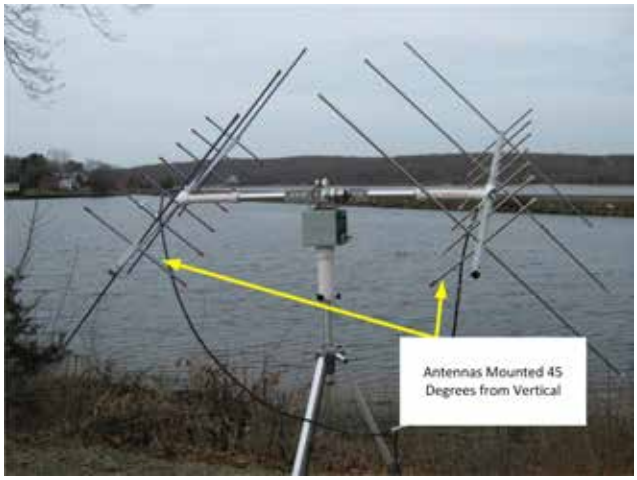
The AMSAT® Journal

Volume 37, Number 3 May/June 2014

in this issue ....

AMSAT's New Office
10605 Concord Street
Suite 304
Kensington, MD 20895



Tricked Out WRAPS Rotor adds 2nd Beam and Circular Polarization

Periodicals
POSTAGE PAID
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and at additional
mailing offices

AMSAT-NA
10605 Concord Street, Suite 304
Kensington, MD 20895-2526

How You Can Help Build New and Exciting Satellites

Donate to the President's Club

Gold, Silver, Bronze and Core levels are available to match your ability to participate.

Cash Gifts

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Gift of Life Insurance

US taxpayers may be able to receive a significant income tax deduction by making
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US taxpayers should be able to avoid capital gains taxes on appreciated securities and receive a deduction for their fair market value.

Bequest

A codicil in your will, naming The Radio Amateur Satellite Corporation as a beneficiary will help insure the continuance of the Amateur Radio Satellite program.

Call the AMSAT-NA office at 301-589-6062 for questions on any or all of these ways you can help build new and exciting satellites.

Support AMSAT-NA

AMSAT Announcements

First Call for 2014 AMSAT Space Symposium Papers

This is the first call for papers for the 2014 AMSAT Annual Meeting and Space Symposium to be held on the weekend of October 10-12, 2014, at the DoubleTree Hotel by Hilton, Baltimore-Washington International Airport (BWI), Baltimore, Maryland. Proposals for papers, symposium presentations and poster presentations are invited on any topic of interest to the amateur satellite community. We request a tentative title of your presentation as soon as possible, but no later than August 1. The final copy must be submitted by September 15 for inclusion in the printed proceedings. Abstracts and papers should be sent to Dan Schultz at n8fgv at amsat.org

BOD Election Reminder

Nominations are due by June 15, 2014 for this year's Board of Directors election.

Under Article V of the AMSAT Articles of Incorporation, an individual may be nominated one of two ways:

- A nomination petition signed by at least five current AMSAT members, or
- A nomination by a member society of AMSAT. A Member Society shall be a recognized group, club or organization consisting of at least five individuals.

Ballots will be mailed to the AMSAT membership by July 15, 2014 and must be returned to the AMSAT office by September 15, 2014 in order to be counted.

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.

Radio Amateur Satellite Corporation (AMSAT-NA)
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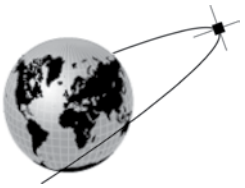
The AMSAT Journal (ISSN: 1407-3076) is published bi-monthly (Jan/Feb, Mar/Apr, May/Jun, Jul/Aug, Sep/Oct, Nov/Dec) by AMSAT-NA, 10605 Concord St., Suite 304, Kensington, MD 20895-2526. Telephone: 301-822-4376, fax: 301-822-4371. Periodicals postage paid at Silver Spring, MD and additional mailing offices.

Postmaster: Send address changes to *The AMSAT Journal*, 10605 Concord St., Suite 304, Kensington, MD 20895-2526.

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 JPEG formats. Kindly do not embed graphics or photos in your manuscript - we prefer receiving those as separate files. AMSAT-NA reserves the right to select material for *The AMSAT Journal* based on suitability of content and space considerations. The editors of this publication are volunteers giving freely of their talents, time and efforts to produce *The AMSAT Journal*.

APOGEE VIEW

by Barry Baines, WD4ASW • wd4asw@amsat.org



I'm writing this the week following Hamvention while traveling in NW Ohio before the Memorial Day weekend. I consider this "downtime" to some degree with the opportunity to "tune out" somewhat, enjoying the weather and focusing on "fun" as a means of recharging batteries. However, our *AMSAT Journal* editor has given me a deadline and so I write this while visiting Deshler, OH watching trains and enjoying tooling around the various railroad "hot spots" in the area using my Segway.

Hamvention

Dayton was hugely successful in all respects for AMSAT. While there is an article being developed on Dayton, allow me to highlight some of the "highlights"…

Booth Sales were excellent with demand exceeding supply for a number of items, such as the LVB Trackers, the newly released 2014 edition of the *Getting Started in Amateur Satellites*; updated Frequency Charts; Elk Antennas; the WRAPS board developed by Mark Spencer, WA8SME; and the *ARRL Satellite Handbook*. In fact, Friday was very busy with most of the "sellout" taking place that day.

The Friday night AMSAT-TAPR dinner was well attended with excellent food and plenty of opportunities to compare notes about the first day of Hamvention with fellow tablemates. Our banquet speaker was Dr. Tom Clark, K3IO who reflected on amateur radio and the Elmers that helped him get into amateur radio and electronics, which subsequently influenced his decision on a professional career. Tom, who proclaims himself to be the "AMSAT Curmudgeon" talked about some of his career accomplishments at NASA's Goddard Space Flight Center and the people he worked with.

The AMSAT Forum on Saturday was well attended with over 200 people in the room learning the latest about AMSAT, our Fox project, the changes taking place with ARISS, an overview of AMSAT-UK's AO-73 (FUNCube) presented by AMSAT-UK's Howard Long, G6LVB and education outreach. Howard also noted that there are several upcoming "FUNCube" launches where the FUNCube transponder will be flown in other spacecraft:

- FUNcube-2 (UKube) June 2014
- FUNcube-3 (QB50p1) June 2014
- FUNcube-4 (ESEO) Late 2015

During my remarks, I noted that AMSAT memberships declined in 2013, with a reduction of over 500 members versus 2012. As of January 2014, we had about 3,145 members with a significant percentage of life members. Losing that many members means a reduction over $22,000 in membership dues (assuming $44.00/year applied towards the Basic membership level). For 2014, our annual operating expenses (office rent, Martha's salary and benefits, printing costs, postage, utilities such as phone/internet, etc.) totals about $294,000.00. Total income from memberships, proceeds from shirts, books, software, etc. is about $207,000.00. That leaves a $87,000.00 per year 'deficit'. While AMSAT can cover this difference with non-designated donations or taking funds from our reserves, this is not a viable long-term approach towards maintaining AMSAT's financial health. It hurts us because non-designated donations which could be used for future projects at AMSAT's discretion are instead used to cover normal expenses, plus using reserves removes resources that may be needed down-the-road.

The "solution" is to increase memberships so that AMSAT is self-sustaining and doesn't need to use donations to cover annual expenses. A back-of-the-envelope calculation suggests that in order for AMSAT to break even, where membership revenues will offset the "deficit", we need to attract and retain 1,924 additional memberships over the December 2013 level, an increase of over 60% in total memberships.

The key to building memberships is whether the existing membership supports the effort. The most effective marketing tool is "word of mouth." Existing members know the organization best and are in an excellent position to inform their colleagues what AMSAT is all about and encourage others to join. Personal contact and interaction one-on-one always works better than web pages and ads. If members actively support the organization, encourage others to join, and "spread the word", then our prospects for improving our membership base will be significantly better.

A related consideration is that there is so much information available on the web today that people may presume that there is little direct benefit to joining. The key membership benefit today is the *AMSAT Journal* which is now back on production

continued on page 4 ...

Apogee View - continued from page 3 ...

schedule with excellent content. Our editor, JoAnne Maenpaa, K9JKM has assembled an outstanding editorial team and their efforts are reflected in an excellent magazine. Consider sharing your copy of the *Journal* with colleagues at club meetings or other occasions and encourage others to join and benefit from the *Journal* as well.

During the AMSAT Forum, I asked how many attending the Forum were AMSAT members. About half the room raised their hands. As a result of my discussing the membership situation as well as a desire to get those people not already members to join, I announced a new membership incentive good through Saturday only: New members would receive a free copy of "Getting Started in Amateur Radio Satellites" mailed to them. Between speaking about our need for new members and the membership incentive, we had 60 people sign up as new members, a three-fold increase over new memberships at the 2013 Hamvention. Renewals were also slightly up as well: 123 during Hamvention 2014 vs. 114 during Hamvention 2013.

As an AMSAT member, please help us to keep this initial effort to build membership going.

One change at Hamvention this year was the establishment of a "Beginner's Corner" where people could ask questions about working the satellites. A number of individuals took advantage of this opportunity, and it may well be the case that having friendly, helpful people to answer questions prompted people to join. The opportunity to also view satellite demos under Keith Pugh, W5IU and company were very popular and again reinforced a good impression.

My thanks to the AMSAT Team at Hamvention, led by Steve Belter, N9IP for their efforts. During the Hamvention, I didn't see one individual who was looking for assistance stand around looking lost; everyone was promptly served. The Engineering Team demo area was very busy with people examining the Fox model and having the opportunity to transmit their signal through the Transmitter – Receiver – IHU prototype as well as hear a sample "canned message" generated by the IHU. Setup and takedown were accomplished in record time thanks to Steve's advance preparation as well as a good number of volunteers to do the "heavy lifting."

AMSAT Office Relocation

Effective May 2, 2014, AMSAT is occupying new office space in Kensington, MD. Details about the move can be found on page 6 in this issue.
While Martha is "moved" to new space, the AMSAT Office itself is not "settled." The relocation created some upheaval, including the need for new stationary, new membership forms, new donation forms, etc. We don't expect to receive these updated materials until after Memorial Day weekend, which means that some administrative matters, such as memberships and renewals where individuals receive a packet from the AMSAT office as well as some AMSAT Store orders are being delayed.

We're also having difficulty with the US Postal Service regarding forwarding of mail sent to our previous address. For whatever reason, we have not received forwarded mail weeks after the change was made and we're doing our best to work with the US Postal Service regarding what has happened to this mail. Hopefully, this will be resolved in the next few weeks.

BOD Election

Nominations are due by June 15, 2014 for this year's election. Due to the resignation of Gould Smith, WA4SXM and later loss of Tony Monteiro, AA2TX, both BoD alternates (K9JKM and K8UD) are now full members. However, their service expires with this election. Consequently, instead of three BoD seats being up for election, there will be four, including the seats currently held by K3IO and W5DID.

Complicating things somewhat is that Gould's seat was up for election this year, so the person who fills that seat in this election will have a two-year term. However, Tony was elected last year and his term doesn't expire until September 2015. Consequently, the person filling out this seat in this year's election will have a one year term so that this seat will revert to election in odd-years. This means that the top three recipients of votes will have two-year terms, the fourth most vote recipient will serve as full member for one year, and the fifth and sixth vote recipient will serve as first and second alternate respectively.

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- A nomination by a member society of AMSAT. A Member Society shall be a recognized group, club or organization consisting of at least five individuals.

Ballots will be mailed to the AMSAT membership by July 15, 2014 and must be returned to the AMSAT office by September 15, 2014 in order to be counted. Election of board members is both an obligation as well as an opportunity by our membership to help shape the future direction of AMSAT. Please take the time to review the candidate's statements that will accompany the ballot and determine who you wish to see on the Board. There are four open seats, so you have the option to vote for four candidates.

ITAR

On Tuesday, May 13, 2014, the same day that I was leaving home to drive to Hamvention, the Directorate of Defense Trade Controls (DDTC) of the Department of State and the Bureau of Industry and Security (BIS) of the Department of Commerce released their long awaited "Interim Final Rules" regarding the transfer of commercial satellites from ITAR (International Traffic in Arms Regulations) managed by the DDTC to the EAR (Export Administration Regulations) under the BIS.

As I am writing this column only two days after Hamvention (and still in Ohio), I am not in position to make comments about the latest revisions. I do know that AMSAT has until June 27, 2014 to file any additional comments and that the rules will go into effect on November 10, 2014. Further, the comments that AMSAT submitted in July 2013 were summarily rejected by the BIS.

My biggest concern is focused on how the BIS will manage "deemed exports". Deemed exports is a concept introduced in ITAR and which will continue to impact those items being transferred from EAR to ITAR. Under ITAR, AMSAT could not have technical discussions with foreign nationals unless a Technical Assistance Agreement was in place with the TAA approved by the DDTC. Since a TAA was not practical, the only time that AMSAT could have technical discussions concerning items subject to ITAR was if the materials were placed in the public domain, and DDTC has specific requirements as to what constituted "public domain." This meant we could discuss items that were "after the fact." Consequently, we could not collaborate with foreign nationals on development of spacecraft technology.
In the near term, we expect to have substantive conversations with regulatory experts to better understand how the BIS

intends to manage "deemed exports" and under what circumstances deemed exports may become an issue. Peter Portanova, W2JV is serving as our lead point-of-contact as our liaison and I am working with him to ensure that our questions/concerns are conveyed and that we develop an appropriate level of knowledge about what to expect with the transition to the "new" EAR.

AMSAT Electronic Services

It turns out that while many of us were at Hamvention over the weekend of 16-18 MAY, the AMSAT IT Team led by Joe Fitzgerald, KM1P was busy implementing changes to our e-mail services. The team successfully relocated the various e-mail list services (e.g. amsat-bb, SAREX, education, etc.) as well as AMSAT e-mail alias service (e.g. wd4asw@amsat.org) and ftp from servers owned by University of California, San Diego to a commercially provided server system in Michigan.

The relocation was done in order to remove ourselves from a university system that has restrictions on the kinds of content that AMSAT may wish to offer in the future as well as take advantage of capabilities that are not available through UCSD.

We believe that the transition went smoothly, but if it turns out that you're finding problems with your mail alias, please let us know by contacting Joe Fitzgerald, KM1P (jfitzgerald@alum.wpi.edu).

Overall, a number of system changes have taken place:

By the time this issue of the *AMSAT Journal* is delivered, full migration to the AMSAT site in Michigan will be completed and AMSAT will no longer be on the UCSD site.

- Pass Prediction page is now running on our site with updated graphics and links.
- Pass Prediction page now automatically adds new satellites.
- ARISS operations support pages were transferred to the new site.
- The server has withstood "hacker" attacks well and security is being further improved to minimize performance issues.

Our thanks to Joe and his team for dealing with what turned out to be a complex issue while maintaining our other services during the transition. Charlie Sulfana, AJ9N worked through the ARISS Ops Support changeover with Joe to keep the ARISS material up to date. And thanks to Paul Williamson, KB5MU and Brian Kantor, WB6CYT for their many years of service managing AMSAT's internet presence from UCSD as well as their support of Joe's team during the transition.

Joe sent out an e-mail commenting, "I can't say enough good things about Paul and Brian. They have been extremely responsive to my requests, and have coached me through the transition. The smoothness of the change is due to their efforts, the glitches were mine!"

ARRL Centennial Convention

AMSAT will be fully participating in the 2014 Centennial Convention taking place this July in Hartford, CT. On Thursday, 17 JUL there will be all day "Training Tracks" sessions covering a number of subjects. AMSAT will be providing a "Satellite Workshop" led by E Mike McCardel, KC8YLD with a team of presenters:

- Barry Baines, WD4ASW (Amateur Satellite Background/History)
- Joe Spier, K6WAO (Orbital Mechanics)
- E. Mike McCardel, KC8YLD (Satellite Prediction Software)
- Peter Portanova, W2JV (FM Satellites)
- Patrick Stoddard, WD9EWK (Analog Satellites + telemetry)
- Burns Fisher, W2BFJ (Fox-1 Engineering)

If someone you know would like to be "totally immersed" into an all day program that will provide you with the basics of working the satellites, then encourage this person to register for this program. The course outline and registration may be found on the Centennial website:

http://www.arrl.org/centennial

Select "National Centennial Convention" and then select the "Training Tracks" link Indeed, if you would like to benefit from this training, then sign up yourself!

Save the Date

The 32nd AMSAT Space Symposium will take place the weekend of October 10-12, 2014 (Columbus Day weekend). We will also be celebrating AMSAT's 45th Anniversary. It will be held at the Doubletree Inn by Hilton Baltimore-BWI Hotel. An AMSAT block of rooms @ $99.00/night is available (AMSAT Code: RAS) with free parking and free WiFi. Breakfast buffet coupons priced at $10.00 each are also available.

More details about Symposium will be released in the next few months, including tours of areas of interest. If you're thinking about writing and presenting a paper at Symposium, now is the time to start considering your subject and organizing your thoughts!

AMSAT 32nd Space Symposium and Annual Meeting October 10-12, 2014 in Baltimore, Maryland

Come to the DoubleTree Hotel by Hilton at the BWI Airport to celebrate AMSAT's 45th anniversary.

- AMSAT Special Room Rate—$99.00 per night
- $10 Breakfast Buffet Coupons—Full Hot and Cold Breakfast
- FREE Parking
- FREE WiFi
- Free Airport and Close-in Transportation

The weekend event features:

- Board of Directors Meeting
- Meet and greet satellite operators from around the world
- Latest news and developments on Fox-1 and other satellites
- Expert demonstrations and presentations
- Special Guest Presentations
- Annual Banquet and prize drawing

For the latest Symposium information:

http://www.amsat.org
then select 'Events'

AMSAT Office Moves to New Quarters

Following 33 years of having an office in the same building in Silver Spring, MD, the AMSAT office reopened on Friday, May 2 at a new address in Kensington, MD. With a new address there are also new numbers:

Radio Amateur Satellite Corp. (AMSAT)
10605 Concord St. Suite 304
Kensington MD 20895-2526

Tel. (301) 822-4376
Fax. (301) 822-4371
Toll Free (888) 322-6728 (in US)

If you call the old Silver Spring phone number you will hear a message notifying them of the new number. The 888 toll-free number in the U.S. remains unchanged. Martha's e-mail address remains unchanged.

The AMSAT office was closed between April 25 and May 1 in order to provide focused attention on the relocation, packing and final preparations. The actual move took place on Tuesday afternoon, April 29 was timed so that movers could unload at the new location after 1700 EDT so as not to interfere with normal business activity at the new location.

Wednesday, April 30 and Thursday, May 1 were spent finalizing the furniture arrangement, unpacking, and setting up the office electronics (phones/ computers/ fax machine).

The AMSAT Office is just north of Washington, D.C. A - Old office 850 Sligo Ave., Silver Spring, MD. B - New Office 10605 Concord St., Kensington, MD

AMSAT Office for 33 years ... 850 Sligo Ave., Suite 600, Silver Spring, MD

New AMSAT Office as of May 1 ... 10605 Concord St., Suite 304, Kensington, MD

A special moving session occurred on April 19 to pack and move AMSAT's historical satellite development archives to Virginia Tech.

(right) Frank Bauer, KA3HDO and Perry Klein, W3PK loading archive files to move.

(bottom, left) Sharon McGwier, N1SMM unloading the moving van at Virginia Tech.

(bottom, right) Bob McGwier, N4HY with another load for the archives.

The deterioration of the current building has been discussed in the AMSAT Journal Apogee View. Martha and the rest of the office team have gone to great lengths to minimize disruptions under very trying, uncomfortable, and sometimes unsafe circumstances in the old office. Finally, the county authorities ordered the building closed.

Frank Bauer, KA3HDO prepares archive files for their move to Virginia Tech.

A view of the chaos at the old place before packing was completed.

Archives ready to go.

Another view of the old place just before the action began.

L-R: Dan Schultz, N8FGV; Martha; Sharon McGwier, N1SMM; Bob McGwier, N4HY; Tom Clark, K3IO at the old office.

AMSAT is in Suite 304.

The new view out of the office is green trees instead of power lines and traffic.

AMSAT Washington-MD Area Coordinator Pat Kilroy, N8PK visited Martha at the new office.

Martha in the new office. She says everything in the building works and she can spend time taking care of AMSAT members instead of trying to have the landlord keep the lights on, elevator working, heat turned on, clean the bathrooms, and take out the trash.

Thank you to all who helped us move!

- Barry Baines, WD4ASW
- Frank Bauer, KA3HDO
- Bob Carpenter, W3OTC
- Tom Clark, K3IO
- Perry Klein, W3PK
- Sharon McGwier, N1SMM
- Bob McGwier, N4HY
- Martha Saragovitz
- Barbara Saragovitz
- John Shew, N4QQ
- Dan Shultz, N8FGV
- Fay Symons
- Joseph Xavier

Peter Portanova, W2JV
PeteW2JV@verizon.net

Ham Radio University was conceived by Phil Lewis, N2MUN who fifteen years ago determined that the Tri-State area did not have a venue that was singularly dedicated to amateur radio education. His idea was to bring interesting subjects and current activities that was stimulating new experimentation in the form of forums presented by subject matter experts. HRU 2014 was located at Briarcliffe College in Bethpage, NY where amateur radio operators and others were treated to twenty-eight forums.

Topics included World Radiosport Team Championship, antique radios, Linux and ham radio, emergency power and, of course amateur satellites. The day also included VE sessions as well as workshops on topics such as antenna modelling and building, as well as on soldering to connectors.

The hands-on workshops proved to be very well attended and will be expanded for 2015. Our guest speaker for 2014 was Mike Lisenco, Hudson Division Director who spoke about the current issues that the ARRL are working on and the ARRL Centennial Convention. A popular destination for those not attending the forums was the club room where local clubs discussed their activities. As well, there were interesting setups featuring antique radios, kit-building, and the AMSAT table.

This year I brought my Yaesu FT-817 transceiver with an on board panadapter, that Mike Seguin, N1JEZ designed and was built by Ed, KD2ADC. I used the FT-817 as a portable satellite station for the linear activity. It's interesting to see the Doppler effect as viewed on the panadapter, which always gets a reaction from a group. I also brought my newly built FOX-1 model, available thru the AMSAT store. Typical comments were, "I didn't think a satellite was that small and you could actually fit a transponder circuit on board"!

I have been involved with Ham Radio University for many years and enjoy making my amateur satellite presentation to a large room of hams and others thinking about joining our hobby. It was a special thrill for me, this year, to see the expressions on the audience faces when I showed them the wonderful detail the FOX-1 model.

I look forward to making my satellite presentation at the ARRL Centennial, and being part of the AMSAT forums. This is an event you should not miss, unless you plan on attending the next Centennial.

The Fox-1 CubeSat Model is available in the AMSAT Store: http://store.amsat.org/catalog/

Pete, W2JV provided hands-on satellite operating and equipment demonstrations at Ham Radio University 2014 held at Briarcliffe College in Bethpage, NY. (Photo by Adele Portanova, KD2CYL)

Pete, W2JV (ex-WB2OQQ) with his newly built FOX-1 model, available thru the AMSAT store, typical comments were, "I didn't think a satellite was that small and you could actually fit a transponder circuit on board"! (Photo by Photo by Adele Portanova, KD2CYL)

AMSAT at the Greater Houston Hamfest

Allen F. Mattis N5AFV, n5afv@amsat.org, and Andy MacAllister, W5ACM, w5acm@amsat.org

AMSAT was represented again this year at the Greater Houston Hamfest (GHH) held March 22, 2014, at the Fort Bend County Fairgrounds in Rosenberg, Texas, southwest of Houston. The GHH is the second largest, and fastest-growing, hamfest in Texas with approximately 1,000 attendees. This year the GHH hosted the American Radio Relay League (ARRL) South Texas Section Convention. Keynote speakers were Bob Allison, WB1GCM, ARRL Senior Test Engineer, and Joe Eisenberg, K0NEB, editor of the CQ Magazine "Kit Building" column. Six additional speakers, including Federal Communication Commission Resident Agent Stephen Lee from the Houston FCC office, also made presentations.

The GHH had 18,000 square feet of indoor exhibit space with 215 tables for vendors and individuals, a large tailgate area with early buyer access before the main hall opened, an adjacent RV camping area with 36 spaces, VE test sessions where 15 examinations were administered, a fox hunt, a special event station, an equipment test table, a Kid's Corner, and ARRL QSL card checking for DXCC, VUCC and WAS awards.

The AMSAT booth was manned by Carl Kotila, WD5JRD, along with assistance from Andy MacAllister, W5ACM, and Allen Mattis, N5AFV. Satellite demonstrations were conducted by Andy, W5ACM, and Allen, N5AFV, assisted by George Carr, WA5KBH, and Jack Wilson, KF5LOQ. The weather was perfect for outdoor satellite demonstrations, and a good crowd was ready for two passes of Fuji-OSCAR-29 and Saudi-OSCAR-50, which were nearly overhead. There was a lot of excitement when they heard Hector Martinez, CO6CBF, work our Brazos Valley Amateur Radio Club (BVARC) station KK5W on both satellites.

The BVARC, the organizer of the hamfest, gave away six raffle prizes. The main raffle prize was an Icom IC-7100 mobile HF/VHF/UHF transceiver with separation kit and mounting bracket which was won by Steve Smothers, W9DX. Many favorable comments from attendees regarding the AMSAT activities were received by the event managers.

Andy, W5ACM, and Carl, WD5JRD, Putting Final Touches on AMSAT Booth (Photograph by N5AFV)

Andy, W5ACM, Operating FO-29 Satellite Demonstration (Photograph courtesy of W5ACM)

Allen, N5AFV, Tracking FO-29 with Arrow Antenna (Photograph by Travis Burgess, K5HTB)

Dr. Michael Butler, PhD, G4OCR
g4ocr@amsat.org

My experiences as a student receiving the downlink signal from the UOSAT OSCAR-9 satellite in 1983 at age 16 began my on-going interest in amateur radio in space over the years. My letter to the University of Surrey (see right) was originally published by AMSAT-UK in early 1984. My story also has a mid-point in September 2001 when Maarten Meerman (Principal Engineer at that time) was extraordinarily generous with his time in giving me an individual guided tour of the facilities at Surrey Satellite Technology Ltd.

I am currently writing an article provisionally titled "Participation in the ARISS Project on a $500 Budget" planned to be published in an upcoming issue of the AMSAT Journal. My article discusses aspects of the interplay between space exploration and school and college education, via amateur radio. It explores the incredible things that are possible for surprisingly little financial outlay.

The article brings full circle something that begin for me way back in 1983. In addition to my letter I have saved the UOSAT OSCAR-9 QSL card and Dr. Meerman's business card commemorating our visit. (shown below).

Watch for my article and see how you might inspire a student today!

Dear Sir,

Concerning the UOSAT Spacecraft Educational Project. I write to you, on behalf of my school, South Wolds Comprehensive School, Keyworth, where we have recently begun a series of experiments in order to receive data from the UOSAT spacecraft. I understand that you are anxious to receive correspondence from Schools becoming involved with this project, and so I am writing to outline our progress so far.

Much useful information has been obtained from the booklet *UOSAT: a Guide to its Capabilities, Operation and Usage,* which was received from the University of Surrey by the school. From the design on p.30 of the above-mentioned publication, we built a crossed dipole antenna in order to receive the circular polarisation 144MHz transmissions from the satellite. This was constructed in the school workshops, and it was arranged to place this antenna on the roof of the school science buildings. This is giving reasonable signals from UOSAT, but some experimentation with the position of the antenna may still need to be attempted. The receiver in use is the Trio TR-2300, and the antenna down-lead is about 10m. of UR43 cable.

To receive the afsk ASCII data, a decoder unit to the specifications on p.44 of the above-mentioned publication was constructed. This was completed in the school labs during my lunchtimes and spare time, and tested and set up using an audio signal generator and oscilloscope. All appeared to be well, so we went ahead with the interfacing of the decoder to the computer. The decoder was connected to the input of the serial port of the BBC Microcomputer in use in the school. The setting up commands were as follows:-

```
MODE 0
*FX7,4    - set baud rate to 1200
*FX2,1    - switch input to serial port
```

This allowed data from the decoder at 1200 baud to be inputted at the serial port, and immediately displayed on the VDU. In practice however, poor signals from the satellite resulted in much of the data being lost. However, with some patience and careful setting-up of the decoder fair results were obtained. With a tape of the satellite recorded at my own home, a yield of about 75% of good data was obtained.

We can therefore conclude that our system is working, and that with some refinement, we should be ready to receive data from the satellite on a regular basis.

To aid us in our experiments, I would be grateful for any information with which you can supply us. In particular, any orbital predictions available and schedules for the operation of the various onboard experiments would be very helpful indeed.

Our project has only been running for about half a term so far. Broadly our objectives for next term are:-

1) to improve and refine our system until data can be received regularly in usable quantities;

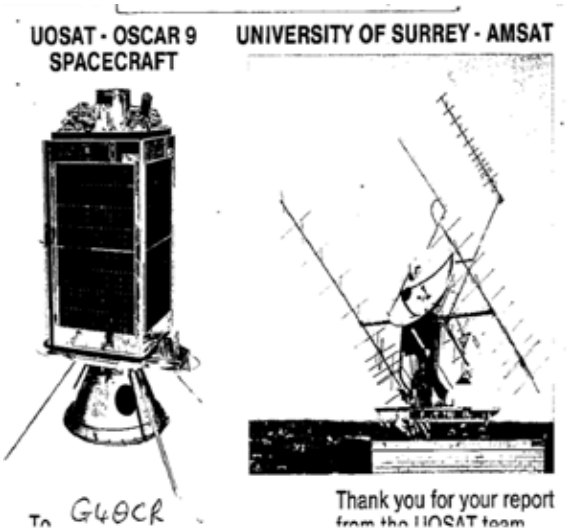
2) to allow more people at the school to become involved with the project;

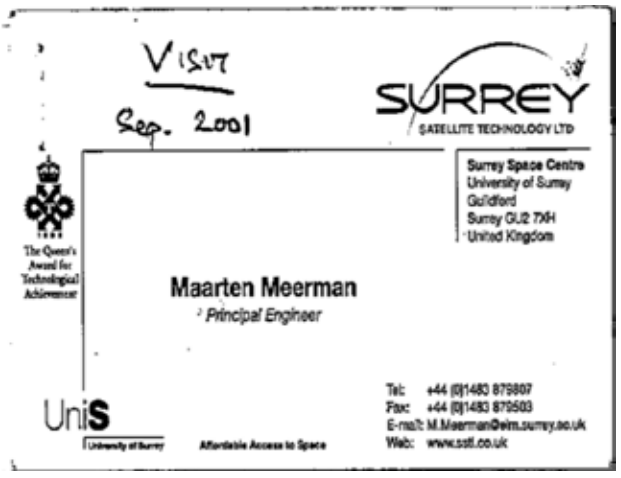
3) to initiate some discussion on the interpretation of the data received.

I would like to add that I am a regular listener to your 3.5MHz Sunday morning net, and that I have been following the UOSAT project since before the launch of the satellite.

I thank you in advance for your help, and look forward to hearing from you in due course.

M.Butler, G4OCR, School Sixth-former, Nottingham, NG12 5JN
27th December, 1983





Japan Launches SSTV Amateur Radio Satellite

The SPROUT amateur radio satellite (Space Research On Unique Technology), built by students from Nihon University, was launched on May 24, 2014 from Japan's from the Tanegashima Space Center. It accompanied Japan's ALOS-2 Synthetic Aperture Radar satellite into a 654 km orbit.

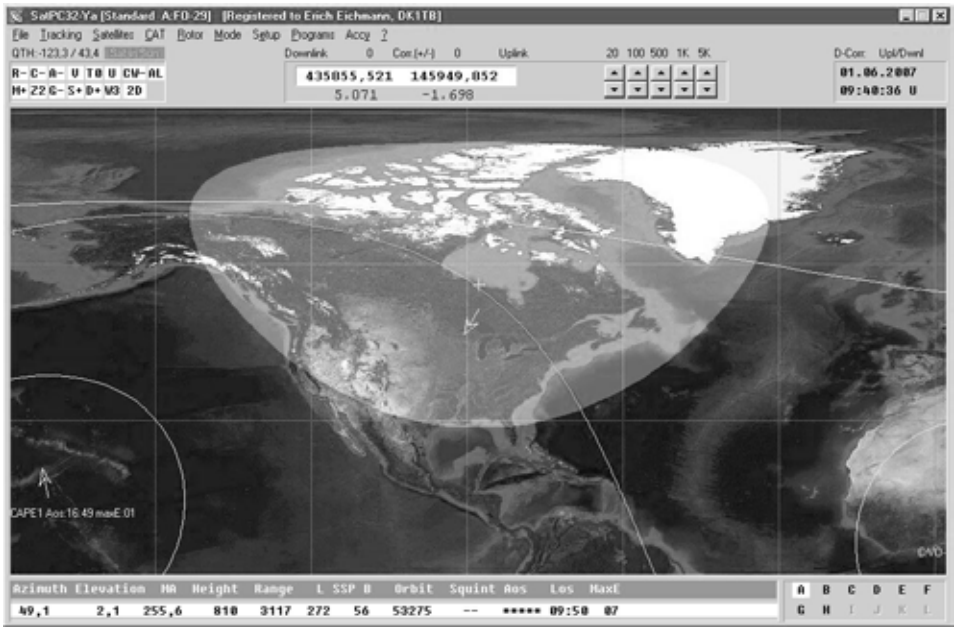
- FM Digitalker that will enable the satellite to speak to amateurs around the world.
- Voice Message Box that will record transmissions from radio amateurs and play them back.
- AX.25 1200 bps Packet radio Digipeater with Text Message Box function.
- Pre-loaded images from the Message Gallery will be transmitted using FM Slow Scan TV (SSTV).
- Photos of the Earth will be transmitted by SSTV
- SSTV images can be received and displayed using free software such as MMSSTV.

SPROUT JQ1ZJQ	
Frequency (MHz)	Mode
437.525	CW downlink
437.525	FM packet downlink; 1200bps AFSK, 9600bps GMSK
437.600	Digipeater uplink
437.600	Digitalker downlink
437.600	SSTV downlink

SPROUT websites

http://sat.aero.cst.nihon-u.ac.jp/sprout-e/

http://amsat-uk.org/2014/05/21/sprout-amateur-radio-slow-scan-tv-satellite/



The FUNcube Dongle and SDR Software School Experiments at UCF in Cuba

Hector Martinez, CO6CBF/KF5YXV
co6cbf@amsat.org

I presented a paper and an accompanying power point presentation at the 2013 AMSAT Space Symposium in Houston. In it, I described my personal experience introducing amateur satellite operation at the University of Cienfuegos, located in Cienfuegos, Cuba. For my introduction, I ran two marvelous pieces of engineering: a FUNcube Dongle and an SDR - Radio Console.

Sometimes, we don't have the most most suitable instruments in our school laboratories for measurement and testing. I have found that SDR receivers and satellites have the potential to be used to demonstrate theoretical concepts in engineering, physics and mathematics classrooms. In fact, they have done so very well here in our university!

Late last year, I had the highest honor of attending the 30th Annual Space Symposium in Orlando, Florida. Honestly, AMSAT Symposiums have been one of the most exciting times in my life and of course, an outstanding source of knowledge. Thanks again to everybody who have made my trips possible, in particular, the AMSAT Board of Directors; Patrick Stoddard, WD9EWK, and Clayton Coleman, W5PFG. I never will forget it!

During my trip, I received a lot of donations to improve my satellite station. I became a proud owner of one of the earlier versions of the FUNcube Dongle [1]. I believe it is the only FUNcube Dongle in my country! Thanks again to all my friends who generously donated equipment to improve my station! This has greatly improved amateur satellite operation for me.

My first configuration with the Dongle included running HDSDR software version 2.15; it needed an additional ExtIO file but it wasn't difficult to find on the web [2]. It was my first time playing with an SDR receiver and I was amazed. I tried all the settings, receiving the 2 meter local repeater (145.130 MHz), and after that I looked for HO-68 `s beacon. These initial tests demonstrated the excellent performance of this small receiver.

Drew Glasbrenner, KO4MA, told me that he had heard good things about the SDR-Console software [3] when used with the FUNcube Dongle. The file for it was 31.2 MB which is difficult to download due to my limited Internet bandwidth. I asked for a bit of help at the university and I got it.

Hector, CO6CBF (front row, right) with students and professors at the University of Cienfuegos after a successful experiment measuring Doppler shift using HO-68

(left to right) Hector Martinez, CO6CBF, Patrick Stoddard, WD9EWK, and Howard Long, G6LVB at the 2012 AMSAT Symposium in Orlando. Howard presented a FUNcube Dongle to Hector which he describes his experiences in this article.

My second configuration with the Dongle was running SDR-Console version 1.5. What a great combination! This demonstrated that the software is just as important as the hardware we choose to get good performance from an SDR radio system. The SDR-Console is not only an advanced solution for the FUNcube Dongles but it also included a lot of very interesting features.

It is being continually revised with new features added on a regular basis. For FUNcube Dongle owners the console offers almost everything you need in one package:

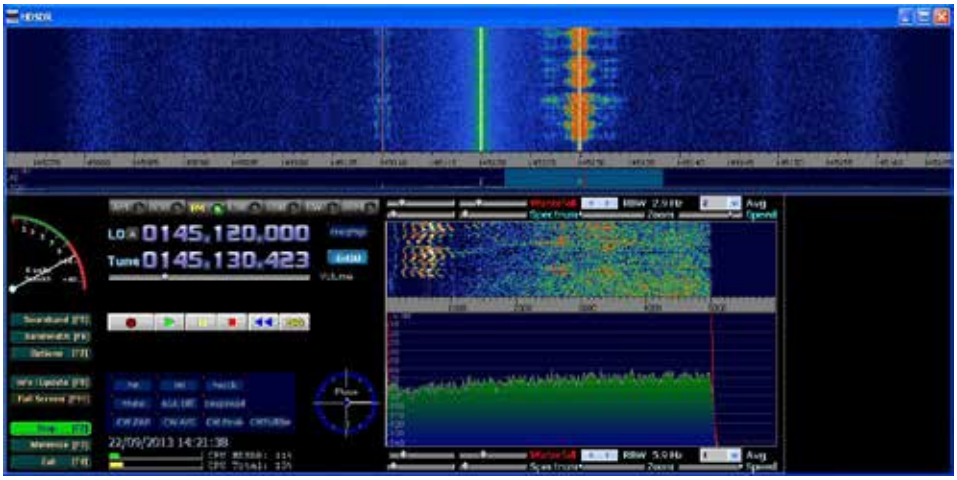
- No license is required.
- Satellite support including tracking, doppler correction, and a NOAA weather image viewer.

- Full range of modes, filters and other DSP options.
- Recorder automatically starts when the currently selected satellite is visible (AOS) and ends when it is no longer visible (LOS).
- It can record the raw IQ (in-phase and quadrature modulator) data returned from the SDR radio or soundcard in a sequence of WAV files and the IQ WAV files can be played back to analyze received signals.
- The waterfall displays nearly all of the transponder passband and all contacts in progress.
- The console supports remote connections via network with a very narrow bandwidth.
- It can send the IQ data to other programs. It is very useful to decode digital modes like JT65.
- You can make a Panadapter for non-SDR transceivers like FT-817 using FUNcube Dongles and the Console [4]; you can adjust the offsets simply entering the frequency difference and selecting up or down-converter..
- You can combine the Console and FUNcube Dongles with others radios to operate fully automatic, full-duplex, control on the satellites.

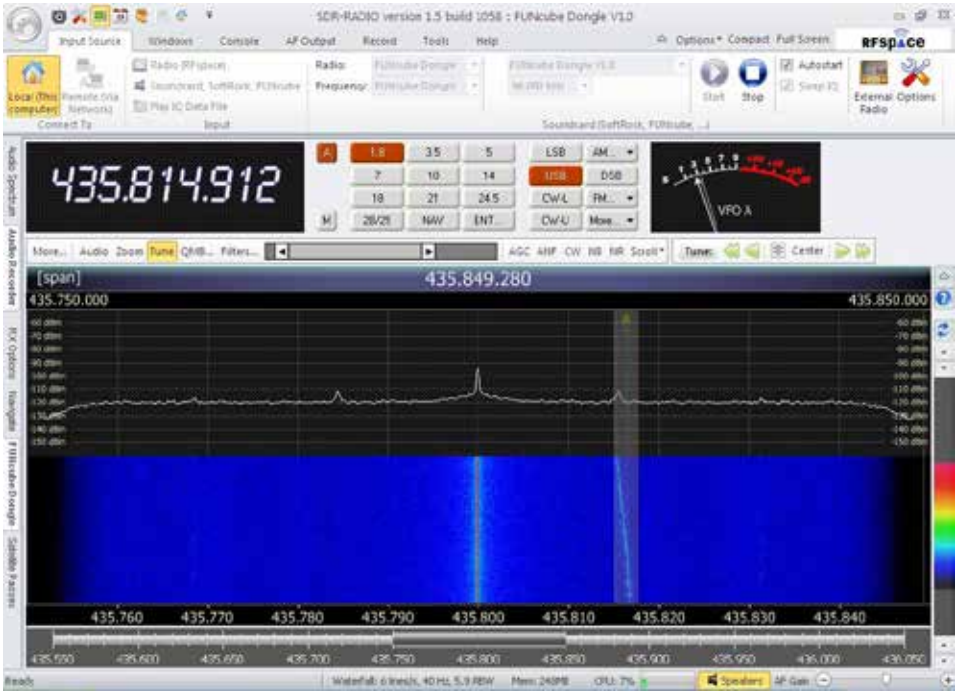
I had made some satellite presentations in my university. Even when operating with my homebrewed and primitive setup, I attracted some enthusiasts. One is already licensed and many others are getting to pass their license exam.

I was invited to speak about ham radio and satellites when my university celebrated "Science Day" on January 15, 2013. During my presentation, I made some contacts on FO-29. We listened for some beacons and collected telemetry frames. It was my first presentation with my new gear and the Dongle caught all the attention. There were a lot of excited students. The physics teachers loved to see the Doppler shift on the waterfall and the IQ analysis facilities!

The SDR Console software allows an advanced analysis of all signals received in the 96 kHz Dongle's bandwidth. When combined together, you can record all the bandwidth as an IQ recording and play it back later at any time on any computer. It results in a very advanced instrument



Hector's initial testing demonstrated receiving a local 2 meter repeater using the FUNcube Dongle and HDSDR software.



Hector's second configuration using the FUNcube Dongle and SDR-Console software.

to support studies of physics phenomena. My teachers and I chatted for a long time about how motivating and encouraging this kind of experiment could be for students. We found we needed to figure out how implement in the practical class curriculum.

I found a solution a few weeks later. A requirement for completing my college degree was a final class project in which I reported on the results of my investigations. One of my final projects was for a class named "Methodology of Knowledge". I found a way to present my research showing the methods of practical experiments for engineering students. I had hardware, software, motivation and standard procedures to develop this project. My goal was to demonstrate how students could use the SDR receiver in real time from their laboratories using the hardware and software already installed and accessed on the university network. I installed the SDR - Console software in my office computer at the university. I recruited fellow students to test my remote receiver over the network. While we listened to a local 2 meter repeater we added computers on the network. We found the limited bandwidth of our network limited the number of users.

Hector demonstrating amateur satellite operating to professors and students on the campus at the University of Cienfuegos in Cuba.

The university satellite station

Hector receiving the ARISS contact to feed into the multi-user access experiment using SDR-Console and the university network as described in the article.

Even while using lower values for FFT size, resolution and maximum lines/second in the SDR Server; more than three users connected turned the system unstable.

I told Mark Hammond, N8MH, about my project. Mark suggested I update the SDR - Console to the new 2.0 version. I did so and it definitely worked better. It allows nine users to be connected with a decent audio quality. It looks like this new version is more compatible with a limited bandwidth network.

Our first attempt with satellites involved receiving an ARISS contact. As we didn't have satellite antennas installed at the technology office, I was outside tracking the ISS with an ELK antenna and a ThinkPad laptop connected to the university`s network. My teachers and fellow students were successfully connected remotely from the laboratory. Success!

On August 30th, 2013 Version 2.1, build 1494 (Beta) of the SDR-Console was released. Once again, I received support from the university to download the large file. Version 2.1 has some very interesting features added. I was fascinated with the clean user interface, which had no unnecessary features. It had all we need for a full satellite operation with some earlier issues fixed.

After my first attempts with the new version of the software and my FUNcube Dongle, I noted an issue in the console frequency correction. The +/- 500 ppm range was not enough to correct the frequency shift on the receiver. The real frequency was around 8 KHz away from frequency shown on the waterfall. My Dongle is one of the earlier versions; I supposed it could be the problem. I contacted Simon Brown (the SDR - Console creator) and he fixed it quickly. SDR - Console is not only amazing SDR software but it also has a great support. On September 18th, 2013; just a few weeks from the latest update, a new kit (build 1513) was released.

We are making plans to construct better satellite antennas. Meanwhile, we operate using homebrew omni-directional antennas with homebrew preamplifiers. The university's instructors request I turn on the system to listen for ARISS contacts and listen for other satellites. Our dream is an ARISS contact!

The FUNcube Dongle makes a very nice satellite receiver with the SDR – Radio

program. Needless to say, that is a perfect combination for satellite reception and an outstanding tool to inspire future generations. The state-of-the-art performance and visual display support our curriculum by making complex theories interesting and easy to understand. It is just incredible that a 150 kHz to 240 MHz and 420 MHz to 1.9 GHz all-mode receiver fits in the palm of your hand [5]. Thanks to Howard and Simon for this amazing combination!

My university project has not only made complex theories interesting and easy to understand for students but has also motivated other amateur radio operators to turn their gaze skyward. The Cuban Satellite Group (GROS) has been working very hard to promote amateur radio satellites in our country [6]. We have seen how hard is to accomplish things in space and the amazing job AMSAT has accomplished since its founding. We appreciate AMSAT's efforts to keep amateur radio in space. We would like to help AMSAT with our small seed, but unfortunately we don't have funds for donations. ITAR restrictions remain a barrier to expanding technical education outreach. So, right now our only way to help AMSAT is promoting Ham radio by satellite and encouraging other operators to join us.

FOX-1 will be an enjoyable satellite for Cuban operators and a great tool to encourage new satellite enthusiasts. Unlike 70 cm radios, almost every Cuban Ham has a 2 meter FM handy talky. So, everybody will be able at least to listen for FOX-1! We look forward to its successful mission!

Web Page References

[1] http://www.funcubedongle.com/

[2] http://www.hdsdr.de/

[3] http://v2.sdr-radio.com/ -and- http://www.dit-dit-dit.com/Blog/tabid/88/post/funcube-dongle-pro-plus/Default.aspx

[4] http://www.w1ghz.org/small_proj/small_proj.htm

[5]http://www.funcubedongle.com/?page_id=1201

[6] http://www.frcuba.co.cu/index.php?option=com_myjspace&view=see&pagename=GROS&Itemid=100278

(left to right) Felix, CM6FTV; Lazaro, CO6TW; and Hector, CO6CBF at the 2013 AMSAT Field Day.

Successful Southern California DM12 Satellite Operation

(L to R) Laura and Larry (WA6DIR) Steinhauer and Allen (N5AFV) and Anita Mattis

A successful 3-day satellite operation from grid square DM13 took place March 14-16, 2014. Allen Mattis, N5AFV, and his wife were attending a wedding in Dana Point, California and the wedding provided an opportunity to operate satellite passes from DM13. Tom Simpson, N6NUG, frequently operates on the satellites from DM12, and Larry Steinhauer, WA6DIR, frequently operates from DM14, but DM13 is seldom active on the satellites.

Equipment used by N5AFV consisted of an Icom W32A HT with an AL800 telescoping antenna. Four SO-50 passes were worked and 14 contacts were made.

QSL information is to N5AFV as shown on QRZ.com.

The highlight of the operation took place on Sunday, March 12, 2014. A contact was made with Larry, WA6DIR, on a morning pass of SO-50 and approximately 4 hours later Larry and his wife, Laura, arrived at Dana Point for a visit. After having made 411 satellite contacts with each other over a 13-year period, N5AFV and WA6DIR finally met in person.

The FOX-1 IHU and Telemetry Simulator - or - Making Good Use of Cheap Evaluation Boards

Burns Fisher, W2BFJ
burns@fisher.cc

This paper describes a printed circuit board initially designed by the author to eliminate some of the error-prone and clutter-prone jumper and breadboard hardware arrangements that the Fox-1 software team was becoming increasingly dependent on. The initial idea was to provide a motherboard which would provide a place to plug in a processor evaluation board as well some of the most important components that were to be on a real Fox-1 IHU (Internal Housekeeping Unit) board. As time went on, though, circumstances dictated that the board should turn into more of a general purpose IHU simulator.

While the board described in this paper is specific to the Fox-1 satellite, the technique is quite general. Manufacturers provide inexpensive evaluation boards for many kinds of processors and other components. These evaluation boards can be incorporated into a project using this motherboard technique with much less design, expense, and surface-mount soldering expertise than would otherwise be required.

Some of this paper may be more interesting to those who have had little experience in designing and building printed circuit boards (which was me before this project!) than to those who are already experts.

Figure 1: STM32L1xx Discovery Board

Genesis of the IHU Simulator The Software Development Board

The Fox-1 IHU will be built around an STM32L151 microprocessor control unit (MCU), which consists of an ARM Cortex M3 CPU core, flash program memory, RAM, A/D and D/A converters, SPI, I2C, and USB bus controllers, serial ports, and a number of general-purpose I/O pins. The Fox-1 software team, of which the author is a member, started developing the basic software framework on an STM32L1xx Discovery board. This $15 board, in addition to an MCU, holds a crystal oscillator clock, a USB-based means of programming and debugging, a power converter from the +5V USB input to +3V, some LEDs, some buttons, and importantly, 56 header pins to allow access to many of the processor pins as well as the +3V regulator output. The Discovery board's low cost made it possible for each software developer to have a processor to work on locally.

It was not long before we started to make connections to the Discovery header pins with jumper wires and to connect additional components on the jumpers. The first was a set of jumpers from the processor's CMOS serial port to a level-converter and then to a computer's RS-232 serial port so that we could get text into and out of the system. As we started writing drivers, we needed to connect an SPI-bus memory peripheral (the F-RAM), thermal sensors and audio input/output for the A/D and D/A converters, and I2C bus peripherals. We built up quite a rat's nest of fairly fragile wiring, Radio Shack solderless breadboards and components (Figure 2). We ended up spending some of our development time debugging wires that had fallen off or broken. Probably worse, each developer had a different and inconsistent setup reflecting the drivers or other modules that he was working on.

The straw that broke the camel's back for me was the need to connect two Discovery boards with an I2C bus. Bill Reed, NX5R, had such a setup for developing the I2C drivers, and would soon need more components. Mike McCann, KB2GHZ, and Jonathan Brandenburg, KF5IDY, were also getting more and more complex setups. I started thinking about an easy way to connect up everything quickly and neatly and with less pin counting. My first thought was ribbon cables that could plug into the two 28-pin headers on the Discovery board, but what about the other end? Eventually I came up with the idea of building a motherboard with sockets for the headers on two Discovery boards, an F-RAM chip, and maybe an RS232 level converter. I called this the "Fox-1 software development board" but the name was about all that I achieved this time. It went on the back burner as other projects and Fox software components intervened.

Necessity is the Mother of the Motherboard

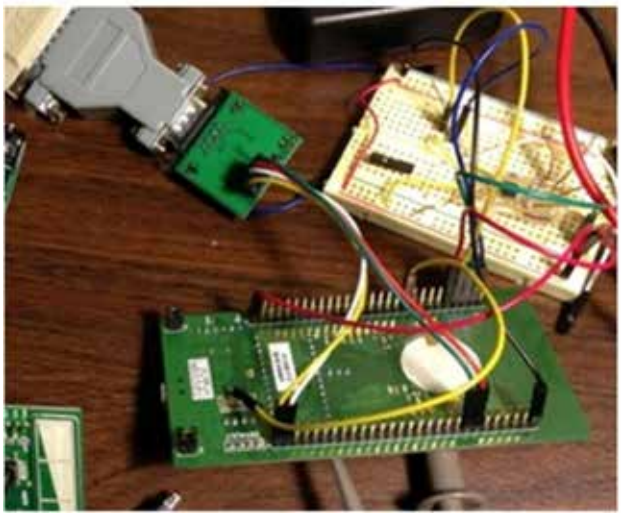
Aside from the rat's nest problem, things were going pretty well for the software team in May 2013. We had the first actual prototype IHU card, Version 1, Serial Number 1, designed and built by Bdale Garbee, KB0G. This IHU card ran the software very well, and we displayed it transmitting a voice ID at Hamvention. In addition, the promise of more of these boards arriving reduced the need for the software development board.

But then disaster struck: The Black Forest Fire of 2013 burned thousands of acres in Colorado and consumed over 500 homes, including KB0G's. The human consequences of this disaster are terrible (at least two lives lost, thousands of people affected for years to come). While the most serious toll of the fire was human, one small consequence was that all the un-built Fox-1 IHU Version 1 (V1) boards along with the components that would have been used to build them were lost. Suddenly the software development board seemed to be back on the table.

The IHU Simulator Is Born

We already had some white-wire Engineering Change Orders (ECOs) on IHU V1 and additional design changes affecting the IHU were coming. Fox-1 chief engineer Tony Monteiro, AA2TX (SK), hoped to avoid the expense of a V3. That implied no additional IHU prototypes for a while. This lack of boards would cause some issues not only for the software team but also for integration testing as other Fox-1 prototype boards appeared. The answer appeared when AA2TX described to me a breakout board that was being designed for the Fox-1 satellite bus (Figure 3). The breakout board has two headers set up to allow test points on the satellite bus, along with satellite bus con-

nectors on either side. These connectors allowed other Fox-1 boards to be stacked on the breakout and signals accessed for testing. It occurred to me that I could build the software development board with headers that matched the breakout board, and connect them with ribbon cables. Even better, I could assign many of the processor pins to their correct satellite bus pins and be able to test parts of the integrated satellite before the real IHU appeared. Voila! An IHU simulator!

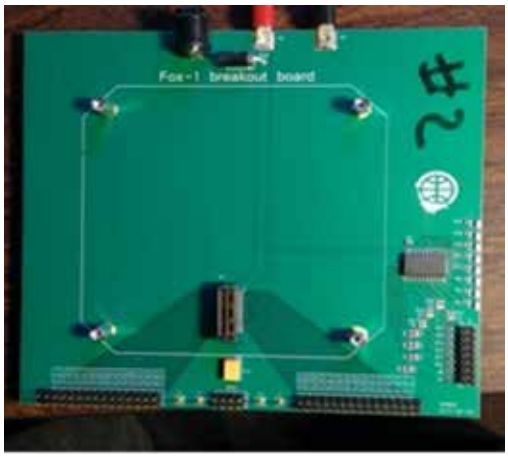


(left) Figure 2: The original rat's nest of wires which inspired the development of the IHU Simulator board.

Designing The IHU Simulator

The Requirements

The original Fox-1 design called for STM32L151 processors on the PSU and battery boards as well as on the IHU. To code and test interactions between pairs of processors, I started with the idea of designing room for two Discovery cards with an I2C bus connecting them. In other words, we would partially simulate a PSU or a battery card as well as the IHU. The simulator would also contain an F-RAM chip and connectors for a ribbon cable. Furthermore, I wanted to be able to power the board either from the same wall transformer that powers the Fox breakout board, or from connecting the USB programming cable to a Discovery board. And what the heck, I might as well put a USB connector on the simulator to act as the Fox umbilical and allow the board to be powered from that USB plug as well. This led to a number of jumpers and a diode to define where the +5 V power was coming from (only 1 source at a time!). The +3 V required by other components comes from the Discovery board itself (remember it has a power converter built in).



(right) Figure 3: Fox-1 bus breakout board

For data busses, the simulator needed to provide pull-up resistors for the I2C bus and to connect I2C to the satellite bus and to the two Discovery boards. The F-RAM on the board is a slave on the SPI bus.

Some other requirements involved debugging. I included 8 LEDs and many ground and +3 V pins, all of which can be jumpered to satellite bus pins or Discovery pins. These allowed us to visually check logic signals (for example 'transmitter on') or to manually connect logic levels to sensors (for example 'receive antenna deployed'). I also designed in a couple of potentiometers which would produce a variable voltage input for the Discovery analog-to-digital converters. It turns out that we hadn't yet built any boards with pots installed.

One requirement was removed by NX5R's fortuitous find of a cable with a USB plug on one end, a serial port simulator built in, and female header pins with CMOS logic levels on the other end. (Search for "PL2303HX" on Amazon or EBay). This device completely removes the need for a CMOS/RS232 level converter. It looks like a USB serial port to the computer, and we can connect it directly to header pins on the simulator board (taping up the red +5 V wire).

The last requirement came late. The decision was made not to use an MCU to generate telemetry on the battery card, but rather an I2C-based analog-to-digital converter chip. This led me to design a location for two of these chips (along with address jumpers) and to extend the I2C bus so that programmers could work on the A/D chip before the battery card was available.

Tools

A recent technical article introduced me to a tool called ExpressPCB to design printed circuit boards. The author had made his own masks and etched his own board. Doing my own etching did not interest me, but the tool seemed worth a look. It turns out that there is a pair of tools, ExpressSCH and ExpressPCB, with which you can draw schematics, and then design a matching printed circuit board. You can also send the design over the Internet for the board to be built. The tools are available from ExpressPCB. ExpressSCH and ExpressPCB are free, and while they do a good job, they are limited.

See: http://expresspcb.com

A few more tools helped a great deal. You can print your schematic or PCB design, but you cannot produce a PDF file; that missing feature makes it harder to share your design or have it reviewed. CutePDF Writer is a great free tool that looks to Windows like a printer. You just print your design or schematic, and it turns into a PDF.

See: http://cutepdf.com

The "Express" tools come with a library of component templates, but of course, they never have exactly the one you want. There are many more available at the ExpressPCB Yahoo group. You do have to join the group (and get a Yahoo account) in order to download their library files, but all of these things are free.

Although the "Express" tools help you a bit to make sure the board is designed to match the schematic, that help is limited. It consists of matching the components on the PCB to those on the schematic and then highlighting the pins that are on the same net (i.e. need to be connected together). However an ExpressPCB Yahoo group member wrote a wonderful tool called xCheck (). This tool compares all the nets on the schematic to the traces on the PCB design and among other things, will tell you if there are missing or extra connections. It truly saved this board from being a total mess.

See: http://www.softpedia.com/get/Science-CAD/xCheck.shtml

And finally, although I am mainly a Linux user now, and these tools run on Windows, the free virtual machine monitor "Virtual Box" from Oracle enabled me to use my Linux machine running Windows in a virtual machine. You do need a Windows kit and license, though.

See: http://virtualbox.org

The Design

It is unnecessary to go through all the trials and tribulations of drawing the circuit diagram. Anyone else who has done this understands. However, a few mechanical hints may be useful.

First, ExpressPCB and ExpressSCH require that each device have numbered pins (no letters), although the pin numbers can be hidden on the schematic and the PCB silkscreen. Labels can also be added. For the Discovery board sockets, I hid ExpressSCH's notion of pin numbers and substituted as labels the names of the pins on the Discovery board, which in turn matched the names of the General Purpose I/O devices in the code (for example B2, C7, etc.). With a similar technique, I labeled the pins on the ribbon cable connectors to match the satellite bus pins that they would connect to. Thus I could use the Fox satellite bus and MCU definitions as the basis for a ribbon-to-Discovery connection definitions. Care is required to match the labels to the same pin number between ExpressSCH and ExpressPCB.

Next, ExpressPCB does not have any automatic routing software, nor could I find any 'add-on' software tools that could do this, so I had to do the routing myself. A general guideline for a two-sided board, which I found numerous references on the web, is to place the horizontal traces on one side and the vertical traces on the other side. (For a 4-layered board, do the same, but with power and ground on the other two layers.) I did use a two-layer board, and this technique worked very well! At first I tried to avoid vias (i. e. connections between layers), but they do not add cost with ExpressPCB, and I found no guideline that suggested avoiding them. After a while I stopped worrying and things got even easier.

As discussed earlier, ExpressPCB can read an ExpressSCH schematic, match up the components and give you an indication of which pins must be connected. For example, if you click on one pin, all the pins it should be connected to are highlighted. This feature is very worthwhile; it is worth the trouble of making sure that the component names and pin numbers all match between SCH and PCB. I went through each pin on each component and drew traces to make the connections. (A detailed copy of the schematic and printed circuit board layout is available from the author on request.

Something that I found surprising while doing the routing is that there is plenty of room to route a signal trace between two pins in a 0.1" connector. It was even easy to solder the pins without shorts in the final product! However, when there are several components close to each other, each with many pins (such as the Discovery board and the ribbon cable connector) you must leave extra room between components for all the signal lines that have to pass parallel to each other and between the components. I also reduced the size of vias from the default to allow traces to be a bit closer together in these tight spots. See the space between J1 and B1 at the top of the PCB layout on page 21.

I also used a ground plane on the bottom of the board. It may have been unnecessary at these low frequencies, but it seemed like a good idea. However, in places with many "wires" I ended up with ground plane sections that were cut off from the rest of the ground plane. That seemed bad, so I eliminated the ground plane in locations where there were many wires.

Components

Since I had no tools for and no experience with surface mount technology, I designed the boards with through-the-hole components wherever I could. This was no problem with resistors, capacitors, diodes, headers, and sockets. However, there were two components that are only available in surface mount: the F-RAM and the ADS7828 A/D converter. The F-RAM chip was actually large enough for me to solder with traditional techniques, although it was pretty much at the limit of my capability. The A/D chip was smaller and with twice as many pins. There was no way could I hand solder that. KB2GHZ came to the rescue by discovering a company called Proto Advantage which would solder surface-mount chips on a small adapter board with DIP pins on the bottom. These could be used in a socket or soldered through-the-hole (Figure 4). It was a great find!

See: http://www.protoadvantage.com

Check, Double Check, Triple Check

I cannot emphasize enough that you should recheck over and over even when you think you are done. I must have gone over the connections 5 or 10 times, and as you will see I still had a few bugs.

First I checked the labels on each Discovery pin to be sure that they matched the labels on the physical board. I checked the pin labels on the ribbon cable header to be sure that they matched the satellite bus labels on the breakout board. I checked the official ExpressXXX pin numbers between SCH and PCB to be sure that they matched the labels.

Next, I checked each line on my Discovery-to-satellite bus definitions to be sure that it matched the connections on the PCB design. Here is one time that hiding the pin numbers and using labels had me at a disadvantage. It is possible to print out all the connections (nets) with xCheck. However, they are listed by pin number, not by label. That is not very helpful for checking.

Another check is to select each pin and let ExpressPCB highlight all the other pins it should be connected to. Trace the connections to be sure that you have reached all the pins.

Finally, I used the xCheck tool, mentioned above. xCheck looks at all of the pins on all of the components in the schematic and figures out all the connections that should be made to them. Then it looks at the PCB and confirms that all the connections that it has found are made, that there are no connections made that it does not know about, and that all pins on all devices are connected. For that reason, it provides special schematic symbols to mark pins that you intend to leave unconnected. You can see the little "x" markings on unused pins in the partial schematic shown in Figure 6 on page 21. It also checks design rules. For example, are two traces too close to each other, or is something too close to the edge of the board? This is a fabulous tool! It found more problems than my entire set of manual checks put together. Again, the extra work of using the "no connection" symbols and making sure names match correctly is very worthwhile so that this tool works correctly and cleanly.

For each checking/fixing pass I made, I found a few more errors. On one of the first passes, I discovered that the two ribbon cable connectors were reversed top and bottom. On another pass, xCheck discovered that when I changed those cable connectors and rerouted the signals, I had managed to cross two traces on the same side of the board! (xCheck considered this to be connecting two nets together). xCheck also found a few traces that might have come close enough to connect to the right pin, but that connection was not explicit in the board description data. I don't know what would have happened during board manufacturing.

Finally the day came when I got through all my checks without finding any problems. I put everything aside, and came back a day or two later and checked again. (I probably found something else…)

Pulling the trigger

Finally, I decided that the time had come to ship

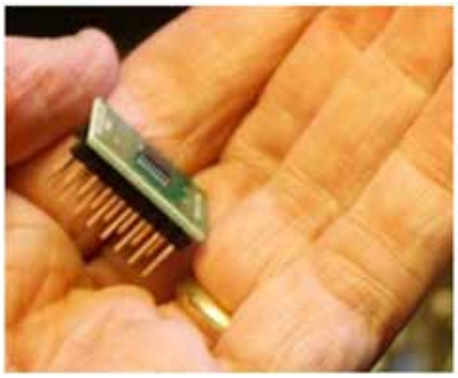


Figure 4: ADS7828 A/D converter mounted on adapter board.

my design off to ExpressPCB to have the boards built. I pushed the button on the app and got the usual series of questions. Except that these questions made a big difference in price!

Do you want silkscreen? You mean you have to pay extra for getting the board labeled? I had carefully drawn a lot of stuff that would help builders and users, but silkscreen was pretty expensive, so I backed off and changed some of the silkscreen to copper traces.

Do you want a solder mask? I thought this was the stencil that you use to put on solder paste for reflow soldering. I was not going to use that, so I said no. Luckily, I telephoned AA2TX for moral support, and he told me that the solder mask is the green solder-resistant film that covers the board except for where you are soldering, and keeps you from getting solder all over the place. He told me it would be really hard to solder without. Ok…I said yes to the solder mask. And that actually came together with the silkscreen, so I went back and removed my copper letters and numbers.

I finally completed everything, looked at the price and gulped, pushed the final button to send off the design, and waited.

The Finale

Hey la-day-la, my boards are back

The boards finally arrived by UPS about a week later. They were absolutely beautiful. The company had done a fantastic job! (Figure 5) In the meantime I had written a test plan of sorts (Make sure +5 V and ground are not shorted; make sure +5 V has the correct polarity; make sure +3 V gets to the F-RAM and ADS7828 in the correct polarity. Then test everything else.)

I soldered on a couple of the most critical components (all in accordance with my test plan, of course) and plugged in the power. Voila! It ran; it talked to the F-RAM; it talked to the serial port! Time to finish building serial number #1, and then build the rest!

Bugs, Solutions, and Lessons Learned

While installing the components, I found three design bugs. I just totally messed up and never noticed these problems despite all my checking. I found another bug later that was due to my misunderstanding the Fox bus specification. A few board ECOs were required later because of changes to the bus spec after the simulator was built. I'm going to detail the bugs since they have lessons to teach.

1. Hole sizes. Note to self: not all components have the same lead sizes! When I placed the holes for header pins, I simply edited the ribbon cable connectors (which had the spacing I required). The ribbon cable connector pads had holes of .029 ± .004, and the connectors fit properly. However, the header pin size was .025±.004. Notice the overlapping tolerances. The headers would not go into the hole. Usually, I could solve this by pressing the headers into the holes with pliers, but for headers with more than 2 or 3 pins, I needed to grind them down a bit. Not a disaster, but it took time, and I lost a few headers to excessive grinding.

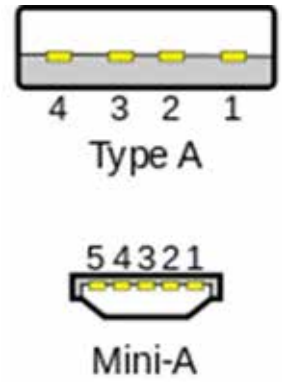
   Lesson: those mechanical specs that we often ignore for home projects can be really important!

2. Physical component sizes. The ExpressPCB component library was pretty good at showing the outlines of parts. However, the Proto Advantage 16-pin DIP adapter was not the size of an actual 16-pin DIP component. It was noticeably larger. Luckily, I had placed the two DIP pads far enough apart to fit. However, one of them was too close to the header that I had designed for making connections to it. For now, we are not using the header and the A/D chip that are too close together. If a second one is needed later, we could solder in some wires where the header was supposed to go. Again, not a disaster, but a reduction in functionality.

   Lesson: pay attention to outline dimensions too. Don't just assume that the library components are correct.

3. Read the diagram right. Try looking up the wiring diagram of a USB connector and you will find something like Figure 6.

You may have guessed the issue. Are we looking at the male or the female connector, and are we looking at the connector itself, or at the solder pins? I thought I knew. I thought I triple-checked.



But I was wrong. I had made mirror images of the connections to the USB connector. It was not fixable. I just filled the USB connector I had soldered on with hot-glue and never installed the rest.

Lesson: triple checking is not always good enough if you are checking against your own prejudices! Compare with a installation of a similar type known to be good. Use an ohmmeter. Invent your own technique!

I won't go through the other problems and fixes in any detail. They all involve having to connect a different Discovery pin to a different bus pin, and mostly picky errors, misunderstandings, or actual changes to the specification. Besides a soldering iron, an X-ACTO knife, some fine wire (I used #30 wire-wrap wire), and a bit of hot glue to hold

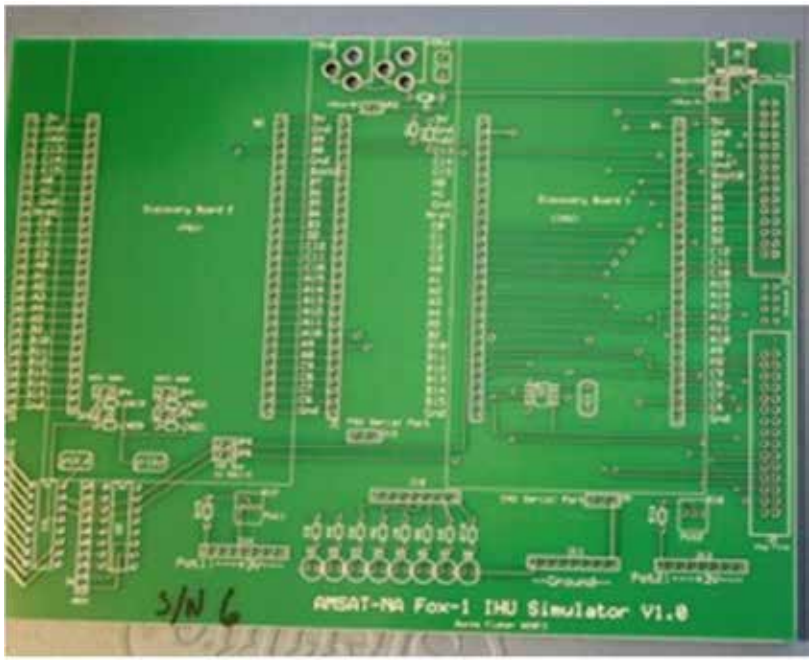


Figure 5: The Fox-1 IHU Development Board

it all together mechanically works wonders. The lesson to be learned here is simply that for a board of any complexity at all, you will have to do some modifications after the board is built. Don't kick yourself about it. Just expect it, sigh, and make the modifications.

Using The Simulator

I built the first board, KB2GHZ the second, and then I built the other four. We now have 6 simulator boards and 4 or more breakout boards (which connect the simulator to the satellite bus), as well as a number of prototype experiment and other satellite boards soon. Several of us are using the simulator standalone to give easy access to the A/D converter chip, and the F-RAM, as well as other signals and grounds and a couple of us are using them with breakout boards to work with other satellite boards. The worst bugs on the board have turned out to be not serious impediments to its use.

We have used the simulator board to debug software's interaction with battery and experiment boards (pair integration testing) and to a lesser extent the Tx and Rx cards. As more Fox-1 IHU cards are built we will use the simulator less and less frequently, but in the meantime, it has proved its worth.

Final Thoughts About the IHU Simulator

This technique could be useful for future satellites. Although we all hope that a disaster like the Black Forest fire would not play into the decision, there will always be a shortage of 'real' boards early in the process. It seems likely that a quick way to use evaluation cards will always be useful.

I also have ideas for several projects in my shack and my home that I might base on an evaluation board like the Discovery using this technique.

If I were to design another board through ExpressPCB, I would use a great deal of care to try to reduce the size either to exactly 3.8"x2.5" ($51 for 3 boards) or to keep the size under 21 square inches ($166 for 6 boards). Larger boards have a significant setup cost, a tiny per-board charge, and a moderate cost per square inch. One way to save considerable size would be to use ribbon cables to connect the evaluation board to the PC board rather than providing the (mostly unused) square inches to mount it. Digikey (and probably Mouser) can build many different sizes of ribbon cable to order inexpensively.

Current Fox-1 IHU and Software Status

As of early May 2014, the software is nearly complete. We were able to develop essentially all of the software functionality on the IHU Simulator so even with only a single actual IHU card available, the software team was able to complete most of its work. When a Version 2 IHU card became available, it required only a few changes of #DEFINE to allow the software to run on it, and we could begin testing the IHU card itself.

Currently we have demonstrated a receiver, a transmitter, and an IHU card all working together as a cross band transponder, while collecting telemetry and mixing it with the downlink audio. (If you were at this year's Dayton Hamvention, you may have seen this demonstrated!) We have also demonstrated the software determining that the satellite was just ejected from its cubesat PPOD in space, waiting for 45 minutes, sending commands to deploy the antennas, and then starting up to wait for a ground command.

Our priority now is to finish those few more items that are always on a software project's checklist, to keep test the software, to support the test of new satellite boards, and to support hardware integration.

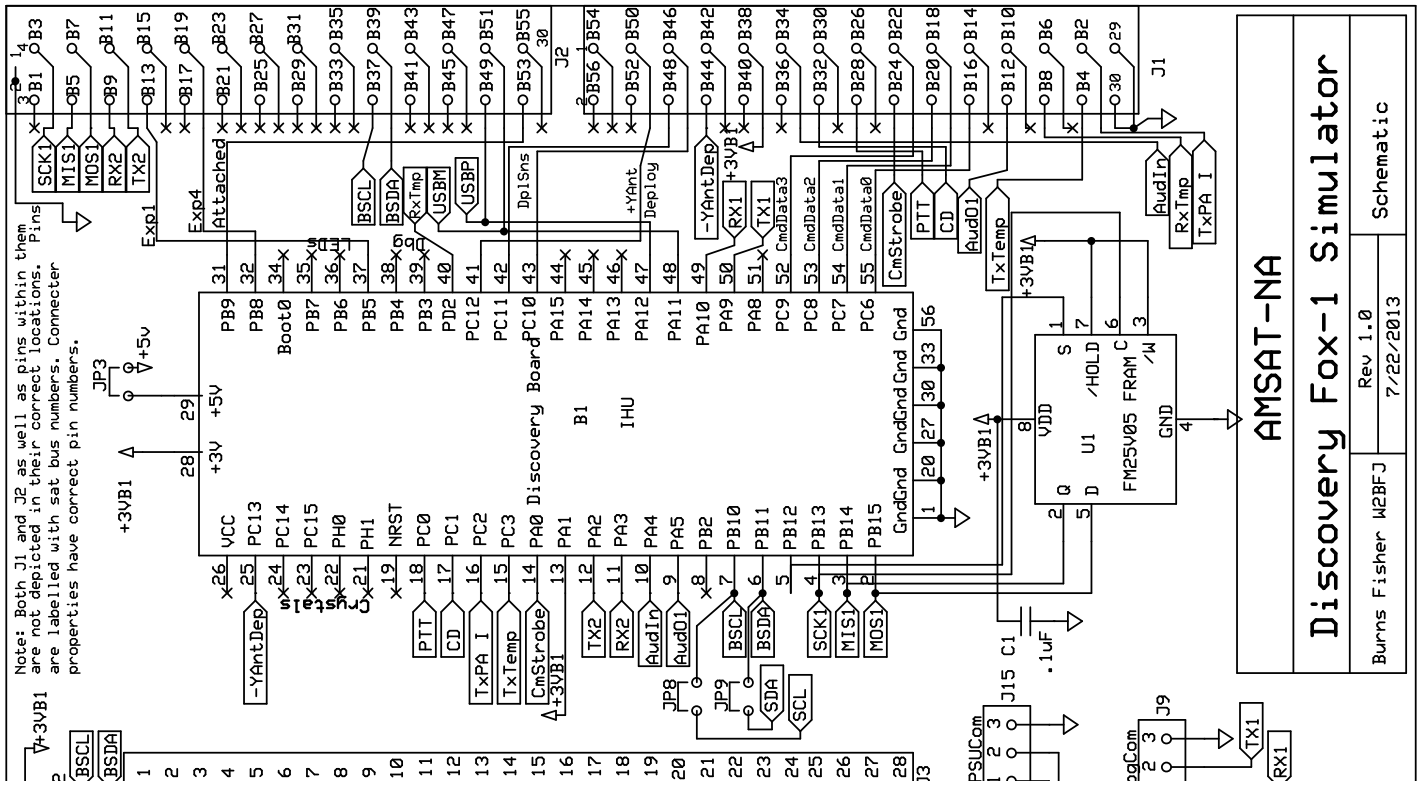
We will be doing a third version of the IHU board to fix a few more of those bugs that always creep in, but that should not be a major effort.

We are all excited to see Fox-1 completed, and when it rockets into space, it will be a source of enormous satisfaction to a huge team of software and hardware designers and builders!

The author (left) and AMSAT Vice President Engineering Jerry Buxton, N0JY (right) with the Fox-1 engineering model at the 2014 Dayton Hamvention.

The author demonstrated the IHU Simulator at the 2013 AMSAT Board of Directors meeting and at the Symposium in Houston.

Satellite operators Bob Liddy, K8BL (left) and George Carr, WA5KBH shown discussing linear vs. circular polarization over lunch during Bob's annual winter trek from Ohio to visit relatives in Texas. Enroute Bob visited George in Lake Charles, Louisiana for an eyeball QSO. Send your photos to journal@amsat.org.



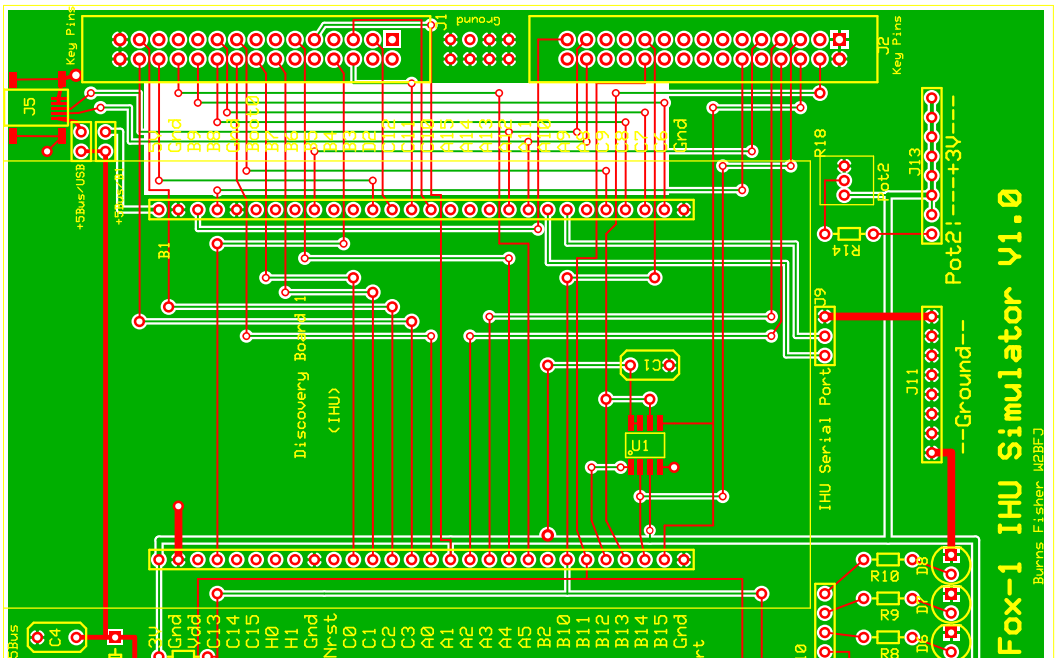


Figure 6: Partial Schematic and PC Bpard Layout

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Contact Martha at the AMSAT office 301-822-4376 to order.

The complete units will be built in groups, so get your orders in early. Units will be shipped as they become available.

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Minimum donations requested for various configurations:

1) Bare board - $20 + S&H – no parts kits available
2) Populated board, serial interface - $100 + S&H – no kit with USB unit, rotor cable and LCD available, we do have a parts list with recommended part numbers and sources.
3) Custom Ten-Tec Enclosure powder coat, silk-screened, drilled/punched - $50 + S&H
4) Complete unit - board, USB output, rotor cable, LCD, enclosure - $200 + S&H **our most popular

Documentation for the LVB Tracker can be found at: http://www.LVBTracker.com

Boards and complete units may be ordered from the AMSAT office at 301-822-4376 or from martha@amsat.org

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❒I prefer to make my donation in one yearly payment of $_____

Copy this form and send it with your information to: AMSAT, 10605 Concord St., Suite 304, Kensington, MD 20910

THANK YOU!

Stefan Wagener, VE4NSA Named ARISS Canadian Delegate

Stefan Wagener, VE4NSA/VE4SW, (above) joins Dave Taylor, W8AAS, as a delegate to ARISS. Stefan will also work with AMSAT Vice-President Human Space Flight Frank Bauer, KA3HDO, along with Lou McFadin, W5DID, ARISS Hardware Manager.

Barry Baines, WD4ASW, President-Radio Amateur Satellite Corp. (AMSAT-NA) announced that Stefan Wagener, VE4NSA/VE4SW, has agreed to serve once again as the Canadian AMSAT delegate to the ARISS Working Group. Stefan comes highly recommended by Maurice-André Vignault,VE3VIG/VE2MA, the former Canadian AMSAT delegate who recently decided to step down.

Stefan has been an active amateur radio operator for over 30 years, both in Europe (DG1GWS) and North America. He held a call in the US (KC8NSA) while in the States starting in 1989 and since 2001 has been living in Winnipeg, Manitoba using VE4NSA/VE4SW. Stefan became a Canadian citizen in 2009.

Stefan's interests in amateur radio in space and ARISS are reflected in his extensive participation in these areas. As an AMSAT-NA member, he has served as an Area Coordinator, helping local amateurs in Manitoba become involved in satellite communications. He also organized the direct ARISS school contact that took place at a Winnipeg school in July 2007. The contact took place at Maples Collegiate and was the first ARISS school contact to take place in Manitoba with the school using Stefan's call (VE4NSA). He is currently serving with a local Winnipeg High School (VE4ISS) on an ARISS ground station and STEM outreach. He also has interest in amateur television, serving as sysop for a Yahoo! Group focusing on Ham TV.

Professionally, Stefan holds a PhD in microbiology and has worked for the Public Health Agency of Canada and currently for the Canadian Grain Commission. His has assisted the Canadian Space Agency (CSA) and European Space Agency (ESA) on planetary protection issues and policies as a "biorisk" and "biocontainment" specialist.

Barry said, "ARISS is a critical program for amateur radio and AMSAT. Finding enthusiastic, capable volunteers who want to help to make a difference is important to the future of ARISS. I believe you will find Stefan to be a valuable addition to the team."

India's HAMSAT VO-52 9th Year On-Orbit

Mani, VU2WMY, at India's ISRO Satellite Centre announced that HAMSAT VO-52 reached its 9th year of-orbit operations on May 5, 2014. HAMSAT was launched as a piggy back payload aboard PSLV-C6 on May 5, 2005. It gives ISRO great pleasure and satisfaction to note that HAMSAT VO-52 has remained as one of the favorite linear satellite among radio amateurs. VO-52 is noted for her uplink receiver sensitivity, strong down link signals, stability and the ease of operating.

Initially expected to work for two years due to battery specification, HAMSAT VO-52 is still doing strong. The latest telemetry indicates all the parameters and systems to be normal and satisfactory.

HAMSAT VO-52	
Freqency (MHz)	Mode
145.870 - 145.930	CW/SSB Transponder Downlink
435.280 - 435.220	CW/SSB Transponder Downlink
145.936	Beacon; carrier only if Indian transponder active
145.860	Beacon; CW if Dutch transponder active

WRAPS Rotor Enhancements Add a Second Beam and Circular Polarization

Mark Spencer, WA8SME (mspencer@arrl.org)
ARRL Education and Technology Program

Part 1: Tricked-Out WRAPS Satellite Antenna Rotator Adds a Second Beam

The January 2014 issue of *QST* published my article about the WRAPS (Wobbler RadFxSat Antenna Pointing System) rotator system, an inexpensive, portable azimuth and elevation rotor for use with a simple tripod and light weight antennas such as the popular Arrow and Elk handhelds. The WRAPS system is ideal for easy transport and setup of educational demonstrations such as the new FUNcube/AO-73 and upcoming Fox-1, as well as Field Day operations and grid square expeditions.

To support amateur radio in space and broaden availability of the article in support of the ARRL Education and Technology Program, the ARRL has made this article available at:

http://ww2.amsat.org/xtra/wraps-mark-spencer-wa8sme-qst-jan-2014-copyright-arrl.pdf

Additional information about WRAPS is available on-line for ARRL members at:

http://www.arrl.org/qst-in-depth

The WRAPS Master CD which comes with the board includes detailed parts information, PIC microcontroller software, construction information etc may be downloaded from:

http://ww2.amsat.org/xtra/WRAPS%20CD%20Master.zip

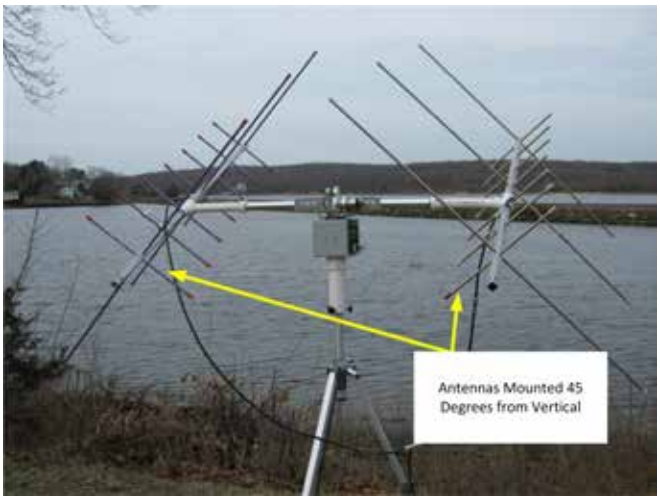
Four related videos of the WRAPS system and operation may be found on the AMSAT YouTube channel:

https://www.youtube.com/user/AMSATNA

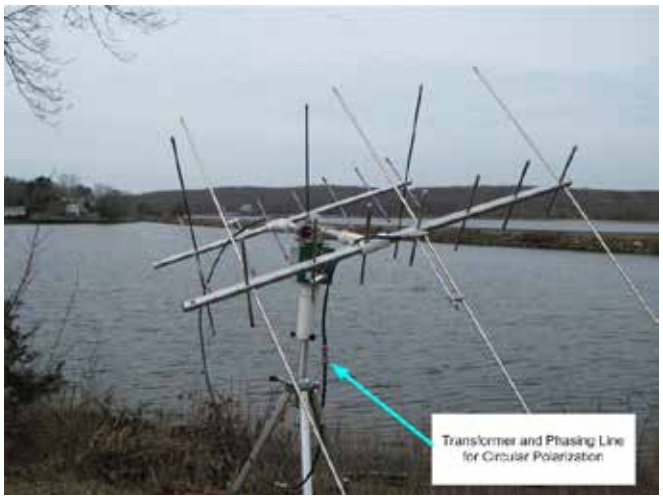
Hams, by their very nature, want to make their equipment do things that the equipment was not designed to do…myself included. A number of the builders of the WRAPS had made requests and suggestions on how to improve the system. One suggestion which caught my interest lead me to revisit the WRAPS to "trick it out" to handle two Arrows to get circular polarization capabilities. Figure 1 and 2 illustrate the result.

A wordy article is not necessary for this modification of the original WRAPS rotator so the meat of this project will be illustrated through pictures. I used most of the existing

The author shown with his original WRAPS rotator project described in the January 2014 *QST*. This article shows how to add the capability to modify WRAPS with two beams and add the capability for circular polarization.



(right) Figure 1: The Tricked Out WRAPS can handle two small beam antennas.



(left) Figure 2: Add phasing lines for circular polarization.

WRAPS project parts. Figures 3, 4, 5, and 6 illustrate the modifications so two antennas can be used.

The added parts to make it a dual antenna capable rotator cost an additional $80 over the price of the parts for the basic WRAPS. The parts list is included in Figure 7. It is still pricy, still portable and battery operated, but it is what it is.

There is no modification to the board or the firmware so it is a straight mechanical modification. Someone could make it into a 180 degree elevation rotator, but it would require an adjustment of the elevation gearing to accommodate that added 90 degrees. The firmware should not need to be changed.

If you would like additional information, please contact me at

mspencer@arrl.org

or at 860-381-5335 (I am located in the United States Eastern Time Zone).

The tricked out WRAPS was on display at the ARRL/ETP booth in Dayton Hamvention for show and tell. The original WRAPS was on display at the AMSAT booth.

AMSAT-NA is pleased to be able to offer the key electronic components in the AMSAT Store:

http://store.amsat.org/catalog/

What you get:

- Unpopulated circuit board
- Programmed PIC chip
- CD-ROM containing instructions and support materials to complete the project

WRAPS requires a tracking program supporting the EASYCOM protocol to provide pointing information. Programs, including free versions, are available for Linux, Mac, and Windows operating systems. AMSAT-NA has fully featured programs available for Mac and Windows machines at the AMSAT Store.

Making complete systems or full kits available is **not** currently contemplated.

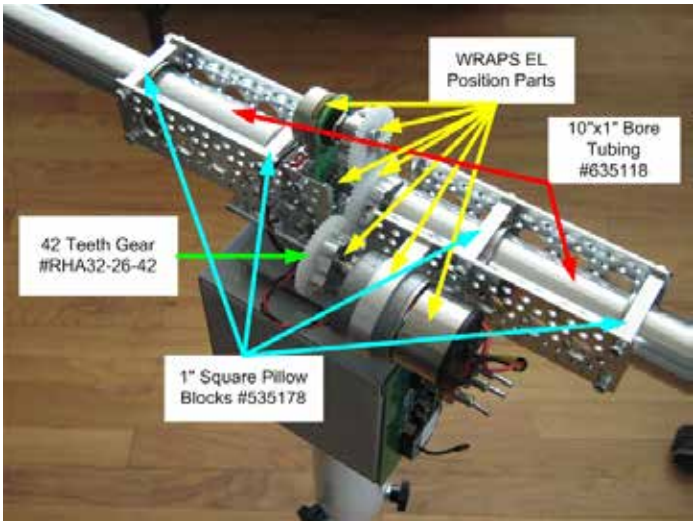


Figure 3

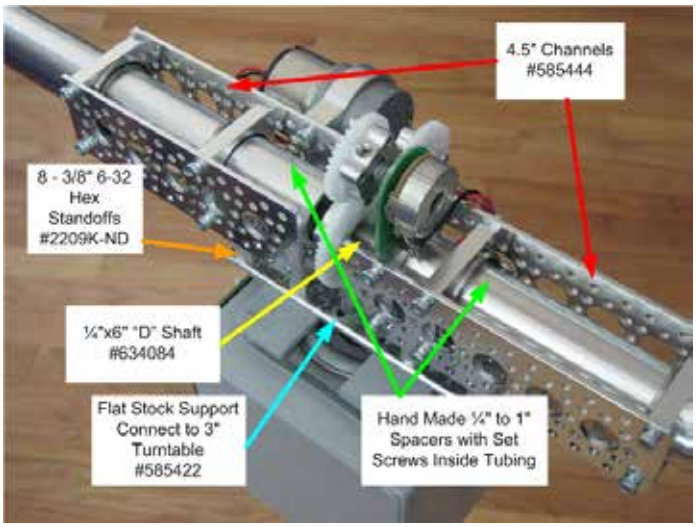


Figure 4

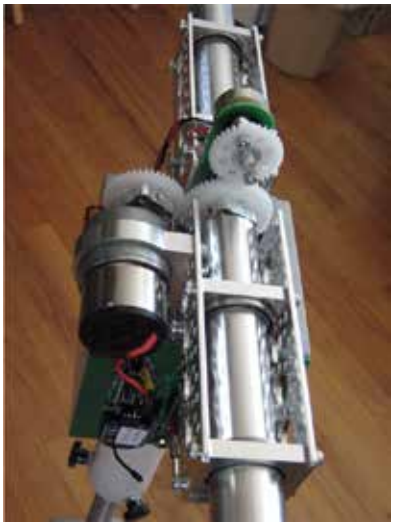


Figure 5

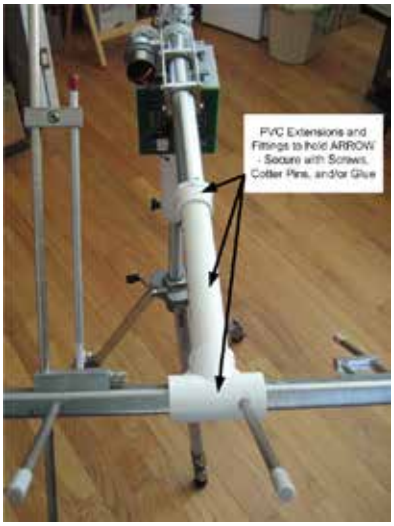


Figure 6

Tricked Out WRAPS ROTOR PARTS LIST				
	ND = Digikey.com			
	others Servocity.com			
Mechanical				
Number	Part Number	Description	Price Each	Price
2	585444	4.5" Al Channel	$4.99	$9.98
1	585422	Dual Flat Bracket	$1.49	$1.49
1	545576	6mmx.770" Set Screw Hub	$4.99	$4.99
1	RHA32-26-42	42 Tooth Gear	$4.32	$4.32
1	634084	1/4"x6" D-Shaft	$2.89	$2.89
4	535178	1" Square Bearing Quad Pillow Block	$9.99	$39.96
2	635118	10" 1" Bore Tubing	$3.49	$6.98
1	632106	1/4" Socket Head Cap Screws (1 pak)	$1.69	$1.69
1	632110	3/8" Socket Head Cap Screws (1 pak)	$1.89	$1.89
8	2209K-ND	6-23 by 3/8" threaded hex standoffs	$0.40	$3.20
as needed	hardware	6-32 flat washers		
as needed	hardware	6-32 screws 1/4" and 3/8"		
1	Local Hardware	3/4" PVC Tee	$0.59	$0.59
2	Local Hardware	1/2" to 3/4" PVC Coupling 1/2" Male Threaded	$0.52	$1.04
1	Local Hardware	7" - 3/4" PCV Pipe Section	$1.00	$1.00
				$77.39

Figure 7: Parts list for the Tricked Out WRAPS rotator.

Part 2: Circling the WRAPS: This Modification Shows How to Add Circular Polarization to Two Antennas

The purpose of this article is to describe a technique I used to make a ¼ wavelength delay-phasing line of non-standard impedance out of standard 50 Ω coax to circularly polarize a pair of Arrow antennas.

I have received some very positive and inspirational feedback from the builders of the WRAPS portable satellite antenna rotator system that is described in January 2014 QST. The feedback first inspired the "tricked out" WRAPS which is a modification of the original design to handle two Arrow class antennas mounted on a horizontal boom. Next, the tricked out WRAPS inspired me to look into a polarity switching system to change between RHCP and LHCP by the flip of a switch. This idea was combined with a previous project I developed, the minimalist preamp, that was described a while back in the November/December 2012 *AMSAT Journal*. The result is a polarity and frequency band agile antenna-mounted preamp for portable satellite operations.

Figure 8 illustrates one way to achieve LHCP circular polarization by inserting a ¼ wavelength delay line in the center of the interconnecting cable harness that is made of two coax transformer sections and the phasing line. To switch to the opposite polarity, the rig feed point is simply shifted to the other side of the ¼ wavelength delay line (Figure 9). This arrangement is complicated because the impedance at the ends of the 75Ω transformer sections is approximately 100Ω and the delay line impedance needs to match that impedance. One hundred ohm coax is not a common coax, but short sections for phasing lines can be homebrewed out of standard coax.

Homebrew coax of non-standard impedance

The impedance of coax is dependent on three factors; the dielectric constant of the insulating material between the inner conductor and the outer shield, the diameter of the insulating material (the internal diameter of the outer shield braid), and the diameter of the center conductor (Figure 10). The relationship between these coax characteristics are detailed in equation 1 (the cited web location has a nice coax impedance calculator to help play with the math). In this project, I modified lengths of RG-8 Mini Foam coax to create coax with an impedance of approximately 100Ω by replacing the center conductor with thinner, Cat-5 conductor wire.

$$Z_o = \frac{138 * log\left(\frac{D}{d}\right)}{\sqrt{E_r}}$$

Equation 1.
From: http://www.microwaves101.com/ *encyclopedia/calcoax.cfm*

These are the specifications for RG-8 Mini Foam cable:

- The insulation is foam polyethylene with a dielectric constant (E_r) of 1.16.
- The insulator diameter (D) is 0.157".

The diameter of one strand of a Cat-5 Cable (d) is 0.02 inches. Plugging these values into equation 1 results in an impedance for the modified coax of 114Ω. This is a pretty good match to the 112Ω output of the transformer lines (using standard 75Ω RG-6 coax). The problem is how to replace the center conductor of the RG-8 Mini coax?

The following is the process that I used to

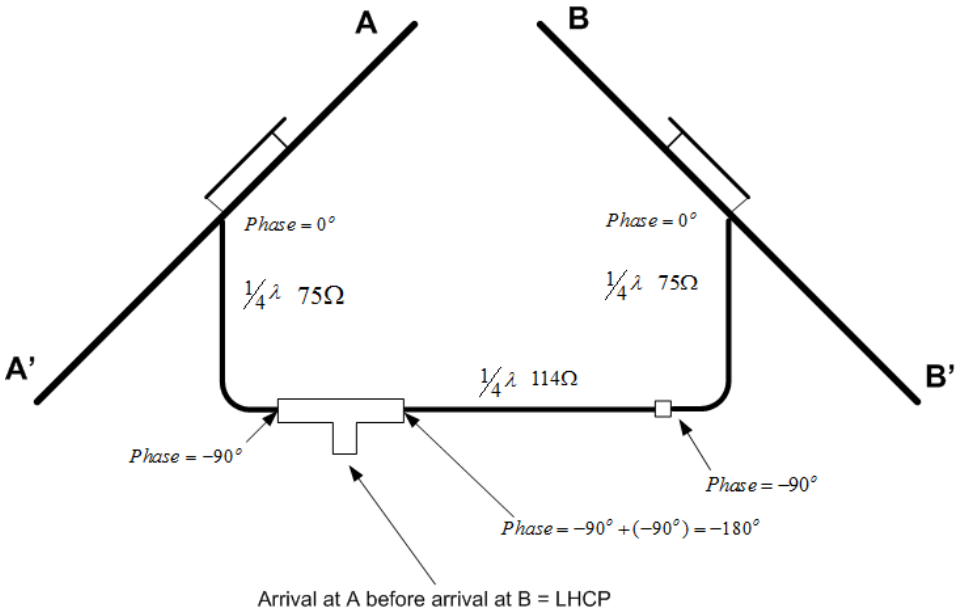


Figure 8.

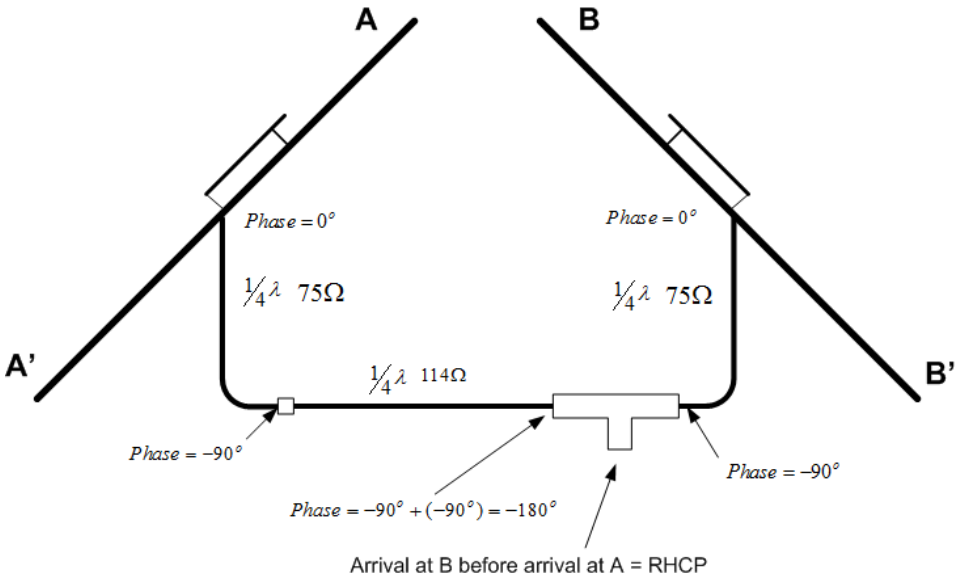


Figure 9.

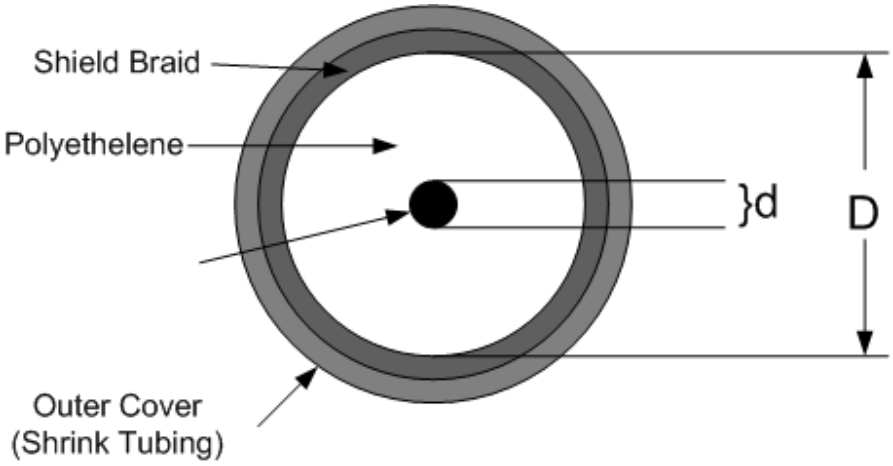


Figure 10.

replace the center conductor of short lengths of RG-8 Mini coax to make the phasing lines (refer to Figures 11 and 12).

1. Cut a section of RG-8 Mini cable that is slightly longer than what you estimate the electrical ¼ wavelength will be. I simply use the standard antenna wavelength formula. The actual velocity factor of your homebrew cable will be pretty good, so don't under estimate this length (i.e., the velocity factor is much better than 0.6).

2. Carefully remove the outer covering of the RG-8 Mini coax using care not to score or cut the underlying braided shield.

3. Scrunch the braided shield like a Chinese Finger Trap toy so that the shield can be removed from the foam center insulator.

4. Using a knife to make sharp and clean edges, cut the foam insulating material into short sections so that the sections can be pulled off the center conductor (a little trial and error is appropriate, for me, lengths of about 5 inches seemed to work).

5. Strip the insulation off a length of one strand of a Cat-5 Cable conductor, the cable I had on hand had a solid conductor.

6. Slide the foam insulation sections over the new center conductor.

7. Using the appropriate size of heat shrink tubing, put a short section of heat shrink tubing over the joints in the foam insulation, heat to shrink.

8. Slide the braid shield over the form insulation and stretch out to the length of the modified cable.

9. Install a crimp BNC connector to one end of the modified cable; you are now ready to determine the electrical ¼ wavelength for the phasing line.

Determining ¼ electrical wavelength

You will need an antenna analyzer (I have the MFJ model) or a SWR/watt meter to determine the electrical ¼ wavelength for the phasing line. If you are absolutely certain of the coax cable's velocity factor, you could probably apply that velocity factor to reduce the calculated length of a cable to the elec-

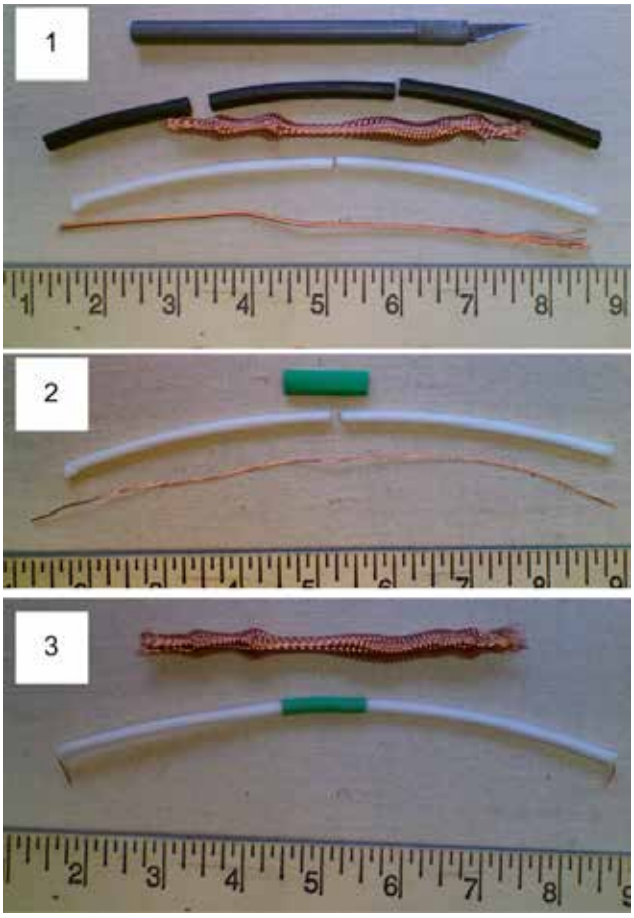
trical length. In this case, the velocity factor of your homebrew cable is unknown so you will have to use the following procedure.

Make a jig with a mating coax connector for your analyzer or SWR meter (my meters needed a PL259), a 50Ω carbon resistor (small wattage would be fine), and a female BNC connector. Install the resistor in series with the connector center pins using leads as short as practicable. Ground the outer shields of the connectors; the solder lug on the BNC connector works well. What this 50Ω terminating jig does is to allow any odd multiple of ¼ wavelength coax cable (which is open at the other end, regardless of the impedance), to resonate at 50Ω at the meter (jig) input.

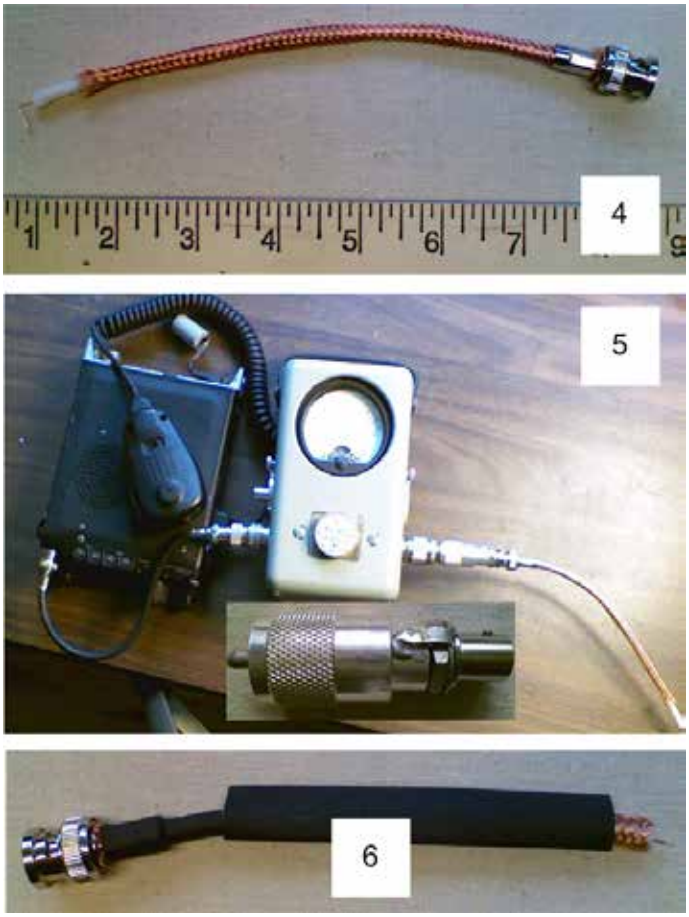
Connect your homebrew 100Ω cable section to jig attached to the analyzer or the SWR meter. If you are using an SWR meter, you will need to attach a low power transmitter to the SWR meter to use as an RF source. Set the analyzer or rig to the frequency of interest (2 m, I use 146 MHz; 70 cm, I use 436 MHz). The SWR will read high. Incrementally trim off small sections of the homebrew coax, perhaps ½ inch at a time; as the SWR lowers toward 1:1, start trimming less, perhaps ¼ inch increments. When you reach very close to 1:1 SWR, trim one more short ¼ inch increment (to make up for the BNC connector to be installed later).

To complete the homebrew phasing line, install heat shrink tubing over half of the entire length of the cable snug up against the previously installed BNC, and then shrink the tubing. Slip another section of shrink tubing over the other half of the cable, but do not shrink the tubing yet. Install the other BNC connector. Just to be sure, double check the cable on your SWR setup; it should be close to 1:1 SWR. The final step is the cover the last half of the cable with the shrink tubing, heat to shrink, and you're done.

Construct the two odd-multiple of ¼ electrical wavelength transformer lines out of RG-6, 75Ω cable (just straight RG-6, not modified). For my WRAPS system, I found that ¾ wavelength transformer lines are required for the 2 meter antennas, and 1¼ wavelength transformer lines are required for the 70 cm antennas to span the distance between the antennas. Install a couple of BNC "T" connectors between the transformers and the delay line. A pictorial representation of the completed antenna feed harness is illustrated in Figure 13. To switch between RHCP and LHCP, simply move your rig feed point from one BNC "T" connector to the other.



(Above): Figure 11. (Below): Figure 12.



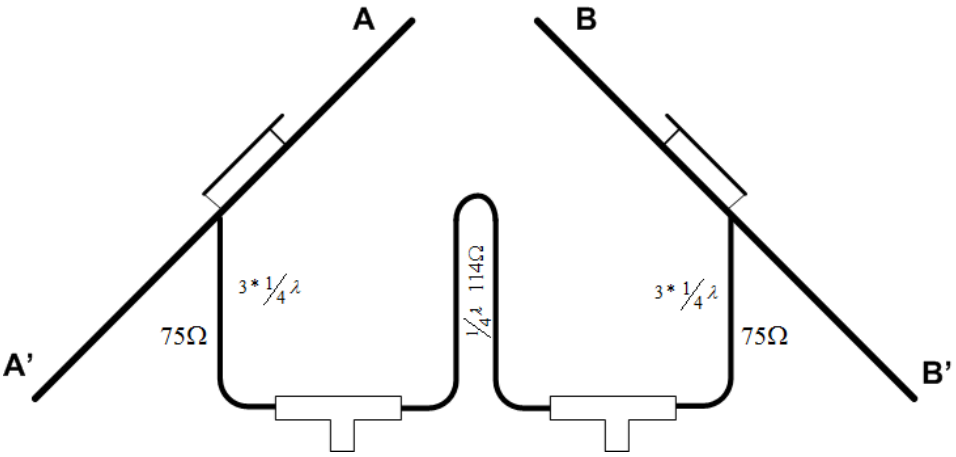


Figure 13.

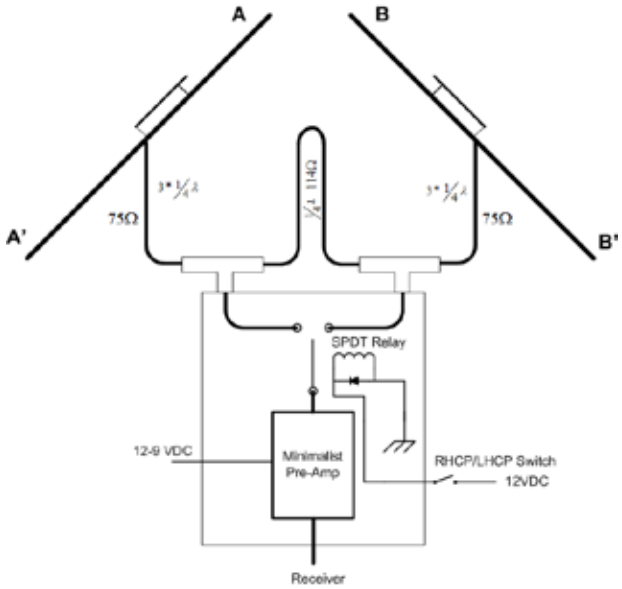


Figure 14.

Electro-mechanical polarity switching

The goal of this project however was to create an electro-mechanical way to make polarity changes. An RF appropriate SPDT, relay controlled switch will do the trick (Digi-key part number Z3288-ND). I included the polarity switching relay on a redesigned minimalist preamp PCB for this project, pictorially illustrated in Figure 14 and photos of the completed unit (with cover removed) are in Figure 15.

Power for the preamp is supplied with one line, 12 VDC switched power for the polarity relay is supplied by another line. This system is NOT set up for polarity switching of the transmitter side of the station. From my experience, there is far more need for polarity switching on the receive side. If there is polarity shifting at the satellite, I have found that I can usually over-power any attenuation due to polarity shifting by momentarily boosting my transmitter power, therefore I simply leave my transmit antennas fixed in RHCP mode.

Add a diplexer for a complete polarity agile station

If you use a dual band HT for your portable operations, you will need to insert a diplexer into the station configuration as illustrated in Figure 16. (An excellent homebrew diplexer is described in November/December 2009 *AMSAT Journal*.)

Operation

The minimalist preamp is broad-banded and covers both the 2 meter and 70 cm bands. I created a circular polarization harnesses for both bands with the BNC "T" connectors on each side of the phasing lines. If I am going to operate a satellite with a UHF uplink and a VHF downlink, I install the preamp on the VHF cable so that the antenna is RHCP when the polarity switching relay is at rest (non-energized) and I connect the transmitter to the BNC connector on the UHF cable for RHCP (vice versa for the UHF down, VHF up). Most of the time, the satellites are RHCP. I find that most of the polarity fades happen early (above AOS) and late (above LOS) in the pass. When a fade is detected, simply flip the polarity switch to energize or de-energize the relay; this action moves the ¼ wavelength delay line back and forth between the antennas and creates the RHCP/LHCP polarity shift. As I mentioned, I mitigate the polarity shifts on the uplink by manipulating the transmitting power to a level appropriate for respectful satellite operations.

Early in my satellite operation experience I used fixed RHCP and I simply accepted the fades. After I upgraded my station and included polarity switching, I could not believe what a difference it makes! By a simple flip of a switch, the signals would go from S-0 to S-9 in many cases; the difference is truly amazing.

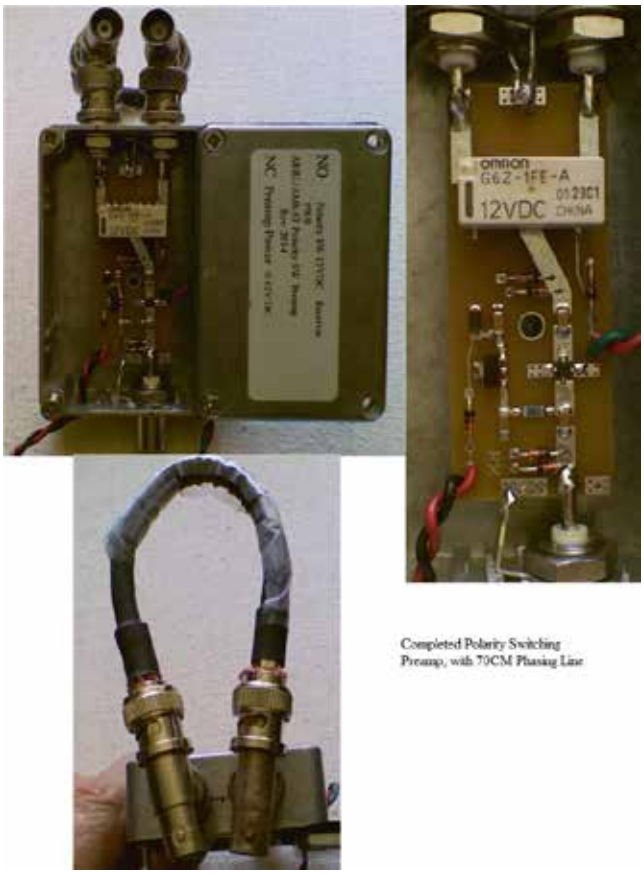
I have become a firm proponent of antenna mounted preamps, and now, polarity switching. This relatively inexpensive modification to your portable station just might be the station upgrade you have been looking for to enhance your satellite operating experience.

An expanded discussion of circular polarizing antennas can be found at this web location:

http://ww2.amsat.org/xtra/Polarity%20Switching%20Preamp.pdf

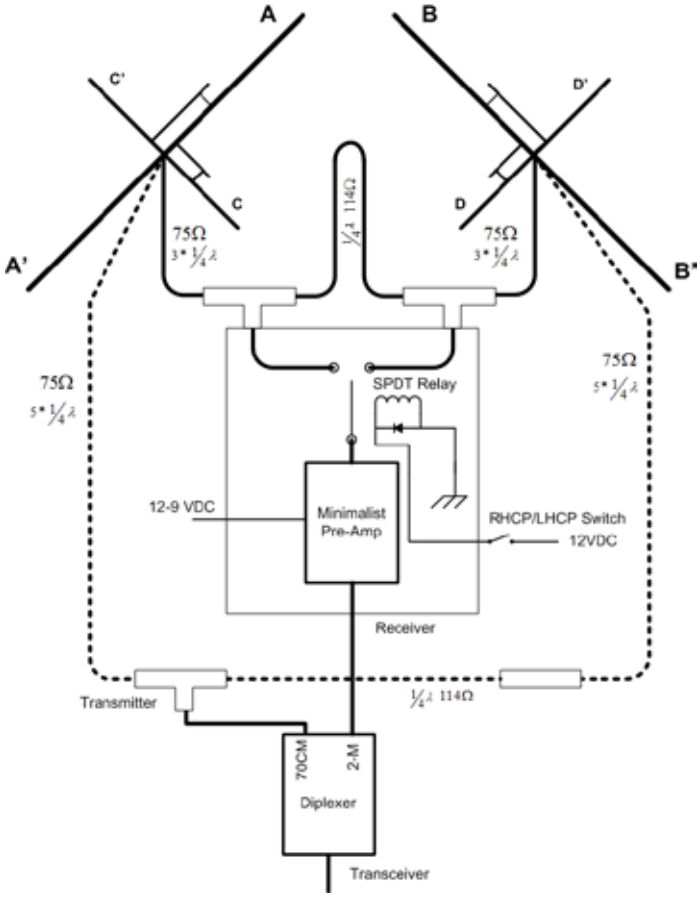
If you have questions or need additional information, please contact me at

mspencer@arrl.org



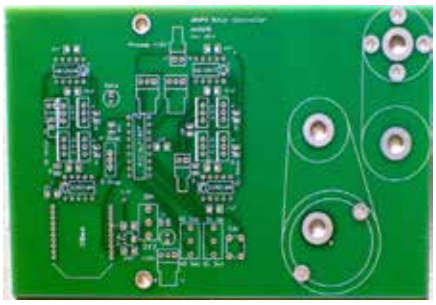
Completed Polarity Switching Preamp, with 70CM Phasing Line

(Above): Figure 15. (Below): Figure 16.



WRAPS Project Parts in the AMSAT Store

http://www.store.amsat.org/catalog



The WRAPS Circuit Board kit includes:

- Unpopulated circuit board
- Programmed PIC chip
- CD-ROM containing instructions and support materials to complete the project
- Additional project details can be found on-line in the product description in the AMSAT Store.

AMSAT will offer both, the Original Broadband Satellite RX Preamp, and the new Broadband Satellite RX Preamp with Antenna Polarization Switching (as described in the accompanying article). Watch the AMSAT Store and AMSAT News Service for availability in late July, 2014.

Dutch Delfi-C3 6th Year On-Orbit

Wouter Weggelaar, PA3WEG, on behalf of the Delfi-C3 ops-team says that Delfi-C3 has celebrated its 6th birthday on April 28, 2014. The spacecraft is still operational, telemetry only, on 145.870 USB

Delfi-C3 has exceeded its mission lifetime by six times now, and on-board telemetry still does not indicate degradation in performance.

So far, the Delfi-C3 distributed ground station network (DGSN) has collected over 2037513 frames, received by 376 registered radio amateurs and many more on the guest account, using the free RASCAL software. This would not have been possible without the continued support of amateur radio operators.

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

Here are opportunities to launch your amateur radio experience to new heights ...

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.

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 Drew Glasbrenner, KO4MA at: ko4ma@amsat.org.

AMSAT's web presence needs a site content editor and authors for content development for technical articles and feature development.

To volunteer send an e-mail to Alan Biddle, WA4SCA at: wa4sca@amsat.org.

AMSAT Engineering Team Satellite Development

AMSAT's Engineering Team is looking for volunteers with a passion for electronic hardware and software development ...

- Analog circuit & power design
- RF circuit design
- Software development
- Electronic construction
- System integration
- Testing and debug
- Must have commitment to deliver on your part of the project.
- U.S. ITAR restrictions apply to many positions..

To volunteer send an e-mail describing your area of expertise to Jerry Buxton, N0JY at: n0jy@amsat.org. Jerry requests that you include your AMSAT member number and a phone number for him to contact you.

AMSAT Publications

AMSAT has immediate needs for volunteers to help with publications on the web, weekly bulletins, and printed materials.

- Join the AMSAT News Service (ANS) team as a weekly editor on a rotating basis.
- Be an assistant Editor for the AMSAT Journal magazine developing and publishing print articles on amateur radio in space.
- Graphics and photo editor

To volunteer send an e-mail to JoAnne Maenpaa, K9JKM at: k9jkm@amsat.org

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 E. Mike McCardel, KC8YLD at: kc8yld@amsat.org.

AMSAT Field Operations

AMSAT's Field Operations Team is looking for satellite operators to promote amateur radio in space with hands-on demonstrations and presentations.

- Promote AMSAT at hamfests
- Setup and operate satellite demonstrations at hamfests.
- Provide presentations at club meetings.
- Show amateur radio in space at Dayton, Pacificon, Orlando Hamcation.

To volunteer send an e-mail to Patrick Stoddard, WD9EWK at: wd9ewk@amsat.org

You can find more information on the web ...
www.amsat.org ... click AMSAT ... then click Volunteer