The AMSAT® Journal

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Volume 44, Number 4 July/August 2021

Field Day Results

In this issue —

AMSAT Announcements

Virtual AMSAT Space Symposium and Annual General Meeting - October 30, 2021

Due to the lingering effects of the COVID-19 pandemic, AMSAT has changed plans for its 39th Annual Symposium and General Meeting from an in-person event to a virtual event.

This is a chance for "Amateur Radio in Space" enthusiasts from all corners of the globe to learn more about AMSAT's Strategic Plan, GOLF program, CubeSat Simulator and other exciting developments taking place in the amateur satellite world.

AMSAT will host its 2021 AMSAT Virtual Space Symposium and Annual General Meeting on Zoom for its members on Saturday, October 30th from 9:00am CDT – 5:00pm CDT (UTC-5). The event will be a combination of pre-recorded video segments along with live question and answer sessions.

Registration for members is required and is available on AMSAT's Member Portal, **launch.amsat.org**. Registration is free and registered attendees will receive a digital copy of the AMSAT Symposium Proceedings, entered into the Symposium prize drawings, and be able to participate in discussions during each question and answer session.

The 2021 AMSAT Virtual Space Symposium and Annual General Meeting will be available to the general public on AMSAT's YouTube channel, **youtu.be/RTvcceM7Tz0** at no cost.

Final papers for the Symposium Proceedings must be submitted by October 18, 2021 to Dan Schultz, N8FGV, **n8fgv@usa.net**. Symposium presentations should be limited to 15 minutes of pre-recorded video. Video presentations must be submitted by October 18, 2021, to Paul Stoetzer, N8HM, **n8hm@arrl.net**. We ask that presenters be available to take questions via Zoom following the airing of their pre-recorded video.

Questions regarding the Symposium can be directed to info at amsat dot org.

We hope you can join us!

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The AMSAT Journal staff is always interested in article submissions. Whenever possible, submissions should be sent via e-mail to journal@amsat.org using plain text or word processor files; photos or figures in TIF, GIF or JPG formats. Kindly do not embed graphics or photos in your manuscript. We prefer receiving those as separate files. AMSAT reserves the right to select material for *The AMSAT Journal* based on suitability of content and space considerations.

Apogee View

Robert Bankston, KE4AL
President

A Sustained FM Presence in LEO

While our volunteer engineers focus on GOLF, developing the systems and technologies necessary for our path upward to high Earth orbit (HEO), we must not forget our responsibility to promote amateur radio satellites and encourage the next generation of operators and builders.

Advancing the art and science is not enough. We also need to provide an easy entry point to amateur radio satellite communications to support our space education and outreach activities.

The Importance of EasySats

AMSAT's Echo (AO-51) and Fox-1 (AO-85, AO-91, and AO-92) satellites, as well as SaudiSat 1C (SO-50), have been the most widely used amateur satellites. They are so popular because they can provide basic radio communications with very simple ground station equipment and are easy to use. An FM repeater, even in a low Earth orbit (LEO), allows amateur radio operators to communicate over substantial distances using just a handheld transceiver (HT) and a small handheld directional antenna. Cross-continental and, if you are lucky enough to live near the coast, transcontinental communications are possible.

These so-called "EasySats" have provided countless hours of enjoyment to many thousands of amateur radio satellite operators around the world, making QSOs, chasing grids, and even just providing a chance to send out a casual hello to an old friend. More importantly, FM satellites are extremely valuable in introducing satellite communications and are often used for demonstrations at schools and public events.

With AO-85's battery failure and AO-91 and AO-92 on borrowed time, AMSAT will soon find itself without an FM satellite in space. So, the time to act is now.

The Proposal

AMSAT's Strategic Plan, Objective 4.1, FM Operations, provides fairly specific guidance: "Develop, deploy, and support a series of 1u spacecraft to support continued FM amateur satellite operations in low Earth orbit." As such, any proposal must include a sustained FM presence in LEO.

The Fox-1 CubeSat series taught us some valuable lessons. First, batteries in a 1U CubeSat are more likely to have a three-year life span rather than the expected five years. Keeping battery levels above the minimal voltage rating is critical. The popularity of AMSAT's FOX-1 series, especially at night when the satellite was in eclipse, was the primary cause of their shortened battery life. Any proposal must include both battery management and battery failsafe. The design must include provisions that automatically switch the satellite to Low Power Mode (beacon and telemetry only) when the battery voltage drops to a cautionary level and automatically return to normal operations when sufficient battery power is restored. In addition, the satellite must be designed so that, when the battery fails, the transponder can continue to operate when the satellite is in sunlight. Similarly, the design should include an autonomous capability so that the FM repeater can operate without relying on ground control or a functioning processor in the command, control, and telemetry module. These safeguards and failsafes should extend the usable life of our satellites.

Second, it is impossible to keep a strict schedule when relying on a "free ride" under NASA's Educational Launch of Nanosatellites (ElaNa) initiative. Once accepted into the program and manifested on a launch, you are at the mercy of the launch provider, and things don't always go as scheduled. Case in point, Fox-1D (AO-92) launched before Fox-1C (AO-95). To ensure the launch of one satellite every three years, we will need to purchase launches. In addition, we need to have a "flight spare" on standby in case there is an integration inspection issue with the primary satellite or a subsequent launch failure.

The Challenges

Every satellite project requires both people and funding. As mentioned already, all of our engineers are consumed by our GOLF program. This leaves us with either open-sourcing the project or purchasing a commercial, off-the-shelf satellite. Open-sourcing would work for the initial design process; however, there is no current precedent to allow the open-source building of a satellite under U.S. Export Administration Regulations (EAR).

While many commercial companies offer complete off-the-shelf 1U CubeSat platforms, only one includes an FM repeater that meets our mission requirements. Purchasing a ready-to-fly CubeSat seems to be our best course of action, given AMSAT engineers' focus on GOLF, but it comes at a cost.

Two 1U FM CubeSats (flight model and flight spare), a 1U FM CubeSat engineering model (without solar panels), and a 500 km, Sun-synchronous orbit launch will cost just over $283,000. Each additional launch, one every three years, will cost approximately $138,000, as we would only need to purchase one CubeSat and the launch.
So that leaves us with the big question – How are we going to pay for it?

An FM satellite provides a worldwide benefit. Therefore, we need to conduct an international fundraising campaign, partner with other AMSAT organizations, and request funding from other organizations.

The benefits of providing a sustained FM presence in LEO to promote and support amateur radio in space far outweigh the costs, especially when we implement a plan that allows our AMSAT engineers to continue their efforts on our path Onward & Upward. If approved by our Board of Directors, I hope you will support us.

Educational Relations Update

Alan Johnston, Ph.D., KU2Y
V.P. Educational Relations

Congratulations to Tom Schuessler, N5HYP, and his team for once again organizing and running an AMSAT table at the Frontiers of Flight "Moon Day" STEM event in Dallas, TX, on Saturday, July 24th, 2021 (Figure 1).

They demonstrated the new Pi Camera capture and SSTV transmission mode of the CubeSatSim, and the feedback was all positive!

A group of us are moving forward with an AMSAT Space Symposium presentation on high altitude balloons (HAB) and STEM education. I will also give an update on the AMSAT CubeSat Simulator Program and also the new CubeSatSim Lite.

Soon, Teachers in Space will be launching their first CubeSat called Serenity. Teachers in Space (**teachers-in-space.com**) is an amazing organization that has done some great educational programs with high altitude balloon launches, sub-orbital launches, and is now about to take the next step into orbit. The 3U Serenity CubeSat includes a camera and an array of sensors, and amateur radio operators can communicate with it. Here is their IARU coordination information **www.amsatuk.me.uk/iaru/finished_detail.php?serialnum=734**. The CubeSat is also flying a Raspberry Pi running an experiment with a private blockchain designed by Villanova University. Serenity was on the first orbital launch attempt of the new Firefly Aerospace Alpha rocket, which unfortunately failed to reach orbit. Hopefully, Firefly's next launch attempt in the coming months will be successful! Their website provides information about the mission and a lesson plan to set up a Raspberry Pi ground station teachers-in-space.com/serenity/. To get in touch with Teachers in Space; you can email them at **info@teachers-in-space.com**.

I am looking forward to this launch and many more from this great space educational organization!

For the latest CubeSat Simulator news, follow our dedicated Twitter account @CubeSatSim. If you are interested in doing a demo to a group or school, I can ship you a loaner – contact me via email at **ku2y@amsat.org** or on Twitter **@alanbjohnston**.

Figure 1 — The AMSAT table at the Frontiers of Flight "Moon Day" showing the CubeSat Simulator Loaner and Fox-1 Engineering Model. In the photo from left to right: Virginia Smith, NV5F; Calvin Gluck, W7KYG; and Tom Schuessler, N5HYP. Also assisting but not pictured here were Guy Dineen, K1GBD, and Jay Cox, KG5BZW.

Amateur Radio Satellite Awards Spotlight

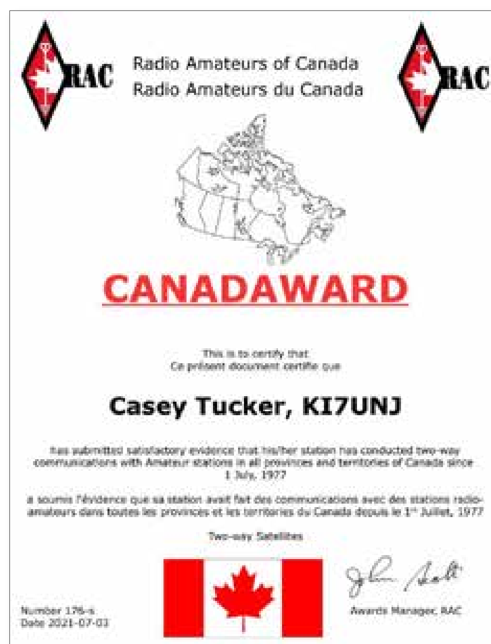
RAC CANADAWARD

The Radio Amateurs of Canada (RAC) recently announced that, as of July 1, 2021, QSLs from Logbook of the World (LoTW) will now be accepted for all RAC Operating Awards, including the Canadaward.

The Canadaward is available to any Amateur who confirms two-way QSOs with Canadian Amateur stations located in each of the Canadian Provinces and Territories. All QSOs must be on one band only, of which satellite contacts count as a separate band. Only contacts made after July 1, 1977 will count for this award.

Please visit https://www.rac.ca/operating/rac-operating-awards/ for more information about RAC's Canadaward.

Visit https://www.rac.ca/operating/rac-operating-awards/instructions/ for specific instructions on how to apply.



Building a CubeSatSim

Dan Noel
University of Southern Maine
Mechanical Engineering '24

I remember attending, about three years ago, a technical briefing at the National Geospatial-Intelligence Agency. I was fascinated by the intricacy of their satellites, how the satellites were powered, how they communicated, and how they captured images. However, I also quietly resigned to the idea that most of these concepts were well beyond my comprehension. In the years between then and now, I underwent a significant career shift. I spent this past summer as an Undergraduate Research Assistant at the University of Southern Maine, where I am currently enrolled in the Mechanical Engineering program.

The team I was working with is developing an Earthshine CubeSat that will capture images of the Moon at various phases from low Earth orbit and then relay those images back for processing. These images will be used to determine Earth's effective albedo by using calculations that rely on irradiance, phase angles, and distances. The albedo is a physical property indicating reflectivity that can be used in climate change calculations, a field with relevance and importance that increases daily.

My role in this team was to build a CubeSatSim as a proof of concept for the later stage development of our Earthshine CubeSat. For me, this was a very daunting task. I had no experience soldering and no hands-on experience with sensors, Raspberry Pi's, or circuit boards. Thankfully, nearly all the components for the build had already been purchased, and the frame had been 3D printed, so it was just a matter of applying myself and embracing the steep learning curve.

The heart of the build was setting up the Raspberry Pi Zero, and, like every other step of the build, I struggled through this process. First, I did a headless setup using an existing image which required installing a handful of programs, an RNDIS driver, and adding a couple of files to the boot drive. After a few days, I successfully imaged the Pi, established a username and password, and created a radio callsign. Armed with freshly acquired soldering skills, I was also able to complete the first steps of the Mainboard. I attached the LEDs, resistors, on/off switch, micro–USB board, RBF switch,

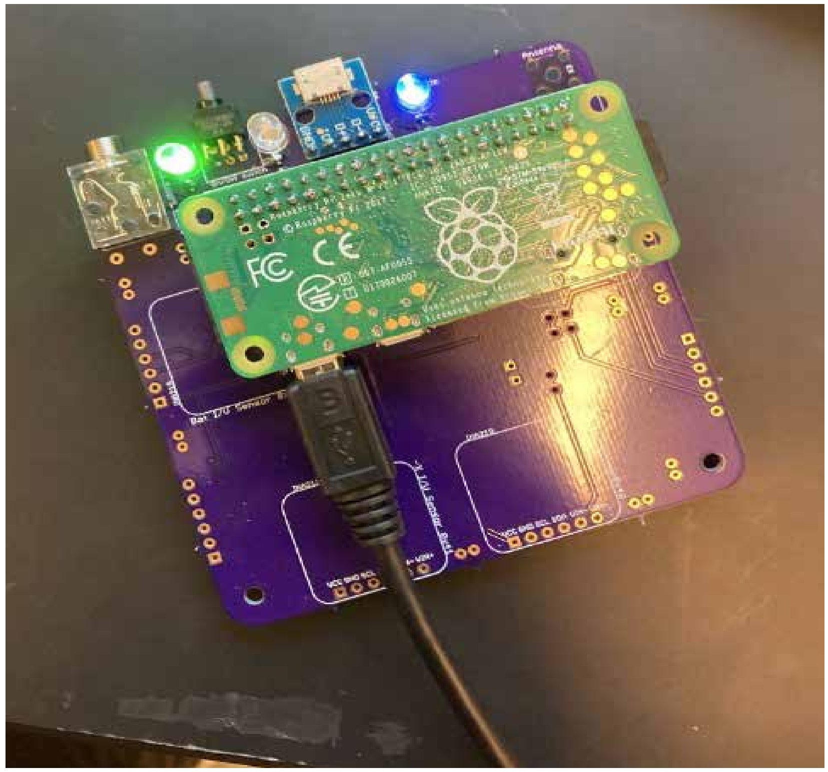


Figure 1 — Mainboard passing power and transmitting test.

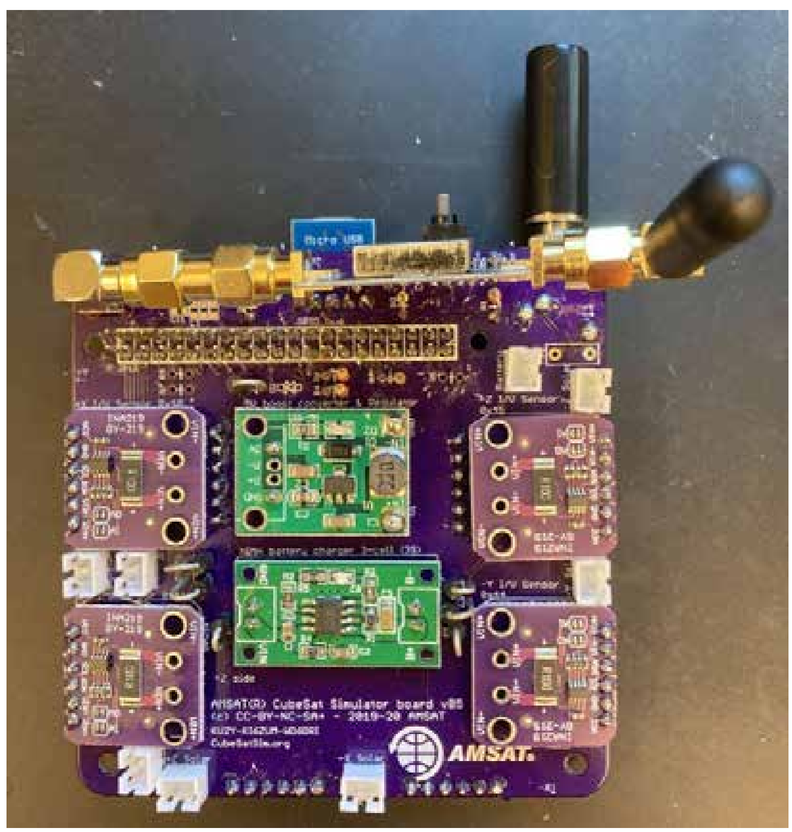


Figure 2 — Completed mainboard.

and GPIO header. By connecting these two components, I was able to run my first diagnostic tests (see Figure 1). Thankfully, the board was both receiving power and transmitting.

After passing the first phase of testing, I continued to add onto the Mainboard by installing the INA219 boards, a 5 V boost converter board, a NiMH charger board, an external Band Pass Filter with SMA connectors, diodes, and the JST 2.0 connectors (see Figure 2). These components allow the CubeSatSim to measure and regulate current traveling between the Mainboard, the Battery board, and the solar panels. Our battery board is powered by three AA batteries, attached to the Mainboard by JST connectors, and the current configuration has two solar panels also attached by using JST connectors.

With the Mainboard and power sources working, the next step was to build the board containing the sensors. This appropriately named STEM board will include a STM32 microcontroller, a BME-280 Temperature Humidity Barometric Pressure Sensor, and the MPU-6050 (GY-521) 3-Axis Accelerometer and Gyro (see Figure 3). These will allow us to determine the temperature, elevation, and angular velocity of the CubeSatSim. Since I used the STM32, I needed to boot flash the device before uploading the code that would allow it to communicate with the Raspberry Pi Zero and transmit the data it was recording. I did this using the Arduino interface, first by installing the STM32duino bootloader. While this was far from a smooth process, after a couple of days of struggling with .bat files and DFU device errors, I was able to upload the correct sketch to the STM32.

With the final board completed, I just needed to assemble the components and place them inside the frame (see Figure 4). This was a straightforward process of attaching GPIO headers and securing the boards and frame using multiple nylon screw sets. The CubeSatSim can now transmit hardware temperature, ambient temperature, battery voltage and current, air pressure, altitude, solar panel voltage and current, and angular acceleration in the x, y, and z directions. This data is received by an RTL-SDR and processed by an AMSAT program designed on the FoxTelem application.

To avoid some of the issues with inventory and compatibility that I endured, I suggest that prospective builders buy their supplies directly from the AMSAT store. This would avoid ordering custom boards from overseas suppliers and difficulties with SD card flashing. These products are available at **www.amsat.org/shop/**. I would also suggest using the Sparkfun Pro Micro instead of the STM32 for the STEM board. While the STM32 worked fine, I did have to buy an additional component and struggle through the bootloading process.

For those interested, a complete overview and instruction set for this build can be found at: **github.com/alanbjohnston/CubeSatSim/wiki**.

Lastly, I would like to extend my gratitude to Dr. Alan Johnston and Dr. Daniel Martínez, whose guidance, patience, and insight are why I was able to complete this project.

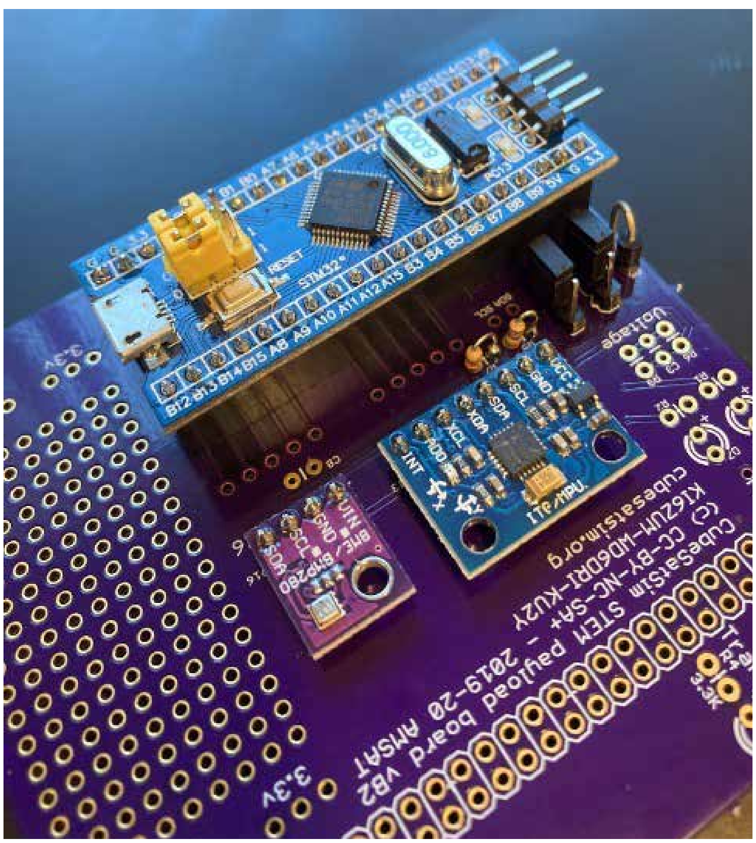


Figure 3 — STEM board with microcontroller and sensors.

Figure 4 — Completed build with solar panels and frame attached.

Editor's POV: A Potential Inflection Point

Joe Kornowski, KB6IGK
Editor

I'm sensing a potential inflection point in our hobby ascending from just below our visible horizon. And I want to provoke some thoughts about it in the hopes that we can get in front of it a bit.

As I recently read an article about Elon Musk taunt-tweeting Jeff Bezos, suggesting Bezos retired as Amazon's CEO to file lawsuits against SpaceX full-time, I felt uneasy. The article focused on Amazon's recent protest letter to the FCC asking it to reject SpaceX's proposed amendment to its Starlink plan. The amendment would add a second-generation satellite network composed of approximately 30,000 satellites.

Amazon's subsidiary, Kuiper Systems, LLC, operates its own satellite system. Kuiper received FCC approval in July to deploy and manage its internet satellite constellation of 3,236 birds.

Battle of the Space Titans

My brow started to furrow. I felt like some nerdy kid watching an escalating movie battle between T-Rex and King Kong billionaires for orbital domination. And these two behemoths aren't the only providers. So, I'm not exactly settling in with popcorn to watch how this plot unfolds.

In this new monetizing space race, we realize no one cares about AMSAT and a pretty small number of amateur radio enthusiasts putting up even a few dozen birds the size of half a bread loaf – even if we tack on the educational interests of our university payload partners. And that's the problem.

Orbital space is like radio frequency spectrum. It's a finite, highly desirable resource. The significant commercial interests, along with the astronomy community and the government with its own space "interests," will drive the decision-making in terms of government regulation, who pays to play, etc.

Remember what happened to the so-close-to-passage legislation to extend the FCC's PRB-1 limitations on antenna restrictions to HOAs? And the ARRL put the pedal to the metal on that one. So did the HOA lobbyists.

As with the radio spectrum, amateur radio always has played at the fringes of space. And like radio spectrum, the carrying capacity of orbital space is limited and, therefore, very high value. Tolerance for the flotsam and jetsam of hobbyist radio satellites could disappear entirely and quickly as the commercial traffic ramps up exponentially.

Our Place in Space

We can chant "Keep amateur radio in space!" all we want. The real question is, what "space" will there be for us, if any? What does amateur radio in space look like when orbital space becomes like an autobahn at rush hour, with its own equivalent of tolls, HOV lanes, vehicle restrictions and the like that extends far beyond what now exists?

I'm wondering what the options might be for amateur radio satellite enthusiasts. We're a scrappy and innovative bunch. Many of you are certifiably brilliant.

Do we focus more on near space, like high altitude ballooning, as AMSAT's current strategic plan calls for?* See Bill Brown's (WB8ELK) introductory article on amateur radio high altitude ballooning in this issue. Maybe we align with the commercial players to offer amateur radio space tourism, whatever that might mean. Deep space, anyone?

Would you please let me know what you think? We'll publish a selection of responses. Send your comments to: **journal@amsat.org.**

[*AMSAT's current strategic plan, under "AMSAT STEM Initiatives," provides:

5.2 High Altitude Ballooning. Develop programs to support and sponsor the use of amateur radio in high-altitude balloon (HAB) launches.]

Amateur Radio High Altitude Ballooning

Bill Brown, WB8ELK

Thirty-four years ago, I saw a documentary of Colonel Joe Kittinger parachuting out of a high altitude balloon from 102,000 feet. He described seeing the blackness of space and the curvature of the Earth. I really wanted to see that incredible view firsthand but didn't want to risk my life doing so. So I came up with the idea of launching a live TV camera hooked to an amateur television transmitter on 70 cm and launched it on a large weather balloon into the stratosphere. The view was amazing, even though the images were black and white. The views were exactly as Joe Kittinger had described and could be seen hundreds of miles away by amateur radio operators on their ATV (amateur television) receivers.

Imagine how well you would operate on VHF and UHF with an antenna more than 20 miles tall. An amateur radio operator can be heard direct line-of-sight over 400 miles away from a balloon at 100,000 feet altitude.

ARHAB Balloon Flights

Since that time, thousands of Amateur Radio High Altitude Balloons (ARHAB) have launched worldwide. A high-altitude balloon is a great platform to test out satellite hardware before launching it into orbit. We've flown crossband repeaters, simplex repeaters as well as linear translators. The R.F. footprint is a pretty good fraction of what you would experience in actual orbit. These flights are also a great way to excite students and help inspire them to pursue careers in aerospace engineering, atmospheric sciences, and any STEM fields. Many of these student flights carry cameras onboard and can now be tracked via APRS directly on their smartphones as they launch and recover their very own near-space mission.

A typical ARHAB flight consists of a latex weather balloon that is measured in size by its weight. To achieve flights over 100,000 feet, I would recommend using a 1200 to 1500 gram balloon, but some fantastic flights to over 80,000 feet can be conducted using balloons as small as 600 grams. An excellent source to buy these balloons is Kaymont.com. Due to the stratospheric rise in the cost and availability of helium, most groups now use hydrogen for these flights, which is

perfectly safe as long as you take reasonable safety precautions.

FAA Part 101 regulations allow us to fly payloads of up to 6 pounds for a total of 12 pounds for everything hanging below the balloon without getting any special waivers. The most significant weight cost is usually the batteries. At temperatures that can go below -60 deg C, the best choice are lithium batteries.

Parachutes are necessary, and a couple of companies make parachutes for rockets with special mods for high-altitude balloons. Spherachutes.com is a good source and can make chutes with custom colors. Another good supplier is the-rocketman.com. These companies have charts to select the proper size based on your total payload weight.

APRS trackers are the best choice to follow your balloon's ascent to near space and help you recover the payloads after they have parachuted back to Earth. There are many suppliers of these but keep in mind that even trackers with 20 mW output power can be quite effective during a flight. Anything that is one watt or less will be sufficient and also provide you with excellent battery life. You can track APRS-enabled balloons on **aprs.fi**, and after your balloon has exceeded 2000 meters in altitude, a website called tracker.habhub.org dedicated to high-altitude balloons will display your balloon's position. During the descent, it also shows a predicted landing location on the map.

Another site, predict.habhub.org, is an excellent site to predict your balloon's flight path and landing site. To calculate how much lifting gas to use, this site also includes an online calculator called “Use Burst Calculator” that will show you how much lift you need and the peak altitude you might achieve.

I recommend double and triple redundancy if possible since the ride to the Stratosphere and back can cause trackers to fail. So I recommend two separate APRS trackers and a FindMeSpot Trace unit that uses the GlobalStar network to relay your landing site and flight path on a website. If you keep it warm enough, the unit can report during the entire flight.

A typical flight ascends at about 1000 feet/minute and takes approximately 100 minutes to achieve peak altitude. The parachute descent can take about 30 to 45 minutes, depending on the parachute size.

Thus, if you deploy your chase team to the predicted landing site, they can often watch the payloads parachuting out of the sky.

Around the World in 14 Days

The weather balloon flights typically go up to peak altitude, burst and parachute back down. However, a new aspect to ARHAB flights called Pico Ballooning changes that. These ultra-small payloads are typically less than 15 grams total weight and fly on either 36-inch silver foil Qualatex balloons or the SBS-13 balloons that will go higher and get you above most of the storms. These balloons are made out of a special clear plastic in a particular class of balloons called Superpressure. If you get the free lift just right, these will float at the same density altitude for days, weeks, months and sometimes a year or more. The silver foil balloons fly around 28,000 feet, and the larger SBS-13 balloons fly around 43,000 feet. The SBS-13 is available from ScientificBalloonSolutions.com. Depending on the time of year you can circumnavigate the world in as little as 11 days and go around the world multiple times during a single mission.

The payloads usually carry APRS or WSPR mode transmitters, and some of them use different digital modes, including ASCII RTTY, DominoEX, Contestia or Olivia. These APRS trackers for pico balloons are usually totally solar-powered along with a companion supercapacitor. A battery adds too much weight and substantially decreases your float altitude, and puts you at risk of getting knocked out of the sky by storms. Hydrogen is best for higher and longer duration flights, but often helium has to be used in a school setting. APRS has excellent coverage over North America, Europe, western Russia, China, Korea, Australia, South Africa, Argentina, Brazil and Japan. But over the oceans, long gaps in coverage occur because no APRS ground stations exist. Also, we have to use a geofencing algorithm to change regional APRS frequencies as it flies around the world. Geofencing is also important to avoid transmissions over the U.K., Yemen and North Korea. Many amateur radio operators in the U.K. have to resort to license-free transmitters such as LoRa since airborne amateur radio operations are prohibited in the U.K.

WSPR pico balloons (typically on 20 m or 30 m) solves this problem since they can be heard anywhere in the world. A website called WSPRnet.org collects WSPR reports from the WSJT-X program and operates similarly. WSPR balloons typically transmit between 10 to 20 milliwatts, which is entirely sufficient for reception reports thousands of miles away during a flight. Reception of these low-power WSPR balloons has been observed from the other side of the world. The antenna usually is made out of 36 gauge magnet wired tape or tied to fishing line. When flying a pico balloon, make everything as light as humanly possible and make it even lighter. A few commercial sources provide pico balloon supplies and trackers, including WB8ELK Skytracker (APRS or WSPR), Zachtek (WSPR) and QRP-Labs (APRS and WSPR). Also, a few designs are available on GitHub for WSPR pico trackers

For more information on ARHAB flights, you can email Bill at: **wb8elk@gmail.com**.

UPDATE: Debugging AO-109 (RadFxSat-2, Fox-1E)

Burns Fisher, WB1FJ
Mark Hammond, N8MH
Member, Board of Directors

Introduction

At the end of our article in the May/June *AMSAT Journal*, we said, "By the time you read this, AO-109 may be opened for general amateur use." The opening announcement, in fact, came on July 19, just shortly after the Journal was available. Very soon after that, we started getting reports that some SatNOGS (SATellite Networked Open Ground Stations) had seen telemetry signals from AO-109 as early as May 2021. Chris, G0KLA, managed to partially decode one frame from SatNOGS.

Despite the hard work and too many errors for our Forward Error Correction algorithm to fix, we could see some data by ignoring errors. However, we had to guess which data was wrong.

We asked for more people to get telemetry, and we were pleased to receive 29 frames over several days from W7KKE, W7FWF, and K8DP. Even more recently, we have received hundreds of frames from the Dwingeloo Radio Telescope in the Netherlands. Thanks so much to all of them! Because of these ground stations, we can now say a few more things about the AO-109 situation.

What We Have Seen and Learned from Telemetry

The telemetry we have received confirms what we inferred from our earlier experiments:

- The antenna telemetry shows that they are open (more on that later)
- AO-109 is in transponder mode
- AO-109 does receive commands successfully, especially from a strong command station.

In addition, telemetry shows some other anomalies that let us make better hypotheses for other behavior that we have seen:

o The telemetry IS working, which tends to exonerate the telemetry modulator and software.
o The transmitter is sending telemetry with a power output between six and eight mW. You can compare this to our pre-launch testing, which showed a power output of somewhat over 100 mW, as designed.
o The power amplifier current is higher than expected based on pre-launch testing.
o The min/max telemetry shows that the maximum power output since launch was about 440 mW implying that the transmitter was likely working immediately after launch. (During the attempted early commissioning period, we tried both transponding and increasing the telemetry gain, which could explain the relatively high power output.)
o Seeing the telemetry downlink on a waterfall, it is even more apparent that the signal strength varies cyclically. The period seems to be around 25 seconds.
o The high/low telemetry shows that, at one point, we had an output power of around 500 mW, indicating that the transmitter failure occurred in orbit.

After a discussion with Dan W9EQ, one of our transmitter engineers, we believe a reasonable hypothesis for the low power is that one of the dual power amplifier chips has failed due to shorting. This not only increases the current to the PA but reduces the power available to the other PA chip. Dan also hypothesizes that running high power into a poorly deployed antenna might cause the blowout. However, it is still hard to understand why we initially had no reception at all. Note that even if the 70 cm antenna was not fully deployed, it does not cross over itself to make it electrically shorter even when stowed.

Since getting this telemetry, we commanded higher output from the telemetry modulator into the mixer and power amplifier but saw essentially no change in the output power telemetry. According to W9EQ, this is to be expected with a shorted PA. (It may imply that eight mW is the highest to expect from the transponder as well.)

As we hypothesized in the last paper, the cyclic strength of the telemetry beacon could be explained by the antenna being only partly released and blocked by the satellite part of the time as the satellite rotates. Similarly, if the receive antenna were only partly released, it would make commanding difficult for the same reason.

One further hypothesis: Carl, N3MIM proposed that the Nitinol wire used for our antennas was too cold to fully restore to its original shape after it was released. This could explain why both receive and transmit have problems but does not explain why this satellite, in particular, should have problems that the other Foxes did not.

Vanderbilt University Experiment Data

As we said in the previous article, one of our goals is to provide data for the Vanderbilt University COTS radiation experiment. This experiment not only funded the AO-109 flight but also will, in the long term, provide great information for satellite builders who can only afford common off-the-shelf parts in their birds. We are happy to say that we have been able to provide some

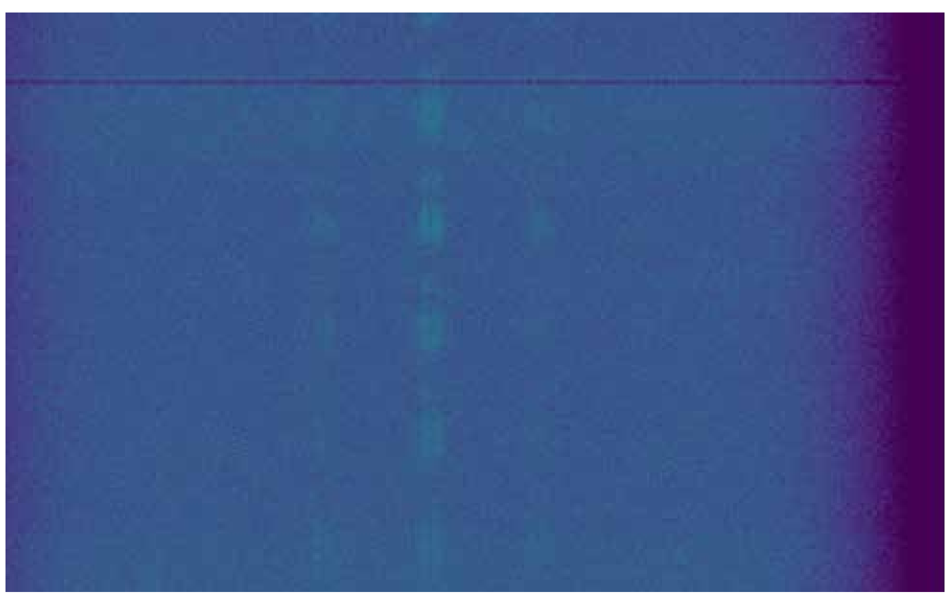


Figure 1 — SatNOGS Station 488 (W7KKE) Reception of AO-109.

data for Vanderbilt. Of course, more data over a longer period will be that much better, but at least Vanderbilt is getting something.

Where is the Data?

The data from AO-109 is on the AMSAT server at the same location as all Fox data. You can see the entire dataset by using FoxTelem and downloading Fox-1E (the latest versions of FoxTelem do not require you to download all the other satellites). You will see that despite having only 29 frames, there are many more health records than that in the WOD tab. This is because of AO-109's new capability: Whole Orbit Data, which captures a full set of health data every 60 seconds, stores it in memory, and transmits several of these WOD data payloads in each frame. (See Fisher WB1FJ, Fox-1E Telemetry, AMSAT Journal, March/April 2018). Similarly, Vanderbilt data is stored as WOD, so more science information than you might expect is also available.

In addition, you can see the AMSAT web page for AO-109 health at www.amsat.org/tlm/health.php?id=5&port=.

Telemetry Reception

Unfortunately, it seems that it requires a fairly "hefty" station to receive AO-109 telemetry. A regular end-mounted M2 LEO Pack, for example, is not enough. Everyone we have seen who has been successful has had a longer yagi, a preamp, and short coax. One person felt that the ability to reverse circular polarity also helped. Several SatNOGS stations have received a signal, but so far, we have not been able to decode any of them cleanly (see Figure 1.)

For Vanderbilt University and our own engineering testing, we would really appreciate even a few frames of telemetry that any station can receive. One way to do this is to use FoxTelem directly via a Fun Cube Dongle Pro Plus (FCDPP) and an antenna, as mentioned above.

Another way that we know works is to record the IF or AF from an ICOM 9700 that is being Doppler corrected during an AO-109 pass. The best chance for useful frames may be to record IQ using SDR# or HDSDR with something like an FCDPP or Airspy SDR Dongle and then playing it back into FoxTLM.

We continue to thank all of our supporters and data collectors around the world! Please keep trying!

AMSAT Field Day 2021 Results

Bruce Paige, KK5DO
Director, Contests and Awards
Member, Board of Directors

Once again, the ARRL has allowed stations at home operating on commercial power to participate fully in Field Day. AMSAT has done the same.

I was surprised that we had 30 stations participate with 26 satellites last year, and this year only 22 stations participated with 29 satellites. The ISS was even turned on in repeater mode to give more possible contacts.

As with every year, the number of satellites is based upon their modes. So, for example, SO-50 has one FM transponder, and I count that as one satellite, whereas AO-7 has two modes, SSB and CW, and gets counted as two satellites.

AO-7	51	4
AO-27	11	
AO-73	28	
AO-91	9	
CAS-4A	119	7
CAS-4B	162	8
CAS-3H	2	
EO-88	14	
FO-99	5	
ISS	12	
JO-97	64	
PO-101	1	
RS-44	250	12
SO-50	7	
TO-108	38	
XW-2A	127	1
XW-2B	81	1
XW-2C	61	1
XW-2F	58	1

The breakdown of satellite usage is as follows. This year twenty-two stations participated in AMSAT Field Day (Table 1).They reported 1144 QSOs with a total of 1223 points. In addition, there were 1112 Phone QSOs and 37 CW/Digital QSOs. Based on the numbers, it looks like RS-44 SSB was the busiest satellite again this year. Next up was CAS-4B, followed by XW-2A and CAS-4A. The choice for CW contacts this year was RS-44, followed by CAS-4B.

This year we have three groups of winners: those operating Club Stations (#/A, E, F), those operating Battery/Home Emergency Power (1B/1E), and those operating Home Commercial Power (1D). All will receive their certificates at the symposium this year.

Here are the Club Station winners. Moving up to first place from last year's second place is the Huntsville ARC, K4BFT, with 149 points (not far from their 178 points last year). In second place is Lafayette DX Association, W9LDX, with 138 points. Photo 1 is Steve, N9IP, and Dave, N9KT, making a contact for W9LDX. The W9LDX satellite team, Steve, W9TN, Dave, N9FN, Dave, N9KT, and Steve, N9IP (photo 2). A lovely night shot of W9LDX operating with Steve, W9TN, and Dave, N9KT (photo 3)

Our third-place club station is in the same position as last year, Johnson Space Center ARC, W5RRR, with 168 points.

As Andy, W5ACM, was a huge part of the operating at W5RRR over the years. Unfortunately, he became a silent key this year. John, AB5SS, placed a picture of Andy over the operating station so that Andy could be with them this year.

For operating at Home on Emergency Power, in first place is Alex, VA3ASE, with 134 points. Second place goes to Scott, K5TA, with 99 points, who was in first place last year. Third place goes to Steve, KS1G, with 83 points. Photo 4 and 5 are Steve, KS1G, with his station.

Our last group is those operating from home

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Satellite	9	8	12	9	16	21	33	28	26	29
QSOs	263	443	305	316	424	728	945	746	1526	1144
Stations	19	23	21	21	22	27	32	26	30	22
Points	329	613	357	386	448	778	995	848	1622	1223

Table 1

with commercial power. First place goes to Dave, W2GDJ, with 90 points. Second place goes to Carmen, WO3T, with 34 points, and third place goes to Terry, N6AJ, with 22 points.

I finished operating the satellites from home around 9:00 P.M. Central time and went over to our club station site, which just happened to be about three blocks from my house this year at our EOC. I then went back in the morning to help tear down all the equipment. I should have worked a few more stations, and I ended up in fourth place for home stations on commercial power with 19 points.

The Lake Area Radio Klub, W0WTN, forgot about operating satellites until Field Day was almost over. Then, they did what any good tailgater would do. They operated from their tailgate. JO-97 was passing over, and Kevin, KB0LCR, was on the radio, and Joe, KK0SD, was doing rotor duty with the Arrow, Mike, K0ATY was on the computer (photo 6 and 7).

This was the second time Andrew, KE5GDB, brought out his mobile satellite station for the Denton County Amateur Radio Club, W5NGU (photo 8). Scott, K5TA, in photo 9, was using his IC-9700, SatPC32, homebrew WA5VJB 3/2 shorty, and a Bioenno 30Ah battery. He only used about 1/3 of the capacity of the battery for the entire day.

I had to finish up the photos with those from the North Fulton Amateur Radio League, K4JJ. If you want satellite antennas, this is the way to do it. Check out photos 10-12, Dave, K4USA, and Daryl, K4RGK, raising the satellite antennas. This is no Arrow arm strong antenna. There is never a bad time to have a drone camera shot (photo 13). Oh, I almost forgot, I was so enthralled with the antenna. Here are Scott, KM4JXE, and Daryl, K4RGK, operating the station (photo 14). I did work W5RRR on several different satellites and W9LDX. But K4JJ was absent from my log. Their antennas must not have been high enough to reach me ;).

As I have said every year, for next year, remember, Murphy will somehow visit someone and spoil the day. Be prepared and have extra equipment, cables, and connectors. Writing this article is always the most fun for me, and I hope you enjoyed reading it.

73 and Good DX
Bruce, KK5DO

Here is a table of all entries received. In the case of a tie, call signs are listed alphabetically.

1	K4BFT	149	4A
2	W9LDX	138	1A
3	VA3ASE	134	1E
4	W5RRR	105	9F
5	K5TA	99	1B
6	W2GDJ	90	1D
7	KS1G	83	1B
8	W5NGU	58	4A
9	N4EH	53	4A
10	K4JJ	49	3A
11	WO3T	34	1D
12	W3BQC	26	4A
13	K8UNS	23	3A
14	W4MLB	23	2F
15	N6AJ	22	1D
16	KE8FZT	20	1B
17	KK5DO	19	1D
18	W3YP	18	1D
19	N8HM	17	1B
20	N5HYP	14	1E
21	AF5D		

Photo 1 — W9LDX.

Photo 2 — W9LDX.

Photo 3 — W9LDX.

Photo 4 — KS1G.

Photo 5 — KS1G.

Photo 6 — K0WTN.

Photo 7 — K0WTN.

Photo 8 — W5NGU

Photo 9 — K5TA

Photo 10 — K4JJ

Photo 11 — K4JJ

Photo 12 — K4JJ

Photo 13 — K4JJ

Photo 14 — K4JJ

Optimizing Your Portable Satellite Station

Keith Baker, KB1SF / VA3KSF

In a previous *Journal* feature, I highlighted a "really cheap" portable satellite antenna mounting system called "The Gizmo." However, as we move into fall here in the Northern Hemisphere, there will still be many opportunities to get "out and about" to operate portably before the cold winter weather sets in once again. So, in this feature, I'll share some additional hints on how you can take your satellite station "on the road" and, perhaps, also successfully rack up those additional satellite contact points for the ongoing "Parks On the Air" competition or the Radio Amateurs of Canada's new "Canadian Portable Operations Challenge."

Your Equipment

As I've repeatedly noted in previous features, satellite operation is NOT a high-power undertaking. As a result, so-called "alligators" — those who operate with "all mouth and no ears" — are about as welcome on our satellites as ants are at a summer picnic! Fortunately, this low power aspect of ham radio operation also makes it ideal for portable operation using power from batteries, a generator, or even solar or wind power.

For most satellite portable operations (beyond simply working the FM birds with a hand-held radio), some kind of "all-mode" equipment is needed to work the analog birds. This can take the form of a larger, all-mode, VHF/UHF radio (such as a Kenwood TS-2000, a Yaesu FT-847, or one of the newer ICOM IC-9700s) or even a pair of the many smaller all-mode radios (such as Yaesu's FT-817s or FT-857s). By design, the FT-817s only put out 10-15 watts or so on SSB and CW, and 100-watt capable FT-857s can easily be powered back into that same output range via menu settings. But, 10-15 watts of SSB or CW uplink power to a hand-held (or tripod-mounted) Arrow or Elk-style portable antenna is usually more than enough power to reliably get you on the analog birds from your portable location, particularly on near overhead passes.

A Word About Power

As I noted, the low power aspect of portable satellite operation makes it ideal for using solar, wind, or battery power to get you up and on the birds. Several of my satellite compatriots have had great success using a pair of all-mode Yaesu FT-817s powered

A compact (or folding) camp-style table helps make portable satellite operation with larger satellite-capable radios a breeze. (Courtesy: Author)

Frank, K6FW, (Left) and Bob, N6UK, use Frank's portable analog satellite radio setup to make contacts from the deck of the cruise ship Carnival Liberty in the Gulf of Mexico during AMSAT's "Symposium at Sea" in 2016. (Courtesy: Author)

Frank mounts his two Yaesu FT-817s along with a Gel-Cell battery inside a nylon camera bag strapped around his neck. (Courtesy: Author)

An ordinary automotive "jump start" battery booster makes an ideal power source for portable satellite work. (Courtesy: Author).

If you plan to operate portably for a lengthy period of time — even at low power — having more than one fully charged battery available will greatly increase your satellite "talk time". (Courtesy: Author)

A "battery booster" (similar to this MFJ Model 1441) helps keep your radio's input voltage steady by eliminating low or marginal voltages from your battery while it's under transmitting load. (Courtesy: Author)

by small "Gel-Cell" batteries, and all carried in a large photo case strapped around their necks while operating "foot mobile." A boom microphone and headset, along with a PTT switch mounted on their antenna's handgrip, round out their portable stations.

While I have successfully tried this same approach using a pair of Yaesu FT-857s, I much prefer a more comfortable arrangement using my Yaesu FT-847 or Kenwood TS-2000 set up on a portable camping table and powered by one or more automobile "jump-start" batteries. The latter are readily (and usually inexpensively) available from the automotive section of most department stores. An additional feature of these battery packs is that they typically have their own built-in AC chargers. What's more, powering down the larger all-mode VHF/UHF radios into the 10-15 watt output range will usually give you more than enough battery capacity to operate on several satellite passes before a battery recharge is needed.

Portable Station Accessories

I've also found that having a tablet computer running any number of satellite tracking programs (such as AMSAT's Sat PC-32) are very helpful…particularly for night operation. Likewise, a small, battery-operated camp lantern helps with manual logging as well as effectively operating your radio. That's because, as satellite passes usually happen relatively quickly, you don't want to spend your valuable pass times fumbling around in the dark hunting for the knobs and switches on your radio!

Also, if you plan to operate from a rare Maidenhead Grid Square (or even the intersection of one or more Grid Squares), a battery-operated computer tablet or smartphone with Global Positioning System (GPS) capability will help you fix your precise location.

Looking Ahead

In another feature article, I'll show you how to add a small DC motor to the simple "Gizmo" antenna mount I discussed in a previous feature to help make your portable satellite operation even more "quick and easy." See you then!

Your author operates via the satellites using battery power, a Yaesu FT-847 and handheld Arrow Antenna from a city park in Sault St. Marie, Michigan (well before the COVID Pandemic!). (Courtesy: Author)

If you plan to operate "off the grid" for an extended period of time (such as at a camp site without access to AC power) a small, portable, gasoline powered, AC generator can provide power for your larger satellite radios and/or recharge your portable batteries, often at the same time! (Courtesy: Author)

Portable satellite night operation all but requires a portable light source and an illuminated computer tablet running your favorite tracking software. (Courtesy: Author)

FM Satellites, Good and Bad Practices

Omar Álvarez-Cárdenas, XE1AO; Miguel A. García-Ruiz, VE3BKM; Margarita G. Mayoral-Baldivia, XE1BMG; Raúl T. Aquino-Santos, SWL.

Introduction

Most radio amateurs interested in satellite communications start with satellites that broadcast on FM because the radio equipment and antennas are the least expensive and the easiest to obtain. As most of you know, making communications via satellite is not as complicated as many people think. The advice given by experienced radio amateurs in this modality is essential to achieve a successful first communication. Unfortunately, once we acquire the knowledge and the ability to implement it correctly, we begin to forget or put aside what we have learned. As a result, we fail to apply those good practices that help not interfere or prevent other radio amateurs from communicating most efficiently and effectively.

In this article, we intend to share the best experiences, advice and recommendations we received from those operators who motivated us to use this fascinating mode of communication. Furthermore, we seek to remind and encourage operators to use good practices that allow us to improve our satellite communications, as well as to recognize when it is necessary to yield to other stations that are calling from some unusual grid, special grid activations, maritime mobile units and even in some emergencies where we must cooperate to keep the allocated satellite frequencies open and accessible.

FM LEO Satellites Overview

We first consider the theoretical basis regarding a low Earth orbit (LEO) satellite for the amateur radio service. LEO satellites are repeaters orbiting the Earth at an altitude between 500 km and 1,500 km. All of them have elliptical orbits that take them approximately 90 minutes to complete. The physical dimensions of a typical CubeSat used for LEO are 10x10x10 cm, and each one must not exceed 1.33 Kg (Murbach et al., 2014). If the satellite owner seeks to integrate more than the essential functions in a CubeSat, attaching more than one 1U (10x10x10 cm) may sometimes be necessary. Given this physical structure, we can easily deduce that it is not advisable to implement high-power transponders in CubeSats. Therefore, we will find such amateur FM satellites with power ranging from 0.25 to 0.5 Watts (Alanazi, 2018). On the other hand, satellites with linear transponders and an orbit close to 1,500 km usually have 5 W transmitters, such as the RS-44 satellite (Figure 1).

A Basic Station for FM satellites

At first, it is difficult to imagine the possibility

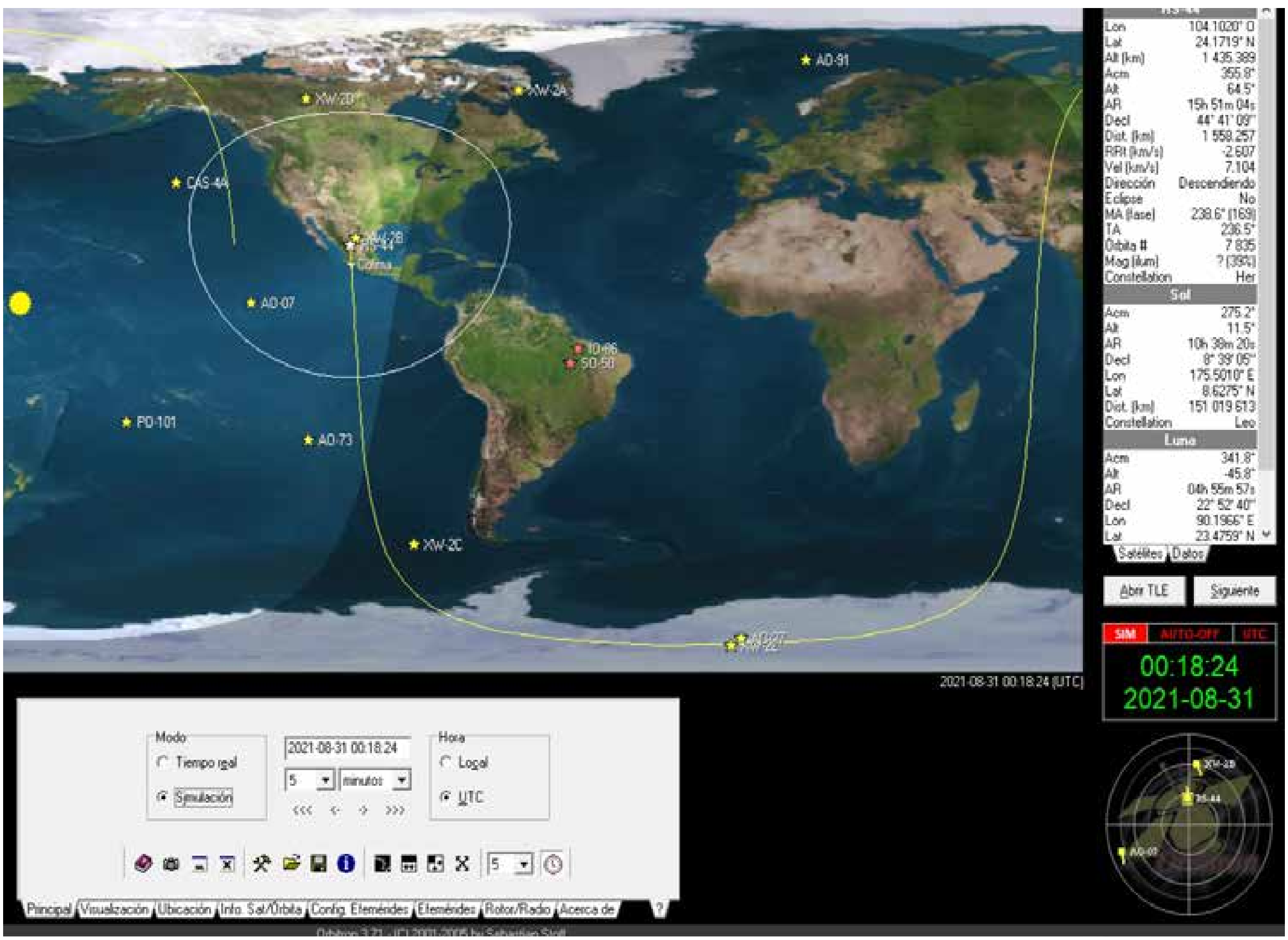


Figure 1 — Satellite RS-44 Footprint.

of communicating through an FM satellite that is on average 650 km above the Earth and has such low power. Still, after the first contact, the satisfaction makes us want to continue doing it.

Making our first contact does not require a significant investment in equipment. A portable VHF/UHF transceiver with five W of power and a directional antenna with a few elements are enough to achieve a first QSO. Communication tests have succeeded with a handheld transceiver (HT) transmitting with one W communicating effectively through LEO FM satellites at terrestrial distances of up to 5,000 km between two stations (Martínez & Currea, 2020).

Suppose the aim is exclusively to communicate or only to get the downlink reception. In that case, an operator can use the vertical antenna of a portable radio or one with a higher gain. However, the satellite pass available reception/transmission time is short. For example, if the satellite pass allowed communication for 10 minutes, with the portable equipment's vertical antenna, you would only be able to hear the downlink for approximately two to four minutes. But suppose you want to have access to a downlink for 10 or more minutes. In that case, a directional antenna with two or more elements is recommended using our arm as a rotor to point directly at the satellite during its pass (Zhang, et al., 2020).

Many FM radios operate in half-duplex mode (both parties communicate with each other alternately, taking turns), which requires knowing how the Doppler effect works, especially when working in the UHF band. It would be easier to have a team that works in full-duplex because we can simultaneously hear our voice in the downlink when transmitting. This will mitigate the Doppler correction. One way to manage the Doppler effect at the 440 MHz band is to record the uplink and downlink frequencies on the radio's memory with their respective Doppler settings from the start of the orbit (acquisition of signal, or AOS), at its maximum altitude and up to the end of the pass, called loss of signal (LOS). This requires roughly five different memory frequencies to be stored in a radio. Knowing the operating frequencies of the FM satellites, the Doppler correction in the UHF band would be 10 kHz above the center frequency for the AOS (two memory frequencies), without Doppler correction when it is at its maximum elevation, and finally 10 kHz below the center frequency until LOS. The 5-kHz steps per click in the portable equipment would correspond to the 5 frequencies previously stored in the radio's memory. When storing frequencies in memory, you need to include any PL tone required to activate the satellite's radio (Smith, 2018).

For example, SO-50 is a V/U satellite with the nominal frequencies of:

> Uplink: 145.850 MHz FM [with 67.0 Hz CTCSS tone]; and
> Downlink: 436.795 MHz FM [±10 kHz for Doppler].

During a SO-50 pass, you will experience a 20-kHz shift in the received 70 cm frequency. This means that if you don't retune your receiver, you will miss part of the pass. Use your memory channels to retune the receiver during the pass to keep the signal strong with your uplink without change as follows:

Memory No. 1 Downlink 436.805 MHz Uplink 145.850 MHz with 67.0 Hz tone

Memory No. 2 Downlink 436.800 MHz Uplink 145.850 MHz with 67.0 Hz tone

Memory No. 3 Downlink 436.795 MHz Uplink 145.850 MHz with 67.0 Hz tone

Memory No. 4 Downlink 436.790 MHz Uplink 145.850 MHz with 67.0 Hz tone

Memory No. 5 Downlink 436.785 MHz Uplink 145.850 MHz with 67.0 Hz tone

A good practice is to create a document with the names of the active FM satellites, their operating frequencies and activation tones, noting the Doppler settings you require for their operation. For example, this web page contains the status of all current amateur radio satellites, including FM satellites: **www.amsat.org/status/**. Click on each one to know its operating frequencies, tone, etc. Once that information is compiled in a document, the memories must be recorded in the radio manually or with some software application such as Chirp (**hchirp.danplanet.com/projects/chirp/wiki/Home**).

Since you will likely track a satellite during its pass using a handheld antenna pointing at a satellite, we must consider each satellite pass' three most crucial azimuth and elevation points: the azimuth at AOS, the azimuth/elevation at maximum elevation and the azimuth at LOS. To avoid any mistakes in this regard, you should use a compass to locate these coordinates at the site where you will operate.

Minimum Equipment

In addition to the dual-band portable equipment, you must decide what antenna to use. While you can use a half-wave telescopic omnidirectional for VHF with an HT, this type of antenna will be limited to passes over 35 degrees of elevation. We

Figure 2 — XE1AO basic portable operation.

strongly recommend a directional antenna and the least length of coaxial cable to the radio. This type of antenna makes it possible to achieve contacts in the AOS and LOS when there are no tall objects at those points obstructing the horizon. As the tracking of the azimuth and elevation angles will be conducted by handling the antenna with one of your arms, it is preferable to use prediction software (this web page shows a list of popular prediction software: amsat-uk.org/beginners/satellite-tracking/) that will allow you to know in advance the orbit of the satellite to select the best location free of obstacles. You should record the time in UTC and the callsign and grid locator of the station worked in the pass. One way to do this is by using an audio recorder (perhaps using this feature on a cellphone) to record the satellite passes, time, satellite name and grid from where it is transmitted. You may want to describe where you made the contacts at the initial portion of the recording (Figure 2).

Preparation for the First Contact

Most radio amateurs who use this mode of communication recommend that, before trying to use the satellite uplink for the first time, you first learn to calculate the orbit, follow it and listen to the satellite communications throughout the pass for several satellites. The greatest challenge is knowing how to locate and follow the pass precisely; if, after doing this exercise on more than three satellites, you can hear it throughout its pass, you are ready for the first contact.

A possible sequence of steps to make your first communication would be the following:

1. Calculate with the software of your choice the passes of the FM satellites that have orbits above 30 degrees.

2. Identify a clear place where the satellite will pass, avoiding buildings, trees or any other object that gets in the way.

3. Verify that you will have a clear line of sight to aim the antenna; to do this, we recommend using a compass.

4. Adjust and verify the frequencies stored in the radio's memory without forgetting the DTMF activation tone. Move to the frequency corresponding to the satellite's AOS.

5. Close to the start time of the pass, fully open the squelch control.

6. Once the satellite reaches the AOS, aim your directional antenna at that point. Make the corresponding azimuth and elevation shift, and when you hear the first stations and have an opportunity to make a call, use your callsign.

7. If any station still does not complete their announcement (QSO), avoid calling it and give a space for it and the others to finish their QSO. It is essential to leave a space between calls to avoid generating interference since FM satellites only have one frequency for all.

If any station responds to your call, exchange your callsign and grid locator. Congratulations! You have achieved your satellite communication.

As can be seen, communicating on FM satellites with low-power portable equipment is simple. However, things can get complicated with the following improper practices:

1. Avoid repeatedly calling on the uplink frequency when you do not hear the downlink. Whistles and phrases like "hello, hello, hello" are often heard. As the satellite uses a single frequency shared by everyone, avoid calling "CQ Satellite."

2. Avoid pressing the radio's PTT button without speaking.

3. Do not use high power. When using a single frequency with stations transmitting at low power (5 W), it is enough to complete the contact with two operators in QSO simultaneously. However, when increasing the power, and given the gain of your antenna, only that station will be heard.

4. Do not call a station that has not yet completed its QSO. We never know if another operator is trying to log a QSO for that grid because it is a rover station (mobile) in a very special location.

5. If the satellite pass has a lot of activity between stations, do not call back a station that you have already worked on a satellite that has passed before. If you do that, you will only saturate the frequency for others who need to communicate with another station.

6. If you hear a rover station activating a grid that many stations want to log, leave a space for them, even stay listening if you do not require that grid. Unfortunately, with maritime mobile stations (those on ships), the satellites become saturated by operators who try to achieve that grid, making it more difficult for someone else to transmit again from that location. In such situations, all of these recommendations and good practices are ignored to achieve the highly-desired QSO.

7. Avoid the bad habit of calling any station you may hear, especially if you have already had more than one previous communication with that station on that and other satellites.

8. Some people call using their callsign repeatedly, without leaving spaces between transmissions, on top of QSOs in progress. Whether there are activations or maritime stations, more than 15 calls per orbit have been counted on this one issue.

Many more situations exist in which the bad practices exhibited by some satellite operators generated great discontent for those who traveled hours to reach a grid that other operators needed or to achieve contact with a station with which they scheduled a QSO, with only a few seconds to make the contact. Moreover, trying to make contacts on weekends when most people usually have time for this hobby is frustrating when operators forget about these better practices, causing misuse of satellite passes.

Conclusions

The mode of communication in amateur radio satellites is fascinating and, to some extent, addictive. The situation with FM satellites is more complicated because of a single shared frequency (unlike linear satellites). To optimize everyone's operating experience, following the recommendations explained in this article is enough to allow all stations to communicate most effectively and efficiently. Despite the great effort of many radio operators, bad practices still occur. Some operators even engage in them intentionally. Do not forget that part of being an amateur radio operator is enjoying the communication methods at our disposal. For this, we need other operators to have a complete QSO. The solutions to bad operating practices in FM satellites are so simple, especially when we realize that they do not affect our abilities and aptitudes as good radio amateurs.

To complement good practices and the general protocol for working FM satellites, remember these key considerations:

- Know your grid locator beforehand, as it is vital for completing the QSOs.
- Do not forget to turn down the reception squelch on your radio.
- Record all communications in UTC. Keep the time updated on the computer or cell phone where your satellite pass prediction program runs, correctly adjusted to an atomic clock.
- Know the frequencies and operating status of the FM satellites.
- Keep in mind that most FM satellite uplinks use a tone for their activation.
- Never transmit if you do not hear the satellite downlink frequency.
- Disseminate to the entire amateur radio community the correct use of satellite frequencies.
- Enjoy your hobby and contribute to the formation of new amateur radio operators.

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eBay Sellers Donate to AMSAT

Are you an eBay seller? One item, ten items, or a full-time business you can donate a percentage of your winning bid to AMSAT.

To do so, do not list your item with the basic listing tool, select advanced tools. eBay will give you a warning message that it is for large volume sellers, however this is where the eBay for Charity tool is found.

You can "select another nonprofit you love" and search for either AMSAT or Radio Amateur Satellite Corporation. Choose the percentage amount of the sale you would like to donate to AMSAT, and boom!.

When your item sells and the winning bidder pays, eBay will deduct the percentage from your take and forward it to AMSAT.

Sometimes we are getting rid of our old equipment, sometimes selling something new. In any case, please consider giving a piece of the pie to a new satellite and choose

Smile for AMSAT at Amazon.com

When making purchases from Amazon, you can select a charity and Amazon will donate .5% of a qualified purchase towards that charity. Select smile.amazon.com when making your Amazon purchases and make Radio Amateur Satellite Corporation (AMSAT) your chosen charity.

Having selected a charity, when you go to amazon.com, you will be prompted to go to smile.amazon.com. However, you can put everything you want in your cart at the original amazon.com site, then leave the site and go to smile.amazon.com and all your items will still be in your cart.

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.

Join the 2021 President's Club

And Help AMSAT Return to High Earth Orbit!

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 to *Keep Amateur Radio in Space*. We have set a fundraising goal of $125,000 to help keep AMSAT viable and effective in the competitive world of space communications.

GOLF-TEE (Technology Exploration Environment) is a rapid development satellite headed for LEO to fly and validate ADAC, deployable solar panel wing, radiation tolerant IHU, SDR and other technologies.

GOLF-1 is planned as a "High LEO" mission with a STEM payload in the progression of GOLF satellites.

With your membership, AMSAT is pleased to recognize your generosity. All members receive:

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Go to AMSAT.org/donate and join today!

Tier	Core	Bronze	Silver	Gold	Platinum	Titanium
Annual Donation	**$120 +**	**$300 +**	**$600 +**	**$1,200 +**	**$2,400 +**	**$4,800 +**
Journal Listing	X	X	X	X	X	X
Certificate	X	X	X	X	X	X
Coin	X	X	X	X	X	X
"RBF" Key Ring	X	X	X	X	X	X
Plaque			X	X	X	X
TAPR/AMSAT Dinner @ Dayton				X	X	X
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President's Symposium Lunch					X	X
Symposium VIP Recognition						X

Recognition items available for U.S. addresses. For contributions from elsewhere please contact Frank Karnauskas, VP-Development at N1UW@AMSAT.org. AMSAT is a 501(c)3 corporation. Donations may be tax deductible. Check with your tax advisor.

With a 50-year Legacy of Success, AMSAT Volunteers …

Build satellites that Keep Amateur Radio in Space!

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Learn, teach and share innovations and best practices in space communications with other radio operators, students, government and the public.

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