ISSN 1085-0708

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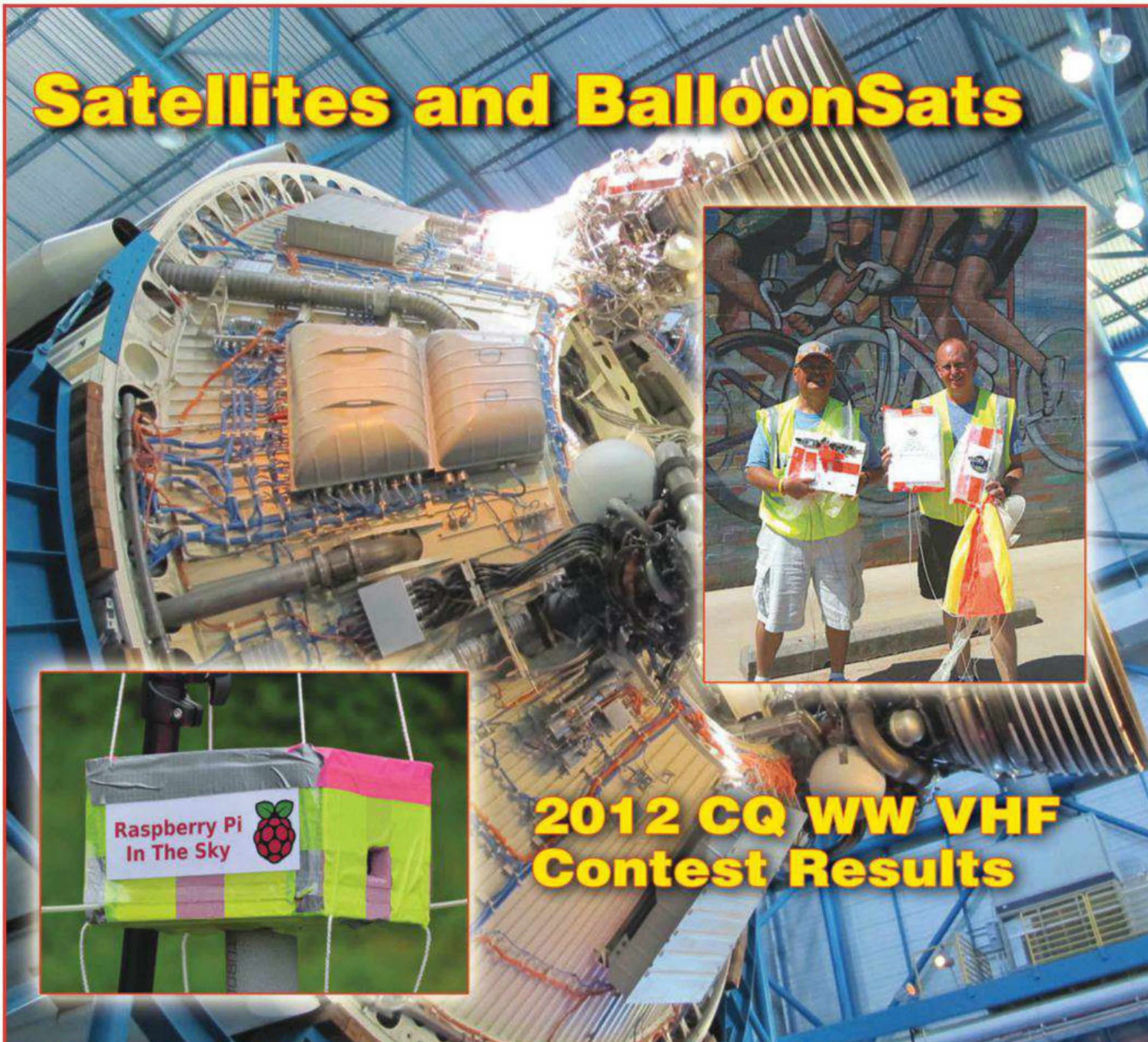

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Printed in the United States of America.
POSTMASTER: Send address changes to:
CQ VHF, 25 Newbridge Road, Hicksville, NY 11801.

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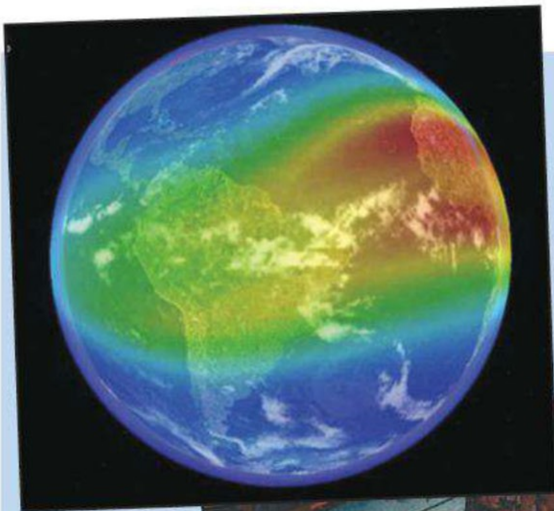
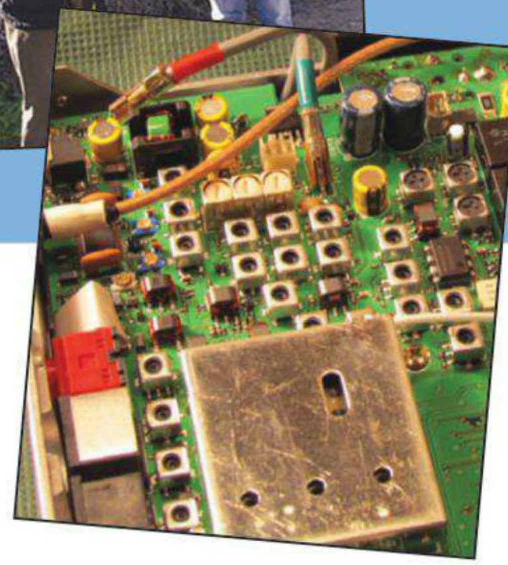
WINTER 2013
Vol. 16 No. 4

FEATURES





COLUMNS

DEPARTMENTS

On The Cover: Main photo: the Saturn upper stage engines; for details see the "Satellites" column by W5IU, p. 77. Top right inset photo: WB5QLD and KD5KNR recovering a payload in Texas; for details see "Up in the Air," by WB8ELK, p. 59. Bottom left inset photo: The Raspberry Pi payload package; for details see the feature article by Dave Akerman on p. 37.

CQ VHF Ham Radio Above 50 MHz

LINE OF SIGHT

A Message from the Editor

Another Year Completed

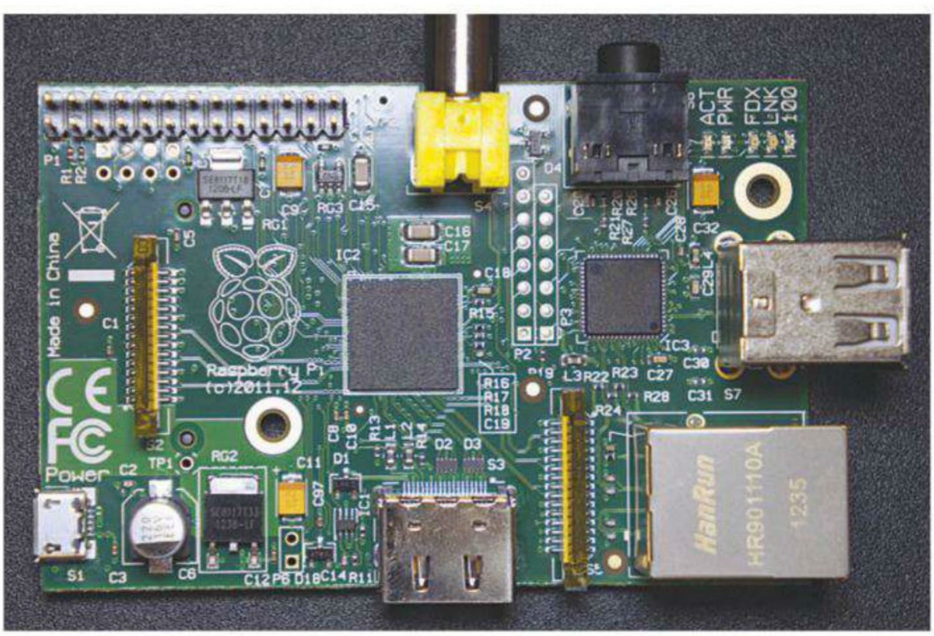
With this issue we close out the 11th year of the reintroduction of *CQ VHF* magazine. With this issue we also make a significant effort to include more technically oriented content. You may have noticed on the cover that one of the inserts is a photo of the payload of the Raspberry Pi in the Sky balloon launch. The article of the same name is authored by Dave Ackerman and starts on page 37. The article is from Ackerman's blog and was referenced on the AMSAT-UK website: <http://www.uk.amsat.org/?p=8978>.

The Raspberry Pi

The following information on the Raspberry Pi minicomputer is courtesy Wikipedia.org: "The Raspberry Pi is a credit-card-sized single-board computer developed in the UK by the Raspberry Pi Foundation with the intention of stimulating the teaching of basic computer science in schools around the world. The Raspberry Pi has a Broadcom BCM2835 system on a chip (SoC), which includes an ARM1176JZF-S 700 MHz processor (The firmware includes a number of 'Turbo' modes so that the user can attempt overclocking, up-to 1 GHz, without affecting the warranty), VideoCore IV GPU, and originally shipped with 256 megabytes of RAM, later upgraded to 512MB. It does not include a built-in hard disk or solid-state drive, but uses an SD card for booting and long-term storage. The foundation's goal is to offer two versions, priced at US$ 25 and US$ 35. The foundation started accepting orders for the higher priced model on 29 February 2012."

As of mid-January 2013 there have been over one-million units sold. Not to be left out, I purchased mine (see photo) late last year, along with the Raspberry Pi starter pack, and the books *Raspberry Pi User Guide* by Gareth Halfacree and Eben Upton and *Programming the Raspberry Pi: Getting Started with Python* by Simon Monk from Adafruit Industries (see: http://www.adafruit. com/). I hope to have some fun with it between now and the deadline for the next issue of *CQ VHF* magazine. I will report on my progress here and in my "VHF Plus"column in *CQ* magazine.

The Raspberry Pi is one of many different open-source hardware devices that are available to work on and develop projects. As mentioned above, it is my intention to include more technically oriented content in future issues of *CQ VHF*. In order to accomplish this goal, I am looking for you to write about your projects so that I may include your descriptions as future articles.



K6RPT-12

One of the most fascinating stories of late last year was the launch of the second transatlantic balloon by the California Near Space Project (CNSP) organization, CNSP-18 (K6RPT-12). Inspired by its December 2011 successful transatlantic flight of the CNSP-11 (K6RPT-11) balloon, members decided to launch another balloon to see if it also could make the same transatlantic flight. True to its purpose, the balloon did cross the Atlantic and eventually landed in Morocco. Author Don Ferguson, AI6RE, tells the story of its flight beginning on page 8.

While some thought that the K6RPT-12 payload was lost forever in the unknown terrain of Morocco, others were challenged to find it. Author Patrick Marteau, CN2GW/F1GXW, was challenged by his French friends to find the payload. Beginning on page 10, he tells his story of how he put together his search team and recovered the payload.

And Finally . . .

During my 11 years as editor of *CQ VHF* magazine and more than 21 years as "VHF Plus" Editor for *CQ* magazine, I have watched the growing interest in the VHF-plus frequencies by a number of different special-interest groups. Originally, most of the coverage in this magazine had been about weak-signal activity. More and more, however, the coverage has shifted to include satellites and balloon launches.

What I have also noticed is that similar technology is being developed within the various sub-niches—sometimes simultaneously and ignorant of the various sub-niches. For example, while lots of work has been done with open-source hardware by experimenters focused on particular hardware, the practical application in the other niches seems to not be keeping up. A case in point is that only a few in the sub-niche of the FunCube dongle have thought about using the Raspberry Pi with the dongle. I believe that there is much work that can be done in both sub-niches to explore the possibilities.

To further the cross-pollinating, I am proposing to start a monthly digital newsletter that would include current news about all of the various sub-niches within the wonderful world of the VHF-plus bands. To that end, I would like your feedback as to your interest in subscribing to such a newsletter. Please e-mail me at <n6cl@sbcglobal.net> with your thoughts. Thank you.

Until the next issue . . .

73 de Joe, N6CL

Current Contests

European Worldwide EME Contest 2013: 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/EMEContest2013CWweb.pdf.

The **June VHF QSO Party** will be held June 8–9. The **ARRL Field Day** will be held June 22–23. For more information on these contests, see the ARRL website: <http:www.arrl.org>.

Conference and Convention

Southeast VHF Society: The 2013 annual conference will be hosted in Cocoa Beach, Florida, April 19-20, at the Cocoa Beach Hilton. For information on registering for the conference, please check the society's website at <http:// www.svhfs.org/>.

Dayton Hamvention®: The Dayton Hamvention® will be held as usual at the Hara Arena in Dayton, Ohio May 17–19. 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, email, 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 2013 annual Southeastern VHF Society Conference to be held in Charlotte, North Carolina on April 19–20, 2013. 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. Paper deadline is February 12. For further information about the conference *Proceeding* guidelines, please download the pdf at: <http://www. svhfs.org/callforpapers2013.pdf>.

Central States VHF Society Conference: Technical papers are solicited for the 47th annual Central States VHF Society Conference to be held in Elk Grove Village, Illinois, at the Elk Grove Village Holliday Inn. For more information please see the society's website: <http://www.csvhfs.org>.

Meteor Showers

February showers and approximate peaks: The *Capricornids/Sagittarids*, February 1*; α-*Centaurids*, February 8 at 0000 UTC; *X-Capricornids*, February 13*.

March shower and approximate peak: The ϒ-*Normids*, March 14.

April showers and approximate peaks: The *Lyrids* meteor shower is active during April 16–25. It is predicted to peak around 0530 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. Other April showers and approximate peaks: *n-Puppids*, April 24; April *Piscids*, April 20; δ-*Piscids*, April 24.

Quarterly Calendar

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

February 3	Last quarter
February 7	Moon perigee
February 8	*á-Centaurids* meteor shower peak
February 10	New Moon
February 17	First quarter Moon
February 19	Moon apogee
February 25	Full Moon
March 4	Last quarter Moon
March 5	Moon perigee
March 11	New Moon
March 16-17	First Weekend of DUBUS EME Contest.
March 19	First quarter Moon
March 19	Moon apogee
March 27	Full Moon
March 31	Moon perigee
April 2	Last quarter Moon
April 10	New Moon.
April 13-14	Second Weekend of DUBUS EME Contest
April 15	Moon apogee.
April 18	First quarter Moon.
April 21	*Lyrids* meteor shower
April 20-21	Southeast VHF Society Conference
April 25	Full Moon
April 25	Partial lunar eclipse will be visible in Europe, Africa, Asia, and Australia
April 27	Moon perigee
May 2	Last quarter Moon
May 5	*ç Aquarids* meteor shower peak
May 9	New Moon
May 10	Annular solar eclipse will be visible in Australia, New Zealand, Central Pacific
May 11-12	Third Weekend of DUBUS EME Contest
May 13	Moon apogee
May 17	First quarter Moon
May 17-19	The Dayton Hamvention®
May 18-19	Fourth Weekend of DUBUS EME Contest
May 24	Full Moon
May 25	Penumbral lunar eclipse will be visible in the Americas and Africa
May 26	Moon perigee
May 31	Last quarter Moon
June 8	New Moon
June 9	Moon apogee
June 8-9	ARRL June VHF QSO Party.
June 15-16	Fifth Weekend of DUBUS EME Contest
June 16	First quarter Moon
June 23	Full Moon
June 22-23	ARRL Field Day
June 23	Moon perigee.
June 29	Last quarter Moon
June 29-30	Sixth Weekend of DUBUS EME Contest

May showers and approximate peaks: *n-Aquariids*, May 6; *n-Lyrids*, May 9; *e-Arietids*, May 9; May *Arietids*, May 16; and *o-Cetids*, May 20.

June showers and approximate peaks: June *Arietids*, June 7*; *zeta-Perseids*, June 9*; June *Boötids*, June 27, 0300 UTC; and β-*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 71, as well as visit the International Meteor Organization's website: <http://www. imo.net>, or download the 2013 calendar pdf at: <http://www.imo.net/files/data/calendar/cal2013.pdf>.

Transatlantic Balloon Flight 2012 CNSP-18 K6RPT-12

Inspired by their December 2011 successful transatlantic flight of CNSP-11 (K6RPT-11) balloon, members of the California Near Space Project decided to try another launch to see if it could also make the same transatlantic flight. Here AI6RE tells the story of the launch, flight, and landing of CNSP-18 (K6RPT-12).

By Don Ferguson,* AI6RE

It was a rainy weekend in San Jose, California, but all indications were that the weather would clear in the afternoon on Sunday, December 2, 2012. Almost a year ago, on December 11, 2011, a latex balloon, CNSP-11, was launched from San Jose and traveled across the United States, the Atlantic Ocean, and on to Portugal and Spain. The balloon burst at 115,000 feet above the Mediterranean Sea and fell into the sea on the coast of Algeria.

By 2:30 p.m. Sunday, December 2, 2012, the weather did clear and the sun showed brightly through the clouds. The California Near Space Project team was ready to launch a second transcontinental balloon flight, CNSP-18. All the usual people—Ron Meadows, K6RPT, Lee; Frank Meadows, KA6TVU; Don Ferguson, AI6RE; Jonathon Corgan, AE6HO; Michael Wright, K6MFW; and Bob Snelgrove, KG6TBY, gathered at Cherry Avenue and Almaden Expressway.

Photo 1. The balloon being walked to the launch site.

The plan was to launch a 1600-gram Hwoyee latex balloon at about 5 p.m. on another attempt to float across the U.S.A. to the East Coast and beyond. Everything progressed as planned, and at 5:28 p.m. PST on December 2, 2012 local time (December 3, 2012 01:28 UTC), CNSP-18 set off on its way across America. The APRS radio callsign of this balloon was K6RPT-12. The balloon is tracked on the web at <http://aprs.fi/k6rpt-12> and those interested were watching from every part of the globe in real time.

When we fill a balloon with hydrogen we must be very concise for a total payload lift to provide enough total ascent to attain about 102,000 feet and not so much to cause it to pass through 115,000 feet. From experience we have learned that at this time of the year there is a constant flow of the atmosphere to the east at above 100 mph. This is way above the normal jet stream that airplanes use, which is between 30,000 and 40,000 feet. See the California Near Space Project website (http://www.cnsp-inc.com/cnsp-18/) for photos of the launch preparation. See the You Tube video of the fill at: <http://www.youtube.com/watch?v=J5QUGMAgkVg&feature=player_embedded>.

When launched, the balloon ascent rate was about 350 feet/minute and that was right at our target and thus assured us of an accurate fill. Now came the hard part. Everything we could control was over, and K6RPT-12 on APRS was on its own with the whole world watching.

This balloon payload was a little different than the package on the 2011 balloon. One piece of data transmitted over the APRS system is "Current Battery Voltage," and we noticed that the battery voltage would decrease at night to below 4 volts. This voltage drop could cause the payload to stop transmitting good data.

This year the package carried a heater module, designed by Jonathan, AE6HO, which was controlled by a photocell and came on at sunset to provide added warmth inside the package. The package had its own battery and appeared to be working as expected. The reported bat-

*4697 Holycon Cir., San Jose, CA 95136-2311
e-mail: <ai6re@donferguson.net>

Figure 1. The flight path of K6RPT-12, based on APRS receptions.

tery voltage was much more stable and did not drop below 3.9VDC for 99% of the flight.

This added weight had to be compensated for by pumping more hydrogen into the balloon. Everything has an effect, and the fill of the balloon is the critical part of the process. Lee Meadows does all of the calculations and generates the mission plan for each flight. His father, Ron, K6RPT, is the overall project director and makes the final decision on each flight.

Back to the flight of K6RPT-12: Everything progressed normally and the balloon leveled off at 103,000-foot altitude. It traveled overnight to a sunrise above Nebraska. As the sun came up so did the balloon's altitude, which rose to 111,000 feet and speed in excess of 210 mph headed ENE. The balloon continued in daylight and left the U.S. at the most eastern point of Maine. The balloon was visually spotted at the University of Maine by Rick Eason, AA1PJ, as it faded into the night sky illuminated by the sun at 111,000 feet.

Daylight takes a very heavy toll on a balloon, as it is flying above 90% of the atmosphere and has very little protection form the harsh UV rays of the sun. While the warmth of the sun is a benefit to the payload radio and batteries, its UV rays also will be the force that causes the balloon to burst and end this flight. CNSP-18 continued east into the sunset just south of Nova Scotia at 180 mph, still headed for France.

At 3:54 UTC on December 5, 2012, 26$^{1}/_{2}$ hours after launch, the balloon passed out of radio range of the APRS gateway 390 miles behind it in Newfoundland. It had changed course to the southeast and slowed to 135 mph. Now we waited to see if anyone ever heard from the balloon again.

After about 8 hours of sleep we arose to see if there was any sign of the balloon. Still nothing received. As in the past, we rely on the hams in Europe to retune to the USA APRS frequency from their normal monitor frequency. So hopefully this was the case today. Many had sent e-mails and messages to friends in Europe to please listen for our little balloon crossing the ocean.

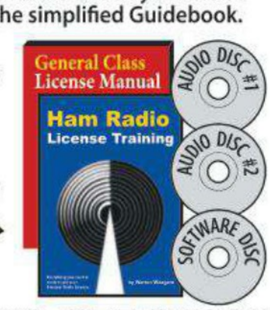
After 22 hours of loss of signal (LOS) it was starting to look as if our balloon might not make it or had gone in a direction where no APRS repeaters could receive the small signal. There were as many ideas being sent to the website as there were people listening for it to succeed.

At 03:40 UTC on December 5, 2012, 23 hours 44 minutes after LOS in North America, the signal was received by Union de Radioaficionados de Granada, ED7ZAE, a station in Granada, Spain that showed the balloon approaching the coast of Morocco. Suddenly all the cell phones started ringing and the computer screens came alive. There it was, K6RPT-12, moving at 72-mph heading ENE toward Morocco, 200 miles ahead.

At 06:37 UTC on December 5, 2012 the balloon passed over the coast of Morocco just 10 miles south of the town of Kenitra at the balloon altitude of 114,400 feet, traveling at 50 mph still heading east. K6RPT-12 would continue for another 140 miles, burst at 118,262 feet, and then fall, heading southeast for another 15 miles. The last radio signal was received at 09:22:31 UTC on December 5, 2012. The last signals were relayed by EA7FQB, Salvador Perez Lanzas, Estepona, Malaga, on the Mediterranean coast of Spain.

The final numbers on this balloon flight: 55 hours, 54 minutes; 6092.5 Great Circle miles; 118,262-foot altitude; highest speed 232 mph.

We thought that this story would end here, and it has for the U.S. side. However, thanks to great work by Patrick Marteau, CN2GW/F1GXW, the payload was recovered. *(See his article elsewhere in this issue.—ed.)*



K6RPT-12 Recovery Report

While some thought that the K6RPT-12 payload was lost forever in the unknown terrain of Morocco, others were challenged to find it. Here CN2GW/F1GXW tells his story of how he was challenged by his French friends and how he put together his search team and recovered the payload.

By Patrick Marteau,* CN2GW/F1GXW

This article is about how the author found the K6RPT-12 balloon payload that landed in Morocco *(see the article "Transatlantic Balloon Flight 2012, CNSP-18 K6RPT-12" by Don Ferguson, AI6RE, elsewhere in this issue—ed.)*. The landing spot was approximately 15 km northwest of the town of Taza in the east of the city of Fez. This article provides a surprising end to the fantastic voyage of the K6RPT-12 balloon.

From left to right: Saaid Bacha, CN8WW, "your servant," Patrick, CN2GW/F1GXW, and Amin Lahcen, CN8YM.

The Challenge

I am a French citizen residing abroad in Morocco. I am also an amateur radio operator. On December 1, 2012, I made a trip to France. While in France, I visited my friend Alain Metais, F1GXY, in Tours.

Alain said to me, "I am looking for you everywhere, because there is an American [high altitude] balloon payload that landed in Morocco, so I thought you might try to recover it." This challenge from my friend is how we began the hunt for the balloon payload in Morocco.

During the week that I was in France we found on the internet an amateur radio operator who was familiar with the hunt for the balloon payload, Alain Verbrugge, F6AGV. I made contact with him to inform him that the weekend of December 14 I could do an expedition to recover the identified flying object. Following this first contact, F6AGV began sending me his first calculations of the likely fall positions.

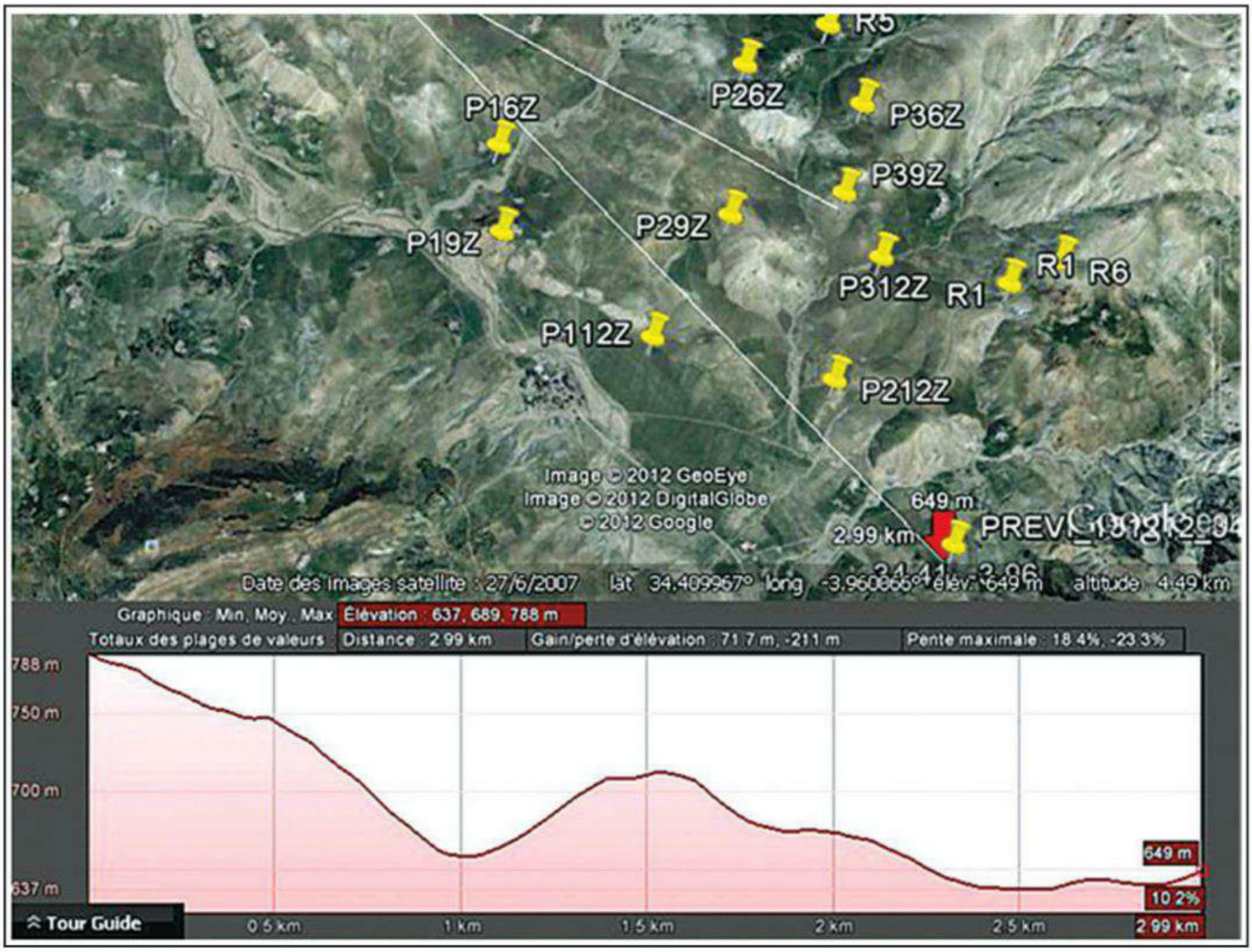
I returned to Morocco the weekend of December 10. Upon my return, I made contact with Kacem Kaoukabi, CN8LR, who is the IARU representative of the Moroccan national amateur radio association, the Royal Association of Radio Amateurs of Morocco, CN8MC. I informed CN8LR of my intention to implement this expedition in Taza with Saaid Bacha, CN8WW, and Amine Lahcen, CN8YM, two men who are from the region of Meknès whom I contacted thanks to a referral from Eddy Loudyi, F5NAK (who is also CN8GX), during a QSO on 20 meters.

Kacem, CN8LR, alerted the local authorities of our arrival and at the same time called on the authorities to proceed with the research on where to look for the payload. On Friday, December 14, in the evening, we gathered at a restaurant in Meknès where we developed our expedition for the next day with Saaid, CN8WW, and Amine, CN8YM, along with a friend of mine, Mohamed, who would be the photographer of the expedition.

My friend Mohamed, the amateur photographer and expert negotiator.

On Saturday December 15, we departed at 6:00 a.m. local time for the 180-km drive. We arrived at Taza with a stop for coffee and fuel. We had a lot of both hope and uncertainty. I confirmed that there was no parachute. The calculations of the payload were as follows: The drop speed

*e-mail: <marteau.louise@hotmail.fr>



The map of the position and descent that Alain Verbrugge, F6AGV, sent to us.

was 16m/s, approximately. The last known point was at 34.41 N and 3.96 W.

Departure to Research the Payload's Location

The GPS in the Kenwood® TH-72A in the vehicle position gave us an approximate position of the calculated point. Soon we arrived at our starting point of our search. Because it was a really easy beginning, I told myself that I should not expect I would suffer, hi!

However, as we began our search we analyzed something that possibly looked like the twin sister of a white box. All of this exertion caused yours truly to begin to tire. It is my lack of exercise! However, Bacha, CN8WW, is not much better, hi! Looking at the woods, we hoped that the payload had not fallen among the trees.

Our looking for the payload wasn't all business, however. Occasionally we were afforded some beautiful views.

Using the GPS in the Yaesu FT-390R to give us a close position to the calculated point, we arrive at our starting point of our search.

Because the beginning of the journey seemed really easy, I told myself that I should not have to suffer much pain from the walk.

After six hours of uninterrupted marching around the mountains with no success, we decided to return at a later date. We were tired and disappointed but happy to have had a very good day. We decided to come back in a week.

Recovery of K6RPT-12

On Sunday, December 23, we returned to the site to ask people whom we had met the previous week if they had heard about the payload during the past week. We were surprised to find someone who informed us that our box had been found by a farm worker. We made contact with this person, but the negotiations were long and complicated (1 hour and 30 minutes). Eventually, we came to a reasonable agreement.

I begin to tire because of a lack of regular exercise. However, Amin Lahcem, CN8YM, who was the oldest on our team, seemed also to not have much energy.

After 1 hour 30 minutes of negotiations, we accepted the agreement because it was late and we wanted to get our hands on the payload.

Looking for a white box in these hills caused us to find objects that at a distance looked like a twin of the payload.

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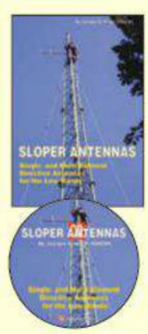

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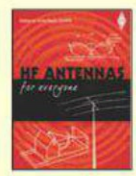

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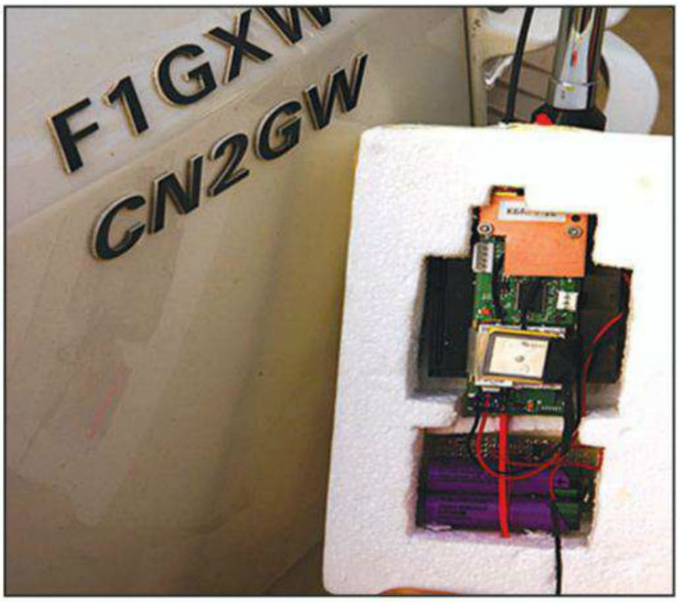
I sure hoped that the payload did not fall in amongst all those trees.

While looking for the payload we were afforded very beautiful views.

The precise location of the payload landing.

The two farmers who originally found the payload.



We wanted to make sure that we did not negotiate for an empty box, so we removed its lid to show its contents.

We accepted the agreement because it was late and we really wanted to get our hands on that payload. We concluded our negotiations by making sure that we did not negotiate for an empty box, hi!

The payload was found by the workers on December 5 at around 11:00 a.m., as it turns out, shortly after it had landed. We asked people to lead us to the exact point of impact to get the precise GPS position. We got the position from our friend Alain, F6AGV. The altitude was 641 meters.

The Research Team and Thank You

Our research team included the following: Mohamed, photographer and intermediary for negotiations; Amin Lahcen, CN8YM, the oldest but the first at the top of the mountain; Saaid Bacha, CN8WW, the "King of CW"; Patrick, CN2GW/F1GXW, "your servant," who must do more exercising, hi!

This is the adventure is over and a big thank you goes to the following: Alain Metais, F1GXY, who was originally responsible for my involvement in this project; Alain Verbrugge, F6AGV, balloons recovery specialist, who was invaluable for the calculation of the points of the payload landing (we found that his calculations were very accurate.); Kacem Kaoukabi, CN8LR, the IARU representative for ARRAM, who alerted local authorities to have a maximum of information and to allow our research without problems.

To all involved in this venture, thank you, and on and up in the air we go!

At last we had the payload in our hands.

A Panadapter for the FT-817 using the FUNCube Dongle

Mike Richards, G4WNC, reviewed the FUNCube Dongle in the Summer 2012 issue of *CQ VHF* magazine. Here N1JEZ, W1FKF, and W1GHZ adapt it to be a panadapter for the very popular Yaesu FT-817 transceiver.

By Mike Seguin, N1JEZ,* Don Twombly, W1FKF, and Paul Wade, W1GHZ

An interesting new SDR receiver called the FUNcube Dongle[1,2] recently went on sale in support of AMSAT-UK's FUNcube satellite project. The unit is a self-contained SDR receiver that can cover 64–1700 MHz. It is USB based and shows up as a sound card under Windows®. No special drivers are needed. It works with most SDR software that supports I & Q. The dongle includes an LNA, tuner, and audio card built into a small package with an SMA RF input. The quadrature sampling rate is 96 kHz, providing about 80 kHz bandwidth after the decimation filter skirts of the Analog-Digital Converter.

N1JEZ first thought of using it as a panadapter for weak-signal work on10 GHz and up. The FUNcube would tune both 144 MHz and 432 MHz, the two transverters' IF frequencies. To use it directly would require switching between the Dongle for receive and IF radio for transmit; W1GHZ tried this for one microwave contest, but found it inconvenient. Then Don, W1FKF, suggested that it might be used by tapping the common IF in the radio used with a transverter.

We all use the Yaesu FT-817 as an IF for transverters on 10 GHz and up. It has a common 68.33 MHz first IF. This looked perfect, as the FUNCube could tune that easily. Also being a common IF, it would be the same for 144 or 432 MHz.

Photo 1. The FUNCube Dongle.

*e-mail: <n1jez@burlingtontelecom.net>

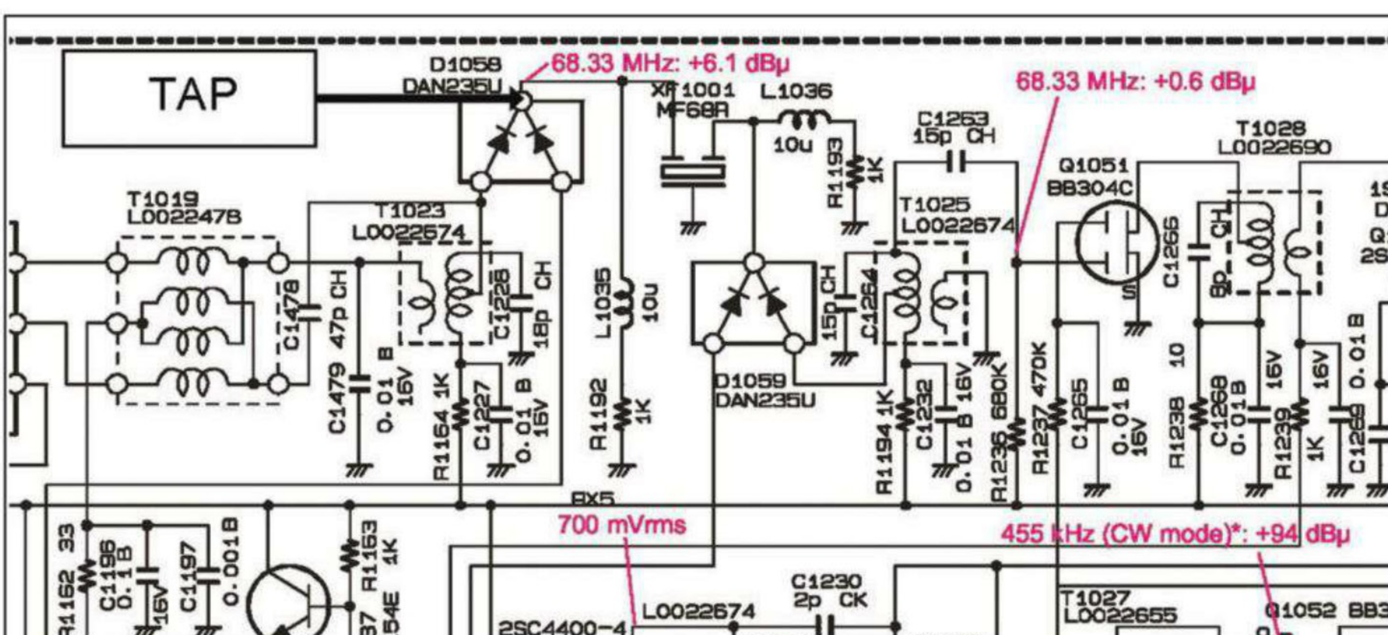


Figure 1. Excerpt from FT-817 schematic diagram showing TAP point. (Partial schematic and block diagrams courtesy Yaesu USA)

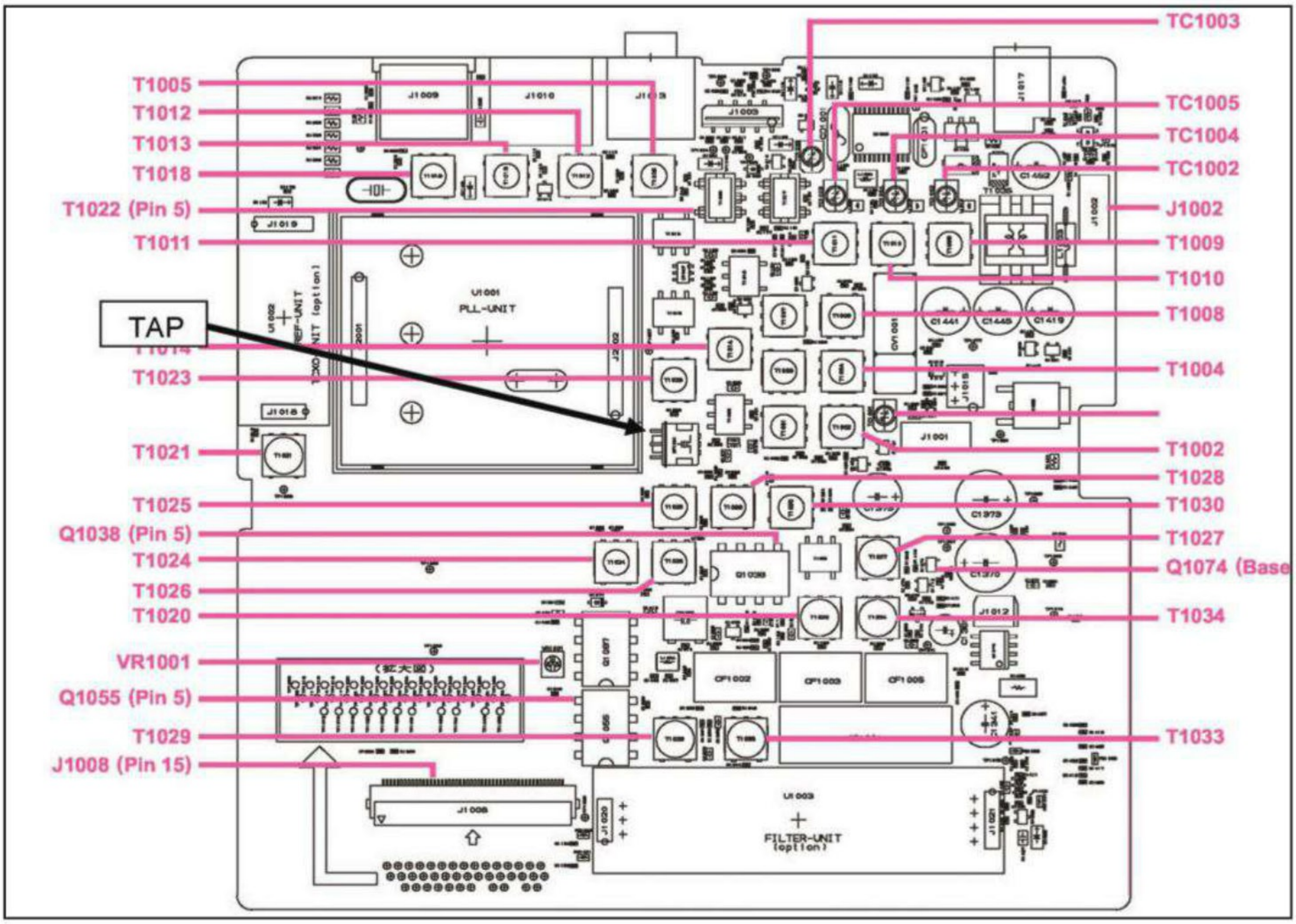


Figure 2. Physical location of TAP point in FT-817.

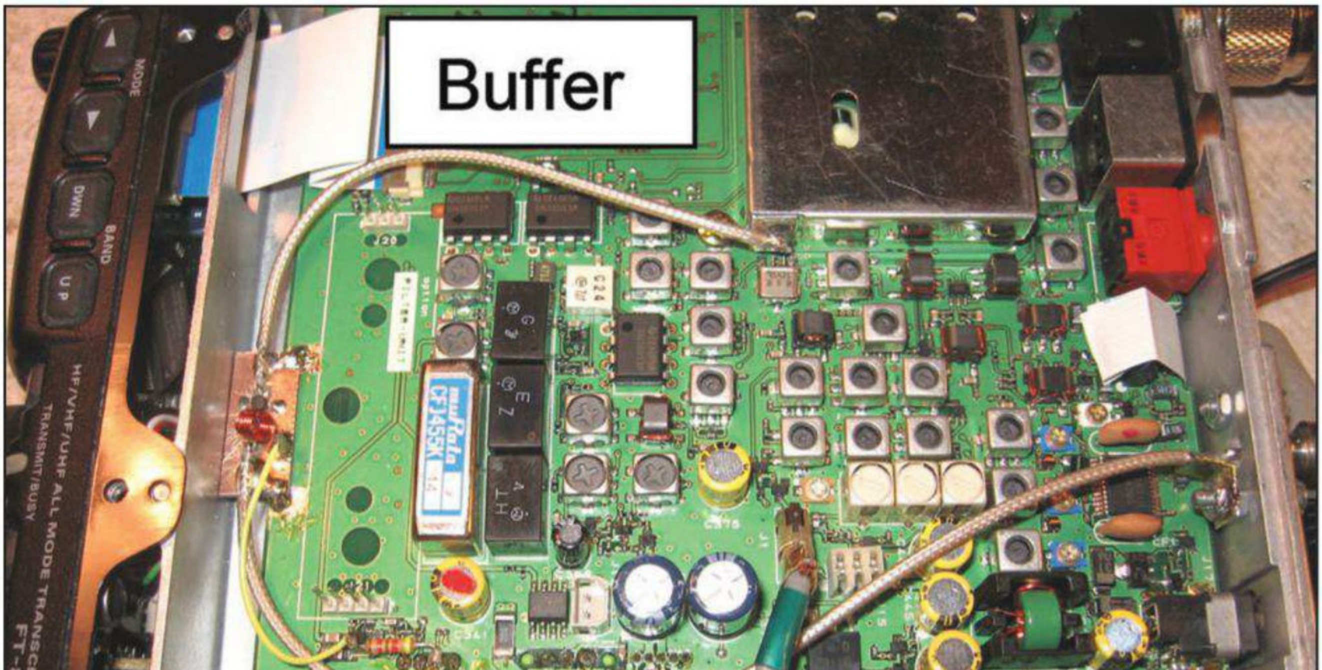


Photo 2. The MMIC active isolation buffer on the left, soldered to the front lip of the top board. The SMA connector is mounted on the rear, as shown on the right of the photo.

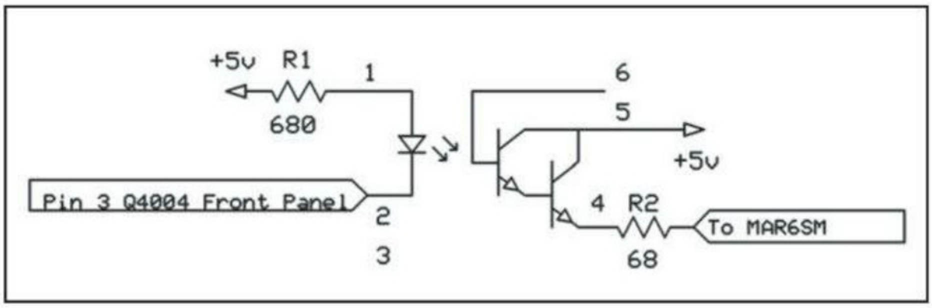


Figure 3. Darlington Opto-Isolator switch for buffer amplifier.

The first step was to identify a location to tap the common IF before any filtering. On the schematic, there is a point just before the first crystal filter (XF1001) that looked like a good candidate.

An active isolation buffer amplifier using a MAR-6 MMIC minimizes any interaction with the FT-817 IF. N1JEZ built a small prototype board to mount the MMIC and soldered it to the front lip of the top board near where the optional CW filter normally would go. Miniature coax runs from the TAP point and to an SMA connector mounted on the rear panel for the output. Power for the MAR-6 is +5 volts tapped off the RJ-45 microphone connector.

Initial testing showed a need to shut off the buffer amp during transmit, but it was difficult to find a convenient control signal in the FT-817 that would work on all bands and modes. N1JEZ finally decided to use a trick he utilized on an FT-736R, using the front-panel "busy" (receive) LED to switch the buffer amp. A Darlington Opto-Isolator paralleled across the LED switches the buffer.

Figure 4 and photo 4 show the connection point used for the Opto-Isolator. There is a through-hole off pin 3 of Q4004 on the front panel that will accept a #30 wire. Resistor value R2 was chosen to bias the MMIC at ~16 ma. An NTE-3083 Opto-Isolator was used for the pro-

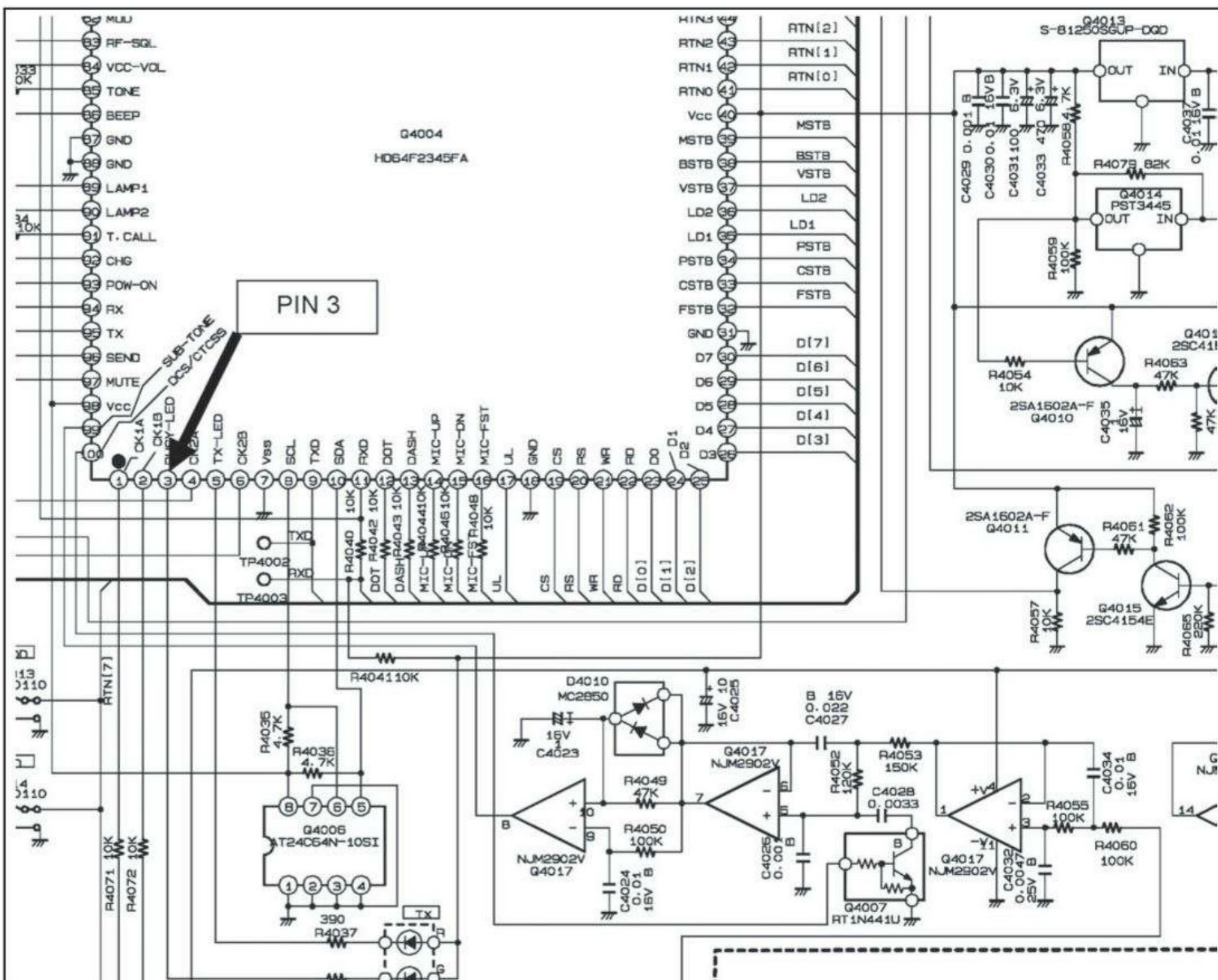


Figure 4. Front-panel connection: pin 3, Q4004.

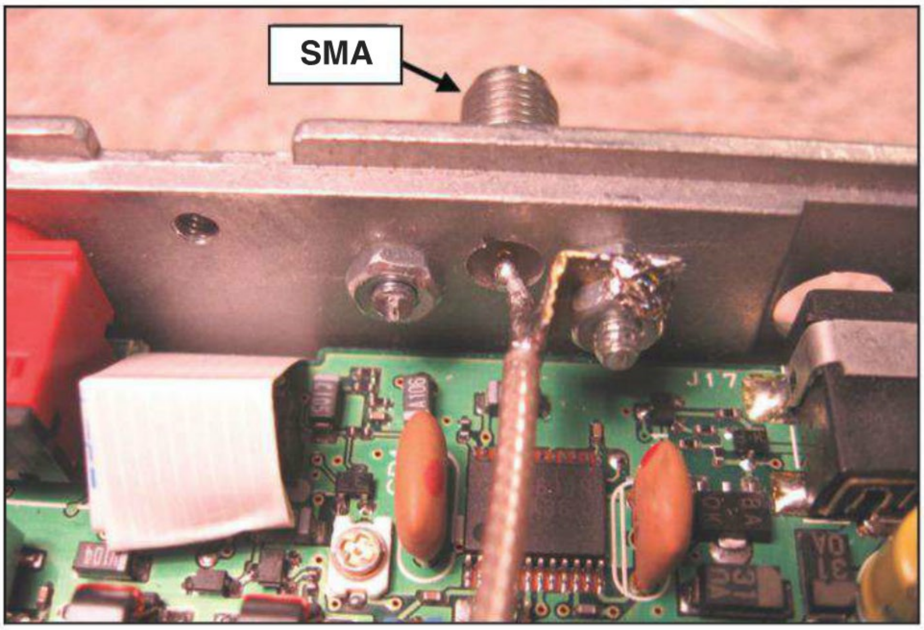


Photo 3. The SMA connector.

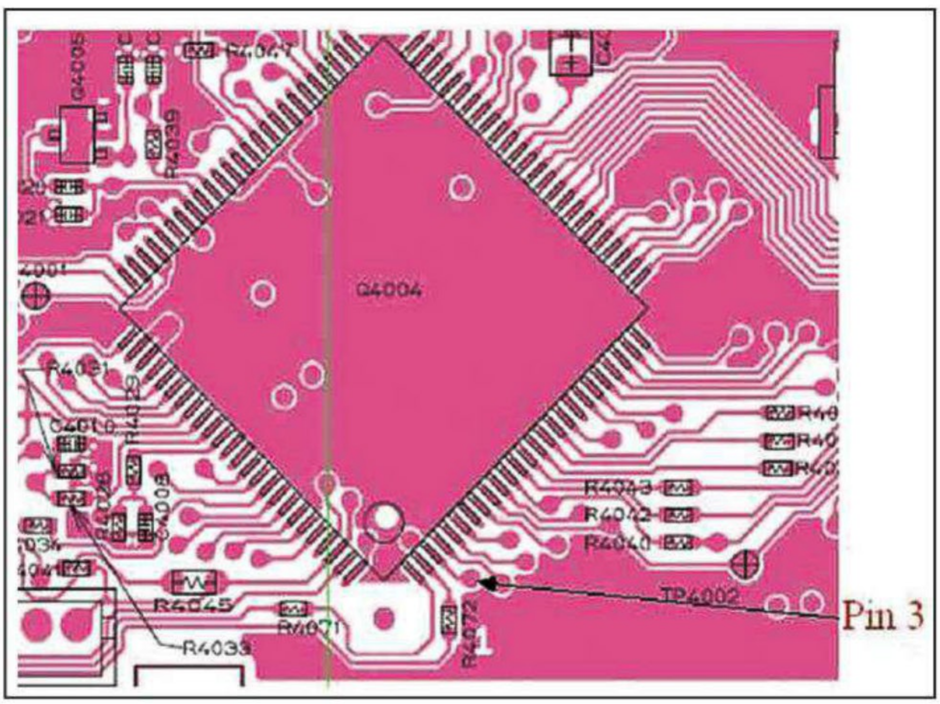


Photo 4. Front-panel connection, Pin 3, Q4004

totype, but a standard 4N33 is the equivalent part.

Photo 5 is a picture of the MMIC buffer and Opto-Isolator prototypes mounted along the front lip of the top board with hot-melt glue somewhere in this project.

Don, W1FKF, suggested looking at the IF output on a spectrum analyzer. He discovered there were some significant carriers present, as shown here.

A Minicircuits SBP-70+3[3] bandpass filter inserted between the FT-817 and FUNCube cleaned up the spectrum and increased sensitivity an additional 3 dB.

The FUNCube Dongle has performed well on 10 GHz. On Sunday, during the first weekend of the 2011 ARRL 10 GHz and Up Cumulative Contest, N1JEZ was on Mt Mansfield, grid FN34om, during some significant rain-scatter propagation. Shown is a screen shot of VE3FN in the waterfall display on 10 GHz. Ray was in FN26rf, which was 234 km distant at 325° via direct path. Signals peaked at an azimuth of 150°.

It was very easy to peak up on Ray. N1JEZ immediately spotted his signal in the waterfall and adjusted AZ/EL for

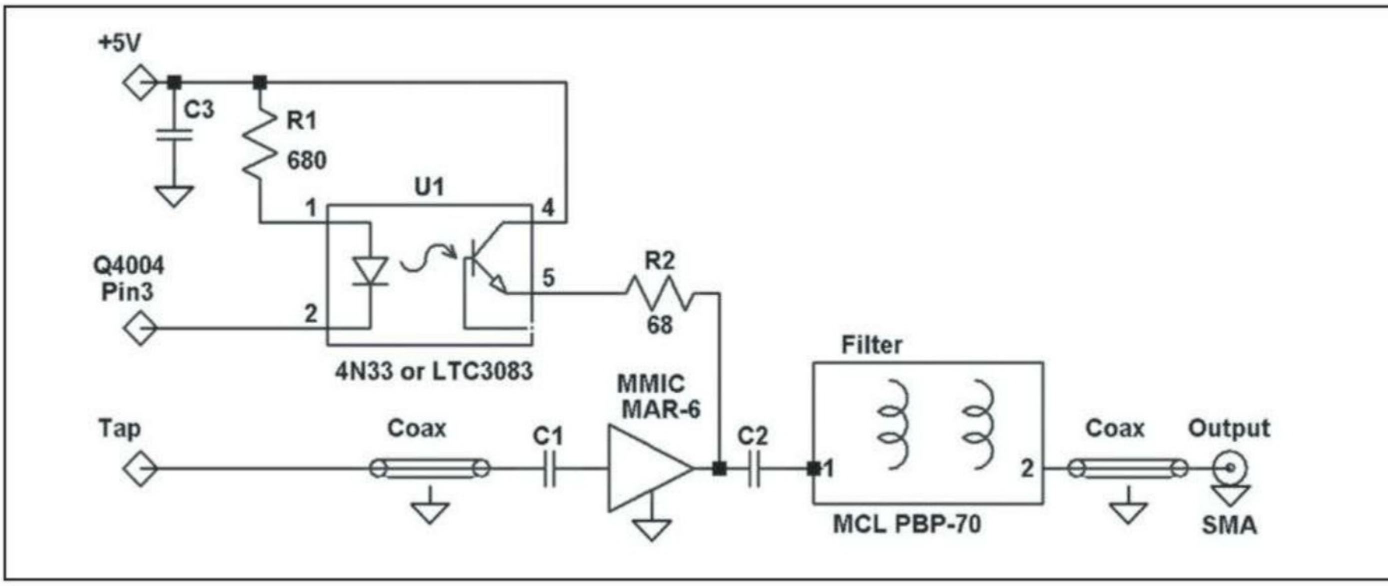


Figure 5. Schematic diagram of the FUNCube Dongle Panadapter board.

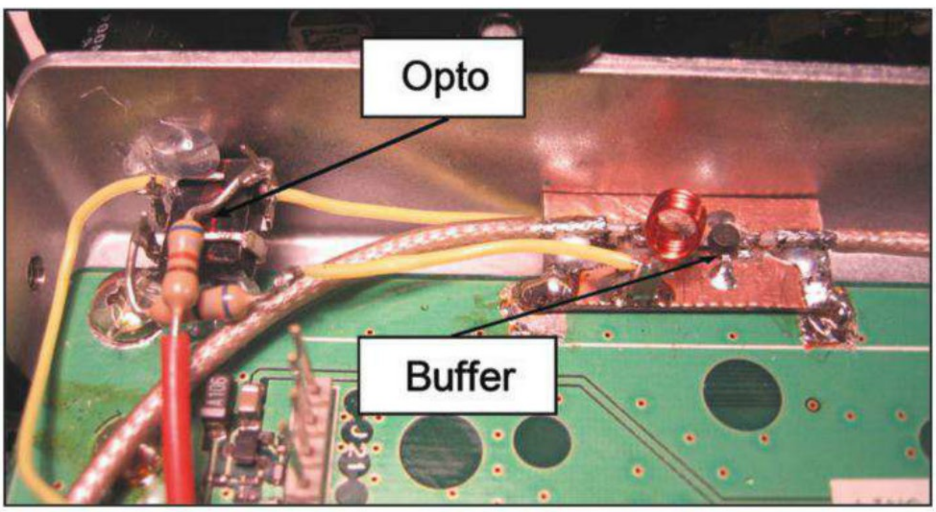


Photo 5. The Opto-Isolator is mounted to the left of the MMIC buffer.

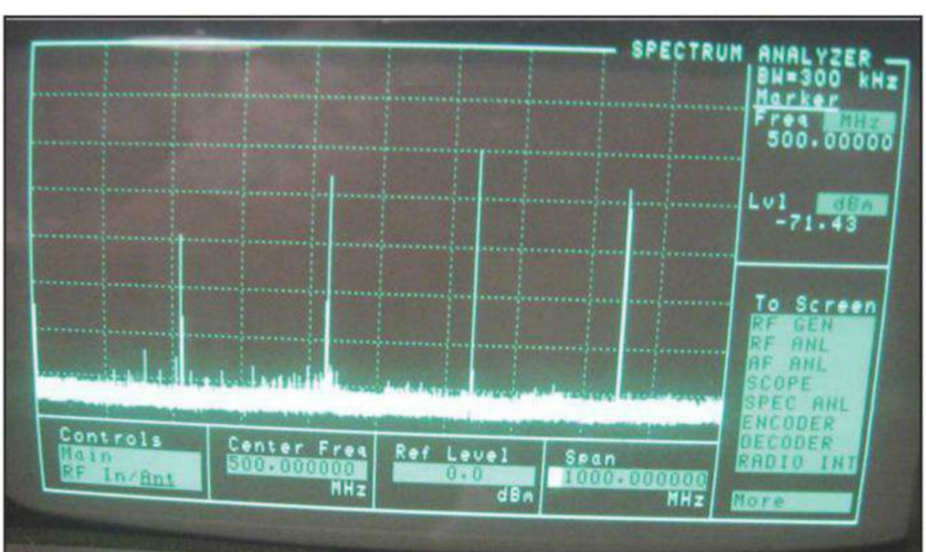


Photo 6. Screen shot of the spectrum analyzer showing significant carriers present before adding the bandpass filter.

maximum signal, and then tuned the FT-817 to hear his signal.

During the same event, W1FKF was operating on CW at a distance of 265 km. The spreading and Doppler shift on his signal is apparent in the lower CW window.

W1GHZ was also on Mt. Mansfield during the contest and saw the system in action. After trying the Dongle externally with a switch, he designed a small board[4] that incorporates all the pieces including the filter.

The board is small and narrow to fit into the limited space available in the FT-817. Photo 9 is the top view and shows the parts placement and external connections. Photo 10 is the bottom view and shows where the MAR-6 MMIC and chip capacitors fit.

Integration

Putting together the board should be pretty straightforward, but integrating it into the FT-817 is a bit more work. Start by taking the covers off the FT-817 and then comparing with the photos shown here to get oriented. Photo 11 shows the completed installation, with the board tucked in behind the front panel, using the space intended for the optional filter. The output coax goes to an SMA connector on the back panel; a cordless drill is used to gently drill through the back panel. Don't forget to put a piece of tape on the inside of the panel before drilling to catch the chips before they get inside the radio.

Photo 12 is a close-up of the board installation, with double-sided foam tape between the bottom of the board and the metal wall of the radio. The filter is soldered down to the FT-817 main board at both ends; the green solder mask must be scraped off to make the connection. The orange wire goes to pin 6 of the RJ-45 microphone connector to provide +5 volts, and the blue wire goes to the front panel board of the FT-817, connecting to pin 3 of IC Q4004, as shown. Wirewrap wire, #30 AWG, just fits in the tiny hole in the front-panel board.

Photo 13 shows the IF tap point before the filter. The shield of the coax connects to the adjacent shield can, and the center conductor to the filter. The center con-

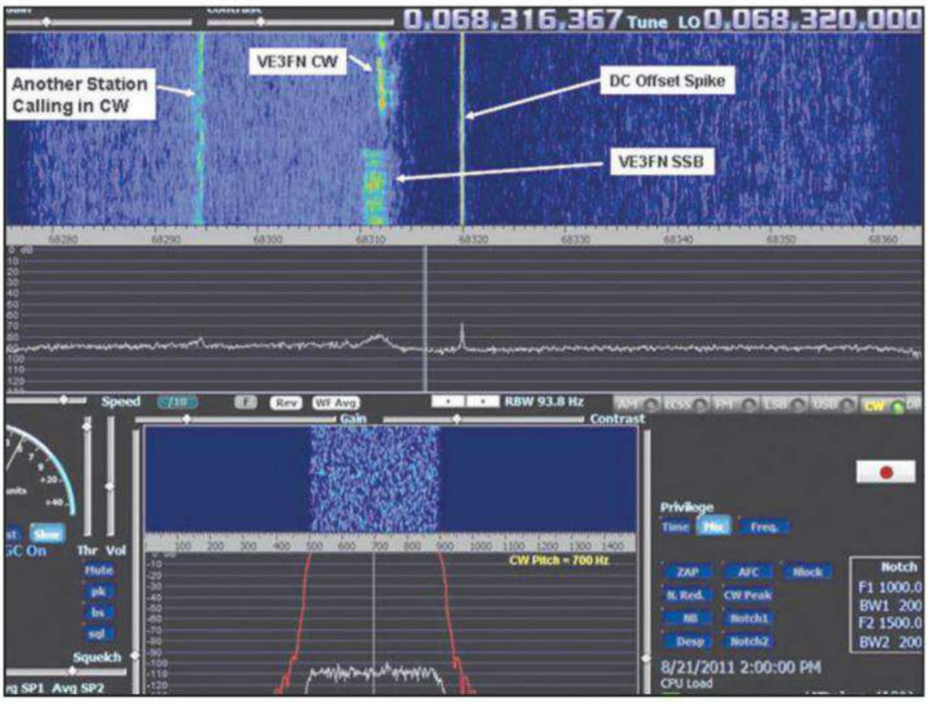


Photo 7. FUNCube Dongle in action on 10 GHz.

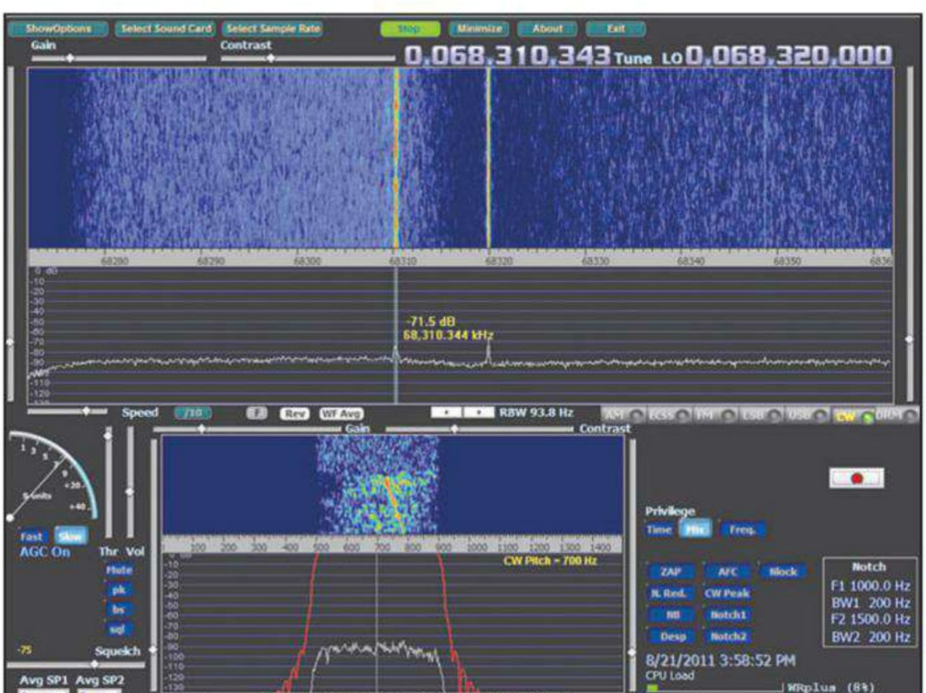


Photo 8. W1FKF on CW.

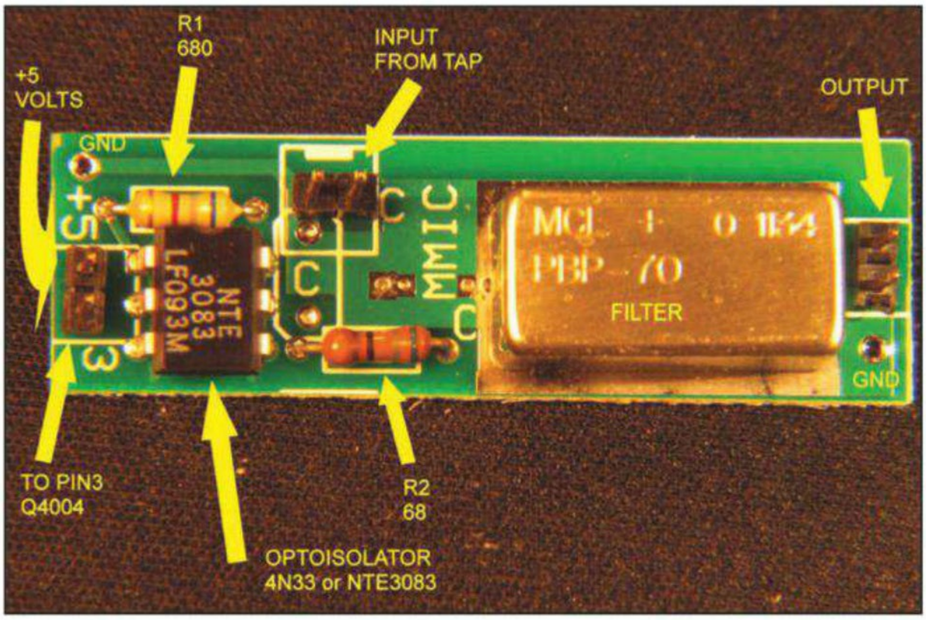


Photo 9. Top view of panadapter board.

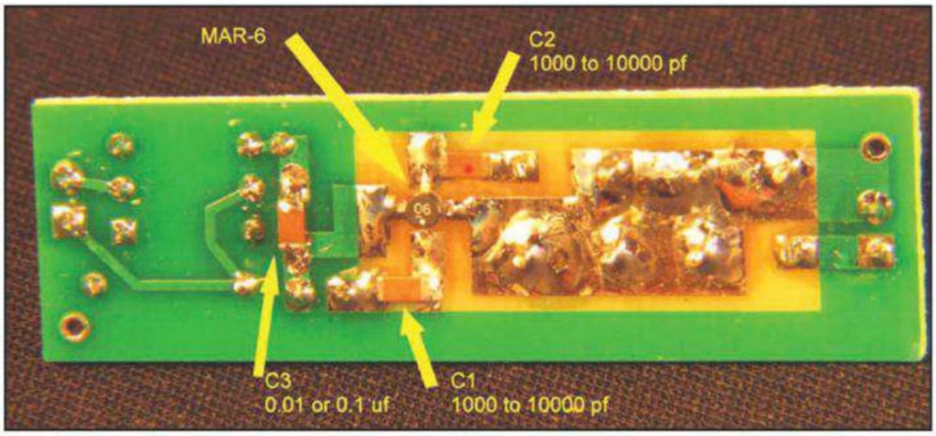


Photo 10. Bottom view of panadapter board.

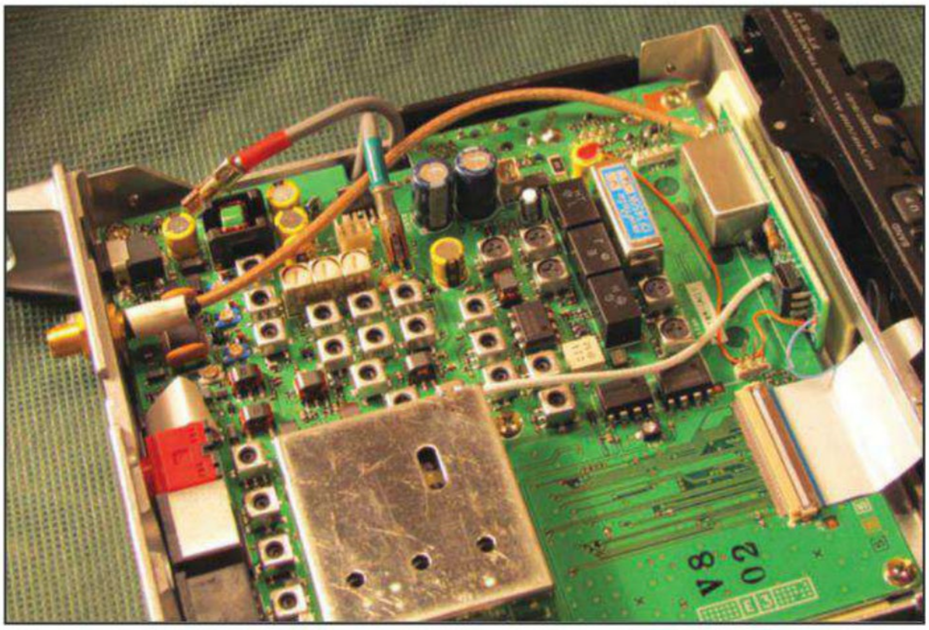


Photo 11. Panadapter board installed in the FT-817.

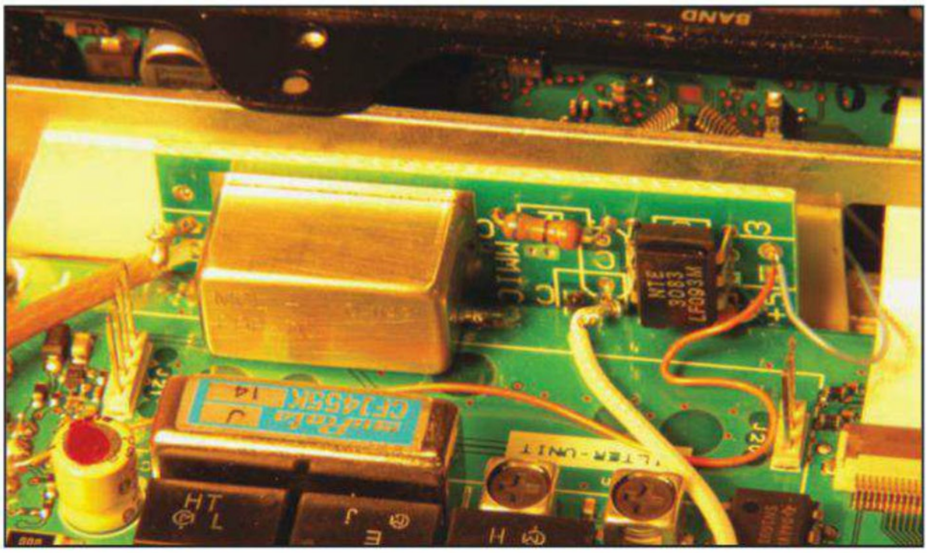


Photo 12. Panadapter board installed in the FT-817 (no CW filter).

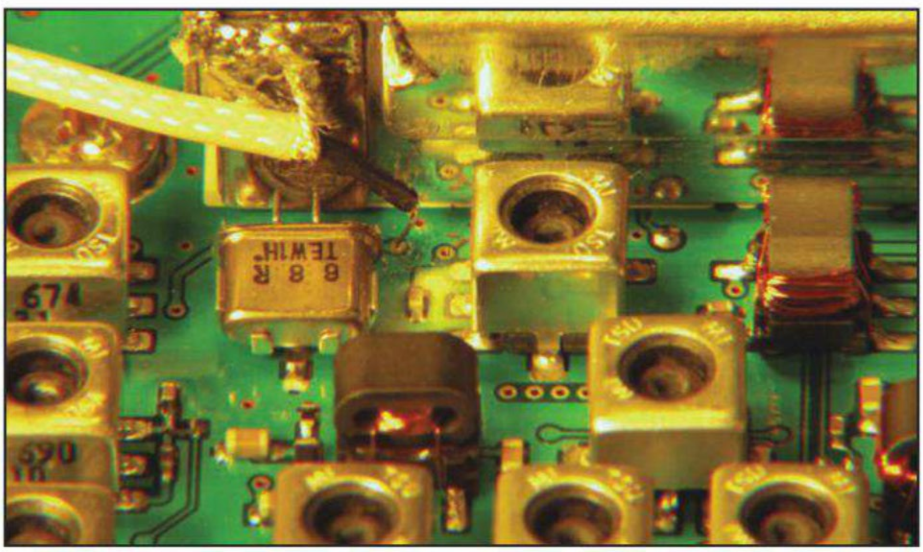


Photo 13. Signal tap at FT-817 filter input.

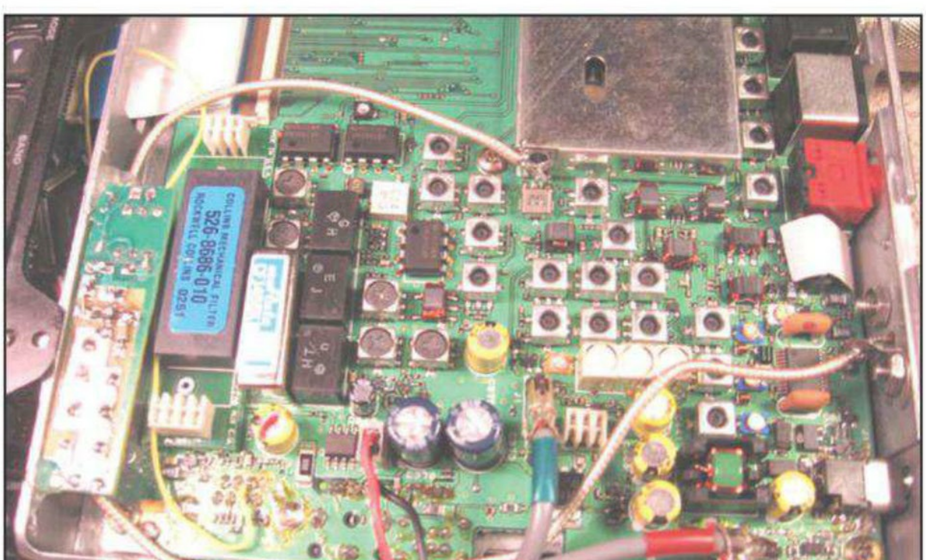


Photo 14. N1JEZ installation with CW filter in the FT-817.

ductor of the small coax will fit into the tiny hole in the PC board connecting to the filter, as shown in the photo, or can be soldered directly to the filter pin.

Note that photo 13 shows the coax connected directly to the filter, while N1JEZ had a 5-pf capacitor between the coax and filter to reduce loading on the circuit. Comparison tests showed that the direct connection makes the panadaptor more sensitive by several dB so that you can see signals that you can't hear. The FT-817 gain is reduced slightly, but weak signal sensitivity is not affected.

That should do it. Before replacing the covers, fire it up. Connect the Funcube Dongle, tune it to 68.33 MHz, and tune in a signal on the FT-817. If all is working, the signal should show up in the middle of the panadaptor display. (This assumes you already have the software working and configured.)

An FT-817 with the optional CW filter is more of a challenge. Photo 14 shows how N1JEZ squeezed one in.

Summary

The FUNCube Dongle is a good way to add a panadapter to the FT-817, a real aid to microwave operation, where finding weak signals can be a challenge. The modification is simple and does not affect normal operation when the panadapter is not needed. The PC boards are available at: <http://www.w1ghz.org/small_proj/small_proj.htm>.

There is no reason why the FUNCube Dongle and this PC board couldn't be used with other radios. So far, it has also been used by KI2L[5] with the Yaesu FT-2000. If you are successful with other radios, please let me, N1JEZ, know.

Notes

1. Website for the FUNCube Dongle: <http://www.funcubedongle.com/>
2. Website for the UK and Ireland Yahoo FUNCube Dongle group: <http://uk.groups.yahoo.com/group/funcube/?yguid=428545443>
3. Website for the pdf of the Minicircuits SBP-70+3 bandpass filter: <http://www.minicircuits.com/pdfs/SBP-70+.pdf>
4. W1GHZ website with information on the PC board for the panadapter: <http://www.w1ghz.org/small_proj/small_proj.htm>
5. Bob Bownes, KI2L, "Installing the W1GHZ/K1JEZ Panadapter Adapter in the Yaesu FT-2000," *N.E.W.S.LETTER*, May 2012. See: <http://www.newsvhf.com/news1205.pdf>

Results of the 2012 CQ WW VHF Contest

By Steve Bolia,* N8BJQ

Based on your comments and my personal observation, conditions for the 2012 CQ WW VFH Contest were less than stellar. The first few hours in the U.S. were pretty exciting on 6 meters, but things headed downhill quickly after that. Depending on where you were, there were short periods of intense openings, but many commented that it was pretty painful for much of the contest period.

First of all, many thanks to John, W1XX, for his many years of service as the CQ VHF Contest Director. Under his leadership, the contest has continued to grow. As many of you know, John has gone on to bigger and better things (politics), which does not leave much time for contest administration. Good luck, John! Fortunately (or unfortunately as my wife says), I had recently retired and had some free time. Having done the log checking for the past several years, I was able to step in as diretor just before the contest.

The 732 logs submitted was only slightly fewer than the previous high of 744 in 2011. Not bad considering the conditions. Amazingly, there were over 500 stations that made multiple QSOs (those reported in more than 10 logs) that could have submitted logs and didn't, and many may have been certificate winners. Please send in your log, big or small. It will certainly help the cross-checking accuracy, and you just may win something. If you need help, ask and I will be glad to help. Paper logs are also encouraged (addressed at the end of the story). Enough begging and on to who won.

USA

Bob, K2DRH, continued his domination in the All Band category with 136K. Second place went to Jim, W4RX, who made more Qs than Bob but could not overcome Bob's advantage in multipliers. NR5M finished third (George had the highest grid total) with Jeff, K1TEO, fourth (with the most 2-meter Qs among AB entries) and Steve, N2CEI in fifth place (with the most 6-meter Qs in this category).

W9RM operating from his future Colorado QTH was the big gun in the 6-meter-only category (see the sidebar for more on Jay's operation). Jay's 580 Qs were nearly 100 more than W5PR, who took second. W5SXD, N8OO, and K5ZG rounded out the top 5.

Stan, KA1ZE/3, turned in the second highest 2-meter score ever in the US with his 31K effort to take the top spot. AB2DE and N2RHL were second and third, respectively.

W4GRW found a good location in EM86 and picked the right six-hour period (the first six) to win the Hilltopper category. Zack, W9SZ, was second, and W3DQT finished in third, K5TED fourth, and N1PRW fifth.

Chris, W1MR, and Curt, K9AKS, again finished first and second in the QRP category, but the scores reflect the overall conditions and were way off from the 2011 scores. Axel, N8XA, moved up one spot to number three. WD5AGO was fourth, and N9TF made the box at number five.

The US Rover category was very competitive with Darryl, WW7D, edging out JK, K9JK, and Marv, W3DHJ, for the top spot. W7QQ activated 8 grids to finish fourth with N2SLN in fifth. Darryl activated 8 grids in the Pacific Northwest, while JK motored around 11 grids in the Midwest. More on Darryl's trip can be found at <http://ww7d.wordpress.com/2012/07/ 26/roving-the-2012-cq-ww-vhf-contest/> as well as in the "Scatter" comments in this article. JK also wrote a very interesting travelogue which is also in the scatter comments. Thanks to all of the rovers for their efforts. You help to make the contest more fun and provide much needed multipliers.

The US Multi-Op title goes to the gang at K9NS with a fine 227K effort. K9HMB, K9PW, K9XW, KO9A, and WB8BZK had a 75 QSO advantage on 2 meters which ended up being the difference. The crew at K5QE (N5NU, K5MQ, N5YA, W5AG, K5QE) survived multiple equipment failures, including missing some prime 2-meter EME time on Saturday, to finish second. Third place went to W3SO with only a 7K edge over K2LIM in fourth, with N8ZM in fifth.

DX

Steve, VE3ZV, utilized his 10-grid advantage to edge out Bob, VE3KZ, for the top All Band spot. Bob had a few more Qs but could not overcome the 10-multiplier advantage. Third place went to European champion OK1DX, with VE7DAY and S51D in fourth and fifth.

Mike, K7ULS, sent this photo from his operating location at 9000 feet on Powder Mountain (DN41).

*e-mail: <n8bjq@cq-amateur-radio.com>

Vlado, E7ØT, turned in the top DX score on 6 meters with his 26K effort. S59A was very competitive but could not make up the 33 Q and 17 grid difference. UR5QU was third, XE2X fourth, and UW7LL/A finished in fifth place.

There was more 2-meter activity in Europe and Asia, especially in the Ukraine and Thailand, than in the US. UXØFF turned in a fine effort from KN45 to finish first. Second place went to E21DKD, who made many more Qs but could not overcome the multiplier advantage that the European stations had. Nikolay worked 76 grids, while Pranee was only able to work 16 grids. US1IY, E22HUV, and 9A1CAL also turned in excellent scores.

In the Hilltopper category, HA2VR operated from JN87 to lead the DX category, with IZ2INN/IZ3 in second and HS8JNF in third.

TOP SCORES

WORLD

All Band

VE3ZV	18,549
VE3KZ	14,697
OK1DC	12,342
VE7DAY	7,740
S51D	5,626

6 Meters

E7ØT	26,100
S59A	19,008
UR5QU	7,370
XE2X	6,741
UW7LL/A	6,300

2 Meters

UXØFF	15,048
E21DKD	11,520
US1IY	5,382
E22HUV	4,872
9A1CAL	4,588

Hilltopper

HA2VR	1,898
IZ2JNN/IN3	814
HS8JNF	340

(continued)

HS8FLU	48
RV9CQ	12
UA3YDN	12

QRP

HA1ZH	8,601
UY5ON	6,206
UU6JF	2,000
UT5ER	1,947
XE2NBW	1,664

Rover

VE3CRU	30,988
US3ITU	30,366
VE3RKS	1,320
E29TUY	1,264
HS4RAY	896

Multi Op

UV6I	81,548
HA6W	39,672
VE7JH	24,354
9A5Y	21,094
E2E	16,558

USA

All Band

K2DRH	136,620
W4RX	120,911
NR5M	112,056
K1TEO	110,490
N2CEI	74,418

6 Meters

W9RM	97,440
W5PR	68,040
W5SXD	42,837
N8OO	41,088
K5ZG	40,150

2 Meters

KA1ZE/3	31,188
AB2DE	420
N2RHL	380
KN2GSP	170
KC5MVV	60

Hilltopper

W4GRW	10,788
W9SZ	3,476
W3DQT	1,456
K5TED	750
N1PRW	650

QRP

W1MR	12,103
K9AKS	9,750
N8XA	7,020
WD5AGO	4,230
N9TF	3,515

Rover

WW7D	30,600
K9JK	27,360
W3DHJ	25,760
W7QQ	17,108
N2SLN	7,239

Multi Op

K9NS	227,766
K5QE	205,318
W3SO	118,692
K2LIM	111,888
N8ZM	96,030

HA1ZH turned in the top QRP score with 8.7K. UY5ON provided a challenge but fell a bit short with 6.2K. UU6JF, UT5ER, and XE2NBW completed the leader box.

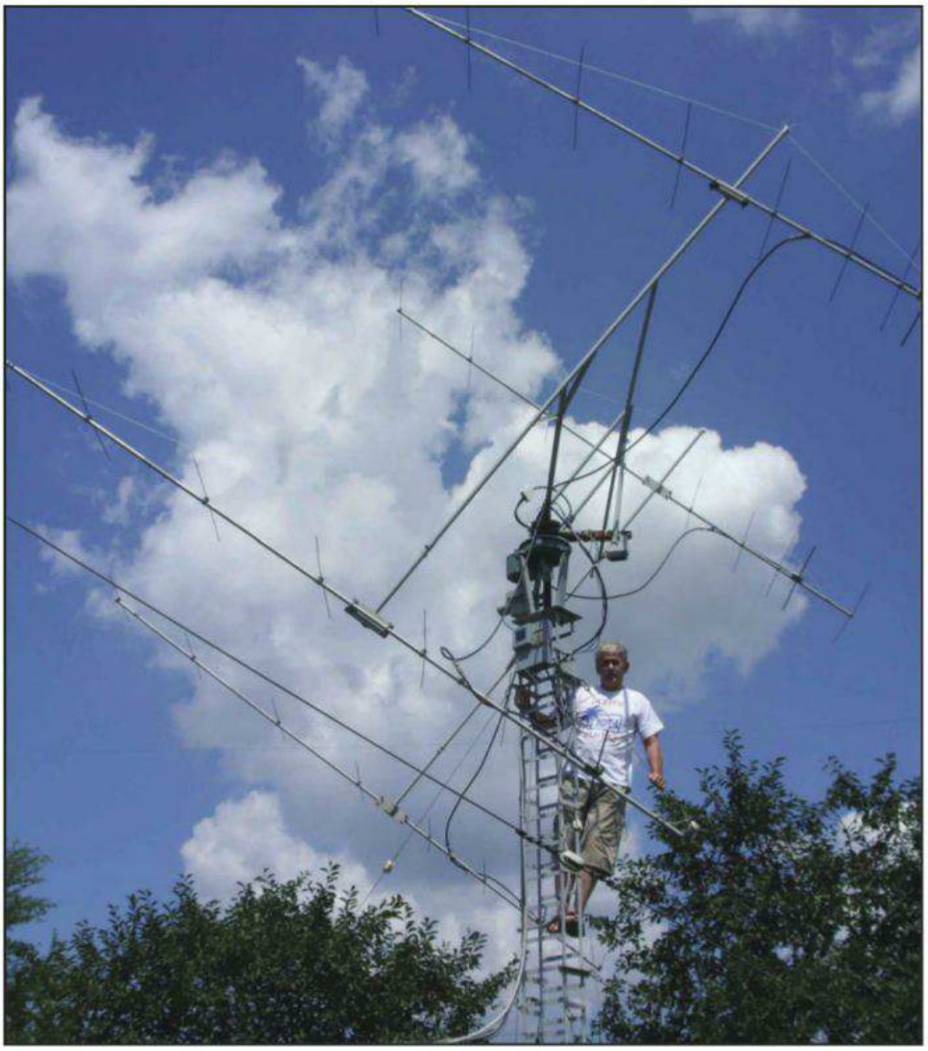
Bill, VE3CRU, and Alex, US3ITU, battled for the DX rover title with the Bill claiming the top spot by about 600 points, while Alex ended with a new European record. VE3RKS, E29TUY and HS4RAY rounded out the top five.

In the Multi-Op category, the group at UV6I turned in an excellent 81K score with their field-day-style operation. They produced a video of the operation that can be viewed at <http://rutube.ru/embed/5856523>. The team at HA6W finished second with VE7JH third, 9A5Y fourth. and E2E fifth.

Now for a bit of analysis from Curt, K9AKS, the keeper of the records.

Although some rather high scores were posted this time in several categories, regional and country all-time records were few. In the All-Band category, NR5M's 112k points broke his 5-land record from a year ago, and K7ULS's 44k points broke the 7-land record from 2010. The big news in the 6-meter Single-Band category was the 97k score posted by W9RM from his new Colorado QTH. If we ignore the blockbuster year of 2006, when ten scores exceeded 100k, Jay's score was the second highest ever world-wide, behind WD5K's 116k in 2001. Also in the 6-meter category, KF6A in Michigan broke the 8-land record with 33k points.

Unlike several countries elsewhere in the world, the 2-meter Single-Op category was largely avoided in North America. However, among the five North American entries, one score really stands out: KA1ZE/3 posted 31k points for the second highest score ever on this continent. W4GRW holds the North American record with 40k in 2003 from North Carolina, and the world high is DK5DQ's 59k points in 2006. Not many high scores were generated by QRPers all over the world who labored through the whole contest. However, in the Hilltopper category, the second highest score ever was posted by W4GRW. Bill must have picked the right



UXØFF's 9-element array helped him to the DX #1 spot on 2 meters.

CLUB COMPETITION

(Minimum of 3 entries required for listing)

UNITED STATES

Club Name	# Entries	Score
POTOMAC VALLEY RADIO CLUB	26	377,536
MT FRANK CONTESTERS	3	352,566
SOCIETY OF MIDWEST CONTESTERS	17	198,623
NORTH EAST WEAK SIGNAL GROUP	12	184,119
GRAND MESA CONTESTERS OF COLORADO	9	153,803
DFW CONTEST GROUP	6	118,829
FLORIDA CONTEST GROUP	13	115,602
PACIFIC NORTHWEST VHF SOCIETY	16	101,780
CAROLINA DX ASSOCIATION	10	58,594
SOUTH EAST CONTEST CLUB	6	53,628
YANKEE CLIPPER CONTEST CLUB	13	48,960
SOUTHERN CALIFORNIA CONTEST CLUB	4	40,001
FRANKFORD RADIO CLUB	7	39,678
ALABAMA CONTEST GROUP	4	36,633
BADGER CONTESTERS	7	31,961
MINNESOTA WIRELESS ASSN	4	26,812
CTRI CONTEST GROUP	4	19,947
ARIZONA OUTLAWS CONTEST CLUB	7	19,575
SOUTHWEST OHIO DX ASSOCIATION	4	17,897
NORTHERN CALIFORNIA CONTEST CLUB	11	16,462
CENTRAL TEXAS DX AND CONTEST CLUB	3	12,897
KANSAS CITY DX CLUB	4	11,143
BRISTOL (TN/VA) ARC	9	10,954
MT AIRY VHF RADIO CLUB	3	9,272
MAD RIVER RADIO CLUB	4	7,810
PORTAGE COUNTY AMATEUR RADIO SERVICE	3	4,886
HUDSON VALLEY CONTESTERS AND DXERS	3	2,313
WEST PARK RADIOPS	3	1,290
TENNESSEE CONTEST GROUP	4	1,279
WILLAMETTE VALLEY DX CLUB	3	554

DX

Club Name	# Entries	Score
UKRAINIAN VHF INTERNATIONAL CONTEST CLUB	21	124,325
CONTEST CLUB ONTARIO	14	76,063
UKRAINIAN CONTEST CLUB	7	29,641
CROATIAN CONTEST CLUB	4	22,465
BLACK SEA CONTEST CLUB	4	14,289
GRUPO DXXE	3	12,017
RHEIN RUHR DX ASSOCIATION	3	7,252
MSU ARC - THAILAND	3	6,040
CDR GROUP	5	1,743
MARITIME CONTEST CLUB	3	1,270
LATVIAN CONTEST CLUB	4	1,260

six-hour window; he posted a 10K score, second only to KFØQ's 18k score in 2006. Dedicated Hilltopper W9SZ broke the 9-land record with his 3476 score.

In the Multi-Op category, K2LIM's 111k score broke its own 2-land record from 2010 by about 8k, and K9NS's 227k was over 100k higher than the previous 9-land record posted by N2BJ in 2006. VE7JH's 24k is the second highest Canadian score ever, behind VE7DXG's 31k in 2000. Rovers were out all over the world, and for the second year in a row US3ITU broke the European record, this time with a 30k score. WW7D's 30,600 broke the 7-land record by just over 1000 points.

The operators at HS4AK.

Soon after the official 2012 contest results are released in this issue of *CQ VHF*, updated lists of all-time high scores by continent and region will be posted on the CQ VHF Contest website (www.cqww-vhf.com).

Other Stuff

There were 368 grids activated during the contest by the 732 entrants. Many of these multipliers were provided only by the rovers and portable operators who devoted lots of time, and gasoline, to provide a new multiplier. Remember to thank them th e next time you work them.

Producing these contest results certainly is not a one-man venture. Many thanks to K9JK (certificates) and K9AKS (records) for their valuable advice, assistance, and a much-needed sanity check at times. Also Yuri, UT1IC, and Champ, E21EIC, went above and beyond to help with gathering all of the logs from their respective countries and getting them safely into the robot. Many thanks also to W3KM for his software support. In the past few years, log checking has gone from a long and painful process that was very labor intensive to one that is a lot simpler, more accurate, and much faster. Without Dave's modifications, bug fixes, and upgrades this would not be possible.

Please send in a log for the 2013 contest. No matter what size it is, it will help improve log-checking accuracy for all, and you might win something. The more logs we have on hand, the more accurate the results will be. Even if only half of the 500 or so who did not send in a log had done so, we would have had a much larger cross-check database for the 2012 contest.

Cabrillo is the preferred format that almost all logging software will export. If your logger does not export to Cabrillo (and most do), it probably does export an ADIF file. You can send that directly to me via e-mail and I can convert it to the required format, or there are several free converter programs that will do this for you. For those who create a paper log, if you have internet access you can type in your log at <http://www.b4h.net/cabforms/cqwwvhf_cab.php>. It is quick and simple to use and will submit your log to the robot for you. If all else fails, please send a copy of your paper log to Paper Logs, CQ VHF Contest, PO Box 481, New Carlisle, OH 45344.

Due to the change in *CQ*'s contest editorial schedule to accommodate the changes in contest-score reporting, you are reading the 2012 CQ WW VHF Contest results in *CQ VHF* this year. All of the other *CQ* magazine contest reports (CQ WW DX, CQ WPX, RTTY WPX, RTTY) have been moved forward by several months to get the results to you much earlier than before. The plan so far is for the 2013 VHF contest results to be back in *CQ* magazine in the January 2014 issue. For the 2012 CQ VHF Contest results, also check the *CQ VHF* magazine website (again, <www.cqww-vhf.com>) for updated records and perhaps some other goodies. The full results will be posted there as well when the Winter 2013 issue of *CQ VHF* is in print. Also look at the *CQ* magazine website (www.cq-amateur-radio.com) for the full results.

The 2013 CQ VHF contest will be run on the third full weekend in July (20 & 21). The rules will be in the Spring 2013 issue of *CQ VHF* as well as in the June 2013 issue of *CQ*.

We are always open for good suggestions to improve the contest. If you have something, please drop me an e-mail at the address shown on the first page of this article. The goal is to keep the contest simple and also fun for all.

See you in the contest!

73, Steve, N8BJQ

Scatter

Nagoya Kougakuin College 60th anniversary special station... **8J2NKC**. Packed an FT857 and 2M Moxon on trip. Tried a couple spots in Maine and Vermont, but hard hearing distant stations without a Yagi ... **AB2YI/R**. Propagation on 7/22 was absolutely terrible to southern Tennessee. Had to work for the few QSOs made. However, it was still lots of fun, swinging my Yagi trying to sweep up anything ... **AC4G**. Challenging conditions but a few good openings on 6 meters. Was able to hold and make a run on a frequency on both 6 and 2 at points in the contest for the first time. Very few western stations heard from EN81 during contest ... **AC8HU**. Running my R7 vertical with 2:1 SWR and 80W on 6M produced a lot with the few openings; my second VHF from USA, first from DN22 ... **AD6D**. Some interesting 6M openings, although at times it seemed like the band was open, but very few people were home. In general, it seemed like local activity was lower than normal. Very little activity on 2M ... **AF6RR**. Thanks for QSOs! Hope see you in next contest with better conditions ... **CO8DM**. Lousy conditions, difficult and challenging, but oh, so enjoyable! My favourite contest each year ... **EI9FBB**. I made only one QSO on 6M, but I am happy, mny tnx ... **HR2/NP3J**. First rover attempt with my son, Kevin, KB1EAN: 8 grids in a total trip of 885 miles (532 roving during contest hours), 40 contacts, 192 points. Roving in the upper reaches of Maine is like maintaining a bonsai tree – small results but still rewarding! ... **K1HC/R**. Fun! ... **K3MD**. Could have used better conditions but lots of fun anyway ... **K4CGY**. Murphy came to live with us this time. We blew up every station we had at least once. However, Bill, N5YA, was able to patch it all together again so that every station was working at the end of the contest. We lost a lot of time on 2M EME on Saturday due to a faulty cable. It looked good, but was intermittent. That cost us a lot of contacts on Saturday. It was absolutely great to have the CQ contest and the DUBUS 2M digital EME contest on the same weekend. There were hordes of EU stations looking for contacts with the US on 2M. Great fun ... **K5QE**. Very disappointing. I was sure hoping for better conditions ... **K6CSL**. My Sunday operating time was limited as I chose to take in the Oak A's/Yankees game. The A's had won the previous 3 games of a 4 game set and I wanted to see the sweep. They did, the first time ever in Oakland. An historic baseball afternoon ... **K6OAK**. Worst contest ever. My FTDX5000MP on 6 meters quit communicating with the N1MM on the computer 9 hours into the contest. So I hand logged until I remembered to bring up Writelog and continue the contest. Next morning when I turned on both computers, the second one would turn itself off. After the contest, replaced power supply in it. After contest, found that I probably got RF into the keyboard/mouse and that stopped communication between transceiver and N1MM. Works ok now. Poor Es the first day, but picked up second day, but I was up to my knees in "what is going on here?" so my heart was not in it anymore. Passive

QSO LEADERS BY BAND
WORLD

Single Op 50 MHz		MULTI OP 50 MHz	
E7ØT	225	9A5Y	199
S59A	192	VE7JH	191
VE7DAY	152	VA7FC	159
VE3KZ	127	UV6I	151
VE3CRU/R	110	HA6W	108

Single Op 144 MHz		MULTI OP 144 MHz	
E22HUV	406	HS1EFA	736
E21DKD	360	E22JPA	318
E22JME	266	UV6I	276
HS3AB	264	E2E	211
US3ITU/R	233	HS4YFR	194

USA

Single Op 50 MHz		MULTI OP 50 MHz	
W9RM	580	K5QE	560
W5PR	486	K9NS	549
N2CEI	402	W3SO	332
NR5M	396	K2LIM	322
K2DRH	378	N8ZM	304

Single Op 144 MHz		MULTI OP 144 MHz	
KA1ZE/3	226	K2LIM	217
K1TEO	200	W3SO	212
W4RX	190	K9NS	204
K2DRH	156	N8ZM	139
W2KV	87	K5QE	129

GRID MULTIPLIER LEADERS BY BAND
WORLD

Single Op 50 MHz		MULTI OP 50 MHz	
E7ØT	116	9A5Y	106
S59A	9	UV	73
VE3CRU/R	72	HA6W	67
UR5QU	66	UT7E	54
XE2X	63	VE7JH	48

Single Op 144 MHz		MULTI OP 144 MHz	
UXØFF	76	HA6W	47
VE3CRU/R	50	RN3F	46
US3ITU/R	49	UV6I	43
VE3ZV	39	HG6Z	41
9A1CAL	37	YT2F	22

USA

Single Op 50 MHz		MULTI-OP 50 MHz	
W9RM	168	K9NS	177
K2DRH	144	K5QE	155
NR5M	142	N8ZM	112
W5PR	140	W4WA	106
N2CEI	140	W3SO	97

Single Op 144 MHz		MULTI-OP 144 MHz	
KA1ZE/3	69	K5QE	96
NR5M	61	K9NS	61
K2DRH	54	W3SO	60
K1TEO	54	K2LIM	57
W4RX	51	N8ZM	53

assistance only ... **K6WAB**. Enjoyed a weekend of blue skies and sunshine by roving eastern Washington DN08-07-06-05. Last year I tried five grids east-west. Too much driving. This year I tried four grids north-south (the short direction across the grids). Still too much driving. Next time I'll loop around one grid intersection. These mountainous grids are a tough drive since most of the best locations are gated off at the end of long dirt roads. On Saturday, I had to compromise in DN08 since the desired peak was gated shut. Then I spent hours searching DN07 on dirt roads without finding any decent spot. I got behind schedule and had to skip DN06. On Sunday, in DN05 it turned out another desired peak is now signposted "no public access." Time for another drive. I found a very good spot on a rise among wide-open crop fields. No obstructions taller than a stalk of wheat! An hour opening to California let me enjoy being the DN05 focus of a 6M pileup, always great fun. Thanks to all the Pacific NW 2-meter stations who tirelessly found my distant signal. This is "weak signal" at its finest ... **K7BWH**. Things started out slowly on Saturday but really came to life on Sunday with a very intense 6-meter opening covering the western half of North America. My only request is that the length of this contest be extended to match that of the ARRL June VHF contest. It's too short ... **K7EK**. Wow. Slow going from Idaho but fun ... **K7JAN**. I added Missouri to last year's Illiniowa rove making this an Illimissouriowa rove. In addition to EM49, EM59, EN30, EN31, EN40, EN41 and EN50 visited in 2011, I added EM58 and EM48 on Saturday, stopping for the night near the EM38/39/48/49 grid corner. EM38 and EM39 were added on Sunday. As I noted in 2011, the two days were very different in conditions, like two different contests, though the days were reversed in 2012. This year, Saturday was the "6 meter" contest, with 65 Qs on 6 (from 37 unique grid squares) and a respectable 15 Qs on 2, while Sunday was the "VHF" contest yielding 35 Qs on 6 (from six unique grid squares, only three of which were "new" from Saturday) and 50 Qs on 2. Approximately the same number of QSOs both days and the "scored" multipliers were about the same as well but definitely more QSO points on Sunday while Saturday yielded more unique multipliers. I started Saturday at the bottom edge of EN50, just off i-55 near Elkhart, IL. Saturday's propagation was largely to Colorado and New Mexico with a few QSOs to El grids in Florida and EMx0 grids (just above the Gulf of Mexico coast). To the east and northeast, I only found two stations, from FN42 and FN43. A jog to the west and little south brought me into EM59 – no more Florida but still strong into Colorado and New Mexico and more western EMx0 grids plus one contact out to DM07 California and one to DL95 Mexico. I managed a few more contacts from EM59 while driving south along I-55, including Texas (EL29 and EM31) and Oklahoma (EM06), until I entered EM58 at about 2115. Six meters seemed to be fading by then but Colorado stations were still booming in so a quick pull-in to a convenient interstate rest area was made to work a few of them (and make a necessary stop). Continued driving in EM58 to a high spot I had identified but that yielded only one additional QSO (again from Colorado). Continuing the drive, I turned west on I-270 into EM48, skirting the north side of the St. Louis metro area. While I did make a stop for food and fuel, that stretch of driving yielded only one additional QSO, though it was with a station in Utah. Wanting to be out shortly after sunrise the following morning, I did a little bit of local reconnoitering to pre-identify where the grids changed around the corner but basically called it a wrap for the evening. Early Sunday morning yielded some slightly enhanced tropo on 2 meters, as I hopped among EM38, EM39, EM48, and EM49 near that grid corner, with QSOs across the state of Missouri and into Kansas as well as into Illinois. I also caught a very brief opening on 6 meters Sunday, morning, to stations in NC and SC, but that was the only 6 meter enhanced propagation I encountered on Sunday. Later Sunday was pretty quiet, as I worked my way north in Missouri, staying in EM49 and EM39, then EN30 and finally into Iowa (still in EN30) but finally to EN40. I had to hustle to get to EN31 and made it with only 40 minutes remaining in the contest and then I hustled some more to get to EN41 with less than 20 minutes remaining. Fortunately, K2DRH, K9AKS, and the multi-ops at K9NS were "chasing" me as I finished up the grids, as Sunday would have been very dismal otherwise (apparently they weren't finding any better QSO opportunities either). Unique grid counts were 40 on 6 meters and 14 on 2 meters, among 18 states on 6 and 5 states on 2. I recorded 72 different call signs in my log including two other rovers. Thanks to *CQ* magazine for its continued sponsorship of this contest. Special thanks to outgoing CQ WW VHF Contest Director W1XX for his efforts over the past several years. Welcome to new CQ WW VHF Contest Director N8BJQ and thanks for his efforts going forward. Final thanks to all who were on and especially to those I was able to work from the Coroverolla ... **K9JK/R**. Band conditions were tough. Could barely hear anyone ... **K9SAT**. I operated "Hilltopper" from Megunticook, located in Camden, Maine (FN54), using battery power, a buddipole antenna for 6 meters, and a 3-element handheld Yagi for 2 meters ... **KB1HNZ**. 13 watts in to a 80/40m fan dipole, ..but at least I got on! ... **KG9Z**. Conditions were very unusual and sporadic. One minute signals were S9, the next minute they were gone like someone flipped a switch. There were a few good openings to Southern CA, AZ, and NM that made things fun. Good contest ... **KI7JA**. My first CQ WW VHF Contest. Using an inverted vee dipole cut for 6M up about 20 feet, I needed a big opening, which didn't happen down here in south Florida. Nevertheless, it was fun. BTW, adding CW to the mix wouldn't have changed the face of my world, as I could only hear local FL stations calling CQ contest. Hopefully better cndx and a better antenna setup next year ... **KK4CIS**. Glad I had one opening to JA, as I never heard any stations stateside ... **KL7KY**. Listen, listen, contact, listen, listen, contact, listen listen, contact, contact, and that was the way it went ... **KN4Y**. My first serious attempt at a VHF contest. Lots of fun, even with limited operating time and modest antennas - par Moxon and a 4-element 2M Yagi at 20ft. Looking forward to more VHF operating ... **KS1G**. Saturday was pretty devoid of Es, had two one-contact openings all day. Sunday morning was another story, with a nice long opening into CA. One of the high points was working W7/HG1DUL who was atop Mt Adams at 12,000 ft, and over 100 miles away. And me with only a vertical and 35 watts on 2M! ... **KX7L**. I participated in this contest for the first time. It seems my 5m LW antenna did not catch many signals. 73 Kazu ... **MØCFW**. Too bad the Friday night conditions didn't return! ... **N1HOQ**. Brief 6M openings on Saturday and Sunday. Conditions not great but still a fun event. My favorite contest of the year. Two-meter activity in Alabama was the worst that I've heard in years, no one on the band. Maybe next year with the new FM rules. Fingers crossed ... **N1LF**. All contacts made with indoor antennas ... **N2MH**. This year Es has been on vacation. Only a quick burst worth two DX contacts. I have never experienced such poor conditions on 6 meters. I thought my antenna had a broken element again, but the Es on the spotter was centered in the Midwest. Lowest score in years ... **N2SLO**. Great contest, worked hard for my score ... **N3JNX**. Great contest, except for storms on Saturday afternoon ... **N4DXY**. Condx fairly good for a few days leading up to the weekend, but not much once the contest started ... **N4PN**. Living in an apartment so I worked from my truck ... **N4YHC**. Good runs Saturday. Stinko propagation Sunday ... **N5EPA**. On Saturday, to escape very hot weather, my XYL and I did a 200 mile rove in DM04 with a brief visit to CM94. There were very few stations heard on Saturday and I made only one 6M Es contact that day. Along the Ventura and Santa Barbara Co. coastline, tropo conditions down to DM03/13/12 were great but activity was just about nil when I was on! We did have a nice drive and dinner though. On Sunday morning, 6M was open to the PNW as I did errands near my home QTH in DM04ne, so I made a half dozen QSOs with friends in the Seattle/Vancouver area. Rig: FT100, 50w and 1/4-wave whip antennas for each band ... **N6ZE/R**. Typical sporadic-E season with some decent openings. All had fun and looking forward to next year ... **N8ZM**. This was definitely QRP in more ways than one! I took down all the V/UHF beams earlier in May to put up rotatable dipoles (multiband) to focus on 30m and

OPS & GRIDS ACTIVATED

MULTI-OPS

8J2NKC: JH2EUO, JK2VOC, JN2KRG, JN2OFP, JO2ASQ, JR2WLQ, JG4IQC. **9A5Y**: 9A3NM, 9A5TO, 9A7DX. **E21GJB**: E21GJB, HS2LDV, HS1VWP, HS7HVJ, E22TTS, E22TTR, HS5GYI, E22SPN. **E22JME**: E22JME, HS9JGQ, HS6XLO, E22OOJ, E27GRD, E22VUG. **E22JPA**: E22JPA, HS8MOJ, HS8KRR, HS8MCG, HS8JDX, HS8WWV, HS8LHG, HS8MAC, E29KMB, E22CZH. **E22SBP** + HS3TIV. **E2E**: HS1CHB, JA1WTI, E20MIO, E22SVI, E29MFJ. **HA6W**: HA6ZFA, HA5OKU, HAØLZ, HAØLO, HAØLC, HAØMK, HA6WP. **HG6Z**: HA6IGM, HA6QD, HA6VV, HA6VW, HA6ZS, HA6ZV. **HSØAC**: HS2JFW, E29BUQ, E21EIC. **HS1AR**: HSØNNU, HS6MYW, HS6NDK, HS6FUJ, E20NTS, OTHERS. **HS1EFA**: E23BVH, HS4YRM, HS4YRL, HS4YRJ, HS6ZEW, E27HXF, E22FMI, E22LEL, E23PIO, E29DFJ. **HS3AB**: HS3TPH, HS3TXF, HS3NRW, HS3RTW, HS3RHS, HS3WOI, HS3WOJ. **HS3XAC**: HS3XAC, HS3TQA, HS3WQW, HS8HXQ, HS4TNR, HS3TMV, HS4OYS, HS3UPK. **HS4AK**: HS4LKW, E20YLM, HS4NOR, HS4HDH, HS4LFU, HS4NDO, E20FVS, HS4FAJ. **HS4RTC**: E27BYU, E29AOR, HS4RTC, HS3XFK, HS6ZKQ, E29FAK, HS4SCI, E22USR. **HS4UYG**: HS4UYG, HS4SSZ, E22YZS, HS3VNE, HS4UTQ, HS3XRB, HS4VCJ, HS4YEU, HS4WOC, HS4YGG. **HS4YFR**: HS4YFR, HS4OZG, HS4YGC, HS3SMS, HS4YIX, HS4OXW. **HS5AC**: HS0OAG, HS1NIV, E20QVD, E22ZMG, E22KXE, E22ZHS, E22ZHJ, HS5IGY. **HS5FAI**: HS5FAI, HS5TUI, HS5QBE, HS5WYM, E28LX, E22XDO, E22XDP, E22YUP, E22YUQ. **HS9HND**: HS9HND, HS9HZD, HS9YDO, HS9WOE, HS9ZAH, E29UMD, E23ARH, E23ARJ, E23ARI. **K2JB** + W4PH. **K2LIM** : KA2LIM, W9KXI, KB2YCC, NX2W. **K2OAK** : WV2ZOW, WO2U. **K5KDX** + K5KDL. **K5QE:** N5NU, K5MQ, N5YA, W5AG, K5QE. **K7IP**: K7IP, KG7HQ, K7OFT. **K9NS:** K9HMB, K9PW, K9XW, KO9A, WB8BZK. **KBØHH**: KD5EKX, KA0KCI, KB0HH. **KB1NTA**: KB1JDX, KB1LYF. **N4DXY** : N4JDB , K4DJL, N4ION. **N8ZM**: K8TQK, KB8ZR, KD8FO, N8ZM, WB8ART, WB8TDG, W8ULC. **RF9C**: RA9CMO, RZ9CJ. **RK3DXB**: ER1DL, RV3DHC. **RK6AXN**: UA6BI, UA6AER. **RN3F**: RK3AW, RK3FT, RW3AC. **SX1K**: SV1JGX, SV1MQJ. **UT4IXZ**: US9IDE, US5IRD. **UT4UWR**: UT4UJQ. **UT7E**: UR5EFJ, UR3EZ, UV5EOZ. **UV6I**: UT7IY, UR7IMM, UT1IC. **VA7FC**: VE7GFC. **VE2NGH**: VE2OFH, VA2SH. **VE3SMA**: VE3NPB, VE3SMA. **VE7JH**: VE7JP. **W1QK**: NG1R, W1QH, W1QK. **W3SO:** W3BTX, W3TEF, W3TM, WA3TTS, W3BC, W3YOZ, K4VV. **W4NH**: W4ZST, W4KXY, NN4W, N4NIA, KI4US, K4TJD, W5TDY, WE8W, WG8S, WW8RR, W0ONR. **W4WA** + K4IDX. **WN2E**: K5YG, KF5CXG, K5EYK, W6CSA. **YT2F:** YU1FG, YU1VG, YU1GV. **ZV2K**: PY2SHF, PU2VGS.

Rover Ops & Grids Activated

ABØYM: DM78, DM77, DM87, DM88, DM89, DN71, DN81, DN80. **AB2YI**: FN54, FN43, FN33. **E29TUY** + E27EZG: OK03, OK04. **HS4OQI**: OK06, OK16, OK05, OK15. **HS4RAY**: OK16, OK15, OK05, OK06. **KØBBC**: DN85, DN86, DN95, EN05, EN15. **K0CS**: DM79, DM89, DN80. **K1HC** + KB1EAN: FN53, FN54, FN64, FN65, FN66, FN56, FN55. **K7BWH**: DN08, DN05. **K8MR**: EN90, FN00, FN01. **K9JK**: EN50, EM59, EM58, EM48, EM38, EM39, EM49, EN30, EN40, EN31, EN41. **KA3KSP**: EN90. **N2SLN**: FN23, FN22. **N6GP**: DM13, DM03, DM04, DM14. **N6ORB**: CM88, CM87, CM97. **N6ZE**: DM04, CM94. **N9TZL**: EM79, EN70. **NV6C** + KJ6NO, W6ELI: DM04, DM03, DM13, DM14, DM23, DM24. **R8CAA**: MO05, MO06. **RAØLQ/MM**: JN74, JN73, JN72, JN82, JN81, JN80, JN90. **US3ITU**: KN98, KN97, KN87, KN88, KN86, KN76, KN77, KN89, KN99. **US6IF**: KN50, KN88, KN87, KN86. **VE3CRU**: EN93, EN94, FN04, FN14, FN13, FN03. **VE3RKS**: EN93, EN92, FN02, FN03. **WØBL**: DM79, DM78. **W3DHJ**: DM88, DM87, DM77, DM78. **W7JDB**: DM27, DM28. **W7QQ**: DM78, DM79, DM89, DM88, DM87, DM77, DM75, DM65. **WA4JA**: EM75, EM76, EM66, EM65. **WB2SIH**: FN33, FM33, FN32. **WW7D**: CN76, CN77, CN87, CN88, CN98, CN86, CN96, CN97.

My Experience in the 2012 CQ VHF Contest

By Jay Morehouse, W9RM

I operated field-day-style from my future Colorado QTH just inside the boundary of DM58. I wanted to use the summer contests to test the new location and also shake down my expedition push-up mast system. While the antenna (a single 5-el) and power output (500W from a converted MLA2500) were modest, the QTH seemed very promising.

Two-meter activity is sparse on the west slope of the Rockies, so I decided to enter the Single-Band 6-meter category. I did make a number of 2-meter QSOs (DM58 is very rare there), but they weren't enough to overcome the advantage of numbers "back east" in the two-band category. An entry there will have to wait for permanent towers.

Saturday started strong, well ahead of my June score. Single-hop openings into the Midwest and the Pacific NW kept me busy well into the evening, but only a few double-hop QSOs were made. Sunday morning saw a repeat to the NW for about two hours, but then the band packed up and only scatter QSOs were made the rest of the contest. If the band had stayed, I'm sure 1000+ QSOs would have been in reach. Still, it was a fun experience even with only fair 6-meter conditions and I'll be back in 2013 with a better station!

The W9RM operating position.

The view from DM58.

40m. So down came the 13B2 and the 3-element 6 meter beam along with the 19-element 432 antenna to make way for a D3W and D4 rotatable dipoles. I did, however, put up a stack set of 2 meter M^2 ho loops at about 48 feet, above the dipoles so I could continue to play on VHF. For 6 meters I used the D3W along with my trusty MFJ-949e tuner! The D3W is actually pretty close to resonate on 6 meters, but not close enough for the internal tuner on the PROIII to tune it in. I was on for most of Saturday and part of Sunday. Saturday was the best day of the two for propagation. I was hoping that the Saturday early morning 2 meter ehancement would have continued into the contest, but unfortunately, it did not. Six was good off and on most of the afternoon and early evening Saturday, with little activity on 2 meters. I pulled the plug early Satuday night around 0330 so I would be able to get up just after sunrise in hopes of 2 and 6 openings. That ended up being an uneventful adventure (even with 6 meters not opening much, I thought there would have been local activity on 2 meters). I spent a couple of hours calling CQ, back and forth on 2 and 6 without any replies. Pulled the plug around noon local time on Sunday, but did come back for the last hour, only to hear two local stations calling CQ I had already worked. Absolutely no activity the last hour. Although conditions were far less than steller, I was still able to make contacts with all stations I heard. Had fun all things considered. 73, Gene ... **N9TF**. My first VHF contest since I was KF6GYM in 2001. In KH6 I never operated during VHF contests as there was no progagation to the mainland that I observed ... **NH7RO**. Poor propagation to my area. One DX in 6M FY1FL and one DX in 2M NP2X. Hope for better propagation next time. Wish contest was the weekend before. Good luck to all ... **NP3CW**. Only Es propagation on 6M during some short periods. 73, Kees ... **PA5WT**. Rover station maritime mobile, from north to south at Adriatic sea; IC-7000, simple vertical ant; 2M band only. **RAØLQ/MM**. Pretty bad conditions, just two little openings to south-eastern part of EU. A good one was to be part of the very first QSO ever made between FL11 and FL10 on 6 meters when worked Doug/CO8DM abt 57 kms away. Will see you all next year! ... **T48K**. Nice weekend, was able to share family with NAQP RTTY and CQ WW VHF contest, on 6M only. Had some opening until Sunday noon but still had fun. Thanks for those QSOs ... **TG9AJR**. Great contest. Prop played games with me, but I persevered and am happy with the score. Many thanks to *CQ* as sponsor and to all who participated. See you next year. 73 ... **VE3CRU/R**. Very poor conditions, lots of local interference, lightning on Sunday ... **VE3MSC**. Operation from Lake Joseph, district of Muskoka, ON ... **VE3SMA**. CQ WW VHF Contest is unknown in VK. I have sent some information to local VK6 reflector as well as VK contest club reflector. I think more work will need to be done to get more VK's to participate in this contest. Weather was not cooperating for the field-day-style operation as we were in a winter season ... **VK6DXI**. Pressed for time. Operated with an FT-817 and omni angle loop. Antenna mounted inside a second-story room in a stucco house! ... **WØDJM**. Pretty good condx on Saturday but it was a slugfest on Sunday trying to find new stations to work during late July Es season doldrums. How about allowing QSOs points for voice QSOs and for CW/digital QSOs? It would keep us awake when the 6M band is dead. 73 ... **WØETT**. I have a vanity callsign. I was questioned by an "8" in grid EM31 if I was legitimate! I could have asked him the very same question! It was a fun contest but the condx weren't all that good. 73 to all ... **W1EBB**. Worked the contest until late Sunday morning, just as 6 meters started to perk up a bit. The noise level on 2 meters was nil on Saturday night. K2LIM, N1IBM, KA1ZE/3, and W4RX were all loud. Heard N8ZM in EN80 briefly but couldn't find him on the band again. Forced myself to use the old straight key this contest; 30% of my QSOs were on CW, and thoroughly enjoyed each one. Thanks to all for sticking with me ... **W2AJM**. Wish the band opened while I was on.. TS50 and vertical from my car ... **W2CCC**. Saturday early into contest was great with openings into Midwest. Sunday morning ground wave was pretty good ... **W4VHF**. Bad WX at the beginning of the contest prevented working many stations on the West Coast ... **W4WA**. The contest was a blast! Great to have 6M open for the duration of my operating. There was some 2M tropo before the contest but it disappeared as soon as the contest started, wouldn't you know it ... **W9SZ**. Fun contest, had limited time to operate ... **WA2FGK**. Not a great contest compared to previous years but some sporadic-E activity was observed on Sunday on 6 meters ... **WB2AMU**. Conditions were dismal at best. Brief openings to Cuba, VP, XE, and the west US. Last 10 minutes of the contest there was an opening to New England ... **WB4SQ**. Poor condx on both days made this a real struggle ... **WD5COV**. Like last year, I roved around the Pacific Northwest landscape, splitting transportation between a small airplane and a car. Saturday began pretty badly, as low clouds delayed my arrival until 1.5 hours after the contest start. And weather restricted me to two grids out of the plane. I activated three more grids out of my car on Saturday afternoon and evening and then three additional grids on Sunday. Despite the Saturday difficulties, I was quite pleased with the results. Saturday problems more than made up for on Sunday by being at 3,200 feet with an excellent southern exposure just as 6 meters opened up to so. CA. I ended up quadrupling my score from 2011. Oh ... and I had a blast! More story with some pictures can be found here: <http://ww7d.wordpress.com/2012/07/26/roving-the-2012-cq-ww-vhf-contest/> ... **WW7D/R**. Very poor conditions. All Saturday band was closed and Sunday a couple hours were with any stations on the 6m band. This was my worst CQ WW VHF Contest, high noise and QSB all time. I hope the next time better conditions for transmit on magical band, best 73's to all ... **XE3N**. Pleased to run, for the first time, a couple of hours in this contest. Setup the IC-7000, 100w and a 5-el Yagi in a crowded urban area. 73 Szigy ... **YO2IS**. Thanks to all my QSO partners and best wishes to all! ... **YO5DAS**.

Number/letter groups after call letters denote the following: Class (A = all band, 6 = 6 meters, 2 = 2 meters, Q = QRP, H = hilltopper, R = rover, M = multi-operator), Final Score, Number of QSOs, Number of grid locators, State/Province (USA/Canada only), Grid Locator or Number of grids activated (rover only). Rover scores for USA are listed separately. Certificate winners are listed in boldface.

2012 VHF RESULTS

NORTH AMERICA

UNITED STATES

K1TEO	**A**	**110,490**	**562**	**145**	**CT**	**FN31**
AF1T	**A**	**31,509**	**279**	**81**	**NH**	**FN43**
W3EP	A	18,720	246	72	CT	FN31
K1TR	A	14,520	160	66	NH	FN42
W1AN	A	13,500	186	54	CT	FN41
WZ1V	A	13,440	181	56	CT	FN31
W2DAN	**A**	**8,471**	**162**	**43**	**RI**	**FN41**
N1JEZ	**A**	**7,000**	**97**	**56**	**VT**	**FN44**
W1RZF	**A**	**6,975**	**115**	**45**	**MA**	**FN42**
NE1B	A	6,683	131	41	NH	FN42
W1XX	A	5,625	100	45	RI	FN41
N1JD	**A**	**5,115**	**122**	**31**	**ME**	**FN44**
W1ZC	A	4,641	83	39	NH	FN42
K1VUT	A	4,402	114	31	MA	FN41
AD1DX	A	4,392	103	36	MA	FN41
N1HOQ	A	3,104	70	32	MA	FN41
W1OUN	A	2,632	70	28	MA	FN42
NZ1I	A	2,470	68	26	CT	FN41
W1DYJ	A	2,090	70	22	MA	FN42
N1ZN	A	2,079	58	27	CT	FN31
N1TQ	A	1,782	58	22	MA	FN42
KB1ORX	A	1,560	43	24	CT	FN41
KC1MA	A	1,444	54	19	MA	FN51
AA1AR	A	1,050	41	25	MA	FN32
K1BV	A	832	64	13	CT	FN31
W2RG	A	616	33	14	MA	FN41
W1GHZ	A	576	24	18	VT	FN34
N1JHJ	A	520	26	13	NH	FN44
KA1CQR	A	363	22	11	CT	FN31
K1LMY	A	171	14	9	MA	FN32
NF1O	A	160	20	8	NH	FN42
KA1C	A	40	6	4	ME	FN54
N1EDU	A	12	3	2	ME	FN53
W1RM	**6**	**2,430**	**90**	**27**	**CT**	**FN31**
N1IW	**6**	**1,992**	**83**	**24**	**NH**	**FN42**
W1FV	**6**	**1,428**	**68**	**21**	**MA**	**FN42**
N1BCL	**6**	**840**	**35**	**24**	**VT**	**FN34**
K1MVM	6	784	49	16	CT	FN31
K3IU	**6**	**459**	**27**	**17**	**RI**	**FN41**
N1DG	6	403	31	13	MA	FN42
K5ZD	6	77	11	7	MA	FN42
AB1OD	6	50	10	5	CT	FN31
KA1R	6	30	6	5	MA	FN42
W2CCC/1	6	9	3	3	VT	FN34
(Op: K2CS)						
N1PRW	**H**	**650**	**40**	**13**	**MA**	**FN42**
KB1HNZ	**H**	**325**	**18**	**13**	**ME**	**FN54**
W1KMH	**H**	**9**	**3**	**3**	**VT**	**FN33**
W1MR	**Q**	**12,103**	**198**	**49**	**NH**	**FN43**
W1QK	**M**	**18,760**	**275**	**56**	**CT**	**FN31**
K2OAK	**M**	**13,380**	**186**	**60**	**MA**	**FN32**
KB1NTA	M	363	23	11	CT	FN41
KO2OK	**A**	**9,154**	**186**	**46**	**NJ**	**FN20**
N1IBM	A	7,260	120	44	NJ	FM29
W2KV	A	5,487	90	31	NJ	FN20
N2MH	A	4,123	100	31	NJ	FN20
K2QO	**A**	**3,700**	**70**	**37**	**NY**	**FN03**
W2JJ	A	3,200	100	32	NJ	FN21
(Op: WA2VUN)						
W2EV	A	2,916	63	36	NY	FN03
W2AJM	A	2,900	76	29	NY	FN21
KC2QZF	A	2,666	64	31	NY	FN03
WA2BAH	A	2,201	57	31	NY	FN32
W2BVH	A	2,072	54	28	NJ	FN20
N2SLO	A	1,974	54	21	NY	FN30
W2OSR	A	1,365	45	21	NY	FN30
N2CSP	A	1,300	43	26	NJ	FN20
KA2CYN	A	1,122	47	17	NY	FN31
N2DCH	A	720	23	18	NY	FN22
W2REA	A	666	24	18	NY	FN02
W2JCN	A	592	31	16	NY	FN21
KA2MCU	A	351	19	13	NY	FN32
K2OEQ	A	280	17	14	NY	FN24
W2CVW	A	252	27	9	NJ	FN20
W2SA	A	198	22	9	NJ	FN20
WA3AFS	A	135	15	9	NY	FN32
K2ZD	**6**	**6,084**	**117**	**52**	**NY**	**FN21**
N2JJ	6	1,586	61	26	NY	FN33
N2BEG	6	1,008	42	24	NY	FN12
WB2AMU	6	442	26	17	NY	FN30
WS9M	6	286	22	13	NY	FN13
N8PPF	6	104	13	8	NY	FN03
AB2DE	**2**	**420**	**21**	**10**	**NJ**	**FN21**
N2RHL	**2**	**380**	**19**	**10**	**NY**	**FN02**
KN2GSP	2	170	17	5	NY	FN30
W2JEK	**Q**	**430**	**43**	**10**	**NJ**	**FN20**
N2VFU	**Q**	**220**	**13**	**10**	**NY**	**FN31**
KC2JRQ	Q	30	5	3	NY	FN30
KC2LST	Q	15	5	3	NJ	FN20
K2LIM	**M**	**111,888**	**539**	**148**	**NY**	**FN12**
WA2FGK	**A**	**43,709**	**315**	**109**	**PA**	**FN21**
(Op: K2LNS)						
K3ZO	**A**	**33,465**	**301**	**97**	**MD**	**FM18**
KA3HED	**A**	**15,904**	**170**	**71**	**DE**	**FM29**
W3TDF	A	14,478	202	57	PA	FN20
K3ISH	A	13,680	161	76	PA	FN21
K1DQV	A	11,385	152	55	MD	FM19
W3UR	A	9,990	185	54	MD	FM19
K3MD	A	9,680	134	55	PA	FN10
WA3EOQ	A	7,261	100	53	MD	FM09
K3TUF	A	7,222	112	46	PA	FN10
W3MEL	A	5,472	122	38	PA	FN10
WA3F	A	5,355	119	45	PA	FN10
N3ALN	A	4,218	105	37	MD	FM19
W2GPS	A	3,955	83	35	MD	FM19
K3CNH	A	3,528	62	42	DE	FM28
W3LL	A	3,220	83	35	MD	FM19
KM3G	A	2,581	73	29	PA	FM19
N3WD	A	2,077	55	31	MD	FM19
WB3IGR	A	2,015	47	31	MD	FM18
N3AM	A	1,000	40	20	MD	FM19
K3WW	A	611	47	13	PA	FN20
K8GU	A	448	25	14	MD	FM19
N3JNX	A	312	16	13	PA	FN11
K1DS	A	180	13	10	PA	FN20
K6PFA	A	136	17	8	MD	FM19
N3AFT	A	70	10	5	MD	FM19
K3CT	**6**	**4,392**	**122**	**36**	**PA**	**FN20**
K3AJ	**6**	**620**	**31**	**20**	**MD**	**FM19**
KB4BKV	6	324	27	12	MD	FM19
N3QE	6	126	18	7	MD	FM19
KA1ZE/3	**2**	**31,188**	**226**	**69**	**PA**	**FN01**
K3HX	**Q**	**54**	**9**	**6**	**PA**	**FN00**
N8HM	**Q**	**32**	**4**	**4**	**MD**	**FM18**
W3SO	**M**	**118,692**	**544**	**157**	**PA**	**FN00**
W4RX	**A**	**120,911**	**561**	**161**	**VA**	**FM19**
N2CEI	**A**	**74,418**	**438**	**157**	**FL**	**EM80**
N4WW	A	28,120	296	95	FL	EL98
N3MK	A	26,125	228	95	VA	FM27
W4VHF	**A**	**25,175**	**231**	**95**	**NC**	**EM96**
K1HTV	A	22,790	246	86	VA	FM18
KN4SM	A	19,475	169	95	VA	FM16
N4TWX	A	17,845	204	83	FL	EL89
NG4C	A	13,202	150	82	NC	FM16
W4AS	A	10,404	146	68	FL	EL95
K2SX	**A**	**9,313**	**139**	**67**	**SC**	**FM03**
K5EK	A	7,128	108	66	NC	FM03
W4TUN	A	5,832	94	54	SC	EM84
K4RW	A	5,544	90	56	SC	EM92
N9CM	A	5,459	103	53	FL	EL87
AA4DD	**A**	**4,320**	**88**	**36**	**TN**	**EM86**
N1LF	**A**	**2,691**	**67**	**39**	**AL**	**EM63**
K4FJW	A	2,576	67	28	VA	EM86
N4AU	A	2,088	54	36	AL	EM62
KS1G	A	1,988	65	28	VA	FM18
K4FTO	A	1,742	52	26	VA	FM18
KU4V	A	1,680	48	30	NC	FM05
N4HWH	A	1,664	64	13	NC	EM86
K4EJQ	A	1,650	58	22	TN	EM86
N4HB	A	1,625	44	25	VA	FM17
W1LVL	A	1,450	43	29	FL	EL99
W4MAY	A	1,394	41	34	FL	EL97
AD4TJ	A	1,288	39	28	VA	FM08
AA4H	A	1,216	47	19	TN	EM86
N2QT	A	1,134	42	27	VA	FM07
W2YX	A	1,080	38	24	FL	EL96
W4JAM	A	1,075	43	25	VA	FM07
WB4IUY	A	1,066	32	26	NC	FM05
K4YYL	A	1,032	40	24	SC	EM84
WA4ZKO	A	972	28	27	KY	EM78
W4AMP	**A**	**828**	**29**	**23**	**GA**	**EM74**
K4EDI	A	550	35	11	TN	EM86
W4FRA	A	520	22	20	NC	FM15
KTØP	A	425	24	17	VA	FM08
N4GG	A	418	22	19	GA	EM74
K4CWA	A	396	41	6	TN	EM86
KS4X	A	294	21	14	TN	EM75
KE1F	A	176	16	11	FL	EL99
K4NRT	A	128	20	4	TN	EM86
KJ4ZIT	A	62	31	1	TN	EM86
(Op: K4EDI)						
KD4UQY	A	56	12	4	TN	EM86
N4DTF	A	49	7	7	TN	EM55
N3TG	A	48	12	4	VA	FM18
N4YHC	A	30	5	5	KY	EM78
K4PG	A	28	7	4	FL	EL96
AI4GR	A	16	4	4	NC	EM85
K4QE	A	12	3	3	NC	FM05
N4OX	**6**	**31,284**	**316**	**99**	**FL**	**EM60**
N4BP	6	16,892	206	82	FL	EL96
N3LL	6	15,826	193	82	FL	EL86
K4MM	6	14,875	175	85	FL	EL97
KN4Y	6	9,310	133	70	FL	EM70
WA2VYA	6	9,180	135	68	FL	EM70
KD2JA	6	8,978	134	67	FL	EL98
N4MM	**6**	**4,300**	**100**	**43**	**VA**	**FM09**
N4TB	6	4,160	80	52	FL	EL97
AC4G	**6**	**3,330**	**74**	**45**	**TN**	**EM65**
WB4SQ	**6**	**2,562**	**61**	**42**	**GA**	**EM74**
K4CGY	6	2,145	65	33	VA	FM07
W5NZ	**6**	**1,666**	**49**	**34**	**AL**	**EM62**
K4BAI	6	1,504	47	32	GA	EM72
N4PN	6	1,485	45	33	GA	EM82
K4DET	6	1,395	45	31	VA	FM17
N4VA	6	1,298	59	22	VA	FM18
KJ4AOM	**6**	**988**	**38**	**26**	**KY**	**EM77**
N3JT	6	925	37	25	VA	FM18
NV4B	6	570	30	19	AL	EM64
N2WN	6	315	21	15	TN	EM86
KD4QMY	6	120	12	10	GA	EM82
AI4SV	6	76	19	4	VA	FM18
K6RM	**6**	**72**	**9**	**8**	**NC**	**FM03**
KK4CIS	6	20	5	4	FL	EL95
AJ4ZU	**Q**	**1,364**	**43**	**31**	**VA**	**FM17**
W4PAY	**Q**	**1,323**	**63**	**21**	**NC**	**EM86**
WØPV	**Q**	**1,260**	**42**	**30**	**FL**	**EL87**
KI4PWO	Q	517	47	11	NC	EM86
KD4NEM	**Q**	**10**	**5**	**2**	**VA**	**FM18**
W4GRW	**H**	**10,788**	**186**	**58**	**NC**	**EM86**
W3DQT	**H**	**1,456**	**42**	**26**	**VA**	**FM08**
KC8KSK	**H**	**32**	**5**	**4**	**NC**	**EM96**
W4WA	**M**	**47,539**	**285**	**137**	**GA**	**EM84**
W4NH	M	25,338	216	103	GA	EM84
N4DXY	**M**	**12,975**	**158**	**75**	**AL**	**EM62**
K2JB	**M**	**9,620**	**122**	**65**	**NC**	**EM85**
NR5M	**A**	**112,056**	**474**	**203**	**TX**	**EM10**
W3XO/5	A	38,090	277	130	TX	EM00
WA5LFD	A	22,834	221	98	TX	EM12
N5BLY	**A**	**18,954**	**238**	**78**	**MS**	**EM50**
K5GKC	A	15,936	186	83	TX	EM13
N5RZ	A	9,585	128	71	TX	DM91
AI5I	**A**	**9,520**	**140**	**68**	**NM**	**DM65**
N5JF	**A**	**7,747**	**126**	**61**	**LA**	**EM40**
WB2FKO	A	6,527	100	61	NM	DM65
AF5CC	**A**	**4,900**	**95**	**50**	**OK**	**EM04**
NH7RO	A	4,140	91	45	NM	DM65
K5GZR	A	4,070	74	55	TX	EL29
W5KI	**A**	**3,864**	**79**	**46**	**AR**	**EM36**
K3TD	A	3,672	70	51	TX	EM10
KC5MVZ	A	1,960	48	35	TX	DM93
WD5IYT	A	972	33	27	TX	EM10
W8FN	A	903	43	21	TX	EM12
W8FR	A	816	31	24	MS	EM54
KD5JHE	A	580	29	20	MS	EM54
N5TIT	A	9	3	3	TX	EM13
W5PR	**6**	**68,040**	**486**	**140**	**TX**	**EL29**
W5SXD	6	42,837	327	131	TX	EM02
N8OO	**6**	**41,088**	**321**	**128**	**LA**	**EM31**
AA5AM	6	20,544	214	96	TX	EM13
WQ5L	**6**	**17,556**	**209**	**84**	**MS**	**EM50**
WD5COV	**6**	**15,228**	**162**	**94**	**NM**	**DM62**
W5GAI	6	8,253	131	63	TX	EM10
N5EPA	6	6,840	120	57	NM	DM64
WØVX	6	4,400	100	44	TX	EM12
K5GN	6	2,706	66	41	TX	EL29
KE5FXE	6	2,574	66	39	TX	EM12
W1EBB	6	1,540	44	35	LA	EM32
NW5Q	6	1,457	47	31	TX	EM13
WS1L	6	1,092	52	21	MS	EM51
W5SRM	6	936	36	26	LA	EM42
K9HZ	6	300	20	15	TX	EL29
K5BZH	6	252	18	14	TX	DM95
KK5JY	**6**	**224**	**16**	**14**	**OK**	**EM16**
WB5USB	6	165	15	11	NM	DM65
KC5WA	6	30	6	5	LA	EM32
KC5MVV	**2**	**60**	**15**	**2**	**TX**	**DM93**
WD5AGO	**Q**	**4,230**	**83**	**47**	**OK**	**EM26**
W5WIL	Q	572	26	22	OK	EM14
K5TED	**H**	**750**	**29**	**25**	**TX**	**EL09**
K5QE	**M**	**205,318**	**689**	**251**	**TX**	**EM31**
KBØHH	**M**	**61,632**	**388**	**144**	**OK**	**EM06**
WN2E	**M**	**25,926**	**294**	**87**	**MS**	**EM50**
K5KDX	**M**	**5,830**	**104**	**55**	**AR**	**EM25**
KG6IYN	**A**	**35,090**	**262**	**110**	**CA**	**DM12**
AF6RR	**A**	**6,348**	**122**	**46**	**CA**	**CM87**
WA6ZTY	A	5,796	132	36	CA	CM98
KC6ZWT	A	3,560	68	40	CA	CM98
K6EU	A	3,276	76	39	CA	CM97
AD6D	A	1,080	37	27	CA	DM22
N6TCZ	A	714	33	17	CA	DM03
WN6K	A	663	39	17	CA	DM13
K6BR	A	612	30	17	CA	CM97
WB6BET	A	481	29	13	CA	CM98
KF6I	A	448	32	14	CA	DM13
AA6WH	A	336	24	14	CA	CM95
KE6QR	A	175	19	7	CA	CM88
W6XK	A	170	17	10	CA	CM97
K6CSL	A	128	16	8	CA	CM97
K6AAB	A	117	13	9	CA	DM06
K1GI	A	60	15	4	CA	CM97
N6DZR	A	45	8	5	CA	CM99
W6CWM	A	32	8	4	CA	DM04
W5DQ	**6**	**5,989**	**113**	**53**	**CA**	**DM15**
N6ML	**6**	**5,400**	**108**	**50**	**CA**	**CM97**
W6OAT	6	1,160	58	20	CA	CM87
N6QQ	6	558	31	18	CA	DM03
K6OAK	6	153	17	9	CA	CM97
N6ENO	6	135	15	9	CA	CM88
KJ6OGE	6	50	10	5	CA	CM87
K6DSW	6	28	7	4	CA	DM04
WB2TVB	6	40	6	5	CA	DM04
KI6TQT	**H**	**150**	**15**	**5**	**CA**	**DM12**
K7ULS	**A**	**44,671**	**320**	**131**	**UT**	**DN41**
N7EPD	**A**	**12,818**	**168**	**58**	**WA**	**CN87**
KD7UO	A	9,100	139	50	WA	CN97
WA7TZY	A	8,150	134	50	WA	CN87
W7FI	A	6,272	101	49	WA	CN87
K7AWB	A	4,371	83	47	WA	DN17
KI7JA	**A**	**4,120**	**84**	**40**	**OR**	**CN85**
KX7L	A	2,639	81	29	WA	CN87
N6LB	A	2,121	73	21	WA	CN98
KG7P	A	825	36	15	WA	CN87
K6UM	A	432	27	16	OR	CN85
K7JAN	**A**	**238**	**17**	**14**	**ID**	**DN13**
W7AMI	A	187	13	11	ID	DN15
AI9Q	A	112	13	8	WA	CN85
WØPAN	**A**	**60**	**10**	**6**	**AZ**	**DM43**
K7JQ	A	32	8	4	AZ	DM43
W7WR	A	24	8	3	WA	CN85
KC7V	A	9	3	3	AZ	DM43
K7CW	**6**	**17,028**	**258**	**66**	**WA**	**CN87**
K7EK	6	4,641	119	39	WA	CN87
N6SS	**6**	**1,350**	**45**	**30**	**AZ**	**DM34**
KØIP	**6**	**1,230**	**41**	**30**	**ID**	**DN32**
N7IR	**Q**	**1,066**	**41**	**26**	**AZ**	**DM43**
KE7UQL	**Q**	**81**	**9**	**9**	**NV**	**DN01**
N7VS	**Q**	**10**	**5**	**2**	**OR**	**CN85**
K7IP	**M**	**3,074**	**82**	**29**	**WA**	**CN88**
KB8U	**A**	**56,718**	**342**	**138**	**MI**	**EN71**
AC8HU	**A**	**9,920**	**123**	**64**	**OH**	**EN81**
KM8Q	A	9,570	125	66	OH	EN80
K8GDT	A	8,820	102	60	OH	EN91
KT8TD	A	2,356	62	38	MI	EN82
KB8VAO	A	1,404	36	26	OH	EN91
W8KNO	A	1,296	43	27	OH	EN91
N9AUG	A	897	39	23	OH	EN80
KB8KMH	**A**	**192**	**15**	**12**	**WV**	**EM88**
WO3X	A	120	10	10	OH	EN91
K8GT	A	99	11	9	MI	EN82
N8QE	A	80	9	8	OH	EN91
KF6A	**6**	**33,156**	**307**	**108**	**MI**	**EN73**
N8BJQ	**6**	**11,544**	**156**	**74**	**OH**	**EN80**
K8FL	6	4,845	95	51	OH	EM79
KB8UUZ	6	3,510	78	45	OH	EN91

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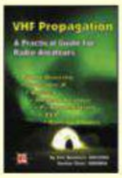

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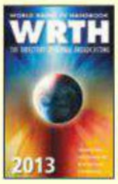

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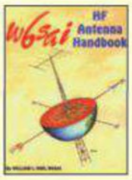

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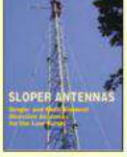

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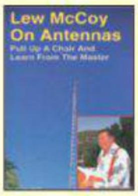

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AC8G	6	1,344	48	28	OH	EM79
W8GOC	6	1,316	47	28	OH	EM79
N8OC	6	1,128	47	24	MI	EN83
KK9T	6	1,053	39	27	MI	EN72
K8AB	6	920	40	23	OH	EN91
N8SBE	6	682	31	22	MI	EN82
KD8LDX	6	500	25	20	MI	EN62
W8IDM	6	320	20	16	OH	EN81
K8BA	6	312	24	13	OH	EM79
W8IDW	6	117	13	9	WV	EM99
NF8M	6	112	14	8	MI	EN82
K8ME	6	50	10	5	OH	EN91
N8XA	Q	7,020	96	60	OH	EM79
KG9Z	"	108	12	9	OH	EN90
KD8NYO	"	36	6	6	OH	EN81
N8ZM	M	96,030	443	165	OH	EN80

K2DRH	A	136,620	534	198	IL	EN41
N9LB	A	14,378	161	79	WI	EN52
W9GT	A	9,768	127	66	IN	EN71
K9CT	A	6,832	81	56	IL	EN50
WV9E	A	6,200	92	62	WI	EN43
K9IL	A	5,580	93	60	IL	EM56
K3WA	A	5,454	101	54	IL	EN50
N2BJ	A	3,888	72	48	IL	EN61
ND9Z	A	3,120	76	40	WI	EN54
N9DG	A	2,911	55	41	WI	EN53
W9TC	A	2,294	62	37	IN	EM79
KC9ELU	A	2,160	43	36	IN	EM79
N9XRO	A	1,488	45	31	WI	EN53
WD9CVI	A	888	32	24	IN	EN71
KU8T	A	682	31	22	IN	EN71
NG9R	A	546	24	21	IL	EN40
K9SAT	A	360	18	18	IL	EN61
AJ9C	A	221	17	13	IN	EN70
NØICV	A	48	7	6	IL	EN62
WB9Z	6	18,011	217	83	IL	EN60
N7MB	6	11,988	162	74	IL	EN50
W9ILY	6	3,552	74	48	IL	EN51
WB9HFK	6	2,337	57	41	IL	EN50
KBØKFX	6	2,142	63	34	WI	EN54
W9VA	6	2,014	53	38	IL	EN62
W9AV	6	1,785	51	35	WI	EN53
W3HDH	6	1,680	48	35	IL	EN50
K9ZM	6	1,485	45	33	IL	EN50
K9JS	6	750	30	25	IL	EN52
K9AKS	Q	9,750	118	66	IL	EN41
N9TF	Q	3,515	72	37	IL	EN52
AF9J	Q	238	15	14	WI	EN52
W9SZ	H	3,476	65	44	IL	EN50
K9NS	M	227,766	753	238	IL	EN52

KØNR	A	55,836	366	141	CO	DM78
KCØVFO	A	16,456	187	88	CO	DM79
WØETT	A	16,119	162	81	CO	DM79
KR5J	A	14,440	130	95	CO	DM78
KØAWU	A	13,778	150	83	MN	EN37
NTØV	A	6,283	77	61	ND	EN08
NØHF	A	5,096	94	52	CO	DM79
AAØMZ	A	3,388	60	44	KS	EM29
W6GMT	A	3,150	74	42	MN	EN37
KIØI	A	1,900	48	38	MO	EM28
WAØRKQ	A	1,862	49	38	KS	EM09
WØERP	A	1,782	47	33	MN	EN34
KFØF	A	1,540	44	35	MO	EM28
KFØM	A	1,305	35	29	KS	EM17
KCØBMF	A	782	32	23	IA	EN31
KSØAA	A	437	23	19	KS	EM28
KCØRQH	A	350	15	14	MN	EN35
KCØVFP	A	30	6	5	MN	EN35
W9RM	6	97,440	580	168	CO	DM58
K5ZG	6	40,150	365	110	CO	DM88
KØSIX	6	39,680	320	124	MN	EN35
NØURW	6	38,934	309	126	IA	EN41
WØRIC	6	35,990	305	118	CO	DM79
KFØUR	6	33,790	310	109	CO	DM78
KBØEO	6	18,800	200	94	MN	EN34
KCØDEB	6	5,734	94	61	KS	EM29
KBØYH	6	4,770	90	53	CO	DM79
WØHBH	6	3,192	84	38	MO	EM48
KØAV	6	1,980	60	33	CO	DM78
KØZX	6	1,512	54	28	CO	DM79
WAØIYY	6	1,404	54	26	MO	EM48
KØBAM	6	759	33	23	CO	DM68
KØIO	6	572	26	22	IA	EN31
KFØIQ	6	20	5	4	MO	EM37
KKØQ	Q	1,240	43	20	CO	DM79
N6HQY	Q	204	17	6	CO	DM78
WØDJM	Q	30	6	5	MN	EN25
WØCEM	Q	25	5	5	KS	EM19
KIØG	H	190	18	10	CO	DM69

ROVER

WW7D	30,600	233	100	8
K9JK	27,360	163	120	11
W3DHJ	25,760	191	112	4
W7QQ	17,108	150	94	8
N2SLN	7,239	89	57	2
KØBBC	6,200	100	62	5
K8MR	4,200	62	50	3
W7JDB	4,050	81	50	2
N6GP	3,690	74	41	4
WØBL	3,290	71	35	2
N6ORB	3,290	94	35	3
K7BWH	2,016	58	28	2
ABØYM	1,794	35	26	8
K1HC	1,620	38	30	7
KØCS	1,584	48	33	3
NV6C	1,215	31	27	6
WB2SIH	1,012	40	23	3
WA4JA	672	27	24	4
N9TZL	340	20	17	2
N6ZE	180	16	9	2
AB2YI	72	6	6	3
KA3KSP	18	3	3	1

CANADA

VE3ZV	A	18,549	158	81	ON	EN92
VE3KZ	A	14,697	167	71	ON	FN03
VE7DAY	A	7,740	166	43	BC	CO70
VA3TVW	A	1,422	46	18	ON	FN03
VE1SKY	A	936	29	26	NS	FN74
VA3WU	A	675	28	15	ON	FN03
VE3MSC	A	658	31	14	ON	FN03
VE3CWU	A	480	32	15	ON	FN03
VA6AN	A	405	20	15	AB	DO33
VE3CX	A	336	24	14	ON	EN58
VE9MY	A	330	22	15	NB	FN75
VE2HAY	A	286	15	13	QC	FN35
VA3GKO	A	168	14	12	ON	FN04
VE3HHT	A	128	9	8	ON	FN03
VE9AA	A	4	2	2	NB	FN66
VE3MV	6	589	31	19	ON	FN03
VE3EK	6	384	24	16	ON	FN03
VE3OIL	6	162	18	9	ON	EN93
VA7ST	6	117	13	9	BC	DO00
VE4EAR	6	16	4	4	MB	EN19
VE7JRX	Q	300	22	12	BC	CN89
VE7JH	M	24,354	280	66	BC	CN88
VA7FC	M	8,507	170	47	BC	CN79
VE3SMA	M	5,220	80	45	ON	FN05
VE2NGH	M	2,263	61	31	QC	FN45
VE3CRU	R	30,988	182	122	ON	6
VE3RKS	R	1,320	33	30	ON	4

CUBA

T48K	6	2,904	66	44	FL10
					(Op: CO8ZZ)
CO8DM	6	2,480	62	40	FL11

HONDURAS

HR2/NP3J	6	1	1	1	EK55
					(Op: JA6WFM)

ALASKA

KL7KY	A	532	38	14	BP51

PUERTO RICO

NP3CW	A	250	18	10	FK68

GUATEMALA

TG9AJR	6	150	15	10	EK44

BERMUDA

VP9/WA4PGM	A	255	17	15	FM72

MEXICO

XE3N	A	5,208	93	56	EL60
XE2X	6	6,741	107	63	EL06
XE2AU	6	216	18	12	DL81
XE2NBW	Q	1,664	64	26	DL95

AFRICA

MADEIRA ISLAND

CT3DZ	A	2,205	49	35	IM12
CT3BD	A	2,170	51	35	IM12
CT3KY	A	456	20	19	IM12

CANARY ISLANDS

EA8ACW/P	6	805	35	23	IL28

ASIA

ASIATIC RUSSIA

RZ9CJ	Q	12	3	2	MO06
RV9CQ/P	H	12	3	2	MO06
RF9C	M	12	3	2	MO06
R8CAA	R	24	6	2	2

ASIATIC TURKEY

TA2AD	A	4,888	72	52	KN51
TA2ST	A	240	12	10	KN40
TA9J	A	1	1	1	LN10

CHINA

BA8AG	A	132	12	11	OM20
BA4SI	6	1,595	55	29	PM01
BG6CJR	6	286	22	13	OM90
BA4MY	6	49	7	7	OM86

ISRAEL

4Z5KO	6	460	23	20	KM72

JAPAN

JO4CFV	A	9	3	3	PM64
JF2MBF	6	144	12	12	PM85
JG3WDN	6	25	5	5	PM74
JJ3WPX	6	4	2	2	PM75
JA1POS	2	2	1	1	PM95
JH3DMQ	Q	672	38	14	PM74
8J2NKC	M	72	10	6	PM85

TAIWAN

BV1EL	A	684	36	19	PL04

THAILAND

E21DKD	2	11,520	360	16	OK04
E22HUV	2	4,872	406	6	OK03
E2ØMWE	2	1,968	164	6	OK03
HS8GLR	2	1,248	104	6	OJ07
HS7WMU	2	530	53	5	NK92
HS3LSE	2	420	35	6	OK14
HS3ANP	2	138	23	3	OK14
HS8JYX	2	114	19	3	NJ98
E21QEB	2	44	11	2	OK03
HS8JNF	H	340	34	5	NJ98
HS8FLU	H	48	12	2	NJ98
E2E	M	16,558	276	34	OK03
HS1EFA	M	14,720	736	10	OK03
HS1AR	M	11,250	211	30	OK04
HS3AB	M	10,032	264	19	OK14
HS4AK	M	9,750	181	30	OK16
HS5AC	M	8,694	166	42	NK98
HS4RTC	M	5,520	230	12	OK03
HS4YFR	M	5,044	194	13	OK16
HSØAC	M	4,898	105	31	OK03
E22JPA	M	3,816	318	6	NJ99
E22JME	M	3,724	266	7	OK04
HS3XAC	M	3,660	183	10	OK06
HS4UYG	M	3,380	130	13	OK16
E21GJB	M	1,848	132	7	OK03
E22SBP	M	1,566	87	9	OK14
HS9HND	M	1,080	90	6	OJ07
HS5FAI	M	756	54	7	OK08
E29TUY	R	1,264	79	8	2
HS4RAY	R	896	32	14	4
HS4OQI	R	100	10	5	4

EUROPE

AUSTRIA

OE4VIE	6	5,264	94	56	JN87

BOSNIA & HERZEGOVINA

E7ØT	6	26,100	225	116	JN84

BULGARIA

LZ2ZY	A	48	6	4	KN13
LZ9M	2	96	8	6	KN32

CROATIA

9A3QB	A	1,716	42	33	JN95
9A6DQB	A	1,325	34	25	JN85
9A3TU	A	912	29	24	JN95
9A1DL	A	510	22	17	JN95
9A2EY	A	120	11	8	JN85
9A4K	6	2,478	59	42	JN86
9A7ZZ	6	651	31	21	JN95
9A2EU	6	600	30	20	JN75
9A1CAL	2	4,588	62	37	JN86
					(Op: 9A6WW)
9A5Y	M	21,094	199	106	JN85

CZECH REPUBLIC

OK1DC	A	12,342	125	66	JN69
OK1CZ	A	1,196	39	26	JO70
OK1KZ	A	696	54	8	JO70
OK1ARO	6	140	14	10	JO70
OK7N	Q	208	16	13	JN69
					(Op: OK1CJN)

ENGLAND

MØCFW	6	16	4	4	IO91

EUROPEAN RUSSIA

UA3WM	2	2,856	51	28	KO72
UA6AX	2	2,726	47	29	KN84
RL3D	2	1,012	46	11	KO85
RN3QRY	2	850	25	17	KO91
RW7A	2	780	26	15	KN95
RL3F	2	672	42	8	KO95
UA4AQL	2	504	18	14	LO20
RA4A	2	416	16	13	LO20
RA4FP	2	390	15	13	LO13
RU4FA	2	252	14	9	LO13
R6AJ	2	176	11	8	LN05
UA4UT/P	2	198	11	9	LO14
UA3DCM	2	128	8	8	KO85
RA6MT	2	60	6	5	LN08
RU3MS	2	32	4	4	KO98
UA4FKD	2	24	4	3	LO13
UA4BI	2	12	3	2	LN28
R1DX	2	2	1	1	KO59
RA3SI	Q	650	25	13	LO04
UA3YDN	H	12	3	2	KO62
RN3F	M	8,188	89	46	KO86
RK3DXB	M	1,020	51	10	KO85
RK6AXN	M	384	16	12	KN94

EUROPEAN TURKEY

TA1CR	2	154	11	7	KN41
TA1TA	2	30	5	3	KN41

FINLAND

OH7UV	6	725	29	25	KP32

FRANCE

FØFEK	Q	1,020	30	17	JN19

GERMANY

DL1DBR	2	260	13	10	JO41

GREECE

SV1NJX	A	154	13	11	KM06
S59A	6	19,008	192	99	JN76
SV2FLQ	6	64	8	8	KN10
SX1K	M	5,405	92	47	KM18

HUNGARY

HA5UA	A	250	14	10	JN97
HA7LW	6	1,728	48	36	JN97
HA5PT	6	1,333	43	31	JN97
HG5BVK/P	2	3,078	57	27	JN97
HA1ZH	Q	8,601	102	61	JN86
HA2VR/P	H	1,898	53	26	JN87
HA6W	M	39,672	228	114	KN08
HG6Z	M	8,692	106	41	JN97

IRELAND

EI9FBB	6	5,049	99	51	IO51

ITALY

IV3AOL	A	128	10	8	JN65
IT9BCC	6	500	25	20	JM67
IW3GST/3	2	660	30	11	JN55
IN3QBR	Q	1,428	42	34	JN55
IZ6ITZ	Q	30	6	5	JN72
IZ2JNN/IN3	H	814	37	11	JN55

LATVIA

YL2CP	A	255	17	15	KO27
YL2JZ	A	35	7	5	KO26
YL2GP	6	806	31	26	KO27
YL2CV	Q	81	9	9	KO16

LITHUANIA

LY2FN	A	168	14	12	KO14
LY7Z	Q	132	12	11	KO15

MOLDOVA

ER1LW	A	3,330	56	45	KN46

NORWAY

LA9DFA	6	1,092	39	28	JP50

ROMANIA

YO5AVN	A	3,024	48	36	KN34
YO5DAS	A	135	9	9	KN17
YO2BCT/P	6	1,410	47	30	KN05
YO2LEL/P	6	609	29	21	KN05
YO2IS	6	480	24	20	KN05
YO9RIJ	6	432	24	18	KN35
YQ6A	6	25	5	5	KN25
YO9BHI	2	8	2	2	KN35
YO9IXC	2	8	2	2	KN35

SERBIA

YT1VP	6	3,572	76	47	JN94
YT7P	2	456	19	12	KN05
YT7WE	2	240	12	10	KN05
YT1DPK	2	70	7	5	KN04
YT2F	M	5,733	80	49	KN03

SLOVENIA

S59A	6	19,008	192	99	JN76
S51D	A	5,626	97	58	JN75

SPAIN

EA3AYQ	A	234	18	13	JN11
AN4AA	Q	9	3	3	IN80
					(Op: EC4AA)

THE NETHERLANDS

PA5WT	6	2,132	52	41	JO22
PI4Z	6	40	8	5	JO11
					(Op: PA5KT)

UKRAINE

UY5QO	A	3,388	60	44	KN77
UY9VY	A	2,320	47	40	KN68
UT7EL	A	2,223	57	39	KN77
UT7EW	A	2,112	52	32	KN78
UR5IFM/P	A	2,015	46	31	KN76
EN1C	A	1,995	44	35	KN59
US9PA	A	330	22	15	KO20
UR3VIO	A	286	13	11	KN69
UR5QU	6	7,370	110	67	KN77
					(Op: UT4UO)
UW7LL/A	6	6,300	100	63	KN79
UZ5U	6	3,900	75	52	KO72
US8AR	6	1,230	41	30	KO60
UW8SM	6	648	27	24	KN28
UT7QF	6	494	26	19	KN77
UT7QB	6	340	20	17	KN77
UXØUW	6	144	12	12	KO50
UX3IT	6	130	13	10	KN88
US4IRT	6	4	2	2	KN88
UXØFF	2	15,048	99	76	KN45
US1IY	2	5,382	117	23	KN98
UT5DV	2	2,024	44	23	KN18
UT5U	2	1,932	46	21	KO50
UT3EK	2	836	22	19	KN78
UR7INK	2	210	21	5	KN88
UT4UKW	2	162	9	9	KN59
US5EY	2	90	9	5	KN67
UT6UC	2	42	21	1	KO50
UY5ON	Q	6,206	80	58	KN89
UU6JF	Q	2,000	50	20	KN85
UT5ER	Q	1,947	38	33	KN78
UT3IK	Q	1,098	61	9	KN98
UR3HR	Q	900	25	20	KN79
UR8QV	Q	864	36	24	KN77
US9IDD	Q	444	37	6	KN98
UT2HC	Q	270	18	15	KN79
UR4IGD	Q	208	26	4	KN98
UY2IW	Q	200	25	4	KN98
US4ICL	Q	200	25	4	KN97
US3ITA	Q	195	20	5	KN87
UR5ICK	Q	184	23	4	KN97
US2IOO	Q	168	21	4	KN98
UT2IY	Q	160	20	4	KN98
US5ITP	Q	160	20	4	KN88
UT3IZ	Q	145	15	5	KN87
UT2IM	Q	120	15	4	KN88
UT2IV	Q	120	15	4	KN88
UT2IJ	Q	104	13	4	KN97
URØET	Q	42	7	3	KN78
UR7AA	Q	1	1	1	KO60
UV6I	M	81,548	427	116	KN98
UT7E	M	8,694	105	69	KN78
UT4UWR	M	4,984	75	56	KN49
UT4IXZ	M	100	13	4	KN87
US3ITU	R	30,366	249	63	9
US6IF	R	576	24	12	4

MARITIME MOBILE
ADRIATIC SEA

RAØLQ/MM	R	560	20	14	7

OCEANIA

AUSTRALIA

VK6DXI	A	15	3	3	OF88

EAST MALAYSIA

9M6YBG	A	6	3	2	OJ85

SOUTH AMERICA

ARGENTINA

LU1CGB	2	242	11	11	GF05

BRAZIL

PU2TRX	A	414	36	6	GG66
PU1KGG	A	30	5	3	GG87
PY2LUC	A	30	5	3	GG67
PY2VOA	A	6	2	2	GG77
PY1RBM	A	4	2	1	GG87
PV8ADI	A	2	2	1	FJ92
PY2NF	2	248	31	4	GG66
PY2LCD	2	232	29	4	GG66
PY2ABV	2	216	27	4	GG66
PY2SD	2	66	11	3	GG66
PY2KS	2	60	10	3	GG66
PY2AE	2	44	11	2	GG67
ZV2K	M	783	45	9	GG77

Checklogs

The following logs were used for cross-checking. Check logs are always appreciated: AA5TB, E73DPR, HA5KDQ, HA8IB, K2PLF, K8MFO, KJ6MBW, N1WRK, NA2NY, RK6ARD, RL3KQ, UA6VY, UR5WCE, UR7QM, UT1IA, UT5ERP, VE3KAO, W7/HG1DUL, WA7LNW, YL3DX, YL3FT, YO3FOU, YO6LV.

Actions of the CQ VHF Contest Committee: The following station received a RED CARD for unverifiable QSOs – UT5JCW.

Raspberry Pi in the Sky

Restrictions in the United Kingdom against airborne amateur transmissions, including prohibiting the use of APRS, make for unique workarounds. This article describes how the open-source hardware Raspberry Pi has been used for transmitting slow-scan digital photos from a high-altitude balloon payload using a low-power transmitter.

By Dave Akerman*

Since the United Kingdom has restrictions against airborne amateur transmissions, including prohibiting the use of APRS, in this article Dave Akerman describes how he uses the very popular open-source hardware Raspberry Pi for transmitting slow-scan digital photos from a high-altitude balloon (HAB) payload using the permitted non-licensed low-power transmitter. The following story is about flying a Raspberry Pi as part of a payload on a high-altitude balloon.

PIE1: Raspberry Pi Sends Live Images from Near Space

High-altitude ballooning (HAB) is a growing hobby in which enthusiasts use standard weather balloons to put small payloads (typically 100 gm to 1 kg) into "near space" at altitudes of around 30 km or so, carrying a tracking device (so the balloon position is known throughout the flight), usually some sensors (temperature, pressure, etc.), and often a video or a still camera storing to an SD card for later retrieval.

The job of the tracker is to read the location from the GPS receiver, possibly also read some sensors, and then format and send a telemetry sentence to the ground over a low-power radio link. In the UK, flights happen after the predicted path is known to be safe (avoiding airports and densely populated areas ,for example) and permission has been gained from the Civil Aviation Authority (CAA).

Here in the UK the tracking system uses the 70-cm radio band (around 434 MHz) using RTTY to send the telemetry down to a number of ground stations run by other enthusiasts. Telemetry from all receivers is sent to a central server that then drives a live map which can be viewed by anyone with an internet connection. The system works extremely well and has been used

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This material appears here courtesy the author and is also available on his blog: <http://www.daveakerman.com/?p=592>.

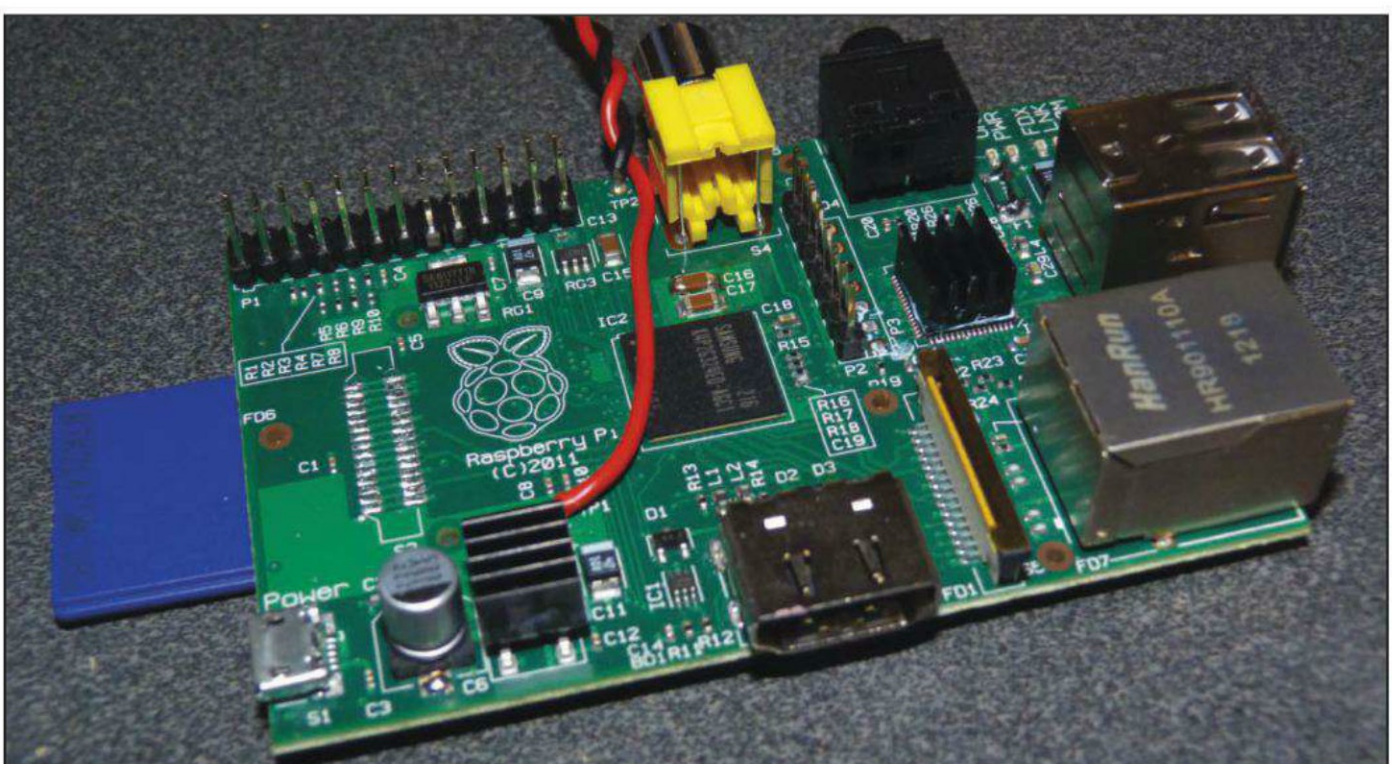


Photo 1. Additional heat sinks attached to the USB/ETH chip and the 3.3-volt regulator on the Raspberry Pi board.

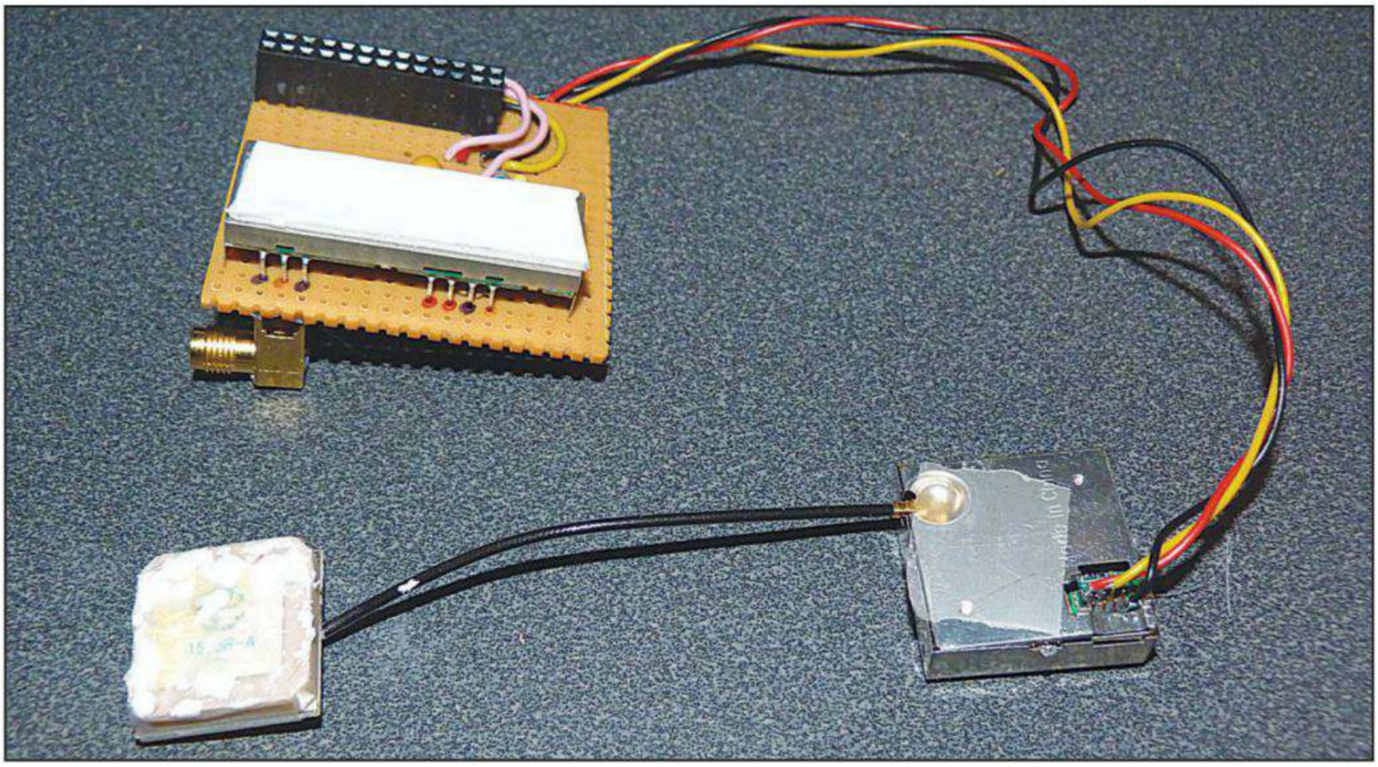


Photo 2. Experimental printed circuit board with the Radiometrix NTX2.

to track payloads at distances of 800 km and more even though the transmitter is limited by UK law to 10 mW ERP.

In early May I received my first Raspberry Pi computer (http://http://www.raspberrypi.org/), and having flown several high-altitude balloons before I thought about using one as a flight computer. In almost all of my previous flights I used Arduino Mini Pro boards (http://http://www.arduino.cc/), and these are ideal—tiny, weigh almost nothing, simple. and need very little power. I looked at the Pi and saw none of these desirable features! What I did see, though, was a USB port offering quick, easy, and inexpensive access to a webcam, meaning that for the first time I could have live images (SSDV) sent down by my payload—something that hasn't been done very often.

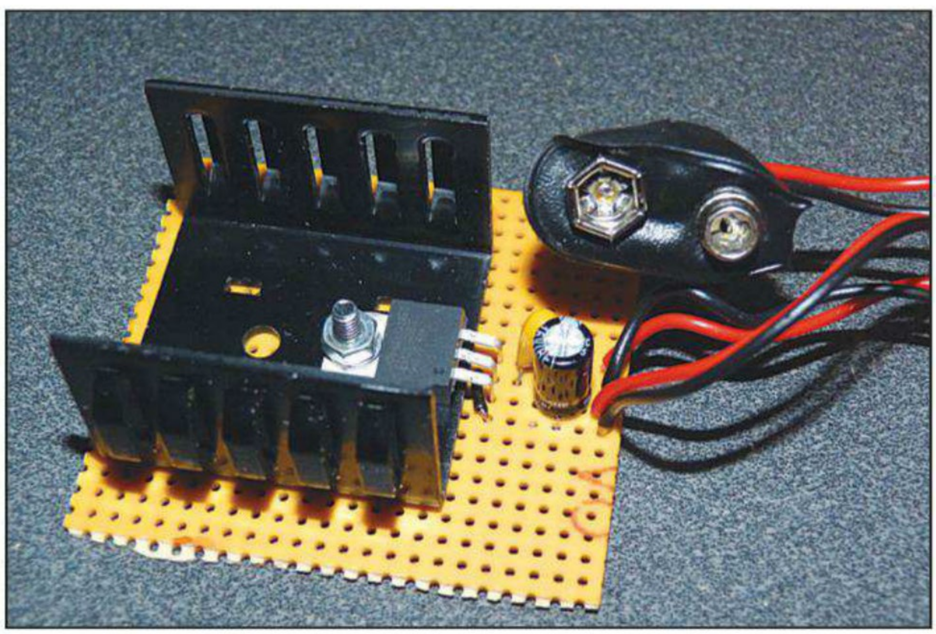


Photo 3. Linear regulator.

"Near Space" is a fairly hostile environment – less than 1% atmosphere, temperatures down to –50 degrees C or so—and if anything goes wrong it's likely to stay wrong. The radio link is one-way, so there's no chance of remotely doing a "pseudo reboot" let alone powering off then on again! Descent can be violent, as can the landing, so even things such as SD card sockets can represent a potential failure mode.

The Pi is a step up in complexity from the usual boards we use, which have no SD cards, or USB, or even an operating system, so the extra power and capability does come at a price, and the first one is an increase in the power requirement from around 60 mA to over 500 mA, and that of course means much higher power dissipation.

People often worry about the low temperatures in near space, but when your payload is generating a few watts of power that is not likely to be a problem! I was much more concerned with how hot it was going to get inside the payload, so I added some heat sinks to the Pi. Photo 1 shows the Raspberry Pi with the additional heat sinks.

I used special thermal adhesive to glue heat sinks to the USB/ETH chip and to the 3.3V regulator. Both get warm but normally not hot, and I feared that at 1%

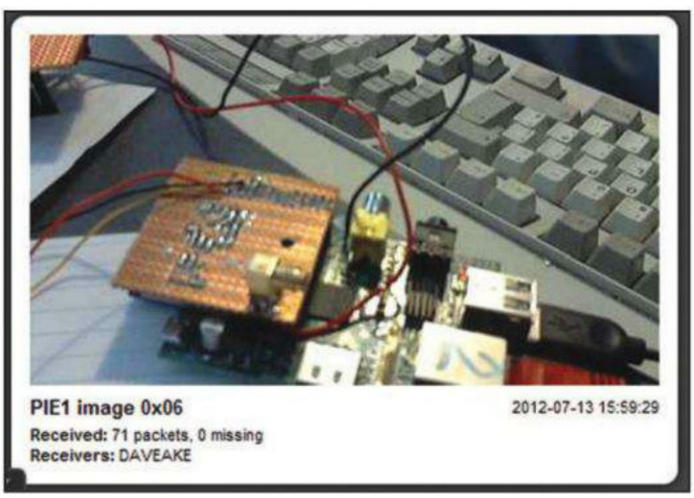


Photo 4. The Pi makes a self-portrait.

atmosphere (so less convection) they'd possibly get too hot. You can also see two wires carrying 5V directly to the Pi; soldered joints are more reliable than using a connector. Another modification was to remove the S2 video connector to make space for components on my expansion board. The final modification was to short out the USB fuses since my webcam's current requirement exceeds their rating. I then added a small piece of strip board carrying a Radiometrix® NTX2 radio transmitter (http://www. radiometrix.com/content/ntx2; see photo 2) to send the telemetry and images down to the ground, and connected that to a simple GPS receiver on a wire tail so it could be kept away from the transmitting devices.

The final item for a basic tracker is a suitable power supply. Energizer® lithium AA cells are the obvious choice, since they are specified to work down to –40 degrees C and are very good at high currents (we need over 500 mA for the Pi plus webcam). On the way to 30 km the outside will get down to –50 degrees C, and even with minimal insulation the batteries will self-heat to stay within their operating range.

The Pi needs 5V supplied to it, so I used an external LDO (Low DropOut) linear regulator (photo 3) fed from 6 AAs which would supply enough voltage to the regulator until they were pretty much flat. With the regulator dissipating up to 3 watts it needed and got a heatsink. This is a lot of heat to get rid of in a payload (which is insulated, because you don't want it to get too cold either, because that can affect other parts). I had some switched mode regulators ordered, but they didn't arrive in time for my flight, so it went up with the linear regulator.

The usual technique with the NTX2 is to send the "1" and "0" values in RTTY by waggling a general-purpose I/O pin up and down at the correct rate—e.g., every 20 ms for the common 50-baud data rate. This is easy when you're programming a bare-metal AVR or PIC; just use a delay routine or, as in my trackers, a timer interrupt. However, the Pi runs a non-real-time operating system, so I could not rely on accurate timing especially if the operating system was busy taking a photo from the webcam. There are other options, but I opted for the simplest one—connect the NTX2 to the serial port. RTTY is just normal RS232-style serial marks and spaces and stop bits, etc., so why not let the hardware UART do the timing for me?

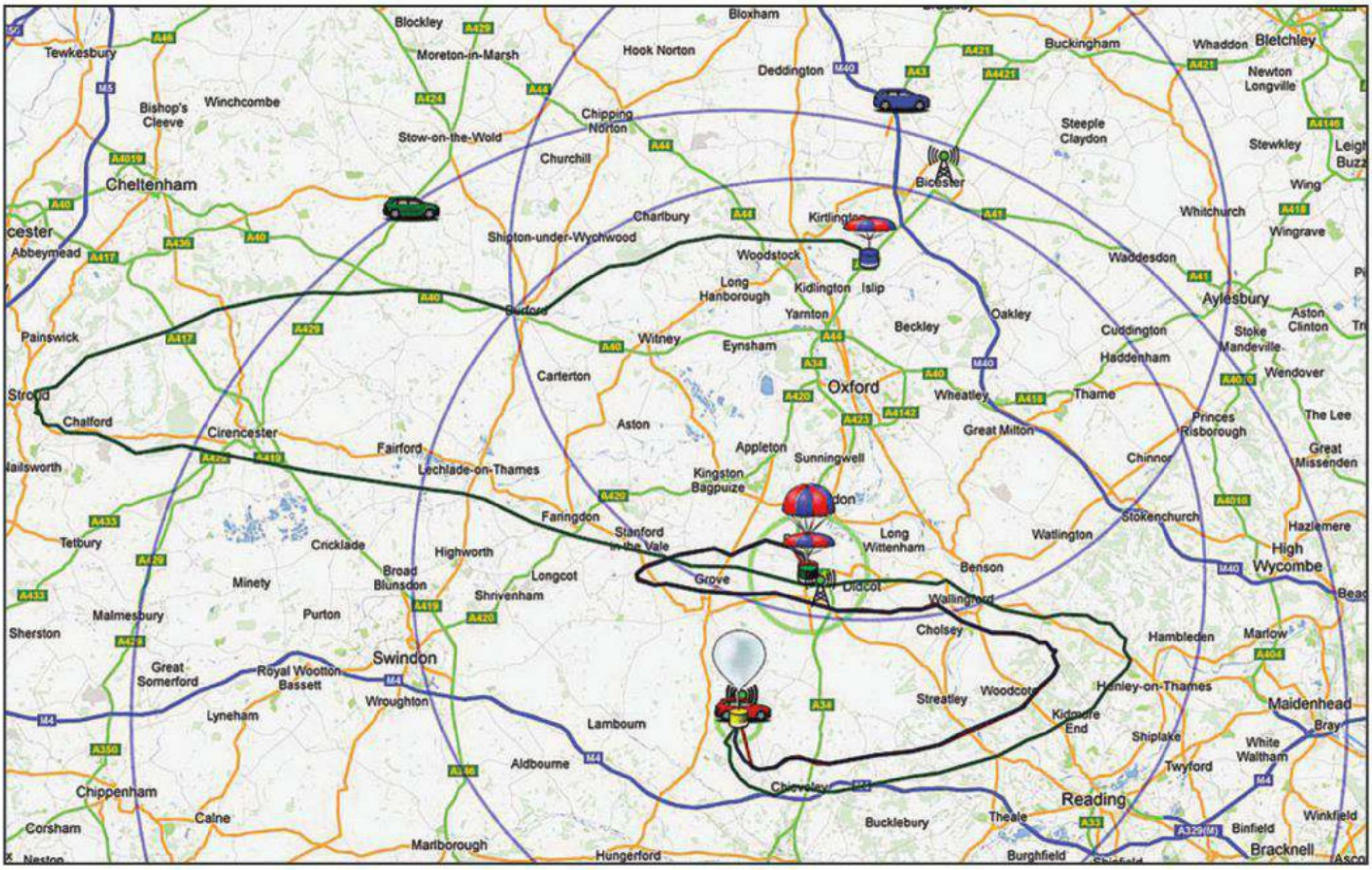


Figure 1. Map of tracking the two launches. The location of the UAVA landing is nearest the launch point.

It didn't take long to write a small "C" program that opened the serial port at 4800 baud, read enough GPS strings to find the longitude, latitude, and altitude, and then close the port and re-open at 300 baud (I found that switching baud rates without closing and opening wasn't always reliable.) to send out a formatted telemetry string.

Of course, to do this I had to disable the login prompt on the serial port, and stop the kernel debug messages being sent to it, but all in all it was simple. All of this was done using the standard Debian image on a 4GB SD card.

Now for the live images. I had to apply a patch to Debian after which it happily recognized the webcam as /dev/video0. I tried a few webcams and settled on the Logitech C270, which is reasonable quality, light, and cheap (in case the payload goes missing!). I tried several webcam imaging programs and found fswebcam (http://www.firestorm.cx/fswebcam/) to be the best (worked without fiddling, yet with enough options to tailor the picture-taking).

Photo 5. The payload package with the various components installed.

Photo 6. The Raspberry Pi payload package.

Remember that the radio system has low bandwidth and with a typical flight lasting two hours or so we don't have time to send large images, so there's no point using the very best webcam and the highest resolution. I settled on 432 × 240 pixels with 50% compression as a good compromise between quality and download speed. I measured the webcam current and it went from 50 mA at idle to 250 mA peak when taking a picture, hence the need to short out the USB fuse (140 mA maximum).

A simple shell script took a photo every 30 seconds, saving them on the SD card so that the tracker program could choose the "best" image (largest jpeg!) for transmission. Each chosen image was then converted to the form for download (split into blocks each with FEC) before being sent one block at a time. I interspersed the image data with telemetry—four image packets for each telemetry packet. Photo 4 shows the Pi making a self-portrait.

With the completed tracker tried and tested, and permission for the flight gained from the CAA, I built a container for the Pi, webcam, GPS, aerials, batteries, and regulator. I didn't want to use too much insulation, as the payload package needed to not get too hot with 3–5 watts being generated inside, so I used 10-mm thick EPX material (see photo 5). Any thinner would have been too fragile.

As the launch day approached the wind predictions consistently showed an S-shaped flight path from the launch site near my home in West Berkshire, initially flying south, then east, then briefly north before turning west at higher altitudes. Then during descent it would go through those directions in the opposite sequence, finally landing somewhere in the Chilterns. With the weather (rain, as it was summer) looking okay, if not ideal, I ordered and collected the gas for the balloon. I obtained permission for two flights (figure 1) so a friend and fellow enthusiast Anthony Stirk, 2EØUPU, could come down and fly two new trackers that he'd built. With three trackers and two flights we opted to fly a large balloon with a small light tracker, then fly a second balloon with Anthony's larger tracker and a GoPro® HD video camera, and then attach the Pi to that. After a bit more thought we decided to add a third tracker as a backup to make sure we got that GoPro back!

The flight day came, and so did the rain, but that was predicted to pass so we waited and then went to the launch site as it eased to a light drizzle. First was the larger balloon with the small payload, so Anthony could make an attempt at the altitude world record. Then came the rather more complicated flight with my Pi payload at the top, then the GoPro payload, and finally my backup "Buzz" tracker which I'd flown before. Photo 6 shows the PIE1 payload package waiting to go. Photo 7 shows the balloon to which it is being attached.


Photo 7: The payload string being attached to the balloon.

The entire train of parachute and three payloads weighed 1 kg (same as my very first payload), and from the balloon to the lowest payload it was around 60 meters in length! The launch was interesting, as initially the wind kept the balloon low and the line was nearly horizontal! After a short wait the wind eased and the balloon lifted and got to an angle where it was safe to launch after running toward the balloon as fast as I could! I was relieved to see it all lift nicely, and that huge train made an impressive sight as it went up toward the clouds.

The launch site is in the village where I live, so afterwards we drove the chase cars back to my house to our "mission control" (see photo 8) to watch the tracking and images from there. The predicted landing spots meant there was no hurry to get back into the cars to chase the payloads, so we had plenty of time to watch the images come in (photos 9 and 10) and grab some food.

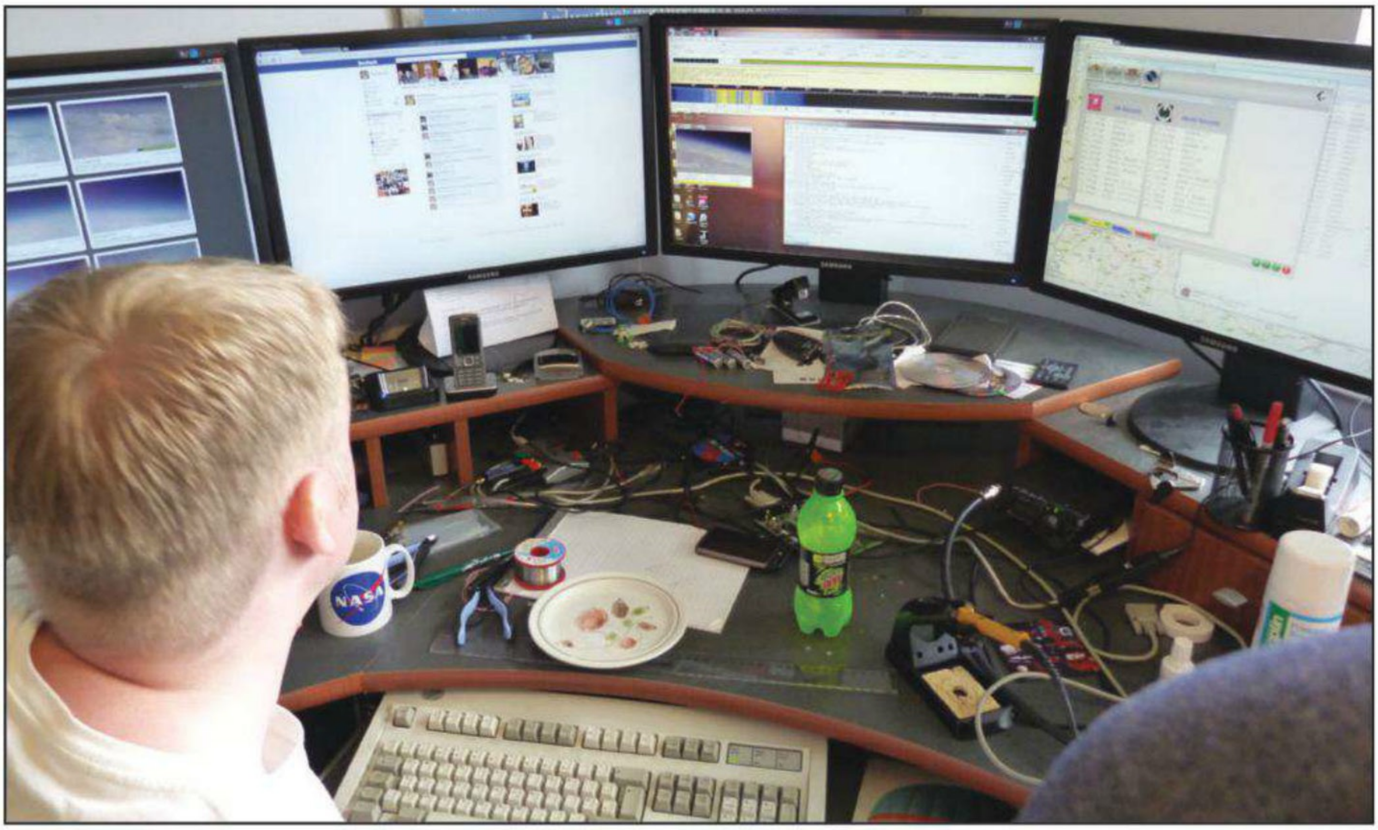
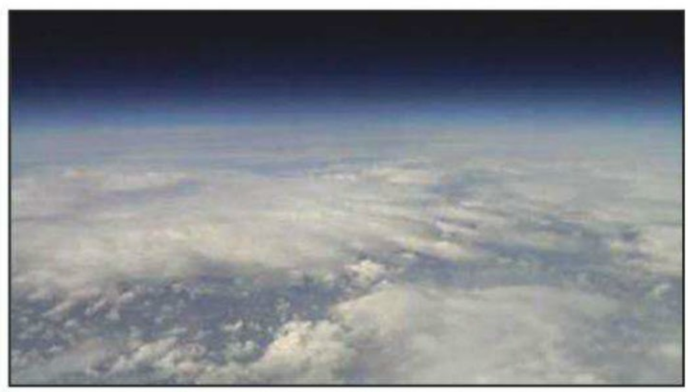


Photo 8: Mission control for the balloon launches.



Photos 9 & 10: Two images sent from the Raspberry Pi in the Sky payload package.

The first flight was the altitude attempt, using a make and size of balloon that from experience either bursts early at around 27 km or exceeds specification to reach 40 km or so. In fact, the top few places in the altitude record table are all held by that make/size. Anthony was, of course, watching the altitude reading in the telemetry quite closely!

Meanwhile, I was much more interested in how well the Raspberry Pi was doing. The GPS position was still showing the position at the launch site, which is a sure sign of interference to the GPS signal. I've not determined yet which it is, but the GPS receiver and antenna were quite close to both the Pi and the webcam in the payload. The next time I'll add screening and increase the distance a little.

However, the image data was coming in perfectly, not only through my antenna and receiver at home, but also via other

Photo 11: Raspberry Pi image from the landing spot.

receivers around the country. As the balloon got higher the pictures got better, and more receivers started getting good data, with some image data even being received as far away as Northern Ireland (over 500 km away—not bad for 10 mW!). Now a PIE flight isn't complete without a PIE chart, so figure 2 is an example, showing the number of image packets received by different listeners (thanks to all!)

Meanwhile, the first flight was creeping up the altitude table, eventually reaching the #4 position only 300-odd meters below the world record. Part of me was hoping it would go higher, but part was happy that it didn't knock me down from my #2 spot in the table! The balloon then burst, and initially the descent looked perfectly normal. However, most of the balloon was still attached, and it managed to produce a parachute-like shape which slowed the descent to only 2 meters per second at an altitude where it should have been doing at least five times that! Turning to the main flight, it was sending in image after image without errors, and each image being better than the last as the balloon went higher and higher.

We were expecting it to burst at around 34 km, but obviously the balloon wasn't aware of our calculations. It went through 34 km, and 35, and …. eventually burst just a few meters short of 40 km (39,994 meters to be exact, putting it at 12th place in the UK altitude record table).

Quite amazing for a medium-size balloon with about 1 kg of payloads underneath it! With both balloons having burst it was time to get going in the chase cars, both of which were equipped with aerials, radio receivers, netbooks or car PCs for decoding and mapping, and 3G internet.

The landing prediction for the main flight was near Didcot, so we headed there and parked up to check on the latest prediction. We weren't far away when the payloads landed at Milton Heights, just a few miles from the launch site. Amazingly, one of the receivers was close enough to still be picking up live images, and after a while everyone could see that the payload had landed safely in long grass (photo 11).

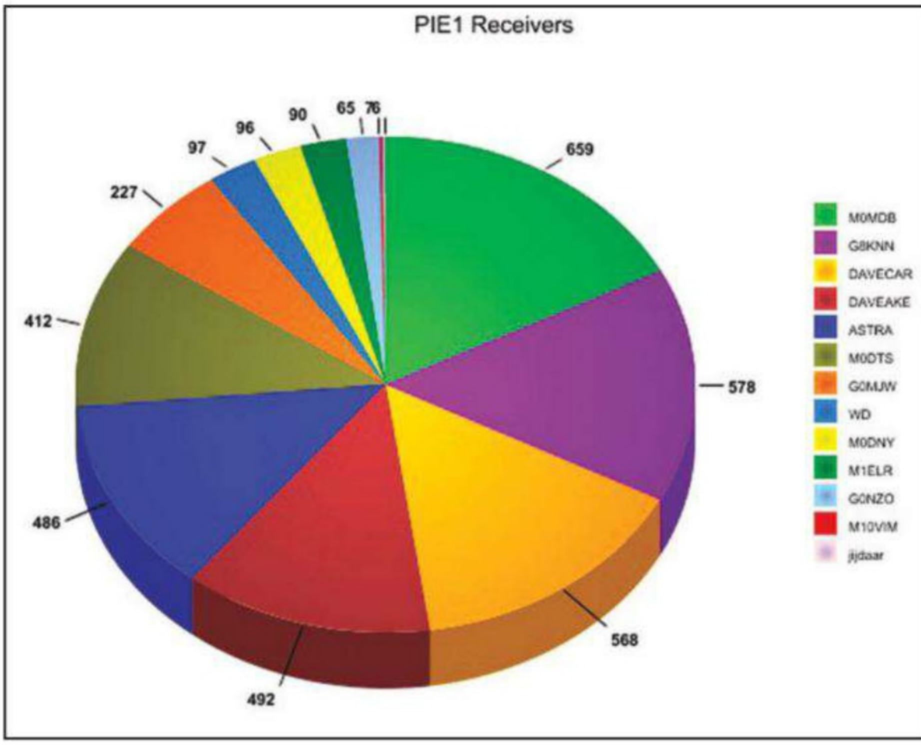


Figure 2. The pie chart showing the number of image packets received by different listeners.

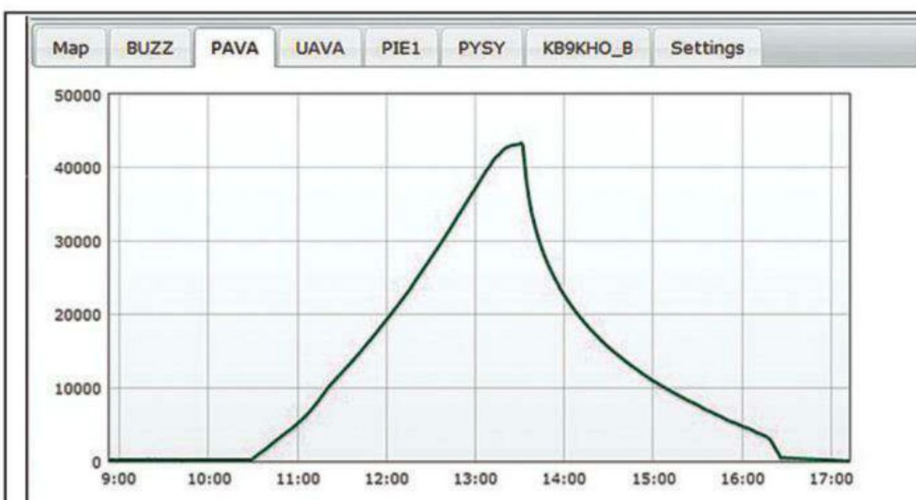


Figure 3. The very unusual altitude plot for the PAVA launch.

Photo 12. Anthony Stirk, 2EØUPU, left, and the author, right, holding the recovered payloads from the UAVA launch.

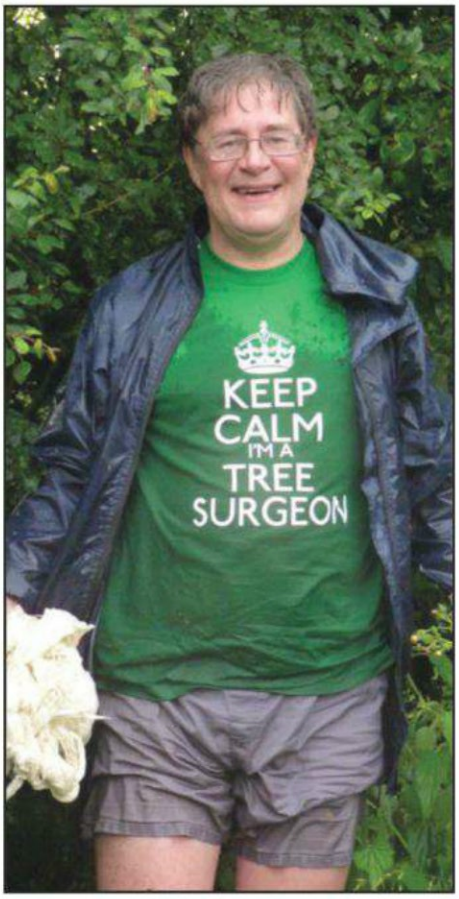


Photo 13. The author holding the shard remains of the balloon of the PAVA launch.

Anthony saw the payloads first from his chase car, in long grass next to a football field. Having obtained permission from the club, we rescued all three payloads and the parachute (see photo 12). Meanwhile, the earlier flight was still coming down, but very, very slowly – less than one fifth of the expected rate! We didn't know at the time, but now we were pretty sure that the latex had managed to form its own parachute. Then, with a few km to go, it suddenly sped up (we think the latex tore) and landed in a field north of Oxford. Figure 3 shows the very unusual altitude plot for the PAVA launch.

It took a while for us to get the final position, but having done so it seemed that it was in a rather inaccessible location. With the rain pouring down, Anthony decided to call it a day rather than try to retrieve what was only £50-worth of tracker. He then drove off, and I went online to tell the other receivers in the UKHAS chat room that I was about to go home, too. "Ah, but it's near a layby on the A34" I was told, "easy to get to" and "the rain will pass in 5 minutes." Well, that didn't sound so bad, so I set off north up the A34, then back southbound to get to the layby.

Well, of those three statements, one was correct—it was just 155 m from the layby. However, the rain just kept on coming, only easing from torrential to very heavy as we sat in the car waiting. Eventually I decided to just go for it, and crawled past trees and bushes to find … a field full of 5-ft. high maize. No chance of seeing the payload from there, although I tried. After failing, I went back to the car to get my Android® phone loaded with HamGPS software that guides you to a target location. It took a lot of effort to get there, and for a while I felt like I was starring in "Dave of the Triffids," but as I got to the target position I walked into the nylon cord between the payload and remains of the balloon! It really wasn't visible at all until I was almost on top of it. Photo 13 shows me emerging, successful, after my expedition.

Thanks go to Anthony Stirk, 2EØUPU, for driving down from sunny Yorkshire to grimmest, darkest Berkshire for the launch and supplying the GoPro HD footage, to Philip Heron for providing the webcam imaging and image encoding software, to Nick for coming along to help out, and of course to my wife Julie for keeping us fed and watered during the day and for driving my chase car whilst I did the techie stuff.

All in all, a great day HABbing. All fourtrackers worked well, all were recovered, and we got some stunning live images back. For more information on this fascinating hobby, visit the UKHAS web site (http://www.ukhas.org.uk/). For more images and video, see the sidebar "More Information and Details."

More Information and Details

All SSDV images: <http://www.flickr.com/photos/daveake/sets/72157630589478676/>
Photos from the day: <http://www. flickr.com/photos/daveake/sets/72157630584759530/>
pAVA Inflation Time-Lapse: <http://youtu.be/gloJM3O2DNo>
Burst video from the GoPro: <http://youtu.be/KGLB9-LdpYM>
Launch video of PIE1, uAVA, and BUZZ8: <http://youtu.be/OnmRudVV q_U>
Landing video from the GoPro: <http://youtu.be/XKF-2Bnj5IY>
Recovery of PIE1, uAVA, and BUZZ8: <http://youtube/Ui_wejYGV u0>
Anthony's write-up: <http://ava.upuaut.net/?p=315&cpage=1#comment -927>
You Tube of Akerman's talk at at the UKHAS 2012 conference: <http://www.youtube.com/watch?v=1LEaf1QLRUY&feature=player_detailpage#t=7681s>
PowerPoint file from UKHAS talk: <https://docs.google.com/presentation/pub?id=1N5EbUOyX-gh7qGffcOQDgMiRoqXTZna58IKzppEj15c&start=false&loop=false&delayms=5000#slide=id.gf5d3757_9_6>

Hopes Dim for 6-Meter F2 Activity During Solar Cycle 24

Perennial 6-meter prognosticator WB2AMU usually has hope against hope for good propagation on the Magic Band. Unfortunately, early indications of the peak of the current sunspot cycle are much lower than had been hoped for. Here he gives his less-than-optimistic report for the outcome of this cycle. Keep trying, though.

By Ken Neubeck,* WB2AMU

As I write this article in late December 2012, I had hoped that by this time my 6-meter logbook would be full of all types of contacts during the months of October and November via the *F2* propagation mode. So far there are no 6-meter *F2* contacts in my log, nor are there *any* contacts on 6 meters for those months. I had this hope based on some observations during early September when there were TEP (transequatorial propagation) and sporadic-*E* contacts made between here on Long Island, New York and Argentina. Also, I remembered how the last solar cycle, Cycle 23, performed during 2000 and 2001 and had hoped for the same type of performance for Cycle 24. During the month of December 2001, 6-meter *F2* openings were a daily occurrence.

Instead, I am looking at the NOAA data during early December as shown in Table 1, and for a solid week there were very low sunspot numbers, less than 80, along with solar flux values less than 100 as the lowest values so far during fall 2012. Figure 1 shows the solar disk for December 3, 2012, and it looks like there is not much there in the way of sunspots. These observations are not just a one-day situation, but more like a trend. Have we started running out of gas for Cycle 24?

At no time during the fall of 2012 did I see any solar flux value exceed 150 as compared to 2011, where on a few days in November, the SFI (solar flux index) exceeded 170, even reaching 180. Those conditions resulted in some marginal *F2* openings between the east coast and the west coast of North America. From the observational data, it appears that for values significantly less than 100, there is little chance of 6-meter *F2*-layer openings occurring. Thus, Cycle 24 seems to have no real momentum building with regard to significant *F2* openings on 6 meters. Essentially, this cycle is fading out rather quickly at the presumed peak, and for the first time since the evolution of ham radio a very weak sunspot cycle has occurred.

As it turns out, November 2012 was one of the worst months for any type of skywave propagation that I have seen on 6 meters in my 20-plus years of operating on the band. I did not observe any *F2*, sporadic-*E*, sporadic plus TEP paths, or aurora from my location during the month.

It would appear that the scientists may have gotten their predictions right for Cycle 24 in that it would be weaker than Cycle 23 and may be one of the weakest over the past several cycles (and since the ham radio hobby began). Many hams did not want to believe this and had hoped for even an average cycle in which some occasional *F2* openings would occur on 6 meters.

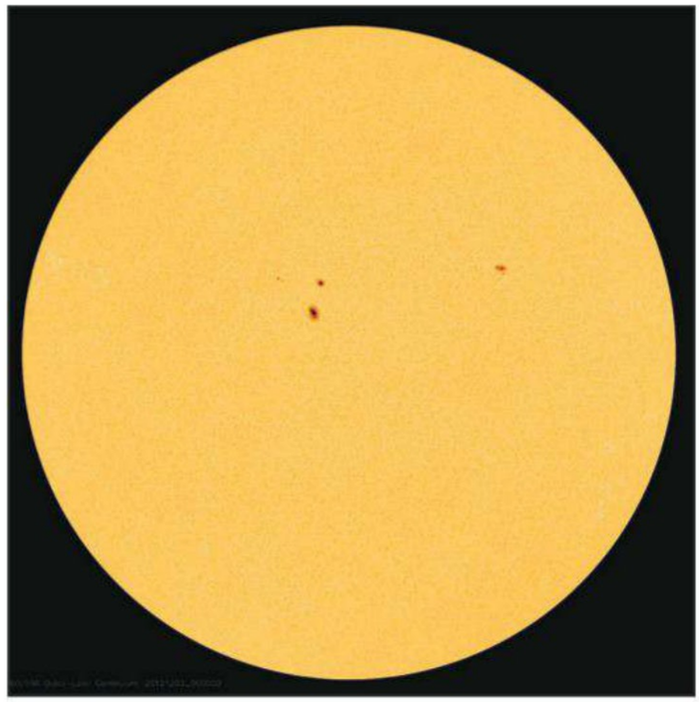


Figure 1. Sunspot activity for December 3, 2012. There is virtually no sunspot activity on the Sun for December 3, 2012. This does not bode well for the peak of Cycle 24 and the rest of this cycle. (Courtesy of NOAA)

The other indicator of geomagnetic activity, the *Kp* index, which can lead to aurora openings on 6 meters, was low for much of 2012. By tracking spaceweather.com, there were potential possibilities during the fall, but only high latitudes saw occasional aurora activity. The last big aurora opening on 6 meters that I observed at my latitude was during the summer of July.

As can be imagined, the low numbers shown in Table 1 meant marginal conditions on the higher HF bands, including 10 meters during the annual ARRL 10 Meter contest. I have been a participant of this contest for over 40 years and have witnessed the sunspot peak years along with the low sunspot years with activity being affected accordingly. The event in December

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2012 saw very poor activity, particularly in light of what is supposed to be the peak of the sunspot cycle. It was not a matter of any factors such as high geomagnetic noise affecting propagation, but instead it was the lack of suitable conditions for *F*-layer propagation. As a result, it was extremely difficult for East Coast stations to work into Europe during the event. Some sporadic-*E* activity helped during the contest for the U.S. stations, but *F2* activity was marginal. My overall score was significantly less than 2011, as European stations were able to be worked during that event.

Yet as poor as the ARRL 10 Meter contest was for 2012, there was actually a 6-meter opening between New Zealand and the northeast U.S. on December 10, an hour after the contest ended. Station ZL1RS was heard on 6 meters by several stations in the northeast beginning at 0030 UTC and was eventually worked by NWØW, NZ3M, and AK3E on CW. Signals were reported to be very weak, but it is amazing that such a path occurred during very weak solar conditions. Most likely this was some sort of *F*-layer (possibly TEP related) path that connected to the northern part of the U.S. via sporadic-*E*. Sporadic-*E* was present on 10 meters during a number of times during the weekend (as observed during the contest) and this form of propagation helps connect to any *F*-layer event that may occur,

Prognosis for the Remainder of Cycle 24

So what does the low sunspot activity really mean?

The weak solar cycle would be very troubling for those veteran hams who have had the experience of observing the regular routine of the solar sunspot cycle for the past few cycles and were hoping for sustained 6-meter *F2* activity on a daily, or even weekly, basis. What is worse is that there are indications by scientists that there may be even weaker solar cycles to follow, so this is very distressing news to hams used to the previous routine.

This is a very hard thing to come to grips with if you are a long-time ham who has experienced three or more solar cycles. You come to expect that the solar peak will bring exceptional activity for the high HF bands and 6 meters as well. Unfortunately, it appears that the very dynamic of the ham radio hobby is going to change for this cycle and the upcoming cycles. The 40-meter band may be the primary HF band, and bands such as 10 and 15 meters will have less activity, although they will still be monitored. This may well be the new reality for ham radio and could result in many changes going forward!

What does this mean going forward in the current cycle? I believe that there still may be some possibilities of *F2* activity during Cycle 24 based on the fact that there was a double-peak configuration for Cycle 23. However, there were specific circumstances for the double-peak of Cycle 23 and the sustained daily 6-meter activity during the fall of 2001 as pointed out in the Summer 2012 issue of *CQ VHF* magazine article by Jim Kennedy, KH6/K6MIO, that may not necessarily be repeated in Cycle 24. Because of the inconsistent behavior of the Sun with resulting low values, it is really hard to determine when the peak for Cycle 24 will occur or if it even has passed already. When I contacted Jim prior to my writing this article, he recommended that 6-meter operators focus hard on the equinox periods for TEP or TEP plus sporadic-*E* combination events to catch possible events.

Any *F2* activity that does occur from this point on will most likely be spotty events, where they will follow a major aurora event caused be a major solar flare impact on the Earth's geomagnetic field.

Date	Sunspot Number	Solar Flux Index
12/3/12	43	98
12/4/12	44	97
12/5/12	58	96
12/6/12	78	96
12/7/12	49	97
12/8/12	23	97
12/9/12	35	97

Table 1. Daily solar activity December 3–9, 2012.

Month	Possible Propagation	Occurrence
January	Sporadic-E	3 to 5 days
February	Sporadic-E	1 to 2 days
March	Aurora	1 to 2 days
	TEP (into southern US)	3 to 5 days
April	Aurora	2 to 5 days
	TEP (into southern US)	5 to 10 days
	TEP plus Sporadic-E	1 to 2 days
May	Sporadic-E	10 to 15 days
	TEP plus Sporadic-E	2 to 3 days
June	Sporadic-E	20 to 25 days
July	Sporadic-E	20 to 25 days
August	Sporadic-E	10 to 15 days
	Aurora	1 to 2 days
September	Aurora	1 to 2 days
	Sporadic-E	1 to 2 days
	TEP (into southern US)	2 to 3 days
	TEP plus Sporadic-E	1 to 2 days
October	Aurora	2 to 5 days
	Sporadic-E	2 to 3 days
	TEP (into southern US)	2 to 3 days
	TEP plus Sporadic-E	1 to 2 days
November	Sporadic-E	2 to 3 days
	F2	3 to 5 days(?)
December	Sporadic-E	3 to 5 days
	F2	3 to 5 days(?)

Table 2. Six-meter activity forecast for North America during 2013.

Typically, flare activity is stronger on the downside of each solar cycle, so that could be a good optimistic thought to have for Cycle 24.

Using my experience from the previous solar cycles and taking into account the diminished aspects of Cycle 24, I developed a prediction table for 2013 with regard to possible 6-meter activity that may be expected for North America (Table 2). While sporadic-*E* has a consistent pattern, the interesting thing will be to see if sporadic-*E* will occur during other propagation paths such as *F2* or TEP. This will require careful monitoring of the 6-meter band during these time periods where such potential could occur.

CQ's 6 Meter and Satellite WAZ Awards

(As of January 1, 2013)

By Floyd Gerald,* N5FG, CQ WAZ Award Manager

6 Meter Worked All Zones

No.	Callsign	Zones needed to have all 40 confirmed
1	N4CH	16,17,18,19,20,21,22,23,24,25,26,28,29,34,39
2	N4MM	17,18,19,21,22,23,24,26.28.29,34
3	JI1CQA	2,18,34,40
4	K5UR	2,16,17,18,19,21,22,23,24,26,27,28,29,34,39
5	EH7KW	1,2,6,18,19,23
6	K6EID	17,18,19,21,22,23,24,26,28,29,34,39
7	KØFF	16,17,18,19,20,21,22,23,24,26,27,28,29,34
8	JF1IRW	2,40
9	K2ZD	2,16,17,18,19,21,22,23,24,26, 28,29,34
10	W4VHF	16,17,18,19,21,22,23,24,25,26,28,29,34,39
11	G0LCS	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	17,18,19,22,23,26,34,38
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	1,18,19,32
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	1,2,18,19,29
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
100	OK1RD	2,6,7,8,9,11,12,13,18,19,21,22,28,39,40
101	S51DI	1,2,6,18,19
102	S59Z	1,2,6,7,10,12,17,18,19,22,23,24,26,31,32
103	UY5ZZ	1,2,3,6,7,10,11,12,13,18,19,29,31,32,39
104	UXØFF	1,2,6,7,10,12,13,18,19,22,28,29,31,32
105	EI3IO	1,3,12,18,19,23,29,30,31,32
106	JJ2BLV	2,4,5,7,8,9,16,18,19,34,35,36,37,38,40
107	EA6SX	1,2,10,12,18,19,22,26,27,28,29,30,31,32.
108	PE5T	1,2,3,6,12,18,19,22,27,29,30,31,32,39
109	SP3RNZ	1,2,3,6,7,13,18,19,23,24,26,28,31,32
110	W9VHF	17,18,19,21,22,23,24,26,28,29,30,34,36,39
111	UT5URW	1,2,3,4,6,7,10,11,12,18,19,29,30,31,32
112	KR7O	18,19,21,22,23,26,28,33,34,35,36,37,39,40

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
25	KCØTO	17 Mar. 11	None
26	TI5RLI	10 July 12	2, 16, 19, 22, 23, 24, 26. 34

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>*

Hawaii VHF/UHF Beacon Update and a Tribute to KH6HME

Over the decades of Paul Lieb, KH6HME's efforts, hundreds of West Coast amateur radio operators were able to work Hawaii on 144 MHz and above, with a few making contact with him on the microwave bands, Unfortunately, he became a Silent Key last summer, leaving a huge concern over whether or not anyone would be able or willing to continue to operate the Hawaii side of the circuit. In this article WB6NOA pays tribute to his dear friend and gives the good news update.

By Gordon West,* WB6NOA

West Coast VHF/UHF weak-signal operators may continue to keep their horizontal beams pointed due west, into the Pacific. The current plan is for the multiple propagation beacons on the 8500-foot site on the Mauna Loa volcano to continue transmitting continuously on 144, 222, and 1296 MHz.

Every July and August, like clockwork, a stationary Pacific high straddles the Hawaiian Islands and the west coast of the United States mainland and Mexico. For sailors needing good winds for the yearly July yacht race from California to Hawaii, they must steer south to avoid getting caught in the Pacific high windless "doldrums."

These windless doldrums lead to intense tropospheric duct creation as the high-pressure cell develops subsidence (heavier air sinking) and stratifies over the Pacific between Hawaii and the West Coast. This stratification of sinking air creates a bump up in air pressure near the water, and this increased air pressure also creates a temperature inversion. The 2500-mile inversion layer literally traps VHF and UHF signals as documented by the U S Navy Tradewinds Experiments in the 1950s and 1960s.

In the early 1960s, ham operators found the July and August "tropo duct" an intriguing technique for communicating between the mainland and the islands. This finding led Paul Lieb, KH6HME (SK), and Chip Angle, N6CA, to mount continuing higher band efforts to ultimately complete a QSO at 5 GHz!

Lieb was also intent on bringing in as many distant signals on 2 meters SSB and FM (!) as well as 432 MHz SSB and FM. After his three-hour drive from Hilo up the mountain to the 8500-foot beacon

Paul Lieb, KH6HME (SK), in front of his volcano shack. In the background are: (left) two stacked 144-MHz Yagis topped by a 1296-MHz loop Yagi; (middle) a VHF/UHF vertical, and (right) a 432-MHz Tagu topped by a 144-MHz vertical.

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site, he would spend as many as three days making stateside contacts to as far north as Washington State, and record-breaking contacts to the tip of Baja California, Mexico. If the bands stayed open, KH6HME stayed at the site!

Unfortunately, last July, Paul Lieb passed away peacefully in his sleep. Grid square BK29GO went silent for QSOs. Even so, the beacons kept on. The dilemma became: Who would carry on the operation or would the beacons come down, leaving only the FM repeaters at the mountainside site?

Good News! A longtime friend of Paul, Fred Honnold, KH7Y, has mounted the effort to keep the weak-signal beacons on the air. "Recently, Dean Manley, KH6B, and I went up to the site. As it turns out, we are in fine shape and I see no bumps in the road for now," reports Fred.

"There are a few items needing attention: A 50-amp power supply needs to be replaced. Plus the heavy winds have bent the 2-inch mast holding the 222- and 432-MHz antennas, so they were pointing up about 30 degrees. However, signals were still being heard on the U.S. West Coast. The 2-meter stacked array is in fine business," adds Fred. He plans to transfer the KH6HME callsign over to the club call W6KFI, the California Pacific Radio Club. Jim, K6MIO/KH6, is the trustee of KH6HME (California-Pacific ARC). Fred reports, "All the paperwork has been submitted. We're still waiting for the license transfer." Working with Fred are weak-signal operators Jim Kennedy, K6MIO/KH6, Dean Manley, KH6B, Robert Newcomb, WH6XM, and Richard Gardner, WH6LU.

Fred also met with Paul's family in southern California and acquired his 20-year-plus collection of notes, letters, and QSL cards. "My hope is to put together enough information to create a KH6HME web page," adds Fred, along with his ongoing effort to recruit youth to get involved with this historic beacon site.

Historic indeed! During one band opening, the signals were strong enough to support an analog amateur television QSO between us, and an FM QSO from a single loop on the beach to his FM mobile as he was driving across the lava fields on the mountain.

"I have also received his logs from the early 1990s forward, but I'm still looking for the records from the 1980s. The logs have been sent to Chip Angle, N6CA, to analyze all the data," adds Fred. Fred indicates there are a few QSL cards received with no indication of their being returned by Paul. Anyone still needing a KH6HME QSL card please contact Fred. He has Paul's well-detailed logs.

In *my* possession are numerous atmospheric notes from Paul, tracking his reception of FM broadcast stations from the mainland, and correlating the tropospheric ducting conditions at the beacon site with measured thermometer and barometer atmospheric recordings. On almost *every* successful series of QSOs over the 2500-mile path, on VHF and UHF bands, a temperature inversion *greater* than 10 degrees was registered at the beacon site, and compared with much cooler readings *below* 7000 feet. We also have many audio tapes of the openings. These will also be sent to Chip, N6CA.

Some of Paul's notes also included atmospheric studies on the days of the band openings, and the thicker the duct, the lower the path frequencies. A thinner duct would lead to enhanced UHF conditions on 432 and 1296 MHz.

However, in all *my* notes, in monitoring the beacons, *never* was there a time when the 432-MHz beacon would be received 2500 miles away without the 144-MHz beacon also being received. Conversely, as the 144-MHz beacon would peak over a several hour period, the 432- and 1296-MHz beacons also would peak. However, almost always the 144.170-MHz beacon signal would show up first as the band was beginning to open.

"The beacon building site manager and I go way back, like 50 years!" reports Fred. "We have met many times over the years in broadcast FM and TV, so what will come out of this is written agreements with the California Pacific Radio Club, W6KFI, and our beacon group?" finalizes Fred.

With six months before solid tropo band openings between the mainland and Hawaii, Fred Honnold, KH7Y, offers positive comments and plans to follow in Paul's footsteps. "We will be adding 2-meter antennas and they will be pointed to Guam for tests this next summer on 2 meters only," says Fred.

I have already pledged to support the new beacon efforts. For those who wish to join us in helping to support the Hawaiian beacon project, in memory of Paul Lieb, you may call Fred at (808) 557-9022 or e-mail him at <KH7Y@alohabroadband.net>.

Thanks go to Chip Angle, "N6Captain-America," for all his microwave work with Paul. Who knows? The tropo duct of all ducts that we *know* is *there* could very well open the 10-GHz path from here to Hawaii!

By Joe Moell,* KØOV

HOMING IN

Radio Direction Finding for Fun and Public Service

RDF Keeps Tabs on Rovers and Provides International Competition for Hams

"Will you have enough material for an article in every issue?" That's the question an editor asked in 1988 when I proposed a regular magazine column about all aspects of radio direction finding (RDF). I confidently replied in the affirmative, not realizing that there would be far more to write about the subject than I could imagine at the time.

This is "Homing In" column number 201 and the backlog of ideas for future columns continues to grow. There are new RDF devices and techniques to review and mobile foxhunting stories to tell. There is a constant stream of news about on-foot transmitter hunting under international rules, which is called foxtailing, radio-orienteering, and ARDF (for amateur radio direction finding).

Besides being more popular than ever in amateur radio, RDF is also being done more and more by non-hams. The proliferation of GPS devices in recent years hasn't come close to eliminating the need for simple and inexpensive radio tracking methods. In previous columns, I have told you about RDF systems for the masses such as the Cat locator,[1] Project Lifesaver,[2] and the Auto-Finder.[3]

Dog owners may be the biggest potential market for consumer RDF tracking. Many who raise hounds for sport hunting have invested in transmitter collars and RDF gear from the same companies that make professional wildlife tracking systems. When their dogs are following the scent of an animal such as a fox or raccoon, they may run several miles away from their owners. Radio tracking allows the humans to catch up and to round up any hounds that stray from the pack.

Owners of non-hunting pet dogs can benefit just as much from a radio tracking system, especially if Fido and Rover have a penchant for disappearing from the yard and playing "catch me if you can." The best system in this case would be one that gives prompt warning when pets have eloped and indicates the direction in which they left.

Tim Crabtree performs the pressure test on a Marco Polo dog tracking tag to verify that it will continue to work if Fido goes swimming. (All photos by Joe Moell, KØOV)

In 2001, entrepreneur Tim Crabtree of Yorba Linda, California set out to develop just such a system. He had many technical hurdles to be overcome and questions to be answered. What is the best RDF technology for good directional performance and ease of use by non-technical persons in this application? What frequency band provides the optimum combination of range and equipment size? How well do RF signals propagate from short antennas on collars when pets are close to the ground? How can battery life be optimized?

After several prototypes and lots of experimenting with Tim's own dogs, it became clear that Doppler RDF technology on UHF could do the job nicely. However, that discovery was just the start of a lengthy process that eventually led to the first production run of the Marco Polo Pet Monitoring, Tracking and Recovery System in 2012. Tim's products can now be ordered directly from his company, Eureka Technology Partners.[4] Availability in local stores is on the horizon.[5]

A Miniature Doppler

Because it doesn't need to include a GPS receiver, a Marco Polo pet tag transmitter weighs less than two ounces and works for up to 90 days without recharging its 4/5-AA lithium battery. It puts out bursts of spread-spectrum signal near 900 MHz that uniquely identify it. Tags are weatherproofed for rain and shallow submersion.

The locator unit measures 3 × 6 × 1.5 inches when closed and performs both monitoring and tracking functions. Once a tag is electronically paired with a locator, the locator can be set to communicate with the tag every 40 seconds for monitoring. If strength of the signal from the tag drops below a programmed threshold, the locator's alarm alerts the user that the pet may have strayed out of bounds.

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There are four possible threshold levels, corresponding to typical boundaries for small condos and campsites, urban settings, suburban yards, and large estates.

In tracking mode, the display helps locate the pet with both Doppler RDF and received signal strength indication (RSSI). Four half-wavelength Doppler antennas, on flexible circuit material, are inside the four doors that fold out from the top and bottom of the locator enclosure. They are geared so that opening the top doors to view the display also opens the bottom doors, placing the antennas are in exactly the correct positions for Doppler RDF.

Upon entering the tracking mode, the locator signals the tag to increase its transmission rate to every four seconds. Each time a transmission is received, the locator displays an arrowhead in one of 16 directions, indicating the approximate azimuth of the signal relative to the locator as it is being held. RSSI is displayed numerically from 0 to 99% and is also shown by the number of range bars emanating from the dog icon on the display. The unit beeps one, two, or three times each hit as another indication of RSSI and the relative distance to the tag.

Making it Consumer-friendly

Over the years, I have introduced hundreds of Scouts and other youth to short-range on-foot transmitter hunting with measuring-tape Yagis. Most catch on very quickly, but there are a few who just don't seem to grasp the concepts. I think that the Marco Polo system is considerably easier for non-technical folks to use. What could be simpler than an arrowhead pointing to the incoming signal direction?

The 22-page Marco Polo manual is small in size, but it's very clearly written for non-technical folks. There are two pages of tips to help beginners grasp the basics of Doppler RDF, including tracking from a vehicle and close-in triangulation. A waterproof Quick Reference Guide card also is included.

Good designers try to think of every way that a consumer can improperly use a product. In the case of this portable Doppler set, the four antennas must be kept perpendicular to level ground. It won't get bearings if it is upright with the display vertically in front of the user's eyes, like a mirror. The manual cautions in several places that the locator must be held out front and carried "like a pan of water" with the display facing up.

A downside of pelorus Doppler RDF displays like this is that signal reflections (multipath) occasionally cause the displayed bearings to "jump around" the directional circle, but that's when the RSSI indications can help. Even when the directional indications become completely unusable, which is rare, the RSSI numbers and bars serve as "warmer/ colder" indications to help the user determine the direction to the tag. As one closes in, the multipath effects generally will diminish and directional indications will improve.

In addition to a directional arrowhead, the Marco Polo locator display shows signal strength as a percentage and by the number of curved bars.

Inside a pair of Marco Polo tags, one with circuit board removed to show the lithium battery.

Instructions for finding a lost pet with the Marco Polo system are on the back of the locator.

Occasionally in areas of high signal reflections, Marco Polo will be unable to obtain a usable bearing because the tone induced by the sequencing of the antennas is not "clean" enough. When that happens, the display flashes "CHANGE LOCATION." Upon moving to a clear location, RDF bearings usually will resume quickly.

It's my guess that the long delay in getting Marco Polo into production had a lot to do with Tim's never-ending quest to optimize the product. As the months went by, he added functions and nuances that turned it from a simple RDF tracker into a feature-rich pet management system. I can't imagine how many times that the firmware in the tag and locator were upgraded and rewritten in the process.

One locator can simultaneously monitor three tagged critters, each with different boundary settings if desired.[6] Locators can "teach" tag codes to each other, a very useful feature when multiple searchers need to track the same lost pet. A jack on the locator provides contact closure for an external "pet missing" alarm in the monitor mode. When charge of tag batteries is low, this information is communicated to the locator and indicated on the locator display. The locator can monitor continuously from its "wall wart" charger, or for about three days on its internal battery.

Dopplers for Dits

In my e-mail this month was an excellent question from a reader in Vermont. He wanted to know if it is practical to use the Doppler RDF method to get bearings from the VHF transmitters used by biologists and wildlife researchers. To give battery life measured in months, these very low-power transmitters send a "dit" with duration of 25 milliseconds or less every second or two.

For maximum range and ease of tracking, the standard direction-finding system for these "ditters" has a directional gain antenna such as a Yagi or HB9CV beam.[7] The receiver has narrow IF bandwidth and a SSB/CW detector with beat-frequency oscillator (BFO), providing significantly more sensitivity compared to FM communications receiver IF stages and detectors. The narrow IF also makes it possible for the critters being tracked to be on individual frequencies separated by a kilohertz or so.

This manual RDF method works very well for field tracking on foot, but it requires special antenna mounting for vehicular use and it isn't amenable to automated bearing-taking and logging with computers. By contrast, Doppler RDF sets are easy to mount on vehicles and many have a serial bearing output for computerized tracking and plotting.[8] However, almost all Dopplers are optimized for transmissions lasting for at least a second.

Readers involved in search and rescue have also asked about Doppler tracking of short-duration signals. The newest generation of emergency rescue beacons[9] transmit on 406 MHz for about a half second at a time. Even though these transmissions contain GPS information, it is sometimes inaccurate. These rescue beacons also have continuous transmitters on 121.5 and 243 MHz, but those transmitters run much less power and sometimes fail. When that happens, searchers need to perform RDF on the higher powered burst transmissions at 406 MHz.

The 406-MHz bursts occur at about 50-second intervals, far too infrequent for manual tracking. One cannot sweep a beam through a full azimuth circle and get a usable bearing in less than a half-second. It can take many minutes to get enough transmissions to deduce the signal bearing manually, hence the desire for the Doppler method.

Typical VHF/UHF Dopplers contain high-Q switched-capacitor filters that are heavily damped to provide the narrowest possible audio passband. Ideally, the filter would pass only the detected Doppler tone frequency, which is the same as the frequency of antenna pseudo-rotation. If the filter were wider, modulation on the signal (GPS data in this case) would introduce errors in bearing readout. These high-Q filters are slow to acquire and resolve the Doppler tone. Long-time Civil Air Patrol member Bob Miller, N6ZHZ, reports that his Doppler, a commercial unit from a well-known company, consistently gives bearing errors of 90 degrees on his practice 406-MHz EPIRB, even though bearings on continuous signals in the same frequency range are accurate.

My answer to the reader in Vermont was that Doppler tracking of short-ping signals is indeed possible. It is being done successfully in the Marco Polo system described above. However, it can't be done using ordinary FM communications receivers and scanners and with the Doppler sets now being sold in the ham radio market. Bob Simmons, WB6EYV, of Santa Barbara, California has constructed a custom Doppler tracking system for wildlife transmitters under contract to a major university. It is based on his PicoDopp RDF set[10] but has several important enhancements.

The first problem to be overcome is delay in signal acquisition. A typical FM communications receiver's noise-operated squelch takes dozens of milliseconds to open when a signal

The final functional test of Marco Polo Doppler locator units is automated with a PC.

comes on. Adding a separate squelch utilizing the receiver's RSSI circuitry can get the response time down to a millisecond or so. This maximizes the duration of the signal pings presented to the Doppler unit.

Next, the Doppler's tone filter must be speeded up. A typical filter with 2 Hz bandwidth will need at least 80 milliseconds to settle. Increasing the filter bandwidth decreases settling time at the cost of decreased noise immunity. This is OK for wildlife transmitters because they usually are unmodulated.

Increasing the antenna switching (pseudo-rotation) rate will improve performance on short-ping transmissions. However, this must be done with caution because the FM deviation of the induced Doppler tone is directly proportional to the switching rate. An increase in receiver IF bandwidth may be necessary if the deviation, and thus the signal bandwidth, exceeds that of the receiver. The complete formula for determining the tone deviation, which is a function of RF frequency, switching rate, and array size, is in Chapter 9 of my book on RDF.[11]

Lastly, the target transmitters must have good short-term stability. Some wildlife tracking tags have simple "squegging" oscillators[12] that produce frequency chirp and amplitude variations over the duration of each ping. Doppler RDF performance will be better with high-stability transmitters such as the ones made by Communications Specialists,[13] which have temperature-compensated crystal oscillators (TCXOs) and digital keying.

Even with all these adaptations, the convenience and automation that the Doppler provides will come with a significant penalty in tracking range. With the advantages of high gain in the antenna and narrow bandwidth in the receiver, it's no wonder that the tried-and-true amplitude method of RDF is still preferred by researchers when their targets can roam over many square miles. By comparison, the best range of Doppler RDF on wildlife transmitters probably will be measured in yards. For a few applications, such as continuous monitoring of wildlife activity in a small area, that may be good enough.

Have you experimented with Doppler RDF on signals of very short duration? If so, I would like to correspond with you by e-mail to compare experiences.

2013: A Big Year for ARDF

I'm pleased to report that a fine location has been selected for the 2013 USA championships of on-foot radio direction finding. The Birkhead Mountain Wilderness near Asheboro, North Carolina features lush forests, streams, and rocky climbs to provide challenging sessions of radio-orienteering. This year's ARDF championships for USA are being combined with the championships of International Amateur Radio Union (IARU) Region 2, which encompasses North and South America.

Hosting the championships will be Joseph Huberman, K5JGH, and Ruth Bromer, WB4QZG. Giving them technical assistance will be Charles Scharlau, NZØI, and Nadia Scharlau, who was ARDF Team USA's first World Championship medal winner. Backwoods Orienteering Klub is the sponsoring organization.

The optional training, sprints, and foxoring events will be October 9–11, followed by full-course competitions on 2 meters and 80 meters during the weekend of October 12–13. The formal announcement with travel, lodging, and registration information goes online as this issue goes to press.[14]

The other IARU regions are also having ARDF championships in 2013. The 19th IARU Region 1 ARDF Championships for all ages will be September 9–15 in Kudowa Zdroj, Poland. The 14th European Youth ARDF Championships will take place in Tri Studne, Czech Republic from June 12–16 for persons with birthdays in 1997 and later.[15] Visiting competitors from the USA are welcome at both events.

Korean Amateur Radio League will host the 9th IARU Region 3 ARDF Championships at Hongcheon Gangwon Province, September 1–6. Since some Pacific islands with KH prefixes (e.g., Guam and American Samoa) are inside Region 3, the ARRL is a member society of IARU Region 3. This means that participants from anywhere in the USA and its territories are eligible to form a national team to compete at the Region 3 championships. If you are interested in traveling to Korea to be on Team USA for these championships, please contact me right away. A Letter of Intent to send a team is due to the Korean organizers by March 31.

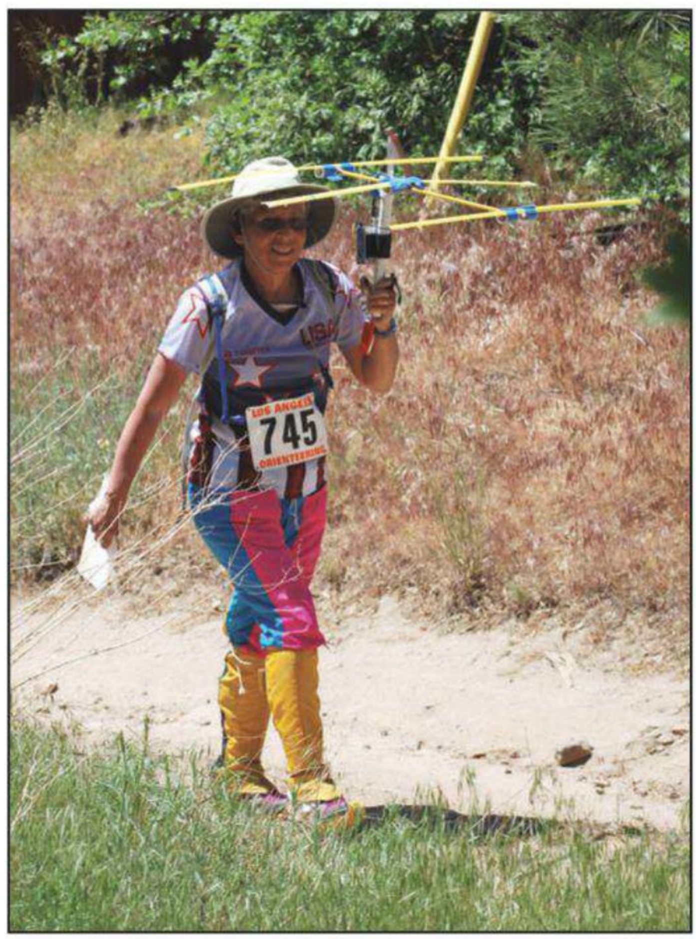
There may be snow on the ground now, but the weather will be warming up soon and it will be time for on-foot transmitter hunting activities nationwide. Start making plans now. There may be a future ARDF champion in your local club waitzing to be discovered and trained. If there is an orienteering club nearby, make contact now to plan some joint activities. I hope to see you at future ARDF championship events.

73, Joe, KØOV

Notes

1. http://www.com-spec.com/thecatlocator/index.htm (see "Homing In" for Spring 2006)
2. http://www.projectlifesaver.org (see "Homing In" for Winter 2008)
3. http://orbitalfinder.com (see "Homing In" for Winter 2011)
4. http://eurekaproducts.com
5. Disclosure: I participated as a consultant in the early prototyping stage of this project. Once the RDF concepts were proven, I left the product development team. I no longer have a business relationship with Eureka Technology Partners.
6. A version of the locator that monitors up to six pet tags at a time is now being tested. Directional indications are provided for only one tag at a time.
7. The HB9CV beam is a coax-fed version of the classic "ZL special." It has two close-spaced elements fed 135 degrees out of phase to provide a cardioid directional pattern.
8. See "Homing In" for Winter 2012 and Spring 2012
9. Emergency Locator Transmitters (ELTs) for aircraft, Emergency Position Indicating Radio Beacons (EPIRBs) for watercraft, and Personal Locator Beacons (PLBs) for outdoor enthusiasts
10. http://www.picodopp.com
11. Moell and Curlee, "Transmitter Hunting—Radio Direction Finding Simplified," TAB/McGraw-Hill #2701, http://www.homingin.com/THRDFSinfo.html
12. http://www.homingin.com/joemoell/ squegg.html
13. http://www.com-spec.com/rcplane/ index.html
14. For upcoming international ARDF events, see http://www.homingin.com/ farsnews.html
15. http://eyac2013.com

A ranger at the Squaw Creek National Wildlife Refuge in Missouri holds two of the tiny VHF transmitters with trailing wire antennas that he uses to monitor and track various species of sandpipers. To maximize battery life, each emits a 20-millisecond unmodulated "dit" about once per second. Thousands of radio tags like this are in use by researchers around the world.



Ruth Bromer, WB4QZG, of Raleigh, NC won a gold medal and a silver medal at the 2012 USA ARDF Championships at Mt. Laguna, California. Then she went on to capture two medals at the ARDF World Cup and World Championships in Slovakia. Ruth and her husband Joseph Huberman, K5JGH, are organizing the 2013 USA and IARU Region 2 ARDF Championships that will take place during October.

By Bill Brown,* WB8ELK

New Heights for Amateur Radio

25th Anniversary Flight

On August 15, 1987, I launched the first amateur radio high-altitude weather balloon in the U.S. which carried an Amateur Television (ATV) transmitter and a low-power 2-meter FM transmitter. Since this was well before the advent of GPS, we had to rely solely on direction-finding techniques to track the balloon during flight. We lost the payload for six weeks, but my backup recovery system (the reward sign) paid off when a farmer found it in his soybean field. Since that time, I've launched over 400 missions in 20 states.

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To celebrate the 25th anniversary of that first flight, I decided to do a long-duration flight this past August 18th that coincided with the Huntsville Hamfest in Huntsville, Alabama.

California or Burst

My goal for this flight was to fly a balloon across the country to California. It turns out that during the summer months the winds in the stratosphere are from the east, which would take a balloon floating around 110,000 feet on a flight to the West Coast in about two or three days.

I assembled three payloads for this flight. The first was a Doppler DF Instruments MicroBeacon APRS transmitter on 144.39 MHz (WB8ELK-11). The second payload was an Elktronics 25-milliwatt QRP 2-meter FM transmitter sending DominoEX22 and 300-baud RTTY. The third payload carried an Elktronics half-watt HF transmitter sending position and telemetry via the digital modes DominoEX16 and 110-baud RTTY on the 20 meter band.

If you inflate a large high-altitude balloon with a small amount of positive lift resulting in an ascent rate below 400 feet/minute, it is possible to get the balloon to float near its burst altitude for upwards of a day or two. I used a new 1600-gram balloon from Hwoyee Balloon

Photo 1. Launch of my first balloon on August 15, 1987. Shown here are Bill Brown, WB8ELK, holding the payload with Joe Brown, WB8MSJ, looking on.

Photo 2. The 500-milliwatt 20-meter HF payload.

that has been known to achieve remarkable long-duration flights. This balloon allowed the California Near Space Project team to fly an APRS payload from San Jose, California to the Mediterranean Sea in December 2011 and once again to Morocco on December 2, 2012.

We met at the NSSTC (National Space Science and Technology Center) building a few miles west of the Huntsville Hamfest to inflate and launch the balloon. There were almost no surface winds, so I was able to stand there in the parking lot holding the last payload with the balloon suspended 100 feet above me while everyone took photos. This was a far cry from my first flight 25 years ago when the winds were over 20 knots and my fragile payload smashed into the ground several times before finally taking off.

The balloon lifted off just after 1:00 pm CDT and we all headed back to the Huntsville Hamfest to track the balloon's flight path. Alan Sieg, WB5RMG, and Tim Cunningham, N8DEU, had a ground station at the AMSAT booth at the hamfest and displayed both the HF and APRS flight paths in real-time.

On the way up to the float altitude, the balloon headed about 80 miles due east and actually crossed into Georgia. As we all held our breath and crossed our fingers, we were relieved to see the balloon actually level off and float around 109,000 feet. At that altitude it headed back west toward Huntsville again and passed directly over the Huntsville Hamfest nearly four hours after we had launched it.

The 20-meter payload was working wonderfully, with hams around the country receiving great reports on the QRP signal, although competing with high-power RTTY contest stations was quite a challenge at times. Partial reports were heard in England. and several complete positions reports were copied by Tomasz Brol, SP9UOB, in Poland at a distance of 4978 miles.

On Through the Night

The balloon continued almost due west at a steady 50-mph clip all night long. Mike Bogard, KDØFW, in Independence, Missouri was able to copy the 25-milliwatt 2-meter FM transmissions from over 400 miles away for several hours during the night. The HF transmitter stopped working just after mid-

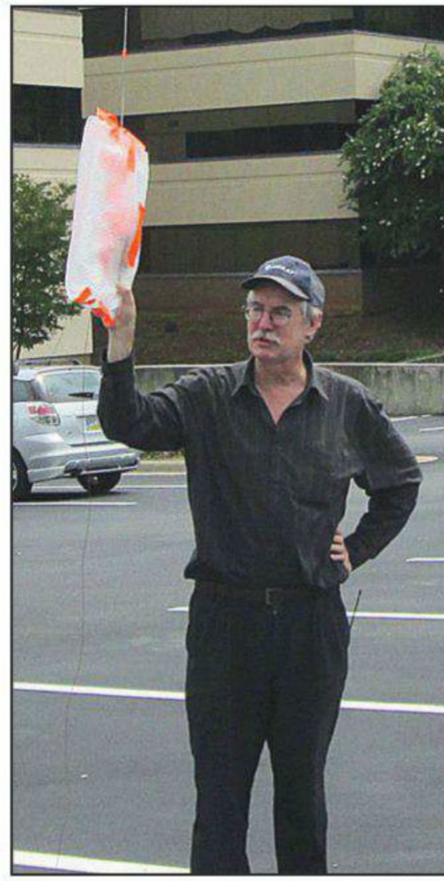

Photo 3. WB8ELK launches the 25th anniversary balloon. (Photo by Mark Garrett, KA9SZX) →

Photo 4. Alan Sieg, WB5RMG (left), and Tim Cunningham, N8DEU (right), tracked the flight from the AMSAT booth at the Huntsville Hamfest.

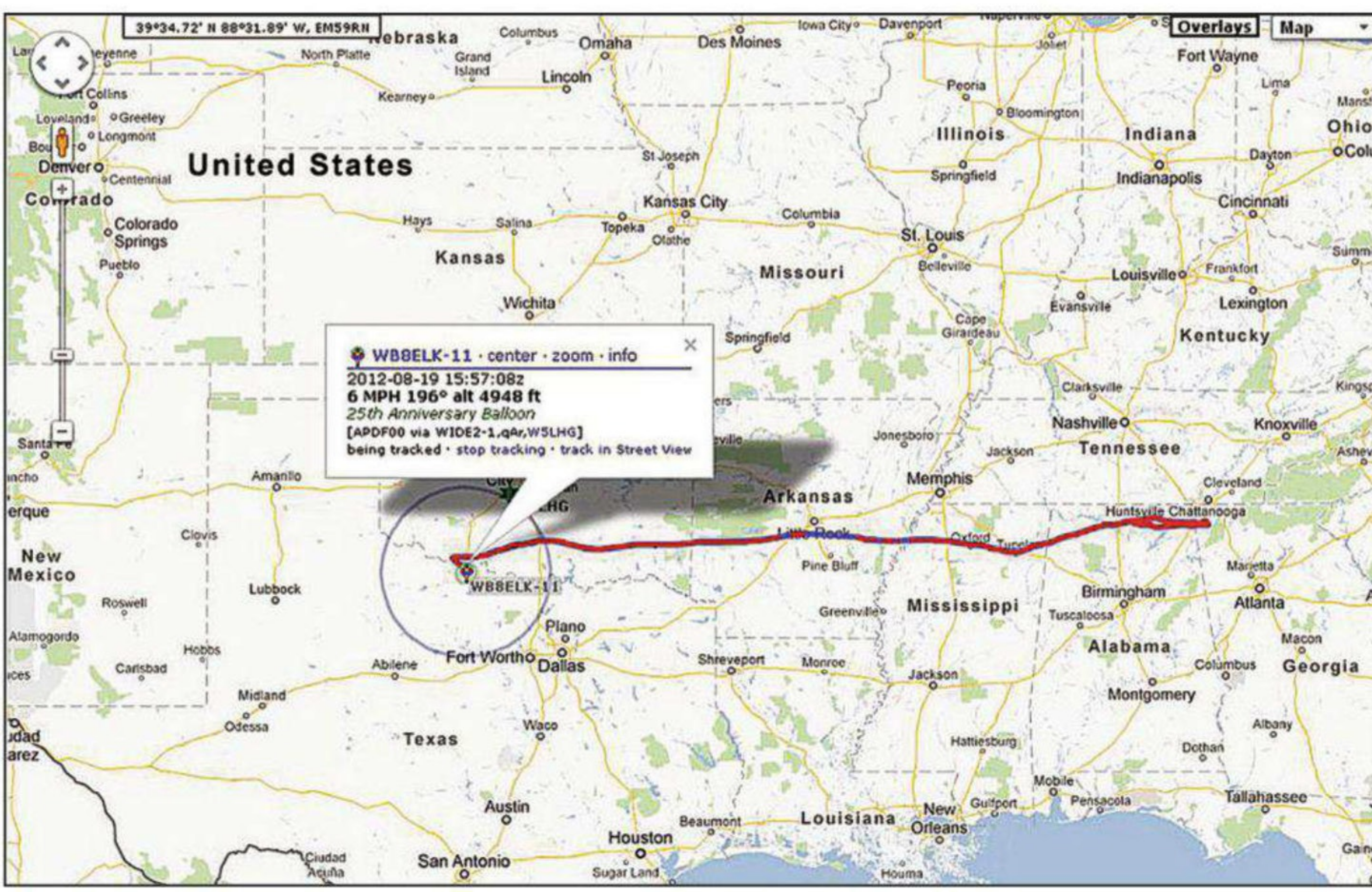

Photo 5. APRS map of the flight path.

Photo 6. Landing site in Wichita Falls, Texas.

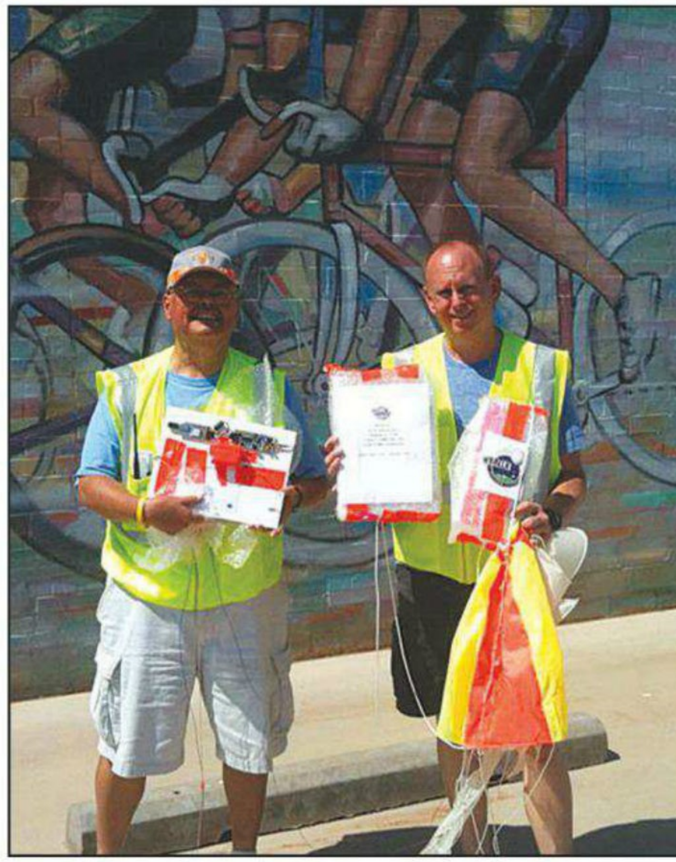

Photo 7. Mike Heskett, WB5QLD (left), and Billy Mason, KD5KNR (right), recover the payloads in Wichita Falls, Texas.

night, as its batteries froze up. The internal temperature was around –51 degrees C at the time. However, the APRS transmitter kept on throughout the night as we followed the flight's progress through Arkansas.

Just after sunrise the HF payload's batteries thawed out and started to work again and many reception reports started to appear on the SpaceNear website (http://spacenear.us/tracker). A few hours after sunrise the balloon burst over southern Oklahoma and parachuted back to the ground just south of the Wichita Falls, Texas Municipal Airport. Even though the last APRS report was at 4900 feet above the ground, I was surprised to still hear the HF signal here in Huntsville, Alabama well after it would have landed. Joe Mayenschein, WB9SBD, in Wisconsin had great reception on it while it was lying in a field in Texas and was able to copy a number of perfect position reports showing the actual landing position.

A Surprise Recovery

I was surprised to get a phone call about two hours after it had landed asking me where I wanted my payloads mailed. It turned out that Mike Heskett, WB5QLD, and Billy Mason, KD5KNR, from the Dallas-Ft. Worth area had been tracking the balloon via APRS. After they saw it starting to come down, they decided to drive over two hours to Wichita Falls to attempt a recovery. They often chase their local ARBONET (Amateur Radio Balloons Over North East Texas) balloon flights, so they couldn't resist another balloon chase.

Mike and Billy tracked down the payloads fairly quickly, since they were lying flat in a grassy area not far from a road along the south edge of the airfield. Their photo of the landing site solved the mystery why the HF signal was so good after landing. As luck would have it, the 20-meter HF antenna had draped itself over a tree when it landed so it was able to put out a great signal even though all of the payloads were lying flat on the ground.

The balloon had stayed up 21 hours and 43 minutes and had traveled 677 miles to the west. It didn't make it all the way to California, but it did make it a significant way in that direction!

73, Bill, WB8ELK

By Bob Witte,* KØNR

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

Those Radios from China

Most of the FM VHF/UHF amateur gear comes from the major manufacturers in Japan. In recent years, a number of new companies from China have entered the market offering low-cost handheld transceivers (HTs). In this article, I'll focus on a few of the most popular radios showing up in the U.S.

For me, the story started in 2010 when I was wandering around the electronic shops in Hong Kong. I noticed there were quite a few low-cost handheld radios being marketed for use in ham radio. I counted ten different brand names, none of them familiar to me. I decided to buy a Wouxun KG-UVD1P dualband (2m/70cm) radio for less than $100 U.S. just to see how good such a radio could be.

Wouxun®

About that same time, the Wouxun radios were showing up in the U.S. with an attractive price of around $100 (figure 1). This caught a lot of attention in the ham radio community, both positive and negative. Many hams were excited to see such a low price point while others were convinced that these radios could not possibly be any good. Some people erroneously claimed that these radios were illegal because they were not "FCC approved."

Wouxun later introduced several other model numbers (KG-UV2D, KG-UV3D, KG-UV3X, KG-UV6D, etc.) that are mostly variations on the same design. In fact, there are so many similar models available it is difficult to keep it all straight. If you do decide to buy one of these, look at the specifications and features carefully, *from the dealer you are purchasing it.* Don't rely on just the model number, as you may find out that the dealer has a unique version of that radio. Wouxun also offers some single-band HTs, but the dual-band models seem to be the most popular.

From my experience, the Wouxun radios seem to be well built (more on that later), but they do have a few unique

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Figure 1. The Wouxun KG-UV2D is one of several dualband handheld transceivers available.

attributes (some might say "quirks") to know about. As shown in figure 1, there are two frequencies shown on the display, which implies the radio has two receivers in it. In reality, there is only one receiver that is switched back and forth between the two displayed frequencies. This is really a single receiver in "dual watch" mode. This is a reasonable tradeoff to keep the cost low, but it can cause confusion when the radio receives a signal on one of the frequencies, locks onto it, and ignores the other frequency.

Another difference to note is that the SMA antenna connector is the opposite gender from most amateur radio HTs. Wouxun uses a *male* SMA connector for the antenna port, while Yaesu, Kenwood, and Icom all use a *female* connector on their amateur handhelds. The land-mobile radio industry tends to use the male connector, so Wouxun likely followed that precedent. We can debate which choice is better, but the key point is to know which one you are buying. Of course, the radio comes supplied with the right flavor of rubber-duck antenna that is compatible with the radio. Oh . . . I should also mention that I have encountered a few Wouxun radios that do use the *female* SMA connector.

The one real disappointment I have with the Wouxun radios is that the S-meter is basically useless. While it looks like a bargraph meter on the display, it really only has two states: Signal or No Signal. In other words, as soon as the signal is strong enough to break through the noise, the S-meter reads full scale.

On the positive side, a drop-in style charger is supplied as standard equipment with the Wouxun radios. These are usually an optional accessory for other HTs, typically costing $65 to $95.

Baofeng®

Another brand of radio from China is Baofeng, which has two popular models of HT showing up in the U.S: the UV-3R and the UV-5R. The UV-3R is a micro-size 2W HT similar in size to the Yaesu VX-3R, but offered in a variety of colors (figure 2). These radios have a street price of around $60.

The UV-5R is a bit larger in size and has an output power of 4 watts (figure 3). As you can tell from the view, this radio has a keypad that can be used for frequency entry and sending DTMF tones. There is an updated version of this radio tagged as the UV-5RC, which sells for about $65 (figure 4).

Interestingly, the UV-5R has some of the same attributes as the dualband Wouxun radios. They use the same "dual watch" approach to implementing the dualband receiver and have a male SMA antenna connector. Not only that, they also have a "binary" S-meter (ON or OFF) as well as a standard drop-in charger. I started to wonder if the two radios shared the same design, but a check of the schematics reveals that they use different circuitry.

There are other Chinese radio brands that are showing up in the U.S., including TYT, AnyTone, and Puxing. I am sure we will see more brands become available with time.

FCC Part 90

These radios are certified for FCC Part 90 operation, which means they can be used in the Private Land Mobile Radio Services (see sidebar "FCC Regulations: Which Part is Which?"). This is a unique twist, since the more established radio equipment manufacturers have kept their land mobile product lines well separated from their amateur radio equipment. Wouxun and Baofeng have really mixed that up by offering a Part 90 radio that has a feature set well suited to amateur radio operation. In particular, most Part 90 radios only cover a single band, VHF or UHF, but these Chinese radios include both the 2-meter and 70-cm bands. Many radio amateurs who are involved in public-safety organizations (law enforcement, fire, medical, search and rescue) quickly became interested in this idea of a Part 90 radio that also plays well for ham radio activity.

One wrinkle that surfaced was that some of the Wouxun radios and the Baofeng UV-3R have their frequency tuning step limited to 5 kHz, which is not quite fine enough to hit all of the public-safety frequencies. Some of the later Wouxun models added a 2.5-kHz step to meet this requirement. For example, a 5-kHz frequency step can be used to select frequencies such as 155.1600 MHz and 154.2650 MHz. However, a 2.5-kHz step size is needed to select frequencies such as 155.7525 MHz. There are a number of Public Safety Interoperability Channels that require the 2.5-kHz step (e.g., VCALL10 155.7525 MHz, VCALL11 151.1375 MHz, VFIRE24 154.2725). The best thing to do for public-safety use is to get a radio that tunes the 2.5-kHz steps.

Some people argue that these low-cost radios are not rugged enough for mission-critical applications such as fire departments and law enforcement. In these applications, the portable radio is a critical life line. Anyone using these radios as first responders will need to do a careful evaluation of the equipment to ensure they are up to the challenge.

What about Quality?

It is difficult to get a clear reading on the overall quality of these units. Ideally, we would collect a large sample of the radios and run them through a series of reliability and performance checks. Lacking the ability to do this, I'll turn to other sources to get a sense of the product quality.

One place to check is the product review section on eham.net. While any one review may be suspect, you can still get a general sense of the experience people are having with a particular model of radio. For the Wouxun and Baofeng radios, there

Figure 2. The Baofeng UV-3R is a micro-size radio available in multiple colors.

Figure 3. The original Baofeng UV-5R transceiver.

Figure 4. The UV-5RC is the newer, upgraded version of the UV-5R.

are a range of comments from "love it" to "hate it." Quite a few people say something like "not as good as my old radio but it works great considering the price." In other words, the attractive purchase price of these radios causes the user to overlook some minor issues.

It seems like every time a new radio appears on the market a Yahoo group pops up to discuss it. The Baofeng and Wouxun radios are no exception, so check out the Yahoo group discussion to hear about any problems people are experiencing. Searching the internet can bring to light reviews of new products. One especially good source of information on these low-cost radios is the hamgear blog by PDØAC.

Radio Tests

I've heard concerns about frequency drift and spurious emissions from these radios, so I have been testing my collec-

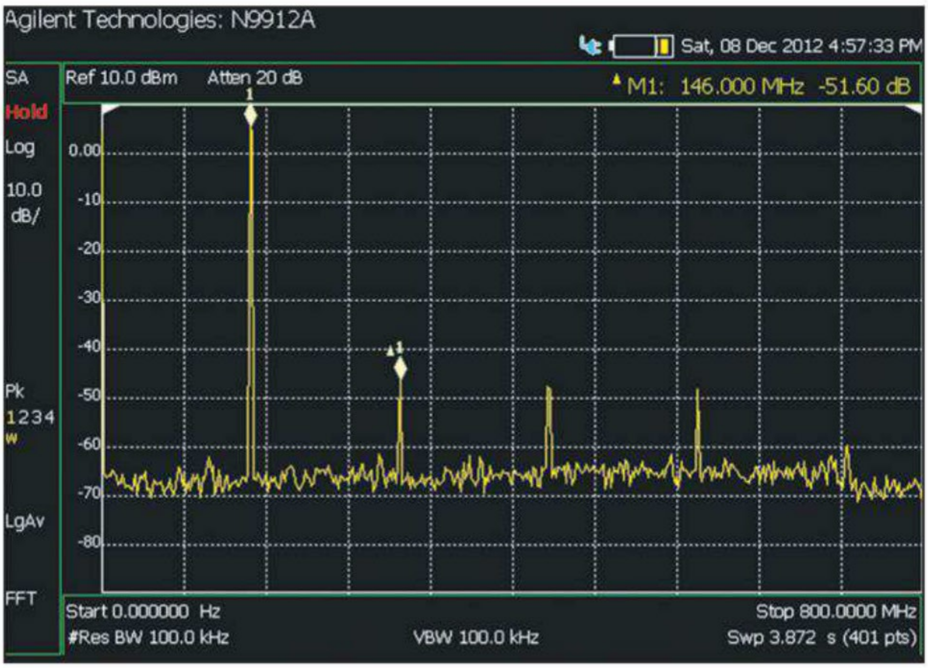

Figure 5. Measurement of the transmitter harmonics of the first unit of UV-5R, on the 2-meter band.

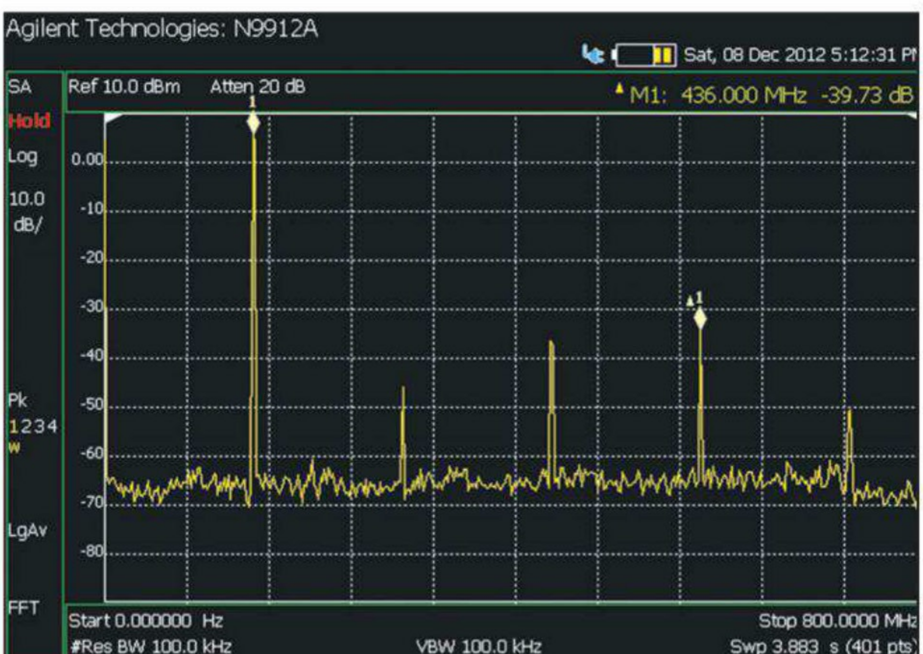

Figure 6. Measurement of the transmitter harmonics of the second unit of UV-5R, on the 2-meter band.

tion of radios for any problems. The two units of the Baofeng UV-5R and three different models of the Wouxun radio that I have all are well within spec on transmit power, receiver sensitivity, and frequency stability. I've checked them multiple times and have not detected any performance drift. These radios are really tight on frequency accuracy, less than 150 Hz error. I suspect this is driven by the tight frequency requirements of Part 90.

Spurious emissions are another story. It starts with an article in December 2011 *QST* magazine, under Technical Correspondence. The ARRL Lab tested a Baofeng UV-3R transceiver and found the second harmonic of the transmitter to be out of spec on the 2-meter band. The unit they tested had a second harmonic 32 dB below the fundamental (versus a spec of 49 dB per Part 97).

I took a look at my two Baofeng UV-5R radios using an Agilent FieldFox RF Analyzer. The first unit tested had the second harmonic down 51.6 dB from the fundamental (figure 5). On the second unit, the fourth harmonic was the worst at 39.7 dB below the fundamental (figure 6). Both units performed much better on the 70-cm band, so I have not included those plots here.

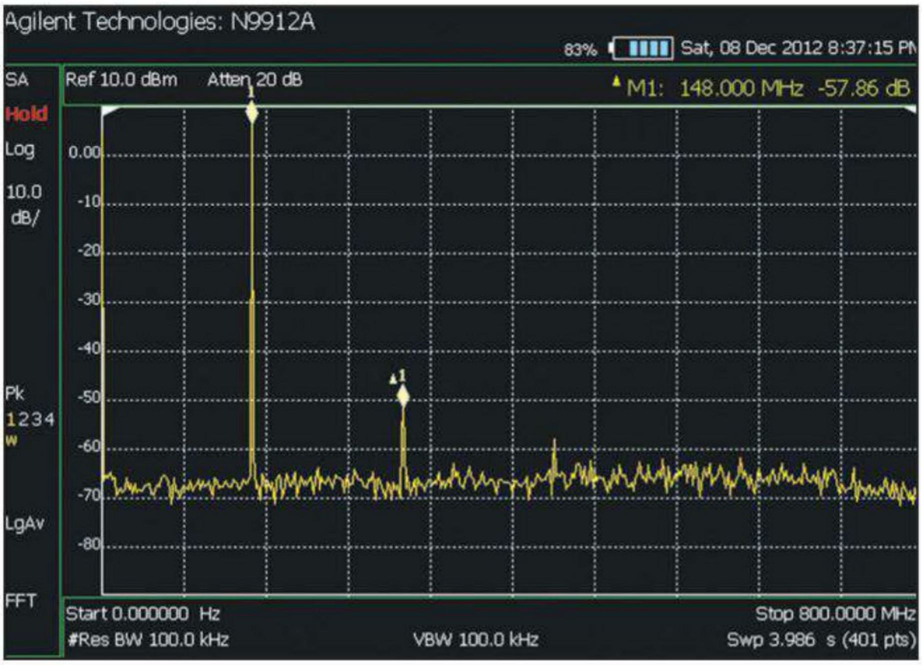

Figure 7. Measurement of the transmitter harmonics of the Wouxun KG-UV2D on the 2-meter band.

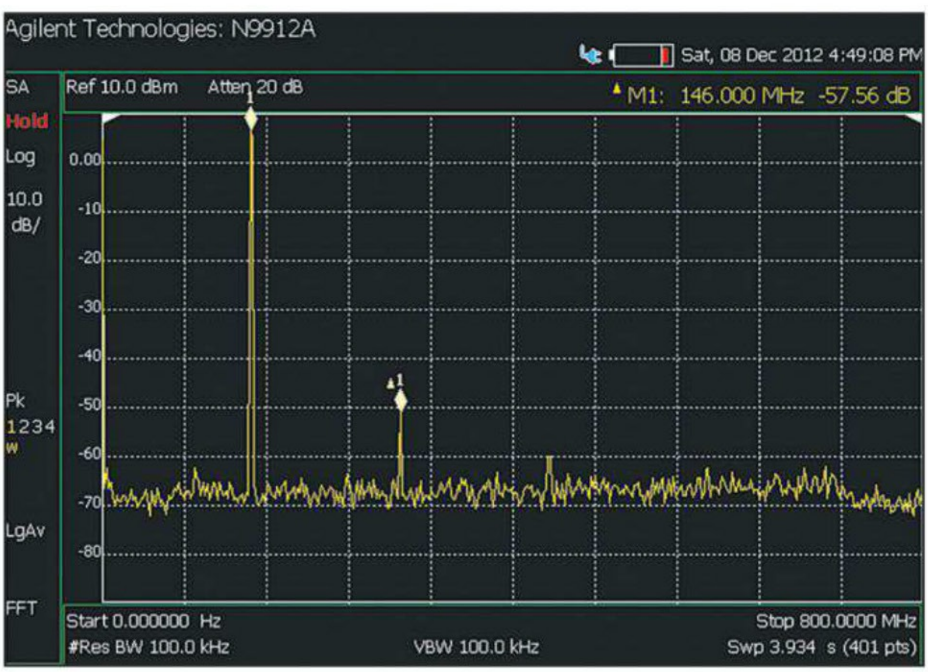

Figure 8. Measurement of the transmitter harmonics of the Wouxun KG-UV6D on the 2-meter band.

Part 97.307(e) says: "For a transmitter having a mean power of 25W or less, the mean power of any spurious emission supplied to the antenna transmission line must not exceed 25 μW and must be at least 40 dB below the mean power of the fundamental emission, but need not be reduced below the power of 10 μW.

The Baofeng has 4-watt transmit power so it turns out that the 25-μW limit is a more difficult constraint than the 40-dB limit. We can calculate how far below the fundamental a 25-μW harmonic is using this equation:

$$10 \log(0.000025/4) = -52.0 \text{ dB}$$

Therefore, the harmonics have to be at least 52 dB below the fundamental. From this, I conclude that the first unit is very close to being in spec and may be within the margin of error for my test setup. The second unit clearly does not meet the Part 97 specification, about 12 dB too high. A comparison of figures 5 and 6 suggest significant variation between these two models, which makes me wonder about the consistency of manufacture. However, wait a minute: We don't really know that these radios are the same design inside…perhaps a design change was made to improve the harmonic performance on the first unit?

I tested the Wouxun radios available to me and found they have better harmonic performance. The Wouxun KG-UV2D unit (figure 7) and the Wouxun KG-UV6D (figure 8) had worst-case harmonics below 57 dB. Again, the performance on the 70-cm band was even better, so I did not include the plots here. These units exceeded the requirements of Part 97.

For comparison, I also tested a popular amateur radio handheld transceiver made in Japan, the Yaesu FT-60. Its harmonic performance was better than the Wouxun HTs, with the second harmonic down by over 64 dB (figure 9).

Overall, the performance of the Chinese radios tested was good, except for the harmonic emissions of the Baofeng UV-5R units; one unit was marginal and the other was clearly not within spec. Again, I want to emphasize that this represents the measurement of a few samples, plus other units of the same model may have different results.

Summary

The question remains, should you buy one of these radios? Clearly, these radios represent a new price point for a dualband handheld transceiver. The fact that they are Part 90 certified is a big plus for some hams. I purchased the KG-UV6D so that I have one radio that covers the ham bands and our local fire department VHF channels. I will caution that some people have been frustrated with the quirkiness of these radios, finding them difficult to use. This is especially true for newer hams.

One surprise for me was that I usually grab a Wouxun or Baofeng radio for casual use. This is because they are inexpensive. If I lose it or crush it, the monetary loss is minimal. This might be the best feature of all.

Keep in mind that these radios are constantly being improved and that new models are being introduced at a fast pace. Before you order a radio, make sure you know the features and specifications of that particular unit. As this article goes to press, there are a number of new dualband mobile transceivers from China being introduced in the U.S.

Tnx and 73

Thanks to ImportCommunciations.com for permission to use the photos of the Baofeng and Wouxun radios.

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 noted on the first page of this column.

73, Bob KØNR

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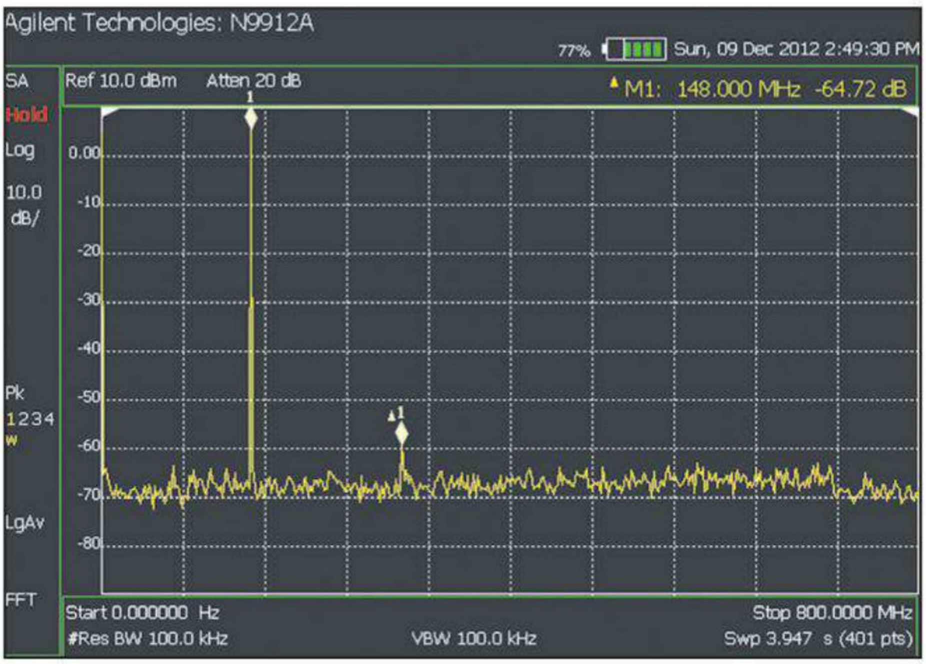

Figure 9. Measurement of the transmitter harmonics of the Yaesu FT-60, on the 2-meter band.

Can I Use My Amateur Radio on the Public Service Bands?

We have quite a few licensed radio amateurs who are members of public-safety agencies, including fire departments, law-enforcement agencies, and search and rescue (SAR). Since they are authorized users of those public-safety channels, they often ask this question:

Can I use my VHF/UHF ham radio on the fire, police or SAR channel?

It is widely known that many amateur radios can be modified to transmit outside the ham bands. The answer to this question is *used to be* that amateur radio equipment cannot be used legally on public-safety channels because it is not approved for use under Part 90 of the FCC Rules. (Part 90 covers the Private Land Mobile Radio Services.) The only option was to buy a commercial radio with Part 90 approval and a frequency range that covered the desired amateur band. Some commercial radios tune easily to the adjacent ham band, but some do not. The commercial gear is often two to three times as expensive as the amateur gear, and just as important, does not have the features and controls that ham operators expect. Usually, the commercial radios do not have a VFO and are completely channelized, typically changeable only with the required programming software.

The situation has changed dramatically in the past two years. Several wireless manufacturers in China have introduced low-cost handheld transceivers into the U.S. amateur market that are approved for Part 90 use. These radios offer keypad frequency entry and all of the usual features of a ham radio. It seems that these radios are a viable option for dual use: public safety and amateur radio, since they are legal to operate under both Part 90 and Part 97 rules.

As noted in the main article, the user should carefully evaluate these radios for reliability and ruggedness before using them for critical safety communications.

FCC Regulations: Which Part is Which?

The FCC regulations cover a wide range of wireless and communications issues, divided into different "parts":

Part 15

These FCC regulations cover a broad range of devices, regulating how much RF energy they are allowed to emit. Most electronic devices are covered by Part 15, everything from clock radios to computers. These are categorized as intentional radiators, unintentional radiators or incidental radiators. Commercially manufactured amateur radio equipment generally needs to have Part 15 Certification.

Part 90

These FCC regulations cover the Private Land Mobile Radio Services, which includes public-safety radio (fire, law enforcement, etc.), paging transmitters, and business radio. Radio equipment must be Part 90 Certified, which includes meeting a broad set of performance specifications.

Part 97

These rules cover the Amateur Radio Service. Since this service encourages technical experimentation, there is relatively little regulation of Part 97 radio equipment. Radio amateurs are allowed to construct their own equipment and put it on the air.

By Kent Britain,* WA5VJB

ANTENNAS

Connecting the Radio to the Sky

Impedance Matching

Many of us have heard the classic story about how you boil a frog. You put it in the pot with nice warm water, oh so comfortable, then slowly turn up the heat while it is sleeping. Boiled frog! The same holds true for impedance matching. Just connect a piece of 50-ohm coax to 72-ohm coax and you have an impedance bump. Some of the signal is reflected and you have generated an SWR. But what if the bump is smoothed out? A slow change as shown in figure 1? Now there is no sudden impedance change, no bump, no SWR.

I had some antennas that were about 30 ohms input impedance, yet I needed them to work over a wide range of frequencies. Therefore, a mini-antenna tuner was out of the question, as that kind of impedance matching tends to work on just one frequency. In photo A are some tapered lines, 50 ohms on the thin end, 30 ohms on the fat end, and a smooth taper between them. Unlike most impedance matching, the line does not have to be a set length. You would like it to be about 1/2 wavelength long. One-quarter wavelength will work, but that's pushing it, and this matching technique works over a very wide range of frequencies.

I agree that it is not very practical to match a 40-meter Windom, but it's simple enough at the higher frequencies.

Lens Antennas

This certainly is a very simple concept. Just put a big lens, as shown in photo B, in front of a smaller antenna and concentrate the signals.

I used these Rexolite lenses on a 94-GHz radiometery project some years ago. This technique was first used by Chandra Bose to focus 60-GHz Herzian waves in the late 1890s. At that time Dr. Bose was using lenses made out of wax.

Er or Dielectric Constant

Any substance with mass has either conductivity or a dielectric constant. Yes, some dielectric materials have a little bit of conductivity, but we will skip over those at the moment. If you take the Er or dielectric constant of the material, and an electromagnetic wave such as a radio wave, the wave will travel though this media at 1 over the square root of Er. Thus, with a plastic having an Er of 4, the speed of light is 1 over the square root of 4, or one half that of free space. Now 300,000 km/sec becomes 150,000 km/sec inside this plastic. If the plastic has an Er of 9, then the speed of light is one third that of free space.

For those of you who are good at picking flyspecks out of pepper, you must be very careful using the published Er of these materials. Usually the dielectric constant/Er is measured at 10 kHz, sometimes 1 MHz, but rarely at higher frequencies. As you go up in frequency the Er usually drops, about 10% less when you get up to UHF frequencies. I have seen this error in many HFSS and NEC antenna models. This also applies somewhat to PC boards. The Er of common PCB materials again drops from a typical Er = 4.4 to 4 or so at 1 GHz, and down to 3.8 to 3.9 when you get to 2.4 GHz. The special RF board materials are blends of different materials and hold a fairly constant Er over VHF to microwave frequency range. But then that's why you pay the big bucks for those board materials.

The Speed of Light

Take a look at the two antennas in figure 2. The radio frequency energy is traveling between Antenna A and Antenna B. Free space is now a transmission line. So what's the impedance of this transmission line? Another way of thinking of this is "What's the impedance of the universe?" The answer goes back to Maxwell's equations, and it is120 pi, or 377 ohms, with a fudge factor for air density and relative humidity. Another

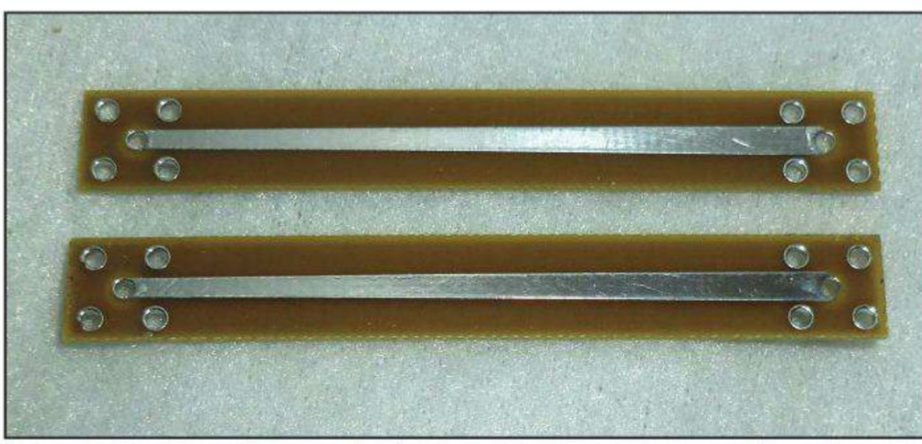

Photo A. 30–50 ohm tapered line.

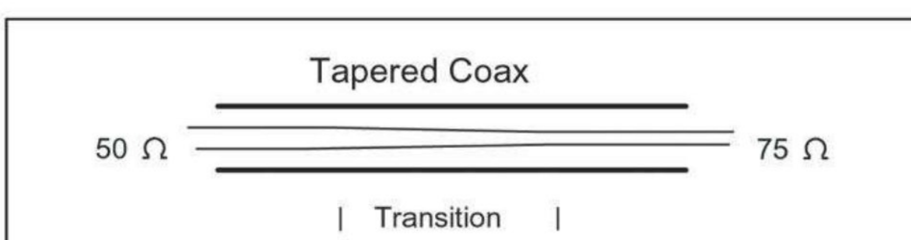

Figure 1. Tapered impedance coax from 50 to 75 ohms.

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way of looking at this is your antenna is also a 50 to 377 ohms impedance converter. (And if you want to build a stealth aircraft, you want to look at a 377-ohm dummy load.)

Non-Reflective Coatings

At this point it looks like I have an attention deficit disorder, but here is where we bring all of this together.

Inside the plastic of the lens, the impedance is about 377/2, or about 175 ohms. Outside the impedance is 377 ohms. A radio wave hitting the plastic sees a 175–377 ohm impedance mismatch and you have an SWR or a reflection. A narrow-band technique would be to find some plastic with an Er of about 2 and cover the lens with a layer 1/4 wave thick. This is very similar to the anti-reflective coatings put on a high-dollar optical lens. Yes, there is impedance even with light waves. But look very carefully at the close-up photo of the millimeter lens in photo C. See the ridges? These are forming a tapered impedance section between the 377 ohms of freespace and the 175-ohm impedance inside the plastic. In short, it becomes an anti-reflective coating, or surface treatment using a lot of tapered impedances.

Photo B. 94-GHz lenses.

Photo C. Tapered ridges on the 94-GHz lenses.

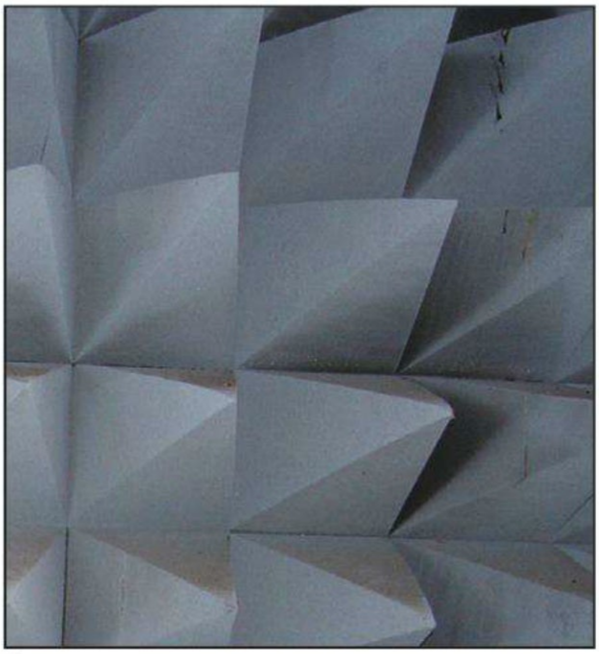
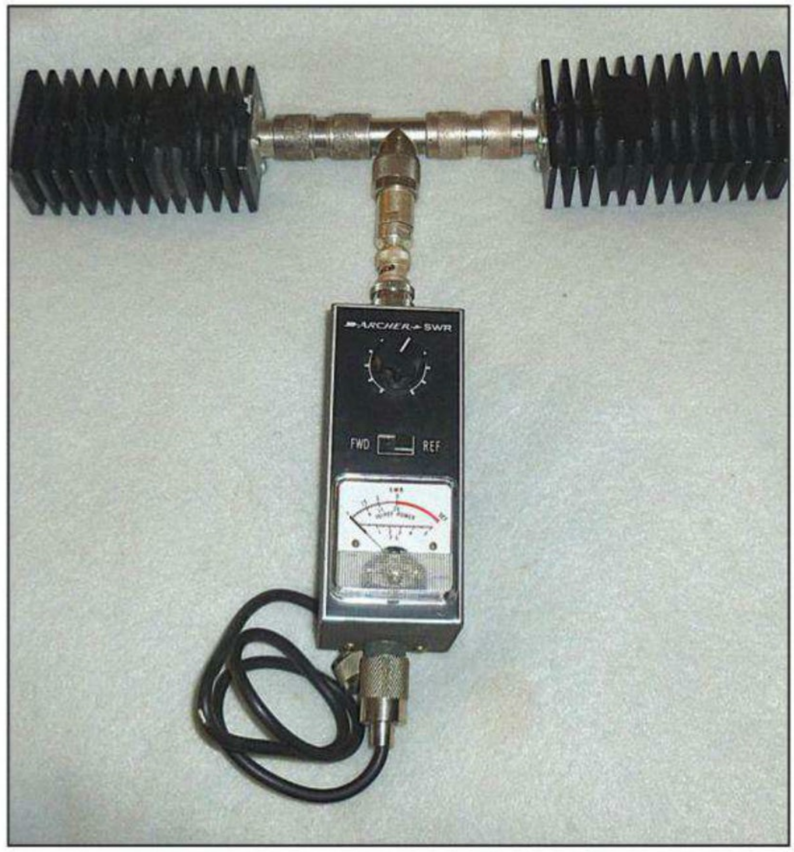


Photo D. Tapered cones in an anechoic chamber.

Photo E. SWR meter with two loads for a 2:1 SWR.



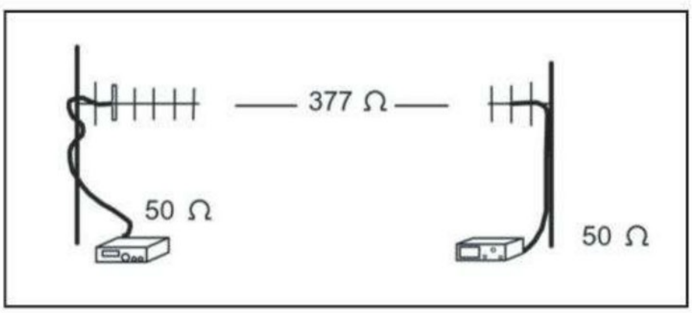


Figure 2 . A 377-ohm transmission line.

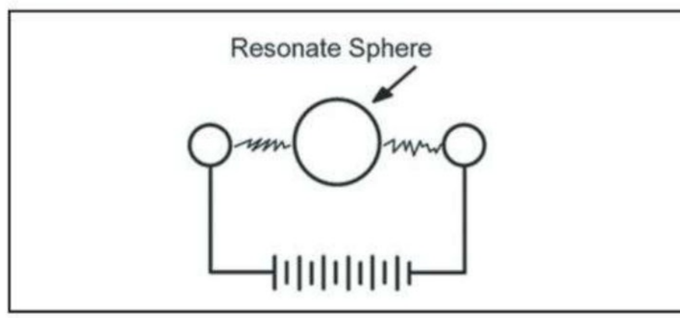


Figure 3. Dr. Bose's 60-GHz transmitter.

Another place you see this impedance tapering is in anechoic chambers such as those shown in photo D. The inside of the chamber is, of course, 377 ohms, the metal walls of the chamber are 0 ohms, so you can think of these cones as forming a 377-ohm impedance match.

60 GHz

60 GHz in the 1890s? Why that's state-of-the-art technology today!

A classic spark-gap transmitter uses the square-wave pulse from an electric arc to excite a tuned circuit. The tuned circuit rings at its tuned frequency, producing a sine wave that slowly decreases in power. These were known as "damped waves." Dr. Bose's transmitter used a sphere that resonated at 60 GHz and was excited by an electrical spark. This made a nice little point source of 60 GHz for a variety of his experiments in polarization and propagation, plus in the design of attenuators, waveguide, transmitters, diodes, and horn antennas. A diagram of his transmitter is shown in figure 3. On the shortwave bands, spark and arc transmitters could be quite efficient at converting electrical power to RF power. I don't know how efficient the transmitter used by Dr. Bose was. But even at 1/10% efficiency, 100 watts or arcing DC could become .1 watt of RF, a strong signal on the 60-GHz band even by today's standards.

You can use the relationship between impedance in ohms and SWR to check the calibration on your SWR meters. In photo E we have an SWR meter with two 50-ohm loads on the antenna connection—50 in parallel with 50 is 25 ohms. This creates a 50/25 mismatch, or a 2:1 SWR. Therefore, a T adapter and two 50-ohm loads should read as a 2.0 SWR on that meter.

Future Projects

As always, we welcome questions and column suggestions from our readers. An e-mail to <wa5vjb@cq-vhf.com> or even a snail-mail to my QRZ.com address will work. For other antenna projects you are welcome to visit my website <www.wa5vjb.com>; look in the Reference section.

The snow is starting to melt, spring is sneaking up on us, and it's time to start rounding up parts for those warmer weather antenna projects. 73, Kent, WA5VJB

By Tomas Hood,* NW7US

VHF PROPAGATION

The Science of Predicting VHF-and-Above Radio Conditions

Propagation on Low VHF

There is an exciting world of radiowave propagation available to the VHF radio enthusiast by way of the ionosphere. Experienced communicators know the joy of working "skip" on the highest bands of shortwave, namely those frequencies around 25 to 30 MHz during the summer when the sporadic-*E* mode comes alive, and also when the Sun's activity is high enough to produce a strongly-ionized *F*-region. Also, when the solar cycle activity is at its peak, propagation via the *E*- and *F*-region supports this "skip" even on the low VHF frequencies, up to 80 MHz or higher.

VHF (very high frequency—30 to 300 MHz) and the highest region of HF (25 to 30 MHz) are used for line-of-sight or direct wave communications (two-way handie-talkies, car-to-car, ship-to-shore, and repeater communications with FM, for instance). Such communications tend to be reliable, as this type of communication does not rely on the variable ionosphere.

On HF, frequency choice is critical, while on low VHF, direct and line-of-sight or repeater communication can be enjoyed with great reliability. However, when the ionosphere supports it, low VHF (30 to 80 MHz) can be the slice of spectrum in which communications across great distances well beyond line-of-sight can be realized.

Those who use VHF can maximize the line-of-sight distance by mounting antennas as high as possible—on top of the tallest buildings, or on mountaintops, even by way of a satellite. When using the ionosphere as a "reflector," however, for the VHFer, when conditions are favorable, any antenna may suffice for communications many hundreds or even thousands of miles distant.

How do low VHF signal propagate off the ionosphere? Let's start with a closer look at this amazing region of our Earth's atmosphere.

The Ionosphere

Earth's atmosphere is a mixture of gases held to the surface of the Earth by gravity. These gases vary in density and composition as the altitude increases above the surface. As the atmosphere extends outward from Earth, it becomes thinner and blends with the particles of interplanetary space.

The first 60 miles of Earth's atmosphere consist of a homogeneous mixture of various gases. This region is called the *homosphere*. Above the homosphere, where gases are no longer uniformly mixed, lies the *heterosphere*. Relatively more of the heavy gas molecules such as N_2 (nitrogen) and O_2 (dioxygen) are found near the bottom of the heterosphere, while relatively more of the lighter gases such as hydrogen and helium are found hear the top.

The atmosphere is also divided into four regions according to temperature trends: the *troposphere*, *stratosphere*, *mesosphere*, and *thermosphere*. The lowest region is the troposphere and it extends from the Earth's surface up to about six miles. The gases in this region are heavier than those in higher altitudes, and include molecular oxygen (O_2) and molecular nitrogen (N_2). The highest mountains are within this region, as is the high-altitude jet stream. Weather is confined to this lower region and it contains 90% of the Earth's atmosphere and 99% of the water vapor.

The atmosphere above the troposphere is called the stratosphere, starting at about six miles out. Gas composition changes slightly as the altitude increases and the air thins. Incoming solar radiation at wavelengths below 240 nanometers is able to create ozone, a molecule of oxygen consisting of three oxygen atoms (O_3), in this layer. This gas reaches a peak density of a few parts per million at an altitude of about 16 miles.

At an altitude above 50 miles, the gas is so thin that free electrons can exist for short periods of time before they are captured by a nearby positive ion. The existence of charged particles at this altitude and above marks the beginning of the ionosphere, a region having the properties of gas and of plasma.

Above the ionosphere exists a vast region of charged particles formed by the interaction between the solar wind and the Earth's magnetic field, the magnetosphere. The magnetosphere begins at about 600 miles above the Earth's surface. It extends to a distance of about 40,000 miles on the side facing the Sun, and to even greater distances on the far side of the Earth away from the Sun.

How is the Ionosphere Formed?

Much of the energy from the Sun that reaches our atmosphere is absorbed. Thankfully, nearly all of the hazardous ultraviolet radiation, gamma rays, and x-rays are blocked before they reach Earth's surface. While most of the radiation from the Sun is absorbed, some of it penetrates deeply into the atmosphere. Atmospheric ozone in the ozone layer is the greatest absorber of ultraviolet radiation, protecting virtually all life forms on Earth. Solar radiation at ultraviolet and shorter wavelengths is considered to be "ionizing," since photons of energy at these frequencies are capable of dislodging an electron from a neutral gas atom or molecule during a collision. We measure solar activity at the 10.7-cm frequency. This measurement is called the *solar flux reading*.

Atoms in the ionosphere absorb the incoming solar radiation, causing them to become highly excited. When an atom is bombarded with enough of this energy, an electron may be knocked away from its orbit, producing free electrons and positively charged ions.

At the highest levels of the Earth's outer atmosphere, solar radiation is very strong, but there are few atoms to interact with, so ionization is small. As the altitude decreases, more gas atoms are present, so the ionization process increases. At the same time, however, an opposing process called *recombination* begins to take place in which free electrons are "captured" by

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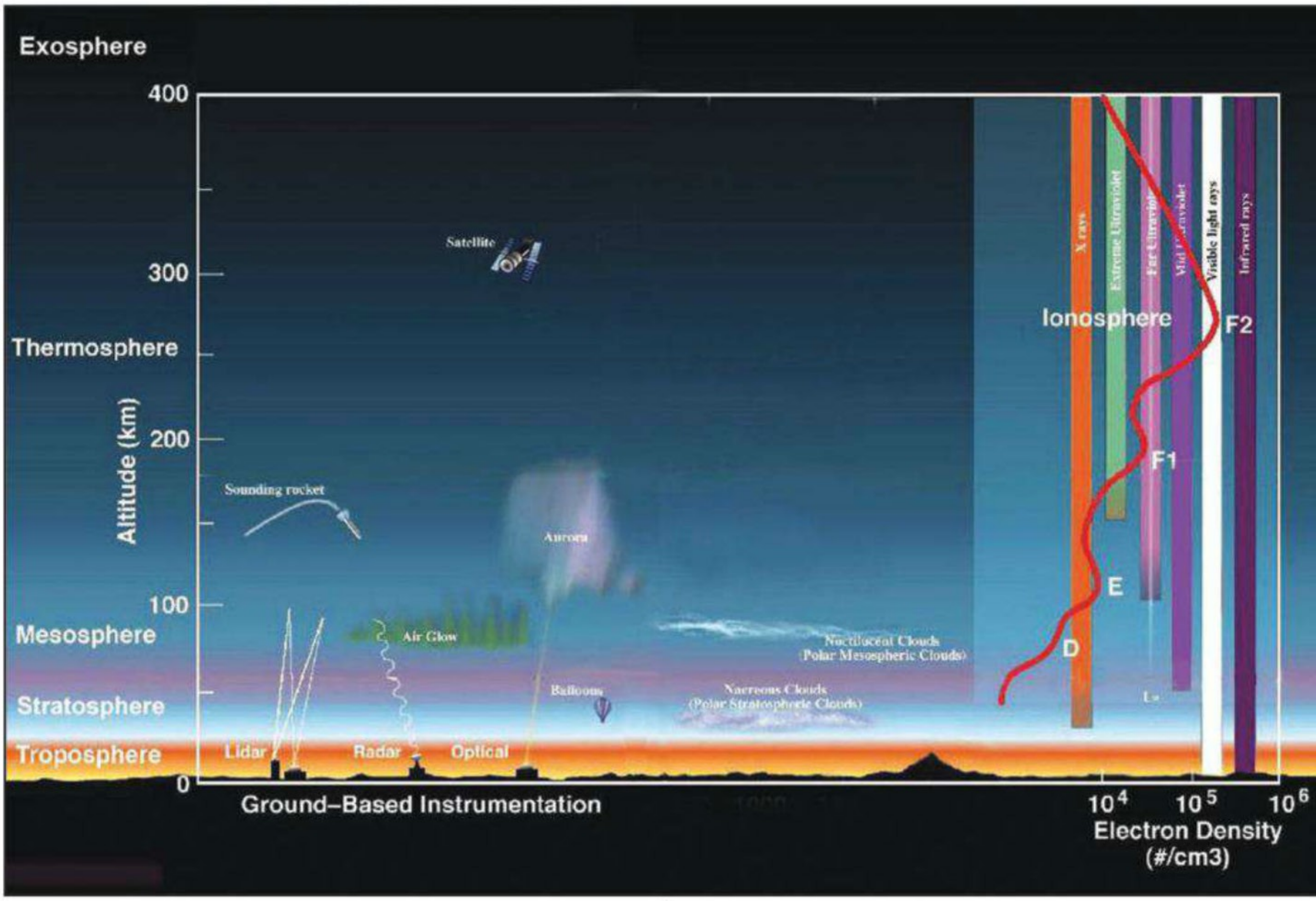
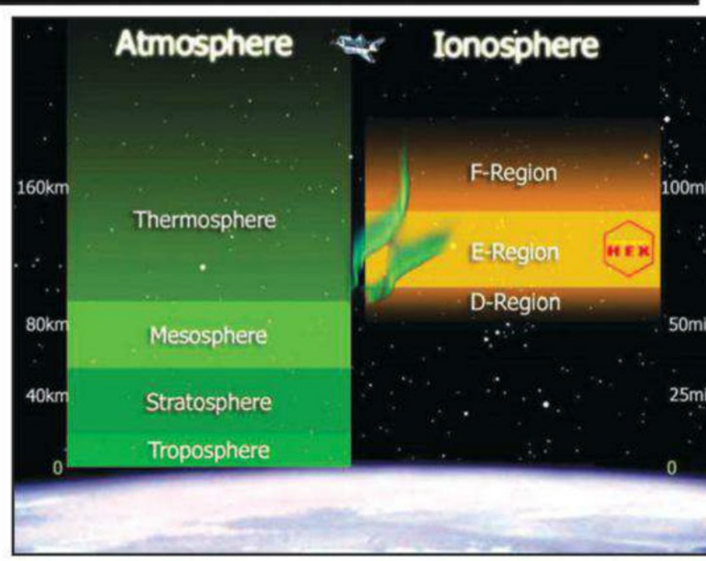




The diagram (top) shows the layers within Earth's atmosphere; the troposphere, the stratosphere, the mesosphere, the thermosphere, the ionosphere, and the exosphere. The diagram (right) also illustrates the ionospheric regions in relation to Earth's atmosphere. The ionosphere is composed of three main parts: the D, E, and F regions. (Credit: NASA/HEX [Horizontal E-Region Experiment])

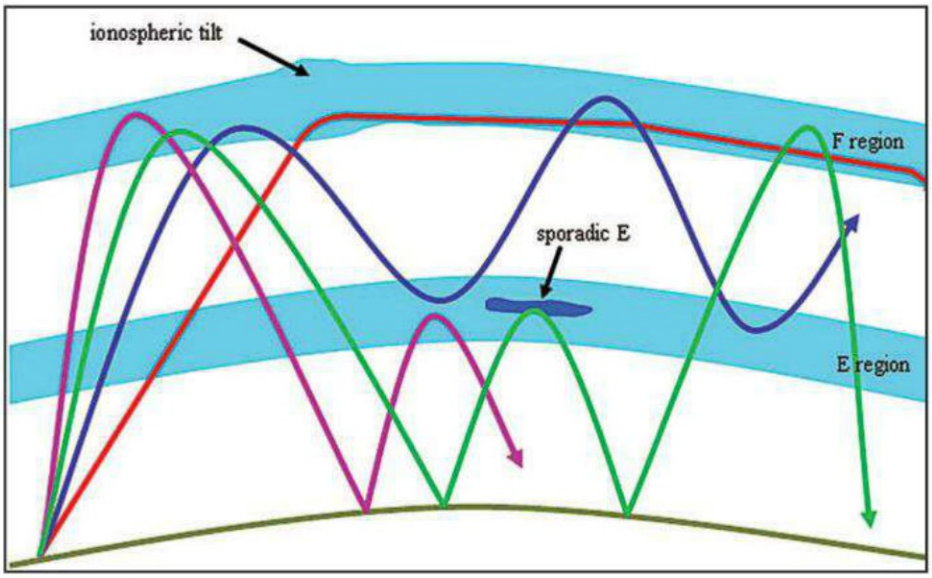
positive ions if they get too close to each other. As the gas density increases at lower altitudes, the recombination process accelerates since the gas molecules and ions are closer together.

Because the composition of the atmosphere changes with height, the ion production rate also changes, and this leads to the formation of several distinct ionization regions, known as the *D*, *E*, *F1*, *F2*, and *F3* regions. (Yes, an outer *F3* layer has been discovered, and so far it seems that when present, it is most dense over the equatorial region during the peak of the day.) The breakdown between regions is based on the density of ions and what wavelength of solar radiation is absorbed in that region most frequently.

The *D* region is the lowest in altitude and absorbs the most energetic radiation, known as hard x-rays. The *D* region doesn't have a definite starting and stopping point, but includes the ionization that occurs below about 56 miles. This region absorbs high-frequency (HF) waves between 3 and 30 megahertz or wavelengths between 100 meters and 10 meters. It refracts frequencies in the range of 3 to 30 kilohertz, very low frequencies (VLF). The *D* region is a daytime layer, because it takes the full energy of the Sun to keep the very dense layer of gases ionized. Once the sunlight is removed, the free electrons quickly recombine with the gases and molecules that are so densely packed, and the ionization nearly disappears.

The next highest layer, the *E* region of the ionosphere, extends from about 56 miles to about 65 miles. The air in this region is considerably thinner than below it. As a result of this thin air there are fewer collisions of ions and electrons, resulting in a population of molecular ions. The *E* region absorbs soft x-rays. This layer is highly variable from day to night, and takes longer to recombine than the *D* layer.

The highest layer is the *F* region, which is the largest part of the ionosphere. It extends from about 65 miles up through the



Oblique sky wave path with no sporadic-E present (red). Sporadic-E forms along the path; its electron density is high enough to refract the wave and its structure is such that it refracts the entire signal (green). Sporadic-E has electron density high enough to refract the wave and its structure is partially transparent (both red and green). When the E- and F-regions are strongly ionized, it may be possible for low-VHF (30 to 80 MHz) radio waves to be refracted, while sporadic-E propagation is typically possible even when the solar acitivity is not strong enough. Sporadic-E is typical during the summer months (see text). (Credit: Ionospheric Prediction Service [IPS], Australia)

end of our atmosphere. Since particle densities decrease as you travel away from Earth, it is difficult to say exactly where our atmosphere ends. Since it is such a large region the *F* layer is divided into two main sections—the daytime layer, *F1*, and the denser *F2* region which exists both during the day and night. A third layer, the *F3* region, has been discovered and appears to occur during the peak solar cycle years over the equatorial region during the middle of the day.

In the *F* region gravity's effect on particles creates different layers depending on their mass. The heavier particles sink to the bottom of the *F* region and the lighter ones rise to the top. Along the day/night meridian electron numbers rise and fall. At sunset electron numbers decrease and recombination of these particles with ions occurs throughout the night. On the sunrise meridian electron numbers increase as neutral molecules and atoms are energized by the solar radiation, again causing ionization.

Radio Waves in the Ionosphere

As an electromagnetic wave enters the ionosphere at the *D* layer, the energy sets electrons in a vibrating motion (at the frequency of the radio wave). Because this layer is so dense, there is a high probability that the energy will be absorbed in a collision with nearby molecules. The electromagnetic energy is turned into kinetic energy (heat), and, as far as radio propagation is concerned, lost. The higher the frequency and the shorter the wavelength, the higher the energy, but also the fewer collisions between free electrons and gas molecules than at lower frequencies. As a result, lower frequency signals are attenuated far more than those at higher frequencies. It is possible that the lowest frequencies are completely absorbed, while higher frequencies will make it through to the *E* layer. (This is why satellite communications makes use of frequencies that are not easily absorbed by the ionospheric regions, namely, those frequencies at VHF and higher).

Since the *E* layer is less dense than the *D* layer, electrons are not so quickly recombined with neighboring atoms, so losses are lower. Because these electrons are not as quickly bound with other atoms, losing energy, the electromagnetic wave is re-radiated. Because the signal is traveling in an area where electron density is increasing, it will go farther.

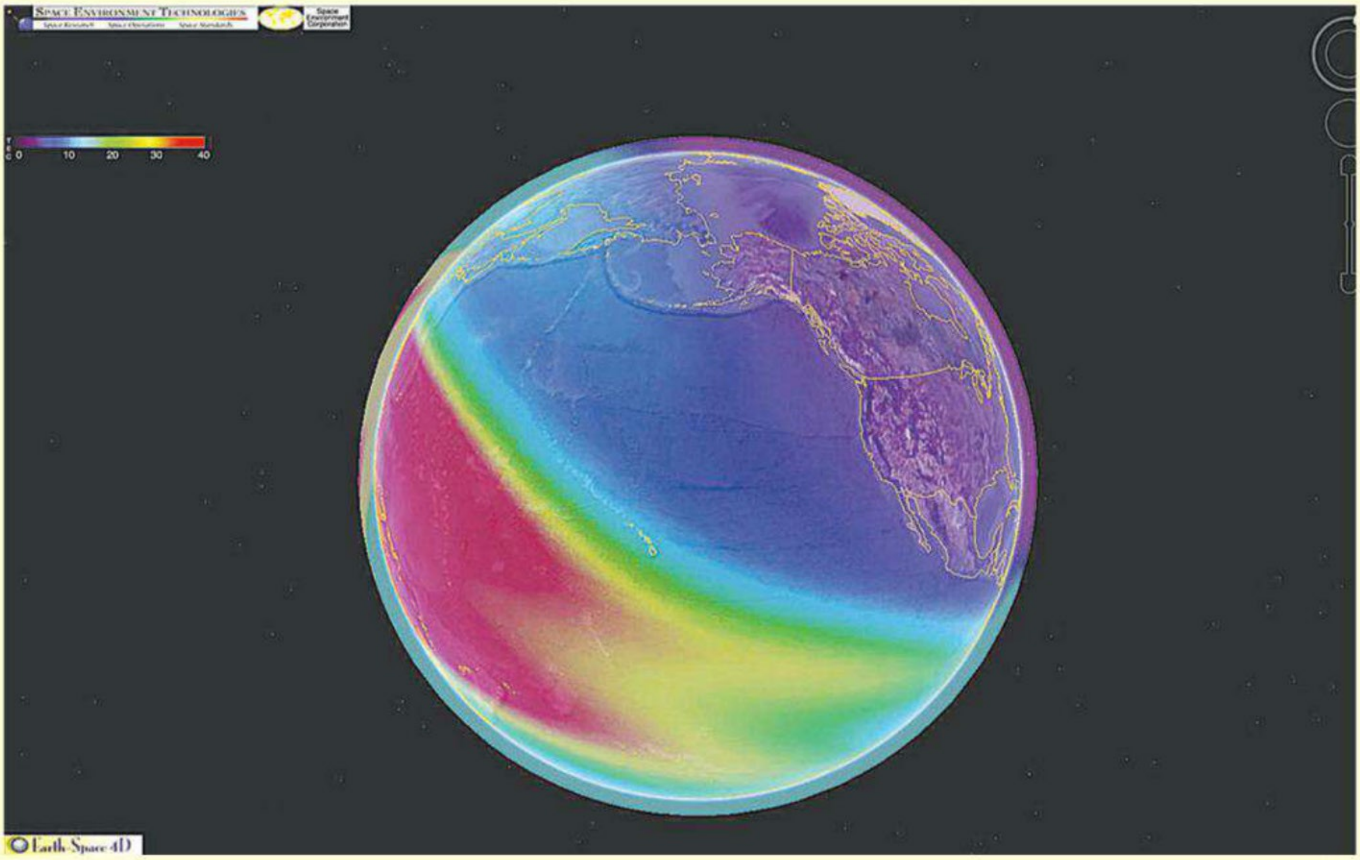
At the same time, the wave is bent away from the denser, and higher, area of electrons. The amount of bending, or *refraction*, is dependent on the frequency of the wave and the density of the ionosphere the radio wave is traveling through, as well as at what angle the propagating radio wave moves through the region. Think of how a pencil might look if you place it in a glass of water. When you view the pencil through the side of the glass, it appears to bend right at the boundary between the air and the water. This is caused by the same principle. Light is being refracted by the difference in density of the mass it is traveling through.

The higher the frequency, the more energy that wave has, making it more likely to pass through to the next higher region. When an electromagnetic wave enters the *F* layer, the same science takes place. The radio signal rides the free electrons of this layer, and if the frequency of the signal is high enough, it will pass through the layer out into space. Otherwise, it gradually will be refracted back away from the higher and denser layers of electrons to be sent back toward Earth.

Those frequencies that are refracted back to Earth have to then pass again through the lower ionospheric layers. *D*-layer absorption will attenuate the signal some more. If there is enough energy in the signal, the wave may bounce between the ionosphere and Earth multiple times, greatly extending the distance it can travel. Other times, it might be so absorbed such that no communications are possible. Yet at other times, a radio wave will enter the ionosphere, bounce off the *F* layer, but then refract back up away from the *E* layer, doing multiple hops until it can punch back through the *E* layer and back to Earth.

All of this depends on how ionized the gases become in these various layers, and how dense each layer is, as well as the strength, angle of incidence, and frequency of the radio signal. Ionization depends on the direct energy from solar radiation. Would all of the layers of the ionosphere perform identically if they each received the same amount of solar energy? No, because of the different gases found in each layer and the density of those layers.

When we look at the daily measurements of the 10.7-cm solar flux, we find that the higher the index, the more ionized these various layers become, making it possible for higher shortwave frequencies to propagate by refraction over great distances. When the flux is low, the ionosphere is weaker and only the lower shortwave frequencies will be propagat-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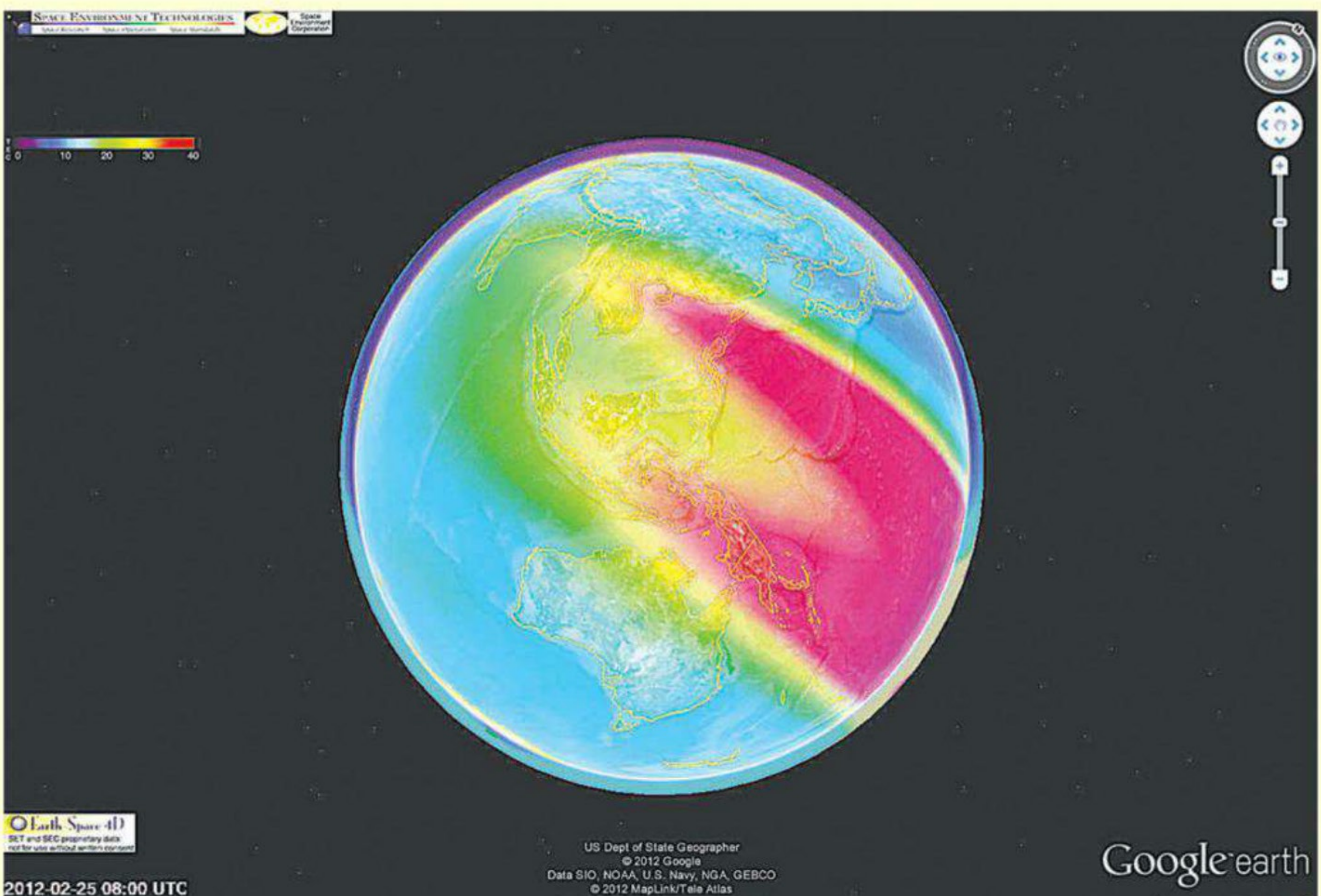
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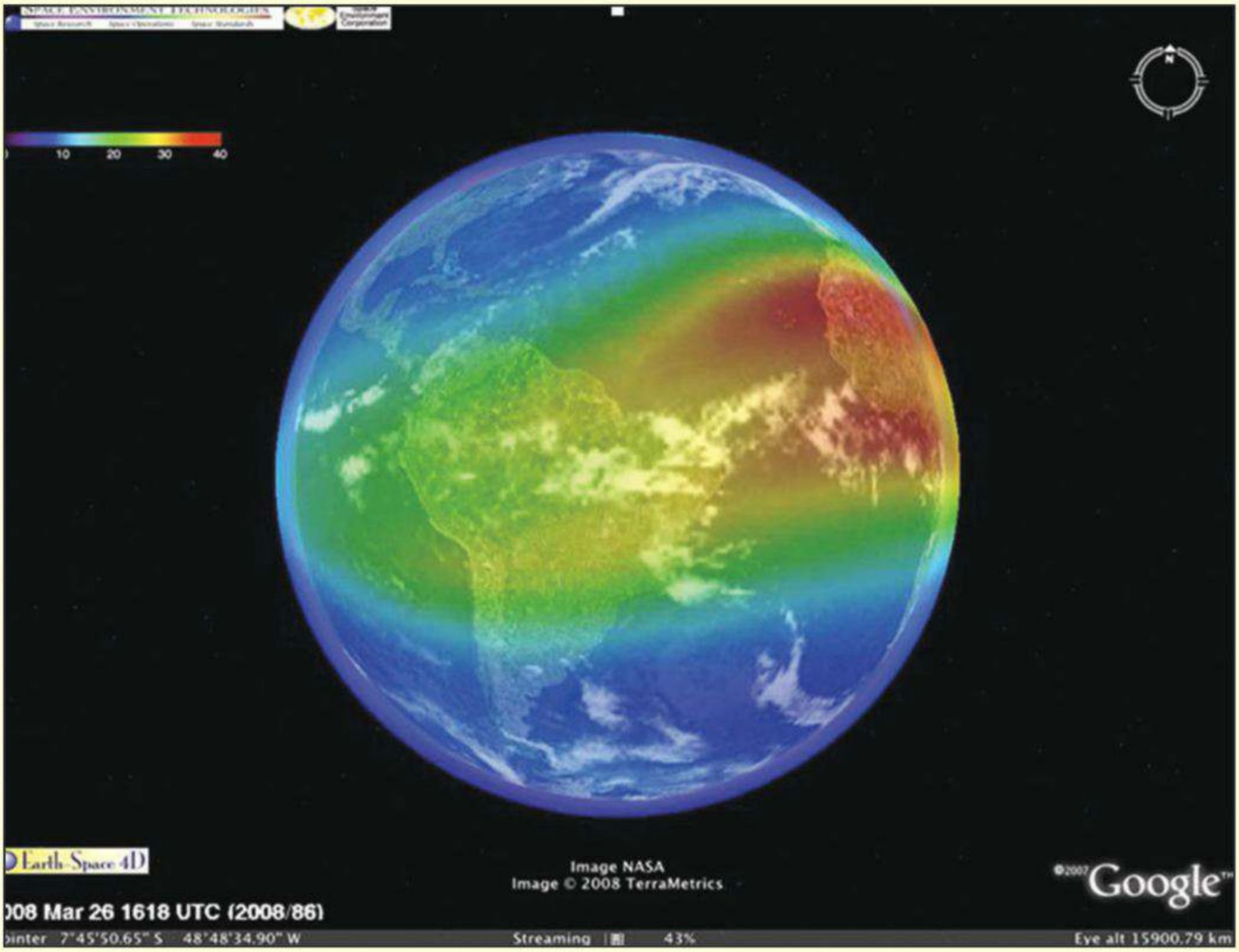

Screen-shots of the 4D ionosphere as modeled by NASA and Google Earth©. Colors represent electron content. Bright red is high density; that's where radio communications are restricted to few or no frequencies. Blue denotes low density; no problem there, propagation will be as expected. Using the intuitive Google Earth interface, users can fly above, around, and through these regions getting a true 4D view of the situation; the fourth dimension is time. This is a real-time system updated every 10 minutes. See: <http://g.nw7us.us/xs3Zwz>. (Credit: Google Earth/NASA)

ed. Of course, there are many variations during the day, between regions in daylight and darkness, and from season to season. Conversely, when the flux is high, during strong sunspot activity in the peak of a solar cycle, the ionosphere is strongly energized, and it is possible for a low-VHF radiowave to refract via the *E*- and *F*-regions, allowing for distant communications (DX) across hundreds to thousands of miles.

That's why this column tracks the sunspot cycle activity in each issue of the magazine. We want to know when the Sun is highly active, so we can be alerted to the possibility of DX on low-VHF. While sporadic-*E* occurs often during the summer (we cover sporadic-*E* in other editions of this column), we VHF DXers are ever on the alert for the possibility of taking advantage of ionospheric propagation if it becomes available.

We'll explore more about this in future editions. What are your experiences with low-VHF DXing? Please let me know.

The Season of Lights

This winter season is a time when the Earth is at a prime phase of its orbit around our Sun and when solar activity may more strongly influence geomagnetic activity. During times of minor to severe geomagnetic storm activity, the ionosphere loses its ability to refract HF. At the same time, however, these geomagnetic storms often trigger auroral substorms that create areas of ionization in the *E* region of the ionosphere capable of reflecting VHF signals. This mode of propagation, sometimes called, *radio aurora*, offers a challenging, yet exciting opportunity to increase your grid-square count.

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 in 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. It is likely this year, as we see continued increase in solar Cycle 24 activity, that we will have significant geomagnetic disturbances for triggering the sort of auroral activity known to bring VHF activity.

During aurora, ionization occurs at an altitude of about 70 miles, very near the *E* region of the ionosphere. The level of ionization depends on the energy and number of solar-wind particles able to enter the atmosphere. To the delight of the VHF communications enthusiast, propagation off the *E*-region auroral ionization is an exciting activity.

While correlations exist between visible and radio aurora, radio aurora could exist without visual aurora. Statistically, a diurnal variation of the frequency of radio aurora QSOs has been identified and suggests two strong peaks, one near 6 p.m. and the second around midnight, local time.

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

The *K* index is a good indicator of the expansion of the auroral oval, and the possible intensity of the aurora. When the *K* index is higher than 5, most operators in the northern states and in Canada can expect favorable aurora conditions. If the *K* index reaches 8 or 9, it is highly possible for radio aurora to be worked by stations as far south as California and Florida.

Expect an increase in geomagnetic storms, and auroral activity, as we move through March and into April. For the daily conditions, you are welcome to check my propagation resource at <http://sunspotwatch.com>, where I have the current planetary *K* index, links to various aurora resources, and more.

Meteors

While there are no major meteor showers during February and March, April has one major meteor shower—the *Lyrids*. While this shower peaks at about 18 meteors per hour, this year many more radio bursts may occur than what can be seen by the un-aided eye. Predictions call for a possible peak as high as 90 per visual meteors per hour.

From January through March there are small events that most people won't even consider because they don't yield any visual success. However, the VHF radio meteor hunter can find that even during days with minimal activity some meteor-scatter propagation may exist.

The Solar Cycle Pulse

The (preliminary) observed sunspot numbers from September through December 2012 are 61.5, 53.3, 61.4, and 40.8. The smoothed sunspot counts for March through June 2012 are 66.8, 64.6, 61.7, and 58.9. Looking at those numbers, some are questioning whether or not Cycle 24 has already peaked, and the cycle is now dying out. Many solar cycle prognosticators are still calling for a peak in 2013, however.

The monthly 10.7-cm (preliminary) numbers from September through December 2012 are 123.2, 123.3, 120.9, and 108.4. These numbers are slightly higher than one year ago. The cycle seems to be increasing in strength, but somewhat slowly. The smoothed 10.7-cm radio flux for March through June 2012 are 126.8, 125.8, 123.8, and 121.1. The activity level is generally high enough to support 10-meter propagation, but rarely 6-meter propagation via the *F2* region. If the cycle does increase in activity, we'll see improvement on low-VHF propagation by way of the ionosphere.

The smoothed planetary *A* index (*Ap*) numbers from March through June 2012 are 8.1, 8.0, 8.2, and 8.3. The monthly readings from September through December 2012 are 8, 9, 6, and 3.

The monthly sunspot numbers forecast for February through April 2013 are 77, 79, and 82, while the monthly 10.7-cm flux forecast is 133, 134, and 135 for the same period. Give or take about eight points for all predictions.

(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 also welcome to share your reports at my public forums at <http://forums.hfradio.org/>. Up-to-date space weather and radio propagation information is found at the NW7US Space Weather and Radio Resource Center, <http://sunspotwatch.com/>.

If you are using Twitter, follow @hfradiospacewx for space weather and propagation alerts, and follow me @NW7US to hear about various topics including space weather and amateur radio news. Facebook members should check out the CQ VHF Magazine Fan Page at <http://www.facebook.com/CQVHF>, and the Space Weather and Radio Propagation Group at <http://www.facebook.com/spacewx.hfradio>.

Until the next issue, happy weak-signal DXing.

73 de Tomas, NW7US

By Keith Pugh,* W5IU

SATELLITES

Artificially Propagating Signals Through Space

30th Annual AMSAT Space Symposium 2012

As promised in the last column, this one will be devoted to a report of the happenings at this year's AMSAT Space Symposium, Board of Directors Meeting, and associated activities in Orlando, Florida, October 25–29, 2012.

Board of Directors Meeting

Most of the annual BoD Meeting is held in open session and all AMSAT members are welcome to attend. I find this meeting very informative and occasionally entertaining. It starts with seating the incoming BoD members from the election held in the summer followed by election of the new slate of officers for the coming year. Next come reports from each of the officers and/or major AMSAT functions. President Barry Baines, WD4ASW (photo 1), started the activity (held October 25–26) with his comprehensive report of activities of the past year. His report to the BoD is a prelude to his report to the membership in the annual meeting held as a part of the symposium. During presentation to the BoD, this report is refined for eventual presentation to the membership. Images are available at: <http://www.amsat.org/ amsat-new/images/fck_images/2012 PresidentReportSlides%282%29>.

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Barry emphasized progress with the International Traffic in Arms Regulation (ITAR), Satellites in Education, plans for the future, and many other facets of the AMSAT Program. The large size of this year's *Proceedings* is a direct result of publishing details of our satellite projects to satisfy "open source" requirements for ITAR.

Complete reports were presented by or for Engineering, Field Operations, Publications, Education Activities, Membership, Budget, Satellite Operations, and other functions.

Space Symposium

As part of the Space Symposium, October 26–28, nine papers were presented on Friday afternoon ranging from a report of AMSAT and ARISS activity at Pacificon 2012 to MAREA—the Mars-lander ARISS Robotics Exploration Activity. Howard Long, G6LVB, announced the FUNcube Dongle Pro+, and several papers were presented on engineering techniques for future CubeSats.

On Saturday, 12 presentations were made regarding a complete, detailed design review of the Fox Project (see photos 2 and 3), AMSAT in education, working satellites with a homebrew setup (Cuban Style, FUNcube launch, and early operations), and high school students building satellites. The report from Cuba by Hector Martinez, CO6CBF (see photos 1 and 4), and the high

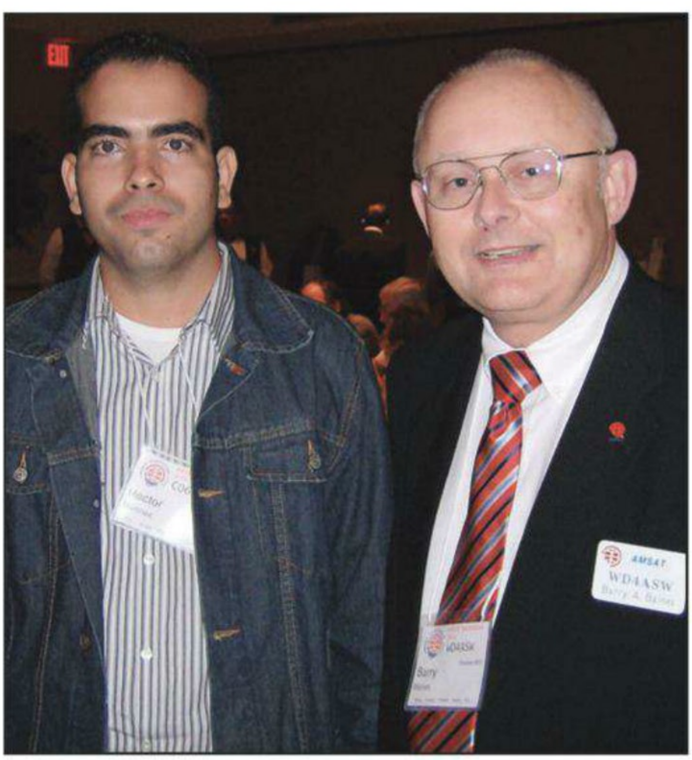

Photo 1. AMSAT President Barry Baines, WD4ASW, and Hector Martinez, CO6CBF)(Photo courtesy KB1SF)

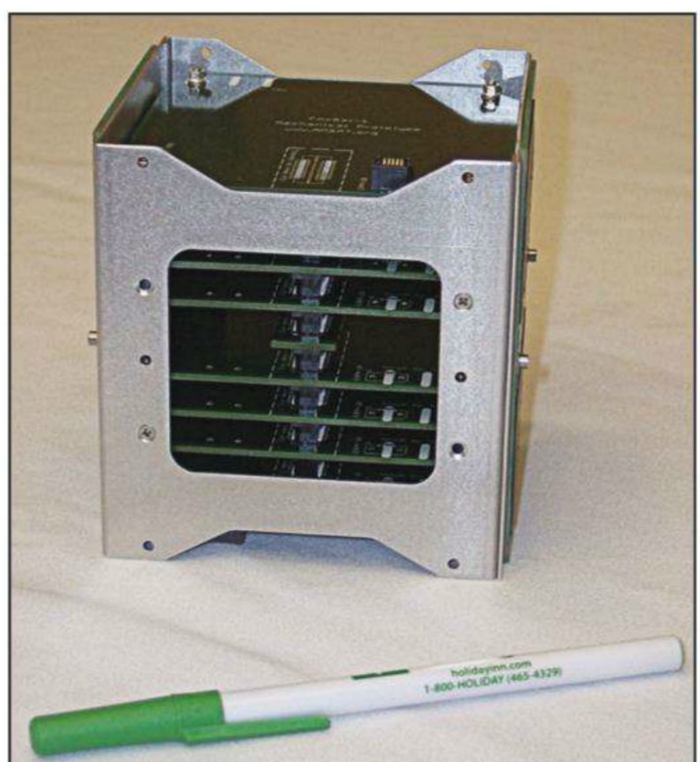

Photo 2. Fox-1 mechanical assembly. (Courtesy KB1SF)

school report by Maurisa Orona were especially inspiring.

Finishing out Saturday afternoon was the AMSAT Annual Meeting. During this meeting, Barry gave the President's Report as refined in the BoD Meeting and participants in AMSAT's programs throughout the year were honored.

Most of the papers presented and a few more, along with Fox design details, are contained in this year's *Proceedings of the AMSAT-NA 30th Space Symposium and AMSAT-NA Annual Meeting 2012*. Copies of the *Proceedings* are available through AMSAT.

Saturday evening was taken up by "attitude adjustment" (Thruster Firings), dinner, a talk by Astronaut Dr. Samuel T. Durrance (photo 5), and prize drawings.

Symposium activity ended on Sunday morning with the annual AMSAT Field Ops Breakfast. Gould Smith, WA4SXM,

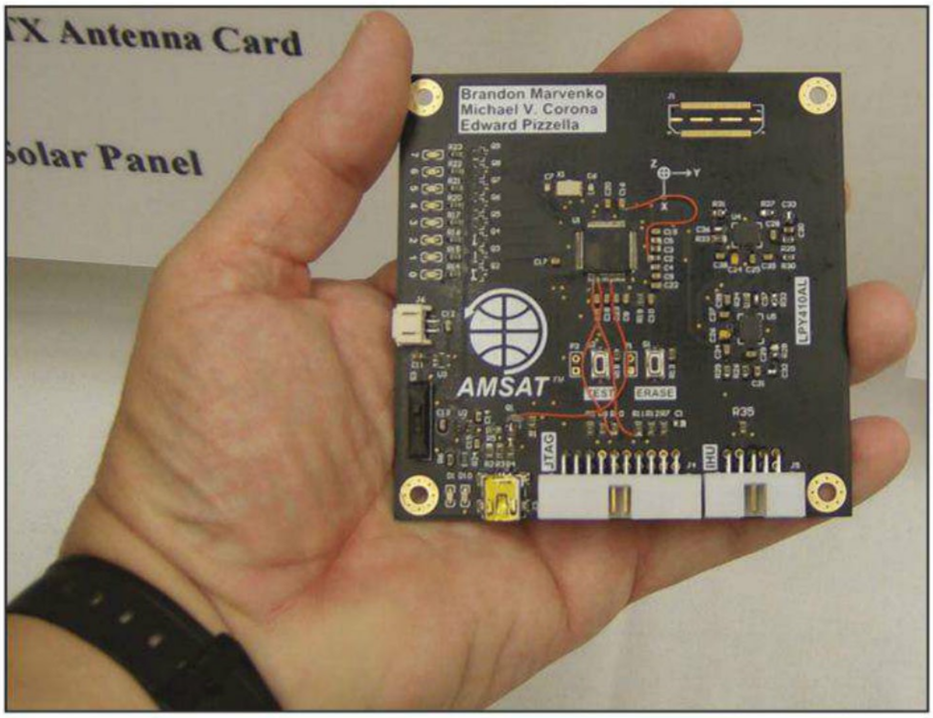

Photo 3. Fox-1 typical circuit card. (Courtesy KB1SF)

Photo 4. Hector Martinez, CO6CBF, AMSAT member Patrick Stoddard, VA7EWK/WD9EWK, and Howard Long, G6LVB. (Courtesy KB1SF)

led the discussions of field ops activities over the past year and plans for the future.

Extra-Curricular Activities!

Sunday was the day to tour the Orlando Tech Museum of Innovation complete with a special "Backstage Tour." If you are a *Star Trek* fan, the special Star Wars Tour was a highlight

Photo 5. Banquet speaker Astronaut Dr. Samuel Durrance. (Courtesy KB1SF)

Photo 6. Kennedy Space Center Director Bob Cabana, KC5HBV. (Courtesy W5IU)

Photo 7. Vehicle Assembly Building. (Courtesy W5IU)

Photo 8. Saturn V main engines. (Courtesy W5IU)

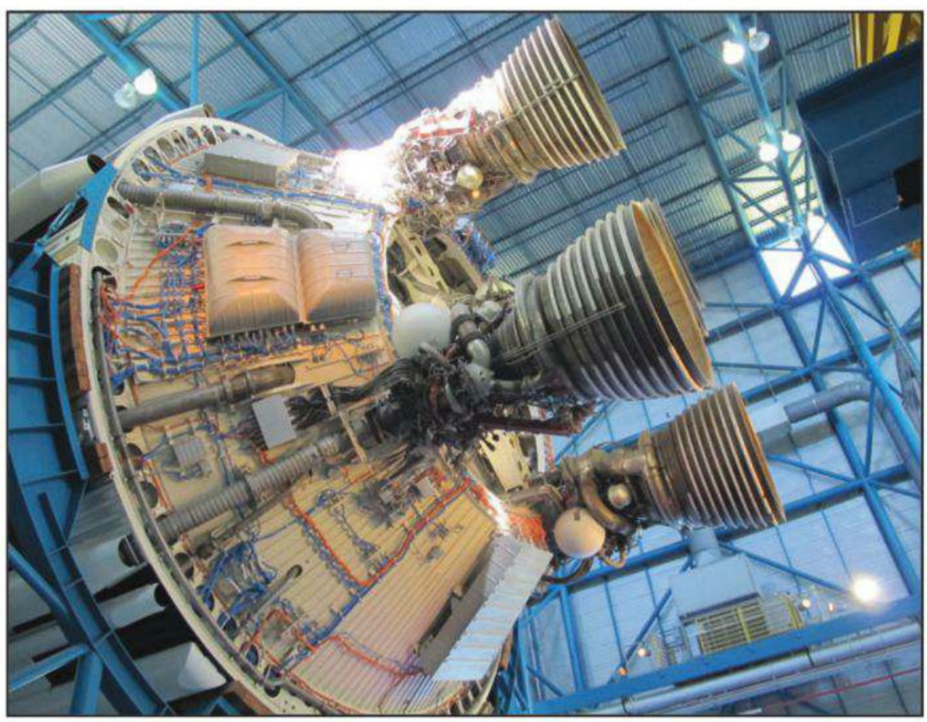

Photo 9. Saturn V upper stage engines. (Courtesy W5IU)

of the day. I've been a rather lazy fan but found the displays of things associated with *Star Trek* fascinating.

Monday we took an all-day tour of Kennedy Space Center with resident guides and visited with Bob Cabana, KC5HBV, former astronaut and current Director of Kennedy Space Center (photo 6). This tour included the Vehicle Assembly Building, launch facilities (photo 7), the Logistics Facility, the Saturn V Display (see photos 8, 9, and

Photo 10. Apollo return capsule. (Courtesy W5IU)

10), and many other things. It was a very complete and interesting tour. I've been on other tours of KSC before but this was by far the best ever.

AO-27 Update

In the last column, I reported that AO-27 had suffered a severe crash. Since then, several attempts have been made to revive it, but they have been only temporarily successful. The AO-27 official web page has not been updated since late October 2012. It has not been officially pronounced dead as yet, but it looks bad.

Summary

Plan to attend the next AMSAT Space Symposium. The location and date have not been determined as yet, but it will be in the October/November 2013 timeframe and at an interesting venue. I've been attending these functions since 1983 and never tire of them. I don't understand everything I hear, but a little bit rubs off each time: "If you're not careful, you learn something every day."

Please continue to support AMSAT's plans for the future of amateur radio satellites. Refer to the AMSAT web page at <http://www.amsat.org> for details. 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/>.

'Til next time, 73, Keith, W5IU

By Dr. H. Paul Shuch,* N6TX

DR. SETI'S STARSHIP

Searching For The Ultimate DX

"What's the Frequency, Kenneth?"

In a previous column, we met my friend Kenneth Schaffer, N2KS. For those of you who missed it, here is a brief recap:

> Kenny … was, as far as anyone can determine, the first Westerner to figure out how to use TVRO receivers to intercept Soviet TV… One of the challenges was geographical. Because of the northerly population distribution of the former Soviet Union, that region's television appetite is not well served from Clarke (equatorial) orbit, but rather from the Molniya highly elliptical polar orbit. However, TVRO antennas were mounted at fixed declination and variable hour angle, all aimed at the Clarke orbital belt, and thus not able to track Molniya birds. Kenny Schaffer figured out how to realign TVRO dishes, allowing him to watch Russian downlinks.

I ended that installment by promising you a look into Kenny's place in popular culture. We begin with a simple song title, which I have borrowed as the name for this column.

According to the album liner notes, the title of a 1994 hit by American alternative rock band R.E.M. alludes to "an incident in New York City in 1986, where news anchor Dan Rather was the victim of an unprovoked attack by one or two assailants who, between beatings, would ask, 'What's the frequency, Kenneth?'"

In this column, I will attempt to show that the "Kenneth" to which the attacker was referring is indeed N2KS, which raises more questions than it answers:

- Why was Rather assaulted?
- Who were the assailants?
- How does this particular ham's name relate to an unsolved crime?
- And, what has all this to do with SETI, the scientific Search for Extraterrestrial Intelligence?

Stay tuned, as all will be revealed.

Kenny first experienced Soviet satellite TV on his Manhattan apartment rooftop in 1983. In good ham radio fashion, he was motivated by the technical challenge rather than the programming content. Soon he recognized the educational resource afforded by his technological tinkering. One of the first places he set up Molniya receive terminals was at Columbia University's Harriman Institute for Advanced Studies of the Soviet Union. The institute's assistant director, Jonathan Sanders, and his graduate students would employ Schaffer's crude technology to secure an otherwise unobtainable glimpse into daily Soviet life, society, and culture.

Kenny Schaffer, N2KS, and Marina Albee, a partner in his Orbita commercial communications venture, appear under a Molniya satellite downlink antenna in this 1980s photo. Symbolically, during the Soviet era, all the Molniya dishes were painted red.

Because Soviet TV broadcasts were generally unavailable in the U.S., the receiver Kenny set up at the Harriman Institute drew a number of visitors. Some, such as English rock musician Gordon Sumner (better known as Sting), were there to learn about the arts scene behind the Iron Curtain. (One of the first adopters of a wireless guitar amplifier developed by Schaffer two decades earlier, Sting was moved by the Molniya viewing experience to compose his popular song "Russians," sung to a theme from the *Lieutenant Kijé Suite* by Russian composer Sergei Prokofiev.) Some of the visitors were American diplomats, hoping to

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use the knowledge gained from the screen to ease international tensions. Others, including TV news anchorman Dan Rather, came to do what journalists generally do—learn about upcoming trends so they later could report on them.

Then there were the visitors from the shadow world, all wanting to know how Schaffer was pulling these elusive signals out of the ether. Kenny generally refrained from telling them, likely hoping to capitalize on his technology by keeping the details to himself. When asked about frequencies and modulation modes, he usually changed the subject.

On the October 1986 night Rather was attacked, he and Schaffer had just left the Columbia campus, where they had been watching Molniya video downlinks. "What's the frequency, Kenneth?" Rather was asked repeatedly while being pummeled by unknown assailants. Kenny Schaffer believes this was a simple (although painful) case of mistaken identity. The muggers followed the wrong man.

Thus, just who were the men who accosted Rather on the streets of Manhattan? CIA? KGB? Industrial spies trying to steal Schaffer's secrets? Up-and-coming rockers wanting to steal Sting's music? If Kenny knows, he's not saying, and Rather refused to speculate.

What we do know is history. Just three years later, the Berlin Wall came down. In 1991, the Soviet Union dissolved. Today, Americans and Russians routinely watch each other's television programming, and it has brought the two peoples closer together. Russian television has also, one might hope, brought us closer to contact with our cosmic companions, for it is those same Molniya antenna mounts, capable of sweeping the Northern sky, that SETI radio telescopes around the world now use to sweep the heavens for evidence of distant technological civilizations. There's still much we don't know, forcing us to constantly ask ourselves, "What's the frequency, SETI?"

In the U.S., President Ronald Reagan is generally credited with ending the Cold War. In Russia, that distinction is bestowed upon Mikhail Sergeyevich Gorbachev. I like to believe that the end of international tensions was facilitated by satellite television. Kenny Schaffer insists it was rock and roll that brought down the Iron Curtain.

I think Sting would tend to agree with Kenny. 73, Paul, N6TX

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