

AMSAT Fox-1C will fly aboard the 2015 SHERPA SpaceX Falcon 9 launch

AMSAT® is dedicated to keeping amateur radio in space. Its membership includes a worldwide group of radio hams who monitor amateur radio satellite signals and use satellites for QSOs. They also design and build the satellites, and control them once in orbit.

Since 1961, more than 70 amateur radio satellites have successfully reached orbit and begun operation. 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 Low Earth Orbiting satellites developed in cooperation with the educational community and other amateur satellite groups.

We are always interested in future development for opportunities to reach higher orbits and pioneering communications capabilities.

### We'd Like to Have You as a Member

Both you and AMSAT will benefit when you join. You get the AMSAT Journal bi-monthly and support from AMSAT Area Coordinators. Member dues and donations provide AMSAT's primary support.

# Imagine!

Your amateur radio contacts via satellite ...

## AMSAT makes it possible ...

### We'll show you how!

Recommended checklist for your station gear to get started using AMSAT's Fox-1 satellites

#### Dual-band radio operation

FM transmitter capability on 435 MHz and FM receiver capability on 145 MHz. A full-duplex radio (capable of receiving and transmitting simultaneously) is recommended. Options include:

- A dual-band, full-duplex handheld radio
- Separate handheld radios (one to transmit and one to receive)
- Separate multi-mode radios such as a Yaesu FT-817 (in FM mode).
- Even if you don't have a UHF transmitter you can still monitor the 145 MHz downlink on most 2M FM rigs - get started by listening.

#### External antenna

To make successful contacts, operating with your HT's flexible antenna is not recommended as your only antenna. These popular directional antenna options include:

- Dual-band Arrow Antenna
- Dual-band Elk Log Periodic Antenna
- Building your own, to get started see: [http://www.amsat.org/?page\\_id=2144](http://www.amsat.org/?page_id=2144)
- Some satellite passes may be occasionally received with just the flexible antenna so don't let lack of a beam prevent you from receiving experimentation!

#### Satellite Tracking Applications

You'll need to know when the satellite is in range of your station. You'll also need to know where to point your antenna. Web-based trackers will get you started:

- <http://tinyurl.com/amsat-predict>
- <http://www.n2yo.com/>
- <http://amsat.org.ar/sat.htm>
- Linux orbit prediction software includes the Predict and GPredict programs.
- Windows orbit prediction software includes SatPC32 (visit the AMSAT store)
- Mac software is MacDoppler (visit the AMSAT store)

AMSAT pioneered the concept of small satellites in low orbits. AMSAT's next satellite effort, called Project "Fox", consists a series of small CubeSats that will provide FM transponders with a 70 cm uplink with a 2 meter downlink that will match the ground performance of previous FM satellites.

### AMSAT is preparing a fleet of five amateur radio cubesats ...

- **Fox-1A** (AO-85) was launched on a NASA ELaNa flight on 8 October 2015, and is currently operational. This satellite has a U-band uplink and a VHF downlink.
- **Fox-1B** will fly with the Vanderbilt University radiation experiments expected in 2016.
- **Fox-1Cliff** will launch on Spaceflight's maiden mission of the SHERPA multi-cubesat deployer during the first quarter of 2016. U- and L-band uplinks with the VHF downlink will be available.
- **Fox-1D** will launch on the same mission as Fox-1Cliff in the first quarter of 2016. Similar to Fox-1Cliff, Fox-1D will also have an FM transponder with U- and L-band uplinks and a VHF downlink.
- **Fox-1E** is built as a flight spare for Fox-1B. If not needed for a spare it will remain available for AMSAT's next partnership in space.

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Find out more and join at <http://www.amsat.org>

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# On-the-air with Fox-1A

Orbital predictions are needed to tell you when to listen and where to point your antenna. You'll need to tell the web site your location:

- Grid square, or
- Latitude and Longitude, or
- For some, selecting the nearest major city is enough to start with for manual tracking.
- Select the satellite you want to track.
- If using a computer tracking program, you'll need to load tracking data, called Keplerian elements, into the software. Initially, we'll recommend the web until you have had a chance to learn more.

Your tracking program can now tell you the basic parameters of the satellite pass:

- **AOS/LOS** - the time of the Acquisition of Satellite (beginning of the pass) and Loss of Satellite (end of the pass).
- **Azimuth** - this is the compass direction (such as north, south, east, or west) which updates as the satellite flies through your view of the sky.
- **Elevation** - this is how many degrees above the horizon the satellite will be flying (0° is the horizon and 90° is directly overhead), which updates as the satellite flies through your view of the sky.

Fox-1 Frequencies		
	Uplink FM (67 Hz tone)	Downlink FM
Fox-1A	435.170 MHz	145.980 MHz
RadFxSat Fox-1B *	435.250 MHz	145.960 MHz
Fox-1C*	435.300 MHz / 1267.300 MHz **	145.920 MHz
Fox-1D*	435.350 MHz / 1267.350 MHz **	145.880 MHz

\* Pending IARU Coordination, Changes will be announced  
 \*\* Switchable by command station, not operational simultaneously

Tune the right frequency. The UV frequency plan used by Fox-1A makes tuning for Doppler shifts no harder than the VU configuration, but it does require some change of technique to decide when to tune. With UV, each station needs to tune their uplink based on their specific location with respect to the satellite. How do you do this?

While the satellite's receiver AFC will help minimize the needed transmission Doppler correction, you must be prepared to make adjustments when using an HT or similar equipment. Some HTs may be set for 2.5 KHz channel spacing, but 5 KHz spacing with the satellite AFC should be adequate. For a typical HT with 5 KHz spacing, the following memory frequencies are suggested:

Fox-1A Doppler Shift Correction		
	Your Transmit Frequency (with 67 Hz tone)	Your Receive Frequency
AOS (Mem.1)	435.160 MHz	145.980 MHz
Approaching (Mem.2)	435.165 MHz	145.980 MHz
Passing (Mem.3)	435.170 MHz	145.980 MHz
Departing (Mem.4)	435.175 MHz	145.980 MHz
LOS (Mem.5)	435.180 MHz	145.980 MHz

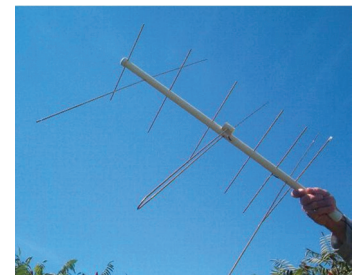
If Fox-1 is heading directly toward you, the Doppler shift will be greatest, but except for passing overhead, it will change relatively slowly. Passes well to the east or west will have smaller maximum shift, but it will change continuously throughout the pass. Learning to compensate for this is a necessary operator skill. Using the recommended full-duplex operation will allow you to hear if you are tuned on-frequency.



The Arrow Antenna. Photo credit: KB1SF



The ELK Antenna. Photo credit: elkantennas.com



Learn how easily you can make your own satellite antenna  
 Photo credit: VE2ZAZ.net



Tom, KA6SIP portable satellite operation in northern Nevada

## Fox-1A Operating Hints

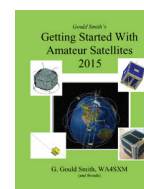
- Use a small beam like the Arrow Antennas Yagi or Elk log periodic, clear of obstructions.
- Select the 67.0 Hz PL/CTCSS for transmit
- Uplink power should be on the order of minimum 200 W EIRP for full quieting at lower antenna elevation angles. With an Arrow, 5 W has been used successfully to make contacts.
- Open your Squelch all the way
- Use a combo headphone/boom mike to reduce feedback/echo (and give you a free hand)
- Use a printout or your laptop, smartphone or tablet to track the satellite path over your QTH
- Apps include Satellite Explorer Pro (iOS) and AmsatDroidFREE (Android)
- Have an audio recorder to log the QSO (it is difficult to talk, point the antenna, do PTT operation, remember the callsign, and think - all at the same time)
- Set your transmit and receive frequencies in memories to make tuning easier
- Twist the antenna as the pass progresses to improve signal strength

## Suggested Fox-1 Basic QSO Tips

A very busy single channel FM satellite is like any FM repeater and you do not call CQ. Exchanges will be crisp and very short, so do not expect to have a lengthy conversation about the weather or your station configuration. Most importantly listening is important: if two other stations are in the middle of the exchange, let them finish. Even though a pass is short, the exchanges are even shorter. You will get a shot so please be patient and respectful of others.

- Listen for others
- Listen for yourself using full-duplex operating technique "W4ABC" (make sure you have your PL switched on!)
- You hear "K9XYZ"
- You say "K9XYZ W4ABC EM74"
- You hear "W4ABC K9XYZ QSL EN52"
- You say "K9XYZ W4ABC QSL 73"
- Please do not call "CQ Satellite" on the FM birds

## You'll find all the details in AMSAT's book:



AMSAT offers the Getting Started with Amateur Satellites book... Available on-line at:

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

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