



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 90 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 pioneered the concept of small satellites in low orbits. AMSAT's Project Fox consists of a series of 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. This allows the use of small ground stations bringing operation in reach of most amateur radio operators.

#### **AMSAT operates a fleet of five amateur radio cubesats on-orbit or ready for launch ...**

- **Fox-1A (AO-85)** was launched on a NASA ELaNa flight on 8 October 2015, and is currently operational. This satellite has a UHF uplink and a VHF downlink.
- **RadFxSat (Fox-1B/AO-91)** was launched on 18 November 2017 with the Vanderbilt University radiation experiments and is operational.
- **Fox-1Cliff** planned to launch Summer 2018 on a SpaceX Falcon 9 from Vandenberg AFB, CA. UHF and L-band uplinks with the VHF downlink plus a camera experiment.
- **Fox-1D (AO-92)** launched in January, 2018 aboard a PSLV flight from India and is operational. Fox-1D orbits an FM transponder with UHF and L-band uplinks and a VHF downlink plus a camera experiment.
- **RadFxSat-2 (Fox-1E)** will launch no earlier than 2nd quarter 2018 aboard a Virgin Galactic LauncherOne flight. It will carry a 30 kHz wide mode V/U linear transponder. It will also have a 1200 bps BPSK telemetry beacon.

## 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.

#### **Directional Antenna**

To make successful contacts, operating with your HT's flexible antenna will not work. Popular directional antenna options include:

- Dual-band Arrow Yagi Antenna
- Dual-band Elk Log Periodic Antenna
- Building your own, to get started see: <https://www.amsat.org/station-and-operating-hints/>
- Some satellite passes may be occasionally received with just the flexible antenna so don't let lack of a beam prevent you from experimenting with reception!

#### **Satellite Tracking Applications**

You'll need to know when the satellite is in range of your station and where to point your antenna. Web, PC, and smartphone trackers include:

- <http://tinyurl.com/amsat-predict>
- <http://www.n2yo.com/>
- <http://amsat.org.ar/sat.htm>
- Linux: Predict and GPredict programs
- Windows: SatPC32 (see AMSAT store)
- Mac OS X: MacDoppler (see AMSAT store)
- iPhone/iPad: GoSatWatch, PocketSat3 & Satellite Explorer Pro
- Android: AmsatDroid FREE & PocketSat3

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

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# On-the-air with the FM Fox-1 Satellites

Tune the right frequency. The UV frequency plan used by the Fox-1 satellites 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:

Frequencies for Fox-1A, B, Cliff, and D		
	Uplink FM (67 Hz tone)	Downlink FM
Fox-1A (AO-85)	435.170 MHz	145.980 MHz
RadFxCat Fox-1B (AO-91)	435.250 MHz	145.960 MHz
Fox-1Cliff*	435.300 MHz / 1267.300 MHz **	145.920 MHz
Fox-1D*	435.350 MHz / 1267.350 MHz **	145.880 MHz

\* Frequencies may vary slightly after launch.  
\*\* Switchable by command station, not operational simultaneously

Fox-1 Series UHF Transmit Doppler Shift Correction				
Transmit with 67 Hz CTCSS on all uplink frequencies	Fox-1A (AO-85) Receive 145.980	RadFxCat/Fox-1B (AO-91) Receive 145.960	Fox-1Cliff Receive 145.920	Fox-1D Receive 145.880
AOS (Mem.1)	Fc - 10 KHz *	Fc - 10 KHz	Fc - 10 KHz	Fc - 10 KHz
Approaching (Mem.2)	Fc - 5 KHz	Fc - 5 KHz	Fc - 5 KHz	Fc - 5 KHz
Nearest (Mem.3)	Fc = 435.170 MHz	Fc = 435.250 MHz	Fc = 435.300 MHz	Fc = 435.350 MHz
Departing (Mem.4)	Fc + 5 KHz	Fc + 5 KHz	Fc + 5 KHz	Fc + 5 KHz
LOS (Mem.5)	Fc + 10 KHz	Fc + 20 KHz	Fc + 10 KHz	Fc + 10 KHz

\* Example: On Fox-1A/AO-85 Fc = 435.170 MHz, then Fc - 10 KHz = 435.160 MHz; Fc - 5 KHz = 435.165 MHz, etc.

Using the recommended full-duplex operation will allow you to hear if you are tuned on-frequency and also avoids interfering if another station is transmitting.



Tom, KA6SIP portable satellite operation in northern Nevada

## Fox-1 Series Satellite Operating Hints

- Use a small beam like the Arrow Yagi or Elk log periodic, clear of obstructions.
- Select the 67.0 Hz CTCSS for transmit. For receive, open your squelch all the way.
- Using an Arrow, Elk, and many other small beams, transmitting with 5 Watts on the uplink have been used successfully to make contacts. Per good amateur radio practice use the least power necessary to complete the contact.
- 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
- 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 for best received signal. When using crossed-yagis like an Arrow, twist the antenna 90-degrees when you switch from receive to transmit; the Fox antennas are linear so you need to adjust for polarization fades as the satellite spins.



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

## 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. To prevent interfering with other stations listening before transmitting 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 67.0 Hz CTCSS 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:  
<https://www.amsat.org/shop/>

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