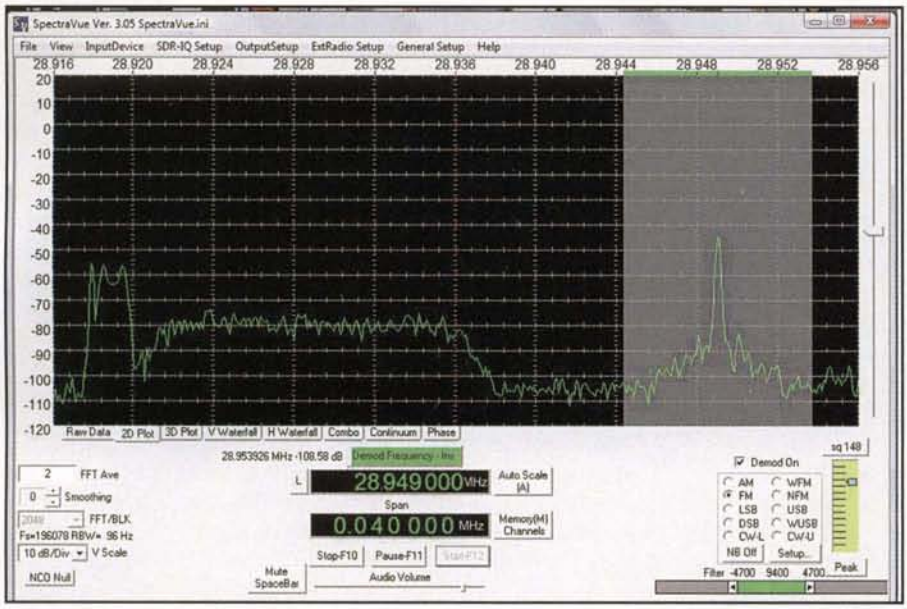


*Figure 2. Output of an SDR displayed with SpectraVue.*

aspects of the program. A worldwide network of ground stations is being organized to provide telemetry coverage for the satellite and the schools involved. Ground station development is also well under way and a key portion of this is the FUNcube Dongle.

FUNcube Dongle has a life of its own and will be a boon to both ARISSat-1 and FUNcube. Visualize a 64-MHz to 1.7-GHz software-defined, all-mode receiver the size of a USB memory stick that will plug into any computer USB port, connect to an antenna, and receive all of the data from the satellite. This receiver is the brain child of Howard Long, G6LVB, and exists today. The first production run (100 units) went on sale on 19 December 2010 and sold out in one minute and eight seconds! It will be available in two versions: FUNcube Dongle Pro and the basic FUNcube Dongle. The Pro version retails for about $150 and the basic version for much less. The frequency range of the basic version is restricted to the range needed by schools to support the telemetry and communications. It will be priced cheaply enough so that it can be placed in the hands of schools by clubs, individual volunteers, etc. With the FUNcube Dongle, a notebook computer, free software, and a simple antenna, a school will have everything it needs to participate in the FUNcube and ARISSat-1 programs. Sales so far have been via the internet, but look for it soon via your AMSAT store – both AMSAT-UK and AMSAT-NA. In the meantime, keep up with its development at: <http:// www.FUNcubeDongle.com/>.

## ARISS 10th Anniversary

This note just came in from Gaston Bertels, ON4WF, ARISS Chairman: "December 21, 2010, we celebrated the 10th anniversary of student conversations with ISS astronauts. On December 21, 2000 astronaut William Shepherd called the Burbank School in Burbank, Illinois and was soon talking with 14 enthusiastic students. Since that first contact, you have conducted 565 successful school contacts in 40 countries and on five continents."

Figure 3 is a photo of Paolo Nespoli, IZØJPA, presently on board the International Space Station, addressing his greetings to the ARISS community, wishing us a happy birthday. We can expect many more contacts this year from the ISS.

The primary purpose of ARISS is to promote education of our youth in math, the sciences, engineering, and technology through exposure to the International Space Station Program. A secondary purpose is to expose students and others to the world of amateur radio and the many benefits of this fascinating avocation.

Working with professional educators worldwide and with the space agencies of the world, ARISS provides opportunities for students of all ages to talk and exchange ideas with astronauts on board the ISS while it is in orbit. Amateur radio

provides the media for this exchange to occur and the volunteers who facilitate the primary purpose.

## ARISS Organization

Based on a proud legacy of human space flight dating back to 1983 and Owen Garriott's STS-9 flight, including the Shuttle Amateur Radio Experiment (SAREX), and MIR, ARISS was formed in 1996. The founders were Roy Neal (SK), K6DUE; Frank Bauer, KA3HDO; Rosalie White, K1STO; and Matt Bordelon, KC5BTL. The team organization is governed by a group of ARISS International Working Group delegates from Canada, Europe, Japan, Russia, and the USA. Delegates are chosen from the radio amateur satellite corporations (AMSATs) of the world, the national amateur radio organizations (such as the ARRL), and the space agencies of the world. These delegates meet via monthly telephone conferences, and about once a year in face-to-face meetings (last year's in Moscow; this year's in the Netherlands). In between, activities are coordinated by e-mail and additional telephone conferences as necessary. These delegates set the policy with advice from the space agencies for operation, coordinate equipment for the ISS, coordinate with education organizations, coordinate school selection for contacts, and provide oversight to the ARISS Operations Group—the other major ARISS group.

The ARISS Operations Group is made up of ARISS mentors, scheduling/technical representatives, and an orbital prediction specialist. An ARISS Operations Lead is selected from within the ranks on a periodic basis. This group meets weekly by telephone conference and much more frequently via e-mail and telephone. ARISS mentors are the volunteers who work with the schools, teachers, and local amateur radio groups that actually make the contacts with the ISS. Scheduling/technical representatives work within the space agencies, primarily NASA in the USA and the Russian Space Agency, to secure the final schedules for the contacts. These scheduling representatives also coordinate training of the astronauts in the use of the equipment on board the ISS and procedures for its use. The orbital prediction specialist does the long- and short-term predictions necessary to support the scheduling of all of the contacts. I will talk more about these functions and their relationships with each other in subsequent paragraphs, outlining the scheduling and performance of the contacts.

## ARISS Operations

The wheels start rolling with the submission of an ARISS application for an ISS contact. Ideally, a teacher hears about the possibility of a contact through professional societies, from other teachers, from amateur radio operators within the community, or via many other routes. The teacher, with the help of local amateur radio operators, fills out the multiple-part application and submits it to the regional ARISS organization. The regional organization reviews the application, obtains clarification if necessary, ensures the application is forwarded to the ARISS international education committee, and enters it into the list of applicants in the order in which it was received. A separate list is maintained for each region of the world, and candidates are chosen from each region in proportion to the number of applicants on the list.

Another list is maintained for "Crew Pick" contacts. These contacts are with schools that are chosen by the astronauts for

*Figure 3. ARISS 10th anniversary greetings from Paolo Nespoli, IZØJPA, on board the ISS.*

their own reasons and are usually separate from the main list. Astronauts are allocated Crew Pick contacts based on their interest in the program and willingness to support contacts from the main list.

The main list can be quite long and the waiting period can be correspondingly lengthy. Currently, the wait for US applicants is about one year. Every effort is made to keep the wait to a minimum, but contacts generally are limited to somewhere between a one and four a week period depending upon the crew's willingness to support contacts and the workload on the ISS.

Another factor to consider is whether the contact is to be "direct" or via "telebridge." For a direct contact, a ground station is set up at the school and the contact proceeds directly through that station with the station on board the ISS. For a telebridge contact, the ground station is located remotely (possibly halfway around the world) from the school and the ground station is connected to the school and other elements through a telephone conference bridge. The ARISS Operations Group has developed and maintains a list of acceptable telebridge stations around the world (these are currently in the mainland US, Hawaii, Australia, Argentina, Belgium, and South Africa).

The school expresses a preference for the type of contact in its application and the ARISS Operations Group will honor this preference whenever possible. A telebridge contact requires much less equipment at the school and is much more flexible on timing of the contact than a direct contact. However, it actually requires more coordination on the part of the ARISS ops to carry out. A list of requirements for each contact follows:

- The ground station must be within the footprint of the ISS during the time of the contact and the ISS should have a peak elevation at the ground station of more than about 15 degrees. Higher passes are more desirable to maximize the contact time and minimize effects of local obstructions on the contact.
- The pass selected must occur during normal school hours as stated on the application or within an acceptable alternate time.
- The pass time selected must be within the crew's normal off-duty but awake time. Exceptions must be approved by the Space Agency medical personnel. Crew sleep periods are normally fixed, but can be "sleep shifted" during special work periods that coincide with ISS or other activities.

Picking and approving passes that satisfy the above requirements involve several steps that are outlined below:

A list of possible contacts is selected from the prioritized list of contacts maintained by ARISS over a period of time (usually for an ISS expedition).

ARISS mentors are assigned to each school as soon as possible. The ARISS mentor establishes contact with the school and local ham volunteerss, and verifies the content of the application (many times things have changed at the school since the original application was prepared).

The list of candidates is broken up into direct vs. telebridge contacts.

**Direct Contacts.** Direct contact candidates are submitted to the orbital prediction specialist for processing into the "best weeks" list. Best weeks are long-term predictions that will permit selection of schools that have passes within a certain time frame of weeks that satisfy all of the nominal contact requirements above. A school may have several different best weeks within the overall time frame.

Selections are made based on contact priority and best weeks for each school, and the ARISS mentors obtain preferences for the available weeks from each school.

The ARISS mentor continues the dialog with the school to firm up the requirements for the station, answer questions from the teacher and the local amateur radio operators, assist the teacher with resources for lesson plans and in solicitation of questions and names from the students, and obtain a short description of the school and its activities for forwarding to the astronauts. The ARISS mentor also prepares the school for filling out a post-contact survey for ARISS and NASA.

At about four or five weeks before the week selected for a school, detailed pass predictions for the contact are requested from the orbital prediction specialist. These predictions are verified by the ARISS operations lead and sent to the ARISS mentor for forwarding to the school for prioritization within its own school schedule. The passes are ranked #1 through #n by the school and the local amateur radio operators and sent back to ARISS ops.

At this point, the pass ranking, student names, questions, and school description are passed on to the NASA planners by the ARISS scheduling representative for final determination of the selected pass. Usually this final pass time is available one to two weeks before the contact. In the case of Russian contacts, a similar process is performed with the Russian Space Agency.

Before the contact time, a final uplink message is sent to the astronaut containing the time, station callsigns, frequency information, the school description, and the students' questions, along with their first names, in the order the questions are expected to be asked.

At this point, the contact is ready to go from a planning standpoint.

**Telebridge Contacts.** For telebridge contacts this process is modified somewhat. Telebridge contacts are usually fitted into the schedule between the best weeks for direct contacts or are scheduled during special times that are specified by the school or event and agreed to by ARISS ops. Telebridge contacts are usually reserved for schools that either cannot obtain local ham club support for a direct contact or have time requirements that are not flexible. The modified steps for a telebridge contact follow:

Telebridge contacts are prioritized by the same process as direct contacts, but they are usually done when direct contacts are not possible, as mentioned above.

For telebridge contacts, the orbital prediction specialist prepares a list of the passes for each telebridge station that can support a contact during the dates/time frames requested by the school and within crew constraints. This list can contain many passes and include multiple stations.

The ARISS lead pares down the list when possible and sends the remaining passes to all of the telebridge stations that have passes on the list for verification of support.

The ARISS lead receives the responses from the telebridge stations and prepares a list of available passes for further prioritization by the school. This list is sent to the ARISS mentor and he forwards this list on to the school.

Once the prioritized list is returned by the school, the process continues in much the same manner as for a direct contact.

One other step is added: A contact moderator is selected by the ARISS lead to oversee final readiness verification at the school and at the telebridge station. The moderator also makes sure school personnel and any audience are aware of how the contact will be done and the amateur radio involvement in the contact. A moderator is added, since many times the level of expertise at the school during the contact is less than it would be during a direct contact.

At the appropriate time, the moderator turns over control to the telebridge station to establish contact with the ISS.

Control is then maintained by the telebridge station operator and the school contact supervisor until the pass is over.

The moderator then completes the process with a closing statement.

In recent years, ARISS has succeeded in including distribution of the audio from the contact over the internet by utilizing EchoLink and IRLP. These are two methods of including many more listeners worldwide in the distribution. Doing this with a telebridge contact is relatively easy. With a direct contact it is a little more difficult, but recently success has been achieved by feeding the audio into a PC at the school and utilizing Skype (an internet telephone) to forward the resulting information to the operator who completes the conversion to EchoLink or IRLP. These operations are also carried out by ARISS volunteers.

The last thing that happens in an ARISS contact is the enthusiastic response of the school kids, and their increased interest in science and ham radio when the contact is successfully completed. This is the pay the volunteers cherish for their efforts and is the reason we eagerly volunteer for this duty.

## Summary

I hope this column has given everyone some additional insight into ARISS and the process of scheduling and conducting ARISS contacts. I also hope no one is scared off by all of the details involved. After all, ARISS is always looking for a few more good volunteers and a few more enthusiastic school teachers to "share the wealth."

Since the ISS was launched, over 400 of these school contacts have been conducted and over 40 have taken place on Expedition 18 during the last six months. Many more are planned in the future. The 400 number does not include all of the SAREX and MIR contacts that preceded ISS operations.

Don't forget to support ARISS in its education efforts, and let's welcome ARISSat-1 to the classroom and the ham shack in the new year. It represents a golden opportunity to showcase amateur radio and amateur radio satellites to kids in the classroom and to promote STEM education while having "hands on" and "heads on" fun.

Continue the amateur radio satellites in education theme with FUNcube. Support this AMSAT-UK project like our own. It is a natural carry on to ARISSat-1, and will be the predecessor to AMSAT-NA's project FOX and other future satellites.

Please continue to support AMSAT's plans for the future of 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>. Follow the projects and progress of AMSAT-UK at <http://www.uk.amsat.org/>.

Please support AMSAT in its fund raising efforts so that they can continue to put more "Birds" on the air.

73, Keith, W5IU

By Joe Moell,* KØOV

# HOMING IN

## Radio Direction Finding for Fun and Public Service

# RDF for the Masses

*There was very good attendance and participation at our antenna-building workshop and transmitter hunt last November in Tri-City Park. (All photos by Joe Moell, KØOV)*

"Keep turning! Listen carefully! You want the highest pitch at the highest number!" That's what I say over and over as I teach young people how to do radio tracking.

Several times a year, some fellow transmitter hunters and I meet with Scouts and other youth in local parks to show them the fun of radio direction finding (RDF). We put out lots of tiny transmitters in the trees, bushes, and grass, and then we give them our RDF gear and show them how it's done. After that, they set out in groups of two or three. Of course, one of us always follows along with them to help and to make sure that they play safely.

Parents and Scout leaders like it because the kids learn about radio waves and get an idea of how researchers track radio-tagged critters in the wilderness. They are also happy that their kids are getting some good exercise. For us, it's a chance to gently introduce them to amateur radio. Maybe there are future hams among them. One or more might even become an international champion of radio-orienteering, also called foxtailing and Amateur Radio Direction Finding (ARDF).[1]

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Nowadays when hams do hidden transmitter hunting for fun and sport, it's mostly on the 2-meter band. Effective directional antennas are of a reasonable size. Most of the time these antennas "point" directly toward the hidden signal, at least at short range. Often there are reflections from buildings, hills, and so forth that add just enough of a confusion factor to make it a worthwhile challenge.

## Easy-to-Build Antennas

Our standard RDF antenna for these hunts is the inexpensive three-element Yagi designed by Joe Leggio, WB2HOL.[2] It has a PVC-pipe boom and measuring-tape elements. Making one from scratch is easy, but it seems that most hams prefer doing it from a kit of parts. Several times a year, Marvin Johnston, KE6HTS, and I stage antenna-building workshops in a local park, followed by some on-foot 2-meter transmitter hunts. Marvin provides the parts kits.[3] He puts out an assortment of tools plus an inverter-powered soldering iron on the park's picnic tables.

The basic WB2HOL-designed Yagi has a good directional pattern when oriented for either horizontal or vertical polarization. It can be scaled for other frequency ranges, such as the 121-MHz aircraft band for tracking Emergency Locator

*This measuring-tape Yagi with offset attenuator in its boom was assembled from Marvin Johnston's kits.*

Transmitters (ELTs) or to the 172- and 218-MHz bands that are used by researchers for wildlife radio-tracking. All it takes is a change in the dimensions in accordance with the ratio of 146 MHz to the desired frequency.[4]

An important addition to the WB2HOL Yagi is a coax choke balun, consisting of seven turns of feedline wrapped tightly around the PVC handle behind the reflector and secured with tape. This minimizes RF current on the outside of the coax shield, which would skew the directional response pattern.

Ordinary 2-meter handie-talkies and scanners with S-meters work fine with measuring-tape antennas for on-foot RDF, but newcomers quickly discover that one more piece of gear is necessary: an RF attenuator. It goes between the antenna and the receiver. Without one, you won't be able to get close enough to a camouflaged transmitter to identify it, because the receiver's S-meter will be pinned in all directions.

The passive attenuators made from resistors and toggle switches, which are common for mobile transmitter hunts, aren't effective on foot because handie-talkies and scanners are notorious for poor case shielding. Strong signals will penetrate the case and pin the S-meter. On-foot hunters prefer "active" attenuators (also called "offset" attenuators) which convert the strong on-frequency signal into a weaker off-frequency signal.[5] Tune your receiver to the offset frequency and adjust the signal level for mid-range on the S-meter with the potentiometer on the attenuator box.

KE6HTS makes a 1 1/4" by 3/4" attenuator circuit board with the regulator, oscillator, potentiometer, and mixer diode. He brings these boards to our in-park workshops where they can be fitted into an enclosure of the builder's choice. Marvin also has a version of the attenuator in a plastic electrical box that goes inside the boom of the measuring-tape Yagi.

Taking bearings on 2-meter signals with a Yagi and offset attenuator is merely a matter of pointing the antenna and watching the S-meter for maximum signal. As the saying goes, "It's so simple, a child can do it." For a while, I was telling kids that it's like pointing a fringe-area TV antenna toward the station's tower. Their quizzical looks made me realize that I was showing my age. A better analogy today would be the aiming of a satellite dish.

Not all children do RDF equally well. For some, it's intuitive. They swing the antenna back and forth, quickly zeroing in on the direction of maximum signal. Others just don't seem to get it, at least not at first. They turn the antenna just until the signal comes up, and then they stop turning and start walking. They ignore the possibility that the signal might have come up even more if they had kept turning.

Operation of an offset attenuator is easy for some but becomes a mystery for others. I have to keep reminding them to increase the attenuation as they approach the transmitter and to use the attenuator setting as a way to judge the distance. The kids, especially younger ones, do better with a receiver that has built-in automatic attenuation. Sniffer4 by Bryan Ackerly, VK3YNG, of Melbourne, Australia, fills the bill.[6]

Sniffer4 is a frequency-synthesized receiver for the 2-meter ham band and the 120-MHz aircraft band with AM and FM detectors. Signals strength is indicated by the pitch of an audio tone. The higher the pitch, the stronger the signal. There is also a built-in autoranging attenuator with nine steps, as displayed on a single-digit readout.

Getting a bearing with Sniffer4 and a measuring-tape Yagi is merely a matter of turning in azimuth to get the highest tone pitch with the highest number on the single-digit attenuator readout—hence my instruction to the kids at the beginning of this article. As the kids walk along and the attenuator number jumps up to 5 or 6, I encourage them to start sweeping the antenna up and down as they look into the trees and the grass to try to spot the little transmitter box.

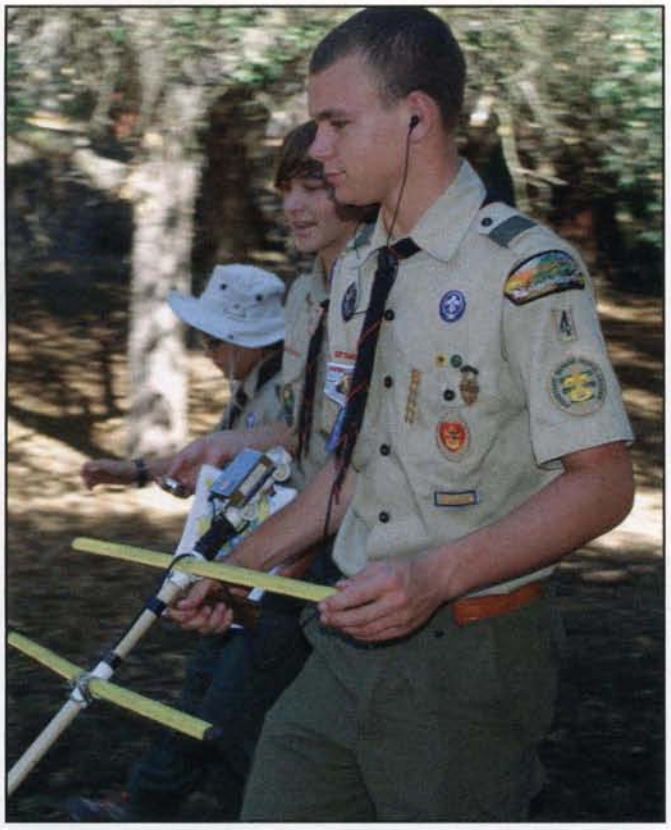
Can average people of all ages learn this RDF technique to find lost objects and animals? Spence Porter, WA6TPR, thought so when he began selling tiny transmitters in the 218-MHz range, plus matching receivers and directional antennas through his company, Communications Specialists.[7] He has produced this gear under several trademarks, including The LoCATor for domestic felines.

Spence's present customer base includes law enforcement agencies that buy his 95-milliwatt peak transmitters for covert tracking under FCC Part 95, as well as wildlife researchers who track radio tags under FCC Part 90. Licensed hams can use his transmitters and receiver/antenna sets in the 222-225 MHz band. They are ideal for recovering radio-controlled aircraft and model rockets.[8]

## Dude, Where's My Car?

Finder Technologies[9], a startup company in Poway, California, has just entered the personal RDF tracking market. Its Auto-Finder is touted as the solution for forgetful and geographically-challenged persons who misplace their vehicles in large parking lots.

Auto-Finder operates in the 2.45-GHz industrial/scientific/medical (ISM) band, which made it possible for Finder Tech engineers to shrink the direction-finding antenna by more than a factor of ten, com-



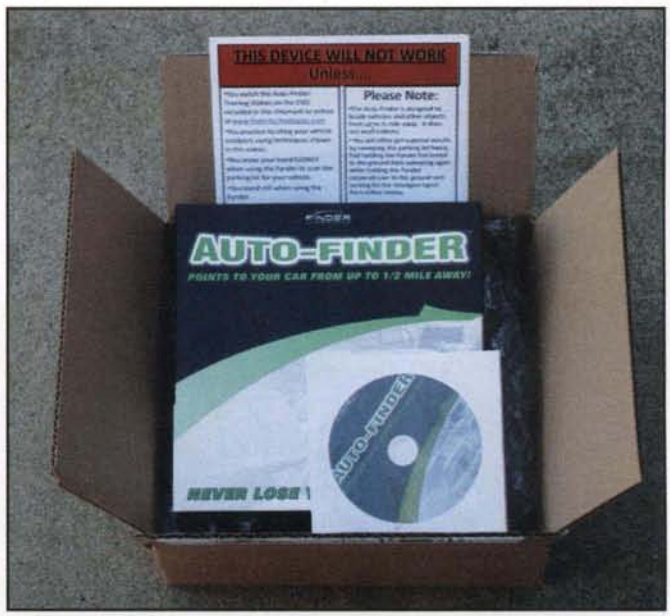
*A group of Scouts sets out to look for hidden transmitters in Goleta, California using a measuring-tape Yagi and Sniffer4 receiver. Note the wooden handle that makes it easy to hold the antenna at the balance point. A seven-turn coax balun is wrapped around the boom behind the reflector of the Yagi.*

*For beginner transmitter hunts, I use 50-milliwatt "Squawk-box" transmitter boards from Bob Simmons WB6EYV <http://www.silcom.com/~pelican2/PicoDopp/MICROHUNT.htm>. They are programmed to transmit a voice message and ID at frequent intervals. I put them in chalkboard-eraser-size plastic boxes with locking devices made from piano wire to prevent theft. Attached to a sturdy branch in a tree or bush, they can't be spotted at a distance.*

pared to Com-Spec RDF systems. Auto-Finder's RDF antenna and receiver fit into a $1\frac{7}{8}$" square by $\frac{5}{8}$" thick key fob, which the maker calls a Pointer Remote. A basic matched set of a transmitter (which Finder Tech calls a Beacon) and a Pointer Remote retails for about sixty dollars.

When you open the box, the first thing you see is a paper that cautions you to read the directions fully and to view the enclosed 10-minute video on DVD[10] before attempting to mount the Beacon and track it. The recommended transmitter location is on the inside of the windshield just behind the rear-view mirror. That puts it high and in the clear for best range, although any metallized tinting in close proximity on the glass will attenuate the signal.

Three AA batteries power the transmitter and two 27A batteries power the key fob. Claimed battery life is over six months of normal use. Unlike Com-Spec RDF gear, an Auto-Finder Beacon isn't on all the time. It's triggered by a transmission from the user's key fob. Transmissions are digitally coded for security and to prevent multiple owners from inadvertently tracking each other's cars. Customers with more than one car can "teach" their Pointer Remotes to recognize and track an unlimited number of vehicles. Conversely, each Beacon can be tracked by key fobs of up to five family members. A Pointer Remote attempts to activate the Beacons of all paired vehicles when it calls for a bearing, so if more than one of the owner's cars is in range, their beacons will "jam" each other.




*A bold caution greets Auto-Finder purchasers as they open the box: "Watch the video and practice!"*

## Video Instruction for ARDF

Auto-Finder includes a DVD that explains in simple terms how to do RDF with its product. How about a DVD that explains on-foot ARDF to hams?

Expert photojournalist Gary Pearce, KN4AQ, has produced an instructional video on the principles and practice of radio-orienteering under international rules. From video and audio that he recorded at the USA ARDF Championships, he has assembled a 36-minute documentary that thoroughly explains the rules, equipment, and techniques of this growing ham radio sport. If you can't find a speaker to talk to your local radio club about ARDF, this is the next best thing. Since it includes plenty of "hunter's eye views," it might be even better.

This DVD is available from Amateur Radio Video News in Cary, North Carolina. On the web, it's <www.arvidnews.com>.

*Joe Moell, KØOV*

Finder's video makes tracking look easy and touts range of up to a half-mile in a normal parking lot, or three floors in a parking garage. I had my doubts about ease of tracking, because microwave signals bounce like ping-pong balls on steroids. That's why they are preferred for digital phones; they propagate into buildings and cars through windows and other small openings. There are plenty of signal reflections that affect Com-Spec RDF sets on 222 MHz, but this ought to be ten times as bad. Objects one-tenth the size will reflect signals at 2 GHz, compared to 200 MHz.

The video cautions users to step away from stores and other buildings before trying to find direction to their cars in the lot. It tells them to hold out the fob horizontally and turn slowly in a full circle, listening carefully for the direction of maximum signal as indicated by highest pitch and fastest beeps. Then it instructs users to repeat the full-circle search with the fob turned 90 degrees to vertical orientation. It reminds them to aim up and down if the car is in a multi-story garage.

Those are the same techniques that we instruct beginning 2-meter on-foot transmitter hunters, but Finder's directions are different because they caution users to stand still while taking bearings. Hams experienced in VHF/UHF transmitter hunting on foot know that it's best to keep moving and to take bearings continuously as they go. That averages out the signal reflections from nearby objects. However, the signal strength indication of the Auto-Finder has slow response compared to typical 2-meter S-meters. That makes it less likely to give clear indications when walking.

## Soggy Searching

My Auto-Finder arrived on the first day of a long-lasting rainy spell. Three days later, there had been no break in the showers and the forecast was for several more days of the same. (Yes, it can happen in southern California, but it seemed as if I was in Seattle.)

With my column deadline looming and no more excuses to give the editor, I took the system to a very large shopping center, got out my umbrella, and started walking in the steady rain. I expected that the precipitation would attenuate the signal and make it a short trek, for the same reason that RF at 2.45 GHz is absorbed by your coffee when you heat it in your microwave oven.

The parking lot is about a third of a mile from end to end. I was able to bring up the Beacon with the Pointer Remote for that entire distance. The three LEDs on the fob always provided a good measure of how far away the car was, but the directional indications were far less consistent. They were the most accurate when the path to my car was unobstructed and there weren't any cars, kiosks, or other clutter in the way. Of course, I could spot the car with my eyes under those conditions. When I was farther away among lots of cars and trucks, the percentage of reliable bearings went down, and when I walked in between the buildings of the center, the bearings became unusable.

This walk in the parking lot reminded me of e-mail I'd received a week earlier from a 2-meter mobile T-hunter in Michigan. He was concerned about occasional false and inconsistent bearings as he drove along toward the transmitter. How could these false bearings be explained and perhaps eliminated?

I wrote back that occasional false bearings are normal, even when there doesn't appear to be any nearby signal reflector or other cause. I told him to keep moving and it will usually average out. You may not take the most direct route, but you will get to the transmitter eventually.

For me, a few bad bearings in a recreational transmitter hunt just make it more interesting. If they make the hunt last longer, it just means that I spend more time having fun that day. I even enjoyed my long rainy walk at the shopping center with the Pointer Remote. However, if I were a weary shopper with arms full of packages and sore feet, I doubt that I'd appreciate a car-finder that didn't always take me directly to my vehicle.

The entrepreneurs of Finder Technologies think that Auto-Finder is just the beginning. They state that their Child-Finder and Pet-Finder are coming soon. I wonder if they will also attempt to compete against Project Lifesaver[11] in the growing market for tracking Alzheimer's patients.

Is there a ham radio application for Auto-Finder? Part of its 2405–2480 MHz operating range is within the 2390–2450 MHz ham band. Who will be the first to hack this gear for ham radio transmitter hunts on 13 centimeters?

Auto-Finder RDF is far from perfect, but a persevering car owner can use it to get within sight of his or her vehicle. It's less expensive than a GPS-based parked-car locator system would be, and GPS fixes would be unreliable for cars in underground garages.

While on the subject of GPS, I should mention that it was a matter of considerable controversy at the World Championships of ARDF last September.[12] Competitors from many countries wanted to take devices containing GPS receivers onto the courses with them. Since radio-orienteering is intended to involve navigation in the woods by map and compass only, there was strong opposition to that.

According to Team USA 2010 co-captain Dale Hunt, WB6BYU, "The language banning GPS devices was removed from the last revision of the international rules. Many competitors wanted to use Garmin Forerunners[13] for their clocks and to record their routes for later analysis. The international jury for these championships initially decided to ban all GPS devices entirely, but was asked to reconsider.

Dale continues, "The advice of the ARDF Working Group was inconclusive, partly because the question was not stated clearly. In the end, the jury relented and agreed to allow all GPS devices, primarily because that was the only timer that many competitors had. There was no time for them to go out and buy new watches." That decision incensed the competitors who had left their Forerunners at home because they thought they wouldn't be allowed, based on the old rules. Everyone expects this matter to

*The Auto-Finder system consists of a remotely activated transmitter (at left) for vehicle mounting plus a key fob that activates the transmitter and takes bearings on it.*

be revisited and a clear policy established before the 2012 World Championships in Serbia.

In the USA, the policy regarding GPS devices on competitive ARDF courses during 2011 is that they may be used only for Route Gadget[14], timing, and post-run analysis (including Forerunners). They must not have a map display and must not provide a navigation advantage. Leave your iPhone with your other belongings at the starting line.

## Make Plans for Albuquerque in Sept.

The location and dates of USA's next national championships of on-foot transmitter hunting have been set. Albuquerque Amateur Radio Club and New Mexico Orienteers will be the hosts on the weekend of September 16–18, 2011. USA's yearly championships will be combined with the biennial ARDF championships of International Amateur Radio Union (IARU) Region 2 (North and South America).

A half-day "model event" practice and equipment-testing session will take place on Friday, the first day. That will be followed by a weekend of competitions, Saturday on 2 meters and Sunday on 80 meters. Medals will be awarded after each event. More schedule details are available on the web.[15]

Co-chairs of the organizers are Jerry Boyd, WB8WFK, and Mike Pendley, K5ATM. They are planning to make available a couple of days of intense ARDF training during the week before the championships. The mountains around Albuquerque have many suitable forested regions, so these championships will take place in well-mapped venues that have not been used in the past for championship radio-orienteering.

USA's ARDF Championships are open to anyone of any age who can safely navigate in the woods with handheld radio gear for several kilometers. Participants will be divided into eleven age/gender categories as defined by IARU. Don't worry if you are inexperienced at radio-orienteering, as this is a chance to learn from experts. An amateur radio license is not a requirement.

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Your stories and photos of hidden transmitter hunting and other RDF news are always welcome. Right now I'm writing up the results of last year's CQ World-Wide Foxhunting Weekend,[16] so if you haven't sent your club's report, please hurry. Mark your calendar for the 2011 Foxhunting Weekend, which will be May 14–15, and then start planning a local hunt that brings out the newcomers and challenges the local experts.

73 and happy hunting, Joe, KØOV





## Notes

1. http://www.homingin.com/intlfox.html
2. http://theleggios.net/wb2hol/projects/rdf/tape_bm.htm
3. http://www.west.net/~marvin/wb2hol.htm
4. For higher frequencies, the antenna becomes smaller. For example, the ratio of 146 MHz to 172 MHz is 0.85. Multiply each of the three element lengths and the two boom spacings (director to driven element and driven element to reflector) of the WB2HOL design by 0.85 to get the dimensions for a 172-MHz Yagi.
5. http://www.homingin.com/joek0ov/offatten.html
6. http://www.foxhunt.com.au
7. "Homing In: RDF for the Masses—Pulsed Emitters Near 220 MHz," *CQ VHF* magazine, Spring 2006
8. "Homing In: New Gear for 1.25-meter Foxhunting," *CQ VHF* magazine, Spring 2008
9. http://www.findertechnologies.com
10. Videos are also available in the Finder Technologies website.
11. "Homing In: RDF Protects Lives, Provides Fun and Promotes Goodwill," *CQ VHF* magazine, Winter 2008
12. "Homing In: ARDF Team USA Returns from Croatia with Three Medals," *CQ VHF* magazine, Fall 2010
13. http://en.wikipedia.org/wiki/Garmin_Forerunner
14. http://www.routegadget.net/
15. http://www.homingin.com/farsnews.html
16. http://www.homingin.com/joek0ov/nfw.html

By Rich Arland,* K7SZ

# BEGINNER'S GUIDE

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

## An Economical VHF+ Station: The Next Step

Over the last couple of columns we have explored a cost-effective approach to building a decent VHF/UHF amateur radio station. Unlike those who prowl the HF portion of the RF spectrum, we who chase DX, grid squares, and satellites on the "high bands" have a number of obstacles to overcome in order to arrive at our dream station. One never-ending problem is noise. Yup, good old noise! The HF folks really don't care about noise all that much. As long as their receivers can hear the target station all is fine. However, we who live on the upper end of the RF spectrum face a totally different situation—that of finding methods of boosting the target signal without a significant boost in noise!


*The Mirage KP-2 Preamp*

### Defining the Problem

In order to approach the noise problems encountered at VHF+ we must first understand where this noise comes from and then we can plan our strategies to combat it. Noise is everywhere—in the atmosphere, in our equipment (component noise, phase noise, etc.), coaxial cable and connectors, and of course, the cosmos, most notably our own sun. It seems as if everything produces noise, and it is our job to find ways to counteract these noise sources to ensure that our target signal(s) is readable and we can extract intelligence from it. Of all of these noise sources the coaxial cable/connector problem is probably the easiest to identify and fix.

In order to minimize the noise generated in our VHF+ receiving system we must utilize sound engineering practices. As basic as it sounds, simply replacing the existing runs of coaxial cable with new, certified, quality coax and using quality connectors (I prefer Amphenol RF Products for both UHF, more commonly called "SO-239/PL-259," BNC and N connectors) will go a long way toward minimizing our system noise. More about this a little later.

### Gain vs. Noise...Life at VHF

Ask anyone who's been in the VHF+ game for a while and they will tell you that you need all the receiver gain you can handle and then some. They are right, within reason. The old adage "you can't work 'em if you can't hear 'em" is oh, so true. However, misapplied receiver gain can be a bad thing—a *very* bad thing. To fully understand where we are going with this, we need to lay some ground work regarding noise, gain, and noise figure (NF), and define some terms.

All receiving systems (starting at the antenna and ending at the speaker or headphones) generate noise. This noise is a product of electrons moving within a solid-state device (transistor, FET, etc.), mixing products within the IF, synthesizer phase noise, atmospheric noise, and a host of other factors, including poor solder connections on your coaxial cables, just to name a few. This noise is cumulative. The total system noise needs to be kept to an absolute minimum to be sure you can work the weak ones on the bands. Your system noise is initially set at the antenna and increases as you progress toward the receiver. That is why experienced VHF+ operators insist on placing their receiver preamps as close to the antenna as possible. That way the noise factor (that little number in dB that is specified by the manufacturer) of the preamp is factored in prior to any additional noise generated by the rest of the system. If your preamp is capable of 20 dB of gain and is placed close to the radio as opposed to at the antenna, any noise generated in the system is also amplified by the gain of the preamp!

The reason is relatively simple to understand if you look at the situation from a noise point of view rather than a signal (S-meter) standpoint. Let's say your super-hot preamp has a gain factor of 20 dB. *That is a lot of gain!* The noise NF is the amount of noise generated internally inside the preamp, and must be fac-

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tored into the entire equation. Normally, in today's world, the NF of a preamp is around .8 to 3.0 dB, depending upon manufacturer, circuit layout, and the solid-state devices employed. What this means, in effect, is that along with 20 dB of gain, the preamp by itself will inject between .8 to 3.0 dB of noise into the system.

Normal human ears can hear a 1-dB change. While it might be hard to distinguish a noise increase of .8 dB, most people can definitely hear a 3.0 dB change. Therefore, there is a very good chance that you may be able to actually hear a change in background noise when you switch the preamp into the system.

By placing the preamp at or near the antenna feed point (these are called "mast head preamps") you can keep the overall system noise in check *and* provide gain at the same time. The gain of the preamp is secondary to the NF. In other words, if you are going to sacrifice anything, sacrifice the gain in favor of noise. In other words, drop a few dB of signal gain in favor of a decreased NF. This will allow you to hear the weaker stations and not cover them up with the system noise of your station.

Recently I obtained a set of VHF and UHF mast head preamps for testing at K7SZ. These units, a Mirage KP2/2M for 2 meters and a KP2/440 for 70 cm (www.mirageamp.com) are very robust devices indeed. The two preamps I tested were special-order items, so the turnaround time was a couple of weeks, just so you know. Both of these units are mast mountable and are remotely controlled via a small control box that is located in the shack, next to the radios. DC voltages are fed to the preamps via the coaxial cable, so no additional wiring is needed. The units can be adjusted for gain from 15 dB to 22 dB to help tailor them to your individual needs.

Over the past year or so I have insisted on spending money only when actually needed. Thus, while I could have opted for building my own preamps, the idea of tackling the weatherproofing and associated problems with fabricating these devices didn't really appeal to me. Therefore, I chose the commercial versions instead. Homebrewing these preamps is a noble effort, to be sure; however, you are going to spend nearly the same amount of money building them as buying them commercially. In talking with Zack Lau, W1VT, from the ARRL Lab, I


*The Mirage KP-2 Control Box*

was enlightened further by his candor. Finding devices to use in these homebrew amps is getting harder by the day. The use of MMIC devices has all but relegated discrete FETs and GaAsFETs to oblivion. Unfortunately, these MMIC units, while suitable for cell-phone frequencies at or near the 1-GHz range, are *not* suitable for use at lower UHF frequencies such as 432 MHz! Therefore, it is better (and much less frustrating) to buy commercial units by Mirage and Advanced Receiver Research (www.advancedreceiver.com/) than to whip out the old soldering iron and inhale solder fumes!

My two Mirage preamps arrived very well packed and ready to install on the antenna masts. Since I lack the necessary test equipment to fully evaluate these two units, I had to rely upon a less-than-scientific process involving my FT-726's S-meter! Hey, it was handy and it gave a *relative* idea of what the preamps were or weren't doing.

To make a long story short; with the preamps in line on 2 meters and 70 cm I did notice a considerable difference in receive signal level (RSL) on both bands. This was especially apparent on the LEO satellite passes I monitored. Doing an "in vs. out" test on these devices there was a definite increase in signal levels with the preamps in the system. I was able to detect a slight increase in background noise. Comparing my Tokyo Hy-Power Model 82V, 2-meter, 80-watt "brick" linear amp with its internal 18-dB receiver


*Tokyo Hy-Power 2-meter amplifier*

preamp with the Mirage 2-meter mast-mounted preamp, the overall difference was very apparent. The Tokyo Hy-Power linear boosted the receive signal, but it also boosted the associated noise levels. This amounted to about a 3 S-unit difference with and without the linear amp's preamp. The Mirage preamp, on the other hand, boosted the signal about a full 2.5 S-units with only a slight increase in background noise! Ergo, mast-mounted preamps are definitely the way to go!

As a side note, in wandering the internet I have found several modifications to my old favorite FT-726 to improve the 2- and 6-meter performance. Both entail building a tiny FET preamp for the IF output of the band module which will greatly enhance the weak-signal reception of this radio set. This makes a lot more sense than trying to increase the gain in the RF amplifier of the band module, which will tend to destroy the receiver performance by increasing the susceptibility to intermod.

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That is it for this session, gang. The upcoming year should be good one for 6-meter DXing, as the sunspot activity on "Ole Sol" is definitely picking up! Now is the time to plan for spring antenna work and to get your stations up and running full bore. Until next time, have fun with the hobby and vy good DX.

73, Rich, K7SZ

By Bill Brown,* WB8ELK

# UP IN THE AIR

## New Heights for Amateur Radio

# HF Balloon Tracking

The majority of amateur radio high-altitude balloons (ARHAB) are tracked on 2 meters using GPS-enabled APRS transmitters. The extensive APRS network of digipeaters, home stations, and Internet Gateways (IGATES) now provides the ability to track a balloon throughout the majority of its flight using the Internet. However, what if you fly across a remote area where APRS activity is sparse or nonexistent? This is particularly true for those of us planning transatlantic balloon flights this winter. It sure would be great to have a system with which you could track a transmitter beyond line-of-sight by using the HF bands.

Fortunately, thanks to a collaboration of programmers and hams in the UK and Canada, a website custom-designed for high-altitude balloons using GPS-position telemetry encoded by a variety of formats is now available. As mentioned in a previous column, you can follow flights using this new system from around the world at <http://spacenear.us/tracker>.

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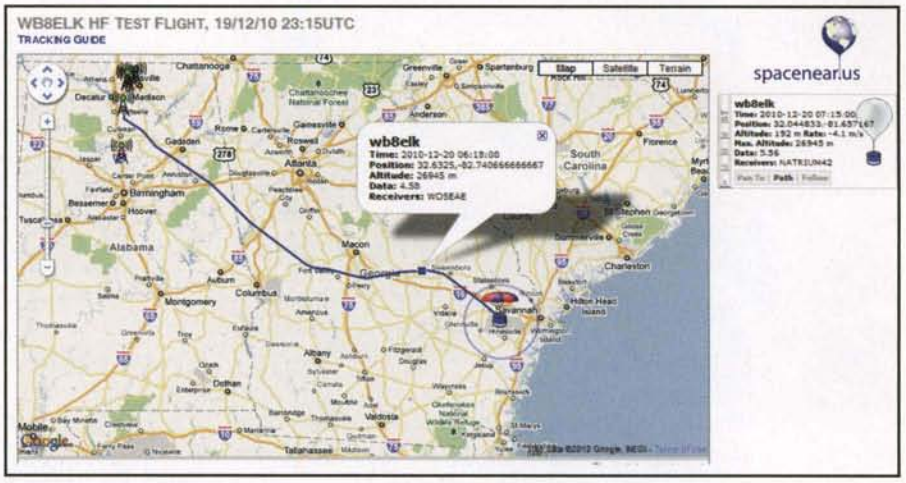


*Photo 1– Flight path plot of the WB8ELK 40-meter balloon.*

This is a work-in-progress and now includes the ability to display the balloon's position on a Google Map, chart the altitude, predict the flight path in real time, and display the telemetry. In addition, all receive-station locations listening for the balloon are displayed on the map. To become a ground station for these HF flights, you can download the free balloon-modified version of the also free digital-mode program FLdigi, called dl-FLdigi, from the following website: <https://github.com/jamescoxon/dl-fldigi/downloads>.

If you receive an error-free frame of telemetry and are connected to the Internet, dl-FLdigi will automatically upload your received telemetry to a server in the UK and will plot it onto a Google Map at the SpaceNear.us/tracker website.

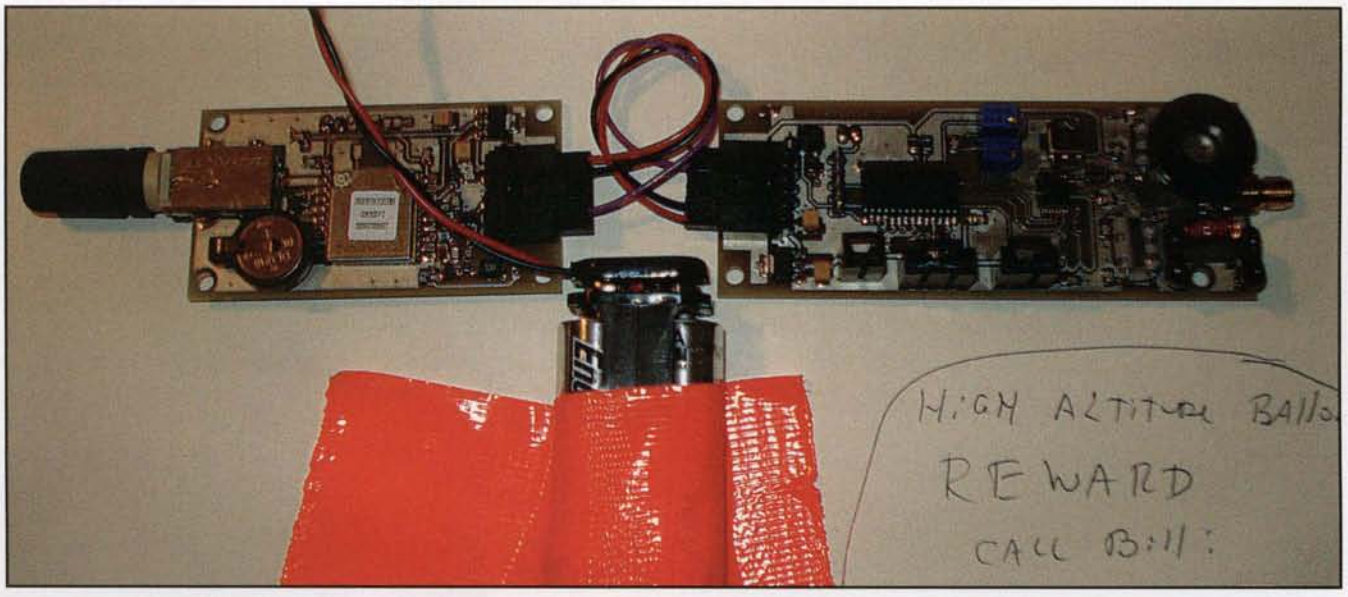


*Photo 2– Elktronics HF transmitter with GPS.*

*Photo 3– Ninth-grade student Nick Simerly prepares his science fair experiment.*

*Photo 4– Nick Simerly inflates the balloon.*


*Photo 5– Ground stations listening for the balloon.*

The more hams on the ground who can listen, the more likely that at least a couple of them are in the ideal zone to receive the low-power telemetry.

## Test Flight on 40 meters

After experimenting with a variety of digital modes for HF telemetry, I have found that DominoEX, Feld-Hellschreiber, 8-bit ASCII RTTY, and good old-fashioned CW are the top candidates for weak-signal HF signals. These modes are also the ones that are relatively straightforward to implement on small microcontrollers without the need for extensive floating point math calculations. DominoEX16 mode seems to perform the best of all under these conditions. I've been customizing a board I call the Multi-Mode Transmitter (www.elktronics.com) that will be used in the upcoming White Star Balloon transatlantic flight attempt (www.whitestarballoon.com).

Since 30 meters and higher frequency bands have been closing at night, I decided to see how a QRP transmitter on 40 meters would perform during a night flight. Although I plan to fly a 2-watt transmitter for the White Star flight this January, for this test flight on December 19, 2010, I flew a transmitter running a mere quarter watt sending out DominoEX16, 110-baud ASCII RTTY, Hellschreiber, and CW. The antenna was a half-wave dipole made out of #22 hookup wire with the payload at the center feedpoint.

## Science Fair Experiment

In addition to the 40-meter experiment, 9th-grade student Nick Simerly of Westminster Christian Academy in Huntsville, Alabama flew sensors and a datalogger for his upcoming science fair project. He had pressure, temperature, and humidity sensors attached to a TI MSP430 evaluation board. In his next flight in January he plans to fly a balloon repeater to demonstrate using high-altitude balloons as communications satellites for his project.

We streamed video of the payload assembly and launch via the British Amateur Television Club's website (www.batc.tv) and had quite an audience from around the world. After beating down a particularly impressive demonstration of Murphy's Law, we finally managed to lift off at 8:30 PM. Surface condi-

tions were ideal thanks to a full Moon and dead-calm surface winds. It was quite a sight to see a 66-foot tall vertical antenna stretching up over our heads as the balloon lifted everything on its way to the stratosphere. It was about 100 feet from the balloon down to the bottom of the 40-meter dipole. I attached a water bottle filled with a few coins and a reward note inside to hold the dipole straight as well as to act as our backup recovery system; basically, we flew a message in a bottle to the edge of space.

With only a few ounces of positive lift, the ascent rate was quite slow and took 4 1/2 hours to reach the burst altitude of 88,000 feet. The long flight combined with a very strong jet stream managed to take us all the way from Huntsville to within a few miles of the Atlantic Ocean for a landing just west of Savannah, Georgia.

## Target Practice

The 40-meter telemetry from the balloon was received by stations from across Alabama, Iowa, Missouri, Iowa, Wisconsin, Texas, Michigan, Oklahoma, Colorado, and Illinois, as well as reception via internet radios in Ohio and Connecticut. The DominoEX well outperformed RTTY when it got weak, and I received a few nice reports from the Hellschreiber as well.

Thanks to WD5EAE's Beverage antenna in Texas (as well as W1TXT's internet radio in Connecticut), we received a final report just 600 feet above the ground. That was the good news. The bad news was that it appeared to have landed smack dab in the middle of an artillery shooting range on the Fort Stewart Army base just west of Savannah.

Sure enough, personnel at the tank artillery shooting range called me first thing in the morning and told me they had found the payloads and had them in their command center. Fortunately they didn't sound too upset over it. Nick Simerly's dad Tim traveled over to the base and was able to retrieve the payloads from the Army personnel at the shooting range. Good thing that they found it, since otherwise our payloads would have been used for target practice. . . . I'll still check for bullet holes and tank treads when I get things back!

---

Stay tuned for upcoming HF flights on 40 and 30 meters. You can see the launch announcements at: <www.arhab.org>.

73, Bill, WB8ELK


*Photo 6– Landing on the tank artillery shooting range.*

By Kent Britain,* WA5VJB

# ANTENNAS

## Connecting the Radio to the Sky

# Connecting Multiple Radios and Antennas

With multiple scanners, software defined radios (SDRs), and other rigs, it is often handy to be able to connect two radios to the same antenna, or for that matter, connect two antennas to one radio.

In photo A we have the common TV antenna splitters. I can hear it now: "But it's 75 ohms." No, the splitter is a hybrid transformer and the transformer has no impedance of its own (figure 1). It's just as happy with three 75-ohm connections or with three 50-ohm connections. There was little variation in performance between 30-ohm and over 100-ohm loads. Take my word for it: These little transformers are quite happy in a 50-ohm system.

The first use of hybrid transformers I'm aware of was telephone handsets. The load was the 600-ohm telephone lines; one side went to the microphone and the other side went to the earphone. Now the audio from the phone line could be split between the earphone and the microphone (figure 2). Also, the 20–30 dB of isolation between the microphone and earphone ports allowed you to hear your own voice, but not get blasted out by the direct audio from the microphone.

I have tested a lot of the splitters over the years, and even supported a factory for a few years that made tens of thousands of these little guys a year. The splitters at the "Dollar Store" work just a well as the $10 ones from the hi-fi stores, especially when we are going to take their guts out.

These hybrid transformers are not really made for transmitting. The ferrite saturates at about 5 watts, and when the ferrite saturates, it looks more like a T connection than a transformer. That is, it stops being a hybrid transformer at more than a few watts. In theory, with the high isolation between ports 1 and 2 we could have two 440-MHz talkies connected to the same antenna at the same time and talk on either of them without damage. However, I really don't recommend doing that. If the ferrite does saturate, or if the antenna has a high SWR, about half of that RF power from one talkie will be hitting the input of the other talkie. That's very dangerous for the health, or warranty, of the other talkie.

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*Photo A. Low-cost power dividers.*

In photo B we have the guts of a TV splitter, and you can see that little ferrite bead and the windings. Just unsolder the three connections and transplant the transformer into a housing with your favorite coax connectors—BNC, SO-238, SMA. The transformer doesn't care.

The winding with two wires goes to the Common connection, the other two wires go to Port 1, and the other to Port 2, as shown in photo C.

Now for the magic of a hybrid transformer as shown in figure 3. See how Port 1 and Port 2 barely talk to each other when the Common connection has a load? In

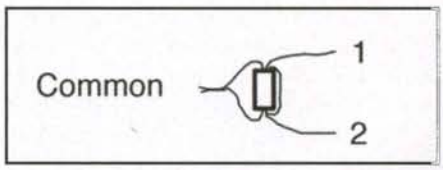


*Figure 1. The basic hybrid transformer/splitter.*

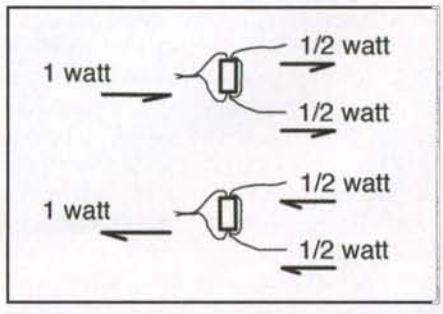


*Figure 2. The hybrid transformer as a splitter or a combiner.*

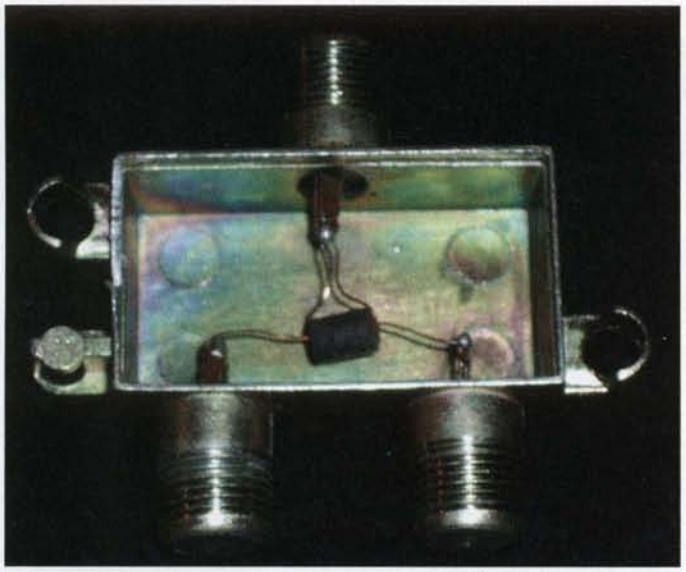

*Photo B. Internal construction of the TV splitters.*

figure 4 I have an actual plot of that Port 1/Port 2 isolation from 10 MHz to 1 GHz with markers on the VHF and UHF ham bands all measured in a 50-ohm system.

At 6 meters the two ports have about 10 dB of isolation. That's usually enough isolation to keep two receivers from interfering with each other. Now on to 2 meters, where the isolation is about 12 dB. However, up at 440 MHz it has well

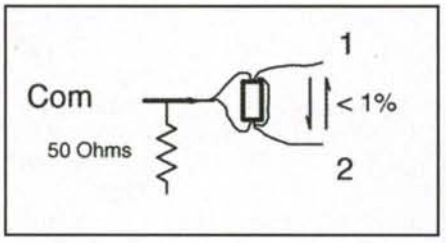


*Figure 3. Port 1 to Port 2 isolation.*

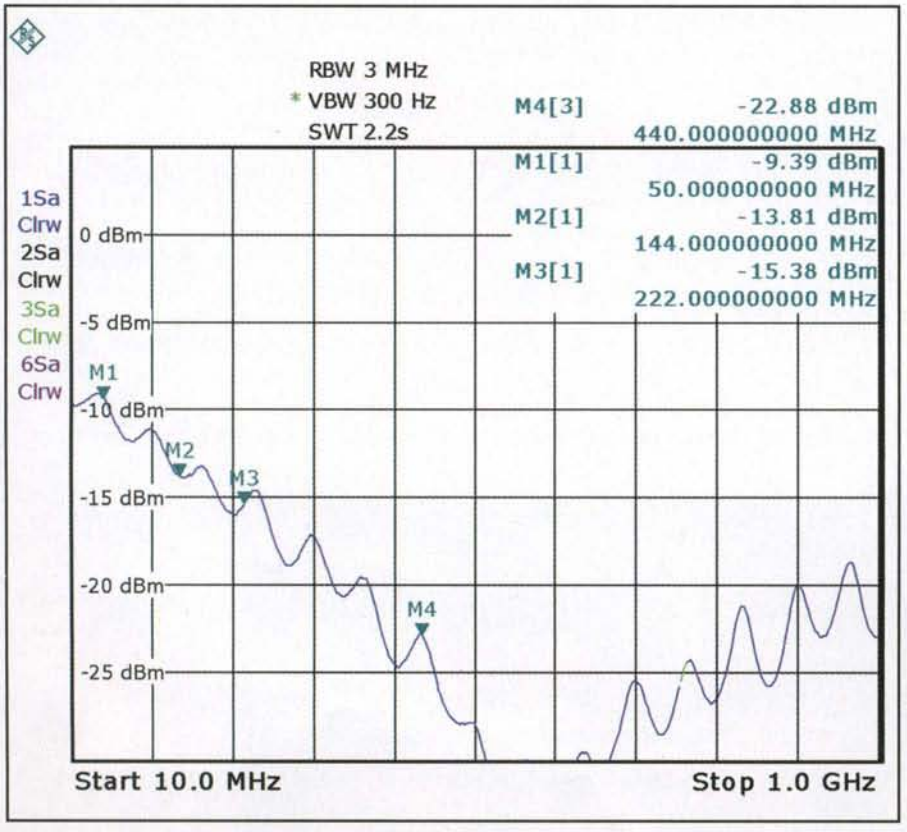


*Figure 4. Plot of Port 1 to Port 2 isolation of the finished splitter.*

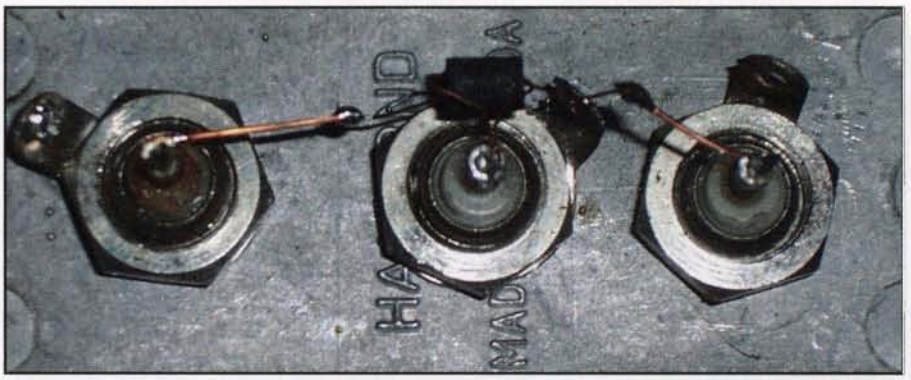


*Photo C. Remounted hybrid transformer.*

over 20 dB of isolation. It is hardly surprising that a TV splitter has its best performance in the UHF TV band, but that little ferrite bead and a few bits of wire showed well over 30 dB of isolation in the lower UHF TV channels. It still had good performance at 900 MHz, and another test showed about 15 dB isolation at 1250 MHz. If you want to connect two receivers to the same antennas, these transformers split the signal evenly with little loss and maintain your system impedance for either 50 or 75 ohms.

Here is another use for these hybrid transformers, shown in figure 5. They can be used as power dividers and power combiners to combine two amplifiers. If you are in the QRP range—that is, under 5 watts or so—you can use them on both the input and output of the amplifiers. With higher power amplifiers you will need to use a more conventional power combiner, but if the drive level is only a few watts, then you can still use these little and inexpensive hybrid transformers on the input of the amps. They are particularly handy if you are combining more than three amplifiers.

Now that you have a good idea of what these hybrid transformers can do, you can easily make some out of old TV splitters (photo D). And if you need a splitter on a specific frequency range, you now understand what you are looking for in those Mini-Circuits catalogs; see <www.minicircuits.com>).

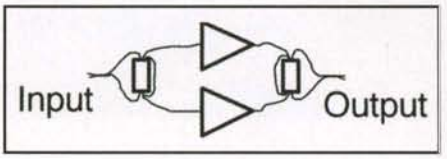


*Figure 5. Using the hybrid transformers to combine amplifiers.*

## UK Microwave Group

In 2010, I was again able to attend the annual general meeting of the UKμG, or UK Microwave Group. As you can see in photo E, this time we shared the facilities with AMSAT UK and a working group on the FUNcube satellite. *(For more information on FUNcube, and FUNcube Dongle [see below], see the "Satellites" column by W5IU elsewhere in this issue—ed.)*

In photo F we have the circuit boards out of the flight "Bird" undergoing software testing over its RF links.

One side project from the FUNcube is the FUNcube Dongle. The FUNcube Dongle is a USB-powered 50 MHz to 1800 MHz receiver. There have been


*Photo D. Finished signal splitter and labeling.*

some differences in the lock range of the PLLs so that frequency range is approximate at this time. However, it is an amazing frequency range from such a small receiver. In photo G is one of the early FUNcube Dongles and a waterfall display from the Dongle on the computer listening to the FUNcube at the end of the table. The technology that places a 50–1800 MHz software defined radio into a USB stick only shows how far we have come. And the IQ software that demodulates the RF signals can also easily generate the same signal. It will not be long before we have the 160-meter through 2450-MHz talkies with software options for CW, AM, FM, USB, LSB, QPSK, BPSK, QAM, CDMA, COFDM, and any other modulation we can think of.

*Photo E. FUNcube work session at the UKμG annual general meeting.*

## NiZn Batteries

This is a bit off topic, but I really wanted to make some comments about the new NiZn rechargeable batteries. I picked up a set of nickel-zinc batteries and their charger—yes,a special charger—at the Dayton Hamvention® last year. First, they are 1.6 volts vs. 1.2 volts for NiMH batteries.

I have several products that just don't like the 1.2-volt batteries. One of my cameras and one of my talkies flash "low battery" even when I put freshly charged NiMH batteries in them. With a 1.6-volt battery they are quite happy down to the point where there just isn't enough power left in them to run the device.

The NiZn batteries are rated 2500 ma hours, vs 3200 ma hours for some of my better NiMH batteries. At first you might think there is less energy in the NiZn batteries, but when computed in watt/hours: 2500 ma/hrs × 1.6 volts = 4 watt hours for the NiZn, and 3200 ma/hrs × 1.2 volts = 3.84 watt hours for my best NiMH batteries. Therefore, the NiZn batteries actually have a bit more energy in them than the the NiMH batteries. So keep an eye out for these guys!

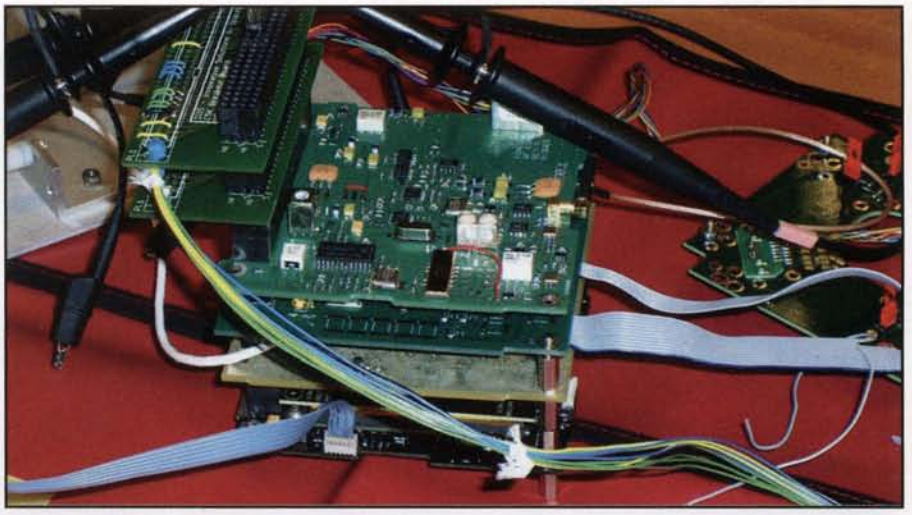

*Photo F. FUNcube undergoing software testing over its RF links.*

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As always, our readers are one of the best sources of ideas for future antenna projects. Any antenna questions or antenna projects you would like to see in a future column, just drop me a note. Snail mail to my address on the first page of this column always works, or an e-mail to <wa5vjb@cq-vhf.com> works fine.

For additional antenna projects you can visit <www.wa5vjb.com> and browse the Reference section. Spring is coming soon, so get some antennas ready to go up!

73, Kent, WA5VJB

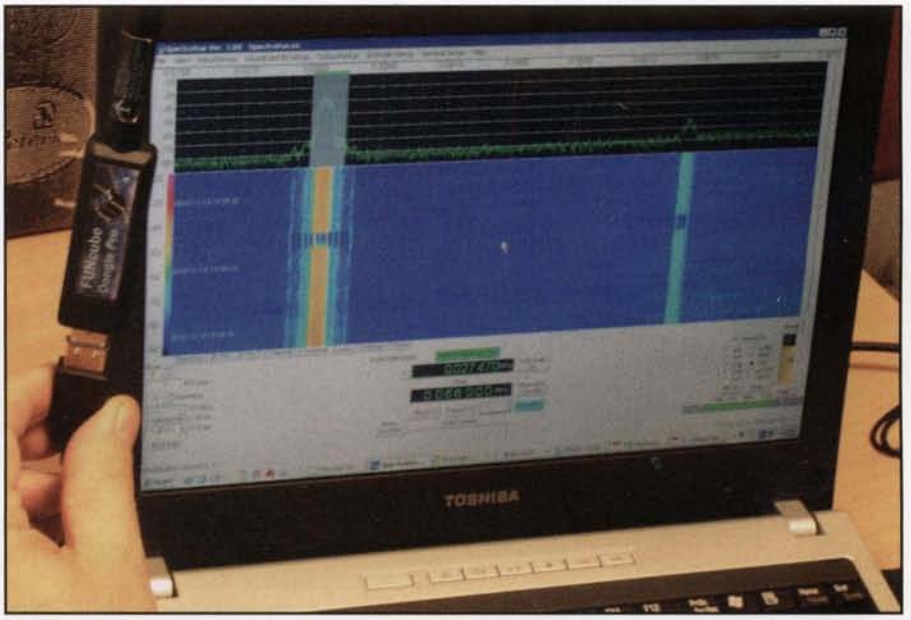


*Photo G. FUNcube Dongle software-defined 50–1800 MHz receiver.*

By Tomas Hood,* NW7US

# VHF PROPAGATION

## The Science of Predicting VHF-and-Above Radio Conditions

## Shattering Scientific Ideas!

On August 1, 2010, an entire hemisphere of the sun erupted. Filaments of magnetism snapped and exploded, shock waves raced across the stellar surface, billion-ton clouds of hot gas billowed into space. Astronomers knew they had witnessed something big. It was so big that it may have shattered old ideas about solar activity.

What awed the science community, and inspired many sensational news stories around the world, was how all of the events were interconnected: multiple flares, coronal mass ejections (CMEs), filament eruptions, long-distance interactions all over the Sun, and strong thermal variations. It might be expected to see multiple flares, and perhaps a coronal mass ejection, on the same day. This day, however, was filled with rare events.

"The August 1st event really opened our eyes," says Karel Schrijver of Lockheed Martin's Solar and Astrophysics Lab in Palo Alto, CA. "We see that solar storms can be global events, playing out on scales we scarcely imagined before."

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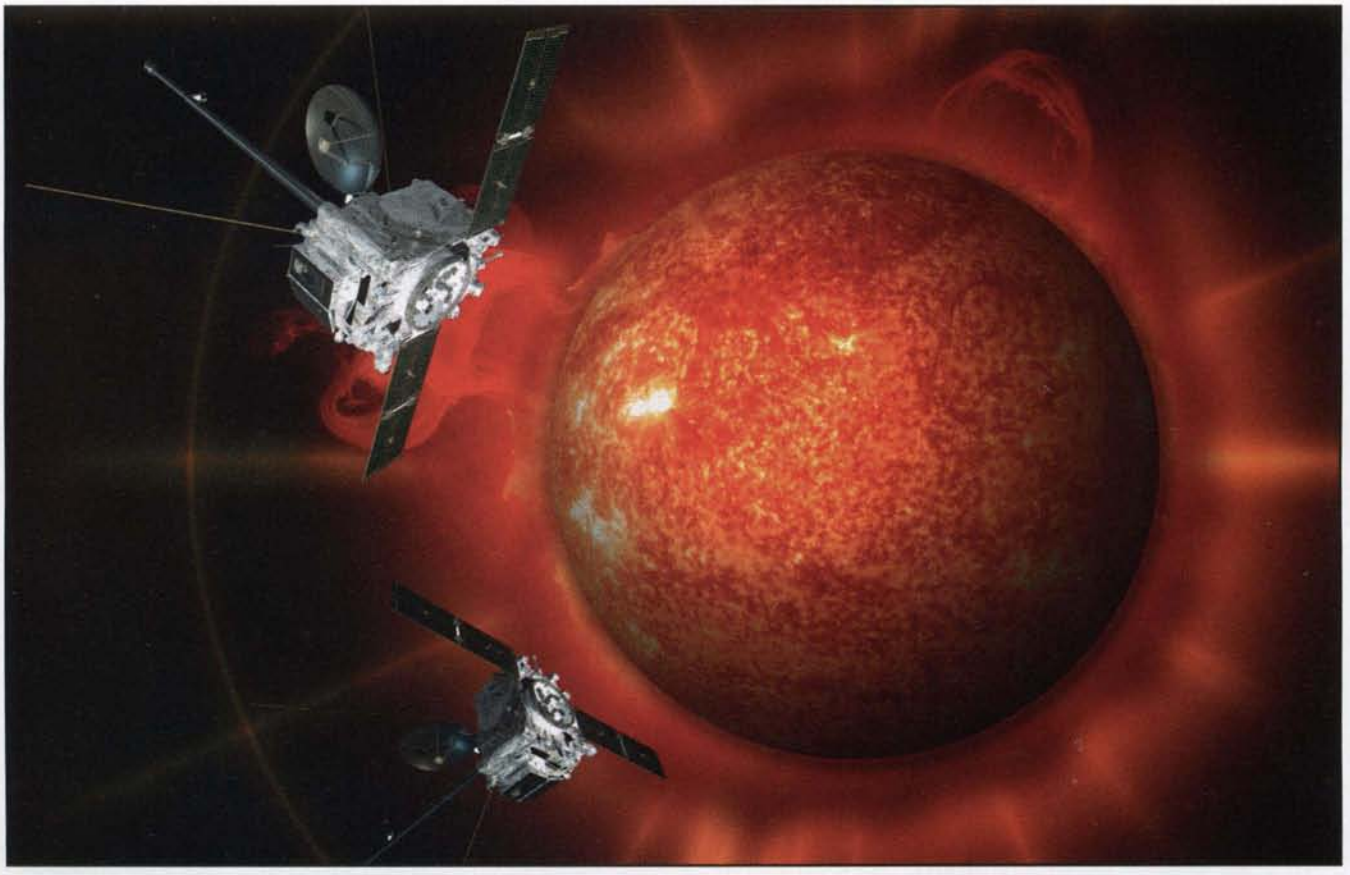
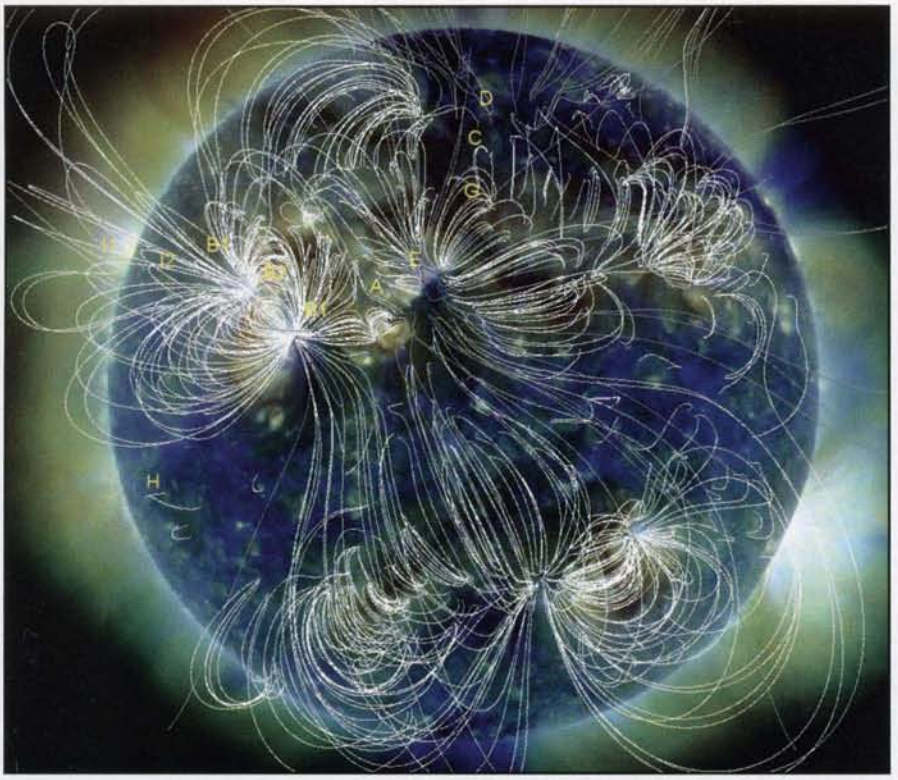
In the months since this amazing day, Schrijver has been working with fellow Lockheed-Martin solar physicist Alan Title to understand what happened during the "great eruption." They had plenty of data: The event was recorded in unprecedented detail by NASA's Solar Dynamics Observatory and twin STEREO spacecraft. With several colleagues present to offer commentary, they outlined their findings at a press conference at the American Geophysical Union meeting in San Francisco.

At approximately 0855 UTC on August 1, 2010, a C3.two-magnitude soft X-ray flare erupted from NOAA Active Sunspot Region 11092 (1092), triggering a coronal mass ejection, as well as a "solar tsunami," a huge wave that "rippled" away to the northwest from the sunspot region. This seemed to have triggered a huge filament eruption as well as a second coronal mass ejection.

Prior to the filament's eruption, NASA's Solar Dynamics Observatory (SDO) Atmospheric Imaging Assembly (AIA) instruments revealed an enormous plasma filament stretching across the Sun's northern hemisphere. When the solar tsunami wave triggered by the C3.two-class X-ray explosion plowed



*An illustration of the STEREO spacecraft and the sun. (Source/Credit: Jay Friedlander/NASA STEREO)*




*Locations of key events are labeled in this extreme ultraviolet image of the Sun, obtained by the Solar Dynamics Observatory during the great eruption of August 1, 2010. White lines trace the sun's magnetic field. (Credit: K Schrijver & A. Title/NASA)*

through this filament after rippling through the corona, it appears to have caused the filament to erupt, sending out a huge plasma cloud (CME).

This wave can be seen emerging from the origin of the X-ray flare and sweeping across the Sun's northern hemisphere into the filament field (see the movie at <http://tinyurl.com/pcaug1wave>). Solar scientists conclude that both eruptions, occurring together, are linked, despite the approximately 400,000-kilometer distance between the flare and the filament eruption. How can this be? While we cannot always see the magnetic field lines between solar features (magnetic field lines are not visible unless there is plasma trapped along these field lines), we can assume from this event that huge connecting field lines existed between the sunspot region and the filament in the Sun's northern hemisphere.

During this time, multiple filaments of magnetism were seen lifting off the Sun's surface. Incredibly, large-scale shaking of the solar corona was also observed.

The two coronal mass ejections reached Earth's magnetosphere starting on August 3. When the shockwave of the huge plasma clouds plowed into the magnetic force field, it connected in a way that "opened" the atmosphere, allowing the plasma to ride the magnetic field lines down to Earth's magnetic poles. This resulted in aurora light shows that were seen around the world, as far south as Michigan, and as far north as New Zealand (for amazing photographs of the aurora lightshow, visit SpaceWeather.com: <http://www.spaceweather.com/aurora/gallery_01aug10_page3.htm>).

"To predict eruptions we can no longer focus on the magnetic fields of isolated active regions," said Title. "We have to know the surface magnetic field of practically the entire Sun." This revelation increases the work load for space-weather forecasters, but it also increases the potential accuracy of their forecasts.

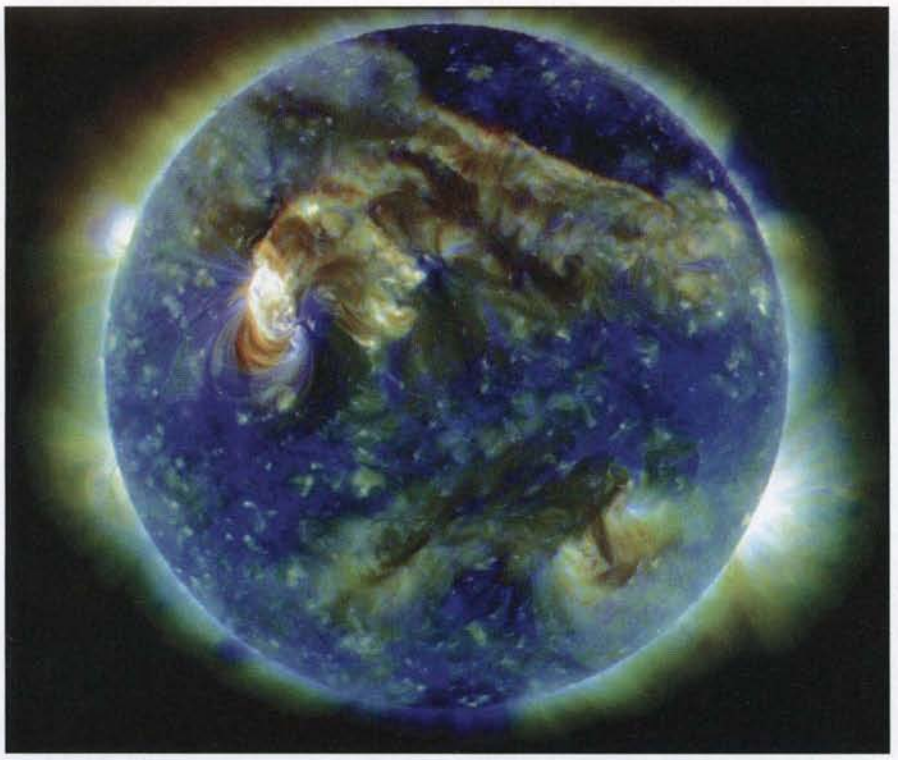
"The whole-sun approach could lead to breakthroughs in predicting solar activity," commented Rodney Viereck of NOAA's Space Weather Prediction Center in Boulder, Colorado. "This in turn would provide improved forecasts to our customers such as electric power grid operators and commercial airlines, which could take action to protect their systems and ensure the safety of passengers and crew."

In a paper they prepared for the *Journal of Geophysical Research* (*JGR*), Schrijver and Title broke down the great eruption into more than a dozen significant shock waves, flares, filament eruptions, and CMEs spanning 180 degrees of solar longitude and 28 hours of time. At first it seemed to be a cacophony of disorder until they plotted the events on a map of the Sun's magnetic field.

Title describes the *Eureka!* moment: "We saw that all the events of substantial coronal activity were connected by a wide-ranging system of separatrices, separators, and quasi-separatrix layers." A "separatrix" is a magnetic fault zone where small changes in surrounding plasma currents can set off big electromagnetic storms.

Researchers have long suspected this kind of magnetic connection was possible. "The notion of 'sympathetic' flares goes back at least three quarters of a century," they wrote in their *JGR* paper. Sometimes observers would see flares going off one after another—like popcorn—but it was impossible to prove a link between them. Arguments in favor of cause and effect were statistical and often full of doubt.

"For this kind of work, SDO and STEREO are game-changers," said Lika



*On August 1st, almost the entire Earth-facing side of the Sun erupted in a tumult of activity. There was a C3-class solar flare (white area on upper left), a solar tsunami (wave-like structure, upper right), multiple filaments of magnetism lifting off the stellar surface, large-scale shaking of the solar corona, radio bursts, a coronal mass ejection, and more. This multi-wavelength (211, 193 & 171 Angstrom) extreme ultraviolet snapshot from the Solar Dynamics Observatory (SDO) shows the sun's northern hemisphere in mid-eruption. Different colors in the image represent different gas temperatures ranging from ~1 to 2 million degrees K. (Credit: NASA/SDO/AIA)*

Guhathakurta, NASA's Living with a Star Program Scientist. "Together, the three spacecraft monitor… [nearly the entire] … Sun, allowing researchers to see connections that they could only guess at in the past."

And it is true. Barely two-thirds of the August event was visible from Earth, yet all of it could be seen by the SDO-STEREO fleet. Moreover, SDO's measurements of the Sun's magnetic field revealed direct connections between the various components of the great eruption—no statistics required.

Much remains to be done. "We're still sorting out cause and effect," says Schrijver. "Was the event one big chain reaction, in which one eruption triggered another—bang, bang, bang—in sequence? Or did everything go off together as a consequence of some greater change in the sun's global magnetic field?"

## August 7th M-Class Flare

Another news-worthy event was the M-class X-ray flare that erupted from active sunspot region 1093 on August 7. This flare was 10 times more powerful than the C-class flare on August 1 that caused so much news media attention on August 3 through August 5. This M1.0 magnitude solar flare peaked at 1824 UTC on August 7 and ejected a huge mass of coronal plasma. Many hoped that the coronal mass ejection, or CME, originating from the sunspot region 1093 would trigger auroral displays around the world just like those that occurred the prior week. However, because this CME was not fully Earth-directed, most of the CME missed the magnetosphere, resulting in only the slightest increase in geomagnetic activity between August 10 and 11.

This flare, one of the biggest since the start of Cycle 24, also triggered a metric type II radio burst. This kind of radio burst can be heard from a radio receiver tuned to, say, a 6-meter frequency as the burst occurs. The burst sounds like rushing wind.

You can hear a recording of a type II radio burst as recorded on 50 MHz by Thomas Ashcraft on April 2, 2001 at 2151 UTC that occurred during the X22.0-magnitude X-ray flare, by browsing to <http://tinyurl.com/50MT2RB>. Incidentally, the April 2, 2001 flare is the second largest event on record after the X28.0-magnitude mega-flare which occurred on November 4, 2003.

A movie of the August 7 M-class flare showing a series of filtered views of the event as seen by the Solar Dynamics Observatory's Atmospheric Imaging Assembly can be viewed at: <http://tinyurl.com/20100807mflare> and is available in high definition.

While you are viewing movies, be sure to check out the movie located at <http://tinyurl.com/20100803cme>, which shows a simulation of Earth's magnetosphere on August 3. About two-thirds into the movie, you can see the arrival and then the passing of the coronal mass ejection from the multiple-eruption event of August 1, 2010. Browse also to <http://tinyurl.com/20100801filament> and watch the massive filament eruption associated with the C-class flare of August 1, 2010.

As we move forward into an ever-more energetic phase of sunspot Cycle 24, we're expecting many more days similar to August 1, 2010. With that will come more and more coronal mass ejections, and when that occurs at just the right time, we VHFers will enjoy aurora-mode propagation, as well as other possible modes.

## Propagation Outlook for February through April

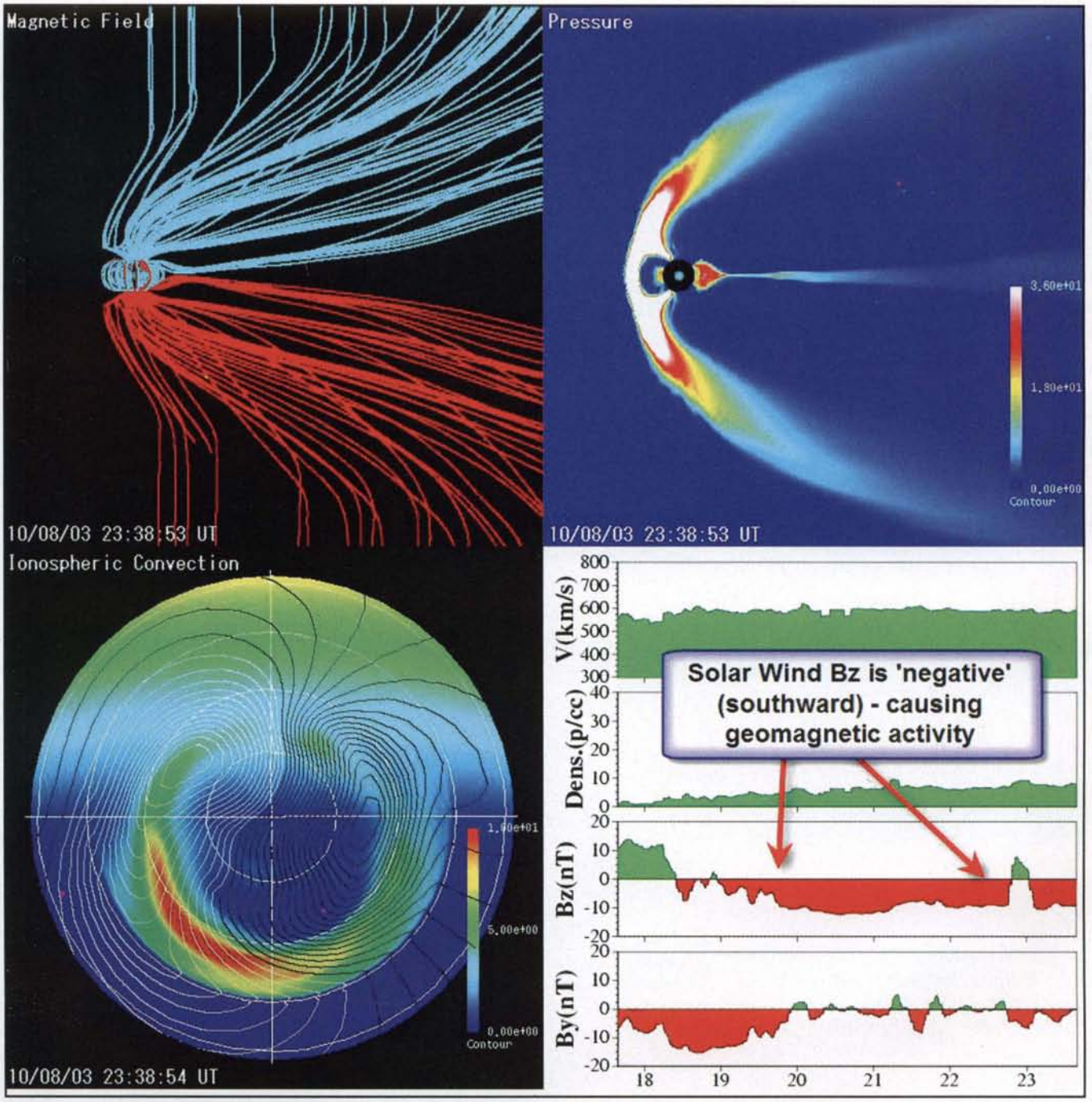
Because of the nature of the Earth's orbit around our Sun, we have two seasons each year when any adverse space weather has a greater influence on causing geomagnetic disturbances. The first is known as the Spring Equinoctial season; the second is known as the Autumnal Equinoctial season. These are the two times during the course of the Earth's orbit around the Sun when the Earth is in just the right position to be most influenced by solar activity. The Spring Equinoctial season peaks between March and April of each year. Because we're in the very start of solar Cycle 24, it is likely that we will have significant geomagnetic disturbances this year, triggering the sort of auroral activity known to bring about VHF activity.

## What is the Aurora?

Aurora is a direct result of solar plasma interacting with gasses in the upper atmosphere. Aurora occurs during geo-

magnetic substorms. During these substorms, solar wind plasma resulting from coronal mass ejections can rain down into the atmosphere. Gasses in the atmosphere start to glow under the impact of these particles. Different gasses give out various colors. Think of a neon sign and how the plasma inside the glass tube, when excited, glows with a bright color. These precipitating particles mostly follow the magnetic field lines that run from Earth's magnetic poles, and are concentrated in circular regions around the magnetic poles called "auroral ovals." These bands expand away from the poles during magnetic storms. The stronger the storm, the greater these ovals will expand. Sometimes they grow so large that people at middle latitudes, like California, can see these "Northern Lights."

Because the Earth's magnetic dipole axis is most closely aligned with the Sun's solar wind spiral in April and October, the interaction between the solar wind




*The magnetosphere simulation from August 3, 2010, which shows the passage of the coronal mass ejections from the double-eruption that occurred on the Sun on August 1st. When the Bz goes negative during such an event, it means that the solar wind's magnetic orientation is "southward" in relation to the Earth's magnetosphere. This causes a magnetic connection that allows plasma, riding on the solar wind, to enter into the Earth's atmosphere, triggering geomagnetic storms and aurora. (Source: NICT, Japan; used by permission, NW7US)*

and the Earth's magnetosphere is greatest during these two seasons. This is why aurora is most likely and strongest during the equinoctial months. When you see the solar wind speed increase to over 500 kilometers per second, and the $B_Z$ remains mostly negative (the IMF is oriented mostly southward), expect an increase in geomagnetic activity, as revealed by the planetary *K*-index (*Kp*). This year, the spring equinoctial season will be active, with a few strong geomagnetic storms. If we do experience moderate to storm-level activity due to recurring coronal holes, look for Aurora-mode propagation. The higher the *Kp*, the more likely you may see the visual aurora. However, you don't have to see them to hear their influence on propagation. Listen for stations from over the poles that sound raspy or fluttery. Look for VHF DX. Sometimes it will enhance a path at certain frequencies, while other times it will degrade the signals. Sometimes signals will fade quickly, and then come back with great strength. The reason for this is that the radio signal is being refracted off of the more highly ionized areas in the E region of the ionosphere that are energized by this aurora. These ionized areas ebb and flow, so the ability to refract changes, sometimes quickly. I've observed the effect of aurora and associated geomagnetic storminess even on lower HF frequencies.

## Radio Aurora

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

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

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

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

## Meteors

While there are no major meteor showers during February and March, April has one meteor shower worthy of note. The Lyrids peak on the night of April 21. While this shower will only peak around about 10 visual meteors per hour, or about one per every six minutes on average, they can provide some good radio bursts. It is possible to see the hourly meteor rate (ZHR) reach as high as 25 per hour this year.

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

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

## The Solar Cycle Pulse

The observed sunspot numbers from October through December 2010 are 23.5, 21.6, and 14.5, and while show some downward trending, are never-theless higher than a year before, when the same months had sunspot counts of 4.6, 4.2, and 10.6. The smoothed sunspot counts for April through June 2010 are 14.0, 15.5, and 16.4, much higher than the year before (200), when they were 2.2, 2.3, and 2.7.

The monthly 10.7cm (preliminary) numbers from October through December 2010 are 81.6, 82.5, and 84.3 (showing that even with a downward trend in sunspots, their energy has increased, as seen in the upward trend over these three months). One year prior, in 2009, we saw 72.3, 73.6, and 76.8. The smoothed 10.7cm Radio Flux for April through June 2010 are 78.3, 79.0, and 79.7, again showing higher than the previous year when we saw 69.3, 69.7, and 70.2.

The smoothed planetary A index numbers (*Ap*) from April through June 2010 are 5.5, 5.7, and 5.8, slightly higher than the previous year (4.3, 4.1, and 4.0). This is consistent with the increase in solar energy. The monthly readings from October through December 2010 are 6, 5, and 3, compared with the 3, 3, and 1 from one year prior.

The monthly sunspot numbers forecast for February through April 2011 are 50, 54, and 59. The monthly 10.7cm is predicted to be 107, 110, and 114 for the same period. That's really great news, as we'll likely see improvement on F-layer propagation higher and higher in the radio spectrum.

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

## Feedback, Comments, Observations Solicited!

I am looking forward to hearing from you about your observations of VHF and UHF propagation. Please send your reports to me via e-mail, or drop me a letter about your VHF/UHF experiences (sporadic-*E*, meteor scatter?). I'll create summaries and share them with the readership. I look forward to hearing from you. You are welcome to also share your reports at my public forums at <http://hfradio.org/forums/>. Up-to-date space weather and radio propagation information are found at the NW7US Space Weather and Radio Resource Center: <http://sunspotwatch.com/>.

Until the next issue, happy weak-signal DXing.

73 de Tomas, NW7US

By Mitch Gill, NA7US

# EMERGENCY COMMUNICATIONS

## The Role of VHF in EmComm

## Trends and Thoughts

There has been an increasing trend that I believe is going to cause potential major problems in the VHF/UHF radio community if a disaster strikes. The trend began after 9/11 and consists of many local, county, and state agencies that have encouraged their employees to get their Technician license. The trend also includes some church groups, such as the Mormon (Church of Jesus Christ of Latter Day Saints) church, to name but one.

I am all in favor of increasing the amateur radio population. I am also all in favor of preparation for disasters and accessibility to state, county, and local agencies. And having churches on the air just gives us more information when a disaster strikes, but what will actually happen when that disaster does strike? I have talked with some city officials who got their license and they believe that they will be able to coordinate their employees and task them using VHF/UHF.

I asked what frequency are they using, who is the net control, how often do they need to check in and what happens if someone else appears on the frequency with an emergency. I usually get silence or the response is that they will take over the use of a repeater! Take over the use of a repeater? How can they talk over something they do not own or actually have any control over? As for an emergency, they do understand that they must stop and assist in the emergency. OK, before you start e-mailing me, let me add the caveat that there are some out there who do understand and who know how to run a net.

The problem is not the number of new Technicians, and it is great to have all this information and assistance available. However, I find that there is a severe lack of training or understanding with the majority of these agencies. The confusion that can occur could put life and property at risk.

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There are groups I am aware of that have made the effort and succeeded in training operators working at all the hospitals in Washington State. The Western Washington Medical Services Communications Team operates nets, trains new radio operators, and conducts exercises in the event of catastrophic emergencies.

I propose that we endeavor to find those hams who work for these agencies that desire to use our frequencies and offer to train them. We can do that or we can expect mass confusion and possible loss of life because of well-intentioned people who do not understand what problems they are causing. In addition, they need to understand the FCC rules.

The Federal Communications Commission (FCC) issued Public Notice DA 09-2259 on October 20, 2009, which states: "The Commission's Rules specifically prohibit amateur stations from transmitting communications 'in which the station licensee or control operator has a pecuniary interest, *including communications on behalf of an employer.*' The notice goes on to say that during a disaster or emergency incident, where no other means of communication exists, an employee operator may operate the employer's amateur radio station for the purpose of responding to the emergency or disaster. However, operation of the radios by employees during drills, exercises, and tests is specifically prohibited, unless a waiver has been applied for and granted in advance through a government agency."

An exception can be made but must be requested and granted first.

### VHF and UHF Radio Grant

***Insert DHS.JPG***

Here is a new twist on obtaining amateur radio equipment for your ARES or RACES group. The Department of Homeland Security is awarding grants in this area. I recently came upon an article in Sentinel-Standard.com (serving Ionia County, Michigan) where their RACES group has been given office space at the Ionia County Dispatch. They will act as a backup for the police and fire in the event of a disaster. If the fire and/or police lose their repeater, the group will have the capability of setting up a temporary repeater. Here is the best part: All of the counties in Michigan will be getting radios capable of amateur frequencies, police and fire.

The documentation for the FY2011 Interoperable Communications grant should have been released in December. If you are not sure how to fill out a grant, you might consider contacting the Ionia County Races and see if it can assist.

This is a great way to be able to supplement services during a disaster. The radios they are obtaining are capable of transmitting for 15–20 miles and even more with repeaters.

Are there others out there who have utilized these grants? Let me know. If you want more information on what the group is doing, you can look at: <http://www.ioniacountyorg/emergency-services>.

### Long-Distance Emergency Communications

***Insert Sat2.JPG "There are many satellites that can be used amateur radio operators!"***

If a major disaster hits your area, you potentially will lose all of the repeaters, and depending on structures and topography, obtaining communications within 10–15 miles may be impossible as well.

## Radio Amateur Satellites—All Passes

Search Period Start: 09:58 Tuesday, 28 December 2010
Search Period End: 09:58 Wednesday, 29 December 2010
Observer's Location: Ravensdale (47.3530°N, 121.9830°W)
Local Time: Pacific Standard Time (GMT 8:00)

| Satellite | Date | Times | | Max. Altitude | | | Downlink Freqs (MHz) |
|---|---|---|---|---|---|---|---|
| | | Start | End | Time | Alt. | Az. | |
| Saudisat 1A | 28 Dec | 10:06:17 | 10:09:59 | 10:08:09 | 12 | NNE | 436.775 MHz |
| UOSAT-12 | 28 Dec | 10:07:57 | 10:15:55 | 10:11:55 | 26 | NW | 437.025 FM, 437.400 FM |
| Hamsat | 28 Dec | 10:22:23 | 10:29:32 | 10:25:57 | 25 | WNW | 145.90 MHz |
| OPAL | 28 Dec | 10:24:40 | 10:34:36 | 10:29:39 | 53 | WSW | ? |
| HO-68 | 28 Dec | 10:36:40 | 10:51:01 | 10:43:52 | 75 | WNW | 435.675 MHz FM |
| Oscar 11 | 28 Dec | 10:40:04 | 10:47:45 | 10:43:56 | 30 | WNW | 145.825 FM, Beacon 2401.500 USB |
| SO-67 | 28 Dec | 10:42:58 | 10:44:35 | 10:43:46 | 11 | WNW | 435.3500 MHz FM |
| SAUDISAT 1C | 28 Dec | 11:04:11 | 11:13:17 | 11:08:40 | 41 | NE | 436.800 MHz |
| KITSAT 1 | 28 Dec | 11:18:02 | 11:34:17 | 11:26:09 | 79 | NW | 435.175 FM |
| Saudisat 1A | 28 Dec | 11:45:01 | 11:53:24 | 11:49:13 | 38 | NE | 436.775 MHz |
| UOSAT-12 | 28 Dec | 11:52:29 | 11:55:05 | 11:53:47 | 11 | NNW | 437.025 FM, 437.400 FM |
| RS-15 | 28 Dec | 11:54:38 | 12:06:46 | 12:00:42 | 15 | W | 29.354 –29.394 USB, Beacon 29.352 USB |
| AO-27 | 28 Dec | 12:11:23 | 12:19:43 | 12:15:33 | 25 | ENE | 436.795 MHz FM |
| Oscar 14 | 28 Dec | 12:14:29 | 12:22:49 | 12:18:38 | 25 | ENE | 435.070 FM, Uplink 145.975 |
| Oscar 19 | 28 Dec | 12:20:05 | 12:23:40 | 12:21:53 | 12 | NE | 437.125 CW, 437.150 USB |
| HO-68 | 28 Dec | 12:25:41 | 12:35:12 | 12:30:27 | 19 | NW | 435.675 MHz FM |



You only have a VHF/UHF radio. So what can you do if you want to get a message to a relative out of your area or call for assistance? You can use a satellite!

Did you know that since its inception that there have been over 70 amateur radio satellites launched into space around the Earth? There is a large contingent of amateur satellites operating at this time. With a simple VHF/UHF radio with a rubber-duck antenna, you can contact someone through several satellites. To test what you can do go to <http://www.heavens-above.com> and register with your location and then look under SATELLITES for "Radio amateur satellites—24 hour predictions (all passes). The information on the screen will show the satellite name, downlink and uplink frequencies, and where in the sky to look. A sample of what you will see is shown in the accompanying table. Even better is to start at <http://www.amsat.org> and look for the articles for beginners and several programs to track satellites. For emergencies I highly recommend that you download satellite tracking software on a laptop or PDA device so that you will be able to use it even if the power goes out.

Keep in mind that there are many modes for the satellites and FM is just one of them. Experiment and you may find that not only is it a viable emergency communication, but a lot of fun as well!

73, Mitch, NA7US

By Thomas Dean, KB1JIJ

# ATV

## Amateur Television – Methods and Applications

# Video Capture and Streaming

Today's common analog amateur television systems can easily cross over into the digital realm. Cards and boxes that allow a computer to capture video in the NTSC or other formats are inexpensive and easy to use. In addition, a great number of utilities exist that allow us to work with, share, and catalog our captured video. This column will provide an overview of how an amateur radio experience can be greatly enhanced with readily available hardware and software.

## Capture Devices

The first step to get video onto the computer is through a capture device. These devices generally have either a PCI or USB interface and can come with a variety of features. Some of the simplest cards capture standard NTSC video through a composite RCA cable and encode the video in an MPEG format to allow it to easily be played, stored, or shared on a computer.

*e-mail: <Thomas.Dean@usma.edu>

Other cards have tuners in them, which would allow them to operate as a receiver for an ATV station. Many cards can also capture video in a variety of forms, such as S-Video, component, or PAL. Today, most modern cards also work with digital broadcasting standards (DVB and ATSC), and there are several hybrid cards available which allow both analog and digital video formats to be captured.

A listing of devices that are compatible with the utilities I will be discussing can be found here: <http://www.linuxtv.org/wiki/index.php/Hardware_Device_Information>. The device I have on hand is the Hauppauge WinTV-PVR-USB2, which allows me to directly receive an amateur television signal sent on the standard analog cable channel 57 (421.25 MHz).

## Video 4 Linux

Most capture cards have proprietary software that allows them to work in a Windows® environment. In Linux, there is a common Application Programming Interface (API) called

**Example: Receiving Code**

```
#!/usr/bin/env python
# Creates a multicast connection, puts stream on LO device

from gnuradio import gr
import os, sys, socket, struct

local_if = '0.0.0.0'
server = '239.240.0.100'
port = '1234'

class top_block(gr.top_block):

    def __init__(self):
        gr.top_block.__init__(self)

    # Blocks
        self.gr_file_sink_0 = gr.udp_sink(gr.sizeof_char*1, "127.0.0.1", 1234, 1324, True)
        self.gr_udp_source_0 = gr.udp_source(gr.sizeof_char*1, "239.240.0.100", 1234, 1324, True, True)

    # Connections
        self.connect((self.gr_udp_source_0, 0), (self.gr_file_sink_0, 0))

if __name__ == '__main__':
#creates multicast connection based on /usr/local/share/doc/python2.6/examples/sockets/multi.py
    sock = socket.socket(socket.AF_INET, socket.SOCK_DGRAM, socket.IPPROTO_UDP)
    sock.setsockopt(socket.SOL_SOCKET, socket.SO_REUSEADDR, 1)
    sock.bind(('', 1234))
    mreq = struct.pack("4sl", socket.inet_aton(server), socket.INADDR_ANY)

    sock.setsockopt(socket.IPPROTO_IP, socket.IP_ADD_MEMBERSHIP, mreq)

try:
    top_block().run()
    except KeyboardInterrupt:
    pass
```

Video 4 Linux (V4L), which makes interfacing with nearly every capture device identical. Most capture cards require a driver to be installed, available from the manufacturer. Once this driver is installed, an analog device will show up as */dev/video0* (video1, video2, etc.). This is automatic, as V4L is built in to the Linux Kernel. Interacting with the device is now identical to interacting with a web cam, and there are many ways in which we can access and work with the video stream.

## MythTV

One useful utility to log all your ATV activities is MythTV. MythTV is an open-source digital video recorder (DVR) that runs on Linux. It contains just about every feature that you would expect from a DVR that you would get with your cable box, for example. It allows you to archive, sort, and automatically record video. In addition, the software allows you to separate its backend from its frontend over a network so your ATV work could be distributed across a network. More information about MythTV can be found at <http://www.mythtv.org/>.

## VLC

Another common utility for working with nearly any sort of video format is the VLC media player. This player can easily open up the capture device to be played. It also has the ability to save the video to a disk and even transcode the video into a different format. The player also has some ability to stream the video feed in real time. I have found this feature somewhat difficult to use. Basic functionality can best be implemented from the command line. The following command is an example of streaming device */dev/video0* to a computer located at IP address 192.168.0.101:

```
nice vlc v4l2:// :v4l2vdev="/dev/ video0" sout=':standard
{mux=ts,access =udp,dst=192.168.1.101:1234}'
```

More info about VLC can be found at <http://www.videolan.org/vlc/>.

## Scripting andProgramming

The most flexible way that I've found to stream video from an analog capture device is to write scripts to handle this. Languages such as Python make this a relatively simple task, as it has much built-in network functionality. By rolling our own server, we can easily manage who has access, how the video is distributed, and add in nearly any functionality that we want. Three basic distribution methods for streaming video are broadcast, multicast, and unicast. A broadcast connection sends a stream to every user on the network, which could cause a burden on large, branched networks. Unicast makes a separate stream for each user accessing it. Multicast is commonly used on large networks, as it sends a stream to a single group IP address, which is shared by everyone accessing the stream. This is a common method for distribution on large networks.

Those familiar with software radio may be familiar with the gnuRadio package, which is a collection of functions useful to modulate, demodulate, and manipulate signals. gnuRadio includes the functionality to send and receive data from a network source. This has many implications, and shows a possible way one could make a software ATV transmitter.

To test out some of these concepts, I took some ATV feed and captured it. While it was not the most direct way, I used VLC to send the stream to my loopback network device (IP address 127.0.0.1), and then set up a multicast server in Python to push this across my campus network. For demonstration purposes, I passed this through gnuRadio. On the other side, I had a Python script which did the opposite. I then received the video through VLC by opening the network stream on my loopback device. Included is the script I used for the receiving end. The multicast server is very similar. The Python documentation includes many useful examples of how to work with network streams.

## Going Further

Since we now have a way to get our video streams into a programming environment, there are endless possibilities of what could be done with them. One interesting area to explore is video processing. There are a large number of programming packages available to work with video, both in real-time and post-processing. Jon McLoone wrote a fascinating blog on how to make a Webcam Intruder Alarm with Mathematica that can be found here: <http://blog.wolfram.com/2010/11/10/how-to-make-a-webcam-intruder-alarm-with-mathematica/>. In this blog, he takes a webcam feed, detects large changes, and then creates e-mail alerts. This blog also serves as a great introduction to some of the basic concepts of video processing. The way Jon wrote this program would also work with capture cards as discussed above, meaning we could easily adopt this as a way to make sure our ham shacks are secure through amateur television!

73, Thomas, KB1JLL


*Figure 14. The prototype 29-MHz module.*

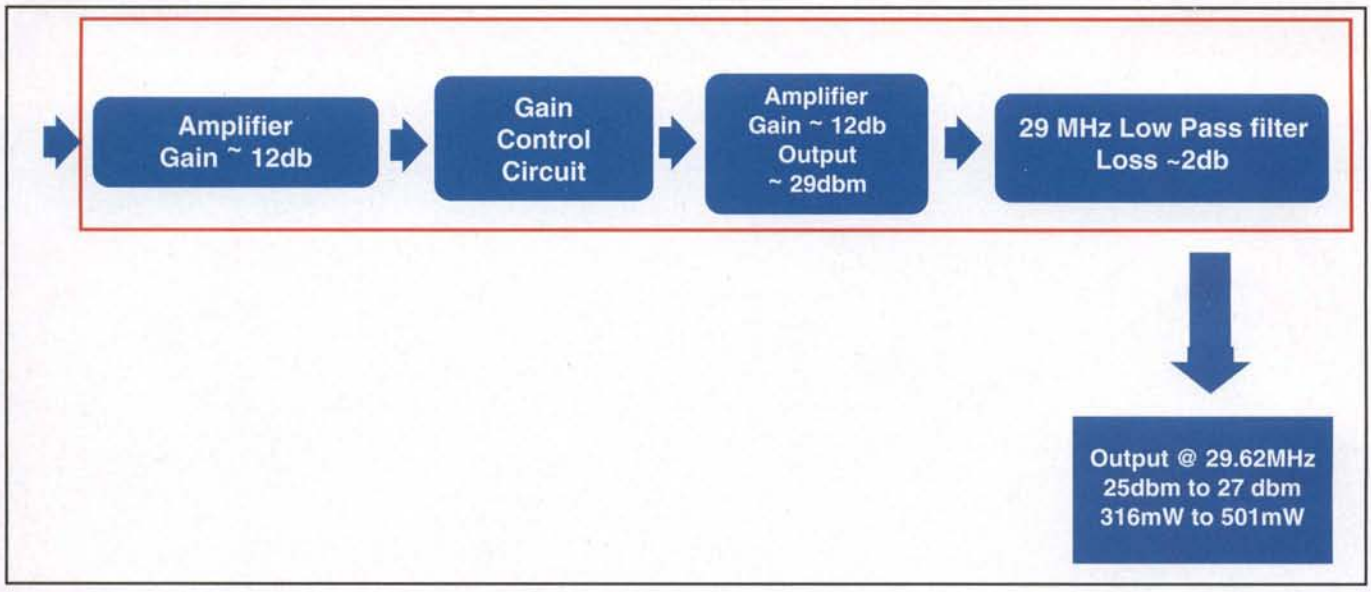


*Figure 15. Final amplifier module.*

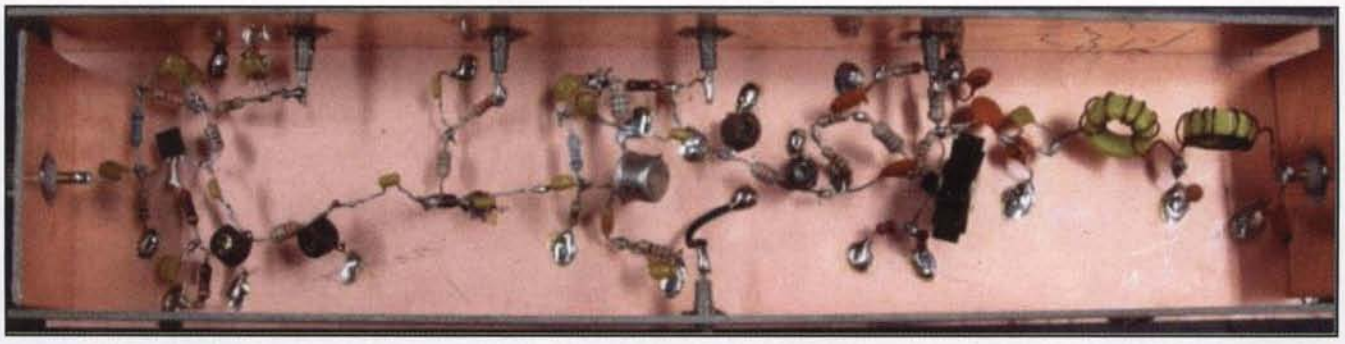

*Figure 16. Prototype of the final amplifier module.*

Results compared well between the two types of test systems. Due to input limitations on the PXI chassis, we had to run those tests without the final amplifier module (figure 19). We also did some limited on-the-air testing to verify the reproduced quality of modulated signals.

## Conclusions

The performance of the system is adequate between –60 dBm and –8 dBm input signals. The output power is approximately 500 mW with strong input signals. Harmonics are down better than 40 dBc in the prototype test bed. We are encouraged by the results of this experimental test bed. The design presented here is not yet adequate to fly in a high-altitude balloon payload. We have learned a lot in the process of designing and building this prototype test bed. Shielding is critical in a system that has this much overall gain even when it is distributed across three different frequencies. We had one occasion during the prototyping when we accidently created a very strong oscillator rather than a frequency translator.

Please do not treat this work as a construction project. The design is not finalized and we need to make several improvements before it will be ready to fly. The two main things that need work are much-improved filtering and incorporating an AGC circuit rather than the man-

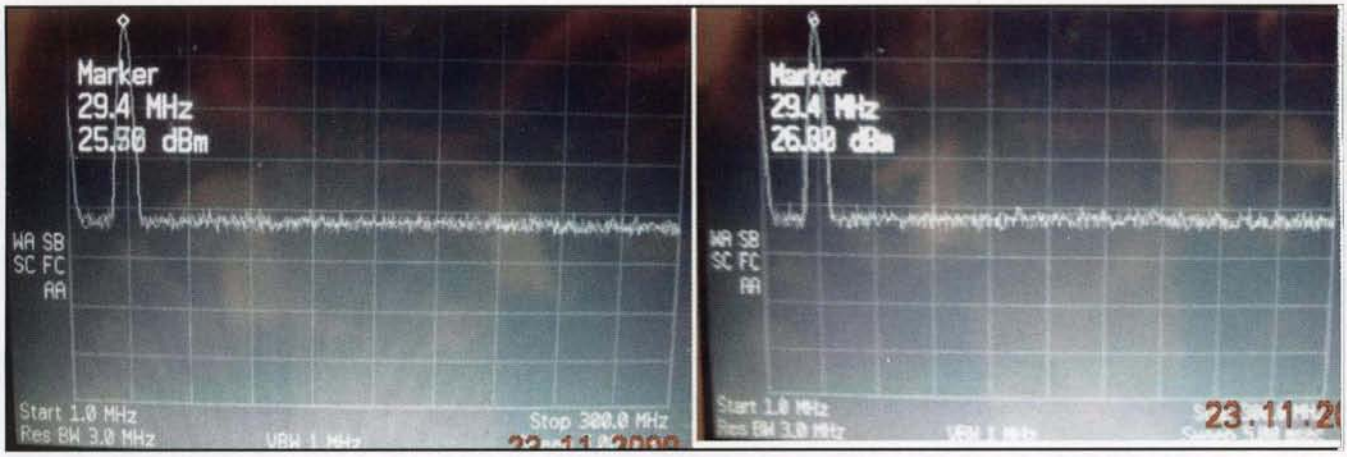


*Figure 17. The spectrum-analyzer display of the output of the final module.*

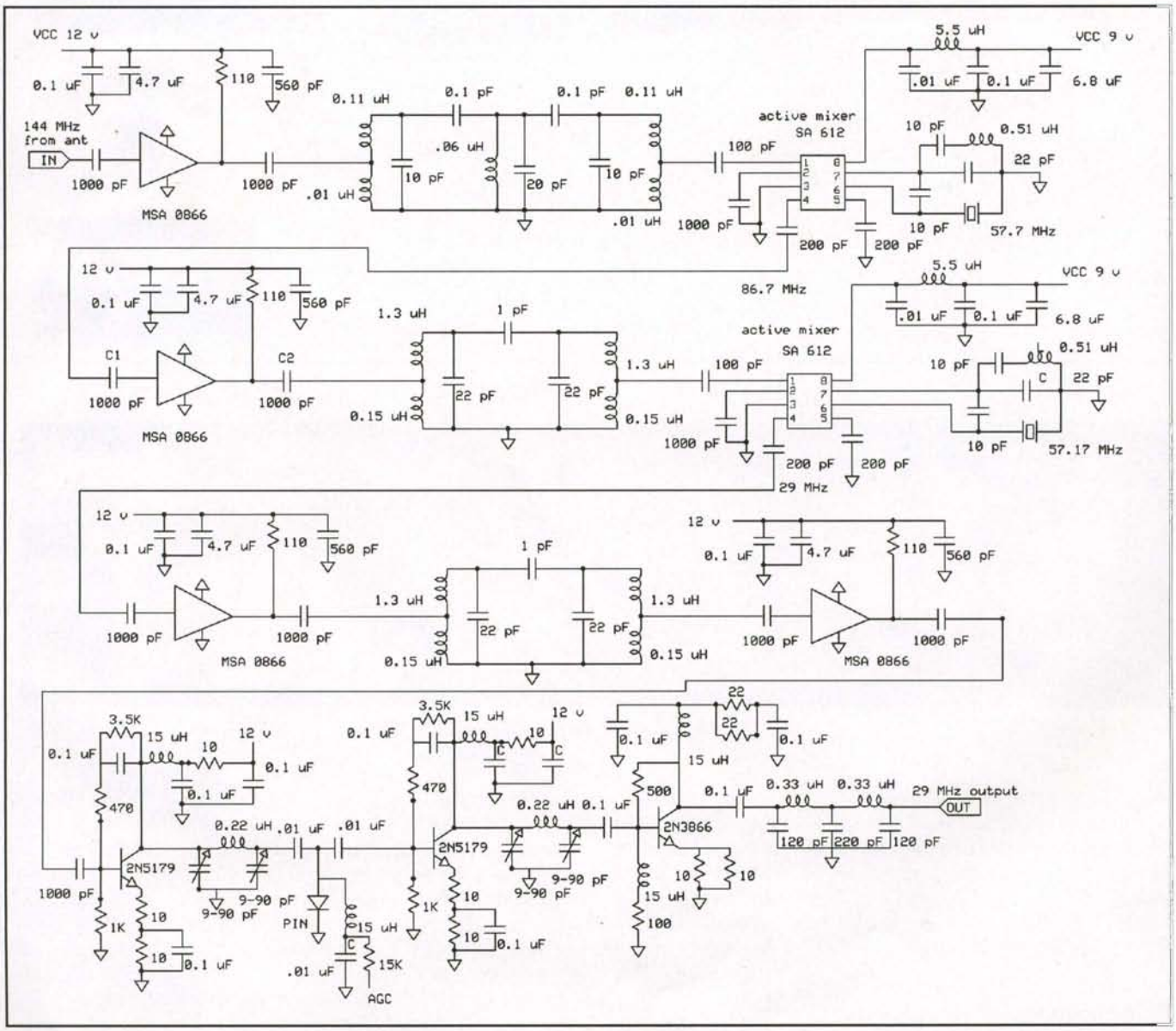


*Figure 18. Overall prototype test-bed schematic.*

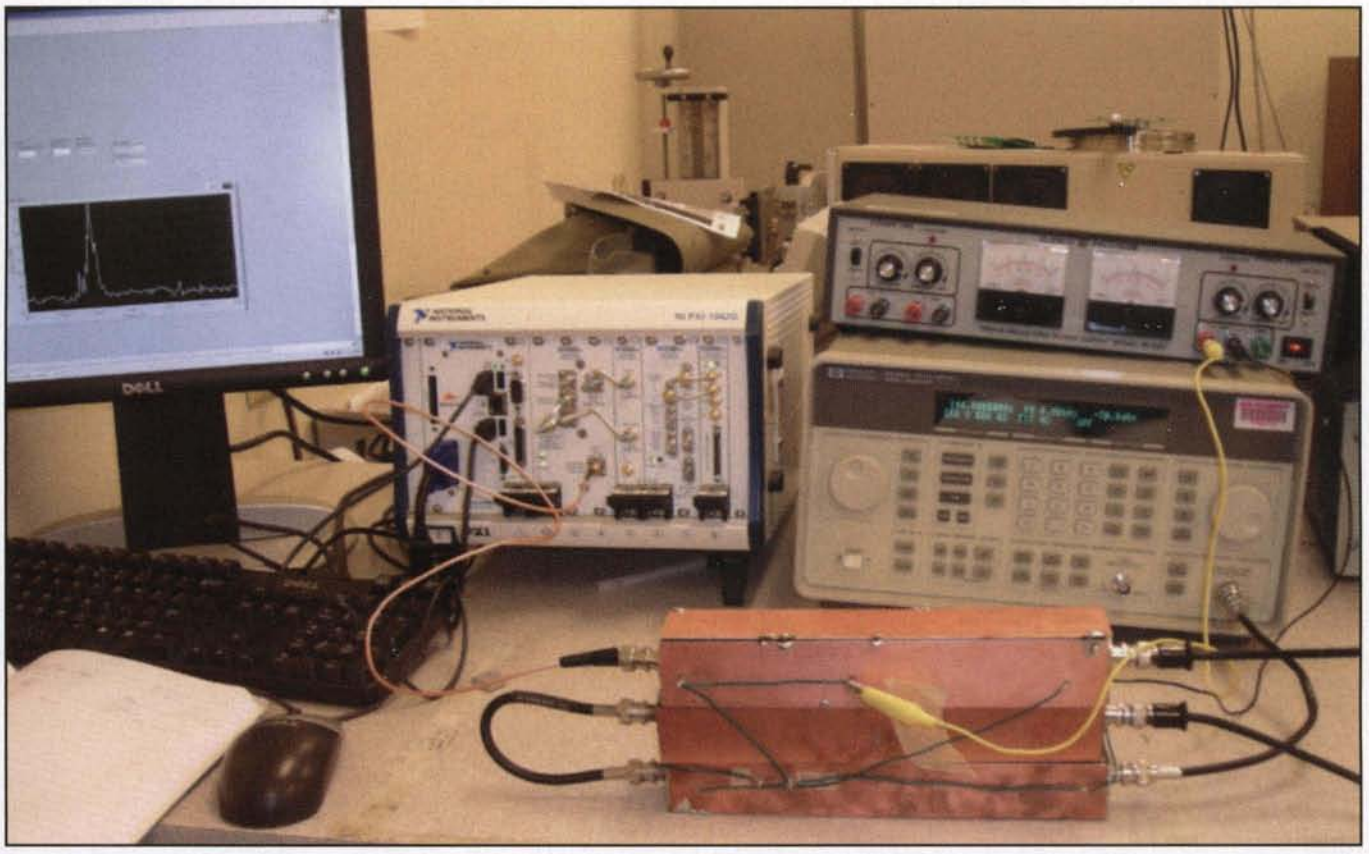

*Figure 19. The prototype system minus the final amplifier module being tested with a PXI automated RF test chassis.*

ual method of gain control we have used so far. We swept the input frequency across the 2-meter band and observed the output on the 10-meter band. The overall bandwidth of this design is too wide. We have not yet given up on using LC filters, but we certainly need to spend more time on that part of the design. There are several things we will likely do differently in the next version of this design, including the location of filters following mixers and improved impedance matching in several places, particularly with the mixers.

Nozar and her sister Mozar had never worked with RF circuits prior to the spring of 2009. This was the second RF project for each of them. The successful design of a system like this would be a good challenge to even an experienced RF engineer, so we are happy with the results to date on this project. The design, prototyping, and testing all were done by Mozar and Nozar. The project adviser, WC5Z, let them work out the details of the design and prototyping issues on their own, and only gave them some limited suggestions along the way. This project idea was suggested to WC5Z by Jerome Doerrie, K5IS, who has been a great inspiration regarding ham radio balloon activity.

**About the Authors**

Mozar and Nozar Naing are both graduate students in Electrical and Computer Engineering at Texas Tech University in Lubbock, Texas. They each earned their Technician Class Amateur Radio License as part of class requirements for their Project 1 class while undergraduates at TTU. They both took the RF Projects class with Dr. Michael Helm, WC5Z, who is an Instructor in the ECE department at TTU. This project was the result of work over the summer and fall of 2009 during undergraduate project coursework at TTU. WC5Z has been a ham since 1968 and has the distinct pleasure of teaching the RF projects class at TTU for the past four semesters.

By Dr. H. Paul Shuch,* N6TX

# DR. SETI'S STARSHIP

## Searching For The Ultimate DX

## Remembering Malcolm Raff, WA2UNP

When first I encountered Mal Raff, on the air in the mid 1970s, I knew we were destined to become lifelong friends. I knew this not because of our shared passion for amateur radio, nor by his particular callsign, but rather from the curious phonetics he used to articulate it. "W A 2 Uranus, Neptune, Pluto," enunciated the voice through the ether, and I knew at once that my new ham radio acquaintance shared my interest in planetary astronomy. In the months that followed, through sporadic on-the-air contacts, I learned that Mal and I shared interest in aviation and music as well.

None of this is surprising, given Mal's background. An undergraduate physics major at Gettysburg College, an outstanding small liberal arts institution in Pennsylvania, this bright New Jersey native went on to attend graduate school at the University of Illinois, where, circa 1961, he took his first flying lesson. This was about the same time that I, slightly younger, was enjoying my own first flying lesson in Florida. However, Mal, being perhaps more motivated, perhaps more resourceful than I, raced through his ratings, picking up private, instrument, commercial, and flight instructor certificates in short order. In time, his academic career transported him to the University of California, Berkeley (I followed his footsteps there some years later). At Berkeley, Mal Raff acquired a Ph.D. in astrophysics, and a fascination with helicopters that culminated in his adding a rotor-wing instructor's rating to his aviation credentials.

It was that helicopter instructor rating that ultimately led us to meet face to face around 1980 at the Reid Hillview Airport in San Jose, California. I based my own Beechcraft at that particular field, and Mal came fling-winging down from Oakland to introduce himself. We became instantly inseparable, talking ham radio and flying in person whenever in close proximity, and on the airwaves when not.

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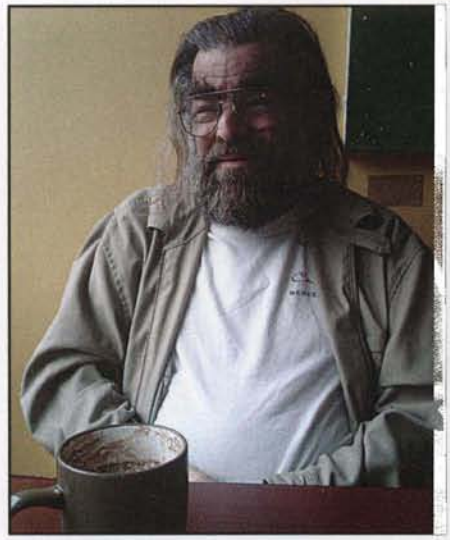
In 1982, when friends and I co-founded the Frazier Lake Airport in Hollister, California, Mal showed up there in a Bell 47, logging the first landing before we had even begun to construct a runway. Although never a member of the Frazier Lake Airpark Association, Mal nevertheless managed to fly in to many an airport barbecue, as my guest, in whatever helicopter or airplane he happened to be flying that year.

Our careers wound in curiously diverging directions. After grad school, Mal started off in academia, then gave up a teaching post to work in the aerospace industry. I left my aerospace engineering position to accept a college faculty assignment, then using academia as a springboard to go back to school for my own Ph.D. We quipped about which one of us was walking backward through life, but Mal always encouraged my personal and professional growth.

Mal's own professional growth astounded me. He made a dramatic jump from aerospace into biotechnology, developing some of the earliest DNA sequencing techniques, and contributing software to the ultimate classification of the human genome. I once asked Mal how one segued from astrophysics to genetic engineering. "The tools are exactly the same," he replied. "I used to use them to image the very large and distant. Now I apply them to imaging the very small and near. Same difference." That was the kind of insight that made Mal Raff incredibly interdisciplinary.

Richard Factor, WA2IKL (another pilot and interdisciplinary renaissance man) and I started up The SETI League in 1994. Mal was early to sign on and became an active and ardent supporter. Our shared SETI interest had become evident more than a decade prior, when Mal accepted my invitation to give a colloquium at the college where I then happened to be teaching. His chosen topic: "Speculations about Extra-Terrestrial Visitors." Mal made regular financial contributions to The SETI League (the size of which fluctuated as his personal fortunes waxed and waned), attended several of our SETICon technical



*Possibly the last picture taken of Malcolm I. Raff, WA2UNP, by cell phone on October 17, 2010. (N6TX photo)*

symposia, served on our scientific advisory board, chaired our Strategic Planning Committee, and consoled me as the organization's resources shrank almost in inverse proportion to our growing technological acclaim. Mal shared Richard's vision for privatized science; we were just never able to figure out how to make it pay for itself.

Upon his retirement, Mal decided to expand his musical horizons. Always a gifted pianist, he immersed himself in Brazilian jazz. Deciding he wanted to learn to play the vibraphone, Mal tackled that instrument with the same dedication I had seen him bring to his mastery of aviation, engineering, and biotechnology. He became a regular fixture at (and generous benefactor to) the Berkeley Jazz School. Although the Brazilian jazz combo he cobbled together never gained headliner status, they managed to make beautiful music at a number of Bay Area venues. I would enjoy taking in a performance whenever my travels brought me out west.

When my daughter Erika (who was like a niece to Mal) staged her performance piece "Orbit: Notes from the Edge of Forever" at San Francisco's Intersection

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for the Arts, Mal and I attended the premiere together. He and I were the only people in the audience to crack up when Erika's co-star uttered the throw-away line she had scripted in his honor: "Oh, be a fine girl, kiss me!" We were probably also the only attendees to recognize a rhythmic pulsing in the musical score as the Morse code characters "CQ."

Mal celebrated his 70th birthday at the Jazz School on April 18, 2010. He was diagnosed with a fast-growing brain tumor on August 1st, and died at home on November 3rd. I visited with him two weeks prior; we talked for two hours, hugged each other, and said our goodbyes. I feel that I have lost a brother.

Malcolm I. Raff is survived by his wife, Connie Woods; a sister in Washington's Crossing, Pennsylvania; a very old tortoise; and about a dozen rescued birds, including one very intelligent cockatoo.

Rest in peace, my friend. Paul, N6TX

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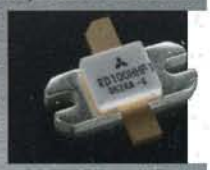

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