The AMSAT® Journal

Editor-in-Chief
Joe Kornowski, KB6IGK

Assistant Editors
Bernhard Jatzeck, VA6BMJ
Douglas Quagliana, KA2UPW/5
Paul Graveline, K1YUB

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in this issue ...

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AMSAT Announcements

2019 AMSAT Board of Directors Election Results

The 2019 AMSAT Board of Directors election concluded with a total of 1,052 ballots cast. Of that total, 892 were cast electronically and 160 were cast via paper ballot.

The total votes received by each candidate are as follows:

Jerry Buxton, N0JY	526
Howard (Howie) DeFelice, AB2S	435
Drew Glasbrenner, KO4MA	515
Jeff Johns, WE4B	366
Brennan Price, N4QX	480
Patrick Stoddard, WD9EWK	585
Paul Stoetzer, N8HM	399
Michelle Thompson, W5NYV	675

AMSAT's Bylaws, Article III, Section 5, provide: *The candidates receiving the largest number of votes shall be declared elected to the seats being contested. The two candidates receiving the next largest number of votes shall be declared First Alternate and Second Alternate, respectively, to serve until the next annual election of Directors or as provided in Article II, Section 7 hereof.* Accordingly, the following candidates were duly elected:

Jerry Buxton, N0JY - Director
Drew Glasbrenner, KO4MA - Director
Patrick Stoddard, WD9EWK - Director
Michelle Thompson, W5NYV - Director
Brennan Price, N4QX - First Alternate
Howard (Howie) DeFelice, AB2S - Second Alternate

AMSAT's Mission
AMSAT is a non-profit volunteer organization which designs, builds and operates experimental satellites and promotes space education. We work in partnership with government, industry, educational institutions and fellow Amateur Radio societies. We encourage technical and scientific innovation, and promote the training and development of skilled satellite and ground system designers and operators.

AMSAT's Vision
Our Vision is to deploy satellite systems with the goal of providing wide-area and continuous coverage. AMSAT will continue active participation in human space missions and support a stream of LEO satellites developed in cooperation with the educational community and other amateur satellite groups.

Editorial Office: Joe Kornowski KB6IGK, 3310 W. Braker Ln., Suite 300-322, Austin, TX 78758. Please e-mail *Journal* submissions to: journal@amsat.org, Editor's telephone: 512-574-1233 (cell). Advertising Office: AMSAT Headquarters, 10605 Concord St., Suite 304, Kensington, MD 20895-2526, Telephone: 301-822-4376.

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Apogee View

Paul Stoetzer, N8HM
Executive Vice President

I am pleased to be writing this edition of "Apogee View" in Joe's place as a special guest columnist. For those of you who don't know me, I am somewhat new to amateur radio satellites and AMSAT. My first experience with amateur satellites was listening to the ARISSat-1 voice beacon and decoding its SSTV images in August 2011. In September 2012, I made my first satellite QSOs (on AO-27) and joined AMSAT. In 2015, I was elected Secretary by the AMSAT Board of Directors; and, in 2017, I was elected Executive Vice President. I also have served as both an alternate and a regular member of the board.

As I write this in late September, getting ready for the upcoming Symposium, summer refuses to yield to the cooler air of fall here in Washington, D.C. I hope the weather will be more comfortable for the Symposium in nearby Arlington, VA, in a few weeks.

In mid-September, we received the fantastic news that Amateur Radio Digital Communications (ARDC) awarded a very generous grant to ARISS for the InterOperable Radio System (IORS) and related infrastructure. ARDC is the owner and manager of the Internet network known as the AMPRNet. In June 2019, ARDC initiated a philanthropic endeavor to provide monetary grants to organizations, groups, projects, and scholarships which have significant potential to advance the state of the art of Amateur Radio and digital communications in general. While ARISS still needs additional donations to fund the IORS fully, this grant significantly helps the endeavor. ARISS plans to have the IORS ready for launch by the end of the year. AMSAT thanks ARDC for their substantial contribution to this effort.

ARISS is a key component of AMSAT's vision. As printed inside the front cover of each issue of *The AMSAT Journal*, "Our Vision is to deploy satellite systems with the goal of providing wide-area and continuous coverage," as we "continue active participation in human space missions and support a stream of LEO satellites developed in cooperation with the educational community and other amateur satellite groups." AMSAT teams are hard at work on each clause of that vision statement.

The GOLF program is making good progress with development of the GOLF-TEE satellite. GOLF-TEE is a crucial element of our path back to high orbits and fulfilling the first clause of AMSAT's vision to provide wide-area and continuous coverage satellite systems. Systems aboard GOLF-TEE include active attitude determination and control (ADAC), a radiation-tolerant internal housekeeping unit (RT-IHU), and a Fox-1E type VHF/UHF linear transponder. GOLF-TEE also will include a software defined radio (SDR) with a high-speed X band (10 GHz) data downlink which may also provide a simultaneous X band downlink of the V/u transponder passband, effectively providing V/x capability for use and evaluation. All of these technologies are crucial for missions to HEO and GEO, and additional information will appear in future issues of *The AMSAT Journal*.

Our participation in human space missions also is expanding. As announced at the AMSAT Forum at the Dayton Hamvention, international AMSAT and ARISS organizations have formed a group known as AREx (Amateur Radio Exploration). Work currently is underway on the design of a ham radio system for NASA's Lunar Gateway. The Gateway will be a small

spaceship in orbit around the Moon that will provide access to more of the lunar surface than ever before, with living quarters for astronauts, a lab for science and research, ports for visiting spacecraft, and more. The first sections of the Gateway are scheduled for launch in 2022. The plans call for various uses of L (1.2 GHz), S (2.4 GHz), C (5 GHz), and X (10 GHz) bands for repeater-type communications, both analog and digital, through Gateway, image transmissions from both inside and outside the Gateway, possible access to experiments aboard Gateway, and two-way communications with astronauts while Gateway is crewed. The challenges for amateurs involve the substantial increase in free space path loss compared to satellites in low earth orbit. We are very excited about AMSAT's participation in this project. More details will be presented at the 2019 AMSAT Space Symposium and articles will certainly follow in future editions of *The AMSAT Journal*.

Finally, we continue to support a stream of LEO satellites. RadFxSat-2 / Fox-1E is ready for launch no earlier than December 1, 2019 on the ELaNa XX mission. That mission will launch on the first commercial flight of Virgin Orbit's LauncherOne air launch to orbit system. Stay tuned to ANS for further updates on the launch date.

The linear transponder and telemetry system carried aboard Fox-1E was designed for use in different CubeSats by merely adding an interface adapter for connection to the host bus. Noting the prevalence of CubeSats built and launched by universities and other organizations, AMSAT adopted a goal of "amateur radio in every CubeSat." Interested CubeSat programs wanting to fly an amateur radio payload may partner with AMSAT to carry one of these modules on their spacecraft. By providing amateur radio capability, the CubeSat program gets a worldwide ground station network to receive their telemetry and experiment data while the amateur radio community gets a transponder to use in orbit.

The first of these partnerships is with the Husky Satellite Lab at the University of Washington. Their 3U CubeSat, HuskySat-1, is scheduled to launch on the ELaNa XXV mission from Wallops Island, VA, on October 21. Northrup Grumman's Cygnus spacecraft will carry HuskySat-1 on a mission to the International Space Station. After completing its mission at the ISS, Cygnus will continue to a higher orbit of approximately 500 km to deploy HuskySat-1. After a 30-day mission to complete tests of its experimental payloads, a pulsed plasma thruster, and a K band (24 GHz) communications system, the satellite will be turned over to AMSAT, and the linear transponder will be made available to the amateur radio community. In addition, AMSAT Vice President of Engineering, Jerry Buxton, N0JY, and Vice President of Operations, Drew Glasbrenner, KO4MA, have been hard at work identifying and working with several CubeSat groups interested in carrying this system. We hope to be able to make additional announcements soon.

The 2019 AMSAT Board of Directors election recently concluded. I congratulate the winners and look forward to working with the newly-elected board to further our vital mission to Keep Amateur Radio in Space. By the time this Journal arrives, the 2019 board of directors meeting and 50th Anniversary AMSAT Space Symposium will have concluded. It promises to be an exciting weekend exploring both AMSAT's five-decade history and the work we are doing for the future.

While there will no doubt be many challenges in the future, I am confident in the organization's ability to overcome them. We will Keep Amateur Radio in Space. I look forward to attending the AMSAT Centennial Symposium in the fall of 2069 at the age of 84. Hopefully, by then we will be discussing our plans for amateur radio on the first crewed interstellar mission.

Educational Relations Update

Alan Johnston, Ph.D., KU2Y
Vice President, Educational Relations

Last month, I had an opportunity to bring AMSAT to the robotics and maker community. I heard about a STEM (Science Technology Engineering and Math) event called Robotstock ("2 days of peace, love, and robots" – like Woodstock but for robotics fans) in suburban Philadelphia. The timing was right – it was the weekend before classes started for the fall at Villanova, so I signed up for a table on the "Maker's Row." A FIRST Robotics group organized the event. I'm quite familiar with this community as I've mentored two high school teams in the past — Team 1329, the RoboRebels, and Team 2412, the Robototes.

It was a great experience. I was fortunate to have Villanova CubeSat Club students helping me staff the table and leading the interaction with the near-constant stream of STEM-interested people. We showed off CubeSat Simulators, tracked amateur radio satellites live on a monitor, helped kids hold the Fox Engineering Model. We even took a few outside to listen to satellites using a tape measure Yagi-Uda built by freshman students at Villanova and an RTL-SDR. Our theme was "CubeSats are Space Robots" (Figure 1).

We encountered many different people who were interested in various things. Some liked to hear about universities and schools building CubeSats and having them launched into space. Others enjoyed seeing the 3D printed frame of the CubeSat. And still others loved listening to the sounds of the demodulated telemetry and holding the models in their hands.

I always thought more opportunity existed for increased interaction between the robotics and maker communities and the ham radio and CubeSat communities. This experience seemed to prove that out nicely. We received an additional invitation to run a table at the Philly Mini Maker Fair in October — more on that in my next column. Next year, I hope to attend other maker and robotics events. Perhaps you have a robotics or maker event in your area? If you were interested in attending, I would support you with a CubeSat Simulator and other items. I'm working on developing some activities and things to do at these events. If you have

Figure 1 — AMSAT and Villanova CubeSat Club Table at Robotstock Event in Philadelphia.

Figure 2 — CubeSat Simulator built by David White, WD6DRI, Mt. Carmel Amateur Radio Club, W6SUN, in San Diego, CA.

ideas or interest, feel free to reach out to me via email at **ku2y@amsat.org** or on Twitter **@alanbjohnston**.

Our loaner AMSAT CubeSat Simulators continue to rack up the miles as they travel around. In August and September, the K4AMG Memorial Amateur Radio Club used the CubeSat Simulator on NASA Day at the Slover Library in Norfolk, VA, and at the Virginia Beach Hamfest and Convention where they ran a Youth Forum and a Youth Lounge. Thanks to Rich Siff, W4BUE, and Duane Ettwein, KJ4YKG, for taking the CubeSat Simulator to these events. In September, very active AMSAT member and Ambassador Tom Dougherty, N0TJD, organized a Satellite Field Day at Faust Park in St Louis, MO, and used the CubeSat Simulator.

And it seems that some CubeSat Simulators are being built on the other side of the Atlantic. I hope to have reports in the future from France and Spain about developments there.

As always, please contact me if you have a classroom visit or activity planned, or a hamfest or demonstration coming up. And if you have built a CubeSat Simulator, I'd love to see photos to share here and on social media.

Interview: ANS Editor in Chief, Mark Johns, K0JM

Mark Johns, K0JM, M0GZO, ex-WA0RGV, ex-K0MDJ, ex-9H3DJ.

The Journal *reached out to newly appointed ANS Editor in Chief Mark Johns, K0JM, to learn more about him and how he sees the challenges ahead in his new role.*

Journal: You've held an interesting variety of call signs. Can you give us a short history?

K0JM: I've only had my current callsign a little over a year, so there's still some confusion about who I am! I've been fortunate to have many great experiences in ham radio over the years, so I've managed to collect a few callsigns.

Back in a previous century, about 5th or 6th grade, in Des Moines, Iowa, my friend Jon Ahlquist and I started playing around with electronics. We were about 12 when we found a junk TV set in somebody's trash and started taking it apart to recycle the components, mostly for projects that ended in smoke. We both went on to get licensed (he's WA0WYX) and to become college professors. Fortunately, we had many good elmers along the way. One of mine was Jack Peterson, K0AMB (SK), a Navy radioman and later a Lutheran minister, whose parents lived next door to me.

I got my novice license about the time of my 15th birthday and was assigned the random call of WN0RGV. In those days, you could only be a novice for one year, then you had to either upgrade or get out of the hobby. The written tests were never a problem for me, but I always struggled with the Morse Code, so at the end of my year I became a Technician with no HF privileges back then. Two-meter FM wasn't really a thing yet, so as WA0RGV, I played around on 6 meters for two more years before I could get my code speed up. I was only a General class operator for three months. Next time the FCC examiner came to town, I passed the Advanced exam. But I never could get my code speed to 20 wpm. I didn't pass Amateur Extra until years later, when the code requirement was dropped. I've always admired, and been a bit jealous of, operators who are adept at CW. I practice and practice, but it just doesn't come to me.

While other high school kids worked to save up for a car, Mark, as WA0RGV, worked to save up for a transceiver.

K0MDJ was my dream callsign, because it's my initials, and I had it for many years, from 1997 to 2018. But just a few years ago, when nearing retirement gave me more time, I started getting involved in HF contesting. K0MD is a very well-known contester, and we were located only 70 miles apart, so I was creating some confusion in the contests. That's when I started looking for a 1x2 call, and became K0JM in 2018.

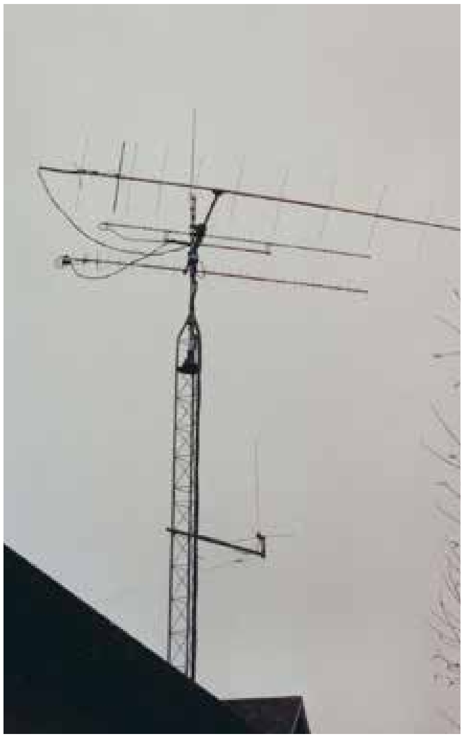
Finally, as a college professor, I've had a couple of opportunities to live and work overseas. In 2011, we moved to England for a year, and I was given the call M0GZO, which I still hold and can use if we go back. I also did a half year exchange in Malta, and had the temporary call of 9H3DJ.

Journal: So, what got you interested in satellites?

K0JM: I've always been a tinkerer, probably more than an operator. I always have some sort of project or technical challenge I'm working on – or at least some new rig, gadget, antenna, or something that I'm saving pennies to get and incorporate into the station.

Satellites, for me, were a technical challenge. I started listening to 10 m and 2 m downlinks in the late '70s. It was sometime in the early 1980s when I acquired a couple of Icom transceivers, an IC-290H and an IC-490A. I know I got them used, but can't remember if it was a hamfest or what.

I remember building antennas, using old RCA rotors, burning up some homebrew pre-amps, and getting better at using the



Satellite array at K0MDJ in Cedar Falls, Iowa, around 1997.

cardboard OSCAR Locator to plot passes. I eventually was able to get a station ready for AO-10. When I could start working DX via satellite, I definitely was hooked. Like most, I just kept adding capabilities gradually over time.

Journal: What about your academic career?

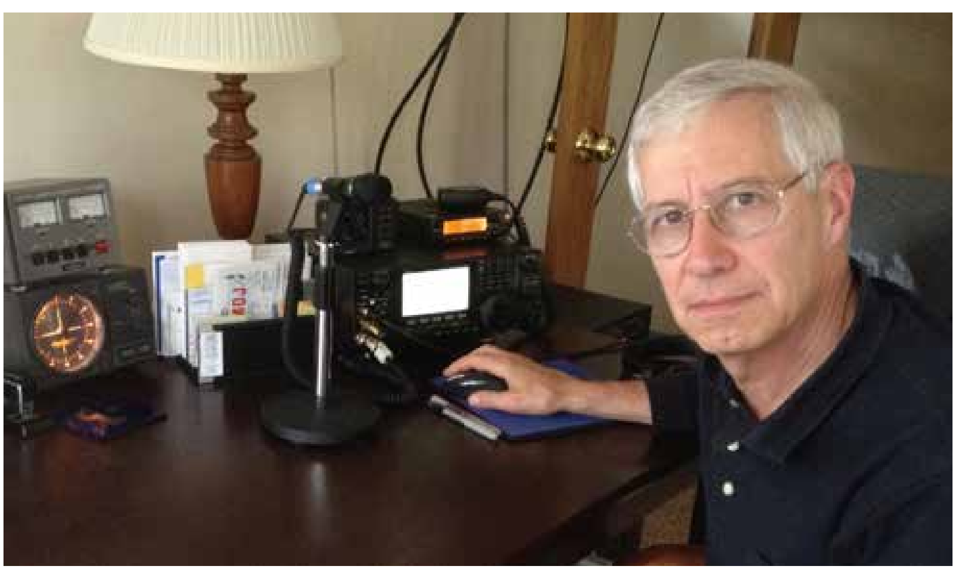
K0JM: I retired in May 2017 from Luther College, a small liberal arts college in northeastern Iowa, after almost two decades of teaching media studies, media production, broadcast journalism, and public relations – as well as some basic public speaking courses, although that wasn't my main area. I'm proud that I have many former students who are now full-time journalists, or other types of professional communicators in businesses and in non-profit organizations. But I'm also proud of the ones who became teachers or librarians or other things.

Journal: And what did you do before teaching?

K0JM: With a name like Luther College, it shouldn't be a surprise that the school is affiliated with the Lutheran Church. I am, in fact, an ordained minister in the Evangelical Lutheran Church in America (ELCA), but I haven't been in the marrying and burying business for a very long time.

Largely because of ham radio, I passed the old FCC First Class Radiotelephone exam back when I was in college. With that ticket in hand, I was able to get a job as an engineering technician, and later as an air control director, at a public television station in the Twin Cities. This is how I worked my way through seminary. I even dropped out of seminary for awhile and worked full time for a commercial TV station. So, when I did finally become a parish pastor, serving a few congregations in Iowa and Minnesota, the word was out that I had some expertise in the media field.

I did some media production for the denomination, and some consulting on communication strategies at the congregational level, then regionally, and later for the ELCA denomination. I wrote some communication resource materials published for congregations and ELCA non-profit organizations. Finally, I quit my job and went back to school. I earned my Ph.D. in mass communication from the School of Journalism at the University of Iowa and became a full-time academic.



Mark as K0MDJ in Decorah, Iowa, in 1997.

Journal: So how does all of this experience inform what you plan for the AMSAT News Service (ANS)?

K0JM: First, I don't anticipate any big changes for ANS. Our main task is to produce a weekly summary of news that is of interest to the amateur satellite community, as well as special bulletins when there is breaking news, such as a launch or something else that is too important to wait for the weekend.

Our goal is to distribute these bulletins as widely as possible – first as plain text emails that can be read easily on any device, no matter how primitive the technology, and also on the AMSAT website in an HTML format.

But as I've always taught my students, the communication function in any organization – and especially in a voluntary association such as a church, or a non-profit organization like AMSAT – is not just to be the mouthpiece of the organization, but also the ears. Communication runs two ways.
ANS volunteer editors (and we're always looking for more volunteers, by the way – you don't have to have a degree from a school of journalism). ANS volunteer editors spend a good deal of time each week reading, and only a bit of time writing. We look at the amsat-bb mailing list, we read the satellite forums in places like QRZ.com, on Facebook and Twitter. We look at the pages of other AMSAT organizations around the world (thanks to Google Translate!), the NASA website, various commercial space news sites, and so on. It's important that we know what amateurs are thinking, and what kinds of news items they are looking for.

We also keep an open email account, ans-editor@amsat.org Because it's open we get tons of spam, but we keep it open in spite of that because we want anyone in the amateur satellite community to be able to send us their news tips, their ideas, the stories they think we should be looking into. We're constantly listening to what's on the minds of satellite operators.

Journal: But basically, the News Service is still public relations for AMSAT, isn't it?

K0JM: We leave that to the Journal! Just kidding. Sure, we support the organization.

Antennas at K0JM, Brooklyn Park (Minneapolis), Minn.

You'll see the blurbs in ANS bulletins on how to donate or volunteer or buy things at the AMSAT store online. But ANS has always been rather independent. It's a "user service," not a service to the front office. The board and officers are not telling us what to write each week. Essentially, each volunteer editor is finding his or her own content and deciding for themselves what's important.

We all pitch in. If an editor sees something newsworthy, and it's not her week to edit the bulletin, she still shares it with the team member who is "on" for that week. It's a very collaborative, team approach. We're working to be more consistent and standardized about how we write about things, just for the sake of clarity. But each editor has a lot of leeway in putting together their weekly bulletin.

Journal: Have you heard some say that AMSAT is too secretive?

K0JM: It's true that sometimes there are things we can't say. The organization has launch agreements, for example, sometimes with contractors carrying military payloads. These sometimes specify that we can't publish a launch date, or other details, until it happens (even if some other sources are doing so). But aside from those kinds of restrictions, we have a free hand.

The truth is, if it's something that secret, I don't know it, either. ANS doesn't have a security clearance. We pretty much report what we know.

I've read the criticism, and it surfaces every few years, about how "closed" AMSAT is, and how it keeps things secret. That's never been my experience. Usually, it's just a case where nobody has asked the question.

And what is also true is that the entire organization is made up of people who are volunteering their time, most while maintaining a "day job," plus family obligations, and so forth. There are only so many hours in a day, and sometimes people simply forget to take the time to share what they know. That's our job at ANS. We listen to what the satellite community wants to know, and do our best to ask the right questions of the right people to supply the answers.

But every organization can always do a better job of communicating. That's another thing I taught in the classroom. Corporations, government agencies, non-profits, voluntary associations — all need to work very intentionally at communicating more effectively all the time. As a professional communicator, that's what I'm working on, and what all of our ANS volunteers are working on.

For Beginners – An Amateur Radio Satellite Primer

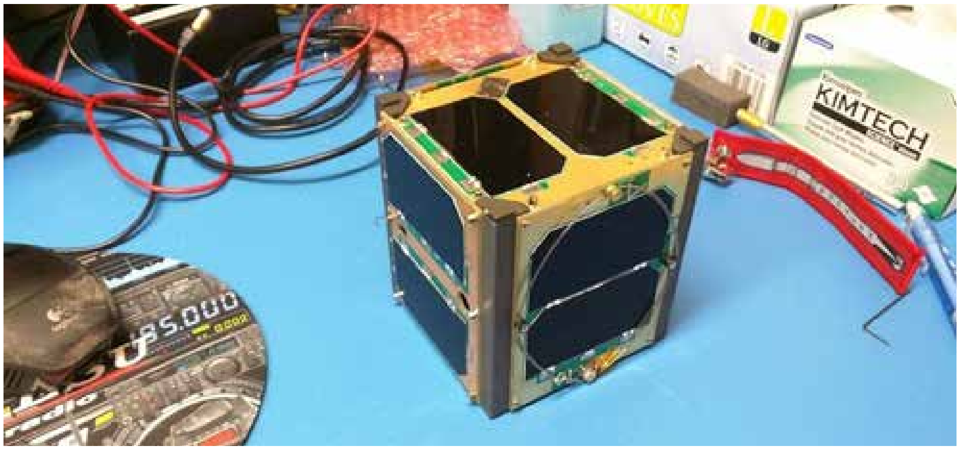
Keith Baker, KB1SF/VA3KSF, Treasurer and Past President

[Portions of this column first appeared in the December 2018 issue of The Spectrum Monitor *magazine. Thank you, MT!]*

One of the great features of amateur radio is that it is several hobbies rolled into one. If you become bored with one aspect of the hobby, there is always something new or different to try. For over the last 60 years or so, using our fleet of amateur radio satellites to communicate has always been one of the more interesting aspects of amateur radio.

My goal in my satellite-related writings for several publications (starting with my first "getting started" book called *How To Use the Amateur Radio Satellites,* which was used as an AMSAT member benefit back in the mid-1990s) and then for recurring columns in *Monitoring Times*, *The Spectrum Monitor* and *The Canadian Amateur* magazines) has always been to provide those interested in this aspect of the hobby with a general introduction to the basic concepts of tracking and operation as well as the customs currently in use on the amateur radio satellites. My other goal has been to give our more experienced satellite operators some practical, "hands-on" tips on how to use our current fleet of amateur radio satellites as

The author holds one of the early engineering models of our AMSAT Fox series of satellites at a recent AMSAT Symposium. (Courtesy: AMSAT)



The flight model of AMSAT's RADFXsat-1 (Fox-1B, later AMSAT-OSCAR-91 on orbit) awaits final testing at the Fox Labs in Texas. (Courtesy: AMSAT)

well as to offer the very latest information on those satellites already in orbit, plus those currently "on the drawing boards" for eventual launch.

However, if you are new to amateur satellites (or the "birds" as we satellite operators often call them) and have recently joined AMSAT, it's essential to establish a general understanding about how to find and track these modern-day wonders before you make your first attempts at using them.

As it's been a while since I've shared a basic introduction to satellite operating in our *AMSAT Journal* (and based on the scores of new AMSAT members I've since spoken to on the satellites and at our various AMSAT booths during recent hamfests) it's probably time to once again go back to the basics and share some "how-to" information for those who are just becoming interested in this fascinating aspect of our wonderful hobby. So, let's get started.

Overcoming the "Fear Factor"

Indeed, for most of us, the thought of using our own radio equipment to hear or talk through a satellite conjures up a sense of mystery and awe. At the same time, it creates a certain amount of fear...fear of doing something wrong, or of not ever being successful no matter how hard we try. In years past, when only one or two amateur satellites were in orbit, hams had to really work hard to even hear one of the OSCARs (Orbiting Satellites Carrying Amateur Radio) as they whizzed overhead.

As of this writing, some 20 or so active satellites are up there (with scores more on the way!), and that's not even counting the crew of the International Space Station (ISS) who use the amateur radio equipment installed aboard that permanent orbiting laboratory. So, it's safe to say your chances of at least hearing one of them (or, if you have a U.S. Technician ticket, actually communicating through one or more of them with your current equipment) is far better now than at any time in the recent past. All it takes is a little knowledge and some basic equipment and antennas, some of which you may already have or that you can build for just a few dollars.

Tracking the Birds

To listen for, or communicate through, an amateur radio satellite you first have to find out when it will be within range of your station. Fortunately, most of us now have a computer in our ham shacks with access to the Internet, so tracking satellites has become much easier than it used to be.

Today, several satellite-tracking programs are available in shareware form or for purchase, as well as in a variety of different computer formats. What's more, numerous web sites related to amateur satellite operation now have online tracking programs that make rough tracking a snap. But, if you're serious about satellite tracking, you should also become familiar with how to use sets of orbital data called Keplerian elements.

Known to veteran satellite operators simply as "Keps," these data are derived from observations of each satellite's orbital motion. (Kepler, you may recall, discovered some interesting things about planetary motion back in the 17th century!)

Today, NORAD, the North American Aerospace Defense Command, keeps

The RadFxSat-1 (now AO-91) mission patch. (Courtesy: Vanderbilt University)

A worker bolts one of the three "PeaPod" carrying structures, one of which successfully carried AMSAT's Fox-1B satellite (now AO-91) to orbit to the upper stage of its Delta II rocket. (Courtesy: NASA)

The Delta II launch vehicle carrying AMSAT's Fox-1B satellite (which later became AO-91 on orbit) successfully lifted off from Vandenberg AFB at 1:47 Pacific Standard Time on November 18, 2017. (Courtesy: NASA)

track of almost everything in Earth orbit. Periodically, they issue orbital information on non-classified satellites to the National Aeronautics and Space Administration (NASA) for release to the general public. The information is listed by each satellite's catalog number and contains numeric data that describes, in a mathematical way, how the satellite is moving around the Earth.

Without getting into the complex details of orbital mechanics (or Kepler's laws!), suffice it to say this data is what your computer software uses to plot the predicted paths of satellites. That is, once you've loaded your location (latitude and longitude), the current time (along with your local offset from Coordinated Universal Time (UTC)) along with the Keplerian element files into your satellite tracking software, the computer then solves the complicated orbital math to make a prediction of where a selected satellite should be at the current (or a future) time.

Keplerian Element Sources

However, because they are such a vital ingredient to this part of our hobby (and because they age over time) finding a reliable source for the latest Keplerian elements for amateur radio satellites should be high on your list of things to do as you get started in satellite work. Many amateur radio-related websites often list Keps.

Our AMSAT website lists the latest Keps in a variety of downloadable formats at **www.amsat.org/keplerian-elements-resources**. For the so-called "easy FM birds" (like our recently launched AO-91 and the ISS), the AMSAT website even sports an embedded online tracking feature which allows you to simply plug in your latitude and longitude (or your Maidenhead Grid Square) to find out when those satellites of interest will next be in range of your location. That online tracking program can be found at **www.amsat.org/track/index.php**.

Beacons

Probably one of the first things you will learn to do after you find out when a particular satellite will be within range of your station is to listen for the satellite's beacon. Most satellite beacons consist of one or more transmissions coming from the satellite that will assist you in your search as well as tell you other things about the satellite's health and the nature of its transponders.

Satellite beacons operate in many modes, from Morse code to a variety of digital formats, and can usually be found on frequencies immediately above or below the satellite's other downlink frequencies. In addition, as most satellite beacons transmit with a fixed amount of output power, they can also serve as a superb reference point for setting up and calibrating your station antennas and other equipment.

Most satellite telemetry signals, which consist primarily of transmissions about the health of the satellite, are also sent to ground controllers by way of the beacon. What's more, some satellites even provide information regarding their transponder schedules, along with other items of interest to satellite operators, using their beacons. However, in the case of AO-91 and most of our other popular FM satellites, the single-channel downlink itself is the beacon.

Transponders

So, once you have a reliable way to know when the satellite is within range of your station, and you've become familiar with its beacon, you next have to learn how to use its transponder. A transponder is a circuit that receives your uplink signal and then retransmits what it hears via its downlink transmitter, much like a terrestrial FM repeater does. However, unlike a terrestrial FM repeater, which has a specific input and output frequency in the same band, most amateur satellite transponders receive and then retransmit what they hear on another frequency (or frequencies) on another amateur band entirely. In short, most amateur satellites act much like cross-band "repeaters in the sky."

Moreover, as a satellite is a moving target, signals passing through it will exhibit a pronounced Doppler shift, just like the changing pitch of a train whistle as it approaches and then passes. During a satellite contact, as the satellite approaches you, both uplink and downlink frequencies will appear higher than those published. As the satellite passes overhead, both the uplink

SATELLITE	*MODE*	*UPLINK (MHz)*	*DOWNLINK (MHz)*	*BEACONS (MHz)*
AO-91 (Fox-1B)	U/V (Mode B)	435.250	145.960	FM Voice (67.0 Hz Tone to Access) FSK 9600 bps data

and downlink frequencies will then appear to drop slowly in frequency from those published. And, as if that weren't confusing enough, this apparent frequency shift will seem to be more pronounced on the higher frequency (shorter wavelength) amateur bands than on the lower ones.

Our example satellite (AO-91) uses what's called a "bent pipe," FM transponder. That is, whatever FM signals are sent up to the satellite on its single-channel uplink are then "sent through the pipe" back down on its single-channel FM downlink.

Operating Modes

One of the terms you will also come across in satellite work will be a reference to the mode of a satellite's transponder. A satellite's operating mode is nothing more than a shorthand way veteran satellite operators identify the various combinations of uplink and downlink frequencies available for use.

Back in the early days of satellite operating, one or more letters of the alphabet were used to designate satellite transponder modes. For example, if a satellite's uplink frequency was on 2 m and its downlink frequency was on 70 cm, the satellite was said to be operating in "Mode J." An uplink on 70 cm with a downlink on 2 m was called "Mode B," and so on.

Today, because so many satellites with different uplink and downlink transponder combinations are now in orbit, a more simplified system that includes the first letter of the band in use (VHF, UHF, SHF, etc.) has emerged. As a result, the old "Mode B" has now been renamed "Mode U/V" because the satellite's uplink transponder is tuned to UHF and its downlink transmitter is set for the VHF bands. Likewise, the old "Mode J" has now been dubbed "Mode V/U" and so on. The AO-91 transponder I'm talking about is the one for Mode U/V — or the old Mode B — with uplinks in the 70 cm band and downlinks in the 2 m band.

That's enough of the "getting started" information for this time. But please stay tuned. In subsequent *Journal* articles, I'll continue to show you how easy it is for you to become active on the "birds." We'll be exploring how to select your satellite antennas, feed lines, and radios as well as some helpful hints to make your first forays into satellite operating far more enjoyable. See you then!

Repurpose Your Station for Satellite Operation

You may already have the gear for making contacts through the VHF/UHF LEO transponder satellites.

Chip Margelli, K7JA

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At the time this article was being prepared, there were 14 SSB/CW transponder satellites active, along with three FM-only transponder satellites. The SSB/CW satellites include FO-29 (operating on “Mode V/U,” which is an uplink on 145 MHz and downlink on 435 MHz), the XW-2 series of Mode U/V satellites (435 MHz uplink, 145 MHz downlink), along with AO-73, EO-79, UKube-1, and LO-87 (also 435 MHz uplink/145 MHz downlink). These are all low Earth orbit (LEO) satellites, which means two things: (A) they are low, orbiting a few hundred miles high, which means that they can be quite loud; and (B) because they are in low orbits, they can whiz across the sky in 10 minutes from horizon to horizon. These are complementary factors — because the satellites have strong signals, we don’t need super high antenna gain. High-gain antennas are highly directional, which we don’t want because the satellites are fast-moving targets.

What Antennas to Use

My main antenna system consists of a pair of six-element optimized wideband antenna (OWA) Yagis for 2 meters on a single boom, and a pair of separated loop-fed Yagis (loop-fed arrays, or LFAs) for 70 centimeters, mounted on an insulated boom — a Melamine-coated closet pole bought at a local hardware store (see Figure 1). I had these antennas on hand from previous uses, and the exact antenna design details are not important. You may have antennas on hand that will work fine.

As mentioned previously, we do not want long and highly directional antennas for making contacts using LEO satellites. Any small Yagis for the 144 MHz and 430 MHz bands can usually yield a fine satellite system. You can build your own, but there are many inexpensive manufactured beams that can be mounted and elevated for our purposes. For the UHF side, if you own any small 144 or 435 MHz Yagis, they will do the job.

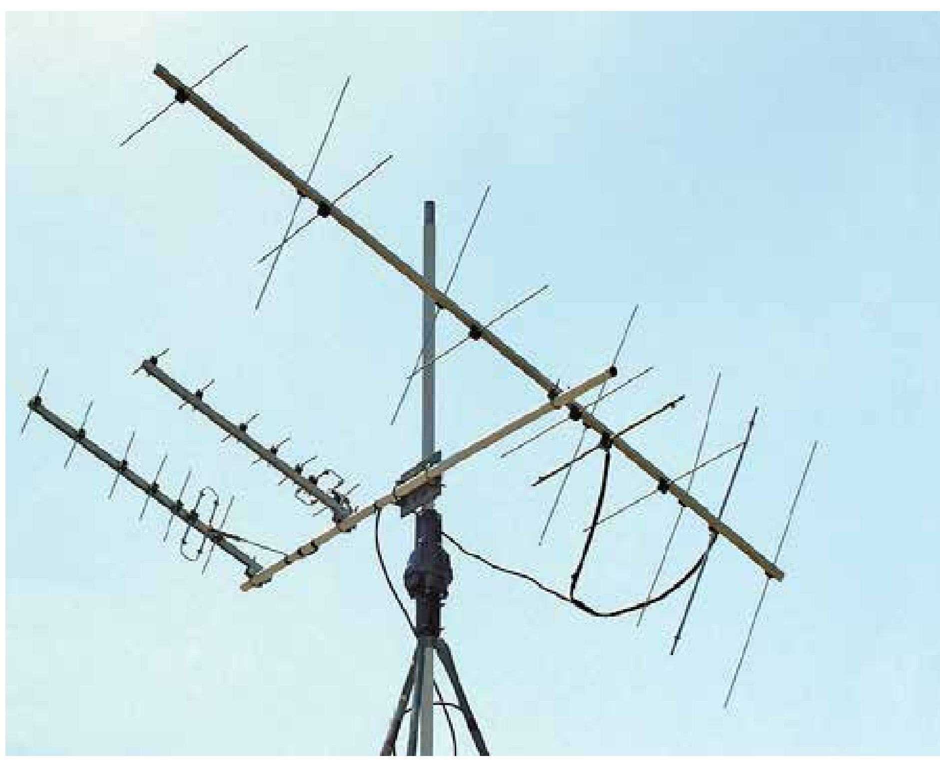

Figure 1. [Courtesy: ARRL]

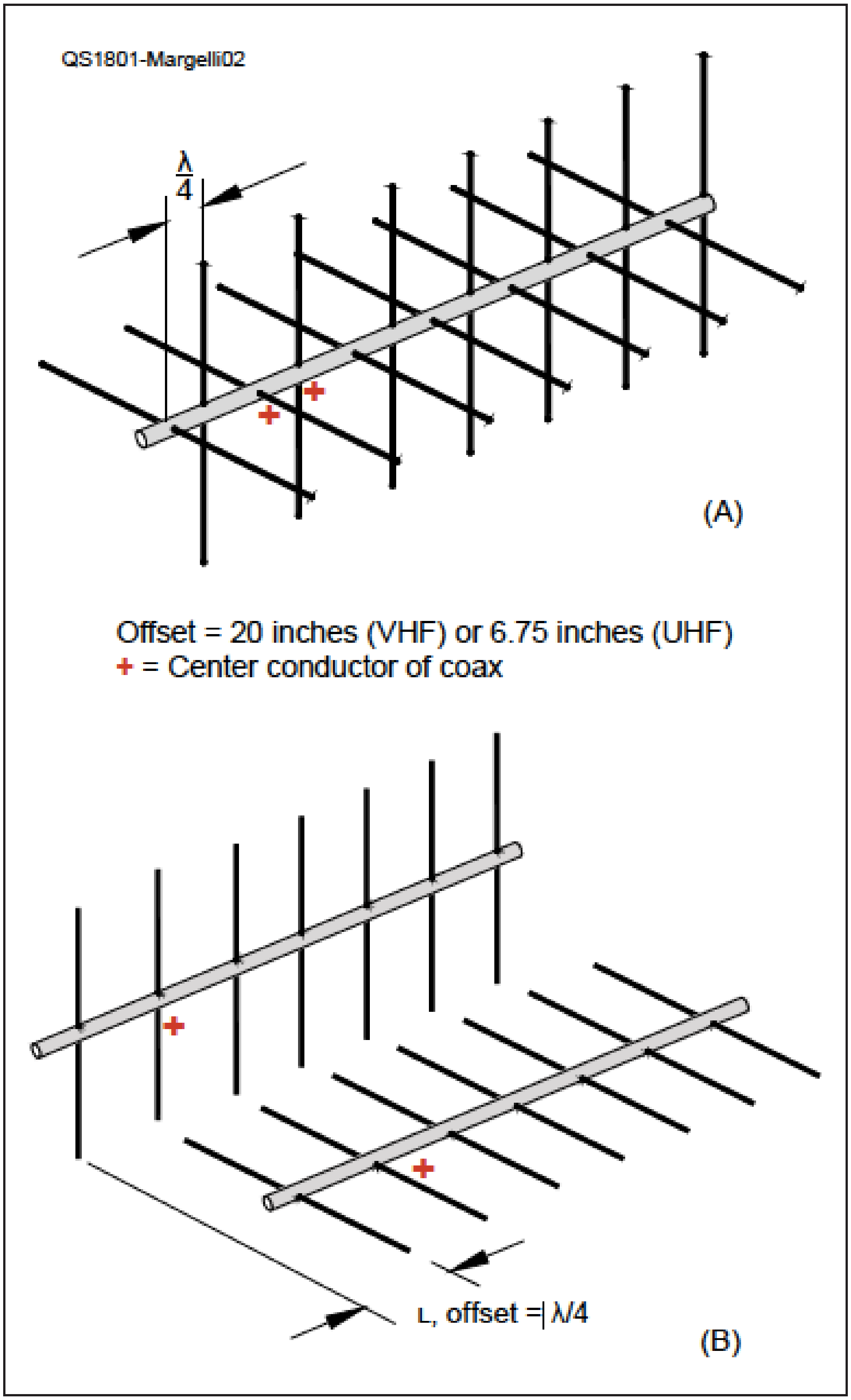

Figure 2 — Beams fed in phase can achieve elliptical polarization when mounted at right angles to each other and with a quarter-wavelength forward stagger. [Courtesy: ARRL]

Azimuth Rotation but Fixed Elevation

If you don't have a nice azimuth/elevation rotator and just want to try satellite operation, use a lightweight azimuth rotator, mount an insulated cross-boom above the rotator, and then fix the installed beams with the front ends elevated about 30° above the horizon. This raises the main lobe of the beams upward without sacrificing the low-angle gain, so that most of the satellite's path across the sky will fall within the pattern of the beams you have mounted. Remember — this trick depends on the Yagis not being extremely long, with tight patterns. The broad lobe of a short beam will allow this fixed-elevation technique to give you a big signal at least 80% of the time.

There are many good tracking programs available to help determine where to aim the rotator. I use SatPC32, available via AMSAT (**www.amsat.org**), and there are several apps available for tablet or handheld devices. If you don't have software, go to AMSAT's "Satellite Pass Predictions" web page (**www.amsat.org/track/index.php**). Just put in your latitude and longitude, select the satellite, and the web calculator will show you the time and beam heading of the satellite's rise and fall above/below the horizon, as well as the elevation, and you can interpolate beam headings from there.

Polarizing Matters

We all know that you don't want to try to make a contact with someone nearby who is using a different antenna polarization from yours. If you are in your car using a 2-meter mobile vertical antenna, you'll have trouble hearing or making contact with someone who is using a horizontal Yagi (which is typically used for SSB or CW).

Similarly, amateur radio satellites often use monopole or dipole antennas, and polarization mismatch (as well as dipole end-fire nulls) can be a problem. With linear polarization, we simply lose 3 dB in a polarization mismatch case with either circular polarization sense, but we avoid the deep cross-polarization fades. Still, I have made hundreds of contacts using linear polarization only, on both the uplink and the downlink; yes, there is fading, but the signals do come back in a few seconds.

Fortunately, it's not difficult to minimize the polarization-related fading. You need a duplicate set of elements (or another beam) at right angles to each other, along with a phasing cable to combine the two sets of elements. And you may have the right kind of cable already on hand; if you've ever stacked two beams to increase the gain, that's all you need.

To introduce a 90° phase shift between the two antennas, we could add a delay line to our repurposed phasing line, but we still might want to use it for a stacked beam configuration on another day. There's another way. If we physically offset one beam (or the string of elements mounted at right angles to the other elements) by a quarter wavelength in air (about 20 inches on 145 MHz, 6.75 inches on 435 MHz), we can achieve the desired phase shift for circular polarization.

Figure 3 — Installing a pair of antennas pointed straight up yields big signals when satellites pass directly overhead. [Courtesy: ARRL]

Then our original phasing cables have remained untouched, ready for use in the future for non-satellite applications (see Figure 2).

The No-Rotator Option

As addressed previously, the LEO satellite antenna has a pattern like a dipole, and off its end has a null, which can occur anywhere during a satellite pass, depending on the orbital orientation of the craft and the geometry with respect to the ground. Nothing on the ground will overcome that null.

For 145 MHz, I designed a simple two-element Yagi, and mounted a pair of them on the same boom, fed in phase but physically offset by a quarter wavelength, as described previously. For 435 MHz, I separated and repurposed the rear one-third of an old KLM (now M2) 435-40CX circularly polarized beam; the pattern is not optimal according to the original design, but the SWR is perfect (see Figure 3). For 2 or 3 minutes, as satellites pass overhead, this simple solution provides thundering signals through the LEO satellites, because they are only a few hundred miles away and in your line of sight. I use two-position coax switches to select the best antennas for uplink and downlink.

If you have obstructions surrounding your location, this combination may be all the antenna system you need. The 2-meter array is very broad (at least 70° wide) in pattern, and this will cover a large percentage of your operating needs, with no rotator required at all.

What Radio(s) to Use

Many satellite-ready transceivers have been produced over the years, including the Icom IC-9100, Kenwood TS-2000, Yaesu FT-847, FT-736R, and many others. But if you have one of the compact multi-mode rigs, like the Yaesu FT-857D, Icom IC-706/7000/7100, or even the little Yaesu portable FT-817ND, all these HF/VHF/UHF multimode radios work great. You need two such rigs, because satellite operation is full duplex — you're transmitting and receiving at the same time — and you have to adjust the transmit and receive frequencies separately. But even if you only have one of these rigs, you can try using one of the new generation of inexpensive software-defined radios (SDRs) like the SDRPlay RSP1 or RSP2 as a downlink receiver; these receivers often cover up to 2 GHz and more, and their performance is outstanding.

You, too, can get on our amateur satellites, and it doesn't have to involve much expense — repurpose your current radios and antennas to get started, and you'll get lots of enjoyment from trying something new.

Hamspeak: Cross Polarization

Attempt at communication between stations using antennas of different polarization. In the case of line of sight communication between linear antennas, a perfectly oriented horizontally polarized antenna, for example, will not be able to receive signals from a perfectly oriented vertically polarized antenna. The same is true of two circularly polarized antennas of the opposite sense. In the typical amateur environment, such cross polarization will result in 20 – 30 dB of attenuation compared to using the same polarization.

Chip Margelli, K7JA, is an Amateur Extra-class licensee active since 1963. Chip is a Life Member of ARRL, AMSAT, and QCWA, and a 2006 inductee into the CQ Amateur Radio Hall of Fame. He may be reached at chipk7ja@hotmail.com.

Operating Easy Sats with Handheld Gear

Pedro Sousa, CU2ZG
AMSAT Ambassador

By the time AO-85 launched, very few amateur radio FM satellites existed. AO-85 marked the first time in a while that a new FM U/v satellite was placed into orbit, and everyone was excited about it. But a problem appeared with the satellite's reception. Consequently, QSOs were possible but required better than average station equipment setups on the ground, especially a good antenna.

Some months ago, when AO-91 and AO-92 launched, that station requirement changed dramatically. These two FM satellites are exceptionally easy to access with a basic handheld radio, as announced for the entire FOX satellites series, and a rather simple antenna. Let's look at just how simple it can be.

First, I strongly recommend that before attempting any satellite contact, FM or SSB, you should read AMSAT's recommended practices. The document itself is a set of guidelines that will help you not only access the satellite (hear it) but most importantly increase the likelihood that you will complete a QSO with others. Along with the common sense cordiality and patience that this hobby requires, I want to emphasize two key elements. First, listen. Take time just to listen to some passes and understand how QSOs go. Become familiar with the "standard" QSO structure and their pace for completion. Go to YouTube and watch videos of operators working those satellites, and you will see how they handle the equipment. Take a look at KG4AKV John's Space Comms channel (**www.youtube.com/channel/UCJDdMdjxwFsjdzhXQFHVk2g**) or Patrick's WD9EWK videos (**www.youtube.com/user/va7ewk**). The number of passes you should listen to depends solely on your comfort level and interest. If you transmit and do not hear replies after several attempts, then something's up. One possibility is that you might be getting into the uplink and inadvertently interfering with someone else's QSO.

Second, acquire a full-duplex radio setup. One option is two radios with a cross-polarity dual-band yagi. Another possibility is one full-duplex radio and a dual-band antenna. Still another option might be two radios and one dual-band antenna like the Elk and a diplexer. Whichever setup you choose, I guarantee that once you've tried full-duplex, you will never want to go back. Even when using full-duplex, practice listening. If you still do not hear yourself, it does not mean you are not getting into the satellite. Work to discover and solve the possible problem and try again.

When operating those FM birds with a simple handheld radio, my choice is a Wouxun KG-UV9D. In fact, I own two of them. As more experienced operators know and are thinking right now, this radio is not full-duplex in V/u mode for satellites. Given that there were only a few FM birds up there, my radio choice was the most cost-effective for me at the time. After a while, you tend to know the satellite's spin velocity by monitoring the polarization. You can take advantage of that by aiming your antenna correctly and maximizing the odds of getting into the uplink. I'm not saying you should only work satellites when full-duplex capable. I'm just suggesting that it will make working the passes much easier for you and everyone else.

Figure 1 — Wouxun stock duckies, Nagoya NA771, Nagoya R3 and Nagoya RH-770. [Pedro Sousa, CU2ZG, photo.]

How simple can the antennas be? I have been working AO-91 passes during lunchtime and tested different antennas over the course of several passes. Let's consider the stock Wouxun duckies, the Nagoya RL-770S, Nagoya R3, Diamond RH770, Pryme AL-800, homemade open sleeve short Moxon and the Alaskan Arrow II. See Figure 1.

Stock Duckies

A new Wouxun KG-UV9D includes with two duckies. These small antennas are perfect for carrying your radio around, but for such a small and distant object as a satellite, they are not so great. AMSAT did an outstanding job building the FOX series CubeSats so that even with such stock antennas you can complete some QSOs. I found that when using a duckie, you will only start to hear the downlink around 20 degrees elevation, and the uplink will pick you up around 40 degrees. In fact, my very first AO-91 QSO was with one of those duckies. It works well for overhead passes and low noise environments. I have worked AO-91 from IO91 right next to London's Heathrow Airport, UK, which is a nest of QRM. Also, I've worked SO-50 with a Baofeng and its stock antenna.

Nagoya NL-770S

This antenna is intended for your car, but I found it's effective operational scope to be very narrow on the ham bands when tuned to specific frequencies. For example, it worked fine for 432 MHz with a SWR of 1:1.2 but terrible at 435 MHz with a SWR of 1:1.8. The same applies for the 2-meter band. Even so, you will pick up signals around 15 degrees; the uplink is only accessible above 40 degrees, which is about the same as the duckies. This represents some improvement, but I never completed a QSO with it. So, I tried the NagoyaR3.

Nagoya R3

Also a car antenna, the R3 is very flexible and measures 49 cm, which is longer than the NL-770S. The R3 will receive signals at around 7 degrees and the uplink around 25 degrees. While that is better than the others I'd tried, it still wasn't good enough for me. Besides, this is the antenna I have on the car, so I had to remove it for every pass. Occasionally, I worked passes while driving and could not stop to remove the antenna. I wanted something better. With the satellite's rotation and the antenna being vertical, the fade pace is noticeable, so I had to wait until the signal got back to operate. Nevertheless, take a look at this video where I complete a

Figure 2 — Open Sleeve Short Moxon. [Pedro Sousa, CU2ZG, photo.]

QSO, mobile to mobile, with F4DXV **www.youtube.com/watch?v=518KO687G-o**.

Diamond RH-770

The RH-770 is telescopic, making it perfect for storing in your glove compartment or your laptop case. I have been taking it on short- notice business trips. Usually, I receive signals starting around 7 degrees but can get access to the uplink roughly around 10 degrees. I've activated five DXCC entities with it, so it's not a bad option. While onboard a cruise ship in the Gulf of Mexico at the 2016 AMSAT Symposium, I completed two QSOs on AO-85 with the RH-770.

Pryme AL-800

I'm not sure if I have an actual Pryme or a close imitation of it. The AL-800 is very similar to the RH-770 but about a half-inch shorter. Results were virtually the same as the RH-770. I compared it on distant repeaters on both 2 m and 70 cm without any difference. The down side is the construction material they use. While the RH-770 is durable, I had the Pryme split in two twice because the clamps failed to hold the sections together while extending. I heard someone had one on a motorcycle, and it did not take long before it was gone.

The next antennas are classified as yagis. They take a lot more space and even when disassembled can still be hard to carry around. While I'm focusing on easy setups here, yagis may be a bit off topic but are worth discussing. You will understand why in a bit.

Open Sleeve Short Moxon

This one stays in my car's trunk. It is my workhorse both during the work day and on planned business trips. It can complete QSOs down to -1.5 degrees. At the standard test location (see note below), it can receive the downlink at 4 degrees and the uplink is perfect starting around 6 degrees. I used it in 6 different DXCC entity activations and am still very happy with it. It was home built and the design has the VHF driven and reflector elements folded shorter, which is perfect to carry inside a backpack (see the original version at **www.arsatc.org/images/moxonreduzida_peq.jpg**). I was using it when I set one of my past personal QRB records on AO-91. Some years ago, I built an open sleeve long antenna based on DK7ZB's design with very good results (Figure 2).

Alaskan Arrow II

The Arrow offers perfect signals at -1.5, both ways. I use mine at home, on mountain hikes and for well-planned DXCC activations. At the 3+8 configuration, I can get AO-7 around 1 degree from my QTH balcony and still complete QSOs. As far as I know, current QRB records for AO-7 and FO-29 were accomplished using Arrows. Get the BP versions and off you go to anywhere. You can use it with two radios or just one by adding a diplexer (Figure 3).

All of the omni antennas require extra effort waving your radio around to find the correct downlink polarity, which might not be the same for the uplink. Practice that waving around and you will eventually find the correct angle offset from the maximum downlink signal that allows you to get in the uplink.

With time and practice I bet you will end up figuring out the satellite rotation, if any, its pace and direction, either by using an omni or a yagi. That is a very different article, and I leave it to those more knowledgeable.

Other Setups

From home, I've used a Nagoya NL-770R and NL-770H, but because they are on a mast, the signal fades from time to time just like in the car. Amazingly enough, I have never tried to measure from what angle I can hear it or get in. Then comes the Diamond X300 – also on a mast. The same principle applies regarding signal fading. Back in 2015, I used only this one even for linears, which performs as expected. The XWs are loud, and it performs well but for others you just have the extra gain from it when compared to the 770R and H. I have never seen the S meter move around while using it.

Other small antennas include the famous

Figure 3 — Alaskan Arrow II. [Pedro Sousa, CU2ZG, photo.]

Figure 4 — Nagoya NL-770S. [Pedro Sousa, CU2ZG, photo.]

Diamond RH77CA (U.S.) or RH771 (Europe), or its equivalent from Nagoya NA771, and these will perform somewhere between a stock duckie and a telescopic. There's the Elk log periodic antenna, too, that can be worked by a single radio.

Jerôme, F4DXV, sometimes uses a RH660 telescopic. We had a QSO once while he was hiking, and he states he can work AO-91 just as well as if he were using a RH770.

KB2YSI uses an Arrow setup with a diplexer, but two radios. The diplexer there acts as a filter to minimize desense and interference problems. Check his page at **www.hamqth.com/KB2YSI** for details and schematics. The Arrow itself is very good and I find myself adding features, just like Don. You will never be disappointed with an Arrow, and his setup makes a huge difference. In fact, I'm seeing that setup more and more.

Recommendations

It really depends on lots of factors. Natural environment, radio, connectors, coaxial, local interference. I keep one RH-770 and the short moxon in the car. If a very last second pass is coming up, then I will use the RH-770. If a pass is imminent with at least a couple of minutes, then the moxon. Ideally, I will use the Arrow II.

The bottom line is the stock duckie will get the job done — barely, but done. I'm tempted to say that any "decent" duckie will do. So get out there and listen, then listen some more. Then give it a try. You will feel the excitement, for sure.

Note

Most of these tests were conducted outside my workplace – a tech plaza with all kinds of IT companies, and that means more Wi-Fi than normal. But no cell phone towers or power lines are in the vicinity. Trees limit the south view at about 2 degrees and north at 4. Other selected spots had clear ocean horizon down to the ocean.

Experiences with Low-cost IOio and Moxon Antennas for Satellite Operation

Omar Álvarez Cárdenas, XE1AO,
Miguel A. García Ruíz VE3BKM,
Margarita G. Mayoral Baldivia, XE1BMG,
Raúl T. Aquino Santos (SWL)

In radio experimentation, it is possible to make contacts using Low Earth Orbit satellites (LEO), but some concerns are the high cost of antennas, low loss coaxial, pre-amplifiers, azimuth and elevation rotors, as well as a VHF/UHF multimode transceiver. For those who want to start experimenting with satellite communications on a low budget, one thing to consider is the possibility of achieving communications with a dual band (VHF/UHF) FM portable transceiver, a homemade antenna, duplexer, compass, audio recorder and a free satellite orbit prediction program such as the Orbitron (**www.stoff.pl**).

In a basic FM amateur satellite station, the ham radio operator him/herself performs the azimuth and elevation tracking functions by carrying and manually orientating the antenna towards a satellite. For this reason, it is better to use a lightweight antenna with few elements. This will help to make its directive lobes wider and compensate for the error caused by manually pointing the antenna.

Another concern in amateur satellite communication is the satellite signal reception. It is true that some home stations have UHF directional antennas composed of up to 30 elements, long low-loss coaxial cable, and radios with receiving preamplifiers, allowing them to listen for practically 100% of the pass. However, from our previous experience, a basic station with a double-band FM handheld radio and an IOio or Moxon homemade antenna will allow hearing a little more than 80% of a LEO satellite pass. A manual or portable antenna such as the IOio or Moxon should require approximately eight feet of coaxial cable, which is enough to receive satellite signals (mW) and achieve many satellite contacts.

A variety of homemade antennas can

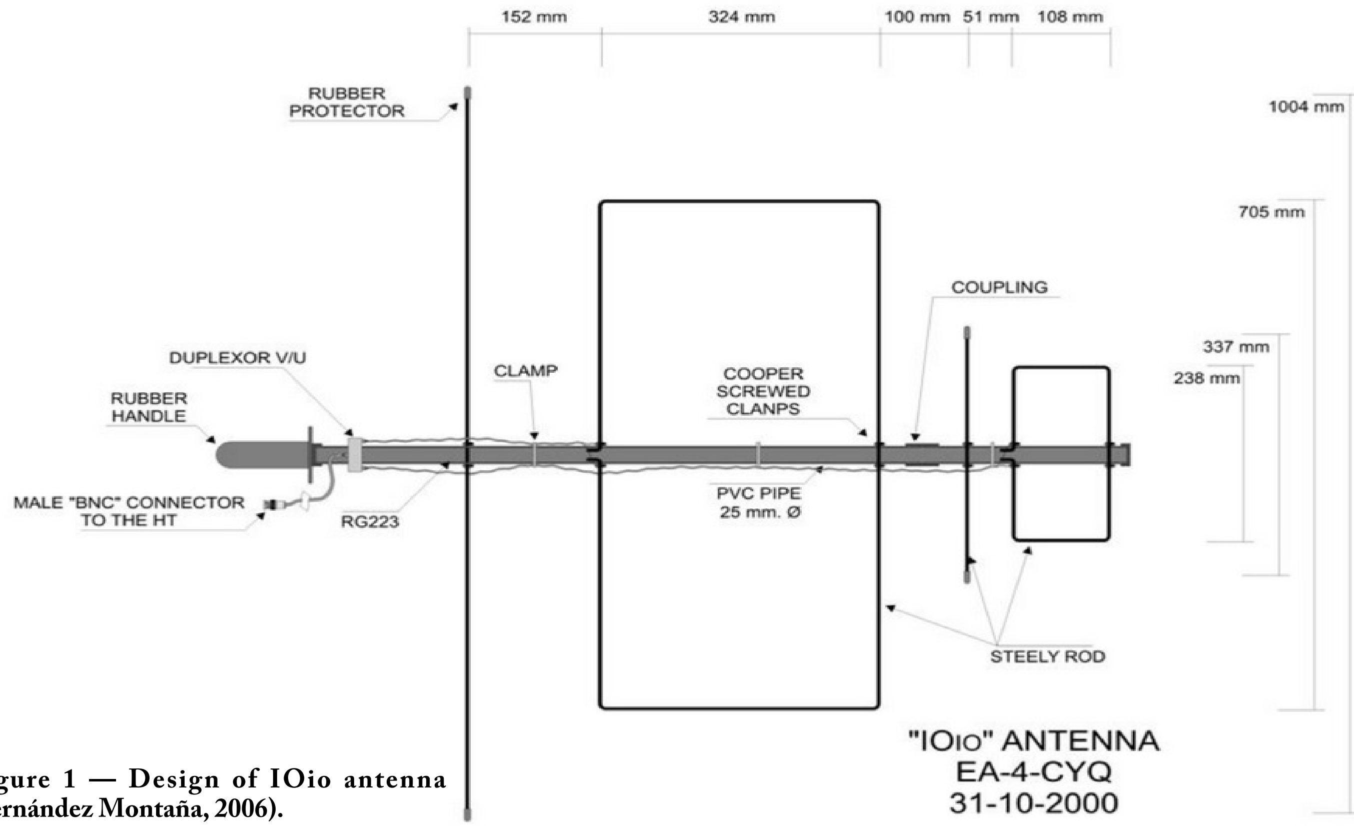

Figure 1 — Design of IOio antenna (Fernández Montaña, 2006).

be used with a handled dual-band radio. To encourage more people to use LEO satellites, we will discuss features, designs, and experiences with the IOio and Moxon antennas.

The IOio Antenna

Juan Antonio Fernández Montaña (EA4CYQ) designed the so-called IOio antenna. His knowledge and experimentation led him to manufacture an antenna that was light, easy to assemble, and portable with some receive gain. His goal in designing the IOio was to develop an antenna possessing the gain of a Yagi but with less boom length. The result was the cubical quad antenna.

If we compare the cubical quad versus Yagi with the same boom length, the quad antenna has more gain than a Yagi antenna. But a quad antenna is three-dimensional, and EA4CYQ wanted to make a bi-dimensional version, working on one plane, taking advantage of Jerry Brown´s antenna design (K5OE) with circular polarization, the TPM II. However, the IOio antenna has linear polarization and 90° manual rotation. This is enough to find the correct polarity of the satellite. Starting from the TPM II antenna's design, EA4CYQ's design was reduced to a reflector and a rectangle to make it bi-dimensional. We made the IOio antenna with aluminum tubes, making the antenna lightweight enough to be used with one hand, strong wire, and copper, or welding rods, depending on our budget and availability of materials.

Figure 2 — Students and ham radio operators holding homebrew satellite antennas.

Once built, we tested our IOio antenna with an antenna analyzer, finding an impedance between 40 and 50 ohms in the VHF and UHF bands, with SWR between 1:1.3 and 1:1.9. So, it was not necessary to use a phasing cable to adapt the impedance of the antenna. The measures and design proposed by EA4CYQ are shown in Figure 1. Figure 2 shows some local ham radio operators and students of the School of Telematics of the University of Colima, Mexico, displaying different types of antennas they built. Figure 3 shows a portable operation using IOio and Yagi antennas built at the school.

The Moxon Antenna

The Moxon antenna, created by Leslie A. Moxon, G6XN, is a low-gain, low-cost antenna that is easy to build as a weekend

Figure 3 — Students holding IOio and Yagi antennas.

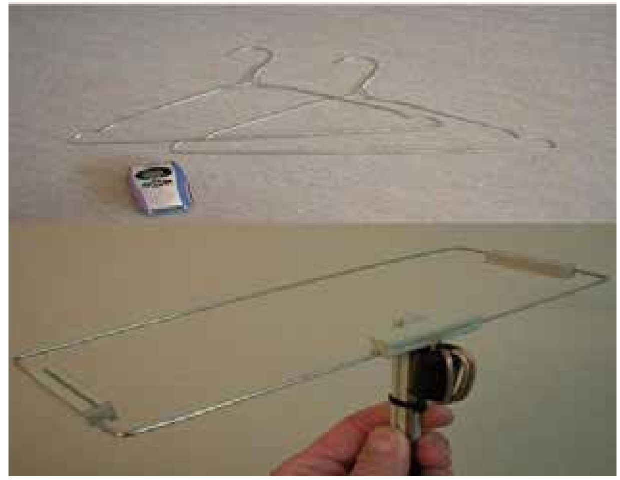

Figure 4 — Students holding IOio and Yagi antennas.

project. Its design is rectangular, with roughly half of the rectangle as the driven element and the other half being the reflector. It is electrically equivalent to a two- element Yagi antenna with bent elements but no directors. One of the most important construction aspects of this antenna is maintaining the correct separation between the excited element and the reflector. Therefore, the Moxon is a beam antenna with good popularity, highlighting three notorious advantages compared to a two-element Yagi:

1. Small physical dimension. The Moxon can be built using lightweight or flexible materials such as a wire inside a plastic tube.
2. A very good front-to-back ratio. The performance modeling results indicate that there is more than 30dB of front coverage and great discrimination of back signals.
3. 50 Ohm impedance. It has a SWR of 1:1 without requiring any type of impedance matching, and additionally, it has a large bandwidth.

The Moxon antenna has even been built for the HF bands and with multi-band designs, all reporting satisfactory performance. It can be used for satellite communications, where its dimensions are even smaller compared with the IOio. You can build a Moxon with the kind of metal hooks used by many commercial laundries for hanging clothes. See the example in Figure 4.

Figure 4. Moxon antenna for the UHF band (Josefsson, 2010).

A free program is available to calculate a Moxon antenna's dimensions for VHF/UHF FM satellites (the Tx is done on VHF, and Rx is done on UHF, though sometimes it is the opposite). The program provides the measurements for construction just by entering the central operating frequency. The program can be downloaded from **www.k6sgh.com/antennas/moxon.htm**.

Once the dimensions have been calculated, both VHF and UHF antennas should be mounted on the same boom, just like the IOio antenna. However, Alfonso Tamez (XE2O) configured his Moxon with a specific mount for the VHF antenna and a separate mount for UHF, which he used successfully for many satellite contacts (Figure 5).

Results

Both the IOio and Moxon antennas are economical solutions for ham radio operators who cannot make a large investment in acquiring HF equipment but want to feel the excitement of long-distance communication. For working amateur radio satellites, you can use basic and inexpensive equipment, such as a portable dual band (VHF/UHF) FM handheld radio, an IOio or Moxon antenna, a duplexer, compass, audio recorder, and a free prediction program. These are enough to get started with this mode of amateur radio communication. Local hams and students from the School of Telematics at the University of Colima have used and tested combinations of satellite antennas, such as:

• A VHF IOio antenna with a UHF Moxon antenna;
• An IOio for working the UHF band and a Moxon for working the VHF band; and
• An IOio and Moxon used where the UHF part was replaced by a three-element Yagi antenna.

In all cases, the antennas were tested on different FM LEO satellites, achieving contacts with Panama, Ecuador, Puerto Rico, Mexico, and the United States from the DK89 grid. Which antenna is the best for satellite operation, the IOio or the Moxon? Both were usable during 80% of the pass with audible signals when the minimum elevation was more than 7°. In terms of dimensions and materials, the Moxon could be a good solution. We invite you, the reader, to make and test both (with the variants mentioned) so that you can select the one that best suits you.

Before each satellite pass, we recommend looking for the best location where you can use the antenna, such as a site free of trees or tall buildings, perhaps on the roof of your home, on a bridge or in areas outside the city. If you have a half-duplex radio, remember one basic rule: do not transmit if you cannot hear anyone on the satellite — listen first. Your uplink frequency may be correct, but you are not listening to your own downlink signal. If that happens and other hams keep calling, the only thing they will cause is

Figure 5 — VHF and UHF antennas made by XE2O.

interference to those who are listening on the reception frequency (it happens frequently).

Do not be discouraged before trying. If you need support or advice, contact any AMSAT members or the authors of this article. We hope to contact you on the sats!

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RMS Queen Mary, Memorial Day 2019

Patrick Stoddard WD9EWK/VA7EWK
wd9ewk@amsat.org

In December 2018, Endaf Buckley, N6UTC, and I conducted a day-long demonstration of amateur radio satellite operation on the RMS Queen Mary, a former ocean liner and now a tourist attraction and hotel, anchored at the Port of Long Beach, California. Those operations, done under the W6RO call sign for the ship's Wireless Room, were successful. I wrote about this event in the January/February 2019 issue of the *AMSAT Journal*. When the Queen Mary's management started planning for a Memorial Day activity, including the W6RO station's plans to participate in the event, the ship's management requested satellite operations to be part of the W6RO Memorial Day plans.

The Queen Mary's Memorial Day activities were titled "Salute to Service," honoring the Queen Mary's service as a troopship during the Second World War. The Queen Mary, along with other ocean liners, transported military personnel to combat around the world. For the Memorial Day weekend, many of the ship's employees would dress in costumes from the wartime period — lots of soldiers and sailors, some nurses, and even Winston Churchill. Plans included presentations and talks on the ship about the wartime period and the Queen Mary's role.

In keeping with the wartime theme, the Wireless Room created a scenario: the room has been damaged, so ship personnel took some backup radio equipment out on deck. W6RO had set up an HF station outside the Wireless Room. The story even covered the planned satellite operations, something that would have still been science fiction in the 1940s.

On Saturday, May 25, 2019, the W6RO HF station was being set up outside the Wireless Room, using some of the HF antennas installed above the Wireless Room. W6RO also operated WIRES-X for those using Yaesu's C4FM/Fusion radios. The W6RO satellite operations were set up on the Sports Deck, an open area next to the Wireless Room, near the ship's bow. This location was on the opposite end of the ship from the site used for the December 2018 satellite operations. The Memorial Day location actually was a better spot for satellite work because part of the vessel shielded the radios from some of the RF coming from the Port of Long Beach, including other cruise ships anchored nearby. The ship's bridge blocked the view to the west, towards the ocean.

W6RO at the Queen Mary Wireless Room. [All photos by Patrick Stoddard, WD9EWK, unless otherwise noted.]

"Winston Churchill" and wife preparing for radio address.

David Akins, N6HHR, and Paul Dyke, G2PA, at W6RO.

Patrick Stoddard, WD9EWK, and Joaquin Solana, XE1R/KE0SPY, at W6RO.

Memorial Day weekend satellite operations on the ship started with AO-92 in the late morning. The first pass covered the central and western portions of the continental U.S., along with parts of Canada and Mexico. A total of 13 contacts were logged in the span of 7 minutes during the AO-92 pass, with stations in all 3 of those countries — a great start to the weekend. W6RO operated on 3 FM satellites (AO-91, AO-92, SO-50), as well as 5 SSB/CW satellites (AO-7, CAS-4A, CAS-4B, FO-29, XW-2C), for a total of 57 contacts on 10 different passes. Endaf, N6UTC, was also operating as W6RO on WIRES-X, along with the other W6RO activities on HF and satellites.

During the afternoon, "Winston Churchill" visited the W6RO station, accompanied by his wife and a military aide. After inspecting the station, Winston sat down behind the microphone at the HF station for some pictures, as if he was preparing to make a radio address to "allied forces."

Sunday morning, May 26, started with an XW-2A pass just after 1600 UTC, followed by the first of two AO-92 passes. AO-92 was in the L/V mode, and we were ready to work that with my standard L/V setup - an Alinco DJ-G7T for the 1.2 GHz uplink, a Kenwood TH-D74 for the 2-meter downlink, and two antennas (a 10-element 1.2 GHz Yagi, tied onto the handle of an Elk Antennas 2m/70cm log periodic). Endaf worked the first AO-92 L/V pass, logging 5 contacts with stations from southern California to Texas. I worked the later AO-92 L/V pass to the west, logging two more contacts with W5SAT in Las Vegas and N6NUG in San

Endaf Buckley, N6UTC, working AO-92 L/V mode,as W6RO.

Patrick Stoddard, WD9EWK, preparing to work CAS-4B as W6RO.

Endaf Buckley, N6UTC, working CAS-4A as W6RO.

Diego. W6RO also showed up on the AO-91 and SO-50 FM satellites, and more SSB/CW satellites (CAS-4A, CAS-4B, FO-29, XW-2C). Forty-six contacts were logged on 11 passes Sunday.

Monday, May 27 was Memorial Day, with many visitors wandering around the Queen Mary. W6RO was visited by costumed members of the ship's crew, and we explained to them the various pieces of radio equipment in the Wireless Room area. We continued with HF and satellite operations. Satellite operations started with a busy AO-92 pass covering most of the continental U.S. Endaf and I generally alternated in working the satellite passes for most of the day, and we were still experiencing busy passes with many stations trying to work W6RO. Along with AO-91 and AO-92, contacts were logged on 3 SSB/CW satellites (AO-7, CAS-4A, CAS-4B) on Memorial Day, for a total of 38 contacts from 8 passes.

Over the three-day weekend, W6RO logged 141 contacts on the satellites. W6RO worked stations across the continental U.S., Alaska, Canada, Mexico, and Costa Rica. Ten other operators kept the W6RO station on the HF bands, as Endaf and I worked the satellite passes. Among the hams who visited and saw the W6RO activities, Joaquin, XE1R/KE0SPY, actually was staying in the hotel on the Queen Mary for the three-day weekend. A long-time HF DXer, Joaquin is now starting to work FM satellites from both Mexico and the U.S. He got interested watching us work satellites, and we enjoyed visiting with him and his wife during the weekend.

Thanks to David Akins, N6HHR, manager of the W6RO Wireless Room, and the Associated Radio Amateurs of Long Beach radio club for working with the Queen Mary's management to ensure W6RO's participation in this event. Endaf Buckley, N6UTC, stayed very busy helping over the weekend, working many satellite passes, putting other passes on Facebook Live video, and operating W6RO via WIRES-X throughout the weekend.

"Patch" Feed for S-Band Dish Antennas

James Miller, G3RUH

[Reprinted with permission from March 2019 OSCAR News *and James Miller; copyright AMSAT-UK.]*

Introduction

Some years ago (1992) when experimenting with S-band antennas, I threw together a simple 2 turn helix dish feed in a couple of hours, well aware that this solution could be improved upon. It had always been my intention to "productionise" a version of this for use with the AO-40 and other amateur radio satellites.

Experiments with an alternative feed based on the "patch" principle showed it to be a better option both electrically and mechanically. Freddy de Guchteneire, ON6UG, used his formidable microwave antenna design skills to develop the feed electrically; then it was refined jointly with James Miller G3RUH who undertook production, manufacture and distribution. Together we offer you this ready-to-use design.

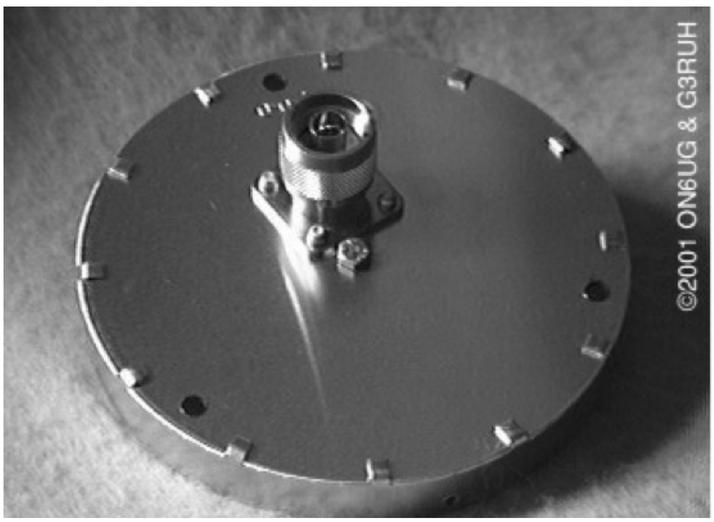
Description

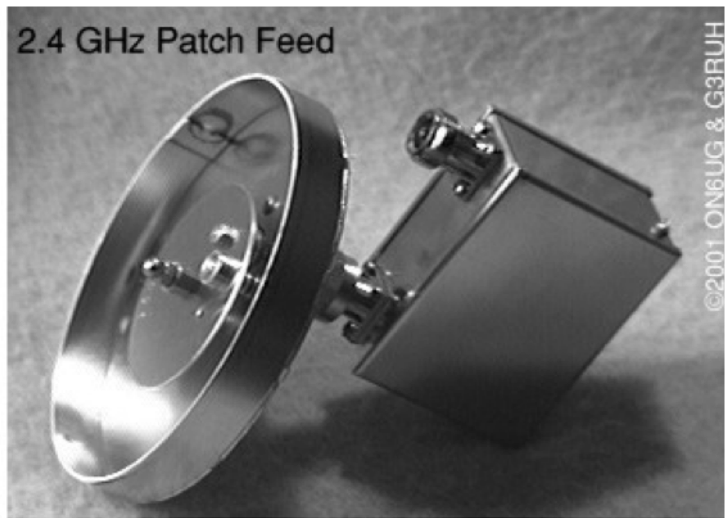
This feed is a patch antenna for 2.4 GHz intended for use with a parabolic reflector dish. It is supplied fully assembled and tested. [Note: downconverter not included!]

When installed in an f/d 0.35 60cm dish for example, the ideal beam pattern of this feed results in a G/T typically 1-2 dB better than with the small helix often used for this application, and the axial ratio is almost perfect. The recommended f/d ratio for a dish using this feed is 0.3 to 0.5, the smaller values giving lowest noise reception (highest G/T), but the higher values a little more gain. SWR is better than 1.2:1 across 2.3 - 2.4 GHz. Any size dish may be used!

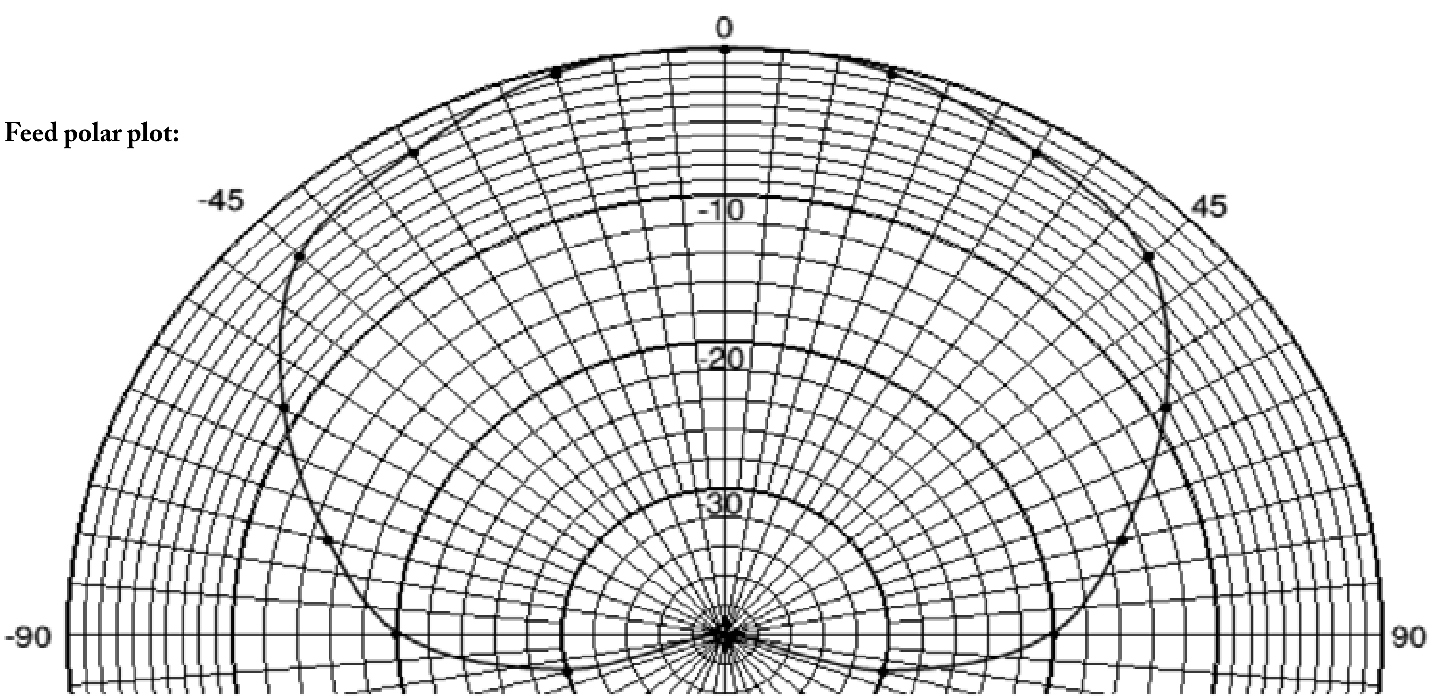
To realise the performance offered by today's lowest noise converters, you need a feed and dish system that together contribute less noise than the converter. This feed achieves that (see plot below).

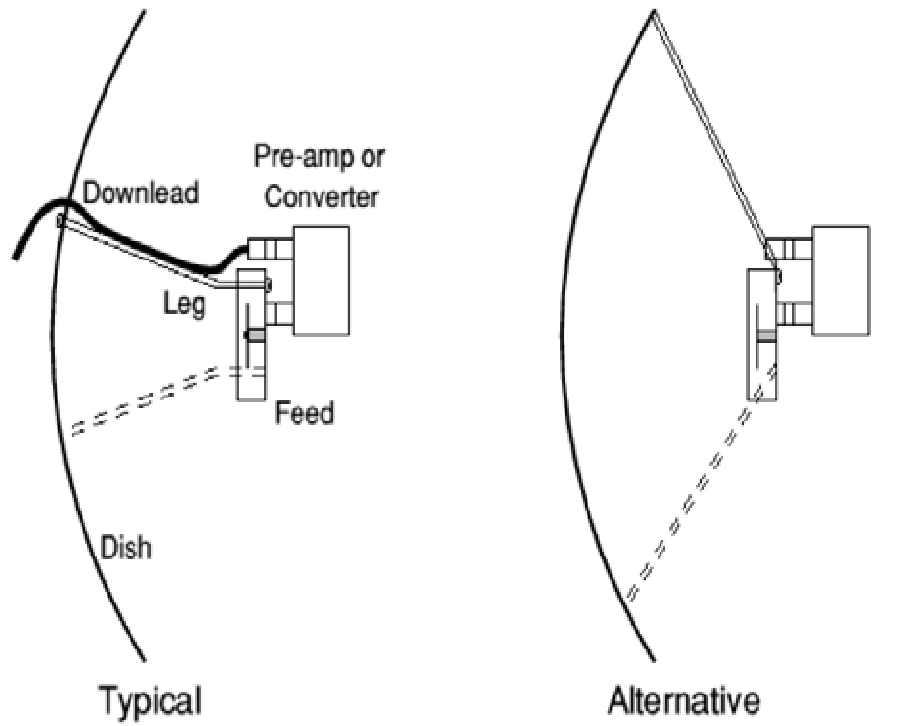
The feed has LHCP (left hand circular





Feed polar plot:





Typical dish installation.

polarisation) so that when installed in a dish the resulting polarisation is RHCP, as used by AMSAT spacecraft. The feed may be used for transmission (150 W) or reception.

An N-male connector is used for direct coupling to typical S-band converters. The alternative N-female connector version can be supplied at no extra charge. Mounting is via legs (not supplied) to three M5 (3/16") holes in the feed. The feed is weather-proofed to keep out direct rain, and is ventilated to prevent internal moisture build-up. All component parts are non-rusting.

The input is DC grounded; static charge cannot build up to damage converters. Remember, the feed is an antenna in its own right, and can be used independently where a wide-beamed low gain system is needed.

The patch has been tested as a transmit antenna up to 150 W - the limit of the PA used. (Anyone successfully exceeding this, please let me know.)

Summary

Frequency	2250-2450 MHz
Gain	8.5 dBic
-3dB beamwidth	85°
-10 dB beamwidth	125°
SWR	< 1.2:1
Axial ratio	1.05:1
Feed polarisation	LHCP [Option:RHCP]
Suitable dish f/d	0.3 to 0.5
Power handling	150 W
Connector	N-male [Option:N-female]
Impedance	50 ohm
Overall diameter	120 mm
Depth	17 mm excl. connector
Weight	130 gram

Price

Price of the S-band feed is £150 [$184.94] plus insured carriage at cost, as follows:

Carriage

UK	£8. [U.S. $9.85]
Rest of world	£13, via air-mail.

Patch Feed Questions and Answers

by James Miller G3RUH

January 28, 2018

What is a Patch Antenna?

A patch antenna is essentially a radiating element spaced fairly close to a ground plane. Often the embodiment looks like a circular band-aid has been stuck onto a flat sheet, hence the name "patch." The driven element can be electrically small, a fraction of a wavelength; a familiar example is the consumer-grade GPS antenna.

Often the implementation uses printed circuit board techniques, usually with fibreglass dielectric. The driven element is sometimes circular, though square and linear shapes are used too.

The driven element can also be full-sized, about 1/2 wavelength in diameter, and air spaced from the ground plane. This is what we use in our S-band patch.

How does a Patch Work?

A patch is usually fed at the edge, or a little way in from the edge. If you look each side of the axis of symmetry, you can view it as two slot dipoles side by side. Alternatively, consider it as a resonant cavity with open sides that radiate. The relative phase of the currents in the two 'sides' can be controlled using a capacitor to give circular polarisation.

What about the ON6UG/G3RUH Patch?

Our S-band design is full size which narrows the beamwidth to an angle very suitable for f/d 0.3-0.45 dish illumination. It has negligible sidelobes which keeps the efficiency high, and it doesn't 'look' over the rim of the dish at the hot and noisy ground. The dielectric is air, which has no losses and this also helps to make it a quiet feed.

The bandwidth is about 200 MHz, so it rejects out-of-band signals that can desense low-noise converters with their generally poor input selectivity. This also keeps the noise down.

Polarisation is almost perfectly circular. This patch feed, plus a deep, slightly underilluminated dish result in good gain, low sidelobes and very low noise, allowing the potential of contemporary ultra-quiet downconverters to be fully realised.

www.jrmiller.demon.co.uk/products/patch.html

Can it be used for Transmit?

Yes. The patch has been tested as a transmit antenna up to 150 watts - the limit of the PA used. Anyone successfully exceeding this, please let me know.

How do you make the patch?

The patch feed assembly contains 13 parts; seven of these are standard components like nuts and bolts; the remaining six are specially made items, such as the reflector plate. These are manufactured in bulk by a commercial engineering workshop using CNC machines. Thus the parts are all the same within tight tolerances, which ensures that each patch works identically. These precision parts are not cheap; the reflector plate and rim, for example, costs about $40.

Before assembly, parts are individually checked for accuracy, and are then degreased. Thereafter they are handled only with gloves. Each patch is jig assembled, checking key dimensions as work progresses. A soft brush and compressed air are used frequently to keep the product meticulously clean. After adjustment and testing the patch is stored in a sealed bag where it remains until you receive it.

It takes about one hour to manufacture a patch, including time to receive the order, log it, do paperwork, send email, pack, label and despatch the parcel.

What is the Gain of the Patch?

The patch feed has a gain of 8.5 dBi and is circularly polarised.

The gain has been determined in two ways. The first uses the measured polar diagram, from which the gain can be calculated to be 8.8 dBi.

The second was a direct measurement using an antenna range. This was performed at the AMSAT-UK Satellite Symposium 2001 held at the University of Surrey in Guildford, England. The gain was compared with that of a standard horn antenna whose performance is known from its dimensions. This gave 8.5 dBi for the patch, and is the adopted figure. At the same session, a large number of other antennas were also measured and gave reasonable results, so lending credibility to the reference antenna and to the measurement technique.

Does the patch gain add to the dish gain?

No. The gain of the feed is not added to the gain of a dish. The purpose of the feed is to "light-up" the dish (in transmit mode). In other words provide RF energy over the total surface of the dish. In receive mode, the purpose of the feed is to receive all possible RF energy from the dish, without receiving spurious energy from beyond the dish edges.

The gain of a dish is set by the area of the dish. The theoretical maximum for a large, perfectly lit circular aperture is given by G = 4*PI*area where the area is expressed in wavelengths. Illumination is never perfectly uniform though; dishes have a finite size, sidelobes, some losses and so on, and the actual dish gain is typically 45-65% of that maximum.

Can you use the Patch on its own as an Antenna?

Yes. The patch feed can be used as a regular 8.5 dBic antenna in its own right. In fact, a RHCP version of the patch could receive error-free telemetry from the AO-40 (P3D) satellite at apogee over a large azimuth.

Note that the standard patch polarisation is LHCP; when installed in a dish, the polarisation will be reversed to RHCP, conventional for amateur radio satellites.

Must I use the G3RUH 60 cm dish?

Absolutely not! The patch feed can be used with any size dish. The feed polar diagram suits dish f/d (focal length/diameter) ratios in the region of 0.3 to 0.5 .

You can also use it with f/d ratios larger than 0.5, but the dish is then overilluminated which reduces gain and increases spillover noise because the feed can see the thermally hot ground behind the dish. That does not mean that it will not work, simply that it works more optimally with a smaller f/d ratios.

You can use the patch feed with ex-TV offset fed parabolic dishes. These typically have an f/d around 0.6, and the above caveats apply.

I want the Patch with an SMA Connector

An SMA connector is small and has different mounting arrangements than the N-type used. So, the reflector plate design would have be to be changed. This is uneconomic for small quantities. Simply use an N to SMA adaptor.

SMA connectors are not strong enough to support the weight of a downconverter under adverse weather conditions. Also most SMA connectors are not water resistant. For these reasons an SMA was not used in the final production.

Don't the feed support legs shadow the dish and reduce gain?

No. In the G3RUH dish+patch, the legs are 1/20th wavelength in diameter at S-band ,and thus are effectively invisible to the patch. There are far greater sources of performance variation, such as propagation and spacecraft spin induced amplitude variations. Even if shading were an issue, it is well under 1% !

Paint your Patch?

There is no electrical requirement to paint the patch feed. However you might wish to do this for aesthetic reasons. Do not allow paint inside the patch, or on the transparent cover. Unscrew the M4 domed nut to remove the cover. Take care not to lose the washer, and don't overtighten when replacing.

The dish can also be painted.

* Do NOT use paint that is loaded with metal.
* Do NOT use paint that can crack or collect dust.
* DO use only a thin coating of paint.

Books

Patch antennas don't seem to figure much in books, even though there are many papers. Kraus "Antennas" 2nd edition ISBN 0-07-035422-7 discusses the patch in general terms, but for practical details you should review the IEEE Transactions on Antennas and Propagation.

Related Topics

My <ACME> antenna with <ABC> feed and an <XYZ> downconverter hears nothing

1. Is the antenna working?
   Find out by doing the Sun noise test detailed in G/T stuff further down.
   If you cannot hear at least a 1 dB increase in noise when you point your
   creation at the Sun compared with overhead, your system is deaf. Most
   likely cause is the downconverter/cabling; then the feed itself.

2. Were you on frequency? Make up the little S-band marker beacon by G0MRF as published in many Amsat magazines during 2001. **www.g0mrf.com/source2.htm**

3. Was it pointed at the spacecraft? Big antennas have small beamwidths.

4. Was the spacecraft turned on? See published schedule.

I have been given a dish. What's its focal length?

You can calculate the focal length of a

parabolic dish by measuring its depth and diameter.

Let: D = diameter of dish
d = depth of dish

Then the focal length is given by:

f = D^2/(16*d)

The shape of the dish is described by the ratio of focal length to diameter, written "f/D." From the above equation:

f/D = D/(16*d)

Many dishes have a reinforcing rim which is not part of the parabolic section, but which makes the overall diameter larger than the electrical diameter. In these notes, "Diameter", "depth" and "focal length" refer to dimensions in the parabolic part.

Example: I have a dish 90 cm in diameter and it's 161 mm deep. Using the formulas:

f = D^2/(16*d) = (900 x 900)/(16 x 161) = 314 mm [focal length]

f/D = D/(16*d) = 900/(16 x 161) = 0.35 [f/D ratio]

Tip: A simple practical way to find the focus of any dish is to stick a few tiny mirrors on the surface, aim the dish at the Sun, and use a small piece of white paper to find where the reflections converge. You can also make small reflective squares from aluminium cooking foil. Scotch-tape (Sellotape) them to the dish.

What's all this G/T stuff?

G/T stands for gain-to-temperature ratio and is a concise measure of the actual performance of a receiving system including the environment, antenna and receiver. The more gain the better (=more signal) and the less temperature the better (=less noise). So, their ratio reflects both of these parameters in a "bigger number = better" way.

With a dish antenna, highest gain is achieved by using the proper shape for the dish, and a well designed feed to illuminate it.

Lowest noise is achieved with a quiet environment such as is found looking up at the sky, a quiet downconverter properly installed, low feed spillover (so feed sidelobes do not see the ground) and low sidelobes from the dish (so it doesn't see ground and/or man-made terrestrial noise).

Based on lower frequency experience where noise is always very high, it is often thought that gain and related signal strength are all that matter in microwave systems. This is incorrect; high signal AND low noise are what matter; not the one or the other, but both together.

Amateur systems are often diminished not so much by reduced gain as by increased noise. More noise is very easy to introduce through poor design, components and installation.

How can I measure G/T of my System?

You need a signal of known strength and a noise environment the same as you intend to use. Happily both of these exist, and are free. The Sun is your signal source, and your environment is already there - space, of course.

You point the antenna at the sky and measure how much noise comes out of the receiver. Then point the antenna at the Sun and measure the noise once again.

The ratio of these two noise powers is called the Sun noise increase, and is directly related to G/T. Call this power ratio Y, then, for antennas with a beamwidth exceeding the Sun's diameter:

$$G/T = \frac{Y-1}{I}$$

where at S-band I ~ 0.5 and depends on the noisiness of the Sun (solar flux), which varies from day to day. You can obtain its values now and for the recent past via the reference:

ftp://ftp.swpc.noaa.gov/pub/lists/radio/45day_rad.txt

These tables actually list the solar flux at 2.695 GHz (typically 120, but can vary a lot), which needs adjusting slightly to 2.4 GHz. Doing that one obtains:

$$G/T = (Y-1)\ \frac{235}{\text{SFU @ 2.7GHz}}$$

For example, the G3RUH 60cm dish plus patch feed plus Kuhne MKU-24 downconverter on 2001 July 25 measured a Sun noise increase of 2.44 dB. Thus Y=10^(2.44/10) = 1.75. On that day the Solar flux for 2.7 GHz was 129, and so G/T = 1.37 (units are K^-1).

Measuring power using the AF output of a receiver requires the AGC not to be activated. Since the S-meter is usually driven from the AGC line, when the meter flickers, AGC is working. Lower the RF gain or insert a small attenuator at the radio input to force the S-meter to stop reacting. Some radios, but not many, have an actual AGC on/off switch.

On the other hand, a Sun noise increase of 2.4 dB is easily audible, and may be all you need to know.

You must use a moving coil meter on its AC range and, because the pointer jumps about, some skill is needed to take a mean reading.

Beware of taking measurements when the Sun is low in the sky, as the antenna will pick up ground noise which will give you optimistic readings.

What can I do with G/T?

G/T is a measure of system performance, and if you check it from time to time, you can tell whether your S-band system is working consistently, or whether there's a problem. So, continuing the above example, if a Sun noise increase is not 2.4 dB, give or take say 0.2 dB, on any particular day, one would suspect a problem.

You can also estimate your system's noise temperature. For example, a G3RUH 60 cm dish has a gain at S-band of about 21 dB, or 10^(21/10) = 126. If G/T=1.37, then T = 126/1.37 = 93 K.

This would be made up from the converter noise (45 K), antenna noise (maybe 20 K) and sky noise (maybe 30 K).

If you make some changes to your system, maybe a different converter, dish or feed, G/T will indicate whether you made an improvement or not.

For detailed results of a Sun noise test with a 60 cm dish+patch over a month or so, see:

www.jrmiller.demon.co.uk/products/figs/sun.zip

Original 2002 Mar 11
Updated 2018 Jan 28 - added power handling info. URLs
2018 Nov 22 - revised noaa link

Recruiting for AMSAT on Field Day

Thomas Dougherty, N0TJD

The most recent Satellite Field Day, September 14, 2019, in St Louis Metropolitan Area for Missouri and Illinois Amateur Radio Club members offered an excellent opportunity to recruit potential AMSAT members. invited guests included amateur radio club members and their families.

The Event

Our event occurred on a beautiful Saturday afternoon from 1 - 5 pm. Our satellite mentors — Jim W0NBC, Jon W0KZ, Josh KE0VYD, Ken KK9N, and Tom N0TJD — handled the set up.

The intent was to entertain, educate, and allow hands-on experience with an Arrow antenna/HT to make satellite contacts. The goal was to stimulate interest with the children in amateur radio satellite technology. Their parents and grandparents already understand how much fun and satisfaction ham radio can provide. This was our opportunity to get the next generation engaged. And we succeeded!

The event started with a presentation that included:

CubeSat Simulator display.

- discussion of the history of amateur radio satellites
- viewing of the CubeSatSim, including decoding/display of telemetry results
- LightSail 2 images, with discussion of now proven theory of photon propulsion
- discussion of ARISS including photos from a St Louis Area contact, and
- a live satellite demonstration by mentors allowing hands-on by children using an Arrow antenna with HT, completing actual contacts.

After the satellite contacts, the kids embarked on a "Fox Hunt" in search of five foxes.

We offered three presentations/mentor training sessions during the afternoon that allowed our amateur radio families to pick the most convenient time for them to attend.

Attendees

We counted 70 hams and spouses in attendance with 10 children who loved the event and asked when we would offer the next one.

We distributed AMSAT membership applications and sold some Getting Started with Amateur Satellites books.

Additional Demonstration

Fusion – Andrea KC0LKV, NOAA image downloads – Josh KE0VYD, FOX HUNT – Ken KK9N

Thanks go to our mentors: Andrea, KC0JVK; Jim, W0NBC; Jon, W0KZ; Josh, KE0VYD; and Ken, KK9N.

Mentors helping kids make satellite contacts.

A family on a fox hunt.

Mentor Tom Dougherty, N0TJD.

Situational Awareness for Amateur Radio Satellites

Pedro Sousa, CU2ZG
AMSAT Ambassador

First, I would like to state that this is my opinion, based on cordiality, common sense and what I feel is right. I have adopted these guidelines myself in consideration for others and for my own benefit. If you would like to practice these guidelines, then please feel free to do so. My belief is that the community, common sense, AMSAT and Authority should work together for the better. If someone feels what I discuss here would disrupt someone else's operation, then let me know immediately. If you feel that it is not interfering but is not the best practice, be reminded this is only my opinion and that I would welcome hearing yours.

Situational awareness starts long before you get on the radio. Way before you figure out who you want to work. For me, it starts with what I like to call the "satellite-monitoring" task. This is when you start to listen for the satellite's beacon and the passband/channel. Study it, see if you can find the average spin rate, how fast it fades, how easy others get into it. Try a couple of passes to get it right.

Then move to the orbit. See how it changes every day. Is it passing later each day? Is it passing earlier? Does the footprint moves east or west on each pass in case of a SSO? Where does the typical footprint fall? How do the apogee and perigee change over a year? What is the footprint path? Who gets it first and last?

Signup for the AMSAT-bb, Facebook pages, WhatsApp groups, and/or Twitter. Many amateur radio satellite enthusiasts there not only can help you but also announce their activations. Create reminders for those special or rare activations, for your friends, and for anyone you would like to complete a QSO with.

The core element of situational awareness is, for me, the pass itself. What areas will be in the footprint, and their sequence? Is the satellite in eclipse or illuminated?

Look for mobile or portable stations, which could mean they are using a simple setup and would like to see if it works, or that they are in a different and new grid.

Look for new callsigns, new entities. The more aware you are of what is going on, the more you will increase your and everyone else's chances of successful operation, and most importantly achieve an orderly pass.

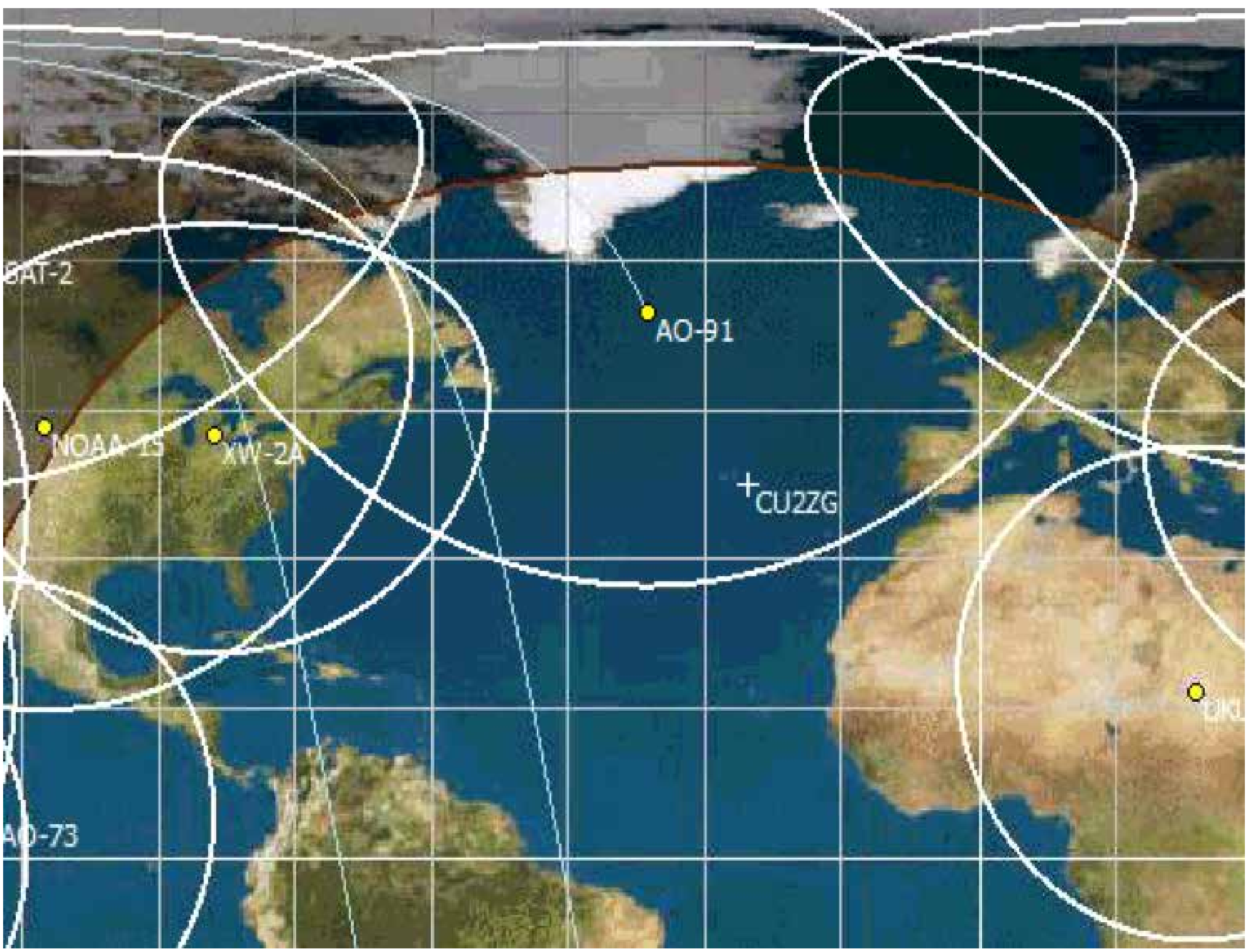
Let me give you two examples. First, a satellite, AO-91, in its Sun Synchronous Orbit, is approaching from the south on its way to the north. It will cover most of the Atlantic, Some of Africa, Cape Verde, Canaries, Madeira, Azores, and then will start to hit Europe and North America. Remember, it will be coming from the south, so northern countries are expected to be heard later in the pass. As it comes over the horizon, I look for it — a beacon or anyone talking — so I can assess whether it is where I expect it to be. If no one is on, I will announce myself and wait for a reply.

During most of the first part of the pass (up to the TCA), there was only me and a station in the Canaries. Now, the crowd starts to get in. Portugal, Spain, France, Central Europe, UK, Ireland, North America and Northern Europe are expected to show up in that order. No one is in Portugal. I get EB1AO from Spain, and I know F4DXV is in France listening, but he does not announce himself. As UK and Ireland come in, I get M0NPT and MI6GTY.

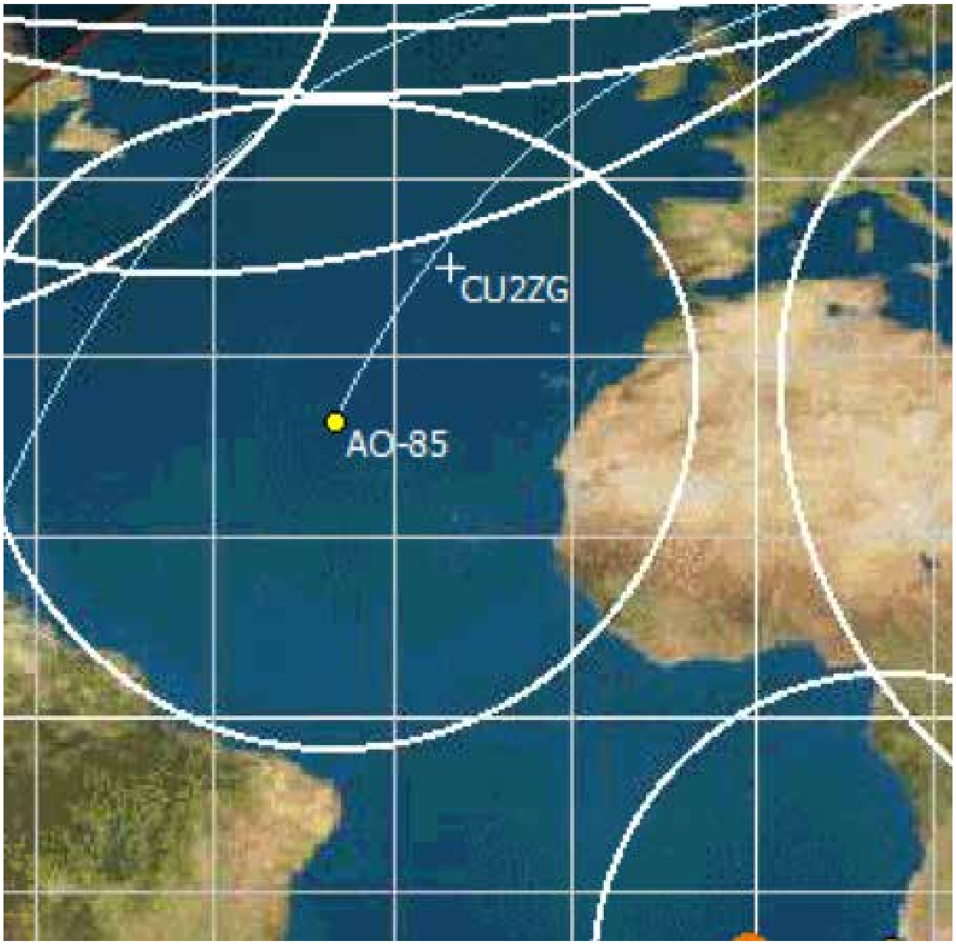
Now the satellite is getting closer and closer to the horizon and I figure I have about three minutes left, when suddenly someone new in Germany shows up. It is not a rare grid, but it is someone new. EB1AO calls him. I have one minute left. Here comes the situational awareness – M0NPT and MI6GTY have at least probably a good three minutes left in the pass and F4DXV around two, so they "give way" for me. I get that station, followed by them. Of course, this is an ideal pass, and most of the time this will not happen. No one was in North America, which was a shame, as we in Europe are eager to get contacts across the pond.

My second example is AO-85 due from the southwest heading northeast. I will get the Caribbean and South America first, and then Europe will come in starting with Portugal and Spain. I know from Twitter that FG8OJ and EB1AO will use this pass to try a new QRB record in this satellite with only a few mutual seconds. That will happen around my TCA. Obviously, when it came over the horizon, Spain was not in range. I have a quick QSO with FG8OJ. Then, I stay put. They have that QSO, and a few seconds later FG8OJ is out of the footprint, so I can get in, sure that I will not interfere. I make a quick call to EB1AO and congratulate him on the new record. The rest of Europe starts to get in.

These two examples are special. It was either a new station or an announced scheduled



AO-91 on a northbound pass.



AO-85 on a very small window pass for Caribbean and Spain.

contact. However, there could be two stations you heard before, and you are completely unaware that they have never completed a QSO before, nor know each other's grids. However, if your situational awareness is available, you will understand that if a station is deliberately calling someone else that has not been heard before in that pass, it means a contact is being looked for. If you are aware of the geography, you can figure out how much time in the pass each one has. Can you log some QSOs in the meanwhile? Should you wait for that QSO to be completed? The answer is yes to both questions, but your common sense and situational awareness will dictate what the best practice should be.

I've observed scheduled contacts with a one-minute window fail because someone felt like CQing or completing a QSO with one of the stations instead of giving way. I have had people telling me half-way through a 45-second mutual window while I was still looking for the other station, they were sorry, and stepped in. The station I am looking for comes in, and I have 15 seconds to go, but it is busy with that someone, who still has 6 more mutual minutes.

FM satellites are single channel, just like a repeater. There is no "is this frequency in use?" but common sense and situation awareness is important. Even on linear satellites, you must exercise discretion, just like on a repeater or HF bands. Remember, no one owns the spectrum, and a satellite as a moving target gives you a limited time for each pass. Avoid stepping on someone else's shoes. There is always a next pass for those looking for others, as well for those less aware. What is most important is to have fun.

Support AMSAT

AMSAT is the North American distributor of SatPC32, a tracking program for ham satellite applications. Version 12.8d features enhanced support for tuning multiple radios. Features include:

1. The CAT commands of the IC-9100 have been extended again. The program now also controls the DV mode (DV for 'Digital Voice') of the radio. With the FT-817 the program now additionally supports the CWR mode.

2. All SatPC32 programs now process significantly larger Keplerian element source files. Especially because of the numerous new Cubesats, the number of data sets contained in the source files has increased significantly. For example the file Cubesat.txt currently contains data for nearly 400 satellites.

3. In all programs (SatPC32, SatPC32ISS, Wisat32, WinAOS and WinListen), the list of satellites contained in the source file ('Available' list in menu Satellites) is now displayed in alphabetical order to facilitate locating individual satellites.

4. The program SatPC32ISS now also allows the creation of up to 12 satellite groups. The new Cubesats have also increased the number of 'in-band' satellites. Originally, in-band operation in amateur radio was only available at the ISS.

5. In order to accelerate a change between the individual satellite groups, the 'Groups' window can now be called up by clicking on vacant areas of the main window, except in the Satellite menu. Such free positions are located on the right and left of the frequency window.

6. In the Satellites menu the data sets of the satellites contained in the active source file can now be displayed. When called, the data set of the currently selected satellite is displayed. The feature helps you to immediately know the identifier of the satellite.

7. The program has improved control of the sub-audible tone required by some satellites. The program can now automatically switch the sub tone on/off when switching between PL tone satellites and others, changing between u/v and v/u satellites, changing the group, closing the program, etc.

A registration password for the demo version may be obtained for a minimum donation of $40 for members and $45 for non-members. Order by calling 1-888-322-6728. The author DK1TB donated SatPC32 to AMSAT. All proceeds support AMSAT.

AMSAT GOLF $125,000 Development and Launch Initiative Goal

AMSAT is excited about developing and launching the next generation of Greater Orbit Larger Footprint ("GOLF") satellites. AMSAT has an immediate need to raise funds to cover development, launch and related expenses for GOLF-TEE and GOLF 1. We have set a fundraising goal of $125,000 to cover these expenses and help us to continue to keep amateur radio in space.

GOLF-TEE (Technology Exploration Environment) will be a rapid deployment to LEO to establish/verify/learn ADAC, Deployable Solar Panel Wings, Radiation Tolerant IHU, SDR.

GOLF-1 is planned as an approx. 1300 km LEO, progression of GOLF-TEE technology, first STEM mission with VU and APS, AO-7/FO-29 supplement, and our first "High LEO" CubeSat.

Donations may be made through the AMSAT webpage at **www.amsat.org**, by calling (888) 322-6728 or by mail to the AMSAT office at 10605 Concord Street, Kensington, MD 20895, USA. Please consider a recurring, club, or corporate donation to maximize our chance of success with this mission.

AMSAT President's Club Support GOLF-TEE and GOLF-1

Contribute to AMSAT directly through easy, automatic charges to your credit card. Since AMSAT is a 501(C)(3) organization donations may be USA tax deductible. (Check with your tax advisor.) To join contact Martha at the AMSAT Office by phone (888) 322-6728 in the US, or (301) 822-4376; e-mail **martha@amsat.org**.

Titanium Donors contribute at least US $400 per month	❒ $400 / month ❒ $4800 one time
Platinum Donors contribute at least US $200 per month	❒ $200 / month ❒ $2400 one time
Gold Donors contribute at least US $100 per month	❒ $100 / month ❒ $1200 one time
Silver Donors contribute at least US $50 per month	❒ $50 / month ❒ $600 one time
Bronze Donors contribute at least US $25 per month	❒ $25 / month ❒ $300 one time
Core Donors contribute at least US $10 per month	❒ $10 / month ❒ $120 one time

Your help is needed to get the AMSAT GOLF-TEE and GOLF-1 Cubesats launched.

For the latest news on GOLF watch our website at www.amsat.org, follow us on Twitter at "AMSAT", or on Facebook as "The Radio Amateur Satellite Corporation" for continuing news and opportunities for support.

AMSAT is Amateur Radio in Space
... and YOU are AMSAT!

Seize opportunities to launch your amateur radio experience to new heights!

AMSAT Ambassadors - NEW

AMSAT Ambassadors program is looking for satellite operators to share enthusiasm for Amateur Radio in Space with others by:

- Promoting AMSAT at in-person events, practical demonstrations, online, or in written communications
- Offering personal mentoring and coaching to new enthusiasts either in-person or via online means
- Connecting members and potential enthusiasts with proper resources at AMSAT.

To volunteer, send an e-mail to Robert Bankston, KE4AL at: **ke4al@yahoo.com.** Robert

AMSAT Internet Presence

AMSAT's information technology team has immediate needs for volunteers to help with development and on-going support of our internet presence:

- Satellite status updating and reporting.
- Add/delete satellites to ANS and the web as needed.
- Research and report satellite details including frequencies, beacons, operating modes.
- Manage AMSAT's Facebook and Twitter presence.

To volunteer, send an e-mail to Robert Bankston, KE4AL at: **ke4al@yahoo.com**.

AMSAT Engineering Team

AMSAT Engineering is looking for hams with experience in the following areas:

- Attitude Determination and Control, and Thermal Engineering, to help in the design of high orbit CubeSats.
- Power systems, for CubeSats from 1U through 6U and LEO to HEO.
- Help with solar, power supply, and battery design for both LEO and HEO missions.
- Logistics, for parts procurement, inventory, and distribution.
- Documentation, for designs, tests, and public relations.

To volunteer, please describe your expertise using the form at **www.amsat.org/contact-amsat-engineering/.**

AMSAT User Services

AMSAT is looking for an on-line store co-manager with WooCommerce experience to update and refresh the AMSAT Store web page when new merchandise becomes available or prices and shipping costs change.

- Add new merchandise offerings
- Delete merchandise no longer available
- Update shipping costs as needed
- Add periodic updates for event registrations
- Interface with the AMSAT Office.

To volunteer, send an e-mail to Robert Bankston, KE4AL at: **ke4al@yahoo.com.**

AMSAT Educational Relations Team

AMSAT's Educational Relations Team needs volunteers with a background in education and classroom lesson development ...

- Engage the educational community through presentations of how we can assist teaching about space in the classroom.
- Create scientific and engineering experiments packaged for the classroom.
- Create methods to display and analyze experimental data received from Fox-1.

To volunteer send an e-mail describing your area of expertise to Alan Johnston, KU2Y at: **ku2y@amsat.org**.

ARISS Development and Support

AMSAT's Human Space Flight Team is looking for volunteers to help with development and support of the ARISS program:

- Mentors for school contacts
- Support for the ARISS web
- Hardware development for spaceflight and ground stations
- Help with QSL and awards certificate mailing.

To volunteer send an e-mail describing your area of expertise to Frank Bauer at: **ka3hdo@amsat.org.**

Find more information at amsat.org. Click Get Involved, then Volunteer for AMSAT.