AMATEUR RADIO - SATELLITE OPERATIONS

PRESENTED BY AI6MC

ARISS
RX 2023-11-23 15:25:51
437.790.36 FM

“I plagiarize”

Pay Attention! There Will Be Test Questions

Making contacts via amateur satellites is a very popular amateur radio activity. There's even an organization dedicated to launching and operating amateur radio satellites—AMSAT (www.amsat.org).

Perhaps the most important thing you need to know when trying to communicate via satellite is where the satellites are. One way to determine the location of a satellite at a given time is by using the Keplerian elements for the satellite. Keplerian elements are the parameters that define the orbit of a satellite, and they are widely available on the internet.

QUESTION: What are Keplerian elements? (E2A06)
ANSWER: Parameters that define the orbit of a satellite

SOME BASIC HISTORY

Project OSCAR members, the American Radio Relay League, and the United States Air Force, were able to secure a launch opportunity on Discoverer XXXVI from Vandenberg AFB, California. It was secured for the very first Amateur Radio satellite called OSCAR I. It was successfully launched into a low Earth orbit on the morning of December 12, 1961…barely four years after the launch of Sputnik I.

The Radio Amateur Satellite Corporation (as AMSAT is officially known) was formed in 1969 as a not-for-profit, 501(c)(3) educational organization chartered in the District of Columbia.

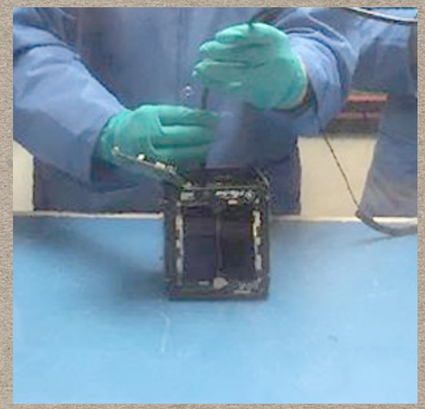
Oscar 1

1st one 1961

OSCAR stands for

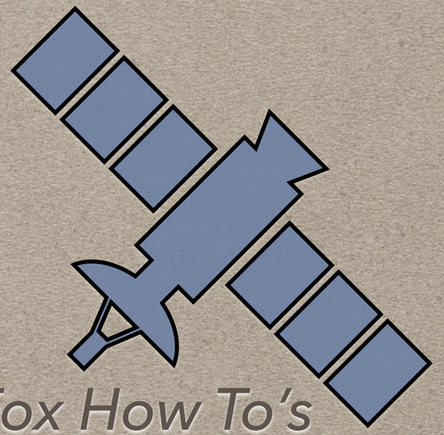
Orbiting Satellite Carrying

Amateur Radio



Fox 1B

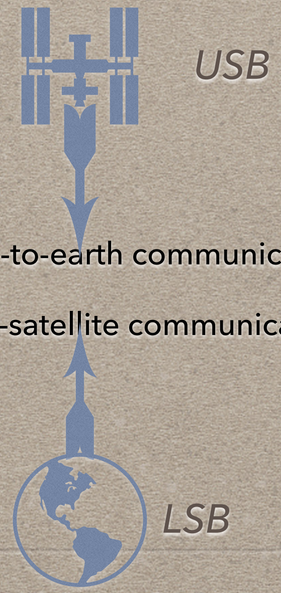
Current Day Example



Fox How To's

BASICS THINGS TO KNOW

- **Most FM satellites are simply FM repeaters in space. Some satellites, however, are more sophisticated. They repeat signals using linear transponders. Transponders are similar to repeaters, except that they receive signals of many different types, including FM, CW, SSB, SSTV, PSK, and packet signals, across a band of frequencies and repeat them across another band of frequencies.**
- **Disipline and Patience - Satellite communication has it's do's and don't like everything else**
- **Language terms:**
- OSCAR = Orbital Satellite Carrying Amateur Radio
- AOS = Acquisition of Signal
- LOS = Loss of Signal
- Bird = Satellite
- Downlink = Channel used for satellite-to-earth communications.
- Uplink = Channel used for earth-to-satellite communications.

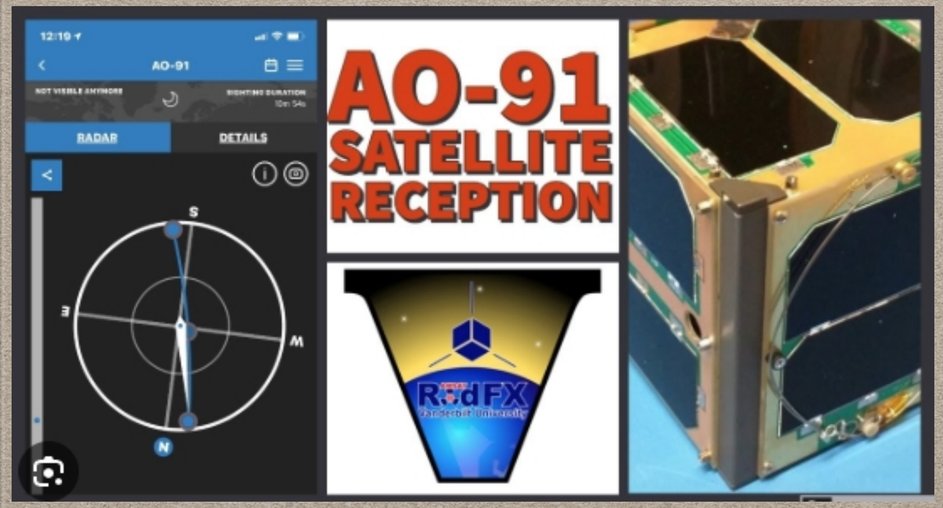


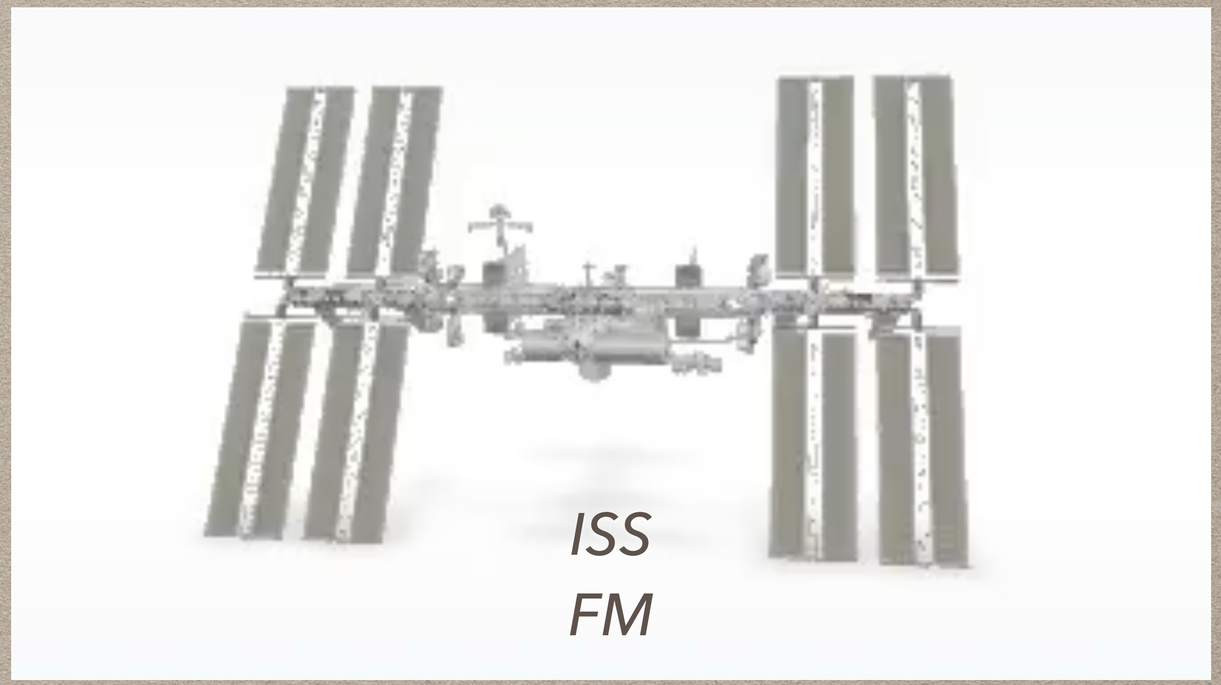
*When I told my 8yr old grandson I was talking to a satellite, he told me "**that's not possible. Satellites don't talk, you communicate using the satellite**" jeez, who's got the Extra class license here?*

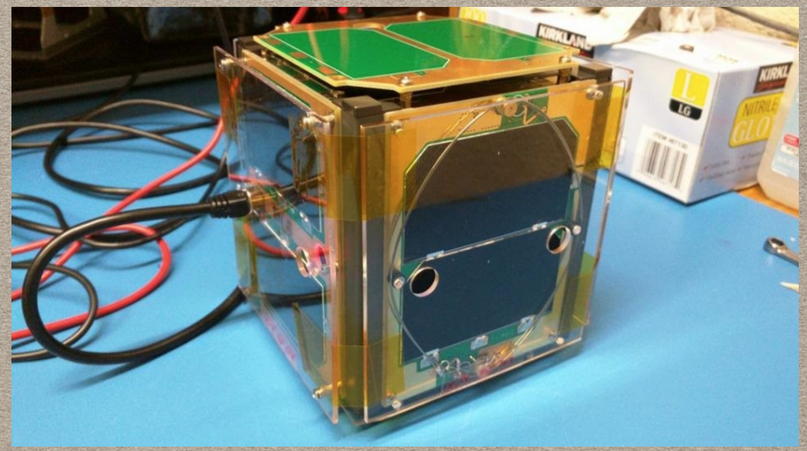
FM VS LINEAR

Unlike the single-channel FM satellites, linear birds use SSB and CW. They also utilize a transponder, which provides anywhere from 20-50 KHz of bandwidth to use. This means multiple people can make contacts through a linear satellite simultaneously.

It's just like tuning across an HF band.







QUESTION: Which of the following types of signals can be relayed through a linear transponder? (E2A07)
ANSWER: All these choices are correct

- **FM and CW**
- **SSB and SSTV**
- **PSK and Packet**

Some amateur satellites operate in the microwave bands, including the L band (23 cm) and S band (13 cm)

QUESTION: What do the terms L band and S band specify regarding satellite communications? (E2A09)
ANSWER: The 23 centimeter and 13 centimeter bands

EQUIPMENT

- VHF/UHF Transceiver
- Full Duplex / Dual Watch / Dual Radios
- You must be able to hear yourself on one frequency while transmitting on another - Uplink & Downlink
- Dual handhelds will work - set one for transmit and the other for receive

Alinco DR-735T VHF/UHF Full Duplex Radio

Kenwood TH-72a Full Duplex

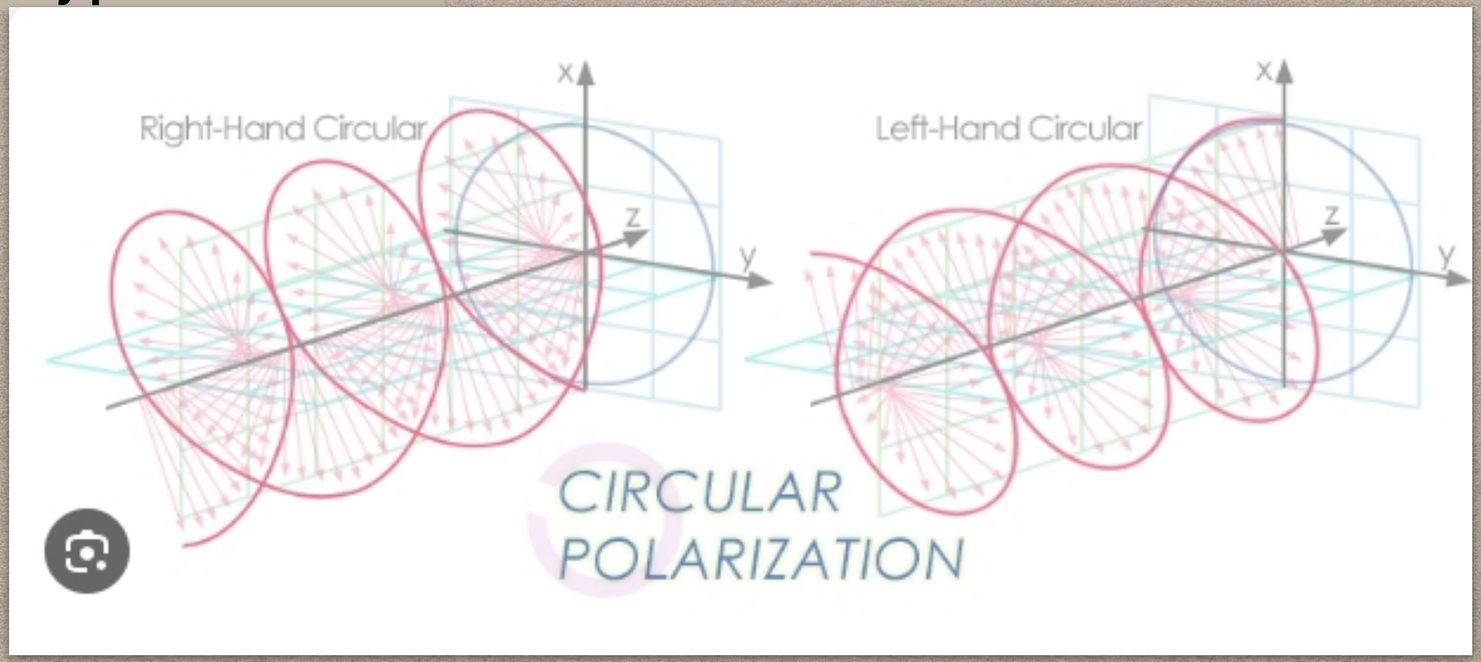
Icom 9700 Full Duplex

Baofeng UV-5R

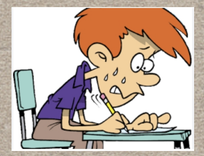
Antenna Polarization

There are quite a few interesting phenomena that result from the fact that satellites rotate while they are orbiting. For example, an amateur satellite may exhibit a rapidly repeating fading effect as the satellite's antenna rotates away from the receiving station and then towards the receiving station. This is called spin fading or spin modulation. The polarization of radio waves from a satellite also changes as it passes into the magnetic field of the Earth. This is called Faraday rotation. To minimize the effects of these two phenomena, most satellites use a circularly polarized antenna.

QUESTION: What type of antenna can be used to minimize the effects of spin modulation and Faraday rotation? (E2A11)
ANSWER: A circularly polarized antenna



Extra Exam Questions



QUESTION: What type of antenna can be used to minimize the effects of spin modulation and Faraday rotation? (E2A11)
ANSWER: **A circularly polarized antenna**

QUESTION: Which of the following techniques is normally used by low Earth orbiting digital satellites to relay messages around the world? (E2A13)
ANSWER: **Store-and-forward**

QUESTION: What is the purpose of digital store-and-forward functions on an amateur radio satellite? (E2A12)
ANSWER: **To store digital messages in the satellite for later download by other stations**

QUESTION: Which of the following types of signals can be relayed through a linear transponder? (E2A07)
ANSWER: **All these choices are correct**

- FM and CW
- SSB and SSTV
- PSK and Packet

QUESTION: Why should effective radiated power to a satellite that uses a linear transponder be limited? (E2A08)
ANSWER: **To avoid reducing the downlink power to all other users**

QUESTION: Which of the following occurs when a satellite is using an inverting linear transponder? (E2A02)
ANSWER: **All these choices are correct**

- Doppler shift is reduced because the uplink and downlink shifts are in opposite directions
- Signal position in the band is reversed
- Upper sideband on the uplink becomes lower sideband on the downlink, and vice versa

QUESTION: How is the signal inverted by an inverting linear transponder? (E2A03)
ANSWER: **The signal is passed through a mixer and the difference rather than the sum is transmitted**

It only requires a Technicians license to operate the Birds!

QUESTION: What is meant by the term mode? as applied to an amateur radio satellite? (E2A04)
ANSWER: **The satellite's uplink and downlink frequency bands**

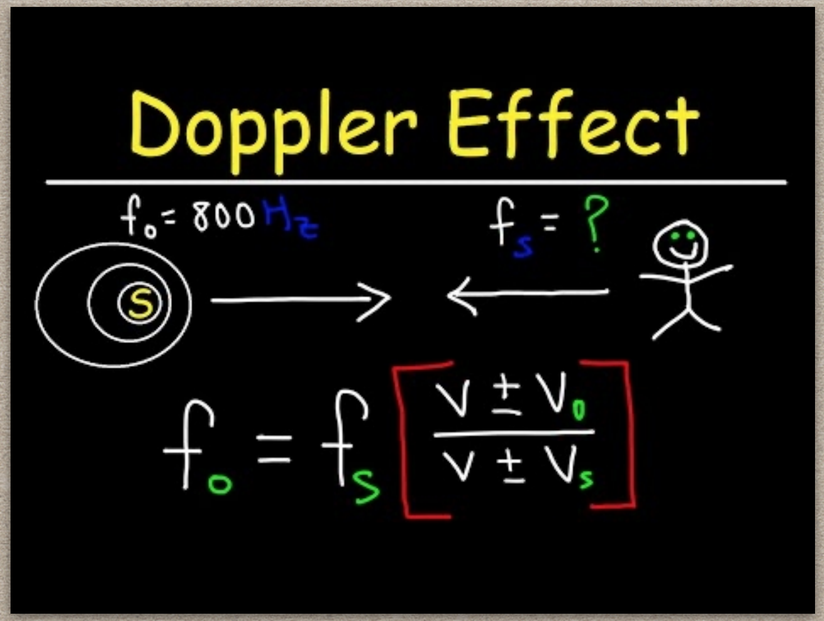
QUESTION: What do the letters in a satellite's mode designator specify? (E2A05)
ANSWER: **The uplink and downlink frequency ranges**

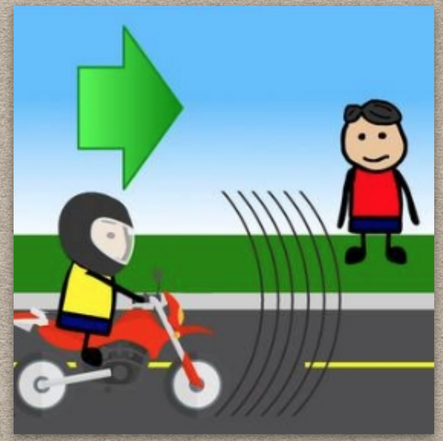
QUESTION: What do the terms L band and S band specify regarding satellite communications? (E2A09)
ANSWER: **The 23 centimeter and 13 centimeter bands**

QUESTION: What is the direction of an ascending pass for an amateur satellite? (E2A01)
ANSWER: **From south to north**

QUESTION: What type of satellite appears to stay in one position in the sky? (E2A10)
ANSWER: **Geostationary**

QUESTION: What are Keplerian elements? (E2A06)
ANSWER: **Parameters that define the orbit of a satellite**





This Doppler shift will cause the ISS transmit frequency of 145.800 MHz to look as if it is 3.5 kHz higher in frequency, 145.8035, when ISS is approaching your location. During the 10 minute pass the frequency will move lower shifting a total of 7 kHz down to 145.7965 as the ISS goes out of range.

The ISS cross band repeater:
145.990 MHz up PL 67
437.800 MHz down

EQUIPMENT

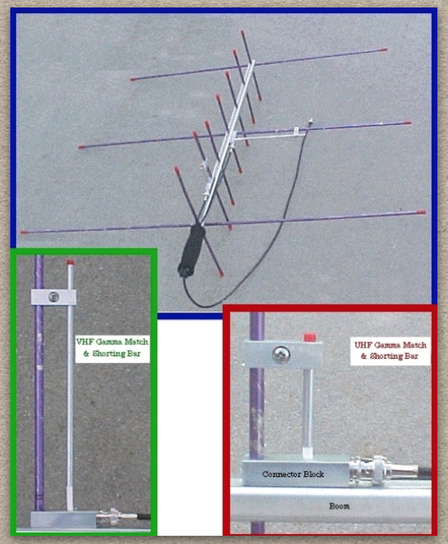
ANTENNA, OF COURSE

THE ROOF ANTENNA YOU USE AT HOME MAY BE ENOUGH TO LISTEN OR CONTACT THE ISS DIGIPEATER AS IT PASSES.

TUNE TO 437.800MHZ FOR RX

SQUELCH OPEN IS BEST.

PASSES ARE SHORT AROUND 10MINS. JUST KEEP LISTENING. YOU SHOULD HEAR STATIONS EXCHANGING GRID SQUARES.



Arrow Antenna VHF/UHF Yagi

Low Earth Orbit (LEO)
Tuned VHF/UHF RHCP system
by M2 (M Squared)

Elk Log Periodic

EQUIPMENT

NOT ABSOLUTELY NECESSARY
BUT WILL SURE MAKE IT EASIER

- Headphones - If you don’t, you’ll wish you did!
- Hand microphone for your TX radio
- Optional Voice Recorder. Will you be able to remember the callsigns you worked?

- (it is difficult to talk, point the antenna, do PTT operation, remember the callsign, and think - all at the same time)

Many of these guidelines are based around two simple "Golden Rules" of satellite operating: Don't transmit if you can't hear the satellite, and operate using full-duplex capabilities if at all possible, meaning you can transmit and receive at the same time. Some radios offer full-duplex capabilities, or you can use two separate radios to achieve this.

- **1) Share the Pass**
  FM satellites are just like a repeater: only one person may transmit at a time. Since a satellite is overhead for 15 minutes at most, each operator will want to make some contacts. Please don't monopolize a pass; let your other ham colleagues have some time on the pass as well. It takes a lot of self-discipline, but sometimes the best engagement is to make one single QSO and sit back to listen for the remainder of the pass.

- **2) Let Other QSOs Finish**
  Please let other stations complete their QSO before you call another station. It's very frustrating when you are calling a station to complete a QSO and another station starts a call before your QSO is completed. Calling someone who has just called another station is considered rude. It's the equivalent of being interrupted; nobody likes being interrupted. If you hear a QSO in progress, please let that QSO finish before you make your own call.

- **3) Minimize Repeat QSOs**
  There are often times where you will hear stations on a pass that you have already worked several times. If a pass has other callers, please refrain from calling a station you have already made contact with numerous times. If you think about it, there are only so many QSOs that can be made during a given pass. Each QSO that is made between two station that have already contacted each other prevents another QSO from happening, one that might be a new grid square or state for another station, or a station's first QSO.

- **4) Don't Call CQ**
  Please don't call "CQ Satellite" on an FM satellite. It's the same as calling CQ on a repeater; you just don't do it. Generally, it's better to pick out a station and call them directly. However If you want to announce your presence an FM satellite pass during a pass with low activity, simply give your call and grid (example: "W1ABC FN32"). If you have given your callsign several times and are not getting calls, there may be a problem with your station. Take a break and examine your station before transmitting again.

- **5) Use Phonetics**
  It can be very difficult during a busy pass to hear and understand a callsign correctly. Using standard phonetics will make initial copy of your callsign much easier, which reduces the need for repeated transmissions. This makes each QSO shorter, which make more of the pass available for others. It is not a race. There is no need to give your callsign quickly.

- **6) Rare/Portable Stations Take Priority**
  It is common for satellite operators to take their equipment with them to portable locations, to transmit from rare grid squares or other DX countries. Courtesy should be extended to these stations; they are providing a rare location to all satellite operators and will be at that location for a limited time. If you hear a station from a rare grid or DXCC entity, use good judgement before calling stations in more common grids. If the rarer station is working a lot of people on a pass, it may be best to let that station work as many people as possible. There will always be another pass to work more common stations.

- **7) Use Only the Minimum Power Required**
  Generally, 5 watts from an HT and a directional antenna is plenty of power to work an FM satellite from horizon to horizon.

- **8) Work the New Stations**
  Satellites are for everybody, and the satellite community LOVES hearing new calls on the FM birds. Regular satellite operators should pay close attention during a pass; if you hear a callsign that's new to you, take the time to call them. You may be that station's first satellite QSO; what an honor!

<u>Note:</u> Being able to hear a callsign and repeat it back correctly (parroting) is an acquired skill. It takes practice. Even though it's not a race, working the FM birds, the exchanges can be very quick. Exchanging callsigns and gridsquares quickly and accurately will make for an accurate contact.

SOFTWARE

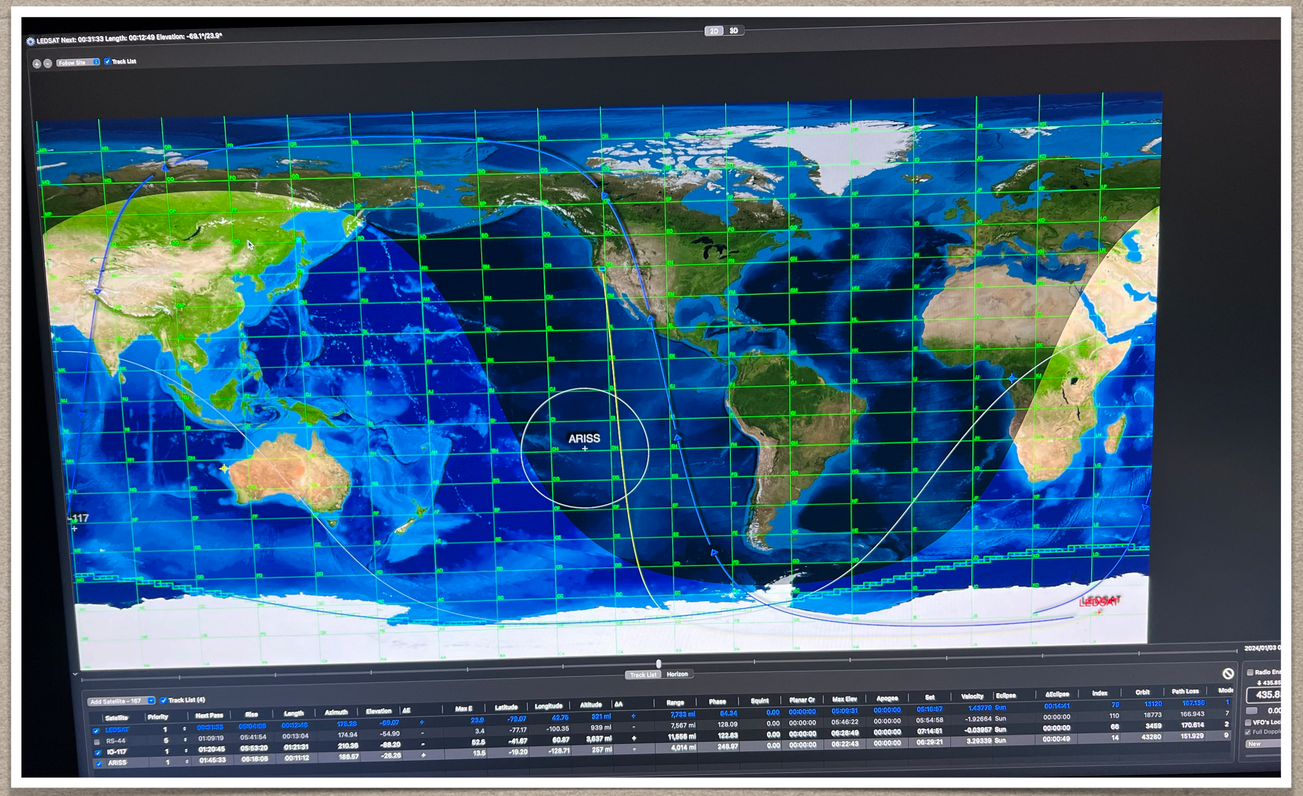
PHONE APPS

*HEAVENS ABOVE

*SPOT THE STATION - NASA

*ISS DETECTOR

*GOSATWATCH



Path Predictions. These apps will alert you to when one of the “birds” is approaching AOS.
(Aquistion of Signal) and usually a ton of other information

Satellite Tracking and Radio Control

These softwares control the rotor Az and El as well as control the radio frequency to compensate for the Doppler effect as the satellite approaches and recedes

* *MacDoppler*
* *SatPC32*
* *S.A.T. self contained antenna tracker by CSN technologies*

GREENCUBE
IO-117 MEO

At 1,243 miles to 22,236 miles above earth, satellites in MEO require significantly less momentum to stay on course compared to their counterparts in LEO. Traveling at approximately 7,000 mph, satellites in MEO circle the globe once every 12 hours, or roughly twice per day. LEO, by comparison, requires satellite speeds of up to 17,500 mph to resist Earth's gravity and stay in orbit.

GreenCube
Microgreens cultivation in a CubeSat

The Amateur Radio satellite community is fortunate to have a relatively new Medium Earth Orbit (MEO) satellite.

Operating with Greencube – What's Required

Greencube requires the following for successful contacts via its digipeater:

A directional antenna with at least 12 dBi gain

A 70cm SSB/FM capable Transceiver with a soundcard interface and at least 25 watts of output at the antenna

Software to control the Transceiver to correct for Doppler shift and provide antenna tracking control or pointing information

A computer running modem software and a Greencube Client Program

A low-noise preamp at the antenna is recommended

"ALPHA INDIA 6 MIKE CHARLIE, CHARLIE MIKE 99"

EARTH STATION AI6MC CM99

*ICOM 9700 VHF/UHF/23CM USING A LEO BODNAR INJECTION BOARD IMPROVED BY SYNCHRONISING THE INTERNAL MASTER CRYSTAL OSCILLATOR WITH AN EXTERNAL GPS DISCIPLINED ONE.

*YAESU GS5500 ROTOR AND CONTROLLER

*CSN TECHNOLOGIES S.A.T CONTROLLER

*HEIL PRO 7 HEADSET FOR ICOM RADIOS

*PANASONIC TOUGH BOOK W/WINDOWS 10

M2 LEO Pack
VHF/UHF antenna's with RHCP
& SSB Preamplifier for 430-440Mhz

GETTING STARTED

AMSAT.ORG

AND WATCH A GAZILLION YOUTUBE VIDEOS

2 Beofang HT's and Arrow Handheld Antenna